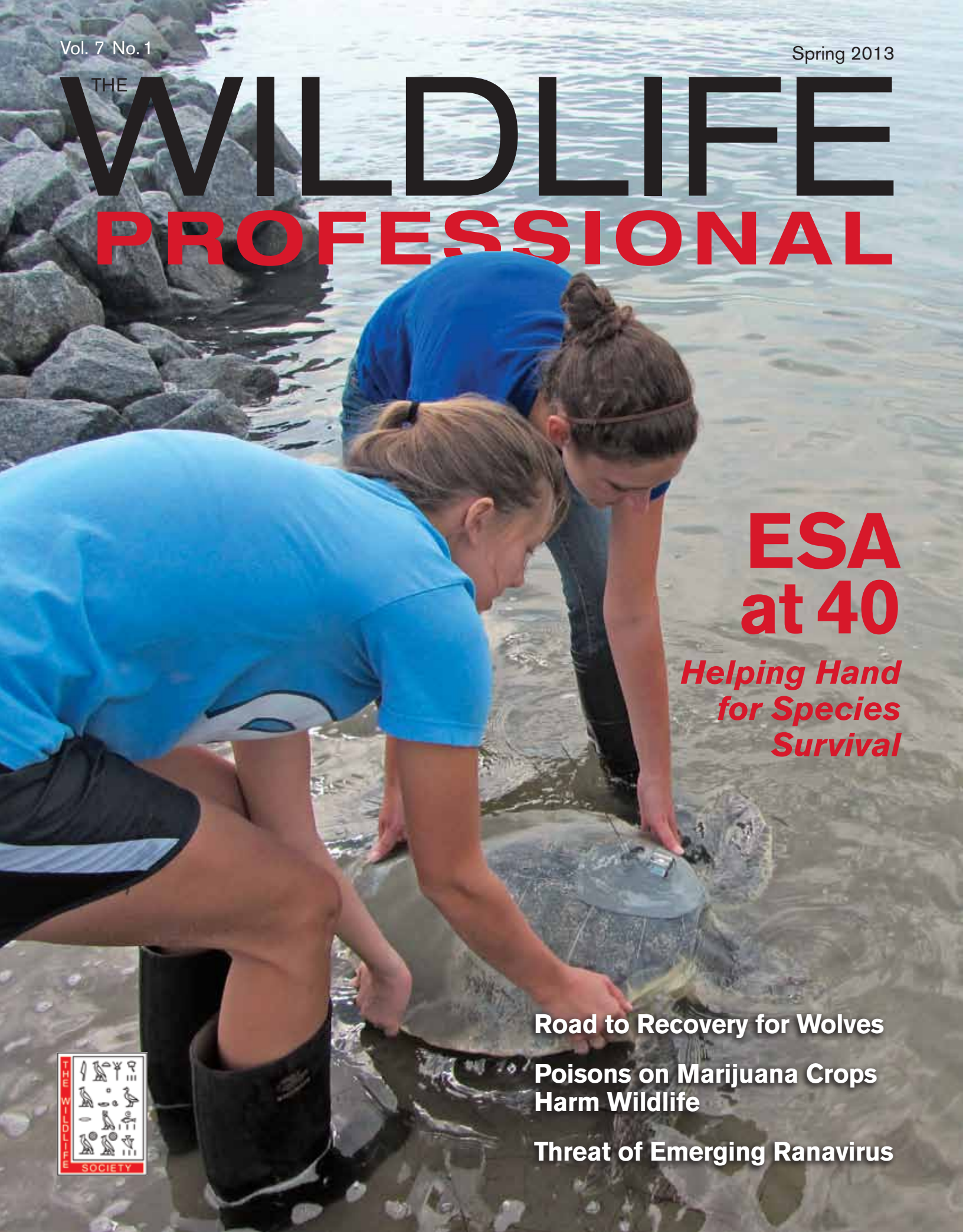
Vol. 7 No. 1

Spring 2013

THE WILDLIFE PROFESSIONAL



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THE WILDLIFE PROFESSIONAL

Spring 2013 Vol. 7 No. 1

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COVER: At North Carolina's Harkers Island, assistant researchers Dana Welker (at left) and Ainsley Smith release an endangered Kemp's ridley sea turtle fitted with a satellite transmitter for tracking by the Beaufort Lab, part of NOAA's Southeast Fisheries Science Center.

Credit: Joanne McNeill/NOAA

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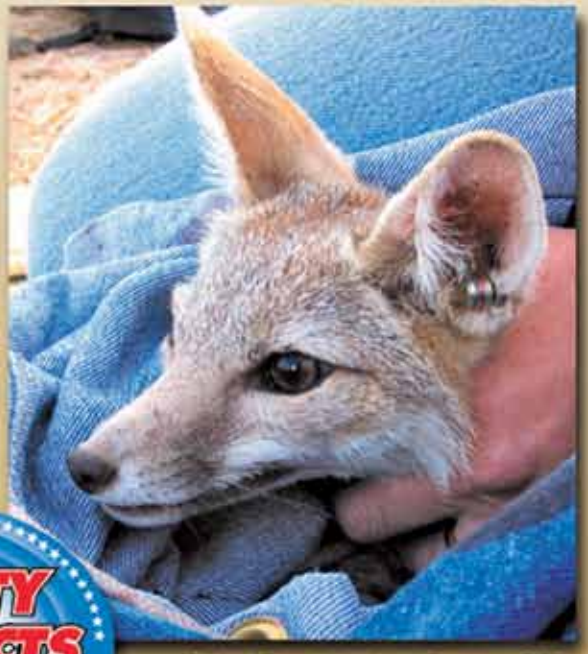

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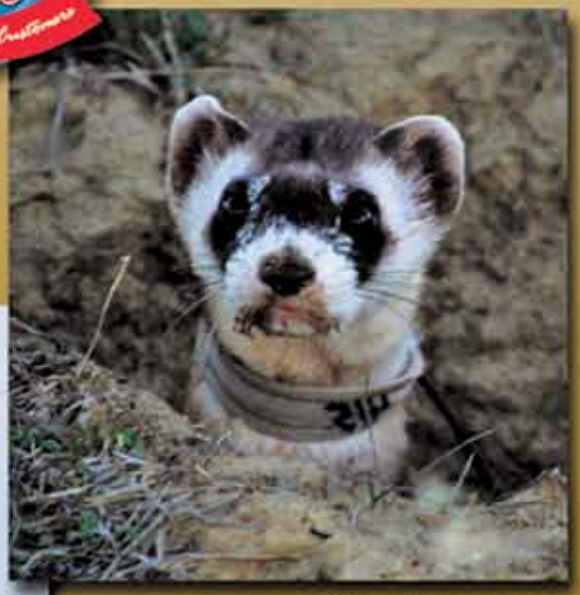

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A Glimpse of What's Possible

REFLECTING ON THE ESA: A VITAL TOOL IN IMPERFECT HANDS

By Dan Ashe

Credit: Tami Heilemann/DOI

Dan Ashe is Director of the U.S. Fish and Wildlife Service.

From the turbulent 1960s sprang a generation of laws restraining conquest of our nation's natural resources. Those laws included the 1973 Endangered Species Act. Now 40 years old, the ESA has endured, matured, and secured hundreds of species from extinction. Its enactment was like John Lennon's retrospection on the 1960s: "It wasn't the answer. It just gave us a glimpse of the possibility."

Since 1973—and thanks in part to the ESA—we have learned it is possible to have vibrant real estate markets in California and Florida, and still have viable populations of California gnatcatchers and Florida panthers. It is possible to harvest timber in old-growth forests, and still have habitat for marbled murrelet and migrating salmon. It is possible to deliver reliable water to Los Angeles and Phoenix, and recover smelt and chub in the Sacramento and Colorado Rivers. It is possible to produce energy from the Permian Basin, and have permanent protection for the dunes sagebrush lizard. It is possible to hear the elk's bugle and the wolf's howl as a symphony for which Aldo Leopold's mountain would rejoice, and not as a harbinger of hatred between hunter and hiker that many portray. Inherent, however, in each of these is a spirit of compromise and restraint.

We cannot have all the development, all the timber, all the water, all the energy, or all the game that people may desire. And we cannot ensure that all species will persist in all their historical abundance, geography, and diversity. As humans continue to expand in numbers (reaching at least nine billion by 2050) and affluence, we will occupy more of the planet's ecological space and consume more of its resources, leaving less for the rest of biodiversity. We can wish it weren't so, but it is that simple.

We choose to hide such inconvenient truths behind convenient slogans like "win-win." And when the fallacy of win-win ecology is revealed, we like to blame something other than our own greed and ambition. Some blame a law they call inflexible, unworkable, and unreasonable—the ESA as perfect scapegoat. But as you read some of the reflections in this fine publication—the product of one of our legacy professional societies—ask yourself if the shortcomings cited are in the ESA or in us.

We face many challenges in conserving biodiversity. My top ten: A changing climate, habitat loss, habitat fragmentation, species invasion, wildlife trade, disease, water scarcity, pollution, over harvest, and human indifference. The ESA is not a challenge. It is a gift to the entire professional wildlife conservation community—an expression of our nation's desire to conserve biodiversity. It is our possibility. We have seen it succeed, and we have seen it fail. It succeeds or fails based upon our strength or weakness, our ability or inability. We are the limiting factor. It's easy and convenient to blame the tool, and for sure we can improve it. But we need to be better craftsmen. We all have to be better. Better biologists. Better managers. Better diplomats. Better negotiators. Better partners. And yes, better directors.

We are getting there. I see it in the promising work to conserve the greater sage-grouse, a candidate for ESA listing. State and federal agencies are aligned, and a legion of NGO and industry partners is organizing. The possibility of a landscape-wide conservation effort—on a scale unseen since the 1986 launch of the North American Waterfowl Management Plan—is emerging. The ESA will work to help conserve the grouse if we are up to the challenge, and if we are capable craftsmen. We will also improve the law's implementation by sharpening and adjusting the tool. FWS and NOAA have published an Advanced Notice of Proposed Rulemaking to solicit ideas.

Out of the turmoil of the 1960s came arguably the most powerful and consequential of all environmental laws. It has worked miracles, like helping the manatee to recover amidst a sea of motorboats and restoring the California condor to western skies. The ESA is not *the* answer, but it gives us a glimpse of what is possible, and a spirit of optimism for what we can accomplish if we well execute that most human of qualities: judgment. ■

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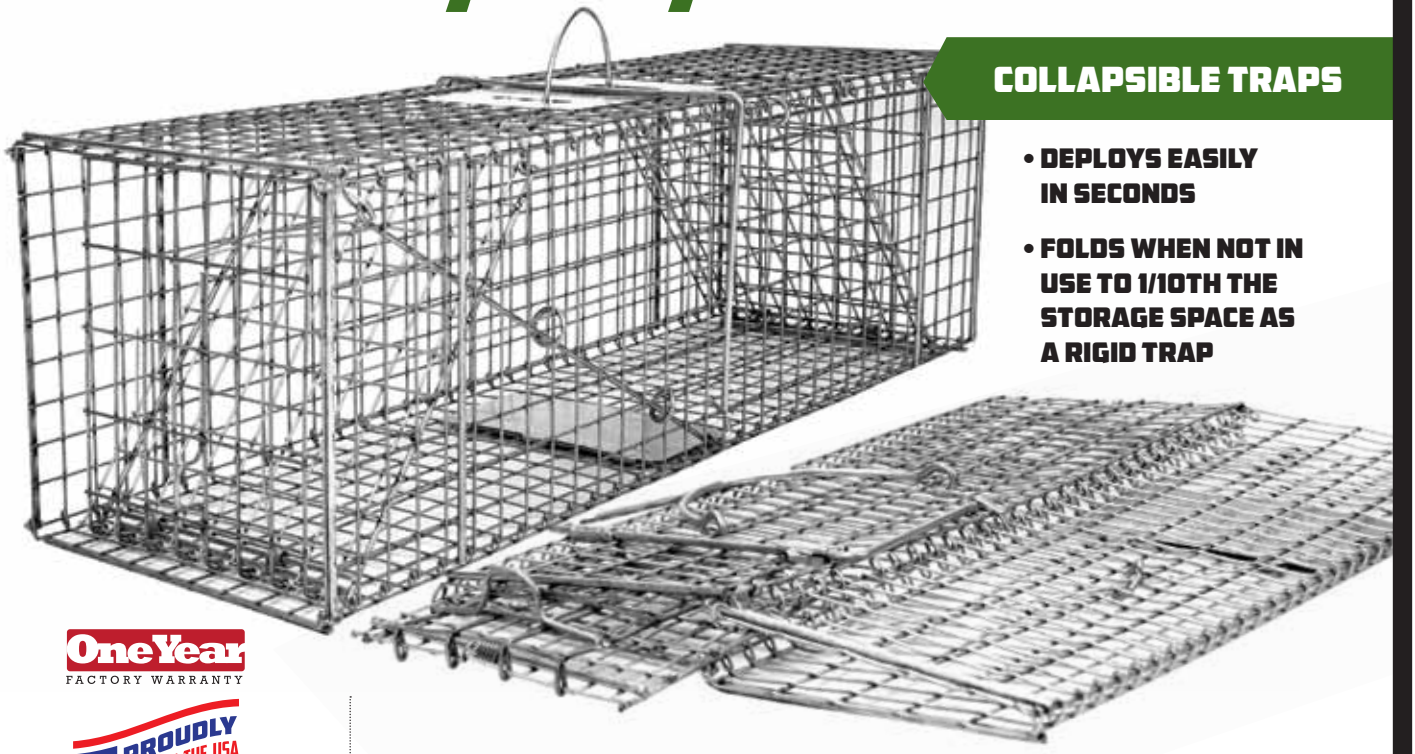

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Vol. 6 No. 4
Winter 2012

Deer-Breeding Battle

I just finished reading "A Growing Threat: How Deer Breeding Could Put Public Trust Wildlife at Risk" (winter 2012). It's very well done, and this message can't be repeated or expanded on often enough, given the potential consequences of CWD for the public's wild cervid populations. However, game farming is but one of the wildlife management/husbandry practices that increases the risks of disease transmission among North America's wildlife. My recent book (*Where Elk Roam*) examines another long-standing practice that jeopardizes wildlife: the winter feeding of elk, which is wholly due to the actions of federal and state agencies entrusted with managing and conserving the public's resources.

Any wildlife management practices that seek to artificially populate or sustain wild animals engender their own liabilities for population sustainability—something Aldo Leopold admonished decades ago. Beyond the obvious threats of CWD, bovine TB, or other epizootic pathogens to elk and other cervids jam-packed on feed grounds, the long-standing infection of Wyoming feed-ground elk with bovine brucellosis has led to fed elk being vaccinated, tested, and slaughtered—traditional livestock management practices. Yet the disease persists, and at considerable cost in sportsmen dollars spent to "do something" about it. I simply want to underscore that our own profession is not guiltless in exacerbating conditions that promote wildlife disease.

Bruce Smith
Sheridan, Montana

The winter 2012 issue includes an extremely informative article describing the problems associated with commercialization of wildlife. Every wildlife biologist in North America should read this article—then read it again. The only thing missing is a description of how bad it can get, and how much effort and money it takes to reverse the growth of commercial deer breeding, a totally detrimental field of wildlife exploitation. I know first-hand how bad it can get, as I've written a history of Citizen Initiative I-143, which involved a ten-year fight to shut down pen shooting of "trophy elk" in Montana. Every step of the effort was ugly and expensive. Trust me: it's far easier to fight commercialization *before* it happens.

L. Jack Lyon
Missoula, Montana

Editor's note:
To read the author's full account of I-143 in Montana, go to news.wildlife.org/twp.

Rebranding an Old Paradigm?

It seems that Bond et al. (*TWP* winter 2012) simply rebrand as "new" what wildlife biologists and forest managers have known for a long time: wildfire creates vital snag and early-seral habitats important for a number of species. Bond et al. present some impressive research they and others have done to document fire and wildlife-habitat relationships. I am uneasy, however, with their vague assertion that fire is good for spotted owls as long as "some" nesting and roosting habitat remains. Imprecise language about habitat thresholds and extrapolation of results across the species' large and ecologically varied range only fuels controversy over this iconic and threatened old-forest species.

Their statements to support their new paradigm—that forest fire management strives to alter natural fire regimes and that current fire regimes are natural—appear to be incorrect. According the National Cohesive Wildland Fire Management Strategy, fire management goals on public land are: (1) to restore and maintain landscapes that are resilient to fire-related disturbances, and (2) to ensure that human populations and infrastructure can withstand a wildfire without loss of life and property. The concept of managing for resilience is based on *restoration* of natural or sustainable fire regimes (Noss et al. 2006). Since we are fairly knowledgeable about the nature of most of these fire regimes (e.g., Agee 1993) I am unsure what Bond et al. mean about a growing controversy over fire management. There is an impressive body of literature that documents current forest pattern, fire, and other disturbance regimes as being historically unnatural in frequency, extent, and severity for many forest types (e.g. Hessburg and Agee 2003). In that context of changed forest pattern and process and historical loss of old forests to logging, a blanket recommendation to let wildfires burn in wildland areas is not "natural" and is a simplistic management response to a complex ecological and social question (Noss et al. 2006).

I applaud the authors for reminding wildlife professionals of the importance of wildfire to wildlife. It behooves them, however, to better characterize the complexities of the ecological and management issues when recommending simple one-size-fits-all management solutions.

John F. Lehmkuhl, Emeritus Scientist
USFS Pacific Northwest Research Station
Wenatchee, Washington

Graduate Education

In a recent article in *The Wildlife Professional* (winter 2012), Scott Henke aptly summarizes the continued relevance of wildlife graduate programs. In my years of experience working for several state wildlife agencies, I have also served as an adjunct at several universities and worked with graduate students and their faculty advisors, which I have found to be a personally rewarding experience. Having an agency biologist work with a graduate student greatly enhances the student's perspective of his/her work. Professionals also can enhance their knowledge of research processes by working with faculty researchers.

There was a time when many wildlife faculty members were seasoned professionals that completed doctoral studies and moved into the academic field. Specialization and a host of other factors have moved the profession away from that model, yet I have found that students hunger for contact with professional wildlife biologists. One of the most enriching ways professionals can interact with students is to come into the classroom and supplement standard lecture material with relevant management experience.

Because management is supposed to be science based, I also believe that research is an essential part of graduate training. Many agencies have gotten away from conducting in-house research, but agency managers and biologists must still read and interpret research results in order to advance their programs. They must therefore acquire critical thinking skills [so they can decide] which research studies to apply. Direct research experience is the best way to understand how research is conducted so that studies can be properly evaluated.

Roger D. Applegate
Tennessee Wildlife Resources Agency
Nashville, Tennessee

Ethics of Photography

Your article on the ethics of wildlife photography (winter 2012) raises interesting questions that need discussing. Ethics is not always a matter of right and wrong. It is the choice one makes between or among often equally defensible behaviors that may contradict each other and which may have negative as well as positive attributes.

I have overheard conversations by photographers about submitting images taken of captive animals. The photographer may indicate that the animals are captive, but the publication may not include that in a caption. That is not the photographer's fault. In addition, photographers may not be paid for photos with stray distracting branches, inadvertent blotches of light, or other flaws that the magazine's readers might find less than perfect. Magazines, after all, are in the business of selling magazines. Some extra processing beyond setting black and white points … may be necessary for consideration of use.

My husband and I do photograph wildlife in the hopes that our images contribute to societal empathy to protect or at least acknowledge wildlife's importance in the whole world ecosystem. Without this awareness, the often reclusive wildlife have little or no protection in the world as human populations grow. Out of sight, out of mind.

Linda Scarth
Cedar Rapids, Iowa

Omission from Our History

Congratulations to you and all the people who made Volume 6 No. 3 fall 2012 an excellent history of TWS during the past 75 years, and for including the DVD "Opportunity for All: The Story of the North American Model for Wildlife Conservation." It was sad, however, to read about this 75-year history and watch the DVD without seeing any mention of the role that pioneers in trapping and fur management in the U.S. and Canada played in setting the stage for today's principles of wildlife management. I encourage TWS to consider a supplement to the publication and DVD that recognizes the role of trapping and furbearer management during our 75-year history. Sources of information include the North American Fur Auctions/Hudson Bay Company (1670-2012), the National Trappers Association, and the International Association of Fish and Wildlife Agencies.

Charles T. Cushwa
Lynchburg, Virginia

Vol. 6 No. 3
Fall 2012

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States Rise to the Challenge

REFLECTIONS ON THE ESA AT 40

By Ronald J. Regan

Courtesy of Ronald J. Regan

Ronald J. Regan is Executive Director of the Association of Fish and Wildlife Agencies.

As a wildlife biologist, hunter, angler, and dad, I feel that any reflection on the 40th anniversary of the Endangered Species Act (ESA) needs to begin by acknowledging the importance of "keeping all the parts," as Aldo Leopold encouraged against the backdrop of a world war. With equal vigor, we should remember the words penned by Theodore Roosevelt in 1915, as cited by TR biographer Edmund Morris (2011):

The extermination of the passenger pigeon meant that mankind was just so much poorer; exactly as in the case of the destruction of the cathedral of Rheims. And to lose the chance to see frigatebirds soaring in circles above the storm, or a file of pelicans winging their way homeward across the crimson afterglow of the sunset; or a myriad of terns flashing in the bright light of midday as they hover in a shifting maze above the beach—why, the loss is like the loss of a gallery of the masterpieces of the artists of old time.

At a professional level, how can we *not* celebrate a federal act that strives to maintain our fish and wildlife heritage? Yet, after 40 years, many state agency leaders and managers note with a practiced eye of experience that endangered species conservation involves difficult jurisdictional challenges, especially when one considers that the responsibility for fish and wildlife management in the United States is heavily vested in state authority.

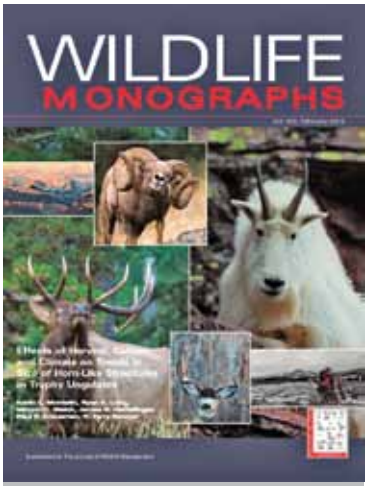
A 2011 multiple-district listing settlement agreement between the U. S. Fish and Wildlife Service (FWS) and plaintiffs—sweeping in hundreds of species for formal listing consideration—at best creates huge capacity and coordination issues for state agencies and at worst exacerbates erosion of the historical jurisdictional underpinnings for conservation. Indeed, a litigation-driven approach to endangered species conservation at the federal level has led to management paralysis and stateside exasperation, and has prompted species-specific intervention by Congress upon occasion, as was the case with wolves in the northern Rockies (see article on page 32).

Taking a more proactive approach, state and federal agency leaders in 2010 created an ESA Joint Task Force to identify, prioritize, and seek consensus agreement on particular policy gaps and implementation plans designed to promote better collaboration between the FWS, the National Marine Fisheries Service, and state fish and wildlife agencies (see article on page 26).

Such collaborations give reason for hope. In 2005, for example, all state fish and wildlife agencies developed State Wildlife Action Plans that offer a science-based opportunity to inventory, monitor, and manage more than 12,000 species of greatest conservation need. These proactive plans have helped to preempt the need for some listings, as was the case when the Florida Fish and Wildlife Conservation Commission and its partners used State Wildlife Grant dollars to conduct surveys on population status and habitat of the gopher frog. As a result, 83 previously unknown breeding ponds were identified, which led to a decision *not* to state-list the species and helped prevent petitioning for federal listing range-wide.

Beyond the power of interstate collaboration, I'm amazed at the power of state-federal collaboration when I see the extent of shared energy, vision, resources, and management priorities on a range-wide scale, as is being directed at sage-grouse conservation, potentially obviating a federal listing decision in 2015.

The conservation of endangered species is not an easy task. It is replete with permitting, incidental take, low capacity, and coordination challenges across the jurisdictional spectrum. I know this from my experience in Vermont as a state fish and wildlife agency director. Having spent time with colleagues in Canada, I can attest that they have similar governmental coordination and capacity challenges with their federal Species at Risk legislation. Nonetheless, *keeping all the parts* demands the forthright attention of conservation leaders, and I know state fish and wildlife agencies have done and will continue to do their part unto that end. ■



Credit: TWS

Trophy Horn and Antler Size Declining

Horn and antler size of trophy ungulates harvested in North America has declined over the last century, according to a study in *Wildlife Monographs* (v.183). Kevin Monteith, currently of the University of Wyoming, and colleagues examined more than 22,000 horn and antler measurements recorded by the Boone and Crockett Club between 1900 and 2008. They report average declines of 1.87 percent in trophy antler size, and 0.68 percent in horns. The declines were small but statistically significant for 14 of the 25 categories of trophy species evaluated. The researchers found little evidence that this trend was due to habitat alteration, climate change-induced nutritional limitation, or trophy submissions being skewed toward small sizes. Instead, the results suggest that heavy harvest of males may have caused the male age structure to shift toward younger individuals with smaller antlers and horns. The authors encourage additional research to understand the effects of this shift, but meanwhile suggest that diverting some harvest away from males may help increase age structure and halt declines in horn and antler size of trophy males. In addition, however, they suggest that the recreational, conservation, and wildlife management benefits of hunting may outweigh potential consequences of the small reduction in trophy size.

Credit: Wiley-Blackwell

Mercury Alters Communities

Mercury—a potent neurotoxin—causes behavioral, physiological, and developmental changes in wildlife. In humans, mercury exposure can result in fewer male than female births. Now, a study in the *Journal of Avian Biology* (v.43/3) shows that mercury contamination also alters the offspring sex ratio of birds. Andrew Bouland and colleagues from the Institute for Integrative Bird Behavior Studies at the College of William and Mary counted the number of male and female offspring of three bird species over a one-to-two-year period near rivers contaminated by an industrial point source of mercury in Virginia and compared results to birds near uncontaminated rivers. All three species—the belted kingfisher (*Megaceryle alcyon*), tree swallow (*Tachycineta bicolor*), and eastern bluebird (*Sialia sialis*)—produced broods with 5 to 15 percent more females than expected at the mercury-contaminated sites, regardless of whether the birds fed on aquatic or terrestrial prey. Such an imbalance can lower the number of offspring produced by a population and result in lower genetic diversity. Mercury is becoming more common in the environment, primarily from coal-fired plants. The study results demonstrate that exposure to mercury below an acute lethal dose can negatively affect species in the long term.

Credit: Wiley

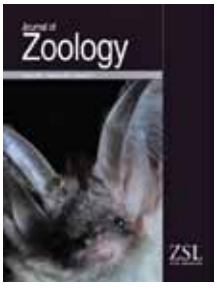
Recovering Interacting Species

Recovery targets for endangered species often ignore interactions between species. For species in a tightly linked predator-prey relationship—such as the northern sea otter (*Enhydra lutris kenyoni*) and the northern abalone (*Haliotis kamtschatkana*), both endangered—management plans that focus on only one species can sometimes risk the other's extinction. As reported in *Conservation Biology* (v.26/6), Iadine Chadès of CSIRO Ecosystem Sciences and colleagues developed a computer model to predict the outcome of proposed recovery strategies that address both sea otters and abalone at once. To make its predictions, the model incorporates the population dynamics of each species, their interactions, and how management decisions affect their abundance. For example, sea otter populations are recovering well, and abalone could be in danger of overpredation by sea otters. However, the model revealed that even if sea otter predation somehow ceased, the abalone populations would not rebound. Instead, the model identified poaching of abalone as that species' most significant threat, and calculated that populations would only grow if poaching were cut in half. Such models cannot guarantee that a management action will succeed, but can help managers make more informed decisions when complex species interactions are involved.

Credit: Blackwell Publishing, Ltd.

Pika and Climate Change

The collared pika (*Ochotona collaris*), found in Alaska and northwestern Canada, is one of only two pika species in North America, but is far less studied than its southern neighbor, the American pika (*O. princeps*). According to research published in the *Journal of Biogeography* (online 11/12/12), the collared pika is much less genetically diverse at both a species and population level than the American pika. There was also little evidence of gene flow between collared pika populations. To determine the species' genetic diversity, Hayley Lanier and Link Olson of the University of Alaska Museum collected tissue samples from collared pika throughout its range between 2005 and 2008. The International Union for the Conservation of Nature—an international organization that assesses the conservation status of species—does not currently classify the collared pika as an at-risk species, but its low genetic diversity and limited migration and range make it more vulnerable to climate change. And climate change within its Arctic and sub-Arctic range are projected to be more pronounced than in temperate climates.



Credit: Zoological Society of London

Shrinkage Saves Salamanders

For the first time, reversible body shrinkage was documented in salamanders after a period of drought. In 2008, a drought in Travis County, Texas, caused Jollyville Plateau salamanders (*Eurycea tonkawae*) to shrink, but according to a study in the *Journal of Zoology* (online 12/18/12), they grew again once spring rains returned. Nathan Bendik with the City of Austin and Andy Gluesenkamp of the Texas Parks and Wildlife Department measured salamander body length and tail width between 2008 and 2010. During the drought, body length decreased up to eight percent while tails narrowed by up to 23 percent, likely due to reduced food supplies and the use of energy stores within their bodies. After the drought, growth resumed. Decreasing body length is rarely detected in vertebrates and may be an adaptation to sustained environmental stress. Climate changes have the potential to increase environmental stressors, which could lead to longer periods of the shrink response, which has unknown consequences. Understanding such stress responses could give clues about overall population health.

Credit: PLoS One

Bird-Window Collisions

An estimated one billion birds die each year in the U.S. after striking building windows. However, a study in *PLoS One* (v.8/1) suggests this estimate may be over-stated since earlier research did not examine the building and landscape features that influence collisions, and assumed that mortality occurs at nearly the same rate at buildings regardless of size and the amount of surrounding green space. Stephen Hager of Augustana College and colleagues counted bird carcasses around 20 randomly selected buildings in an urban area in northwestern Illinois for one year. Bird deaths occurred most frequently in areas with low-density development and at buildings with a large number of windows, suggesting that window area and development density influence mortality rates. Knowledge of how mortality varies across the landscape would allow wildlife managers to prioritize conservation efforts in favor of collision hotspots instead of areas with few to no collisions.

Credit: Zoological Society of London

Impact of Farmed Mallards

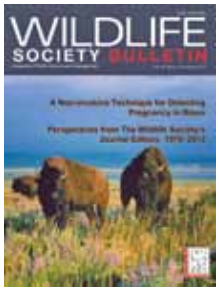
Each year in Europe, three million farm-raised mallards (*Anas platyrhynchos*) are released into the wild to restock populations for game hunters. This number has increased sharply since the 1970s, but the genetic impacts of these releases on wild populations have not been studied extensively. Recent research published in *Animal Conservation* (online 11/6/12) reveals that although captive-bred and wild populations remain genetically distinct, the populations often interbreed. Jocelyn Champagnon of the Office National de la Chasse et de la Faune Sauvage and colleagues compared the mitochondrial DNA and 14 microsatellites—molecular markers—of wild and farm-bred mallards in Camargue, France and discovered a distinct genetic difference between the populations. However, they also found that 23 percent of wild-caught birds are hybrids between wild and farm-bred birds. It is unclear why the high rate of hybridization has not led to the introduction of captive mallard genes into the wild population, but it nonetheless indicates the potential for such an effect. The researchers suggest that such massive releases of farm-bred mallards in the long term pose a genetic threat to wild populations.


Credit: Blackwell Publishing Ltd.

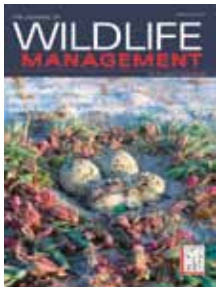
Tigers Require Corridors

Within the Indian subcontinent, Tiger Conservation Landscapes—landscape-based refuges—house 60 percent of the world's wild tigers. Habitat fragmentation and human population growth have reduced the genetic diversity of wild populations in unprotected areas. Sandeep Sharma of the Smithsonian Conservation Biology Institute and colleagues collected tiger feces to determine the genetic structure of the tiger population within one of these areas—the Satpura-Maikal landscape. They report in *Ecology and Evolution* (v.3/1) that the tigers in the region are genetically diverse and show a low level of population sub-division. The results indicate that the Satpura-Maikal landscape provides adequate forest corridors that allow tigers to mix with each other, ensuring genetic diversity and gene flow. The researchers suggest that the survival of tiger populations depends on maintaining forest corridors that connect breeding populations.

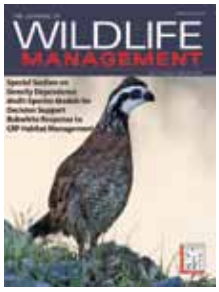
Articles from The Wildlife Society's Peer-Reviewed Journals



Credit: TWS



Credit: TWS



Credit: TWS

Reducing Elk-Human Interaction

Elk behavior in response to hunting pressure and human habitation is not well understood, but a study in the *Wildlife Society Bulletin* (v.36/4) suggests that elk change their movement patterns when threatened by human predation. Shawn Cleveland at the University of Montana and colleagues tracked nine GPS-collared female elk (*Cervus elaphus*) in a wildland-urban interface near Missoula, Montana from 2007 to 2009, including three hunting seasons. Elk movement rates slowed dramatically once the animals reached a distance of 750 meters away from housing areas, and at 1,500 meters, elk movement patterns indicated that they were establishing residences. The results suggest that elk are less threatened at those distances. In hunted areas, movement rates increased because elk associated housing areas with a predatory threat. The authors suggest that knowledge of elk behavior at different distances could be used to establish properly functioning migration corridors near urban areas, and that hunting pressures could be used to influence elk movements, decreasing habituation and human-wildlife conflicts.

Replacement Wetlands

Agricultural expansion in western Canada has reduced wetlands and consequently bird species that require such habitat. In *The Journal of Wildlife Management* (v.76/8), Eva Kuczynski and colleagues at the University of Alberta and Environment Canada demonstrate that artificially-constructed wetlands can mitigate some of this loss. In 2003 and 2007, the researchers surveyed 330 constructed ponds (borrow pits) in Alberta, Canada, for the presence of horned grebes (*Podiceps auritus*), a bird classified as a species of special concern by the Canadian Status of Endangered Wildlife in Canada. Horned grebes occupied 36 percent of the constructed wetlands. Of these, between 75 and 81 percent of the birds produced chicks. The grebes preferred larger ponds containing aquatic and riparian vegetation, but avoided ponds with beavers, human structures, and surrounding forest. More chicks were produced on ponds with riparian vegetation as well. Because the grebe requires aquatic habitat year-round to feed and nest, its use of the borrow pits indicated that the constructed wetlands were quality habitat and may also be suitable for other wetland-dependant species.

Water for Alligator Nests

More than 50 percent of wetlands in Florida have been altered in some way, but researchers do not know how these changes affect the American alligator (*Alligator mississippiensis*), a species that was once endangered and depends on wetlands for nesting. Cristina Ugarte of the University of Florida and colleagues report in *The Journal of Wildlife Management* (v.77/1) that different hydrological attributes affect alligator nest success. The researchers compared nest success with hydrological measurements collected from the Shark Slough, Everglades National Park, between 1985 and 2005. The measurements included annual average and peak water depth, time of peak water depth, and how quickly the depth changed over time. Nests were more numerous and successful during years with a greater average water depth and smaller depth fluctuations. Early annual peak discharge and a greater average discharge from impounded water sources correlated with more nest failures. The researchers recommend adjusting water management plans in order to achieve hydrological conditions that benefit alligators and other wetland species. ■

To submit comments or article suggestions for Science in Short, contact Jessica P. Johnson at jessica.johnson@wildlife.org.

North America

News and events affecting wildlife and wildlife professionals from across North America

Western

HAWAII–In December, researchers with the University of Hawaii Institute of Marine Biology and the U.S. Geological Survey's National Wildlife Health Center Honolulu Field Station reported a coral disease outbreak that's been killing corals on the north shore of the Hawaiian Island of Kauai. Scientists traced the outbreak to a cyanobacterial infection. Cyanobacteria are a type of algae that cause blooms in freshwater lakes and sometimes in the ocean, and while some species of cyanobacteria can be toxic to marine plants, animals, and even humans, this particular strain appears to be limited to corals. This is the first time that this kind of cyanobacterial infection outbreak in Hawaii has occurred on such a large scale, and researchers believe that climate change and land-based pollution could be responsible. Coral reefs provide habitat for approximately 25 percent of the world's marine species. *Source: U.S. Geological Survey*

CALIFORNIA–The California Fish and Game Commission has voted to consider listing the great white shark (*Carcharodon carcharias*) under the Endangered Species Act. The decision came as a result of a petition filed by three environmental groups–Oceania, Sea Stewards, and the Center for Biological Diversity–that called for protection of the species. Although the 3-0 vote in Sacramento resulted in an immediate state protection, the department will conduct a year-long status review to determine if the species warrants protection before making a final decision in 2014. Although targeting and selling great white sharks is banned, there are no limits on the number of incidental catches. Recent studies show that approximately 350 great whites remain in the waters off the Marin County coast and Baja California, Mexico. *Source: California Fish and Game Commission*

Southeastern

KENTUCKY–Officials recently discovered the presence of white-nose syndrome (WNS) in Kentucky's Mammoth Cave National Park. For the last three years, park officials had taken precautions, such as requiring visitors to disinfect their clothes and footwear, to keep the disease from entering the park. WNS was first discovered in a cave in upstate New York in 2006 and by now has already impacted 5.5 million bats across four Canadian provinces and 20 U.S. states (at press time, WNS had been detected in Illinois). Officials first detected WNS in Kentucky in 2011 and, until this recent discovery, the closest WNS-infected site was 50 miles away in Breckinridge County, Kentucky. Populations of the endangered Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), little brown bat (*Myotis lucifugus*), small-footed bat (*Myotis leibii*), tri-colored bat (*Perimyotis subflavis*), and big brown bat (*Eptesicus fuscus*) have all suffered significant declines as a result of the disease. Officials continue to monitor Kentucky's Long Cave, which has a larger bat population than Mammoth Cave. *Source: National Park Service*

FLORIDA–The U.S. Fish and Wildlife Service has released its "Final Integrated Pest Management Plan" for the Florida Keys

Credit: Toby Hudson/Wikimedia

A variety of corals thrive in the waters of Australia's Great Barrier Reef. On the other side of the world, corals in Hawaii aren't faring quite so well as a result of a coral disease outbreak that's been killing corals on the north shore of the Hawaiian Island of Kauai.

Credit: Terry Goss/Wikipedia

A great white shark swims in the waters off Mexico's Isla Guadalupe. The California Fish and Game Commission recently voted to consider listing the species under the Endangered Species Act in response to a petition filed by three environmental groups.

National Wildlife Refuges. The plan calls for the control and removal of exotic animals within National Key Deer Refuge, Crocodile Lake, and the Great White Heron and Key West refuges. The plan highlights the risk that feral cats in these refuges pose to native and vulnerable species such as the Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), the Key Largo woodrat (*Neotoma floridana smalli*), and white-crowned pigeons (*Patagioenas leucocephala*). Although the agency will not implement a large-scale trapping program, it will place a number of traps in various locations within the refuges. Cats that are captured will be taken to local animal shelters where experts will assess the health of the felines and decide their disposition according to county ordinances and standard protocol. *Source: U.S. Fish and Wildlife Service*

North Central

MICHIGAN–Michigan Governor Rick Snyder recently signed legislation that makes the gray wolf (*Canis lupus*) a game species in Michigan. The state's Natural Resources Commission (NRC)–charged with managing game in Michigan–has asked the Michigan Department of Natural Resources (DNR) to gather information to determine whether a wolf hunt will take place and if so, how the hunt would be structured in terms of harvest limits and manner of take, for example. The DNR is in the process of completing a new wolf population survey, planning public meetings, and consulting with native tribes on the issue. Based on its findings, the DNR will make a recommendation to the NRC, which will then make a final decision regarding a wolf hunt in the state. With an estimated population of 700 to 1,000 individuals, Michigan's gray wolves were removed from the endangered species list in 2012. *Source: Michigan Department of Natural Resources*

Southwest

ARIZONA–The Tucson Wildlife Center is expanding its current space for injured golden eagles and other birds of prey that are rehabilitated at the center before being released back into the wild. The center has joined forces with Tucson Electric Power to build two new enclosures for the birds–one is 15 feet wide and 80 feet long, while the other is 20 feet wide and 100 feet long. The enclosures will provide the birds of prey with more space to exercise their wings and recover before their release. The center currently has one enclosure and with two additional cages, it will be able to take in more injured birds. *Source: Tucson Wildlife Center*

Central Mountains and Plains

NORTH DAKOTA–North Dakota's Agriculture and Game and Fish departments have joined forces to create Coyote Catalog–an online database that allows coyote hunters and trappers to connect with landowners who want to reduce coyote numbers in their area. After signing up via the North Dakota Department of Agriculture's website, landowners will receive information on hunters who hope to hunt or trap coyotes in their counties, who they can then contact. Meanwhile, hunters and trappers can sign up for the program on the state Game and Fish Department website. The program is similar to the North Dakota Game and Fish department's deer program designed to match deer hunters with landowners. The Coyote Catalog will remain active until March 31 and resume next winter. *Source: North Dakota Game and Fish Department*

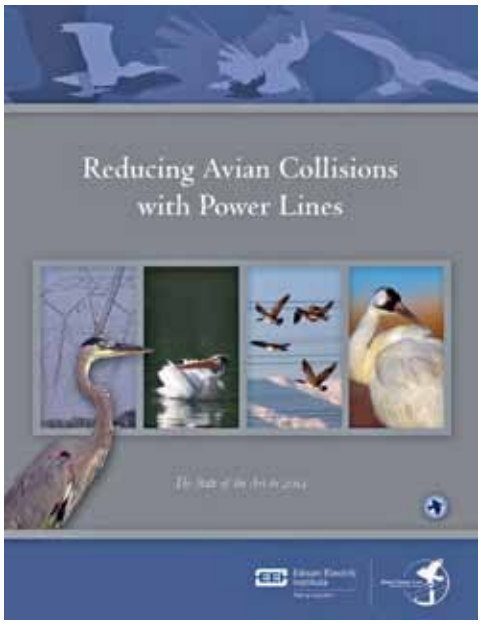
Canada

BRITISH COLUMBIA–In an effort to protect the endangered northern spotted owl (*Strix occidentalis caurina*), the British Columbia government plans to expand its measures to shoot barred owls (*Strix varia*)–a larger and more aggressive species that's been competing with the spotted owl for food and habitat. In the last five years, the provincial Forests, Lands and Natural Resource Operations Ministry has relocated 73 barred owls and authorized the shooting of 39. The government has only authorized shooting of barred owls that are found within a three-mile radius of recently occupied spotted owl habitat. Relocating barred owls was applied in areas that might serve as reintroduction sites for captive breeding programs for the endangered bird. The population of spotted owls in British Columbia has declined

from approximately 500 pairs over a century ago to roughly 10 individuals today, seven of which were found following the removal of barred owls. *Source: Government of British Columbia*

Northeast

MAINE–When it comes to handling dead animals, Maine health and wildlife officials are encouraging people to exercise extra caution. The advice comes on the heels of recent examinations conducted by the Department of Inland Fisheries and Wildlife and the University of Maine's Animal Health Lab that revealed the presence of lungworms in moose that were harvested during last year's moose hunt. People who come in contact with the infected animals could ingest the parasite's eggs and become infected. As a result, officials recommend the use of gloves when field dressing game animals as well as thoroughly cooking all wild game meat. *Source: Maine Department of Inland Fisheries and Wildlife*



Courtesy of the U.S. Fish and Wildlife Service

This guidebook–released late last year–provides measures that electric companies, wildlife agencies, and other stakeholders can implement to reduce bird collisions with power lines.

Northwest

WASHINGTON–The number of gray wolves in Washington appears to have nearly doubled in 2012, according to a recent survey released by the Washington Department of Fish and Wildlife. While the 2011 survey documented 27 wolves, five wolf packs, and three breeding pairs, this recent survey found 51 wolves, nine wolf packs, and five breeding pairs. The actual number of wolves in the state is expected to be closer to 100, including suspected but unconfirmed packs, lone wolves, and those that range into Washington but den elsewhere. Researchers attribute the increase to natural reproduction as well as migration from neighboring states and Canada. *Source: Washington Department of Fish and Wildlife*

General

When Ken Salazar announced in January that he was stepping down as Secretary of the Interior, he was near the end of his fourth eventful year as head of the nation's natural-resource agencies. Among his accomplishments, Salazar is noted for issuing a six-month drilling moratorium shortly after the Deepwater Horizon explosion that occurred in the Gulf in April 2010, as well as undertaking an overhaul of the Minerals Management Service–the government agency responsible for developing offshore energy resources. Further, since 2009, Salazar has also pursued renewable energy, authorizing 34 solar, wind, and geothermal projects on public lands. In the spring, Salazar plans to return to his home in Colorado. *Source: U.S. Department of the Interior*

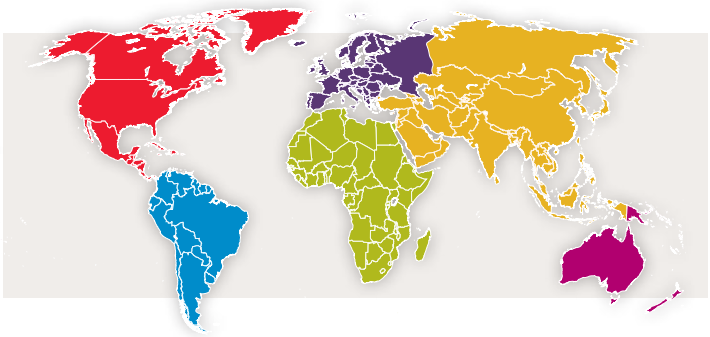
General

The U.S. Fish and Wildlife Service (FWS) and the Avian Power Line Interaction Committee have released a new document about how to reduce bird collisions with power lines using the latest scientific and technical information. The document, "Reducing Avian Collisions with Power Lines: State of the Art 2012," identifies best practices that electric utility companies, wildlife agencies, federal power administrators, and other stakeholders can implement to prevent bird injury and mortality. For example, the manual recommends that engineers work with biologists from an early stage to identify and address collision issues when modifying existing power lines or planning new lines. Wildlife biologists from FWS and the U.S. Department of Agriculture, along with representatives from a number of utility companies, contributed to the document. *Source: FWS, Avian Power Line Interactive Committee*

General

A recent National Wildlife Federation (NWF) report reveals how global warming has already begun to alter wildlife habitats across the United States, and provides measures to protect wildlife and communities from climate-related impacts, such as extreme weather, wildfires, and sea level rise. The report outlines examples of wildlife species that are struggling to adapt to these changes. For example, it highlights a recent study that found that of the 305 species of birds sampled, more than half have expanded their range northward over the last four decades. The NWF report suggests that we need to address the climate-related causes of these range expansions and cut carbon emissions in half by 2030. *Source: National Wildlife Federation*

For comments or suggestions, or to submit news briefs for the State of Wildlife section, contact Divya Abhat, *divya@wildlife.org*.



International

News and events affecting wildlife and wildlife professionals around the world

Africa

UGANDA–Mountain gorillas (*Gorilla beringei beringei*) in Uganda's Bwindi Impenetrable National Park have increased from 302 in 2006 to at least 400 in 2011, according to a recent report by the Wildlife Conservation Society. The numbers are based on a 2011 survey carried out by the Uganda Wildlife Authority, the Rwanda Development Board, and the Democratic Republic of the Congo's Institut Congolais pour la Conservation de la Nature (ICCN). Researchers attribute the success to an increased collaboration between the three agencies. The only other population of gorillas that appears to be increasing is the other mountain gorilla population found in the Virunga Volcanoes to the south. All other populations are on the decline because of illegal hunting and habitat loss. Based on the 2011 survey, mountain gorilla populations are now estimated at approximately 880 individuals. *Source: Wildlife Conservation Society*

Asia

REPUBLIC OF KOREA–The Republic of Korea has reversed its decision to carry out scientific whaling–a plan to hunt an endangered population of minke whales (*Balaenoptera acutorostrata*) for scientific purposes. Instead, the government will carry out research using non-lethal methods. The Republic of Korea had first announced its plan to carry out scientific whaling in June 2012–a proposal that would have been legal under the whaling treaty, which allows for the killing of whales for scientific research. Japan is the only country that carries out scientific whaling, with whale meat from those hunts being sold in Japanese markets. *Source: WWF*

LAO PDR–Conservationists recently moved 19 baby Siamese crocodiles (*Crocodylus siamensis*) from the Lao Zoo into a local wetland in Lao People's Democratic Republic where they will acclimate before being released into the wild. The translocation is part of a joint effort between the government of Lao PDR, Lao Zoo, the Wildlife Conservation Society, and other agencies and local communities to protect the region's endangered population of Siamese crocodiles. The species is no longer found in much of its former range through Southeast Asia and parts of Indonesia largely because of overhunting and habitat loss. As part of the recovery effort, crocodile eggs that are found in the wild are taken to the Lao Zoo where the hatchlings are raised in safety and eventually released back into the wild. Today, there are some 250 Siamese crocodiles in the wild. *Source: Wildlife Conservation Society*

CHINA–During a recent survey expedition along the Yangtze River, researchers counted a total of 380 finless porpoises (*Neophocaena phocaenoides*), marking a significant decline in numbers compared to the last survey in 2006. Experts believe that high shipping traffic poses a threat to the survival of these mammals, because the resulting ship noise could interfere with porpoises' sonar systems, which they need to survive. On average, 100 cargo ships pass through the Yangtze River every hour. *Source: WWF*

Europe

UNITED KINGDOM–According to a report titled "State of Britain's Larger Months 2013," two-thirds of Britain's 337 species of common larger moths have declined significantly over the past four decades. Researchers believe that habitat loss–and a resulting decline in food sources–along with urbanization and changes to forestry management could be to blame. The survey showed that species such as the V-moth (*Marcaria wauaria*)–once a common sight in Britain's gardens and countryside–dropped by 99 percent from 1968 to 2007. Overall, populations of larger moths have declined by 28 percent in the last four decades. Still, it's not all bad news: The report also revealed that about a third of species of larger moths, such as buff footman (*Eilema depressa*) and the least carpet (*Idaea rusticata*), showed a slight increase in population numbers. *Source: State of Britain's Larger Moths 2013*

Credit: A. Plumptre/Wildlife Conservation Society

A juvenile mountain gorilla rests in the brush at Uganda's Bwindi Impenetrable National Park. A recent census revealed an increase in the park's population of mountain gorillas, largely the result of ongoing collaborative efforts to protect the species.

On a Quest to Restore Habitat

BEN WISHNEK studies the relation between wildlife species and habitat restoration

By Divya Abhat

Courtesy of the U.S. Fish and Wildlife Service

Ben Wishnek surveys and maps the location of the invasive yellow flag Iris (*Iris pseudacorus*) along the shore of Washington's Campbell Lake.

The summer of 2007 was pivotal for Ben Wishnek—at the time an undergraduate student at California's Humboldt State University and a summer volunteer with the U.S. Forest Service. This was the first time Wishnek was going to apply his academic knowledge to the field. He was stationed in the San Jacinto Mountains of southern California and tasked with educating campers visiting Dark Canyon campgrounds on the vulnerability of the endangered mountain yellow-legged frog (*Rana muscosa*) that was discovered in the area. "It was a great experience," Wishnek says—and one that confirmed his decision to become a wildlife professional.

Today, Wishnek is pursuing a Professional Science Master's (PSM) degree in Environmental Sciences from Oregon State University. "The program is designed for people who might not want to go into academia ... and want graduate-level science training," Wishnek says. The PSM is different from a traditional master's program in its course offerings. For example, in addition to science courses, Wishnek is taking classes in business, research ethics, and project management. "[The courses] allow you to combine all the business skills with the science courses , so you're ready for the professional world once you get done with your degree," Wishnek says.

This particular PSM is just one of 294 programs offered as part of the PSM Initiative, launched in 1997. In all, there are approximately 130 PSM-affiliated universities across the United States, Canada, the United Kingdom, and Australia.

After graduating, Wishnek hopes to work with a government agency where he can integrate his natural resource skills from Humboldt State and previous field experience with his project management training from Oregon State.

Out in the Field

Wishnek already has some federal work experience. In 2011, he interned with the U.S. Fish and Wildlife Service (FWS), where he carried out post-restoration surveys on Oregon's Bandon Marsh National Wildlife Refuge. The refuge had served as an agricultural site for cattle farming from the 1900s until the early 2000s, when FWS acquired the property and began restoring its original tidal marshes, removing existing dikes and allowing the tide back in. Wishnek surveyed bird and fish species in an effort to quantify which species were present before and after restoration—an area of research in which he is especially interested. "My main interest is habitat restoration and how wildlife species respond to wildlife habitat restoration practices," says Wishnek, who is also the Northwest Section representative for The Wildlife Society's Wildlife and Habitat Restoration Working Group.

Although birds, herps, and fish can get Wishnek's heart racing—he refers to them as his three star taxa—he realizes the need to look at the natural world holistically. "I know that, working as a biologist, you can't be a specialist focused on one taxon," Wishnek says. "You have to be a generalist and be able to integrate knowledge of the landscape processes with the biology of the species you are managing." That's a lesson that Wishnek's mentor, Bill Bridgeland, taught him. Bridgeland, a biologist with the FWS, served as Wishnek's supervisor at Bandon Marsh National Wildlife Refuge. "He took time to come out with me when I was doing some surveys but more importantly, provided a balance

of honest, constructive criticism and encouragement on job performance," Wishnek says.

Since then, Wishnek has carried out a number of habitat restoration surveys on wildlife refuges. Last summer, he worked as a Pathways intern with the FWS, where he tried his hand at a variety of tasks from mapping invasive weeds in the Columbia River Gorge to carrying out ecological integrity assessments of different habitats along the Washington coast. Wishnek also worked for two years with AmeriCorps as a riparian habitat steward and stream restoration coordinator, respectively. During his first year with the program, he worked with the city of Gresham, Oregon, where he did stream habitat restoration, which involved removal of invasive species, planting native plants, and installing habitat structures for the city's wildlife.

Preparing for the Future

Wishnek sees the need for well-rounded professionals in the natural resources field and has made sure to work toward a diverse professional background. "In my professional experiences, I have seen the need for cross-disciplinary communication and, as a result, I chose the environmental science degree because I want to have the ability to integrate my wildlife background with other fields," Wishnek says. "And I look forward to seeing where my professional career takes me." ■

Divya Abhat is Managing Editor of *The Wildlife Professional*.

To find a mentor or mentee, go to http://mentor.wildlife.org/about

MENTOR BILL BRIDGELAND

Wildlife Biologist, U.S. Fish and Wildlife Service

Credit: David Ledig

Bill Bridgeland heads out to service automated cameras on a seabird colony island in southern Oregon.

Over the past few years, raccoons have been frequenting one of the islands off Oregon's south coast to prey on its seabirds. Last summer they caused the breeding failure of a small colony of common murres (*Uria aalge*). Bill Bridgeland, wildlife biologist with the U.S. Fish and Wildlife Service (FWS), was able to document the predation with automated cameras and learned a tremendous amount about bird and predator behavior. This is just one of several seabird colonies on near-shore islands that Bridgeland monitors for sources of disturbance. In addition to discovering "what species of predators are involved, how extensive their activity is on the islands, and the impact they're having on some of the birds that are there," Bridgeland hopes to learn whether these islands are "really viable places for the seabirds to nest because of their proximity to the mainland and vulnerability to predators."

Beyond his work on seabird colony predator management, Bridgeland spends much of his time overseeing the progress of Oregon's largest tidal marsh restoration. In 1999, a merchant vessel called the New Carissa ran aground and broke up near Oregon's Coos Bay, spilling between 70,000 and 140,000 gallons of fuel into area waters. That spill caused the death of more than 3,000 seabirds and shorebirds and resulted in significant ecological damage to Oregon's coastline. The U.S. Coast Guard's National Pollution Fund Center funded restoration claims that included more than $3 million for shorebird and seabird habitat restoration projects, predator management, and environmental education. Further, shorebird restoration funds went toward the tidal marsh restoration project completed in 2011 on the Ni-les'tun Unit of Bandon Marsh National Wildlife Refuge on the southern coast. Bridgeland–whose position is also funded by the settlement–was hired just as the ground work of the restoration project got started, and he was charged with coordinating the extensive ecological monitoring program designed to assess the success of the project at creating habitat for a variety of water birds and aquatic life, including salmon.

That's where Bridgeland met Ben Wishnek. "Ben was hired as my intern during the height of the construction activity, and he was immediately immersed in surveys of birds, herps, and fish, water quality sampling, and helping with public outreach," Bridgeland says. He taught Wishnek necessary field techniques, while training him to be a keen observer of clues to natural processes in the landscape. "These are skills that he had some exposure to in school, but this gave him an opportunity to put them in practice," Bridgeland says.

Home is ... in the Field

Bridgeland began his career as a wildlife biologist more than three decades ago. He spent 20 years after getting his M.S. working as a freelance wildlife biologist on the East Coast. "I did a variety of things including urban wildlife biology, nuisance wildlife control, [and] environmental consulting work." After his long stint in the field, Bridgeland returned to the academic world to get a Ph.D. in Wildlife Ecology at Northern Arizona University. "I consider myself a naturalist with a strong interest in wildlife conservation."

Like most wildlife biologists, Bridgeland is happiest when he's out in the field. However, like many, he spends only a quarter of his time outdoors; the rest of the time, Bridgeland is in his office planning and writing reports or analyzing data from summer field work. Still, Bridgeland's office overlooks the restored tidal marsh, allowing him to observe the results so far of the restoration work. "There's been a dramatic response mostly with bird life coming into the marsh," Bridgeland says. "We get to watch a wide variety of raptors, waterfowl, and shorebirds that are moving through the marsh in front of us. … It's been very gratifying to see how quickly wildlife is responding."

A Sea Change for Survival

THE ENDANGERED SPECIES ACT TURNS 40

By William Robert Irvin

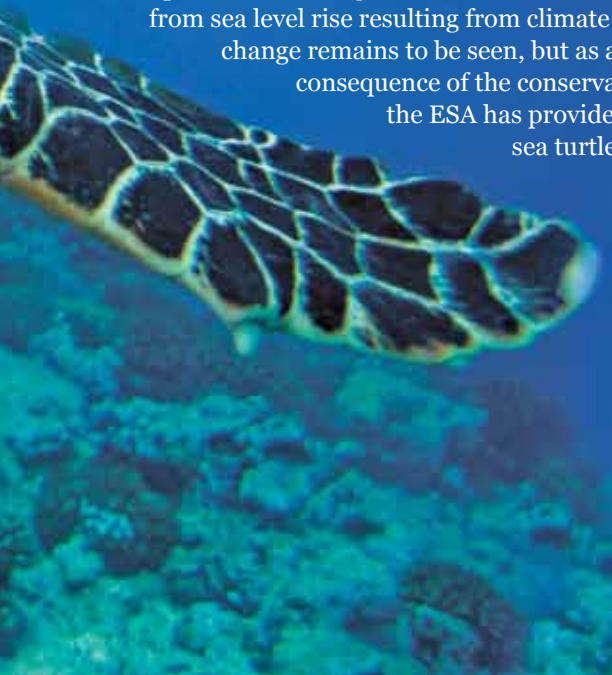
Forty years ago, Congress enacted, and President Richard M. Nixon signed into law, the Endangered Species Act (ESA), probably the most far-sighted and ambitious environmental law in the world. It was far-sighted because Congress recognized that species were going extinct "as a consequence of economic growth and development untempered by adequate concern and conservation." It was ambitious because the ESA set a goal of preventing species extinction by addressing its causes: habitat destruction, illegal trade, disease, predation, inadequate legal mechanisms, and other natural and man-made factors.

Over the first 30 years of my conservation career, I was fortunate to work on ESA issues with many of the dedicated scientists, attorneys, business leaders, and conservationists who shared the law's goal of stemming the tide of species extinctions. Though I was not present at the ESA's creation, I have had the pleasure of speaking and working with some of those who were, and they are rightfully proud of what they accomplished. As a result of this Act, hundreds of species have been saved from likely extinction—from snail darters to bald eagles, from Delhi Sands flower-loving flies to grizzly bears.

One of the ESA success stories with which I have had personal experience, while working for the

National Wildlife Federation and, later, the Center for Marine Conservation, is the multi-faceted effort to save sea turtles from extinction. The ESA enabled the federal government to address the single greatest threat to sea turtles in U.S. waters—incidental drowning in shrimp nets—by requiring the use of turtle excluder devices (TEDs) in nets. While fiercely opposed by some in the fishing industry and their political allies, when properly used, TEDs can reduce sea turtle drowning by 97 percent while allowing a viable shrimping industry to continue. Nesting populations of Kemp's ridley sea turtles in the Gulf of Mexico are now growing at a rate of 15 percent a year. Going further, the ESA spurred the U.S. to take steps internationally to address sea turtle drowning in fisheries of other nations, a move that not only helped sea turtle species, but helped to level the economic playing field for U.S. fishing interests.

Prompted by the ESA, the U.S. worked to convince Mexico and Japan to end the harmful trade in products from endangered hawksbill sea turtles. The ESA's emphasis on habitat protection has also encouraged the preservation of extensive areas of U.S. nesting beaches for Kemp's ridley, loggerhead, and leatherback sea turtles. Whether the ESA can be helpful in addressing threats to those beaches from sea level rise resulting from climate change remains to be seen, but as a consequence of the conservation the ESA has provided, sea turtles are more resilient and thus have a better chance of surviving threats from climate change.



As I learned from my work on sea turtle conservation, implementation of the ESA can be complicated and contentious. It took many years of litigation, overcoming determined opposition in Congress from powerful Gulf Coast politicians, and addressing multiple environmental threats to put sea turtles on the path to recovery. Moreover, as I learned from many conservation battles, the ESA alone cannot solve every problem threatening a species with extinction. Indeed, contrary to what its critics have argued, the ESA is not a red light stopping human progress in its tracks. It is instead a blinking yellow light, requiring us to slow down and think about the consequences of our actions.

That is perhaps the most wondrous feature of the ESA, reflecting the tremendous foresight Congress showed in enacting it in 1973. By institutionalizing caution in decisions by federal agencies—whether to log a national forest, dam a river, or grant a permit to fill in wetlands—the ESA ensures that we will take a hard look at actions that may lead to species extinction. Prohibiting anyone subject to U.S. jurisdiction from killing or harming endangered species, with stiff civil and criminal penalties for violations, compels us all to think about the consequences of our actions. As the ESA enters its fifth decade, its admonition to look before we leap is a wise requirement, for ourselves and future generations.

Credit: Krista Schlyer

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A Timeline of Trials and Triumphs

EXPLORING KEY MOMENTS IN ESA HISTORY

By Divya Abhat

Divya Abhat is Managing Editor of *The Wildlife Professional*.

The year 2013 marks the 40th anniversary of the Endangered Species Act (ESA)—a landmark law established "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." The 1973 Act came on the heels of two notable predecessors: the Endangered Species Preservation Act of 1966, designed to protect vulnerable species native to the United States, and the Endangered Species Conservation Act of 1969, which expanded on the 1966 Act to cover a larger number of species, including animals threatened with worldwide extinction. The 1973 ESA that we celebrate today went further, providing greater protections to listed species along with the ecosystems on which they relied.

Since passage of the ESA, the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS)—the two federal agencies that administer the ESA—have enjoyed notable successes in rescuing dwindling species like the bald eagle and the peregrine falcon. Yet these agencies have also endured steep challenges, such as criticisms over listings and de-listings, frequent litigation, inadequate funding, and struggles with states over jurisdiction.

Despite such challenges, the Act is destined to endure as an imperfect but vital safety net for wildlife and habitats at a time of mounting pressures on the nation's natural resources. Today it offers protections for more than 1,400 plant and animal species in the United States that are listed as threatened or endangered, with close to 200 species categorized as "candidate" species under consideration for inclusion on the endangered species list. Those labels are significant, as they result in the following actions or protections:

Endangered. This designation applies to species currently in danger of extinction. Endangered species are protected from "take"—which includes being killed, wounded, trapped, or moved—and they cannot be traded or sold.

Threatened. This term applies to species that could become endangered in the foreseeable future. It results in many, but not all, of the same protections as are given to endangered species.

Candidate. A candidate species is one being considered for protection under the ESA. Although FWS has enough information on a candidate species' biological status to propose listing, higher priority listing activities keep the listing process from going forward. These species do not receive statutory protection under the ESA.

1966

1996: Congress passes the Endangered Species Preservation Act of 1966, designed to protect animal species native to the United States.

1967

1967: U.S. Interior Secretary Stewart Udall announces the first list of endangered species, which includes 78 birds, mammals, reptiles, amphibians, and fish.

1969

1969: The Endangered Species Conservation Act of 1969 builds on the 1966 Act and authorizes protection of animals threatened with worldwide extinction.

1973

1973: Biologist David Etnier discovers the snail darter in the Little Tennessee River, increasing controversy over construction of the Tellico Dam.

Credit: USFWS

1973: Eighty nations sign the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)—a treaty to protect certain plant and animal species by regulating international trade.

Courtesy of CITES

1973: On December 28, President Richard Nixon signs the Endangered Species Act of 1973, designed to protect vulnerable species and their native habitats.

Such pat definitions belie the political, social, and logistical complexities that arise in the wake of a listing. Nevertheless, during this 40th anniversary year, it's worth reflecting on some of the milestones that have helped define the ESA as one of the most significant environmental laws of our time (see timeline) and explore a few key species, issues, and incidents that encapsulate its journey.

When Industry Impacts Species

Although the key purpose of the ESA is simply to protect wildlife species and their habitats, actual execution of the Act has been anything but simple. For decades, wildlife biologists and researchers have been at odds with some industries and landowners over protections of listed species. While the former will highlight the risk of extinction of a particular species, the latter may express concern that protection measures could restrict development and result in financial loss. Two landmark cases from ESA history highlight this complex struggle.

Snail Darters. In August 1973, David Etnier discovered the snail darter (*Percina tanasi*) in the Little Tennessee River. At the time, Etnier, a biologist and professor at the University of Tennessee, was embroiled in a lawsuit against the Tennessee Valley Authority over construction of the Tellico Dam and Reservoir Project along the same river. Etnier and other experts were concerned that construction could result in the extirpation of a number of fish species, and discovery of the three-inch snail darter only added pressure to protect it and other fish in the region.

Etnier and colleagues began by taking stock of the new species: They estimated that there were probably about 5,000 snail darters in the Little Tennessee River and determined that construction of the dam would almost guarantee the species' extinction. Still, despite lawsuits and appeals to stop the project, TVA continued to build the dam. In 1975, the snail darter was listed as endangered under the ESA, and in 1978, a U.S. Supreme Court ruling made it clear that the ESA forbade completion of projects that would likely jeopardize survival of a particular species. In 1979, however, then Senator Howard Baker (R-TN) and Representative John Duncan (R-TN) pushed through an appropriations rider overruling the ESA and other laws. By November of that year, the reservoir was completed and the river impounded.

Credit: Credit: U.S. Geological Survey

A costumed technician uses a whooping crane puppet to encourage a whooper chick to swim at the USGS Patuxent Wildlife Research Center in Maryland. FWS declared the whooping crane endangered in 1967 under the Endangered Species Preservation Act of 1966. Since then, state and federal management efforts have resulted in an increase in crane numbers from fewer than 20 birds in the 1940s to more than 400 today.

Credit: USFWS

1977: San Clemente Island species of Indian paintbrush (right), larkspur, broom, and bush-mallow become the first plants listed for protection under the ESA.

1978: A Supreme Court ruling related to construction of the Tellico Dam in Tennessee finds that the ESA shows a "plain intent" to "halt and reverse the trend toward species extinction, whatever the cost."

1982: Congress introduces Habitat Conservation Plans (HCP) to protect critical habitat. An amendment to the ESA allows permit holders to "take" protected wildlife if the take is incidental and if the permit holder has an HCP for the species.

1983: FWS approves the nation's first HCP for the protection of species such as mission blue and callippe silverspot butterflies at California's San Bruno Mountain.

1977 1978 1982 1983

Credit: Karyn Rhode/USFWS

A biologist with the U.S. Fish and Wildlife Service works with a tranquilized polar bear in Alaska. In 2008, FWS listed the polar bear as threatened under the ESA largely because of a rapid decline in sea ice—the species' primary habitat.

A recovery team consisting of Etnier, biologists from TVA and FWS, and others then hatched a plan to save the fish. "It looked like about the only thing we could do—assuming that TVA would eventually win and the Tennessee population would be gone—was try to reintroduce them [elsewhere]," says Etnier. The plan worked. Though the snail darter was extirpated from the Little Tennessee River, reintroductions established populations that now exist in the Lower French Broad, the Lower Holston, and Little River. Further, researchers have found what appear to be naturally occurring populations in five additional Tennessee River tributaries. In 1984, the listing designation of the snail darter changed from endangered to threatened. "I suspect it will be eventually moved from the list without much fuss," says Etnier.

Northern Spotted Owl. In 1973, the U.S. Forest Service (USFS), Bureau of Land Management (BLM), FWS, and Oregon's fish and wildlife agency collaborated to form the Oregon Endangered Species Task Force, which began working to protect Oregon's northern spotted owls and their old forest habitat. At that time, however, federal agencies were eliminating "decadent" old forest stands and replacing them with vigorously growing younger trees as part of a forest management plan. The Task Force faced a dilemma: how to maintain the species and its habitat on a changing landscape. By 1977, BLM and USFS agreed to protect spotted owl habitat in accordance with guidelines from the Task Force, which recommended maintaining 400 pairs of spotted owls in Oregon and providing each pair with at least 300 acres of old timber.

Seeing that the spotted-owl habitat problem wasn't restricted to Oregon, the effort was expanded to address owls in California and Washington. The issue heated up as the timber industry expressed concern over the loss of jobs and income because of reduced logging, while environmental and animal activists called for the protection of old-growth forests and spotted owl populations that relied on them. "The more we learned, the worse the situation looked," says FWS/Oregon State University researcher Charles Meslow. Eventually, environmentalists filed lawsuits challenging USFS and BLM timber sales.

By 1987, FWS had received a petition to list the spotted owl, and in 1990 it listed the species as threatened. Within a year, a federal court order halted old forest logging in northwest federal forests. Then, in 1994, the Clinton administration adopted the Northwest Forest Plan, which still forms the basis for forest management for federal lands in the Northwest. Though significant, the plan "hasn't been effective in stopping the decline of the northern spotted owl," says Meslow, likely because of another factor at play: barred owls. Scientists have found that an increase in barred owls has coincided with a decline in spotted owls (USFWS).

Despite decades of efforts to protect the northern spotted owl, its numbers continue to decline, especially in the northern part of its range (southern

Credit: Phil Armitage/Wikipedia

1985: Authorities begin a California condor captive-breeding program in San Diego and Los Angeles zoos and bring the last nine remaining wild condors into captivity.

Credit: Tracy Brooks/USFWS

1995: U.S. Fish and Wildlife Service releases gray wolves into Yellowstone National Park and Idaho, ending a 70-year absence in the area.

1985 | **1990** | **1994** | **1995** | **1999**

Credit: John and Karen Hollingsworth/USFWS

1990: FWS lists the northern spotted owl as threatened under the ESA.

1994: The California gray whale is removed from the endangered species list, making it the first marine mammal to be delisted under the ESA.

1999: The American peregrine falcon (listed as endangered in 1970) is delisted, largely because of a DDT ban in the 1970s that allowed bird populations to recover.

Credit: Frank Doyle/USFWS

British Columbia and Washington). Scientists had hoped that as younger forests matured they would bolster the role of the old forest that these owls rely on. "It's been almost 25 years now and the decline of the spotted owl has not stopped," Meslow says.

Balancing Science and Politics

Like industry, politics can play a significant role in ESA policy and planning. In 2011, for example, legislators from Montana and Idaho attached a rider to an approved federal budget deal, with the rider requiring FWS to remove protections for wolves under the ESA in Montana, Idaho, eastern Oregon, eastern Washington, and north-central Utah, and prohibiting further judicial review.

Far more common than such interventions are questions involving climate science. Climate change was barely a blip on the radar of science or politics back in the 1970s, but today the ESA increasingly considers global-warming impacts on species. In May 2006, for example, the NMFS listed two corals—elkhorn and staghorn—as threatened. The listing was prompted by research showing a significant decline in coral populations over the previous 25 years, largely because of warming oceans. More recently, FWS proposed to list the wolverine (*Gulo gulo*) as threatened under the ESA, largely because of the threat of climate change on the species' snow-pack habitat in the northern Rockies.

Such climate-related listings can pit science against political agendas, oftentimes independent of FWS and NMFS. Consider the polar bear. In 2008, FWS listed it as threatened because of the projected loss of its sea ice habitat due to warming oceans—a controversial listing still on appeal. Some scientists went on to argue that this was one reason to limit greenhouse gas emissions, considered a factor in global warming. But both the Bush and Obama administrations have ruled that the government should not invoke the ESA to curb such emissions. Instead, Interior Secretary Ken Salazar said that the global risk of greenhouse gases had to be tackled by comprehensive policies rather than as a collection of agency efforts implemented for particular species (*New York Times* 2009). In another climate-related case, in 2010 the FWS ruled that although the American pika (*Ochotona princeps*) was potentially vulnerable to the impacts of climate change, it did not warrant ESA listing (FWS 2010) because some research suggested that the species could survive at higher elevations—a ruling that drew much criticism from environmental groups.

Clearly, the ESA will remain a lightning rod, drawing praise and blame. Among its critics, Doc Hastings, Chairman of the U.S. House of Representatives Committee on Natural Resources, wrote in 2012 that the ESA "is failing to achieve its primary purpose of species recovery and instead has become a tool for litigation that drains resources away from real recovery efforts and blocks job-creating economic activities" (U.S. House of Representatives 2012). Conversely, many commend the ESA for protecting vulnerable species. "The Act is a safety net for species in real trouble," says Gary Frazer, FWS's Assistant Director for Endangered Species, "and it's been remarkably successful in focusing attention and preventing extinction of species that desperately need our help." Now 40 years and counting, the ESA will continue to fight for species and their habitats in the face of an ever-shifting world. ■

This article has been reviewed by subject-matter experts.

Comment on the ESA, read about NMFS-FWS sea turtle work, and learn about Canada's endangered species law at news.wildlife.org/twp. Read more about the history of the Endangered Species Act at http://www.fws.gov/endangered/laws-policies/timeline.html.

Credit: Susanne Miller/USFWS

2000: A State Wildlife Grants program allows states to develop State Wildlife Action plans to manage and protect vulnerable species.

2005: Birders in Arkansas report seeing the ivory-billed woodpecker—a bird that many thought to be extinct.

2007: FWS removes the bald eagle from the endangered species list. ▶

◀ **2008:** FWS lists the polar bear as threatened largely because of habitat loss in the Arctic.

2013: FWS proposes to list the wolverine as threatened.

2013: FWS releases a four-year-old Mexican gray wolf into the Arizona wild as part of the Mexican Gray Wolf Recovery Program.

Credit: Ron Holmes/USFWS

ESA40

State Perspectives on the ESA

A JOURNEY OF CONFLICT AND COOPERATION

By Elsa M. Haubold and Nick Wiley

Courtesy of Elsa M. Haubold

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Courtesy of Nick Wiley

Nick Wiley, CWB, is Executive Director of the Florida Fish and Wildlife Conservation Commission, Co-chair of the Endangered Species Act Joint Task Force, Chair of AFWA's Threatened and Endangered Species Committee, and a National Conservation Leadership Institute Fellow.

State-federal partnerships under the U.S. Endangered Species Act (ESA) of 1973 are resulting in myriad conservation successes for wildlife species across the nation. Among the most recent: In January, the U.S. Fish and Wildlife Service (FWS) announced that it will reclassify the wood stork from endangered to threatened. Likewise, 2013 population numbers for the endangered red-cockaded woodpecker show that several sites in Florida have already met their 2020 recovery goals for the species—seven years ahead of schedule—reflecting one of the best examples of state, federal, and private landowner cooperation in species conservation.

Since the inception of the ESA, states have functioned as co-trustees for federally listed species. State natural resource agencies and their experts in species and habitat management play a vital role in cooperating with federal agencies in managing listed species and working to protect non-listed species to prevent future listings. The Act mandates such cooperation: Section 6, titled "Cooperation with the States," requires the Secretary of the Interior to "cooperate to the maximum extent practicable with the states," including "consultation with the states concerned before acquiring any land or water ... for the purpose of conserving any endangered species or threatened species."

Courtesy of FWC

Such cooperation is essential for three main reasons: (1) States have a deep understanding of local values and attitudes toward wildlife conservation, (2) states have principal management authority for resident fish and wildlife, so they are in the best position to assess and meet the conservation needs of at-risk species, and (3) states own and/or manage public lands and provide technical assistance to mangers of private lands that contribute to conservation of federally listed species. In Florida, for example, where more than 25 percent of land is publicly owned, the Florida Fish and Wildlife Conservation Commission has helped manage more than 5.8 million acres of conservation lands that contribute to the recovery of numerous listed species, including the red-cockaded woodpecker.

Courtesy of FWC

Kayaking in Florida's St. Joseph Bay, Robbin Trindell with the Florida Fish and Wildlife Conservation Commission (at rear) helps a colleague rescue a green sea turtle, one of thousands immobilized by a cold snap in 2010. Turtles rescued off the Gulf and Atlantic coasts were warmed at holding centers like one on the Merritt Island National Wildlife Refuge (left). There, volunteers recorded size and other data on rescued turtles before sending them to a rehabilitation facility prior to release back to the wild.

Getting into the Weeds

Although there are great examples of federal-state collaboration, the ESA has also created some challenges for the states and their constituents. One element that complicates ESA implementation for some states lies in structural bureaucracy. The Act is administered by two federal agencies: The FWS and the National Marine Fisheries Service (NMFS), collectively called the Services. The FWS oversees terrestrial and freshwater species, some marine mammals, and sea turtles when they are on the beach, while NMFS oversees most marine species. Unfortunately, the two Services do not always have a consistent approach to ESA implementation, which causes confusion for state partners trying to understand the implications of species' listings.

For example, there's a significant difference in how the Services handle "candidate" species. For NMFS, candidates are species undergoing an ESA status review, but for FWS, species become candidates only after FWS does a status review and finds that a species warrants listing even though FWS may not have resources to immediately develop a listing plan.

While states support the need to federally list species when at risk of extinction, their preference is to "keep common species common" so they don't decline to the point that they require federal protection through listing. When species do reach that point, they generally require a decades-long, arduous, and expensive journey to bring them back to a level where they are no longer endangered (at risk of extinction now) or threatened (at risk of becoming endangered). Among the challenges states face:

Red-tape Blues. ESA listings trigger regulations and requirements that some states find onerous or inefficient. These include requiring the designation of "Critical Habitat" to protect habitat essential to the conservation of the species, and also developing "Habitat Conservation Plans" to secure incidental take permits. Public and private land managers must get incidental take permits for management activities that might cause short-lived harm to a listed species even if the net benefit of the activity outweighs the take. For example, permits are needed when conducting prescribed fire that may kill a few individuals of a listed species but may benefit the long-term survival of a population by improving habitat.

Excessive Litigation. An important component of the ESA is that it grants the public the ability to petition for species to be listed, and citizens can sue the Services if they do not meet their obligations under the ESA. However, many states feel that petitions and litigation filed by NGOs and others against the Services are increasingly impinging on states' trustee responsibilities. That's particularly true of the increasing number of "mega-petitions" for listing numerous species at one time, such as a 2010 petition to the FWS to list 404 aquatic and aquatic-dependent species primarily occurring across southeastern states, and a 2012 petition for the listing of 53 reptile and amphibian species across the U.S.

Credit: Carli Segelson

Credit: Carli Segelson

A team of researchers at the Corbett/Dupuis Wildlife Management Area (top) carefully feed red-cockaded woodpeckers (RCW) that are part of a translocation project. FWC biologist Ross Scott (above) places a translocated RCW into an artificial enclosure in Florida's Big Cypress National Preserve, where the bird will be released.

Federalization. Many petitioned species and candidate species are state trust species, meaning the state has full regulatory authority over their management and take. These fish and wildlife resources are publicly owned and entrusted to the state for management on behalf of its citizens. Many states maintain their own lists of state endangered or threatened species, which can include federal trust species (generally migratory or federally listed species) or species at risk in that state, or both. Federalization occurs when a state trust species is brought under the regulatory authority of one of the Services through an ESA listing. In such cases, state authority is essentially abrogated or becomes secondary to federal authority, ESA requirements, and federal policy. Recent mega-petitions litigated and settled through court action are pushing an unprecedented number of state trust species toward federalization. This is especially troubling from a state perspective because the litigation process offers few opportunities for states to engage in or

influence the outcomes. As a result, outside interests determine management and regulation of species that were previously under state authority, yet state fish and wildlife agencies remain on the front lines of implementing and enforcing these measures.

Limited Capacity. State fish and wildlife agencies are facing steadily increasing workloads with decreasing funding and staffing capacity. Activities associated with ESA listings not only affect state workloads but also cause states to re-prioritize activities and shift emphasis away from other species that may be more in need of conservation attention from a state's perspective. For example, in Florida, for the past year we have allocated one staff member's time to serve as a liaison for federal issues, including addressing petitioned and candidate species. This individual would normally work on other conservation priorities for the state.

Public Perception. Concerns about federal regulations and litigation regarding federal listings can drive public opinion against the ESA with the unintentional consequence of harming species conservation efforts. In Florida, for example, one manager of a large plantation did not want red-cockaded woodpeckers on his land because of land-use restrictions the ESA would impose. However, tools are available under the ESA to help address such concerns. That land manager, for example, ultimately signed on to FWS's "Safe Harbor" program, which assures landowners that if they agree to support a listed species on their land, they will only be accountable for the number of individuals that existed when they entered the agreement. With that assurance, the landowner became willing to actively manage for and even encourage the birds to take up residence on the property.

An Ounce of Prevention ...

The ESA does drive positive conservation efforts that can only be successful and durable when states and federal agencies work collaboratively to become less reactive and more proactive in imperiled species conservation efforts. Fortunately, many states have been actively working toward this end with the Services. For example, after the 2010 petition to list 404 aquatic and aquatic-dependent species, the Wildlife Diversity Committee of the Southeastern Association of Fish and Wildlife Agencies (SEAFWA)—which represents 15 southeastern states and FWS—began developing an action plan to implement coordinated survey and monitoring measures for those species. The goal is to provide landscape level cooperation that delivers effective conservation for these and other species. Of the 404 petitioned species, 374 will undergo status reviews by the FWS in the future, and the committee plans to provide important data to contribute to many of these reviews.

In 2000, states gained a valuable new tool in their efforts to prevent federal listing when the federal State Wildlife Grants (SWG) program enabled all states to develop State Wildlife Action Plans (SWAPs), a historic first for most states. "By laying out conservation actions needed to conserve at-risk species, State Wildlife Action Plans are our best line of defense for preventing more endangered species listings," says Mark Humpert, Wildlife Diversity Director for the Association of Fish and Wildlife

A crew from the Florida Fish and Wildlife Conservation Commission (below) rescues an eight-foot manatee injured by a boat near the mouth of St. Mark's River. The animal was kept wet as it was transported to Lowry Park Zoo in Tampa for treatment. Sadly, it died the next day.

Credit: FWC

Credit: FWC

Agencies (AFWA). The SWG program provides funding for states to conserve the rare and declining species identified in their SWAPs.

Unfortunately, that funding safety net is thin at best: most states receive less than $1 million per year from SWG funding—which ranged from as little as $478,601 for small states like Connecticut up to about $2.4 million for Alaska. That's vastly below the estimated $900 million annually needed to fully implement the SWAPs and conserve the more than 12,000 species nationwide that have been identified as at-risk (AFWA 2011). Humpert has been active in influencing Congress to ensure that SWG program funding continues, arguing that SWAPs have been instrumental in facilitating states' abilities to develop partnerships for conserving non-listed species. Yet year after year the SWG program is threatened by cuts, surviving elimination by HR1 in FY2011 but resulting in funding of $64 million, a 31 percent cut and the lowest allocation since the program's inception.

Case in point: In the Northeast, the New England cottontail (*Sylvilagus transitionalis*) is a priority species in all seven SWAPs in the species' range, state listed as endangered in Maine and New Hampshire, and a FWS candidate species. Hoping to prevent federal listing, states in the cottontail's range are partnering with FWS, the Natural Resources Conservation Service (NRCS), and the Wildlife Management Institute to try to reverse habitat and population declines. With a steering committee that meets quarterly, the partners are cooperating to conduct restoration on state lands, target grants to key landowners for private-lands conservation, and commit millions of dollars for restoration on private lands by NRCS. In 2015, the FWS will determine if listing is warranted. Even if that happens, the cooperative framework is already in place so recovery activities can flow from the existing partnership.

Such collaboration among state agencies is not new. States often work together to conduct coordinated surveys and monitoring to fill data gaps and thereby prevent the need for federal listing of species. One iconic case in point involves the black-tailed prairie dog (*Cynomys ludovicianus*). In 1998, an NGO petitioned FWS to emergency list the species as threatened. That triggered a massive effort among states, management agencies, and tribal entities across the western range of the species to assess its conservation needs and work proactively to prevent listing. In 1999, those groups produced a comprehensive conservation assessment and strategy that assessed risks to prairie dogs—such as plague, grazing competition, recreational shooting, and land conversion—and outlined steps to begin to protect prairie dogs and their habitat (Van Pelt 1999).

In 2000, FWS named the species a "candidate" for listing. That designation gave the states time to implement a coordinated range-wide survey using similar methods in each state. This unprecedented cooperative effort yielded data that resulted in two subsequent findings that the prairie dog did *not* meet any of the five listing factors, which are (1) damage to or destruction of a species habitat; (2) overutilization of the species for commercial, recreational, scientific, or educational purposes;

Credit: FWC

With its distinctive domed shell and stubby legs, a gopher tortoise lumbers toward its burrow in Florida's sandy flatlands. Since a state management plan for the species began in 2007, protected tortoise habitat has expanded by more than 40,000 acres in Florida, where the species is listed as threatened.

Credit: Joe Davis/FWC

Prescribed fires ignited by helicopter burn in a Wildlife Management Area on Florida's panhandle. The burns were set to restore a former timber-production area to natural mesic flatwoods, providing habitat for many species such as endangered red-cockaded woodpeckers and frosted flatwoods salamanders.

(3) disease or predation; (4) inadequacy of existing protection; and (5) other natural or man-made factors that affect the continued existence of the species. Today, black-tailed prairie dogs are estimated to number around 24 million and occupy 2.4 million acres (FWS).

Finding a Better Way

In spite of the challenges, the ESA is an effective tool for wildlife conservation. Given the pressures on wildlife and habitats, however, it's clear that stronger collaboration among the states and the Services is the only way forward. Recognizing this need, states and the Services in 2010 formed the Joint Federal/State Task Force on Endangered Species Act Policy (ESA JTF). Designed as an executive-level forum for discussion among the state and federal fish and wildlife agencies, it comprises eight state fish and wildlife agency directors and four representatives from each of the Services. Its purpose is to provide a process to cooperatively identify and address issues of national significance and to jointly develop recommendations concerning those issues.

The ESA JTF has outlined several priorities. Top priorities include: (1) to define the role of states in listing-petition reviews and status reviews of species so states can ensure that their species data and staff expertise are available to the Services when they evaluate species for listing; (2) to clarify the authority conveyed by the Section 6 Cooperative Agreements that each state enters into with one or both Services; and (3) to increase state involvement in federal recovery planning, critical habitat designations, and implementation of the ESA's mandate for "Interagency Cooperation" (Section 7).

Though still in its nascent stages, the ESA JTF has seen some near-term returns. For example, communication between the states and the Services has improved by providing a forum for agency directors to discuss and work together on issues. A better understanding of the differences in implementation by the two Services exists, and the Services have taken several steps to eliminate some of the differences, such as the FWS revising its policy on timing of impact analysis in designating critical habitat to align with the policy of NMFS so that economic analyses are done when the proposed rule is announced.

More recently, the ESA JTF asked all state fish and wildlife agencies to meet with their federal counterparts to discuss how well they are cooperating on implementing the ESA at the state level. Forty-nine states and territories submitted a report about their meetings to the ESA JTF. Most agreed that while communication and collaboration are better, there is still room for improvement. These reports about the state meetings affirmed the top priorities already identified by the ESA JTF and stressed the importance of developing incentives to enlist private landowners in conservation. The ESA JTF will continue to work on these priorities over the next few years. "Only by envisioning conservation approaches that empower and foster constructive integration of state, federal, and non-governmental conservation machines can we begin to imagine that the great conservation success stories of the 20th century will continue through the 21st century," says Task Force member Larry Voyles, Director of the Arizona Game and Fish Department.

For the ESA to have continued success over the next 40 years and beyond, numerous challenges to implementation will have to be overcome. These are adaptive problems, and the co-trustees—states and federal agencies—will have to work together with other partners to chart the course. Some cultural differences between agencies will need to be sorted out to allow innovative solutions and to break down barriers to partnerships among the public and private sectors. The ESA JTF offers a strong start, for the first time providing an ongoing forum for the federal and state agencies to have meaningful dialogue and roll up their sleeves together to more effectively conserve our precious fish and wildlife resources—both before and after they require the protection of the U.S. Endangered Species Act. ■

This article has been reviewed by subject-matter experts.

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The Challenge of Wolf Recovery

AN ONGOING DILEMMA FOR STATE MANAGERS

By L. David Mech

Courtesy of L. David Mech

L. David Mech, Ph.D., is Senior Research Scientist with the U.S. Geological Survey's Northern Prairie Wildlife Research Center, Adjunct Professor at the University of Minnesota-St. Paul, and Founder of the International Wolf Center in Ely, Minnesota.

"Dave, would you do another legal declaration on the wolf for us?" The weary voice on the phone belonged to Mike Jimenez, Northern Rocky Mountain Wolf Management and Science Coordinator for the U.S. Fish and Wildlife Service (FWS). He was calling from Wyoming to ask me to prepare a document to address a legal challenge to the FWS's August 2012 delisting of the wolf (*Canis lupus*) in Wyoming, a highly controversial move. Mike's tone reflected the reality that—as so many wildlife biologists know and live each day—wildlife management is mainly people management. This contention could not be truer for managing any wildlife species than for managing the wolf.

Dubbed "the beast of waste and desolation" by Teddy Roosevelt (*The Wilderness Hunter* 1893/1900), wolves had been universally hated as prolific predators of valuable livestock and game. Around the turn of the 20th century, members of the U.S. Biological Survey and various state agents, ranchers, cowboys, and other frontiersmen poisoned and persecuted wolves, extirpating them from most of the contiguous United States (Young and Goldman 1944). By 1967, Minnesota and nearby Isle Royale National Park in Michigan held the only remaining wolves in the Lower 48 states, prompting the FWS to place the wolf on the Endangered Species List (established by the Endangered Species Preservation Act of 1966). The wolf then became the list's poster species, and the timing was ideal: *Silent Spring* (Carson 1962) had just seeded and fertilized the environmental movement, which blossomed on Earth Day (April 22, 1970) into the environmental revolution. "Save the wolf!" became one of the movement's rallying cries. And save the wolf we did.

Credit: Undetermined Origin

A rack of dead wolves hints at how hated these predators were in the early days of western expansion. Reviled as dangerous predators that killed livestock and depleted game populations, wolves were viewed as vermin and routinely killed to the point of near extinction in the American West.

Arduous Road to Recovery

It seemed to matter to no one that a thriving population of 60,000 wolves remained next door in Canada and Alaska: Because they were gone from the western wilderness—including Yellowstone National Park and other wild lands in the contiguous states—wolves were officially endangered and considered worthy of salvation. I was an early proponent of that philosophy. My book *The Wolf: The Ecology and Behavior of an Endangered Species* ended by saying, "The wolf haters must be outnumbered. They must be outshouted, outfinanced and outvoted" (Mech 1970). To save the species, federal agencies put protections in place. Soon the ranks of wolf supporters began to rise, making it easier to outvote the anti-wolf factions.

After the passage of the Endangered Species Act of 1973 (ESA), wolves gained new protections. In 1978, the FWS approved the Recovery Plan for the Eastern Timber Wolf (a subspecies of gray wolf) that eventually covered populations in Minnesota, Michigan, and Wisconsin. Wolves were already increasing in Minnesota by that time (Fuller et al. 1992), and the added protection furthered the increase and allowed Minnesota's population to flow over into Wisconsin and Michigan (Wydeven et al. 2009, Beyer et al. 2009). In 1987, the Northern Rocky Mountain Wolf Recovery Plan proposed restoring wolves to Wyoming, Montana, and Idaho. Meanwhile, a similar public attitudinal change in Canada (Carbyn 1983) reduced pressure on wolves there, and dis-

persers from the rising Canadian wolf population began to recolonize Montana (Ream et al. 1991).

The ESA of 1973 also gave new impetus to an idea that had long been simmering among professional conservationists—the restoration of wolves to Yellowstone National Park (Leopold 1944, Pimlott 1967, Mech 1970). Assistant Secretary of the Interior Nathaniel Reed championed the idea in the 1970s. A long political process followed involving considerable Congressional wrangling, a $350,000 appropriation for an Environmental Impact Statement (EIS) on wolf reintroduction, 160,000 written comments on the EIS, an unsuccessful court case against the reintroduction, and a last-minute injunction against releasing the wolves that was soon rescinded (Cook 1993, McNamee 1997).

The process culminated in the reintroduction of wolves into Yellowstone and central Idaho in 1995 and 1996 (Bangs and Fritts 1996) as part of FWS's Northern Rocky Mountain Wolf Recovery Plan. According to that plan, wolves would be considered "viable" (or recovered) in the region once 10 breeding pairs were maintained in each of three designated recovery areas (in parts of Idaho, Montana, and Wyoming) "for a minimum of three successive years" (FWS 1987). Thanks to legal protection and the wolves' biotic potential, the species reached the recovery goal in 2002 with at least 663 individuals, and numbers have continued to increase.

Likewise, the plan for wolves in the Upper Midwest specified that the species would be considered recovered once Minnesota retained its existing population of at least 1,250 wolves for five consecutive years, and when Wisconsin and Michigan were supporting at least 100 wolves between them (FWS 1992). By 1999, Minnesota, Wisconsin, and Michigan had reached those objectives, and their wolf populations also continued to increase.

More Wolves, More Tension

The understanding and intention of both the Northern Rocky Mountain (NRM) and Upper Midwest wolf recovery teams were that once the wolf populations reached their science-based biological recovery levels, the FWS would delist them, and their management—including public harvest—would be returned to the states. Those expectations met numerous roadblocks, however.

In 2003, FWS changed the status of Upper Midwest wolves to threatened rather than endangered, and in 2007 and 2009, delisted them. In 2003, 2008, and 2009, FWS also tried to reclassify or delist the Idaho, Montana, and Wyoming wolf populations. Each attempt, however, was successfully challenged in court by animal-protection groups on the basis of legal technicalities, such as failure to address threats to wolves outside the core recovery areas.

Courtesy of L. David Mech

Walter Medwid, former Executive Director of the International Wolf Center, works with gray wolves captured in Canada in 1995 as part of an effort to reestablish wolves in the U.S. Rockies. After being anesthetized, vaccinated, examined, and radio-collared, the wolves were translocated and released in Idaho and Yellowstone National Park.

Wolf populations in the NRM and Midwest have continued to increase beyond recovery levels, much to the chagrin of many ranchers, hunters, and guides. In the NRM, those folks generally have been extremely patient and tolerant while wolf populations have grown far beyond the levels that many residents had believed they would have to live with based on the publicly vetted recovery plans. After wolves were delisted in the West (except in Wyoming) and then relisted once more by court order in 2010, some western residents appealed to their Congressional representatives. As a result, in 2011 Congress intervened by legislatively delisting wolves in Montana and Idaho (as well as in parts of Washington, Oregon, and Utah), and exempting that ruling from legal challenges (ENS 2011). By then, the NRM wolf population exceeded 1,750 wolves, about six times the minimum recovery level. Likewise, in the Upper Midwest, the Minnesota wolf population had reached more than twice the minimum recovery level, and the Wisconsin/Michigan population hit 12 times the minimum level, so FWS again delisted wolves in the region in late 2011.

With each of these states' wolf populations far higher than recovery levels, some groups began to strongly promote public wolf harvesting. (Federal culling of depredating wolves had been ongoing for years in these states, resulting in removal of more than 4,000 wolves.) All the states with recovered wolf populations (except Michigan) began to allow various forms of public wolf harvest. Their approaches varied: all allowed hunting, some allowed trapping, snaring, and baiting. But all set conservative quotas and seasons in their first year's regulations.

Even so, neither Montana nor Idaho nor Wyoming reached their initial harvest quotas, and wolf populations continued to increase. Montana, for example, had hoped to harvest 220 wolves in the 2010-2011 season but ended up taking only 166, even after extending the season. The state's wolf population then increased by 15 percent. Likewise, Minnesota, which had issued 3,600 wolf permits during the 2012 deer season, saw hunters harvest 147 of the 200 quota. (A second special season for hunting, trapping, or snaring wolves, with 2,400 permits and a quota of 253, did reach that quota.)

Though conservative wolf-harvest quotas were based on population science, hunting of wolves greatly upset many members of the public. Saving wolves had gained a large and passionate constituency. Wolves in Yellowstone were seen by hundreds of thousands of visitors and had generated an estimated $35 million per year for the local economy (Duffield et al. 2008). Some biologists had also concluded that through trophic cascades, wolves were improving populations of everything from beetles to trout in the Yellowstone ecosystem (Hebblewhite and Smith 2010), and the popular media had greatly publicized those findings. (After a recent review of the literature, however, I concur with several other scientists who question those findings [Mech 2012].)

Courtesy of NPS

As part of an intensive study of wolf predation, biologists with Yellowstone National Park track radio-collared wolves of the Sough Creek Pack in Lamar Valley. Research has revealed that area wolves kill an average of 1.8 elk per wolf each month in winter (with kill rates higher in late winter than in early winter)—data that informs elk herd management.

In any case, wolf aficionados took great umbrage at states for instituting wolf harvesting. In Minnesota, for example, some 15 anti-wolf-taking billboards appeared along major highways; protests and vigils were regularly held in front of Governor Mark Dayton's home; new websites were launched; and the ad-hoc group "Howling for Wolves" filed a suit to stop the hunt. When that failed, a lawsuit was filed against the FWS by the Humane Society of the United States and three other groups to relist the wolf in the Upper Midwest.

Delisting had clearly opened the floodgates to action by constituents with strong pro and anti-wolf feelings. It turns out that the 1978 Eastern Timber Wolf Recovery Team had been prescient when it wrote the following: "It is important to remember that the wolf is controversial, so there will be local opposition to any attempt to re-establish the animal or afford it any measure of protection. Similarly there will be opposition from other quarters to any effort to control the animal, although control may be necessary for the good of the animal itself in certain areas. If re-establishment of the wolf is accomplished, regulated taking of the animal undoubtedly will be necessary in the restored range sooner or later" (FWS 1978).

Similarly, Northern Rocky Mountain team members wrote, "We predict that controversy will continue well beyond the time when wolves are recovered and removed from federal protection, although the focus will shift from whether and how wolves should be restored to how wolves should be managed (Mech 1995), particularly in relation to state-regulated ungulate hunting programs" (Bangs and Fritts 1996).

Special Case in Wyoming

Those predictions typify Wyoming's situation. Yellowstone National Park forms about half of the planned Wyoming recovery zone for wolves. How-

ever, the area outside that zone comprises some 80 percent of Wyoming and is intensively grazed by livestock. Wolves in that massive area—which Wyoming named the Predator Zone—regularly prey on livestock, causing problems for area ranchers. From 2003 through 2012, agencies authorized the killing of 70 depredating wolves in the Predator Zone, which resulted in no packs ever being able to persist there. Nevertheless, this area for years has been a special zone of contention for wolf advocates, and still is.

The FWS had mandated that each state develop a management plan showing how it would achieve and sustain wolf recovery. By 2008 the Service had approved recovery plans for Minnesota, Wisconsin, Michigan, Montana, and Idaho, but it had rejected Wyoming's plan partly because it proposed unrestricted taking of wolves in the extensive non-wilderness Predator Zone—long a prominent feature of the state's various wolf management plans. Very few wolves inhabit that area because of their constant conflict with livestock, so biologically nearly all of that portion of Wyoming is inconsequential to Wyoming's wolf population. However, in principle (wildlife management is primarily people management, remember?), the idea that wolf taking would be unrestricted in such a large portion of Wyoming has been unacceptable for many wolf advocates.

Media became complicit in this controversy by failing to note that relatively few wolves inhabit the Predator Zone. That "oversight" appears deliberate. For example, in several phone interviews with the media, other biologists and I have regularly pointed out this key fact, but seldom was that included in a story. The overall impression was that Wyoming intended to wipe out most of its wolves. One widely circulated account stated that eight groups suing the FWS claimed that Wyoming's management plan classified wolves as "predators that can be shot on sight in most of the state" (*Denver Post* 2012).

In any case, FWS refused to approve Wyoming's plan for years, and it was that plan that figured prominently in lawsuits and even in the Congressional 2011 delisting of the wolf in Montana and Idaho but not Wyoming. In 2012, however, the FWS approved a new Wyoming Gray Wolf Management Plan, which had some modifications that addressed the Service's biological concerns but still allowed open, year-around taking of wolves in the Predator Zone. The FWS delisted the wolf in Wyoming in August 2012 (FWS 2012). The state promptly opened a regulated take of 52 wolves in a "Trophy Zone" (which held about 450 wolves, at least 224 of which were outside of Yellowstone National Park) and unlimited take in the Predator Zone. Some 41 wolves were taken in the trophy area and 20 or so in the Predator Zone. As of this writing, two groups of animal-protection organizations are suing the FWS to relist wolves in Wyoming. Thus Wyoming wildlife managers, who had never before had to contend with controversy over public wolf harvests, suddenly were faced with conflicting views of the Wyoming legislature, big-game hunters, and livestock producers on one side versus wolf advocates on the other. The controversy continues to simmer.

Credit: Dan Stahler/NPS

Biologists collar and assess a breeding male (formerly alpha male) of Yellowstone's Blacktail Pack, which was immobilized by helicopter darting. Up to 30 percent of wolves in Yellowstone are collared, says Douglas Smith, wolf project leader for the park. "What we know about wolves," he says, "hinges on having a marked population."

Other Challenges over 'Take'

Once wolf populations recovered in the Lower 48, several states began to allow public wolf trapping (in addition to shooting) and faced new controversy over that method of take. A graphic photo of a legally trapped wolf in Idaho went viral on the Internet in March 2012 and brought worldwide protest. In addition, the Wisconsin legislature passed a law in 2012 allowing hunters to use dogs to hunt wolves in keeping with that state's long tradition of using dogs to hunt bears (*Ursus americanus*), coyotes (*Canis latrans*), and bobcats (*Lynx rufus*). Animal-protection groups

Credit: Douglas Smith/NPS

Gray wolves from a pack in Yellowstone's Hayden Valley move back to their own turf after killing the breeding male of a nearby pack–an act signifying the species' territorial nature. The successful restoration of wolves across the northern Rockies has led to populations far beyond recovery levels and delisting of the species.

successfully sued to postpone that on the grounds that it would be cruel to the dogs, fearing that the wolves would turn on the dogs and eat them! (After the season closed, the court ruled that use of dogs would be legal.)

Wisconsin has also had to deal with two other new wildlife management issues—tribal interests and night hunting—that have arisen since it assumed wolf management responsibility in 2012. Some tribes, including Ojibwes in the Upper Midwest, view the wolf as sacred. "The Ojibwe have always understood the wolf to be their brother. They look at wolves as teachers, showing … how to live on the landscape, how to raise young using family units, how to persevere under persecution—all the traits necessary to survive in this often-harsh environment" (Johnston 2012). Thus Wisconsin reserved 85 wolves of its planned quota of 201 for the Ojibwe, who then vowed not to kill them. Likewise, in Minnesota, tribes have prohibited public wolf harvest on tribal lands.

A regulation in Wisconsin that allowed night hunting of wolves spawned another new problem and lawsuit. The Ojibwe reasoned that if the state allowed night hunting of wolves, then the natives should be allowed night hunting of deer (*Odocoileus virginianus*). Thus the Great Lakes Indian Fish and Wildlife Commission recently authorized Wisconsin tribes to hunt deer at night with lights. According to one news account, Sue Erickson, a spokeswoman for the Commission, said, "The DNR said it's safe to have hunters in the woods at night hunting wolves and using a light at the point of kill … The tribes are simply instituting the same thing" (*Star Tribune* 2012). The Wisconsin Department of Natural Resources has now sued the tribes to stop their night hunting of deer.

Clearly the varied issues related to public harvest of wolves will be a challenge for all the states with recovered wolf populations—an idea recently captured by Tom Ryder of the Wyoming Game and Fish Department. "Wolves represent every facet of wildlife management and the North American Model of Wildlife Conservation," he says, "touching on public ownership of wildlife, how science must be brought to bear, predator-prey relationships, the challenges of managing a charismatic species, politics, and human dimensions."

Given all those complexities, there are no easy answers to the dilemma facing states trying to responsibly manage such a controversial creature as the wolf. One approach that might help pacify wolf advocates would be for each state to set aside special wolf sanctuaries free from public wolf taking.Such sanctuaries could provide buffer zones around national parks and perhaps reduce the number of park wolves killed just outside the park. (So far in 2012, eight radio-collared Yellowstone Park wolves valuable for research have been killed, drawing much media attention and public condemnation.) Sanctuaries might also help satisfy some of the tribal concerns and would be favored by at least some of the animal protection-groups, although setting aside sanctuaries certainly would not end all the controversies.

In summary, wolf recovery in the Midwest and NRM was easy—for the wolves—but just the opposite for the states. Similar endless and expensive controversy also pervades the ongoing Mexican-wolf recovery program in the southwestern U.S. (see article on page 38) and the red-wolf (*Canis rufus*) program in the Southeast. Such controver-

sy probably ensures that wolf restoration will never be undertaken in other areas.

After that weary phone call from Mike Jimenez, I did submit the legal declaration he requested for the Wyoming court cases. The wolf population is secure in that state today, but only time will tell whether all the legal technicalities were followed in the delisting process. One wonders if all this controversy and litigation by both sides—which began in 1994 and likely will persist into the foreseeable future—might cause some future wildlife-management students to start wondering whether to change their major to pre-law. ■

This article has been reviewed by subject-matter experts.

Share your views on the challenges of wolf recovery and see additional resources on wolf management at news.wildlife.org/twp.

Saga of the Mexican Gray Wolf

THE STRIFE AND HOPE OF A TRICKY RECOVERY EFFORT

By Lisa Moore

In January 2013, the U.S. Fish and Wildlife Service (FWS) released the first Mexican gray wolf (*Canis lupus baileyi)* into the wild in more than four years. The captive-born male, designated M1133, was set free in the Blue Range Wolf Recovery Area straddling central Arizona and New Mexico. Biologists hoped the wolf would replace a free-roaming pack's breeding male that was illegally killed months earlier. Unfortunately, the pack rejected the newcomer, who then roamed into an area where he was unlikely to encounter other wolves for breeding. He was therefore taken back into captivity and placed with a female in hopes that the pair would conceive. If so, they'll be released together to bear their pups in the wild.

Such is the nature of Mexican wolf recovery—a good-news-bad-news story rife with state-federal tensions, complex collaborations, debates over listing status, and hope against difficult odds.

The brightest hope in this tale arose early this year when an annual species survey revealed that the U.S. population of wild Mexican grays is now at least 75 individuals—the highest number since recovery efforts began in the 1970s. Of those 75, all but two are wild born. "This is a successful sign," says Sherry Barrett, FWS's Mexican wolf recovery coordinator. It suggests that "naïve" wolves that originated from captivity can eventually breed, feed, and adapt to life in the wild, perhaps anchoring a sustainable population.

Viewed through another lens, however, this success is thin and tenuous. It has been 30 years since the Mexican Wolf Recovery Plan was created in 1982, setting a population objective of at least 100 Mexican wolves in the wild—a target that has yet to be reached. Biologist Terry Johnson, who led the Arizona Game and Fish Department's (AZGFD) Mexican wolf recovery efforts from 1983 to 2011, attributes the failure in part to rigid federal control that excluded adequate state input and public outreach. "I just didn't see the clear commitment to run the project collaboratively—not just among government agencies, but with the locals who have a vital interest in a living landscape that might or might not include wolves," he says.

Whatever one's perspective, there's no doubt that recovery of the Mexican wolf involves unique biological, ecological, and political challenges that set it apart from recovery efforts for wolf populations in the Northern Rocky Mountain (NRM) region and elsewhere in the U.S. Among the most significant issues:

Captive Breeding. Wolves reintroduced into the NRM came from Canada as wild wolves with natural instincts, little human habituation, and a diverse genetic mix. In contrast, Mexican wolves originate from a captive population with very limited genetic diversity. Inbreeding accumulation may reduce their reproductive fitness and therefore requires close monitoring of both wild and captive groups.

Dispersal Range. Released into large protected areas, wolves in the NRM can disperse among three recovery areas—some 66 million acres in Wyoming, Idaho, and Montana, including over 17 million acres in the Greater Yellowstone Recovery Area—through other states and into Canada (map). The Blue Range recovery area offers 4.4 million acres of habitat, and wolves that leave the area must be captured and returned, making it difficult for the small, isolated population of Mexican wolves to colonize new areas.

Credit: Arizona Game and Fish Department

Born and raised in captivity, a four-year-old male Mexican gray wolf known as M1133 springs to freedom in Arizona's Apache National Forest, where biologists hoped he would breed. After that failed to occur, the wolf was recaptured and paired with a female in captivity, part of an ongoing effort to restore Mexican wolves to their historic range in the Southwest.

Livestock and Land Use. Much of the wolf habitat in the Southwest overlaps with year-round grazing and other land uses such as hunting, increasing the wolves' exposure to livestock and in turn increasing the risks of depredation and human conflicts. From 1998 to 2012, fully 50 percent of known Mexican wolf mortality in the Blue Range area (excluding management actions) came from illegal shooting (FWS).

Politics and Perception. Mexican wolf recovery has required complex collaboration among the AZGFD, the New Mexico Department of Game and Fish, the U.S. Forest Service, FWS, the U.S. Department of Agriculture Wildlife Services Program, the White Mountain Apache Tribe, and Mexico's Dirección General de la Fauna Silvestre. According to the AZGFD's Johnson, changes in program leadership and management style over the years created inconsistency and ill will among recovery staff, agency heads, and the public—distractions that delayed wolf-recovery planning. In 2011, New Mexico pulled out of the recovery effort entirely due to ranchers' concerns about wolf reintroductions (AP 2011). And in February, FWS withdrew a preliminary plan to manage wolves that might wander into the Southwest from Mexico or the NRM because of public uncertainty over the plan's goals (*The Deming Headlight* 2013).

Species or Subspecies?

Mexican wolves were originally listed in 1976 as a distinct subspecies of the endangered gray wolf (*Canis lupus*). But in 1978, Mexican grays and three other subspecies—the northern Rocky Mountain wolf (*C. l. irremotus*), eastern timber wolf (*C. l. lycaon*), and Texas gray wolf (*C. l. monstrabilis*)—were combined under a single gray wolf listing because FWS recognized the entire species *Canis lupus* as "endangered or threatened," a matter it could handle "most conveniently by listing only the species name" (Federal Register 1978). Yet that ruling also said that the "biological subspecies would continue to be ... dealt with as separate entities" and that the Service "will continue to recognize valid biological subspecies for purposes of its research and conservation programs."

Toward that end, FWS approved the separate 1982 recovery plan for Mexican wolves, which launched a 16-year effort to raise a captive population, evaluate genetics, select individuals for release, identify an ecologically suitable release site, and conduct public outreach to gain acceptance for release. In 1998, FWS issued a Final Rule approving reintroduction of Mexican grays, and the first 11 captive-bred wolves were released into the Blue Range recovery area, which includes the Apache and Gila national forests.

Under that 1998 rule, Mexican grays were designated as a "nonessential experimental" population per section 10(j) of the ESA (the same designation as for wolves introduced into the NRM), meaning that captive-bred Mexican gray wolves plus their wild-born offspring are deemed nonessential to the survival of the wolf species and therefore subject to fewer protections than endangered populations. For example, wolves with the nonessential designation that prey on livestock can legally be removed or killed, a management action that is far more restricted for wolves with full endangered status.

Credit: Arizona Game and Fish Department

Wolf biologist Colby Gardner examines a wild-born Mexican wolf pup, captured from its pack in the Apache National Forest in 2009. All wild-born pups are captured so biologists can weigh and measure them, assess their body condition, draw a blood sample, fit them with a telemetry collar, then release them to rejoin their pack.

For a tiny, "nonessential" population, Mexican grays generate intense emotions from all sides. In 2011, the first captive-bred Mexican grays were released in Mexico, but most were poisoned. Still, releases are ongoing in Mexico. In October 2012, FWS rejected petitions from NGOs to again list the Mexican gray separately as an endangered subspecies (Federal Register 2012). The ruling prompted the AZGFD to write a letter asking FWS to clarify the "authorizing basis" for continuing to manage a separate recovery plan for Mexican wolves. And FWS is still working on a long-overdue revision to that plan, now due in 2014.

Back on the ground, members of the Mexican wolf Interagency Field Team continue to monitor the 15 or so small packs of Mexican wolves now in the wild and work with landowners and NGOs to minimize conflicts and bolster public support. Those efforts include hiring range riders and hazing wolves to reduce livestock depredation, and encouraging rotational grazing to keep livestock away from wolf den sites. The recovery effort has been rocky, yet there is reason for hope. "What I'm optimistic about," says Johnson, "is this: we have wolves on the ground that are wild. They're going to find a way to survive." ■

This article has been reviewed by subject-matter experts.

Lisa Moore is Editor-in-Chief of *The Wildlife Professional.*

Cool Head for Controversy

PROFESSIONALISM HELPS ACHIEVE CONSENSUS

By Ed Bangs

Courtesy of Ed Bangs

Ed Bangs is the Retired Wolf Recovery Coordinator for the U.S. Fish and Wildlife Service.

When I was working on wolf conservation in the northern Rocky Mountains of Montana, Idaho, and Wyoming, I heard many choice comments from people on both sides of the listing-delisting divide. Among them: "What brain-dead $@# thought this up?" "Shoot all the wolves and the biologists that brought them." "May your putrid corpse rot in hell."

Clearly, people weren't shy in expressing their opinions about wolves, a capable predator that is uniquely symbolic to humans. Conserving wildlife relies on public support, but reaching a workable compromise that folks from both sides can tolerate can be difficult, especially when it involves wolves. Wolf restoration requires adequate habitat, sound science, clear policy, solid legal advice, honest relationships with the press and public, fair and timely decisions, field skills, luck, and—most important—public tolerance for both restoring and killing wolves.

An even trickier personal dilemma can occur when bureaucrats, politicians, decision makers, lawyers, biologists, academics, and others at federal, state, county, tribal, agency, or business levels (including your employer) embrace a position that you oppose. As a wildlife professional, what is your role and how do you maintain your integrity? I have heard a lot of advice on being a professional, and I know it is easier to give advice than follow it. One useful guide is The Wildlife Society's position statement on The Use of Science in Policy and Management Decisions. I'll add a few thoughts of my own.

Courtesy of Ed Bangs

As livestock producers look on, author Ed Bangs begins to skin a calf suspected of being killed by wolves in Montana in 1989. Examination proved it was not killed by wolves, but others had been. To minimize threats to livestock, the FWS wolf-recovery program removed depredating wolves.

Remove the hair shirt. To quote Dolly Parton, "Get off the cross. Someone needs the wood." Few things are less helpful than proclaiming that only you have 'the' answer and are brave enough to tell the truth. In my wolf-management work, a few biologists publically accused me and others of deception and illegal actions because their opinion did not carry the day. Some were so repulsed by some policies—such as the Wyoming Legislature's predatory animal designation, which treats wolves as vermin—that they opposed delisting, even though the best science indicated that the policy could be biologically supported in some areas. Others only referenced the science that supported their opinion, thereby making wolves appear better or worse than the facts indicated. Lawyers and activists from both sides used these opinions to cast doubt over the validity of the science used to support reintroduction, management strategies, and eventually delisting.

Fanning the flames of all that human drama wasn't helpful to wolves, people, or the wildlife profession. By 2011, Congress had become so frustrated with the gridlock that, for the first time, it legislatively removed a species from the protections of the Endangered Species Act. Conservation is an art that involves skills beyond science. If you can appreciate and value the skills of other professionals and the difficultly of successfully implementing an idea, you will become more effective at your job. Always strive to use science appropriately, and try to keep your professional views separate from your personal beliefs.

Honesty and transparency are essential. I believe a free press is critical to holding our government accountable to its citizens, so strive to remain

open and professional if you deal with the press. Don't make promises you can't keep, and keep the ones you make, because people judge what you do more than what you say. During hundreds of public meetings and interviews about wolf restoration and management, we told the same story (good, bad, and ugly) about wolves to every audience. The message was that real wolves cause real problems that need real solutions, and those issues can be resolved by professional wildlife managers when people are open to compromise.

In 1989, wolves depredated on livestock in northwest Montana, and we had always told livestock producers that we would not let those situations become chronic problems, even if it meant removing depredating wolves. We relocated the only pack outside of Glacier National Park, but sadly, because of our inexperience, only one survived. Luckily that female found a mate, had pups, and formed a pack just north of the Idaho border, forever changing the public debate about wolf reintroduction because it showed that wolves were coming—wanted or not. More important, the Montana rancher involved told other ranchers that FWS kept its word, making a huge difference in the program's credibility.

There will be many times in your career when someone will make a decision you would not. A "yes" person is rarely respected, but saying "no" doesn't have to be disrespectful. Always give your honest input but avoid nagging, which is rarely productive. More than once I disagreed with a decision that didn't follow what I believed was the best course of action. But once the agency made a decision, within my ethics as a wildlife professional I tried to make that decision a success. Some decisions worked, others didn't, but I learned there are lots of paths to success (or failure) besides what I recommended.

Forgive yourself and others. No one is perfect, and all we can hope for is to give it our best shot and learn from hindsight. In southwest Montana, for example, a new wolf pack began depredating on livestock and emotions were running high. I finally had all the wolves in that general area killed. Unfortunately a nearby pack that had not depredated and had a radio-collared member had left their normal home range to feed at a bone yard in the valley where the depredations had occurred. We didn't search for radios prior to the control action and both packs were eliminated, a careless mistake on my part. Strive to do more good and less harm by learning from mistakes, and instead of wallowing in anger or guilt, keep your cool and come up with better solutions in the future.

Few seek help from zealots. Many of us became resource professionals because we personally value wildlife. Don't lose sight of that passion and wonder, but have it in every part of your life, not just your job. If your identity is just your job, you will confuse what your ego or peer group wants with what the job and resource needs. A bigger life will let you become more empathic and understanding to other perspectives and more confident about where the job ends and you begin. You don't have to agree with your agency's decisions, but you have to live with yours. Resource issues are about the collective public—the messy, confusing, illogical, diverse "we" that decides what's right and wrong. Be confident enough to respectfully defend your own boundaries and your role in the process, but respect the right of others to do the same.

Credit: Douglas Smith/NPS

Author Ed Bangs works with a collared gray wolf from Yellowstone's Delta Pack that had been tranquilized by helicopter darting. As a veteran of wolf-recovery efforts throughout the northern Rockies, Bangs learned that a thick skin and open mind can help managers navigate controversial waters.

Enjoy the ride. Helping to conserve nature can be an honorable and personally fulfilling career, but it isn't always easy. Making a difference requires persistence, which requires a passionate, hopeful heart. One of the achievements I am proudest of was that our interagency team that conducted wolf reintroduction and management for nearly 20 years received an FWS award as Recovery Champions. We were, on average, the oldest-aged group to be so recognized, as most of us had been involved in wolf management for decades. Having a program that could retain talent and teamwork, despite the external controversy, internal pressures, and our personal and agency differences, was deeply rewarding.

The graduate students, volunteers, and seasonal biologists, who started their careers with us now help lead state and tribal wolf conservation programs in Montana, Idaho, Wyoming, Oregon, and Washington. Leading ethical professional behavior by example and helping to develop talent in those who will follow is the biggest contribution a professional can make. As I look at today's state and tribal programs and the professionals involved, I know the future of wolf conservation is in good hands.

Return of a Rare Tanzanian Native

THE REINTRODUCTION OF THE KIHANSI SPRAY TOAD

By Patrick R. Thomas, James J. Breheny, and Donal M. Boyer

Credit: Julie Larsen Maher/WCS

Patrick R. Thomas, Ph.D., is the Vice President, General Curator, and Associate Director at the Wildlife Conservation Society's Bronx Zoo.

On October 30, 2012, calls of the Kihansi spray toad (*Nectophrynoides asperginis)* rang out once again in Tanzania's Kihansi Gorge—a welcome noise not heard in the region since 2004. The calls emanated from 72 small containers that arrived with an international group of 45 conservationists and 25 Tanzanians who had trekked up the gorge's wet hillside in the Udzungwa Mountains as part of a reintroduction effort—the first ever attempted for an amphibian species declared extinct in the wild.

The International Union for Conservation of Nature (IUCN) classified the species as extinct in the wild in 2009, but nearly a decade earlier, a number of organizations had already begun the fight to save the small but charismatic species from extinction. Their efforts culminated on that late-October day last year with the release of 2,000 captive-bred Kihansi spray toads at two sites in the gorge by representatives from the Bronx Zoo, Toledo Zoo, National Environment Management Council of Tanzania, Tanzania Wildlife Research Institute, University of Dar es Salaam, Sokaine University, World Bank, Lower Kihansi Environmental Management Project (LKEMP), Global Wildlife Conservation, University of Georgia Savannah River Ecology Laboratory, Tanzania Electric Supply Company Limited, and officials from local Tanzanian villages. Within a week, 435 more captive-born toads were released at a third site in the gorge. According to Sazi Salula, the Permanent Secretary of Tanzania at the Vice President's office, "Reintroduction of Kihansi spray toads and other ongoing efforts depict Tanzania's commitment towards the conservation of biodiversity as well as balancing water needs among the different users."

Small Toad Earns Huge Effort

The Kihansi spray toad is one of 13 species in the genus *Nectophrynoides*. All are native to the Eastern Arc forests and wetlands of Tanzania, and all are unique among toads in that they are ovovi-

Credit: Julie Larsen Maher/WCS

Credit: Patrick R. Thomas/WCS

An adult female Kihansi spray toad transports a young juvenile (above) within the safe confines of the Bronx Zoo's Amphibian Propagation Center (right), which contains a biosecure room dedicated to the zoo's captive-reared colony of the highly endangered species. Years of research about optimal temperature, light, diet, and humidity levels have enabled researchers to breed populations of the toad for relocation back to its native Tanzania.

viparous (Channing et al. 2006), meaning they do not have a free-swimming tadpole stage but emerge at birth as fully formed toadlets. First discovered in 1996, the Kihansi spray toad is endemic to the herbaceous vegetation in the spray zone of the Kihansi Falls (Poynton et al. 1998). Its global range consists of less than two hectares (Channing et al. 2006), and may be the smallest range for any vertebrate ever studied.

The species' population appears to have oscillated naturally with changes in environmental conditions, but possibly was never much more than 20,000 individuals. The population began a steep decline in 2000, however, with the construction of a dam upstream of the gorge, which significantly reduced water flow to the area and greatly lessened the mist from the falls (Channing et al. 2006). This reduction of spray, especially during the June to October dry season, altered the gorge's vegetation and the toads' invertebrate prey, ultimately impacting toad survival.

Recognizing the threat this dam posed to the toads, in 2000 the Tanzanian Government invited the Wildlife Conservation Society's Bronx Zoo to collect a group of Kihansi spray toads and take them to the U.S. to establish assurance colonies should something catastrophic occur to the remaining toads in the wild. In November that year, 499 toads were collected and initially sent to facilities at the Bronx, Detroit, and Toledo zoos. Toad populations at these North American zoos fluctuated for a number of years while researchers developed the skills to successfully manage and propagate Kihansi spray toads in captivity.

The zoo researchers faced and addressed myriad challenges. Through trial and error they had to develop nutritionally-balanced diets for the toads, which eventually began to thrive on a diet of pinhead crickets, fruit flies, isopods, springtails, larval *Tenebrio* beetles, bean beetles, and young roaches of various species. Researchers also had to learn the optimal temperature (69°F, with a range of 61-75°F), humidity (60-100 percent, with enclosures being misted for 22 hours per day), and light-level (12L:12D) requirements for the toads. In addition, researchers had to provide for the species' health needs (e.g., treating toads for intestinal parasites, lungworm, infections, and exposure to chytrid fungus). These were just some of the complex husbandry issues that had to be mastered before the zoo populations could be stabilized and then eventually increase in size (Lee et al. 2006).

Credit: Alyssa Borek/WCS

A gravity-fed spray irrigation system installed in Tanzania's Kihansi Gorge re-creates the spray zone that dried after an upstream dam reduced water flow to Kihansi Falls. Because the Kihansi spray toad's sole habitat lies within the misted vegetation near the falls, reestablishing the spray zone was essential prior to the toad's reintroduction in 2012.

Help from the Homeland

Intense efforts to save the toads were also underway in Tanzania. Approximately nine months after the dam began to restrict water to the Kihansi Gorge, a gravity-fed sprinkler system was installed to mimic the spray zone. Despite this attempt to re-create the natural mist from the falls, the wild population of spray toads continued to decline. In 2003 there was a precipitous population crash that coincided with three factors: a breakdown of the sprinkler system during the dry season, the appearance of the disease chytridiomycosis—which was confirmed from necropsies of dead toads (Weldon and du Preez 2004)—and a brief opening of the Kihansi Dam to flush out sediments, which contained pesticides that were potentially harmful to the toads and their prey (Krajick 2006). The extent to which each of these factors contributed to the final population crash may never be known. A 2004 census found only three individuals, with two other toads heard calling. By 2005 there were no confirmed sightings.

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In May 2007, the IUCN Species Survival Commission's Conservation Breeding Specialist Group (IUCN/SSC CBSG) convened a Population and Habitat Viability Assessment workshop in Bagamoyo, Tanzania to develop guidelines for a Kihansi spray toad recovery plan. The outcome of this workshop included recommendations for the zoo populations as well as identifying what would be required to establish the species back in nature. Recommendations for zoos included maintaining animals in biosecure facilities, encouraging reproduction to maximize population size with no limit on carrying capacity, minimizing the loss of gene diversity, and developing test methods to screen for pathogens. The workshop participants also outlined preliminary steps that would have to be taken prior to attempting to establish populations in the wild, including developing a reintroduction plan that was consistent with IUCN guidelines, conducting a reintroduction feasibility study, and developing a strategy for post-release monitoring (CBSG 2008).

Credit: Kurt A. Buhlmann/University of Georgia

Credit: T Kurt A. Buhlmann/University of Georgia

University of Dar es Salaam graduate student Nassor Mohammed (top) lifts the lid of a "soft release" enclosure to inspect a group of Kihansi spray toads bred in captivity. Toads in these enclosures were able to catch native prey species and successfully reproduce within 3.5 months, essential benchmarks researchers needed to see prior to reintroduction. In late 2012, one partner in the project (above) helped release some of the first toads into the wild.

By 2010 the zoo populations had really taken off: There were more than 6,000 spray toads in breeding colonies in the Bronx and Toledo zoos, with small numbers of exhibit colonies at four other North American zoos. Staff from both zoos also trained Tanzanian biologists and veterinarians to care for the toads, conduct necropsies, and develop their molecular diagnostic skills. Bronx and Toledo zoo staff also provided input on the design and operation of a spray toad facility that was built at the University of Dar es Salaam, Tanzania.

In August 2010 a captive colony of toads from the Bronx and Toledo zoos was established at the University of Dar es Salaam facility, where it was managed by university and National Environmental Management Council researchers. A second spray toad facility, located at the Kihansi Gorge, opened in 2012. The two Tanzanian facilities are able to maintain approximately 3,000 toads. To date, 1,800 spray toads (in four separate shipments) have been sent from the Bronx and Toledo zoos to serve as a breeding colonies at the two facilities. An additional 2,000 toads were sent from the zoos to Tanzania in October 2012 for the reintroduction.

To prepare for the reintroduction, in February 2010, the Lower Kihansi Environmental Management Project within Tanzania's National Environmental Management Council and the University of Dar es Salaam organized a meeting of Tanzanian biologists and an international team of conservationists from the Bronx and Toledo zoos, the IUCN/SSC's Amphibian Specialist Group and Reintroduction Specialist Group, Global Wildlife Conservation, and other partners to develop a plan for reintroducing the Kihansi spray toad back into the Kihansi Gorge (Khatibu et al. 2011). The reintroduction plan set a timeframe to address causes of the spray toad's decline as well as conduct a series of experiments to ensure that reintroducing the species would not negatively impact the Kihansi Gorge ecosystem. Additional experiments would attempt to discern

the best protocols for reintroducing the animals to ensure their long-term survival in the wild.

The "do no harm" experiments, conducted at the Tanzanian facilities in 2011, were designed so that reintroducing the spray toads would not put other amphibian species in the Kihansi ecosystem at risk through the accidental introduction of non-native pathogens. They were also designed to confirm that the zoo-born toads would not be susceptible to pathogens already present in the gorge. Results of these experiments were very encouraging. There was no mortality when amphibian species native to the gorge were placed in spray toad enclosures, or when spray toads were moved into enclosures containing native amphibians, water, and substrate from the gorge. The as-yet-unpublished studies confirmed that the source populations of the spray toads maintained in the biosecure facilities at the Bronx and Toledo zoos were not likely to transmit new diseases into the gorge.

The Final Push

Soft release experiments began in the gorge in June 2012. In preparation for these trials, the toads were marked for individual recognition using subcutaneous elastomer dyes. In the soft release experiments, toads were maintained in three small mesh enclosures in different group compositions for approximately 3.5 months. One enclosure contained eight adult males and eight adult females, the second had 24 sub-adult animals of both sexes, and the third had eight gravid females. The design of the enclosures enabled prey species to enter but prevented the toads from leaving. Each enclosure was used to test different aspects of the toad life cycle, and parallel experiments were conducted with spray toads in the Tanzanian research facilities. The results of these soft releases were very positive. The spray toads were able to capture native wetland prey species such as insects, arthropods, and mites. The toads also were successful in reproducing and had mortality rates which did not significantly differ from rates observed in the captive Tanzanian colonies.

This soft release work paved the way for the reintroductions that took place in October and November 2012. Groups of up to 28 spray toads were released in 24 locations at three sites within the species' natural range in the Kihansi Gorge. Some of the individuals in each group were marked using fluorescent elastomer marks. The reintroduced toads are being monitored by Kurt Buhlmann and Tracey Tuberville—research scientists with the University of Georgia's Savannah River Ecology Laboratory and associate conservation scientists with Global Wildlife Conservation. "It is extremely exciting to be involved in actually returning a species that was extinct in the wild back to its native habitat," they say. "This project is a shining example of international collaboration, linking tremendous effort by the Tanzanians to recreate the unique habitat with successful captive breeding programs and a scientific approach to implementing the reintroduction for a species that was nearly lost."

Credit: Alyssa Borek/WCS

A newly released young male Kihansi spray toad inspects his species' ancestral home for the first time. Groups of as many as 28 toads were released in 24 locations at three different sites within the Kihansi Gorge, the first reintroduction of an amphibian species declared extinct in the wild.

There are now plans to introduce another group of spray toads into the Kihansi Gorge in 2013 in an effort to establish a genetically viable, demographically stable population. Meanwhile, the initial reintroduction is being carefully assessed. And while we cannot yet declare that this effort has been an unqualified success, what has been achieved with this species to date cannot be overstated. "The success story of the small Kihansi spray toad can teach us big lessons for the future of biodiversity conservation," says Claude Gascon, Co-Chair of the IUCN/SSC Amphibian Specialist Group. "While amphibians and other species are incurring severe threats to their survival, it is never too late to use the best science and conservation action to save a species and its habitat. … No species and no situation is too dire to try to save life on Earth. Extinction in the wild is not forever." ■

Silent Forests?

RODENTICIDES ON ILLEGAL MARIJUANA CROPS HARM WILDLIFE

By Mourad W. Gabriel, Greta M. Wengert, J. Mark Higley, Shane Krogan, Warren Sargent, and Deana L. Clifford

Credit: Timothy Archibald

Mourad W. Gabriel is a Doctoral Candidate at the Veterinary Genetics Laboratory at the University of California-Davis and President of the Integral Ecology Research Center.

Another mortality signal on the radio collar of a fisher (*Martes pennanti*) pulses on a wet spring morning, and fear of a repeat of the previous spring's mortalities looms in the backs of our minds. Hoopa tribal biologists scramble to recover the fisher quickly so that a necropsy can be performed to determine cause of death. The field crew reports back that the fisher is not dead but lethargic and lurching on the ground when it attempts to seek cover from approaching biologists. A conference call among researchers, a wildlife pathologist, and a veterinary toxicologist follows to determine the next course of action. Unfortunately, the consensus is humane euthanization. Though testing is ongoing, this is likely the sixth monitored fisher in California that has died from second-generation anticoagulant rodenticide (SGAR) toxicosis since 2009.

Linking SGARs to multiple deaths of a rare forest carnivore has been an alarming discovery. Even more unsettling: We've learned that these deaths appear to be linked to illegal marijuana cultivation on community and public lands—a finding that raises serious concerns for the health of many species of wildlife including fishers, an Endangered Species Act candidate.

Credit: John Jacobson/Washington Department of Fish and Wildlife

The fisher (*Martes pennanti*) is a cat-sized carnivore found in coniferous and mixed conifer and hardwood forests across Canada and in four regions of the United States, including New England, the Great Lakes, the northern Rockies, and the Pacific Northwest. Now a candidate species for listing under the Endangered Species Act, fishers in California are falling victim to rodenticides used on illegal marijuana crops scattered throughout the state's public and tribal lands.

A Growing Concern

Beginning in 2008, full necropsies including toxicological screens—done at the University of California-Davis School of Veterinary Medicine and the California Animal Health and Food Safety Laboratory (CAHFS)—have been conducted to determine proximate and ultimate causes of mortality for fishers from the Hoopa Valley Reservation Fisher Project (HVRFP), Sierra Nevada Adaptive Management Project (SNAMP), and the U.S. Forest Service (USFS) Kings River Fisher Project (KRFP). These ongoing, long-term demographic projects encompass both tribal community forests within the HVRFP and public lands including Yosemite National Park and Sierra National Forest in the SNAMP and KRFP study areas.

Toxicology screening of 58 fishers from these community and public lands revealed that nearly 80 percent of the fishers had been exposed to anticoagulant rodenticide (AR) poisons, with 96 percent of those exposures being SGARs—results that we published recently in *PLoS ONE* (Gabriel et al. 2012). Concerned about this trend, we led an interdisciplinary collaboration including multiple stakeholders from the Hoopa Tribe, Integral Ecology Research Center, USFS, U.S. Fish and Wildlife Service, CAHFS, UC-Davis, SNAMP, and California Department of Fish and Wildlife, pooling together resources and expertise for a comprehensive approach to evaluate this emerging threat.

Co-author Affiliations

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Shane Krogan is Executive Director of the High Sierra Volunteer Trail Crew.

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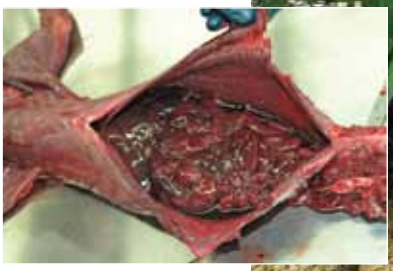
Spatial modeling suggested that fishers were exposed to SGARs ubiquitously throughout the study areas, contradicting current thought that wildlife are at greatest risk to these toxicants near agricultural, urban, or peri-urban settings, where the pesticides are legally used to eradicate or suppress rodent pest populations. However, lifetime monitoring of the California fishers showed that most of the exposed or poisoned individuals never overlapped any of those land-use types. In addition, the use of SGARs within the study areas, in adjacent timberlands, or within campgrounds would violate current state and federal regulations. As a result, our suspicions gravitated towards undiscovered illicit uses throughout the project areas. These suspicions were essentially confirmed after federal, state, and local law enforcement officers verified that the poisons were present at most marijuana cultivation sites found on public and tribal lands.

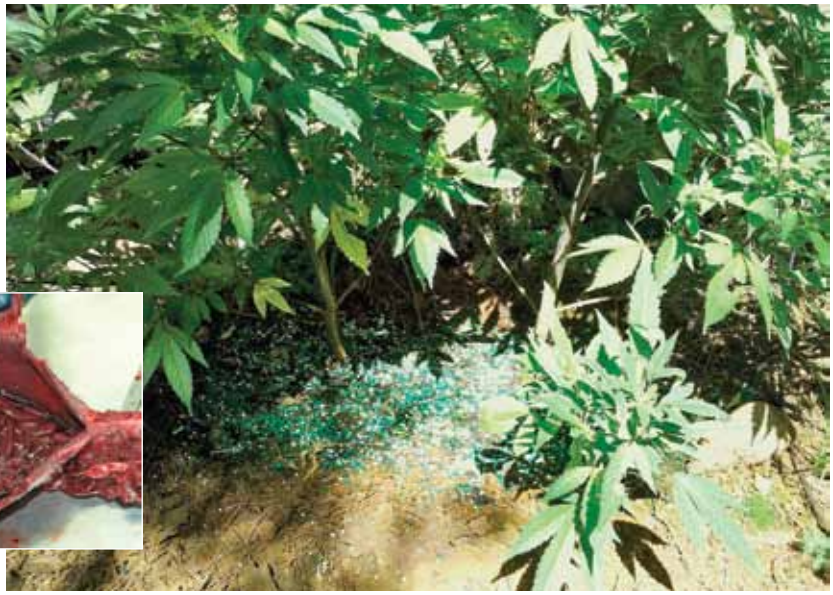


Credit: Mourad W. Gabriel

All of our documented SGAR fisher mortalities occurred from late April through early June, which is prime-time for marijuana seedling planting in California and likely the period of heaviest toxicant use to protect young plants from rodent damage. Regrettably, this is also a key time for female fishers to rear their kits. That unfortunate timing materialized when we discovered a lactating female fisher dead from SGAR poisoning in the Southern Sierra Nevadas. (California currently has two isolated native fisher populations, one within the northwestern coastal mountains, where population estimates are unknown, and another within the Southern Sierra Nevadas, where estimates suggest fewer than 300 adults [Spencer et al. 2011]). Presumably, the dead mother's kits also died due to den abandonment.

In a separate instance, a rescue attempt on an abandoned fisher kit still dependent on its mother's milk was unsuccessful, and the kit was found dead of starvation. Most disconcerting was that SGARs were detected in the kit's tissues. This unexpected finding verified a transplacental or milk transfer of a SGAR from mother to kit, raising concern about fetotoxic or bioaccumulation effects of these pesticides, which are currently unknown.

These findings underscore the need to understand not only the direct impacts of these toxicants, but other possible indirect impacts that fishers and other wildlife may face at the population level. For example, we detected an average of 1.6 different types of ARs per fisher, with some fishers testing positive for four different toxic compounds. There are no data on the possible interactions of two, three, or even four different ARs, or the effects they might have on animal health. Furthermore, we cannot yet determine whether a threshold level of exposure exists beyond which an animal cannot recover, since some fishers died with low levels of SGARs while others displayed no clinical signs even with much higher exposures. We wonder if these toxicants at sub-lethal doses lower resistance to environmental stressors, as seen in other studies, and whether the distribution of SGARs within the landscape will limit prey availability and create sink habitats near cultivation sites. This is just the beginning of a long list of potential cascading impacts now being discussed in California.



Courtesy of Mourad W. Gabriel

Pellets of anticoagulant rodenticide litter the ground beneath marijuana plants at an illegal grow site within occupied fisher habitat. Placed to kill rodents that might eat the valuable plants, these poisons–particularly second-generation anticoagulant rodenticides–have been linked to numerous deaths of fishers. The rare forest carnivores likely die of internal hemorrhaging (inset) after ingesting the anticoagulants or preying on rodents that have fed on the toxicants.

Problem Spreading Like Weeds

Illegal marijuana growing is not just a problem for wildlife. The High Sierra Volunteer Trail Crew is a nonprofit trail-maintenance crew that has spent the past seven years maintaining and cleaning trails throughout the Sierra Nevadas' national forests. In the mid-2000s, the group realized that risks associated with large-scale marijuana production

throughout most, if not all, California national forests threatened backcountry use of public lands. Since then, the trail crew's Environmental Reclamation Team (ERT) has remediated more than 600 large-scale marijuana cultivation sites on public lands. The numbers are daunting, especially when considering that these 600 sites were in only two of California's 17 national forests and may constitute only a fraction of the actual marijuana cultivation sites that exist in these forests. Tommy Lanier, Director of the National Marijuana Initiative, a White House supported program, states that "60 percent to 70 percent of the national marijuana seizures come from California annually, and of those totals, about 60 percent comes from public lands."

Based on data from ERT-remediated sites, at least 50 percent of them have SGARs. Beyond finding anticoagulant rodenticides, the team and other

Credit: Mourad W. Gabriel

Accompanied by armed escorts for security, Hoopa Tribe wildlife biologist J. Mark Higley (in green hard hat) documents corn stalks likely planted to provide food for growers of illegal marijuana (right foreground). Clearings for food crops, water diversions, fertilizers, and debris left by growers cause damage to natural wildlife habitat.

remediation groups frequently find and remove restricted and banned pesticides including organophosphates, organochlorines, and carbamates as well as thousands of pounds of nitrogen-rich fertilizers. Many of the discovered pesticides have been banned for use in the U.S., Canada, and the European Union, specifically certain carbamates, which gained notoriety worldwide after an explosion of public awareness about their use to kill African wildlife. Unfortunately, these same malicious uses are occurring in California, where marijuana cultivators place pourable carbamate pesticides in opened tuna or sardine cans in order to kill black bears, gray foxes, raccoons, and other carnivores that damage marijuana plants or raid food caches at grow-site encampments.

In many cases, law enforcement officers approaching grow sites observe wildlife exposed to what officers call "wildlife bombs" due to their high potential for mass wildlife killing. For example, as federal and state officers approached a grow site in Northern California, they discovered a black bear and her cubs seizing and convulsing as they slowly succumbed to the neurological effects of these pesticides. Because toxicants are usually dispersed throughout cultivation sites, it is remarkably difficult to detect and remove all pesticide threats.

Funding to document, quantify, and remediate the damage caused by illegal marijuana cultivation on public and tribal lands has been difficult to secure through state or federal agencies or even private foundations, possibly due to the common misperceptions that illegal marijuana cultivation is not an environmental but rather a social issue, and that it is not a significant threat to wildlife. Yet we propose that funding is strongly warranted to help researchers investigate toxicant exposure and implications throughout the forests' trophic levels, and to study impacts on all species of conservation concern, including fishers and the northern spotted owl.

Another common misperception is that it is the responsibility of law enforcement to not only protect our natural resources at illegal marijuana sites, but also to remove pesticides and remediate the sites. In truth, there is currently no standardized system for grow-site remediation. Recently, for example, we encountered more than 10 pounds of SGARs and 20 pounds of metaldehyde and carbamates from a single site that law enforcement officers had dismantled within fisher and northern spotted owl territories. Most of these toxicants were left untouched out of concern for the safety of the officers, who are not trained to handle and transport these highly toxic chemicals, especially in the frequent situation where these chemicals are unlabeled. Accordingly, without documentation of the environmental damage and threats from toxicants, and without funding for properly trained personnel, most poisons will continue to be left at grow sites, where they remain a catastrophic threat to wildlife.

Effects Extend beyond Poison

Environmental threats from large-scale marijuana cultivation are certainly not limited to toxicant contamination. At most grow sites, it is standard practice to clear patches of forest within riparian corridors in order to provide enough sunlight for growing plants. The cumulative impact of these practices across the California landscape is unknown, but disheartening in its potential. Last year, at a site within the Hoopa Valley Indian Reservation in northern California, where 26,600 marijuana plants were removed, several acres of hardwood-conifer and alder forest had been cleared along one of the most productive Chinook and Coho salmon-bearing streams in the area. Under no circumstance would this clearing be allowed under the Tribe's management plans or current state or federal regulations established to protect habitat for the salmon.

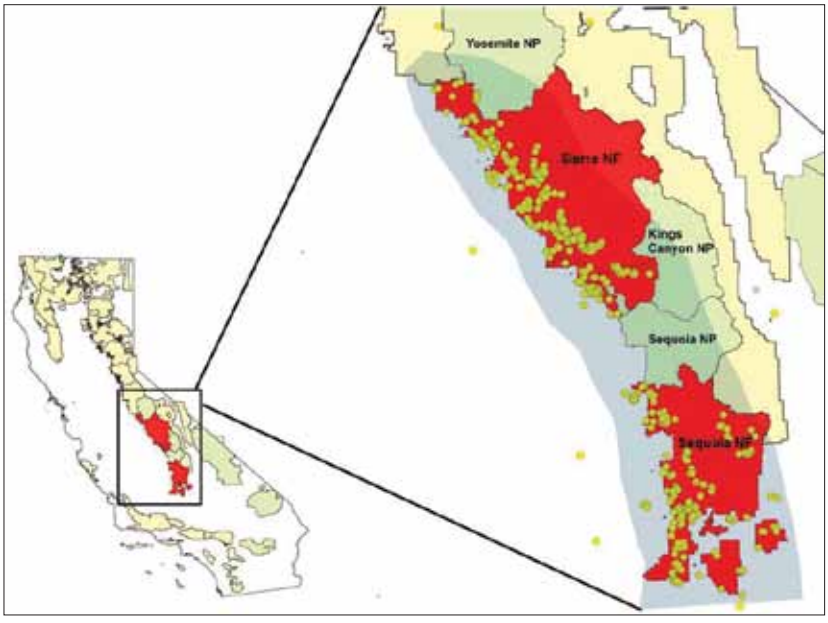
Credit: Environmental Reclamation Team

Credit: Environmental Reclamation Team

Volunteers with the Environmental Reclamation Team display thousands of pounds of garbage, chemicals, and other debris gathered at an illegal marijuana cultivation site in the Sierra Nevada Mountains. Plastic bottles refilled with unlabeled substances (left) sometimes contain carbamates, banned chemicals that growers use to kill bears, foxes, raccoons, and other animals that may harm pot plants or raid growers' food caches.

Because growers prefer areas with a constant and abundant water supply, it is these sensitive habitats that suffer the greatest impacts from marijuana cultivation. Water diversions and pesticide-filled cisterns within streambeds feeding miles of plastic irrigation lines are all-too-familiar a sight. Human waste throughout these sites is also widespread, and because many of the sites on public and tribal lands are inhabited for several months of the year by drug-traffic organizations, extensive camp systems are set up with associated trash dumps and human latrine sites just meters away from water sources.

The camps and plantations are often guarded by armed drug traffickers, so concern for the safety of field crews, students, and biologists working on these lands is ever pressing. Wildlife professionals are fearful of unwittingly running into armed growers at active grow sites, with good reason. Recently, a federal biologist in the southern Sierra Nevadas was chased by armed growers for 40 minutes through the national forest. "When we lost radio contact at one point for 10 minutes, we feared that the biologist was captured or possibly dead," says project supervisor Jodi Tucker of Sequoia National Forest. In another incident in the 2012 field season, biologists surveying for northern spotted owls on the Hoopa Reservation were



Credit: Greta M. Wengert

Dots scattered through California's Sierra and Sequoia National Forests represent some 600 illegal marijuana grow sites reclaimed by crews who removed trash, hazardous chemicals, water diversions, and rudimentary shelters left by growers. Blue shading represents current range of the fisher within the southern Sierra Nevadas, where the population is estimated at fewer than 300 adults.

shot at by suspected illegal growers with high-caliber assault rifles. Luckily, no one was injured, but biologists avoided the survey area until the threat was addressed.

Due to heighted safety concerns and emerging patterns like these over the past several years, wildlife crews now are often composed of two individuals, whereas before, biologists worked independently in the field. The effects of these changes have not been fully ascertained, but it can be assumed that increased labor costs coupled with increased equipment and vehicle expenditures are affecting the size, duration, and thoroughness of data for many studies on California's public and tribal lands.

Because wildlife biologists are also avoiding some study areas due to safety concerns, study designs are now being altered to avoid known grow sites, thus further impacting quality and completeness of data. Research ecologist Craig Thompson from the USFS Pacific Southwest Research Station estimates that during each field season, 10 to 25 percent of the Kings River Fisher Project area becomes inaccessible due to safety concerns. In another telling example during the 2010-2011 field season, two radio-collared fishers in this study area pulsed mortality signals but could not be recovered due to their locations near known grow sites. Eventually, under escort by armed law enforcement officers, biologists recovered the collars, yet the carcasses—and any evidence of cause of death or rodenticide toxicosis—were long destroyed.

In his *Science* editorial "The Tragedy of the Commons," Garret Hardin lamented the loss of our public resources due to the greed and inconsideration of some individuals (Hardin 1968). We believe the vast and ever-growing misuse of our public and tribal forests for the financial benefit of a few individuals is an enormous threat to these resources and a deplorable tragedy of the commons. Our public and tribal land and agencies are being hit on two fronts: first by having to endure the illegal use, take, and destruction of natural resources without our permission, then having to support the financial burden of renewing these lands from the disastrous ecosystem degradation that illicit cultivation produces. Regrettably, most of this is occurring without the knowledge of the public, whose land it is. Though this is a sad story that often brings surprise, disgust, and a feeling of helplessness in those hearing it for the first time, in the words of Rachel Carson, "The public must decide whether it wishes to continue on the present road, and it can do so only when in full possession of the facts." ■

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The Rise of Ranavirus

AN EMERGING PATHOGEN THREATENS ECTOTHERMIC VERTEBRATES

By Matthew J. Gray and Debra L. Miller

Ranaviruses have been called "cold-blooded killers" (Chinchar 2002) for good reason—they are capable of causing illness and death in three ectothermic vertebrate classes (amphibians, reptiles, and fish). Experiments have also demonstrated that the virus can be passed among these groups (called interclass transmission; Bandin and Dopazo 2011), likely facilitating its persistence in aquatic systems. Ranaviruses were discovered in the 1960s (Granoff et al. 1965), yet their role in widespread die-offs of ectothermic vertebrates wasn't realized until the 1990s (Gray et al. 2009). Researchers are now racing to determine what makes ranaviruses so virulent and capable of infecting so many hosts (Lesbarrères et al. 2012).

Credit: Matt Niemiller

The larvae of marbled salamanders (above) were among several amphibian species—including spotted salamanders, wood frogs, and spring peepers—that died due to a ranavirus outbreak in Cades Cove, Great Smoky Mountain National Park.

We've been in that race for eight years after detecting ranavirus in frog communities in Tennessee farm ponds. We found that green frog (*Lithobates clamitans*) tadpoles in ponds with cattle access were 4.7 times more likely to be infected with ranavirus than those in ponds with no cattle (Gray et al. 2007). Although many factors may have contributed to this trend, we suspect that poor water quality (a stressor) and minimal vegetation (which increases contact rates among individuals) in cattle-access ponds played a role.

Since then, we've tested thousands of amphibians across Tennessee and other states and performed dozens of experiments to learn about ranavirus-host interactions. From our experience, ranavirus exists typically at low prevalence (less than 5 percent of individuals infected in a population), then emerges rapidly over a two-week period, with mortality exceeding 90 percent in multiple species. Amphibian tadpoles are most often affected, but other cold-blooded animals (such as freshwater turtles) that come in contact with the virus in water or by eating live or dead infected individuals may also succumb to the disease.

After a ranavirus outbreak, aquatic community composition and ecosystem function can change drastically as thousands of omnivorous herpetofauna die and rot at the bottom of a wetland or lake. In more than 40 years of contemporary research on pathogens affecting ectothermic vertebrates, few pathogens have been found to have as great an ability to transform aquatic ecosystems as ranaviruses.

Ominous Body of Evidence

With one in three amphibian species and over 40 percent of turtles at risk of extinction (Stuart et al. 2004, Buhlmann et al. 2009), ranavirus represents a significant threat to herpetofaunal biodiversity. An emerging pathogen is one whose distribution, prevalence in a population, or host range is increasing. Efforts to search for ranavirus in ectothermic vertebrates has increased, and there is a growing body of research that suggests this pathogen is emerging. Consider:

- Through the use of modern genetic analyses, Andrew Storfer at Washington State University found that novel ranaviruses were located in the central United States, possibly resulting from the transport of infected tiger salamanders (*Ambystoma tigrinum*) used for fishing bait (Storfer et al. 2007).

Credit: Heather Inman

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Credit: Heather Inman

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Credit: Matthew J. Gray

Credit: Debra L. Miller

At Great Smoky Mountains National Park, author Debra Miller (front, at right) and University of Tennessee researchers collect and catalogue salamander tail clips to be tested for ranavirus. Necrosis of the oral mucosa (see arrows) is among the lesions seen in ranaviral disease of red-eared sliders, semi-aquatic turtles common in the pet trade.

- Jason Hoverman at Purdue University (formally at the University of Tennessee) tracked the seasonal emergence of ranavirus in amphibian populations at 40 breeding sites in Tennessee, and documented a die-off involving several hundred green frog and American bullfrog (*L. catesbeianus*) larvae at one of these sites (Hoverman et al. 2012). During this study, about one-third of the sites were classified as having abnormally high prevalence of ranavirus.
- Numerous cases of amphibian die-offs caused by ranaviruses have been reported in the past 15 years, with 94 percent of reported cases occurring since 1998 (Green et al. 2002, Miller et al. 2011), which may suggest increasing geographic distribution.
- Recent emergence of a Frog Virus 3 (FV3)-like ranavirus in eastern box turtle populations (*Terrapene carolina carolina*) in Maryland, West Virginia, and Kentucky could indicate that host range is increasing (Ruder et al. 2010, Seigel and Farnsworth 2012, *The Charleston Gazette* 2012).

Ranavirus Symposium

From July 27-29, the Second International Symposium of Ranaviruses will be held in Knoxville, Tennessee, just before the Annual International Conference of the Wildlife Disease Association (WDA). The symposium will feature presentations and posters highlighting recent research on ranavirus. During two field trips, amphibians and turtles will be captured and sampled for ranavirus testing. To learn more, visit ranavirus.com/ranavirus/welcome.html.

To our knowledge, ranaviruses are capable of infecting amphibians from at least 14 families and over 70 individual species (Miller et al. 2011), 15 reptile species (Marschang 2011), and dozens of fish species (Whittington et al. 2010). Considering this unusually broad host range, this emerging pathogen represents a serious threat to global populations of ectothermic vertebrates.

Life History of a Killer

Ranaviruses belong to the virus family *Iridoviridae*, and six species of *Ranavirus* are currently recognized (Chinchar et al. 2011). It is believed that ranaviruses evolved in fish and subsequently jumped to herpetofaunal hosts (Jancovich et al. 2010). The virus enters a cell by binding to it and injecting its DNA (Chinchar 2002). The cell receptor that ranavirus targets for binding is very generalized and its genetic sequence is conserved (Chinchar and Hyatt 2008), which likely contributes to its broad host range. In the laboratory, ranaviruses can infect fish, reptilian, amphibian, and mammalian cells. Because ranaviruses replicate between 12°C and 32°C (Chinchar 2002), the higher body temperature of birds and mammals precludes them from being suitable hosts (Chinchar and Hyatt 2008).

Transmission of ranavirus can occur quickly by skin-to-skin contact or exposure to the virus in water (Gray et al. 2009). Jesse Brunner of Washington State University demonstrated that ranavirus was transmitted between an infected and uninfected salamander by merely touching them together for one second (Brunner et al. 2007). Jacques Robert at the University of Rochester Medical Center detected viral transcription in the skin, intestines, and kidneys of African clawed frogs (*Xenopus laevis*) only three hours after exposure to ranavirus in water (Robert et al. 2011). He found that the most common route of entry is likely via the epithelial cells of the intestines followed by the kidney then other organs (e.g., liver, spleen), culminating with systemic infections.

The virus enters host cells and commandeers cellular processes (e.g., DNA replication, mRNA synthesis) for its own replication (Chinchar et al. 2011). Cell death can be rapid, occurring in just nine hours (Chinchar 2002), and result in significant organ necrosis and loss of function (Miller et al. 2011). In highly susceptible species such as the wood frog (*L. sylvaticus*), mortality can be as quick as three days (Hoverman et al. 2011).

It's not a pretty death. Ranaviral disease has been likened to Ebola or epizootic hemorrhagic disease for amphibians because their bodies swell and hemorrhage. Hemorrhagic lesions are a key sign in fish and can occur in reptiles. Because ranaviruses infect multiple cell types, tissue necrosis is often extensive in terminal cases. Non-lethal infections have been documented (Grayfer et al. 2012), but their role in ranavirus persistence and emergence is unclear.

In amphibians, necrosis is most prevalent in the liver, spleen, and kidney but can be found elsewhere (Miller

et al. 2011). In fish, the hematopoietic tissue is generally most severely affected. In terrestrial turtles, ranaviral lesions primarily include necrosis of the oral cavity and internal organs (usually respiratory and gastrointestinal tracts), but also may include ocular and nasal discharges. In aquatic turtles, lesions mainly include hemorrhages and ulcerations, with the latter occurring along respiratory and gastrointestinal tracts. Death is likely a consequence of organ dysfunction. Secondary infection by other pathogens also is possible.

Emergence and Its Impacts

The persistence of ranavirus in the environment is a mystery, but likely involves an interaction of high viability outside the host (Nazir et al. 2012), ability to infect multiple host species and age classes (Hoverman et al. 2011, Haislip et al. 2011), and ability to persist in some hosts as latent infections (Morales et al. 2010). Many factors that encourage ranavirus persistence exist in permanent wetlands, but die-offs are also observed in wetlands that dry annually (e.g., Harp and Petranka 2006). Jesse Brunner surmised that sublethally infected adults likely serve as carriers and shed the virus into the water when amphibians return to wetlands for breeding (Brunner et al. 2004). Other ectothermic vertebrates, such as turtles, could serve a similar role. The persistence and emergence of ranavirus in aquatic ecosystems is a cutting direction in research.

Few studies have followed populations with reoccurring ranavirus die-offs, but researchers at the Zoological Society of London report ranaviruses as the likely culprit of common frog (*Rana temporaria*) declines in England (Teacher et al. 2010). Jim Petranka at the University of North Carolina in Asheville documented that recruitment of wood frogs and spotted salamanders (*Ambystoma maculatum*) was nonexistent during several years when ranavirus outbreaks occurred at the Tulula Wetland Complex in Graham County, North Carolina (Petranka et al. 2003). In the Great Smoky Mountains National Park, repeated die-offs involving multiple amphibian species have been occurring for over 10 years (Green et al. 2002, Todd-Thompson 2010), although the effects on population size are unknown. Sites with reoccurring die-offs are a conservation concern due to the possible effects on recruitment and population persistence.

Given that ranavirus infection and mortality tend to be strongly correlated ($r > 0.85$; Haislip et al. 2011, Hoverman et al. 2011, 2012), high prevalence in a population can be an indicator of emergence. Natural resource agencies should consider conducting surveillance studies to identify "infection hotspots," where ranavirus prevalence exceeds 40 percent (Hoverman et al. 2012). Wildlife Ecologist Scott Smith with the Maryland Department of Natural Resources is currently coordinating such a study among five mid-Atlantic states. After surveying 150 ponds in different physiographic regions over two years, Smith and his team hope to determine how common ranavirus is. "Anything that could lead to species loss is of grave concern," says Smith.

Upon locating ranavirus hotspots, natural resource agencies can identify mechanisms for emergence, determine population effects, and develop disease intervention strategies. Field studies should be designed in consultation with disease experts that have experience with ranaviruses. In a book chapter we wrote with David Green of the U.S. Geological Survey National Wildlife Health Center, we provide recommendations on required sample sizes to detect ranavirus given an assumed pathogen prevalence, approximate host population size, and 95 percent confidence level for detection (Green et al. 2009). For example, testing 30 individuals for ranavirus will ensure *detection* if prevalence is >10 percent. Testing 60 individuals will ensure detection if ranavirus prevalence is >5 percent. However, if the goal is to obtain a *precise, unbiased estimate* of ranavirus prevalence, the sample size should be larger. If you are willing to tolerate a 10 percent error in estimating ranavirus prevalence, at least 96 individuals should be tested; 384 individuals should be tested for a 5 percent estimation error.

Credit: Matthew J. Gray

Roberto Brenes, a Ph.D. candidate at the University of Tennessee, performs a necropsy on a black-bellied salamander as part of a long-term ranavirus surveillance study.

The reasons for ranavirus emergence at a site vary, but often are related to stressors that can be natural or anthropogenic in origin (Gray et al. 2009). A common stressor is rapid drying of a wetland, which causes

amphibian larvae to undergo metamorphosis. During metamorphosis, the immune system is endogenously suppressed (Rollins-Smith 1998), which can increase the likelihood of pathogen infection and disease. Brunner and colleagues documented that the likelihood of wood frog tadpoles dying from ranavirus increased 1.7-fold with each stage of development closer to metamorphosis (Warne et al. 2011). Agricultural pesticides and livestock usage of wetland areas also may stress hosts and increase the likelihood of ranavirus emergence (Gray et al. 2007, Kerby and Storfer 2009). A study in Arizona found that tiger salamanders were 4.3 times more likely to be infected with ranavirus in cattle-access wetlands (Greer and Collins 2008), which the authors attributed to greater contact rates because the salamanders clustered more due to less vegetation.

Credit: Katherine Edwards

Author Matthew J. Gray disinfects containers that held salamanders captured for a ranavirus surveillance study. Researchers must disinfect boots, gear, and any equipment that comes in contact with study specimens to avoid passing ranavirus among individuals and research sites.

In addition to external stressors, virus evolution may contribute to ranavirus emergence. Several studies have documented that ranaviruses isolated from captive facilities such as bullfrog farms and bait stores tend to be more virulent than ranaviruses in wild populations (Majji et al. 2006, Storfer et al. 2007, Hoverman et al. 2011). For example, 15 out of 19 amphibian species tested experienced greater mortality when exposed to a ranavirus from an American bullfrog ranaculture facility compared to a ranavirus isolated from a wild northern leopard frog (*L. pipiens*, Hoverman et al. 2011). If such captive-evolved ranaviruses are released into the wild, the effects on populations could be devastating. The emergence of ranavirus in Japan may be a case of a virulent ranavirus from American bullfrogs being released into wild populations (Une et al. 2009).

Another mechanism of ranavirus emergence is pathogen pollution—the transport of a pathogen across large geographic distances by humans and release of it into a naïve population (Cunningham et al. 2003). It is unclear what constitutes a "large geographic distance," but it's probably related to both the dispersal distance of the host and population isolation. If host populations interact through dispersal, host immune systems co-evolve with natural changes in viral DNA. However, in isolated populations or populations separated by a geographic barrier (such as a mountain range), it is possible for viruses to evolve differently (Ridenhour and Storfer 2008). These slight changes in the virus' genome could result in enhanced virulence in a different population. Thus, if humans transport and release infected hosts over large distances, it could result in emergence of a novel ranavirus (Ridenhour and Storfer 2008). Emergence of ranavirus in some areas of the central U.S., for example, was attributed to moving tiger salamanders for the bait trade (Storfer et al. 2007, Ridenhour and Storfer 2008).

Preventing Spread, Learning More

Ranavirus can persist outside the host for greater than 30 days (Nazir et al. 2012) and be transported on objects such as sediment, boots, and nets. Recreationists and biologists can contribute to pathogen pollution if they contact contaminated water or sediment and do not disinfect footwear or equipment. Such may be the case with the spread of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), where high occurrence has been associated with high human access (Pauza et al. 2010). We found that ranavirus prevalence in salamander communities tended to be higher at sites in the Great Smoky Mountains National Park with high access by recreationists (Gray et al. 2009b).

All biologists who work in aquatic systems or handle fish, amphibians, or reptiles should disinfect equipment and supplies that come in contact with these animals or water (Green et al. 2009). Solutions of 3 percent bleach, 0.75 percent Nolvalsan® (chlorhexidine diacetate) and 1 percent Virkon S® (potassium peroxymonosulfate) are effective at inactivating ranavirus with one-minute contact duration (Bryan et al. 2009), and can be applied easily using a pump sprayer. We recommend use of Nolvasan® because it is considered less toxic to amphibians (Hadfield and Whitaker 2005). Additionally, when handling amphibians, biologists should wear disposable vinyl or nitrile gloves rinsed with distilled water and changed before handling different animals (Cashins et al. 2008, Greer et al. 2009, Green et al. 2009).

Beyond these precautions, researchers who plan to release amphibians or other ectothermic vertebrates as part of repatriation projects should test a subset of individuals (up to 30) to verify that they are not infected with ranavirus unless captive isolation protocols are followed (Pessier and Mendelson 2010). Tissue types that can be collected for non-lethal testing of ranavirus infection using polymerase chain reaction (PCR) include toe and tail clips; blood also can be used

(Green et al. 2009, Gray et al. 2012). Tissues that are collected can be stored in 90 percent ethanol or frozen at -80°C prior to testing. If animals are euthanized, we recommend that infection is tested from a homogenate of the liver and kidneys, which increases detection. We found that tail clips resulted in a 20 percent false negative rate when testing for ranavirus with PCR (Gray et al. 2012). If individuals destined for translocation or repatriation test positive for ranavirus infection, we recommend they not be released. There is no current treatment (e.g., vaccine) available for ranaviral disease.

Guidance on design of surveillance studies, tests used for detecting ranavirus, laboratories that specialize in diagnosing ranaviral disease, and biosecurity precautions are available from the Global Ranavirus Consortium (GRC), a coalition of more than 30 international scientists with expertise in ranaviruses. The group's mission is to facilitate communication and collaborative research on ranaviruses among scientists, veterinarians, and field biologists. To that end, the GRC hosts a LISTSERV and convenes a symposium on ranaviruses every two years, with the next scheduled for July 2013 (see box on page 52).

It's essential that wildlife biologists understand the threat of ranavirus and act quickly to address its spread. Many herpetofaunal species of great conservation concern are very susceptible to this pathogen, including the Chinese giant salamander (*Andrias davidianus*), California tiger salamander (*Ambystoma californiense*), gopher tortoise *Gopherus polyphemus*), Carolina gopher frog (*L. capito*), and dusky gopher frog (*L. sevosus*). Several freshwater and marine fish important to global markets are also highly susceptible to infection. In the U.S., for example, Thomas Waltzek of the University of Florida attributed a 2009 die-off of endangered pallid sturgeon (*Scaphirhynchus albus*) fingerlings in Missouri's Blind Pony Fish Hatchery to an FV3-like ranavirus.

Clearly, ranaviruses can impact many ectothermic vertebrate species in the wild and in captivity. We recommend that natural resource agencies and zoological facilities take a proactive role in documenting the presence of ranavirus in populations and take measures to thwart its spread. If we sit idle in the face of this lethal, emerging pathogen, our springs truly may become silent. ■

This article has been reviewed by subject-matter experts.

Go to news.wildlife.org/twp for additional resources on ranavirus.

Greater Sage-Grouse in Wyoming

AN UMBRELLA SPECIES FOR SAGEBRUSH-DEPENDENT WILDLIFE

By R. Scott Gamo, Jason D. Carlisle, Jeffrey L. Beck, Juliette A. C. Bernard, and Mollie E. Herget

Courtesy of R. Scott Gamo

R. Scott Gamo is a Staff Terrestrial Biologist with the Wyoming Game and Fish Department and a Ph.D. student in the Department of Ecosystem Science and Management at the University of Wyoming.

Modern conservation is increasingly reliant on efforts to conserve surrogate species to provide benefits for multiple species. In Wyoming, it's becoming clear that the greater sage-grouse (*Centrocercus urophasianus),* hereafter sage-grouse, could be the perfect surrogate.

In November 2012, the U.S. Fish and Wildlife Service (FWS) issued its annual review of candidate species and determined that although sage-grouse face "imminent" threat from factors such as habitat fragmentation, fire cycles, invasive plants, and energy development, the species is "warranted, but precluded from" listing at this time (FWS 2012). As sage-grouse range extends across 11 western states, a listing would affect a large portion of the U.S. and overlap with extractive and renewable industries, agriculture, and other land uses. In response to these concerns, Wyoming has developed a strategy to conserve the grouse and, at the same time, manage the landscape for the continuing needs of our nation's human population. Because of this effort, and the large expanse of land it affects, the sage-grouse may well serve as an umbrella species for other sagebrush-dependent wildlife (Rich and Altman 2001, Rowland et al. 2006).

Credit: Jaimel Blajszczak /WGFD

The sage-grouse can serve as an umbrella species for mule deer, pronghorn, reptiles, pygmy rabbits, many bird species, and other sagebrush-dependent wildlife. Wyoming's sage-grouse protections may benefit nearly 450 other species, most of which are non-game.

Laying the Groundwork

Umbrella species are essentially surrogate species whose protection may provide conservation benefits to many other animals. In Wyoming, protecting sage-grouse as an umbrella species is particularly relevant since the state's sagebrush ecosystems provide habitat not only to sage-grouse but also to nearly 450 species of mammals, birds, amphibians, reptiles, and fish, most of which are classified as non-game species (WGFD). Approximately 6 percent, or 25, of the sagebrush-associated species are species of greatest conservation need (SGCN) "whose conservation status warrants increased management attention and funding, as well as consideration in conservation, land use, and development planning" (WGFD 2010).

The idea of sage-grouse as an umbrella species first arose in 2001 (Rich and Altman 2001). Subsequent researchers began testing this idea for other sagebrush-dependent species (Rowland et al. 2006, Hanser and Knick 2011). Their work suggested that this ecological theory may have merit. Some researchers have suggested that sage-grouse meet the criteria of an umbrella species with the exception of legal or regulatory status (Hanser and Knick 2011). We propose that sage-grouse may be an effective umbrella species in Wyoming because its habitat overlaps many other species that are dependent on sagebrush communities.

Umbrella species require large amounts of habitat if the species has a large

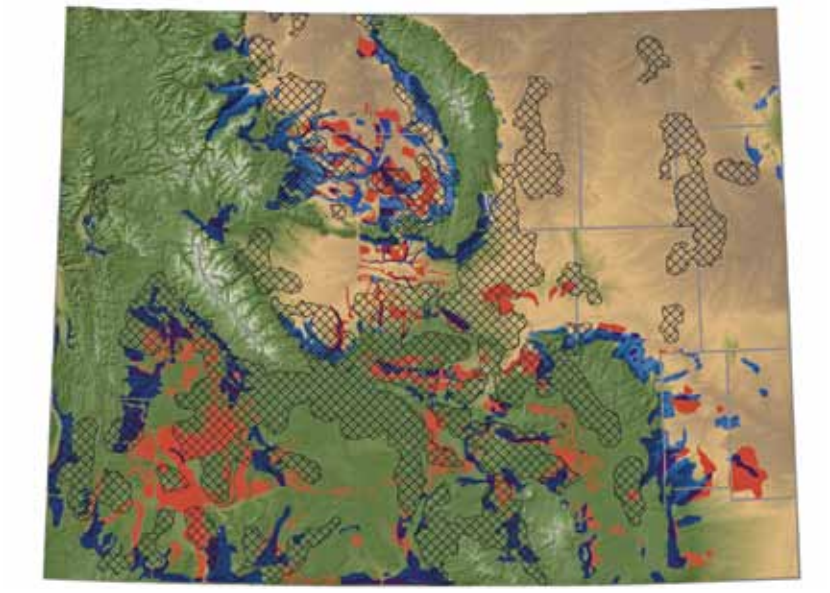
home range or is migratory (Rich and Altman 2001). The first step in modeling habitat for any animal is determining biologically meaningful areas (Fedy et al. 2012). For sage-grouse, those areas are distinct seasonal habitats that occur across large landscapes based on requirements for the following three key life stages:

- **Breeding.** Breeding—which includes lekking, nesting, and early brood-rearing—occurs from spring to early summer, when grouse require habitats composed of sagebrush with an understory of forbs and grasses used for food and cover.
- **Late brood-rearing.** Late summer brood-rearing begins two to six weeks after hatching (Thompson et al. 2006, Hagen et al. 2007), when habitat requirements include plant communities with high herbaceous cover in mesic habitats (Johnson and Boyce 1990, Drut et al. 1994). In xeric big sagebrush communities, late brood-rearing habitat is similar in vegetative structure to that used by grouse for nesting and early brood rearing (Kirol et al. 2012).
- **Wintering.** Wintering habitat requirements are influenced by snow depth and sagebrush height, because sage-grouse rely heavily on sagebrush that protrudes above the snow for food and shelter (Schroeder et al. 1999).

Road to Regulation

In 2007, in response to concerns of potential listing of the sage-grouse, then Wyoming Governor Dave Freudenthal held a forum with representatives of state and federal agencies, non-governmental organizations, and industries. As a result, a team was created to develop a regulatory mechanism for the protection and conservation of the sage-grouse within Wyoming. First, however, an area had to be designated in which that regulatory mechanism could be implemented. This area designation was a key ingredient to provide support for sage-grouse to serve as an umbrella species.

To produce a sage-grouse core protection area map for Wyoming, the governor's sage-grouse team utilized sage-grouse density mapping data and also noted areas of major energy development such as those in southwest and northeast Wyoming. Based on these data, the team created a map of 31 core population areas, which cover approximately 24 percent of the surface land area of Wyoming and include approximately 82 percent of the sage-grouse population within the state (WGFD Cheyenne, unpublished data). Most core areas occur in the sagebrush basins in the western and central portions of the state, with a few in the northeast as well.



Credit: Troy Gerhardt/WGFD

On a map of Wyoming, hatching shows where sage-grouse core population areas (home to 82 percent of the species' population) overlap winter range for mule deer (in blue) and pronghorn (in red). Minimizing surface disturbances in core areas will likely benefit these ungulates.

The Wyoming governor's 2008 Executive Order for Sage-Grouse, or SGEO, provided a process for protecting sage-grouse within the mapped areas, and a revised SGEO issued in 2011 further refined core-area boundaries. The implementation team focused on the protocols, rules, and processes to use in implementing the SGEO within the core population areas. In early 2012, a Bureau of Land Management Instruction Memorandum (BLM IM) laid out guidelines for sage-grouse conservation that closely paralleled those in Wyoming's SGEO.

Contained within the Wyoming SGEO and the BLM IM are protective stipulations for sage-grouse, based upon their biological needs, and a GIS-based procedure for determining levels of anthropogenic disturbance on the landscape within the core population areas (State of Wyoming 2011). These disturbances consist of roads, well pads, pipelines, mine pits, and other such surface alterations. Per direction of the SGEO, such disturbances are threshold limited, thus effectively minimizing anthropogenic activities and disturbances within the core population area boundaries.

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For example, within sage-grouse core population areas, the number of surface disturbances is not to exceed an average density of one per 2.6 square kilometers (640 acres) across the disturbance analysis area defined in the SGEO (State of Wyoming 2011). Total accumulation of surface area affected (both existing and proposed) within an analysis area should not exceed 5 percent. In addition, surface disturbances may not occur within 1 kilometer (0.6 mile) of any active or occupied sage-grouse lek. Outside of the core areas there is greater flexibility and less stringent application of conservation measures, which provides industry incentive to develop outside of core areas.

Common Name	Scientific Name	Distribution (%) in Greater Sage-grouse Core Areas
Birds		
Brewer's sparrow	*Spizella breweri*	36%
Burrowing owl	*Athene cunicularia*	30%
Ferruginous hawk	*Buteo regalis*	37%
Greater sage-grouse	*Centrocercus urophasianus*	33%
Sage sparrow	*Amphispiza belli*	47%
Sage thrasher	*Oreoscoptes montanus*	41%
Short-eared owl	*Asio flammeus*	20%
Mammals		
Pygmy rabbit	*Brachylagus idahoensis*	48%
Sagebrush vole	*Lemmiscus curtatus*	40%
Reptiles		
Greater short-horned lizard	*Phrynosoma hernandesi*	46%
Northern sagebrush lizard	*Sceloporus graciosus*	33%

Credit: J.D. Carlisle and A.D. Chalfoun, unpublished data; Keinath et al. 2010

Distribution models have shown that 11 of Wyoming's species of greatest conservation need—including seven birds, two mammals, and two reptiles—have a significant percentage of their population within the state's sage-grouse core population areas.

Opening the Umbrella

Because sage-grouse core population areas occur as separate units across a larger landscape, they have high potential for overlapping habitat used by other groups of animals such as songbirds, small mammals, and ungulates. Based upon this wide-ranging overlap, high public support for continued existence of sage-grouse, and the regulatory protocol applied within the large expanse of core population areas, the sage-grouse can serve as an effective umbrella species for other species that occur within the sagebrush steppe of Wyoming.

To the extent that a species' spatial distribution overlaps core protected areas and its biological requirements are similar to sage-grouse, that species will be protected within core areas established for sage-grouse. The overlap between sage-grouse core areas in Wyoming (the umbrella) and the predicted spatial distribution of 11 sagebrush-inhabiting SGCN species—two reptiles, two mammals, and seven birds including the greater sage-grouse (Keinath et al. 2010)—suggests that sagebrush-obligate species with restricted distributional ranges (such as the pygmy rabbit [*Brachylagus idahoensis*]) are likely to receive the most conservation benefit under the core area umbrella (J.D. Carlisle and A.D. Chalfoun, unpublished data).

For example, 47 percent of the predicted distribution of the sage sparrow (*Amphispiza belli*) in Wyoming coincides with the sage-grouse core population areas (J.D. Carlisle and A.D. Chalfoun, unpublished data). Thus, the sage sparrow will likely benefit from the protection afforded by sage-grouse core population areas. Other species whose range overlaps sage-grouse core population areas in Wyoming by at least 40 percent (see chart) include the pygmy rabbit, greater short-horned lizard (*Phrynosoma hernandesi*), sage thrasher (*Oreoscoptes montanus*), and sagebrush vole (*Lemmiscus curtatus*). Some non-game species with less overlap—such as the short-eared owl (*Asio flammeus*), whose predicted distribution overlaps core population areas by only 20 percent—may not be afforded as much potential benefit.

A Boon to Ungulates?

The sage-grouse umbrella could yield substantial benefits to ungulates in Wyoming. The state provides habitat to some of the largest populations of ungulates in North America including elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), Rocky Mountain bighorn sheep (*Ovis canadensis*), Shiras moose (*Alces alces shirasi*), and more than 500,000 pronghorn (*Antilocapra americana*). Approximately 45 percent of Wyoming's crucial winter range (a sensitive seasonal habitat) for pronghorn and upwards of double that amount for remaining seasonal habitats overlap with sage-grouse core population areas. By comparison, in the Great Basin ecoregion, sage-grouse habitat overlaps with 50 percent of pronghorn habitat (Rowland et al. 2006).

Many mule deer herds in Wyoming are migratory and utilize sagebrush basins for wintering habitat as they move across a gradient from high-elevation

Credit: Mark Gocke/WGFD

Credit: Mark Gocke/WGFD

A male sage-grouse fans his feathers on sagebrush habitat not far from a line of drilling wells near Pinedale, Wyoming (far left). Biologists who net and collar the birds for study (left) have helped the state establish core sage-grouse areas that limit land-surface disturbances and densities in order to minimize impacts to sage-grouse.

summer habitats (Sawyer et al. 2006, 2009). Although mule deer tend to use mountain slopes and drainages for parturition areas, approximately 33 percent of crucial winter ranges for mule deer in the state are encompassed in sage-grouse core population areas. Thus, a large portion of critical mule deer habitat falls under sage-grouse protective management.

Surface disturbances such as roads, oil and gas well pads, and other man-made features and activities are known to impact mule deer (Sawyer et al. 2006, 2009), pronghorn (Beckman et al 2012), and elk (C.B. Buchanan and J.L. Beck, unpublished data). For example, elk calves were displaced by simulated mining activity in Idaho (Kuck et al. 1985), and research on arctic caribou (*Rangifer tarandus*) and woodland caribou (*R. t. caribou*) has shown that caribou tend to avoid industrial activity such as roads, communities, human camps, and mines (Cameron et al. 2005, Vols et al. 2006, Sorensen et al. 2007, Polfus et al. 2011). Presumably, then, the restrictions placed on development and other anthropogenic activities in sage-grouse core population areas in Wyoming should yield benefits to large, mobile ungulates.

Those benefits may vary, however, depending on the level of human activity. For example, researchers found that piping oil and gas waste fluids through pipelines, rather than trucking the material out of winter range, reduced truck traffic and resulted in greater use of these areas by mule deer (Sawyer et al. 2009). Thus, reduced truck traffic lessened negative impacts on wintering mule deer. Another study found that when human activity around mines, cabins, and hunting camps was minimal, caribou came much closer to these areas than during periods of high human activity (Polfus et al. 2011). Such findings suggest that management strategies to reduce development and activity levels should benefit ungulates on winter ranges where they overlap sage-grouse core areas.

Because sage-grouse core area designations provide habitat for other sagebrush-dependent species—including passerine birds, reptiles, small mammals, and ungulates—sage-grouse fit the requirements of an umbrella species as defined by Noss (1990). We therefore believe that the management of sage-grouse as an umbrella species within the core population area framework shows promise and deserves thorough evaluation. Minimizing the number and scale of anthropogenic disturbances should result in a higher probability of continued use of these habitats by sage-grouse, non-game species, and ungulates alike. Thus, the State of Wyoming has not only created areas of higher protection for sage-grouse, but likely provided additional protections for a suite of other wildlife species.

In Wyoming, as landscapes continue to be subjected to ever-increasing pressures to provide extractive and renewable resources, effective means of conserving wildlife species must be continuously evaluated. We are hopeful that the intense focus on the conservation of an umbrella species such as the sage-grouse will also ultimately bestow benefits on familiar and not-so-familiar co-occurring species. ■

This article has been reviewed by subject-matter experts.

Go to news.wildlife.org/twp for a complete bibliography.

Rooftop Havens

GREEN ROOFS OFFER HABITAT FOR URBAN BIRDS

By Carly Eakin, Henry Campa III, D. Bradley Rowe, Joanne Westphal, and Gary Roloff

Credit: Chadrick Eakin

Carly Eakin is a Graduate Researcher in the Fisheries and Wildlife Department at Michigan State University.

As dawn breaks over a field of wildflowers and shrubs, white-throated sparrows (*Zonotrichia albicollis*) and a Nashville warbler (*Oreothlypis ruficapilla*) begin to call—and a car alarm blares in the alley below. Thus begins a day on a green roof atop Chicago's City Hall, 11 stories above the ground. On the sidewalk below, someone walking among the concrete, glass, and steel of the city might not realize that they are only an elevator ride away from some vital wildlife habitat on top of this and other nearby buildings.

Such urban oases are on the rise. To date, more than 1,030 green roofs have been constructed in the United States covering more than 137 hectares (Greenroofs.com). In some green roof "hot spots" such as Chicago, New York, and Washington D.C., more than seven hectares of green roofs have been installed. These vegetated roofs are typically constructed to mitigate environmental impacts associated with buildings and urban areas.

Credit: Carly Eakin

Native perennials and shrubs carpet 0.2 hectares atop Chicago's City Hall, providing habitat that attracts native songbirds. In 2011, the authors observed 10 bird species using this rooftop haven. Whether "intensive" like this one (with deeper growing media) or "extensive" (with thinner media), green roofs yield aesthetic and practical benefits to building owners.

Although birds have likely been using 'green' roofs ever since the first sod-roof house was built centuries ago, the abilities of modern green roofs to provide meaningful wildlife habitat on small and large scales has been seriously explored within the past 10 years. Researchers have recognized that any type of vegetation installed on a rooftop will support *some* wildlife, even if just urban-adapted species such as rock pigeon (*Columba livia*) that usually take advantage of urban parks, puddles, and trash cans. Based on this idea, researchers realized that green roofs *must* contribute to wildlife habitat, but they wanted to learn how.

The Values of Habitat on Rooftops

Living rooftops minimally consist of vegetation and growing media such as topsoil or engineered substrates like heat-expanded slate or clay (the "soil") placed over a roof's existing waterproof membrane. Drainage, water retention, and root-barrier membranes are also typically part of green roof design.

Though relatively simple in concept, green roofs can yield many benefits to birds, building owners, and society. Touted as an environmentally sustainable technology, vegetated rooftops have the potential to reduce energy consumption, stormwater runoff, and pollution (Oberndorfer et al. 2007). Shade from the plants, evapotranspiration, and additional insulation provided by the growing media can reduce roof temperatures up to 90 percent compared to conventional roofs, which can help cool a building and reduce energy consumption during hot summer months (Peck et al. 1999, Getter et al. 2011). Cooler roofs also mean roof membranes experience less wear via heat expansion and consequently last more than twice as long as conventional roofs (Rowe 2011). Cooler roof temperatures can also reduce the urban heat island (Banting et al. 2005), and green-roof plants sequester carbon and can reduce air pollution (Currie and Bass 2008, Getter et al. 2009). The growing media helps retain stormwater and filter pollutants, which minimizes discharge of polluted urban stormwater into water bodies (Getter et al. 2007).

The quantity and quality of wildlife habitat provided by a green roof often depend on the main objective of the building owner. Some owners want a roof to help

with energy conservation, others want an aesthetically appealing environment, and others may hope to provide wildlife habitat or some combination of these. The owners' objectives determine soil depth, plant selection, and maintenance. Numerous green roof aesthetics can result, though roof types can be separated into two main categories—extensive and intensive—related to growing-media depth.

Extensive green roofs have a thin growing media depth of less than 15 centimeters, which helps minimize weight on the roof. These roofs can provide water retention and energy conservation benefits, but the thin depth media limits the plant species that will successfully grow. Intensive roofs have a thicker growing media depth (>15cm), can provide water retention and energy conservation benefits similar to those of extensive roofs, and also can support a wider range of plant species. However, intensive roofs are limited by the load-bearing capacity of the structure.

Other considerations—such as size, slope, and elevation—may also affect how birds ultimately use a green roof. For example, green roof installations may range from one square meter to more than nine hectares. Larger roofs provide larger areas of vegetation that may attract more individuals, a greater range of species, and species that are sensitive to edge effects. Roof slope may be a limiting factor for bird nesting areas on roofs, while roofs beyond a certain elevation (such as skyscrapers) may not be accessible for birds that typically dwell closer to the ground. Human presence may disturb sensitive species or reduce suitability for nesting. Conversely, irrigation systems used on some green roofs may provide a source of water vital to the nesting success of some birds.

Regardless of roof type, herbaceous cover is the dominant cover type on most green roofs, though vegetation height varies significantly between roof types (Eakin et al. 2012, in review). Extensive roofs are often characterized by a carpet of low-growing (0-20 cm) succulents, such as various species of *Sedum*, which provide cover only a few centimeters tall. Extensive roofs can also support native prairie perennials such as broad-leaved purple coneflower (*Echinacea purpurea*), ornamental perennials like peony (*Paeonia lactiflora*), and/or low-growing (<25cm tall) drought-tolerant shrubs such as creeping juniper (*Juniperus horizontalis*). These roofs provide the structure that wildlife can use as cover, perches, or food.

The deeper planting media on intensive roofs can present an opportunity for a greater range of plant species. Shrubs such as New Jersey tea (*Ceanothus americanus*), vegetables like tomatoes, and tree species including shingle oak (*Quercus imbricaria)* and cockspur hawthorn (*Crataegus crusgalli)* can grow on many intensive roofs. Green roofs with trees, shrubs, vines, and perennials can provide vegetation structure for a variety of birds such as house wren (*Troglodytes aedon*), Nashville warbler (*Oreothlypis ruficapilla*), and downy woodpecker (*Picoides pubescens*). One such roof, on Chicago's City Hall, also features bee hives. Insects that live amongst such vegetation provide a food source for birds.

The Benefits to Birds

Anyone who has seen a pigeon sitting on a city sidewalk or dodged a deposit from one sitting on the edge of a building may not be surprised that birds use green roofs. What may be surprising, however, is that at least 118 bird species have been observed on green roofs in Europe and North America (Fernandez-Canero and Gonzalez-Redondo 2010, Kevin Carroll at City of Chicago, Sylvia Schmeichel at Chicago's Millennium Park, Eakin unpublished data for roofs in Illinois and Michigan). Our own work as part of the Michigan State University Green Roof Team has shown that the vegetation on certain green roofs partially or fully meets the habitat requirements of several bird species.

Focusing on 12 green roofs in Michigan and Illinois, we conducted vegetation measurements and bird surveys during breeding and brood-rearing seasons in 2010 and 2011. In that time we observed 28 native (and three exotic) bird species on the roofs, supporting the concept that green roofs can provide habitat for species of conservation value in urban landscapes. For example, native prairie perennials planted on the extensive green roof of Aquascape Headquarters in St. Charles, Illinois, met some of the habitat requirements for red-winged blackbirds (*Agelaius phoeniceus*) by duplicating what they typically use on the ground. We made 138 red-winged blackbird observations on this roof.

The intensive green roof of the Gary Comer Youth Center held a diversity of vegetables and native perennials that provided habitat suitable for American goldfinches (*Carduelis tristis*), barn swallows (*Hirundo rustica*), chipping sparrows (*Spizella passerine*), and song sparrows (*Melospiza melodia*). Several other green roofs in and near Chicago had vegetation that met herbaceous cover requirements for common

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Credit: Carly Eakin

Credit: Carly Eakin

Credit: Chadrick Eakin

Credit: Carly Eakin

Rooftop Bounty. A female red-winged blackbird (right) perches on native prairie perennials atop the 2.4-hectare Aquascape Headquarters roof in St. Charles, Illinois. At least eight other bird species have also used the site.

On the extensive 4.2-hectare green roof of the Dearborn Ford Truck Assembly Plant, a pair of geese guard their nest. Four goslings (hiding around and under their mother, at right) were observed throughout the 2011 brood-rearing season, after which they presumably fledged.

At Chicago's O'Hare Airport, author Carly Eakin kneels on the 1.6-hectare green roof installed on top of the FedEx hangar. Planted with *Sedum,* the roof absorbs rainfall and thereby helps mitigate surface runoff at the airport.

That same hangar rooftop has also been home to killdeer, ground-nesting plovers known to leave clutches of eggs in nests of *Sedum* (below). Though the authors have observed frequent nesting, successful chick rearing has not yet been confirmed.

yellowthroat (*Geothlypis trichas*) and eastern kingbird (*Tyrannus tyrannus*) (Best et al. 1997), but did not meet their vegetation height requirements. While these roofs were not necessarily designed to provide habitat for any particular bird species or community, their ability to fulfill habitat requirements for certain species demonstrates a tremendous opportunity for green roof design to cater to the life requisites of a species or community to help meet conservation objectives.

Birds appear to exhibit the same behaviors on green roofs that they display in more natural settings. We observed birds on green roofs feeding on insects and seeds, bathing in water sources, using a diversity of vegetation cover, perching, defending territory, and nesting and rearing young. Canada geese (*Branta Canadensis*), mallards (*Anas platyrhynchos*), and killdeer (*Charadrius vociferus*) all frequently nest on green roofs, and Canada geese have been observed rearing goslings three stories above the ground on the Ford Truck Assembly Plant green roof in Michigan. We've seen common grackles (*Quiscalus quiscula*) and red-winged blackbirds make nests in tall, dense rooftop shrubs, and at several of our study sites we observed red-winged blackbirds perch on tall herbaceous perennials and small trees to call and display during the breeding season. In addition, barn swallows (*Hirundo rustica*) and chimney swifts (*Chaetura pelagica)* often dive and swoop over green roofs to eat bugs attracted by the vegetation.

To explore further how bird communities use green roofs, we compared expected and observed bird communities on the roofs. Generally, bird communities known to use various vegetation types on the ground also used green roofs with similar vegetation composition and structure. Species known to forage in turf grass lawns and other low vegetation, such as killdeer and common grackle, were observed feeding on green roofs established with sedum and turf grass. Species associated with tall herbaceous vegetation, such as red-winged blackbirds, were observed on roofs established with perennials such as little bluestem and coneflower. Forest-edge associated species, such as downy woodpecker (*Picoides pubescens*), were observed on roofs established with shrubs and trees.

In addition to seeing expected species on individual green roofs, we also observed other species whose habitat requirements were not met by a green roof. For example, the Aquascape Headquarters roof established with native prairie plant species was expected to provide suitable vegetation for red-winged blackbirds, but other species whose habitat requirements were

not fulfilled by this green roof—such as the American goldfinch, eastern kingbird, and song sparrow—were also observed. If these species were present but their habitat requirements were only partially fulfilled by the green roof, we suspect that the roof and its surrounding landscape likely combined to provide suitable habitat for species. This and similar findings support the concept that green roofs can contribute to bird species habitat, even if the vegetation does not fulfill all habitat requirements.

In our study sites, birds on the green roofs in suburban and semi-rural landscapes typically were a subset of those in the landscape: 29 of the 69 birds observed in the landscape were also observed on green roofs. However, in highly urban landscapes, green roofs often had a greater diversity and abundance of migratory songbirds than did the surrounding landscapes, and the native species observed on green roofs were not observed in the surrounding landscape. This difference between bird communities on roofs and landscapes may be partly due to the structure provided by herbaceous perennials on several green roofs while the urban landscape vegetation was typically dominated by turf grass and trees. This also highlights the potential for creating suitable bird habitat in urban areas.

Greening the City

Imagine looking out the window of an airplane onto the city below and, instead of seeing hot asphalt and gravel roofs, you see rectangles of cool green vegetation covering the buildings (see a visual representation of this at Chicago Green). We essentially did just that by investigating the potential of green roofs to increase overall urban green space. Our analysis of the urban landscape directly surrounding green roofs showed that green space could potentially increase by more than 300 percent if all non-green roofs had vegetation installed. This increase would transform a city from an urban area with little green space to a place where wildlife habitat covers most non-road surfaces, simultaneously providing other energy-saving benefits to building owners. Realization of this dramatic increase could mean construction of green roofs that contribute bird habitat to support native species in need of conservation, not to mention the possibilities to conserve insect communities (Brenneisen 2006, Monsma 2012).

Large-scale construction of green roofs in urban areas could also provide "stepping stones" through cities for migratory species such as golden crowned kinglet (*Regulus satrapa*) or native species with large home ranges such as American kestrel (*Falco sparverius*). Installing green roofs at this scale could greatly help to restore habitat connectivity for some species. This potential should encourage wildlife and natural-resource managers to collaborate with city planners and green roof designers to maximize benefits to wildlife. To that end, wildlife managers should become familiar with policies in their areas that either provide incentives for green roofs or deter their construction.

Cities such as Portland, New York, and Toronto effectively incentivize green roof construction through such measures as fast-track permitting, reduced permit fees, temporary tax abatement, low-interest loans, density bonus programs, and grants for installation. Such incentives can reduce initial installation costs—which can start at approximately $110 per square meter for simple extensive installations and $270 per square meter for more complex intensive installations (Peck and Kuhn 2003)—a major barrier for some owners. Installation of green roofs can also reduce taxes for building owners in cities that tax impermeable surface areas, which place increased pressure on municipal sewer systems. Air pollution mitigation regulations, carbon credits, and policy addressing urban heat islands could also affect green roof construction and the associated wildlife habitat created.

Given the rate of global urbanization, researchers and wildlife managers can look up to the rooftops to expand viable wildlife habitat for the future and boost the chances for at-risk species. Such work is being done, for example, by green roof advocates Nathalie Baumann in Switzerland and Dusty Gedge in the U.K., who have been using microtopography (such as rocks, cover logs, and plant selection) to create nesting and foraging sites for black redstart (*Phoenicurus ochruros*), little ringed plover (*Charadrius dubius*), and northern lapwing (*Vanellus vanellus*) (Gedge 2003, Baumann 2006). These efforts have led to successfully established breeding pairs of black redstart, a rare breeding bird in London, on green roofs.

Such successes demonstrate the potential for green roofs to advance bird conservation in urban areas. The full effect green roofs have on wildlife is still unknown, but by becoming involved in planning, designing, and researching green roofs, wildlife professionals can make the environmentally sustainable technology of green roofs a key component of wildlife conservation. ■

This article has been reviewed by a subject-matter expert.

Go to news.wildlife.org/twp for a complete bibliography.

A Rewarding Road

HOW TRANSPORTATION BIOLOGISTS EASE ROAD IMPACTS ON WILDLIFE

By Sarah Piecuch

Credit: Marty Piecuch

Sarah Piecuch, CWB, is an Environmental Specialist with the New York State Department of Transportation.

Like most wildlife biologists, I am a lover of wild places, a seeker of remoteness, a despiser of the din of traffic. Yet I am employed by the New York State Department of Transportation (NYSDOT). Wildlifers working for road builders may sound like a conflict of interest, even an oxymoron. But we transportation biologists see it very differently.

Biologists at transportation agencies are deeply involved in wildlife conservation. Our job is to ensure the development and maintenance of roads in an environmentally sound manner. Much of this work is straightforward, but also wide-ranging: it involves obtaining federal and state wetlands and stormwater permits, working with engineers to ensure that road projects avoid sensitive wildlife habitat, minimizing and mitigating environmental impacts to streams, wetlands, and endangered species, and managing invasive species. The work can also offer biologists unique opportunities that they might not find in more-traditional roles, such as working on long-range projects with public-private partnerships across state lines, all in the interest of efficiently moving people while protecting habitat.

Credit: Tanya Pace

Harnessed in protective climbing gear, author Sarah Piecuch navigates a bridge-painting project site where a contractor had spotted a nesting Peregrine falcon. Piecuch helped establish a safety buffer around the nest, and monitored the endangered bird's progress.

The need for such expertise has gained recognition at a national level. According to the U.S. Fish and Wildlife Service (FWS), "The Service encourages the design of transportation projects that provide the greatest value to the greatest number of people while avoiding or minimizing impacts to habitat and to the disruption of the ecological processes that naturally sustain these areas" (FWS 2012). In addition, the U.S. Department of Transportation's Federal Highway Administration (FHWA) issues two classes of awards—for Exemplary Ecosystem Initiatives and Environmental Excellence. These awards honor projects that reduce habitat fragmentation and barriers to animal movement, encourage sustainable mitigation sites, foster ecosystem research and planning, or go beyond mere "compliance" to benefit the environment. Achieving these goals, however, often requires some out-of-the-box thinking and intense collaboration.

Roads that Work for Wildlife

One vivid example of broad-scale collaboration involves the I-90 Snoqualmie Pass East project, now under construction in Washington State. Linking Puget Sound to eastern Washington, I-90 intersects the rugged Cascade Mountains in Washington's Snoqualmie Pass region, which has been identified as a critical link in the north-south movement of wildlife species such as bear, elk, mountain lions, wolverines, and several species of small mammals and amphibians. This area is also the focus of an extensive effort by the Washington State Department of Transportation (WSDOT) to expand the highway while making it safer for people and wildlife.

The effort involves extensive collaboration among WSDOT and the U.S. Forest Service, the U.S. Bureau of Reclamation, the FHWA, FWS, the Washington Department of Fish and Wildlife (WDFW), the state's Department of Ecology, the Environmental Protection Agency, and regional cities, counties, and community groups, which are all working together to

develop consensus on their vision for the project. The ultimate goal is to create an efficient six-lane freeway that will have fewer closures from avalanches and rock slides, yet accommodate wildlife movement. Plans include connecting wildlife habitat on either side of I-90 with new bridges and culverts, which will allow for safer passage while minimizing wildlife-vehicle collisions. "It is very rare to have an opportunity to provide and restore ecological connectivity at this scale," says Craig Broadhead, WSDOT assistant manager for biology. "We have the chance to provide untold benefits to wildlife species and populations at a scale far beyond the scope of a typical highway project."

Such projects are expensive, but because road functionality is directly related to commerce and the economy, state DOTs are generally among the better-funded state agencies. Even a simple transportation project can have a large budget, and some transportation project costs exceed the entire annual budget of a state's natural resource agency for targeted species management. It's therefore advisable—and often very doable—to incorporate wildlife improvements into overall road project costs, especially since those wildlife improvements often run less than 10 percent of the total project cost.

For example, NYSDOT was planning a bridge rehabilitation project that cost $11.5 million. We worked with the New York State Department of Environmental Conservation (NYSDEC) to design and incorporate two snake hibernaculums (at a total cost of $10,000) to help protect queen snakes (*Regina septemvittata*), a state-listed endangered species that would not have received habitat management without DOT funds. A day's work of strategically hand-placing flat rocks in

Credit: Eric Zach

Credit: Eric Zach

"I never thought I'd care so much about the sex life of a beetle!" Such were the immortal words of a road contractor facing project delays as biologists with the Nebraska Department of Roads attempted to move endangered American burying beetles away from a road construction path. Teams set pit traps (right, at top) to catch beetles during mating and emergence seasons. Caught in the process, a female beetle (bottom) displays the tools of a carrion scavenger.

Roadblock for a Beetle

When biologist Eric Zach worked with the Nebraska Department of Roads (NDOR) from 2006 to 2011, his daily tasks were anything but routine. He gave consultations on endangered and threatened species, trained contractors and construction project managers, handled migratory bird mitigation, did species and habitat surveys, and helped with project planning and research. "It was a very fast-paced work environment where priorities, deadlines, and project specifics were constantly changing and evolving," he says. "Conflict resolution is definitely part of my vocabulary now."

One of his biggest challenges—and most rewarding experiences—occurred when a road project was planned through habitat of the endangered American burying beetle or ABB (*Nicrophorus americanus*), a carrion scavenger that helps put decaying matter back into the ecosystem. Relatively little is known about how this nocturnal insect spends its days, so any road work in the beetle's range can potentially cause harmful impacts. Zach had to help road-design engineers and contractors understand the importance of avoiding impacts to the beetle. "Educating coworkers about the 'why' behind conservation measures was the best and fastest way to get them on board," Zach says. "After a short life-history lesson on the ABB, most people were somewhat intrigued." But he admits that some conservation approaches can sound "pretty ridiculous" to non-biologists.

In this case, the approaches included setting pit traps with rotten rat carcasses along the course of the project to catch American burying beetles and remove them from the area. The work was done over two time periods—during ABB mating season in June and emergence in August—and could take from four days to two weeks. "Nature doesn't work off of calendar days or Gantt charts the way projects do," says Zach. "A few days doesn't sound like much, but for a contractor with workers and equipment waiting to get started, it could get tense."

Education paid off, however. One of the best quotes Zach heard came from a contractor who was facing work delays until the ABB relocation was complete. "He called one day and said, 'You know, I never thought I'd care so much about the sex life of a beetle!'" The contractor came to understand why the restrictions were necessary for beetle conservation, and the project was completed with minimal impact.

Now with the Nebraska Game and Parks Commission, Zach works on conservation and farm policy programs. "Just as at NDOR, there are many powerful stakeholders in farm policy, and educating them on the needs of wildlife is essential."

Safe Passage for Turtles

The wood turtle (*Glyptemys insculpta*) is an endemic species to North America that prefers slower moving, mid-sized streams and riparian habitats that have sandy bottoms and heavily vegetated banks. In Massachusetts, the species is classified as a "Species of Special Concern" and is protected under the Massachusetts Endangered Species Act (MESA). For this reason, efforts are made during state highway and bridge reconstruction activities to protect against direct "take" of the species.

Credit: MassDOT

That job primarily falls to Timothy Dexter, wildlife biologist with the Massachusetts Department of Transportation Highway Division (MassDOT). Responsible for a host of tasks—from reviewing and designing stream-crossing structures that ensure connectivity for wetland species to handling the permitting process for projects within endangered species habitat—Dexter often finds himself knee-deep in water and mud to protect turtles from construction activities.

Such was the case when a bridge replacement project in western Massachusetts threatened to impact wood turtles and their habitats. To protect the turtles, Dexter and a team of trained MassDOT environmental staff conducted surveys, which detected 11 turtles within and adjacent to the project area. Turtles deemed at risk due to the construction activity were relocated to nearby high-quality habitat away from the construction zone, thus avoiding the state-prohibited direct take of the species. In the process, the team recorded size, sex, age, and other data on individual turtles to contribute to an ongoing long-term study of wood turtles in Massachusetts.

Statewide, MassDOT partners with the Massachusetts Natural Heritage and Endangered Species Program (NHESP) of the Division of Fisheries and Wildlife to minimize turtle road mortality. At one of the worst turtle-mortality "hotspots" in the state, they constructed a "turtle barrier"—two sections of 700-foot-long chain-link fence—along both sides of the highway. Prior to the installation, surveys documented 101 turtle mortalities at the site; a 2012 survey conducted after barrier installation found only seven mortalities. Additional fencing projects are being prioritized based on a state turtle mortality survey program implemented with citizen scientists and overseen by MassDOT and NHESP.

Describing the wood turtle protection project as his "most rewarding experience" on the job, Dexter admits that it can be a challenge conveying the importance of environmentally sensitive design to engineers. But "within the past four years," he says, "I've witnessed a shift in mentality … where engineers are now more open to modifying project design to accommodate environmental enhancements." This shift is due in part to MassDOT efforts to work with regulating agencies such as the NHESP to streamline the permitting process for projects that generate a net environmental benefit. "Consequently," says Dexter, "we can work with our engineers to streamline project delivery and meet deadlines while incorporating environmental enhancements"—a win-win for roads and wildlife.

Credit: MassDOT

Credit: MassDOT

At the site of a bridge-replacement project in western Massachusetts, workers pause while state DOT biologist Timothy Dexter (above, left) bends to retrieve a wood turtle, a state protected species. Wood turtles found at the site (like the male, above) were measured, weighed, aged, sexed, and relocated to safe habitat as part of long-term efforts to study and protect the species. At a road-mortality hotspot elsewhere in the state, Dexter and Dave Paulson of the state's Natural Heritage and Endangered Species Program help build a fence to prevent turtles from crossing the road.

an area cut near the bridge abutments created lots of access to a partially submerged structure that will give the snakes winter shelter from predators.

Power of Persuasion

It can take the skill of a diplomat to arrange such improvements, however. A transportation biologist must be a mediator, or a translator between biologists working for regulatory agencies and the transportation agencies' engineers. Each has its own vernacular that may not be understood by the other. During permitting, I've often noticed that both sides are viewing things from different scales or saying the same things but using different terms (i.e., stream invert = streambed). The result is confusion, misunderstandings, and delayed permit approvals. It's challenging, but once these issues are overcome, great partnerships can develop. In my experience, engineers enjoy the challenge of integrating ecologically sensitive solutions into their project designs. The key is to educate them of the need, and inform them of it early in the project's development.

Early engagement is crucial both internally (with project engineers) and externally (with regulatory agencies) for a transportation biologist, because if you wait until permits are submitted, it is usually too late to add features for the betterment of wildlife. Highway and bridge projects—even those perceived as "simple" roads—can take several years to design, and the closer you get to the construction date, the harder it is to change design plans. Some regulatory agencies tend only to comment on projects when they have a permit application to review, and by that point the project design is 90 percent complete, so changes are very difficult to make without compromising the budget or schedule—both of which are high priorities for transportation agencies.

An example of effective early planning involved a project at Melvin Brook in Clyde, New York. Early in the project's development, I noticed a road-killed otter (*Lontra canadensis*) at the site. Because the large culvert was constantly filled with water, the scent trail of this mustelid had been interrupted. The lack of an upland area forced otters to travel out of the water and over the road embankment to leave a scent trail, thus making them vulnerable to traffic. I explained the need and ideal parameters for an upland bench to be built under the culvert. The project engineers eagerly brainstormed the "how," took ownership of this wildlife improvement, and brought it to life. We made a great team: I identified the need and they created a solution. A year of post-construction monitoring has shown that several medium-sized mammal species are using the bench.

Even the best planning can't prevent unexpected events during construction. For example, after a bridge painting project had already begun, the contractor spotted the nest of a peregrine falcon (*Falco peregrinus*), an endangered species not seen in that area before. Prompt discussions with NYSDEC's endangered species biologists resulted in establishing a buffer area around the nest. Work was allowed to continue while I monitored the adult bird's behavior and fledgling progression to make sure construction activities were not disturbing the falcons. This resulted in minor delays to the project. By summer's end, the contractors were still eagerly observing and reporting the falcon's activities.

Route to Nature's Renewal

Roads have traditionally been viewed as connections for society to transport people and aid commerce. But today the significance of roads has expanded beyond pavement, and their role as links between wildlife corridors is now at the forefront of transportation planning. Likewise, the role of transportation biologists has expanded. Beyond making technical improvements to the ecological integrity of projects, we also contribute to the environmental awareness of the traveling public.

Road travel is often a first step to outdoor recreation, and that's where people connect with wildlife. Dendritic branches of roads that reach into wild areas facilitate encounters with wildlife, returning us to our roots in nature. This leads to the growth of relationships with nature, which are foundational to a person's desire and will to protect the environment. People will protect what they know and love, so it's not a far reach to conclude that roads support the growth of conservation ethics.

It's therefore logical to have biologists working for transportation agencies. It's our job to ensure that roads function in the most ecologically friendly ways possible, while facilitating and enhancing the experiences of the traveling public. It's our job to think beyond the pavement. ■

This article has been reviewed by a subject-matter expert.

Read about how road projects can benefit wildlife at news.wildlife.org/twp.

Wildlife and the National Debt

KNOW THE NUMBERS TO FIGHT THE BATTLE

By Paul W. Hansen

Credit: Kay Stratman

Paul W. Hansen is the Western States Regional Director of The Concord Coalition and Former Executive Director of the Izaak Walton League of America.

As the nation struggles with a growing national debt, we in the wildlife conservation community can and should get involved in finding solutions that will help secure the future of our treasured wildlife heritage. It's a goal the American people support. In July 2012, The Nature Conservancy released a national, bi-partisan survey of voters which found that overwhelming majorities of Americans of all political persuasions support "conserving the country's natural resources—our land, air, and water" (TNC 2012). As the professionals responsible for much of the science and management that underlies resource conservation, we have a unique role to play in achieving this goal.

Our nation is on an unsustainable fiscal path, requiring the government to borrow huge sums each year. Addressing this crisis will require cuts in both annual domestic and defense spending, significant changes in the big entitlement programs, and tax reform that generates additional revenue. It should be clear to all that everything must be on the table to reduce the nation's debt, which Admiral Mike Mullen, former chairman of the Joint Chiefs of Staff, calls the "single biggest threat to our national security" (American Forces Press Service 2011).

Unfortunately, many elected officials have long focused on only one part of the federal budget: the "discretionary" domestic spending programs (including conservation spending) that Congress approves each year. Instead of taking a comprehensive approach to fiscal reform, they keep coming back to the same places to look for more savings—and they never get the larger deficit-reduction job done. Meanwhile, popular programs that most people consider basic government functions—education, infrastructure—are disproportionately targeted for cuts, producing inefficiencies, lost opportunities, public frustration, and poor long-term policies.

Funding for natural resource conservation programs provides a telling example. Cost-effective conservation is a critical concept that receives great lip service in Washington but often comes up short when it comes to actual policy. In 2006, the total contribution from outdoor recreation in the United States was over $730 billion a year, generating 6,435,000 U.S. jobs and $88 billion in federal and state tax revenues. This includes hunting, fishing, wildlife viewing, and the "human-powered" recreations such as hiking, camping, skiing, paddle sports, and bicycling (Southwick Associates 2011).

The portion of the federal budget that covers all environmental and natural resource funding, called Function 300, has been cut substantially in recent decades. In 1982, almost 4 percent of federal spending went to these programs, which include all natural resource, environment, and conservation spending. Today this line item receives less than 1 percent of the federal budget, or $35 billion (Whitehouse.gov). By comparison, tax expenditures—credits, exemptions, deferrals, and other breaks given specific groups in the tax code—now cost $1.3 trillion per year. These tax expenditures cost the nation 37 times more than the entire amount each year spent on all environment and natural resource programs.

Spending on fish, wildlife, and natural resources—of most concern to hunters, anglers and other wildlife conservation groups—is now only 0.4 percent of the federal budget. Deeper cuts have been proposed, including the complete elimination of funding for the North American Wetland Conservation Act and the Land and Water Conservation Fund. Even an inflationary adjustment to the duck stamp, stuck at $15 for over 20 years, was enough to stop the Sportsmen's Act of 2012.

While there must be shared sacrifice if we are to balance the nation's budget and build a sound foundation for economic growth, additional cuts to highly leveraged and cost-effective programs such as natural resource conservation cannot have a meaningful impact on the deficit. By making ourselves familiar with the numbers behind this essential fact of debt reduction, we can use our longstanding credibility to help our large audience of stakeholders better understand what is at stake, and how to address it humanely and honestly. ■

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A Tough Path Worth Taking

BECOMING A WYOMING GAME WARDEN

By Bob Lanka

Credit: San Stiver

Bob Lanka is Supervisor of Biological Services for the Wyoming Game and Fish Department.

I know from experience that a day in the life of a Wyoming game warden goes something like this: You're out 'till around midnight with the local wildlife biologist doing winter spotlight herd counts. It seems like you just hit the pillow when the phone rings. One of the landowners in your district, who supports a lot of wintering game, just heard a shot and saw some headlights move off his east pasture. Without delay you roll out of bed, strap on your law enforcement duty belt, and head out the door, not knowing exactly what you'll find. As you hop into your green department truck with the dancing pronghorn on the door—the shield of the Wyoming Game and Fish Department (WGFD)—you reflect on how you got to where you are today.

For most, being a game warden is a calling more than a job—and in Wyoming, this calling has a long and honorable history. In fact, this year marks the 75th anniversary of the state's competitive game warden exam, one of the most vigorous in the nation. First offered in 1938, it was established to ensure that game wardens earned the job through merit rather than political influence. About half of those who take the exam will pass, and maybe a half dozen of them will be offered jobs and begin what promises to be a memorable career.

Credit: WGFD

Some 15 miles from the nearest road, in an area known as the Thorofare, Wyoming game warden Jerry Longobardi leads pack horses across the upper Yellowstone River. Wardens in the backcountry enforce hunting and fishing regulations and collect wildlife management data.

Scope and Rewards of the Job

Being a game warden requires working weekdays, weekends, and holidays in all types of weather and at all times of the day and night. Though wardens in many states spend the bulk of their time on law enforcement, Wyoming's wardens have highly diverse responsibilities. Most spend about one-third of their time enforcing game, fish, and boating laws and regulations. Another third of their time is spent helping collect and analyze biological data and gaining the field experience needed to manage large and often migratory wildlife populations. The final third involves a range of issues such as mitigating wildlife damage to livestock and crops; working cooperatively with landowners, public land management agencies, and NGOs; providing hunting and fishing information; and being the local "expert" so constituents can find out what's going on with their wildlife and their department.

Part of the job's attraction is never quite knowing what the day will hold—whether trapping bears, darting and transplanting moose, flying in a helicopter to count bighorn sheep, getting a deer out of a resident's back yard, hazing 1,000 elk out of a rancher's field, talking to hunters, or catching poachers. "We are wildlife biologists, wildlife law enforcement officers, wildlife educators, problem solvers, and ambassadors to landowners, hunters, anglers, and communities throughout Wyoming," says Herb "Bubba" Haley, WGFD's North Pinedale Game Warden. After almost 17 years in the ranks, Haley still says, "I've got the greatest job in the world."

Only a select few get to do the job, however. The Wyoming Game and Fish Department has 85 commissioned enforcement officers including the department's Director and Chief Game Warden. We have 50 senior game wardens, each assigned an individual warden district, and 10 game wardens

who work around the state, handling watercraft and fishing enforcement during the summer and assisting regionally with tasks in specific districts as needed. Five individuals work 100 percent on law enforcement in our wildlife investigative unit, focusing on complex cases, such as commercial poaching and illegal license transference, which may result in state or federal wildlife law violations. Four officers work in our Private Land/Public Wildlife (PLPW) program, creating hunter and angler access agreements with willing landowners and helping with law enforcement on PLPW lands. Finally, two wardens supervise and work with a group of non-enforcement personnel in our Large Carnivore Section to address conflicts and management issues regarding grizzly and black bears, mountain lions, and wolves. The remaining officers are comprised of statewide and regional supervisors and a law enforcement program manager and coordinator.

The diversity of the work—as well as a passion for wildlife—is what attracts people to the job and keeps them in it for the long haul. "I've wanted to be a game warden since I was a little kid, and now I can't believe I get paid to do the things I do," says Kyle Lash, one of our newest game wardens. "I don't work with anyone who doesn't care about the wildlife we manage, the habitats they rely upon, and the landowners, hunters, anglers, and citizens we serve. Working with this group of dedicated professionals is something I am glad to be a part of."

Earning a Coveted Slot

Those who do want to be a part of this profession must meet several rigorous requirements that the state has established to ensure that Wyoming hires the most well-qualified candidates. These requirements include:

Education. Candidates must have a bachelor's degree in wildlife management, range management, biology, zoology, or ichthyology, including at least 20 hours of coursework in these fields. This educational foundation is more important than having a law enforcement background because game wardens are wildlife managers as well as law enforcement officers, and the department offers its own training in the law enforcement aspects of the job.

Exam. Candidates who meet the educational requirements will then need to pass Wyoming's competitive game warden exam. Our website shows sample questions from the exam, which covers a range of issues in four broad categories including: (1) wildlife management, such as species identification, diseases, data collection, and damage management; (2) fish, including identification and distribution of warm and cold-water species; (3) law, covering Wyoming statutes, court procedure, legal terms, and search and seizure; and (4) other issues ranging from federal-aid programs and map reading to endangered species, boating safety, trapping techniques, and firearms safety. "In preparation for the test," says Lash, "I took the time to look through the department's website and read all the suggested materials, and took time to call and visit with working Wyoming wardens."

Credit: WGFD

Game warden Kim Olson looks down on a herd of pronghorn antelope that inexplicably got trapped in a rock-bound water hole. She and colleagues built a hay-bale ladder in hopes that the pronghorn would climb out. When that failed, the animals were tranquilized and physically hauled out–one of the many unexpected tasks that arise in the life of a Wyoming game warden.

Interview. Those who pass the exam will have a formal oral interview before a panel consisting of the wildlife division's chief game warden, the two assistant chiefs, and other department personnel. These leaders will be looking for candidates who can deal with pressure, think on their feet, and represent the department and the game warden position in the most professional manner.

Background Check. Before making the final hire, the department does a background check and

administers a polygraph test. Each candidate also takes a psychological exam and fills out a personality profile to help us determine if a qualified candidate is the right fit for the job.

Candidates who meet the department's standards and earn a job offer then serve a 12-to-15-month probationary employment period. During this time, each new hire is required to take and pass a rigorous 13-week training program at the Wyoming Law Enforcement Academy (WLEA) to become a certified peace officer in the state. On their first day at the academy, each individual must pass a standardized physical fitness assessment in order to be allowed to begin the training program. (Those who fail this assessment are sent home.) The training at WLEA includes fitness training, classroom work to learn applicable Wyoming and federal laws, and practical field exercises that cover issues like firearms training.

Credit: WGFD

Red shirts and sidearms are standard issue for wardens like Adam Hymas, who works with colleagues to field check a recently harvested pronghorn. Monitoring hunter compliance with bag limits and hunting licenses keeps wardens busy at "the office"–Wyoming's wide outdoors.

Credit: WGFD

Game warden Craig Smith (at center) steadies a captured ewe bighorn sheep as others take biological samples. Far beyond law-enforcement officers, Wyoming's game wardens help catch and mark wildlife and also help relocate animals to keep herds stocked and healthy.

Usually, the first game warden job for someone just out of the academy involves enforcement of fishing and watercraft laws. Throughout the early part of their career, game wardens typically move from one location to the next, receiving close supervision and gaining the experience they need to build their skills and advance their career. Typically, after two to three years, those who show the necessary skill and dedication may be promoted to the rank of a senior game warden and assigned their own district.

Those who have been in the profession for many years have seen some changes in types of issues they confront. They still see mainly routine violations such as hunting out of season or exceeding bag limits, but they're also seeing an increase in more serious violations. They've seen a rise in illegal commercialization of wildlife and also more wanton destruction of wildlife, such as the illegal take of mature male ungulates on winter range out of season and without a license for the antlers only.

Watercraft use on Wyoming's reservoirs has also increased dramatically, resulting in an increase in accidents that can cause serious injury or even death. Many of these incidents are related to an increase in boating under the influence of alcohol or illegal drugs, and Wyoming wardens are often the first on the scene to handle these crises.

Wrapping Up Another Day

So what happened with that late-night phone call? Pulling into the ranch yard you can see that the landowners are not happy. You interview them and get limited details, approximate time and a vague description of the intruder's truck. Walking out to investigate you find a crime scene—a large, yellowish elk carcass with only its head removed, the remainder left to waste. No doubt this was a bull poached for its antlers.

Despite feeling disgust, you force yourself to keep a clear mind and sharp eye. At the scene you find two sets of footprints, one shell case, tire tracks, and a bullet lodged in the elk's chest. You also find a beer bottle, an unusual brand in these parts. As you leave the scene, you call a long-time sheriff's deputy who knows almost everyone in the county, hoping he can give you a lead. He knows of a couple people who might engage in poaching. As you drive by the house of one of them, you see a pickup in the drive with treads that match the tracks you saw earlier. You investigate, and notice blood in the back and an empty beer bottle from that same unusual brand. Based on your investigation, collected evidence, training, and skill, you obtain a confession from the guilty parties, who are cited and sent to court.

You got lucky. Most cases don't end this quickly and many are never solved. The judge, an outdoor enthusiast, passes down a harsh sentence: winter range violation, large fine, restitution for the animal, and loss of the truck and rifle used to take the elk. As you leave the courtroom you take some satisfaction in a job well done. But there is still a poached elk lying dead in your district, stolen from the herd and from those who would enjoy seeing it or giving it fair chase. Disgust rises again in your throat.

Are you interested in becoming a Wyoming game warden? Are you someone who can talk to a class of fourth graders in the morning and fourth-generation landowners in the afternoon? Are you part wildlife biologist, range manager, psychologist, educator, and law enforcement officer? Can you read people and situations, and know when to simply issue a warning versus come down hard? Can you work with little supervision but still realize you are not self-employed? Can you work long hours in isolated country in adverse weather? If you answer "yes" and have the education and drive to be successful, then we want you—and so would most other state agencies in the nation. ■

This article has been reviewed by subject-matter experts.

For complete details on the Wyoming game warden exam and scope of the job, go to wildlife.org.

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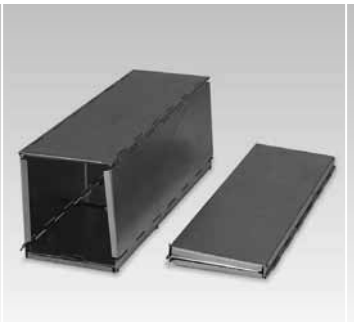

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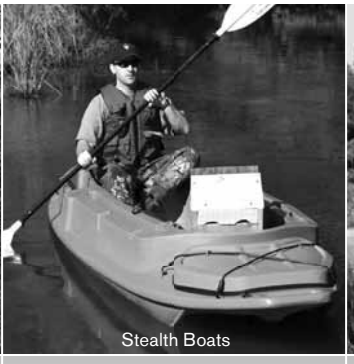
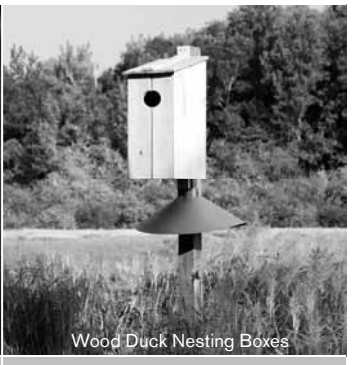
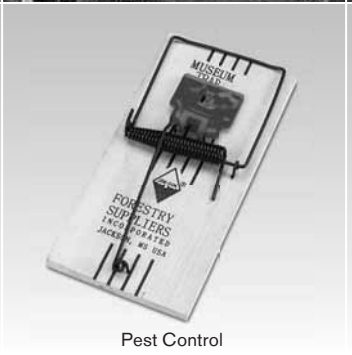


Stealth Boats



Wood Duck Nesting Boxes

Pesola Hanging Scales



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The Truth Lies in the Tusk

According to a recent CITES report, illegal ivory trade has increased significantly over the last two decades, with 2011 seeing a "major surge" in elephant poaching (TRAFFIC 2012). In a recent NPR interview, the *New York Times'* Jeffrey Gettleman noted that today, ivory can sell for approximately $1,000 per pound (NPR 2012). When it comes to cracking down on poachers, however, authorities find it difficult to trace the source of the crime, because the tusk of an elephant killed in an African country could eventually make its way to an Asian market. Now, Alfred Roca, assistant professor at the University of Illinois College of Agricultural, Consumer, and Environmental Sciences, might be able to make their task easier.

Roca and his colleagues recently found a way to determine the provenance of ivory by studying an elephant's mitochondrial DNA (mtDNA), or DNA that's located in the mitochondria—a cell's source of energy. What sets mtDNA apart from DNA found in the cell nucleus is that it's only transmitted by females. Since female elephants don't migrate between herds—unlike males, which tend to disperse as soon as they are ready to reproduce—it's easier to track the location of an elephant, or the origin of its ivory, based on its mtDNA. "The only way the marker could move is if the females migrated or moved somewhere as opposed to every other marker that gets transmitted by males from herd to herd and across the landscape," Roca says.

As part of their research, Roca's colleague Nicholas Georgiadis used a biopsy dart to collect a small sample of skin from 653 elephants from 22 locations in 13 African countries. Next, Yasuko Ishida, a researcher in Roca's lab, sequenced and analyzed the samples and identified 108 unique mtDNA sequences, which could be compared to information on the origin of the elephants. "The first thing we found was that you could actually split up the mitchondrial sequences into eight distinctive regional geographic groupings, [such as western Africa, west-central Africa, and northern-savanna]," Roca says. "So, just by figuring out which of those branches the mtDNA belonged to, you could pretty much say this elephant came from a certain region of Africa. Further, when the researchers looked at the 108 individual sequences, they found that 72 percent of those sequences were found in one location and 84 percent were specific to a given country.

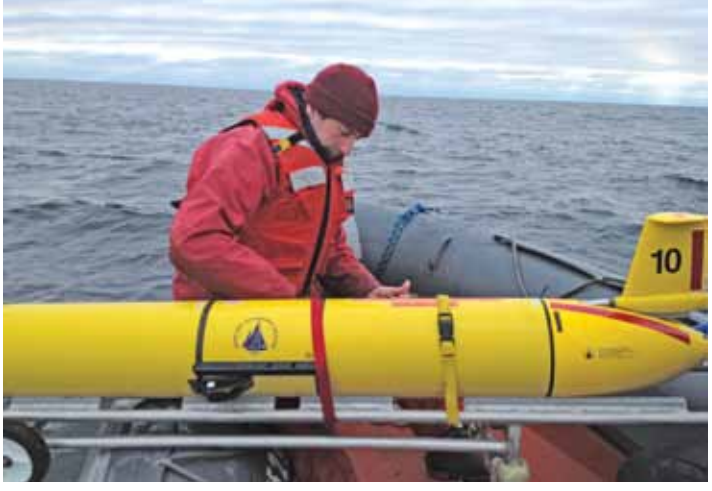
According to Roca, while this method works well on its own, it can be more effective when combined with previous methods relying on nuclear DNA. That's because nuclear markers have been used to distinguish between forest and savanna elephants, and can be combined with mtDNA markers to point to a more precise location. And so, when it comes to cracking down on poaching, based on these newly developed methods and research, forensics labs could sequence the DNA found in the ivory and narrow their investigation down to a particular region.

— *Based on research by Yasuko Ishida et al. 2013.*

Robots Track Endangered Whales

For the first time, in December 2012, an unmanned underwater glider not only located a pod of nine endangered whales, but identified the species—the North Atlantic right whale (*Eubalaena glacialis*)—and did so in real time. The glider instantly sent information to researchers on shore at the Woods Hole Oceanographic Institute (WHOI) who confirmed the whales' presence at sea, and then notified the National Oceanic and Atmospheric Administration (NOAA)—the federal agency that enforces the Marine Mammal Protection Act. NOAA distributed a request to all mariners in the Gulf of Maine to slow their speed in order to avoid colliding with the whales.

"There are only about 500 right whales left, so losing just one or two animals a year can mean the extinction of species," says Mark Baumgartner, an associate scientist at WHOI who, together with glider expert Dave Fratantoni, led the team of



Credit: Nadine Lysiak/Woods Hole Oceanographic Institution

Mark Baumgartner recovers an underwater glider (wings removed) after its three-week mission to record whale calls. The glider surfaces every few hours to get a GPS position and transmit data to shore.

scientists and engineers that developed the whale detection system. Baumgartner says that the glider is useful from both a management and a scientific perspective. NOAA currently manages whale protection by conducting aerial surveys and then issuing warnings to mariners. But small planes are costly and dangerous to operate and are only sent out a couple of times each week. The gliders can operate continuously on battery power for up to six weeks.

Scientifically, gliders improve on traditional methods for studying whale ecology. The gliders can safely operate in rough weather that may imperil research vessels, collect data continuously for weeks, and explore the ocean depths. At a little over $100,000 they are far cheaper in the long-run than the $15,000-20,000 per day cost of a research vessel. When it is necessary to visit a whale pod in person to collect samples and identify individual whales, the glider can reduce the time it takes to locate them from the order of days or weeks to just a few hours.

The gliders are five-foot-long, torpedo-shaped, winged vehicles equipped with a hydrophone (an underwater microphone), a GPS, and a small computer the size of a cell phone that directs it where to go, collects recordings of whale calls, identifies the calls by species, and sends the data back to shore. The computer, called DMON for "digital acoustic monitoring," is equipped with a library of 15 calls from four endangered whale species—fin (*Balaenoptera physalus*), North Atlantic right, humpback (*Megaptera novaeangliae*), and sei (*B. borealis*). The DMON's overall species identification accuracy is 86 percent. Baumgartner says that this number will improve as the call library is expanded. Currently, the glider's only limitation is shallow water because it requires space to move up and down in order to maneuver left or right.

— *Based on research led by Mark Baumgartner and Dave Fratantoni of WHOI.*

Solar Panels Power Remote Research

For 20 years, Caitlin O'Connell-Rodwell has powered a remote research station in southern Africa—and lately that includes everything from laptops to a mini-refrigerator—with just two 200-Watt solar panels. Research stations such as this that are located off the grid often run on noisy gas-powered generators, but the noise and vibration disrupts the normal behavior patterns of the elephants that O'Connell-Rodwell studies.

Credit: Peter Zielyk

Caitlin O'Connell-Rodwell adjusts a solar panel used to power a temporary elephant research camp in a remote area of Namibia's Etosha National Park.

"The noise of removing a plastic audio tape cover would scare the females away," says O'Connell-Rodwell, an instructor at the Stanford School of Medicine. "Solar was the only way that I could think of operating." From June to August, her team lives in a temporary camp at the base of a three-story tower that is rebuilt each season when elephants concentrate at Mushara waterhole in Etosha National Park in Namibia after other water sources have dried up. The team collects and plays back sound recordings of elephant calls in order to study how they communicate. Capturing the call recordings used to require one of the researchers to sit very close to the elephants, but now the recording equipment can be operated from the tower 80 meters away from the oasis, where there is a much lower risk of disturbing the animals.

All that you need is a solar panel, a voltage regulator, and a battery in order to run all of the equipment that you need, says O'Connell-Rodwell. The panels power cameras, laptops, a printer, a microscope, a refrigerator, and an electric fence to deter hungry lions at night. She says that people forget that most laptops operate off of a 12-volt DC charger, which is a lot less energy than is provided by a standard 110 volt AC outlet.

"It's not expensive at all to set up a solar system," she says. "In Namibia, we can rent the panels for 20 percent of the cost of purchasing one. People use what they're used to. It just requires a shift in perspective."

— *Based on research by Caitlin O'Connell-Rodwell.*

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GSM OUTDOORS THINK OUTSIDE

IN MEMORY

James D. Yoakum

Credit: Reginald H. Barrett

On November 20, 2012, The Wildlife Society lost James D. "Jim" Yoakum, the Bureau of Land Management's (BLM) first hired wildlife biologist and a passionate researcher whose countless contributions to TWS's Western Section remain unmatched. He was 86.

Yoakum was born in Templeton, California in 1926. At age 17, he enlisted in the U.S. Navy, serving for the next three years in the Pacific Front. After the war he attended Humboldt State College, graduating with a degree in wildlife management in 1953, and then Oregon State University, earning his Master's degree in 1957.

Yoakum was hired that year by the BLM, where he worked as the agency's wildlife representative in Ely, Nevada. He later moved to Reno (and stayed there until his retirement in 1986), passionately undertaking a variety of BLM projects including the rebuilding of Nevada bighorn sheep and Warm Springs pupfish populations, pronghorn antelope research, and other habitat management projects.

Yoakum had a love of studying and photographing and advocating for wildlife. His fascination with the pronghorn antelope led him to publish, with coauthor Bart W. O'Gara, "Pronghorn: Ecology and Management" (2004), a comprehensive summary of over 30 years of personal research, photographs, and discussion.

Yoakum joined TWS as a student in 1952 and remained an ardent supporter of the organization. Over the years, he served in numerous capacities on the Western Section's Executive Board, including as president in 1970-1971, and as historian—a position he held until his death.

To honor his service to the profession, TWS awarded Yoakum the Western Section's Outstanding Contributions to Wildlife Award and Raymond F. Dasmann Professional of the Year Award, the TWS Special Recognition Award, and the TWS Award of Merit. He was named an Honorary Member of TWS in 1990, and in 1998 the Western Section created the James D. Yoakum Award for Outstanding Service, which recognizes individuals who have provided outstanding long-term service, support, and commitment to the Society.

"He embodied Theodore Roosevelt's famous phrase, 'Speak softly and carry a big stick; you will go far,'" says former TWS Western Section President Rick Williams. "Jim was a steady, yet not bombastic, champion of professional ethics, certification, and the history of our Society. His legacy of dedication to wildlife and the wildlife profession should never be forgotten."

Robert L. Rausch

Credit: Kirill Galaktionov

Robert L. "Bob" Rausch, a famed parasitologist and mammalogist and TWS member since 1945, passed away on October 6, 2012 at his home in Bainbridge Island, Washington. He was 91.

Born in Ohio in 1921, Rausch earned a D.V.M. from Ohio State University in 1945, and later did post-graduate work in Michigan and Wisconsin before accepting a position at the Arctic Health Research Center (AHRC) in Alaska as a parasitologist.

During his 27 years there he devoted his career to the investigation of zoonoses, particularly on the biology of parasites of rodents and carnivores in the Arctic and subarctic regions. Eventually rising to become Chief of the Infectious Disease Section at the AHRC, his research took him to many parts of the world, where he conducted collaborative parasitological studies alongside scientists in Siberia, Japan, China, and South America. For a time he lived among the Nunamiut people of northern Alaska, becoming fluent in their language while conducting fieldwork on zoonotic diseases including rabies, brucellosis, and tularemia, which affected the indigenous people.

After the AHRC closed in 1974, Rausch took a position at the Western College of Veterinary Medicine (WCVM) at the University of Saskatchewan for three years before joining the faculty of the University of Washington School of Public Health's Department of Pathobiology and the School of Medicine's Department of Comparative Medicine. He received an emeritus appointment in 1992.

Rausch received a number of awards and honors, including a Public Service Award from the American Veterinary Medical Association. In 2011 he was named an Eminent Parasitologist by the American Society of Parasitology. He also received honorary degrees from the University of Saskatchewan (Doctor of Laws), the University of Alaska (Doctor of Science), and the Universität Zürich (Doktor der Veterinärmedizin).

Rausch is survived by his wife and colleague of more than 60 years, biologist Virginia Rausch, with whom he published more than 300 scientific manuscripts throughout their careers. ■

GOTCHA!

(Top) Moose (*Alces alces*), Ashley National Forest near King's Peak, Utah. Credit: Caylen Cummins. (Below left) Pacific tree frog (*Pseudacris regilla*) in a dahlia, Thurston County, Washington. Credit: Harriet Allen. (Below right) Chicks of the tricolored blackbird (*Agelaius tricolor*), Kern County, California. Credit: Kelly Weintraub.

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