Decision-making in the Face of Uncertainty

Restoring Fish Passage in the Lemhi Basin

by Andrew J. Tyre

The path to recovery for a listed species can be filled with risk and uncertainty. For example, which restoration actions will yield the greatest improvement for the least cost? Adaptive management, a special type of structured decision-making, is one approach to making wise choices in spite of scientific uncertainty. In a simplified way, it can be described as learning while doing, by planning management actions so the results of current actions provide information to refine such actions in the future.

The bull trout (*Salvelinus confluentus*) is a stream-living fish in the salmon family distributed in drainages of the northwestern United States. The decline of bull trout populations throughout their range, in concert with a number of other

threats, led to listing the species as threatened throughout its entire range in 1998.

Bull trout depend on habitat with the "4 Cs"—clean, cold, complex, and connected. Measuring clean, cold, and complex (in the sense of a diversity of physical structures in the stream) is relatively straightforward. However, determining whether streams are connected or not, and how important connectivity is for the future of bull trout, is more of a challenge.

Connectivity matters because bull trout populations have two distinct life history forms: resident and migratory. Both spawn in small headwater streams, typically from August through November. While resident forms complete their life history entirely within headwater streams,

migratory forms live in headwater streams for 1 to 3 years during their juvenile stage before migrating downstream into larger, more productive waters where their growth rates are greater. As a result, migratory adults are much larger and more fecund than their resident counterparts. Although migratory bull trout generally return to their natal streams to spawn, the migratory individuals are important for recolonizing streams that have lost their bull trout populations.

In the Lemhi River drainage of eastern Idaho, the U.S. Fish and Wildlife Service, in partnership with the State of Idaho and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, is working to address the conservation needs of bull trout and other salmonids. In particular, the agencies are working to restore necessary water flows at appropriate times of year in key sections of the Lemhi watershed to allow bull trout access to headwater streams. Restoring fish passage will allow migratory adults to reenter streams where bull trout populations are currently restricted to the resident form, as well as streams not currently inhabited by the species.

Reestablishing connectivity of isolated populations involves some risk. Another member of the salmon family, the non-native brook trout (*Salvelinus fontinalis*), has been introduced into the Northwest, and it generally occurs in warmer streams than bull trout populations. However, in streams where both species now occur, the bull trout has been observed shifting toward colder stream reaches at higher elevations (where their populations are less productive). Additionally, hybridization between brook trout and bull trout is known to occur, apparently resulting in hybrids that are either sterile or have very low fecundity. Reestablishing connectivity of isolated bull trout populations could allow brook trout to invade areas occupied by resident populations of bull trout. This would potentially reduce both the availability of good bull trout habitat and bull trout productivity through hybridization.

However, due to a dearth of resources we are unable to restore fish passage to every headwater stream in the Lemhi Basin. Boiled down to the essentials, we must choose between addressing this problem in streams that currently have resident bull trout, and those that do not. These choices must be made before the scientific uncertainties are resolved; indeed, given the magnitude of the task and the difficulty of monitoring bull trout, agency managers may never know for certain the exact nature of the risks involved.

In 2005, a group of Fish and Wildlife Service biologists gathered at the National Conservation Training Center, together with scientists from universities and the U.S. Geological Survey, to see if this problem could be addressed by using adaptive management.

Considering what is unknown about bull trout biology, the scientists addressed two distinct questions. First, do brook trout have a negative effect on bull trout, and second, will the migratory form of bull trout return to occupied streams immediately? Combining the two potential answers to each of these two questions yielded four different possibilities. The effects of different choices on the persistence of bull trout were analyzed for each case. In all four cases, the best choice is to restore connectivity to a stream that is currently occupied by resident bull trout. The interesting outcome of the analysis is that the substantial scientific uncertainty does not affect the decision. Even if managers were certain about which hypothesis is correct, it would not change their decision. However, determining which streams to restore depends on the number of streams that are both occupied and connected, so monitoring is crucial to making the best decisions.

The analysis of fish passage restoration in the Lemhi Basin is just one example of how management decisions can be made despite uncertainty about threats to a species. The methods of structured decision-making and adaptive management are not specific to bull trout. Decisions about how to restore other species could benefit from the same type of approach.

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Though there is some risk involved in restoring water flows in the Lemhi watershed, reestablishing connectivity of isolated populations is seen as critical for bull trout recovery. *Photos by Joel Sartore, National Geographic Stock with Wade Fredenberg*

A Slithering Success Story

by Megan Seymour

The Lake Erie watersnake, a harmless, non-venomous reptile once threatened with extinction, has rebounded to the point that the Service proposed removing it from the list of federally threatened and endangered species in June 2010. *Kristin Stanford*

Who would have thought that a few small islands in Lake Erie, a feisty snake, and a group of dedicated folks could come up with a conservation message that reached the nation and contributed to the biological diversity of the Midwest? This is the story of the Lake Erie watersnake.

It started many years ago. French explorers in the 1700s noted an abundance of serpents and named the western Lake Erie islands the "Islands of the Snakes." Accounts from the late 1800s described watersnakes "sunning themselves in heaps, knots, and snarls." In the early 1900s, when this subspecies was described scientifically as the Lake Erie watersnake (*Nerodia sipedon insularum*), it could still be found in large numbers.

It is unique for many reasons, not the least of which is its very limited distribution; it occurs primarily on U.S. and Canadian islands and adjacent waters in western Lake Erie. It prefers rocky shorelines, hiding under large limestone rocks within shoreline vegetation, or within the cracks and crevices of docks, "riprap" erosion control, and other human-made structures. These are also the areas where summer island residents and tourists want to be. Though non-venomous, the snakes are large, moody, and smelly enough to attract few defenders. Between the modification of shoreline habitats, the destruction of inland hibernation sites, and eradication efforts, the Lake Erie watersnake population declined precipitously. In 1999, it was listed as a threatened species under the Endangered Species Act (ESA), and I became its recovery coordinator.

In 2002, as directed under Section 4(f) of the ESA, the U.S. Fish and Wildlife Service began developing a recovery plan for the watersnake. The recovery plan described a series of tasks designed to protect needed habitat and help people learn to coexist with the snake. These tasks included outreach and education programs, population monitoring, and research. The plan identified three objective, measurable recovery criteria—establishing multiple secure subpopulations, conserving habitat

distributed proportionally among the islands, and surveying public opinion. Once the plan was in place, I felt much more confident that a path to recovery existed, and all we had to do was implement it.

The earliest efforts to recover the Lake Erie watersnake focused on outreach to the local residents. A "Watersnakes Welcome Here" campaign conveyed the message that these creatures are harmless and part of the island environment. Hundreds of signs were printed and distributed to island landowners, a bi-annual newsletter was started, and Service biologists met with landowners who had "snake issues." Shortly thereafter, "The Snake Lady" arrived. Kristin Stanford, a graduate student from Northern Illinois University (NIU) studying under Dr. Richard King, was hired to conduct snake research and outreach, and she quickly became the spokeswoman for this misunderstood critter. Stanford embraced the snake and the islanders, both literally and figuratively, grabbing snakes by the handfuls while chatting with local folks about the species' biology, life history, and ecological significance.

Stanford and Dr. King engaged volunteers to participate in annual counts of Lake Erie watersnakes for mark-recapture studies. Regional snake researchers, government officials, students, members of the media, and even island kids joined in each year. Reaching out to diverse stakeholders kept island residents engaged in the process. Stanford's efforts as the face of the public outreach campaign gained her trust among islanders and eventually a starring role on an episode of the Discovery Channel's TV series "Dirty Jobs." Viewed by millions of people across North America, it was one of the series' top-rated episodes. The research and outreach efforts of Dr. King and Stanford earned them the Service's 2010 Recovery Champion Award.

While Stanford brought the plight of the watersnake to a national audience, the watersnake's troubles brought the plight of Great Lakes islands biodiversity to the attention of many throughout the region as well. Ultimately, this has led to a multi-partner coalition amongst the Service, The Nature Conservancy, Nature Conservancy Canada, Ontario Ministry of Natural Resources, the University of Minnesota, the Northeast Midwest Institute, and USEPA Great Lakes National Program Office to identify and plan conservation actions for the biodiversity of Great Lakes Islands as a whole.

Environmental adventure campers help Kristin Stanford bag Lake Erie watersnakes for mark-recapture studies. *Tyler Lawson*

The Service and Ohio Department of Natural Resources (ODNR) funded NIU's outreach and monitoring efforts. The Service also contributed toward habitat protection by ODNR and a grass-roots conservation organization, Black Swamp Conservancy, Lake Erie Islands Chapter. Led by islander and dedicated conservationist Lisa Brohl, the Conservancy took on preservation of smaller island parcels, conservation easements, and even established a local park district. Many of the Conservancy's island properties are permanently protected habitat for Lake Erie watersnakes. In 2010, Brohl was awarded the ODNR Division of Wildlife's Wildlife Conservation Award for her work to protect the Lake Erie islands.

Since much of the watersnake's habitat occurs along the Great Lakes shoreline, impacts are regulated by the U.S. Army Corps of Engineers. The Service developed guidelines for when certain activities can occur and designs for creating snake habitat as part of shoreline construction projects (e.g., docks and erosion control structures). When there is no federal nexus, the Service works with private landowners to develop Habitat Conservation Plans that avoid and minimize impacts to the watersnake from private development.

Twelve years after listing, the watersnake population has increased approximately five-fold, 318 acres (128 hectares) of key shoreline habitat are protected, and the public is more tolerant of the harmless creatures. After analyzing the factors that led to its threatened status, we determined that it has recovered to the point that it no longer needs the protection of the ESA and proposed to remove the species from the endangered and threatened species list in June 2010. We are now moving forward with a final rule to delist the Lake Erie watersnake. While we believe it has recovered and no longer needs ESA protection, we have a duty under section 4(g) of the law to ensure that it will continue to thrive after delisting. Accordingly, the Service has developed a post-delisting monitoring plan that will continue the population monitoring of the past 12 years, evaluate the population status after each census, ensure that protected habitat remains suitable, and assess public attitudes and the need to conduct additional education and outreach. Over the next 5 years, we expect to demonstrate that the watersnake population is self-sustaining and secure.

Although the Lake Erie watersnake may no longer need ESA protection, its legacy as a conservation and recovery success story has benefitted the island environment that it depends on, as well as the Great Lakes Islands as a community. Thanks, you feisty little critter!

Kristin Stanford checks a Lake Erie waternsake for a passive integrated transponder (PIT) tag with Mike Rowe of the Discovery Channel's show, "Dirty Jobs." PIT tags help biologists identify and track individual snakes. *Tyler Lawson*

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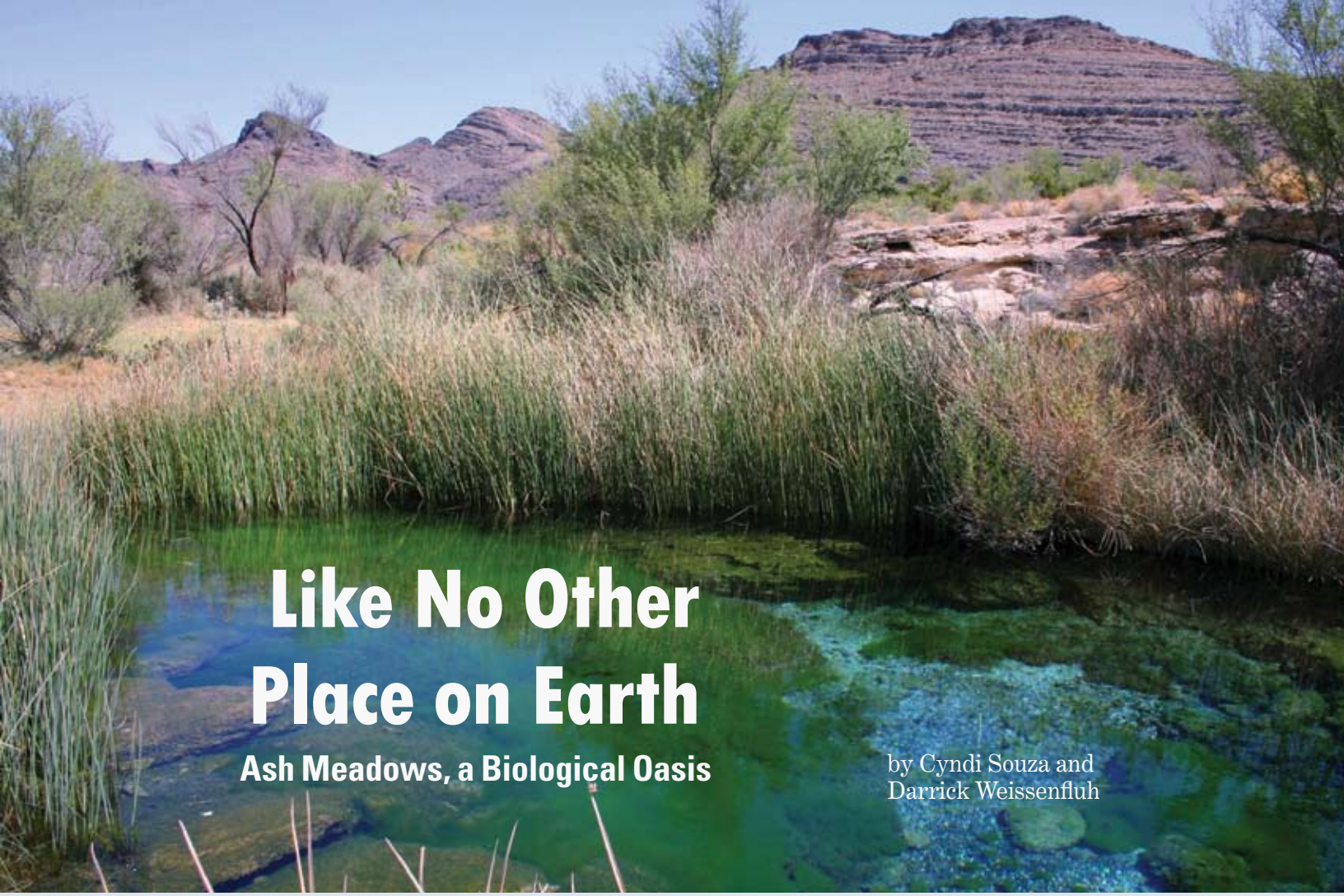

Like No Other Place on Earth

Ash Meadows, a Biological Oasis

by Cyndi Souza and Darrick Weissenfluh

King's Pool, a thermal spring that is part of the extensive wetland system within Ash Meadows NWR, is home to the Ash Meadows Amargosa pupfish.
Cyndi Souza, USFWS

Located in the middle of nowhere, according to most of our visitors, is Ash Meadows National Wildlife Refuge. An area just over 23,000 acres (9,300 hectares), it supports at least 26 species of plants and animals that cannot be found anywhere else on earth. In fact, the Ash Meadows ecosystem supports the highest concentration of endemic species in the continental United States. The refuge contains the largest oasis of springs within the Mojave Desert, which is the driest region in North America, and it was also one of the first sites in the nation to be designated as a Wetland of International Importance. Never heard of Ash Meadows? We know. Few people have, and you won't find it using your GPS.

As you leave the glitz and glamour of Las Vegas, the Nevada landscape becomes a dry, vast, and sparsely populated desert. This is not a place where you would ever expect to see rare flowers, hundreds of species of birds, and fish that swim in Caribbean-blue spring pools. Most tourists drive on past by the refuge entrance signs toward a more famous place, the nearby Death Valley National Park.

Prior to 1960, five endemic fishes were known to exist within the Ash Meadows ecosystem. Around that time, their unusual habitats began to be altered extensively by farming, mining, water diversion, artificial dams and channels, extensive removal of native vegetation, and the introduction of non-native aquatic species. These impacts are blamed for the extinction of the Ash Meadows poolfish (*Empetrichthys merriami*).

Receiving only a few inches of rain each year, the Ash Meadows ecosystem is supported by an aquifer of "fossil" water left behind from the Pleistocene epoch, a time when the region was wetter and crossed by interconnected lakes and rivers. One of its most famous surviving residents is the Devils Hole pupfish (*Cyprinodon diabolis*), which exists only in a single water-filled cavern, Devils Hole. This small fish was already endangered when corporate farming in the Ash Meadows area began to grow to massive proportions in 1967. Large-scale farming in such a dry area requires intensive pumping of ground water for

irrigation. As the aquifer was depleted, the water needed to support the Devils Hole pupfish began to decline. After a 1971 federal court injunction against over-pumping the aquifer, the U.S. Supreme Court guaranteed sufficient water levels for the Devils Hole pupfish permanently in a landmark 1976 ruling. But the decision applied only to the Devils Hole pupfish, since at the time it was the only Ash Meadows species listed as endangered. The ecosystem's other unique animals and plants went unprotected.

In the late 1970s, the landowner, Cappaert Enterprises, determined it no longer had enough water to continue large-scale farming, so it decided to sell the land. In 1980, a private company purchased the property with the intent to subdivide it into 34,000 residential lots. When development began, important habitats suffered further degradation and the aquifer was again threatened, along with the species that depended on it.

In 1982, the U.S. Fish and Wildlife Service published a temporary emergency rule listing two endemic fishes, the Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*) and the Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*), as endangered species. This halted additional habitat damage for 240 days, allowing time to determine if final Endangered Species Act (ESA) protection was warranted. In 1983, both fish species received final ESA protection and The Nature Conservancy negotiated a purchase of the property. The following year, the Service purchased the land from the Conservancy to create Ash Meadows National Wildlife Refuge. A recovery plan for the area was developed in 1990 to restore habitats and recover the listed species, which by then included four endangered fishes, seven threatened and endangered plants, and a threatened aquatic insect, the Ash Meadows naucorid (*Ambrysus amargosus*).

Restoration and Recovery

Back in the 1930s, Ash Meadows speckled dace inhabited at least 13 springs in the area, but by 2009 only two viable populations remained. The Ash Meadows Amargosa pupfish and the Warm Springs pupfish (*Cyprinodon nevadensis pectoralis*) survived in most of their historic habitat but faced lingering threats. Even today, new threats have emerged from pumping and aquifer drawdown in the basin outside the boundary of Ash Meadows NWR.

All of the pupfish species, which reach about the size of your thumb, live for only one to three years. The males, a silvery- iridescent blue, can be seen darting among the algae. This behavior was originally mistaken for the kind of playfulness shown by puppies, hence the name pupfish. In reality, the males are guarding their small territories. But even this display of bravado is no match for invasive species such as western mosquitofish (*Gambusia affinis*), red swamp crayfish (*Procambarus clarkii*), and sailfin molly (*Poecilia latipinna*), which have became established in most springs and compete for the same resources needed by native species. Eradicating invasive species is challenging. Chemical treatments can be lethal to native invertebrates, and physical removal methods, such as netting, are time consuming with usually marginal success. A new plan for restoring the unique creatures of Ash Meadows was needed, so in 1995 biologists began working on an innovative strategy.

In the 1970s, prior to the establishment of Ash Meadows NWR, the springs located at Point of Rocks and King's Spring were excavated and developed for agricultural use. *C. H. Lostetter*

Because it is unlikely that invasive species can be eradicated from the ecosystem, the new management approach is to remove as many non-native fish as possible using traditional methods, such as trapping, while restoring habitats to conditions that favor native fish over non-natives. Focusing on the most numerous invasive species, sailfin molly and mosquitofish, biologists began extensive research on historical habitats, restoration processes, and fish behavior. Among the habitat characteristics they studied were water depth, velocity, and temperature at various sites in the system. The findings guided managers in choosing the designs for habitat restoration.

For example, if invasive species flourish in slower, cooler water, habitat improvements include measures to restore outflows that retain warmer temperatures with flow rates conducive to native species. The success of this strategy was validated in 2003, when the percentage of native species finally surpassed, by a large margin, the invasive species.

In 1997, habitat restoration began at Kings Pool Spring, an area severely affected by the former farming activities. Before the project, Ash Meadows Amargosa pupfish comprised only 23 percent of the spring's fish population, but they rose to 91 percent after the restoration. The entire process took 4 years. Since 2008, 10 populations of invasive aquatic species (e.g., red swamp crayfish) have been eradicated from six spring systems in Ash Meadows.

The Devils Hole pupfish is a truly unique species, with one of the smallest ranges of any vertebrate. This inch-long, iridescent blue fish makes its home in the 93 degree waters of Devils Hole, which is located within Ash Meadows National Wildlife Refuge. *Olin Feuerbacher*

Today, Tomorrow, and Beyond

Reestablishing a healthy ecosystem and historic populations of native species is challenging, but refuge managers have achieved substantial success. In 2010, four miles (6.5 kilometers) of the Fairbanks Spring outflow were rehabilitated to promote the restoration of Carson Slough, which was the largest wetland in southern Nevada before it was drained and mined for its peat. The habitat once again supports the endemic Fairbanks springsnail (*Pyrgulopsis fairbankensis*), the Ash Meadows Amargosa pupfish, and the previously extirpated Ash Meadows speckled dace. Speckled dace disappeared from the Fairbanks Spring system in the 1950s but were reintroduced in 2010. Post-project monitoring reveals that all three species are well established and reproducing.

The successful reestablishment of speckled dace into the Fairbanks system would not have been possible without numerous volunteers and partners. Funding was obtained by the Desert Fish Habitat Partnership, a group representing state and federal resource agencies, tribes, conservation organizations, and other interests. Habitat restoration continues at Ash Meadows NWR. There are plans to reintroduce Ash Meadows speckled dace into other spring systems the fish once occupied.

The desert fish of Ash Meadows are not the only native species benefitting from habitat restoration; many trees and other plants are beginning to flourish. The area also is frequented by a wide diversity of migratory birds. At least 239 bird species have been recorded in Ash Meadows, in addition to 27 mammals, more than 20 reptiles, five amphibians, and more than 330 flowers and shrubs.

Given the high rate of endemism in the Ash Meadows area, it is not surprising that species may still be discovered. In 2009, we learned of two new species of bees that may be unique to Ash Meadows. One can only imagine the fate of these and other unusual creatures if conservation efforts to protect endangered species had not been successful.

For detailed information on habitat restoration as a means to control non-native species, refer to an article by Scoppettone, et al., "Habitat Restoration as a Means of Controlling Non-Native Fish in a Mojave Desert Oasis," published in the June 2005 edition of *Restoration Ecology* (Vol. 13, No. 2, pp. 247-256).

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Saving the Emerald-eyed Dragon

The Strategic Habitat Conservation Approach

by Darin Simpkins and Catherine Carnes

The U.S. Fish and Wildlife Service and its partners have embarked on a new era in conservation through the enhanced application of scientific principals and the implementation of adaptive management across large landscapes.

Though many conservation biology techniques are well understood, less is known about expected population responses to site-specific management actions and large-scale ecological process, such as climate change. Biologists must know specifically what conservation actions are needed, where they are best applied, and how many resources will be required to achieve recovery objectives. The Service calls its new approach to addressing these challenges Strategic Habitat Conservation (SHC).

Hine's emerald dragonfly larvae. *USFWS*

The Service recently joined with The Nature Conservancy, University of South Dakota, U.S. Forest Service, and Wisconsin Department of Natural Resources to implement SHC for the endangered Hine's emerald dragonfly (*Somatochlora hineana*). Signature features of the Hine's emerald dragonfly include its large size (about 3 inches or 7.5 centimeters), large green eyes, and two creamy yellow stripes on its thorax. It is the only dragonfly protected by the Endangered Species Act. The current range of this emerald-eyed dragon is concentrated around the Great Lakes Basin, mostly at select locations in Illinois, Michigan, Wisconsin, and Ontario. It is also found in the Ozark Mountains area of Missouri. The species apparently no longer occurs in Ohio and Indiana. A single specimen is known from Alabama.

The Hine's emerald dragonfly breeds during an approximately six-week period from mid-June through mid-August in shallow, slow-flowing marshes and sedge meadows with thin marl or muck type soils underlain by dolomite bedrock and fed by calcareous groundwater seeps. Eggs are laid in shallow water and hatch the following spring. Hatched larvae inhabit wetlands, especially small spring-fed streamlet channels that flow through the wetlands, for three to five years. The larvae retreat into crayfish burrows in or near the streamlet channels, using them for refuge during times of drought or to overwinter. Mature larvae crawl out of the water onto emergent plants, where they emerge as tenerals (or juvenile dragonflies) and soon mature

into adults with the species' distinctive bright green eyes. Adults forage on aerial prey, including small dipterans (flies), near shrubs and forest edges and over meadows, narrow roads, fields, and lakes near potential breeding sites. Males defend the feeding and mating territories, which are adjacent to aquatic habitats, whereas females generally feed over larger areas until they are ready to mate or lay eggs.

Today, many of the wetland habitats used by the Hine's emerald dragonfly have been mined for limestone. Accelerating residential, agricultural, commercial, and recreational development has reduced the availability and connectivity of breeding, nursery, and feeding habitat. In response, various management activities across the species' range are focused on conserving groundwater supplies, controlling invasive species, and restoring habitat.

We are still learning about the status, distribution, and structure of Hine's emerald dragonfly populations, and about how landscape features and processes relate to dragonfly populations and habitats. The goal of the SHC project is to develop a scalable, landscape-based decision tool that can be used for guiding management actions. Project objectives are to 1) develop and validate landscape-based relationships in order to predict the distribution and occurrence of Hine's emerald dragonflies; 2) assess the size, structure, and genetics of populations across a broad geographical range; 3) evaluate interrelationships among landscape features, microhabitats, and population characteristics; 4) assess the relative importance of habitat characteristics in predicting presence and abundance; 5) apply relationships between habitat and population characteristics to model the potential for areas to support Hine's emerald dragonfly; and 6) evaluate the impacts of climate change on landscape characteristics and management actions, such as efforts to control invasive plant species. Results of this project will be used by managers to identify expected population responses to specific habitat conservation actions, set habitat restoration and protection objectives, and understand why certain actions may be effective in some areas but not others.

The Hine's emerald dragonfly SHC project began this year. It is receiving funding and technical assistance from the Service's Coastal Program – Great Lakes, Partners for Fish and Wildlife Program, and Endangered Species Program, as well as a Great Lakes Restoration Initiative grant from the Environmental Protection Agency. We look forward to learning how to better manage and protect this emerald eyed-dragon of our wetlands.

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Historically, the Hine's emerald dragonfly was found in Alabama, Indiana, and Ohio and probably has been extirpated in those states. Today the dragonfly can only be found in Illinois, Michigan, Missouri and Wisconsin. *Photos by Paul Burton*

Taking Pride in Conservation

Landowners Restore Rare Species in Texas

by Chris Best

(Left to right) Partners for Fish and Wildlife biologist Tim Schumann and landowners Don and Brenda Kirchoff search for native plant seeds along the San Antonio River, Texas. *Chris Best, USFWS*

Is it possible, some people may ask, to protect endangered species in Texas, a state where 95 percent of the land is privately owned? Increasingly, Texas landowners are providing an answer by voluntarily taking steps to conserve endangered plants and animals on their land. Recently, I interviewed members of four Texas families to find out what motivated their sense of stewardship.

One November morning, I joined a small flotilla of canoes and kayaks that drifted down the San Antonio River. Ancient bald cypress trees, still draped in mist, towered over the river banks. An alligator as long as my canoe plunged languidly into a murky pool. Soon, the quiet river became a series of whitewater rapids and tumbled over sandstone ledges. As we traversed the riparian corridor, a narrow green ribbon winding through agricultural plains, we saw glimpses of the pre-settlement landscape. We were there to collect seeds from remnant patches of grasses and forbs for a savanna restoration project on the nearby Kirchoff Farm.

In 2008, Don, Scott, Susan, and Brenda Kirchoff inherited their parents' 200-acre (80-hectare) farm in Wilson County. As a memorial to their parents' conservation ethic, they decided to restore the land to its pre-settlement condition, a subtropical savanna of native grasses and shrubs. Don acknowledges that their land may be too small and isolated to support endangered species, but he hopes it will have great educational value and inspire others to restore habitat. Ultimately, many small habitats might coalesce into an ecological corridor along the San Antonio River.

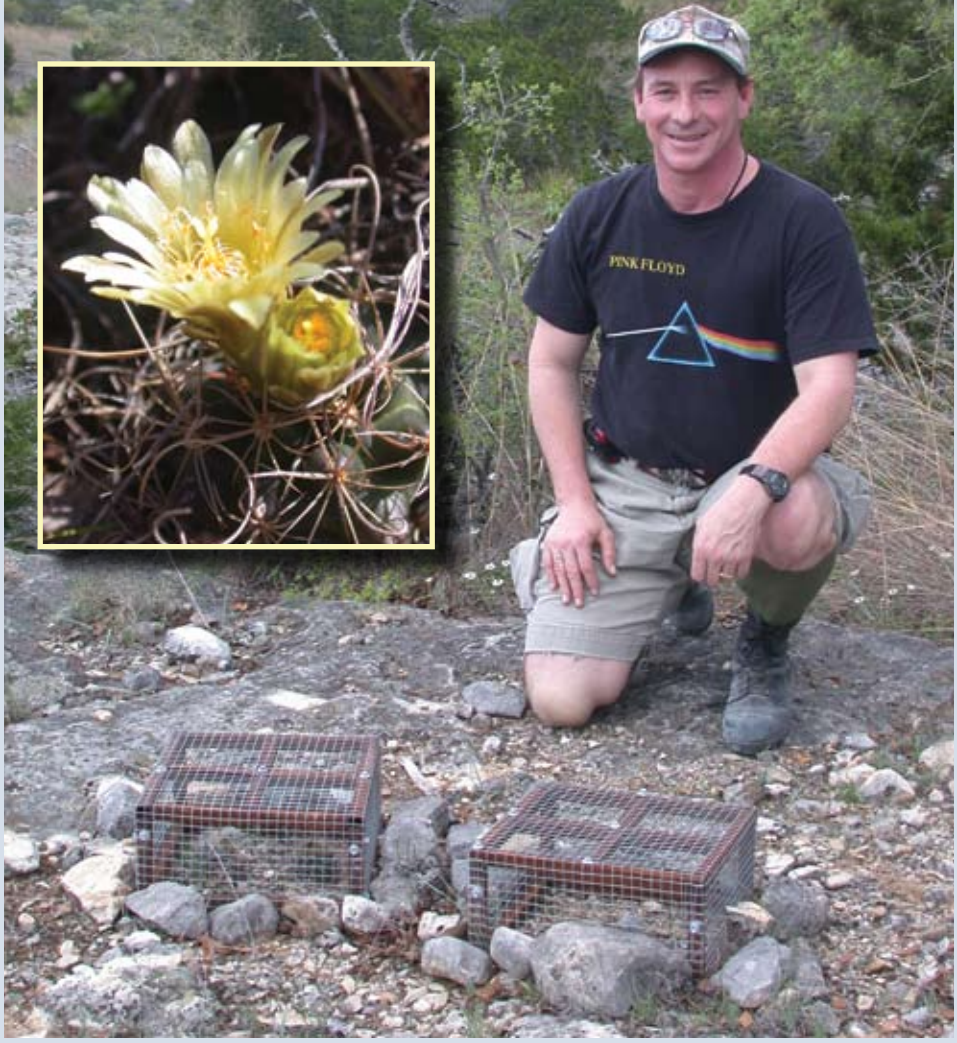
David Bamberger is a businessman who became a conservationist in 1969 when he purchased 5,500 acres (2,225 ha) of over-grazed rangeland west of Austin. Inspired by the delicate beauty of the Texas snowbells (*Styrax platanifolius* ssp. *texanus*), an endangered shrub adorned with bright white flowers, David took on its recovery as a personal goal. He went from ranch to ranch promoting the species' conservation, but it took seven years to overcome the mistrust many landowners have of government agencies.

With $35,000 of his own savings and a $17,000 grant from the National Fish and Wildlife Foundation, David established an extensive cooperative program to survey private ranches, collect seeds, propagate, and reintroduce Texas snowbells on private lands, including his own ranch. His efforts inspired others to join the cause, including Steve Fulton, whose research on Texas snowbells earned him a master's degree from Texas State University, San Marcos. Currently, 24 landowners voluntarily manage

Texas snowbells populations scattered over 130,000 acres (about 52,610 ha) of private land. David has also reintroduced more than 800 surviving snowbells plants into the wild. Now 82, he says he will "retire" after the thousandth of the reintroduced snowbells survives for at least two years in the wild.

Dr. Ashley McAllen traces his family's Texas heritage to 1797, when his ancestors received part of the Llano Grande Land Grant in what is now Hidalgo County. In 1998, Ashley and his brother Geoffrey acquired land in Bandera County where the Sabinal River slices a canyon through the rugged limestone ridges of the Edwards Plateau. The McAllens raise a few cows there, in deference to family tradition, but they believe the real value of the property lies in its recreational use, natural beauty, and biodiversity. Ashley requested a rare plant survey from the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department, and was delighted when Dr. Dana Price and I discovered a small population of the endangered Tobusch fishhook cactus (*Sclerocactus brevihamatus* ssp. *tobuschii*) there in March 2007. He and his children periodically monitor the population, and they became alarmed when they discovered rodents were nibbling their cactuses. They decided to design and install screen cages that effectively protect the cactus clusters. Ashley stated that his positive experiences show that landowners have nothing to fear and much to gain from working with government conservation agencies.

I met Kathy Corbett at her family's ranch in Willacy County, where dense, subtropical shrubland borders La Sal Vieja, a natural salt lake. While much of the surrounding land has been cleared, most of the Corbett's 4,200-acre (1,700-ha) tract remains intact. Rare plants and animals, including the ocelot (*Leopardus pardalis*) and jaguarundi (*Herpailurus yagouaroundi*), two endangered cat species, persist there. In the 1980s, Kathy's husband Michael set aside concerns about the Endangered Species Act and allowed a fellow Texas "Aggie," Mike Tewes, to capture and study ocelots there for his doctoral dissertation. In 2003, Bill Carr, a botanist for The Nature Conservancy, discovered a third endangered species there—the largest known population of Tamaulipan kidneypetal (*Ayenia limitaris*).



Dr. Ashley McAllen protects Tobusch fishhook cactus on his ranch in Bandera County, Texas. *Photos by Chris Best, USFWS*

Although Michael Corbett passed away in December 2008, his feelings for the land live on in the journal he kept to record the ranch's natural history. Kathy read for me the dedication to his journal: "For the love I have for my wife, Kathie and my daughter, Katie, and for the affection I have for this ranch, for this land, for its abundant wildlife, for the salt lake, for the incredible miles of scenic views, for this special habitat of huge, old ebonies, comas and the large areas of wild olive trees growing on our hills, for the large collection of Indian artifacts, the presence of the endangered ocelot and the rare Ayenia plants, all give me great pride that we made a good effort for conservation and financial gain to work together and have a ranch that we, the Corbett and Green families, could all be proud of."

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Mussels on the Move

by Angela Boyer

In August 2010, a major northern riffleshell (*Epioblasma torulosa rangiana*) translocation project took place in Big Darby Creek within the Prairie Oaks Metro Park of Franklin County, Ohio. Nearly 1,500 adult mussels were released at three locations in the creek, which has been designated as a State and National Scenic River. Big Darby Creek is noted for its tremendous diversity and abundance of both aquatic and terrestrial plants and animals, including 43 species of freshwater mussels.

The northern riffleshell is an endangered freshwater mussel that makes its home in streams with a sand or gravel substrate, and it prefers riffles and runs. Prior to 1800, this species was widespread throughout both the Ohio River and Maumee River drainages. It could be found in Illinois, Indiana, Kentucky, Michigan, Ohio, Pennsylvania, and West Virginia. Its range also extended into western Ontario, Canada. Unfortunately, populations have declined dramatically because of reduced habitat quality.

Like many freshwater mussels, the northern riffleshell is sensitive to silt, agricultural run-off, other forms of water pollution, stream channelization, the conversion of free-flowing stream habitat to impoundments, and competition from the non-native zebra mussel (*Dreissena polymorpha*). The decline of the northern riffleshell is not unique; nearly 70 percent of the nation's freshwater mussel species are considered endangered, threatened, or of special concern.

These aquatic gems are important indicators of water quality. Because of the rapid population decline and habitat fragmentation, augmenting riffleshell numbers is essential to the species' recovery. For last year's big translocation project, northern riffleshell mussels were collected from the Allegheny River by U.S. Fish and Wildlife Service and Pennsylvania Fish and Boat Commission biologists. The mussels were transported to the Columbus Zoo and Aquarium mussel facility, where they were briefly quarantined and fitted with passive integrated transponder (PIT) tags. These tags will allow biologists to locate individual mussels in the future and determine the conditions most conducive for long-term survival and reproduction success.

The Columbus Zoo and Aquarium, Ohio State University, Ohio Department of Natural Resources Division of Wildlife, Franklin County Metroparks, and Darby Creek Association all took part in this translocation project. A similar translocation of 1,700 northern riffleshells took place in 2008 at Battelle-Darby Creek Metro Park, just a few miles downstream of Prairie Oaks Metro Park. It remains the largest single release of any federally listed species in the state of Ohio.

A large number of these rare mussels became available for both of these projects as a result of a proposed bridge replacement project in the Allegheny River in Pennsylvania. The bridge project requires the translocation of approximately 200,000 endangered northern riffleshells over the next several years.

When the bridge replacement project was first proposed, a northern riffleshell augmentation and reintroduction plan was already being developed in Ohio, and a captive propagation facility was in place at the Columbus Zoo and Aquarium in cooperation with Ohio State University.

The northern riffleshell is an endangered freshwater mussel that was historically found in the Ohio River and Maumee River drainages. *Angela Boyer, USFWS*

These releases are the first steps to reintroducing and augmenting populations with mussels displaced by the bridge replacement project. Biologists hope that focusing augmentation efforts in areas of Ohio already surrounded by protected uplands in the Big Darby Creek watershed will improve the northern riffleshell's chances for recovery. The information gained from these efforts will also aid future mussel restoration efforts in Ohio and other states in the Midwest.

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(Top): In August 2010, nearly 1,500 northern riffleshell mussels were released at three locations within Big Darby Creek in Ohio. *Angela Boyer, USFWS*
(Bottom): Divers and snorkelers from the U.S. Fish and Wildlife Service and Pennsylvania Fish and Boat Commission collect northern riffleshell mussels from the Allegheny River in Pennsylvania for translocation into Big Darby Creek. *USFWS*

The Return of the "Watchman of the Gorge"

by Mima Falk, Jan Busco, Lori Makarick, and Allyson Mathis

Like many rare plants with very specific habitat requirements, sentry milk-vetch is threatened by habitat loss, climate change, and drought.

Jan Busco, Grand Canyon National Park

One of our nation's rarest plants, the sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*), occurs only in Grand Canyon National Park, where it is known from three locations along the South Rim. This tiny member of the pea family with minute pale purple flowers favors a very specific type of habitat on the canyon edge within shallow depressions in the highly porous Kaibab Limestone. It was scientifically described in 1948 by Rupert Barneby, who gave it the evocative Latin name *cremnophylax*, meaning "watchman of the gorge."

The sentry milk-vetch was listed in 1990 as endangered due to its small population size, very narrow range, and threats posed by recreational activity near the only colony known at the time (Maricopa Point). The Park is one of the recovery partners for this species and has been enthusiastic in conservation actions, taking action even before the recovery plan was completed in 2006. The population at Maricopa Point, for example, was fenced for its protection in 1990. In 2008, the Park followed up by removing the Maricopa Point parking lot to provide additional habitat for the species. The area is being restored with various native plants, and a portion has been set aside for a pilot project to test reintroduction methods for the sentry milk-vetch.

In 2009, with funding from the U.S. Fish and Wildlife Service and in partnership with the Grand Canyon Association, the Park constructed a 200-square-foot (18-sq-meter) passive solar greenhouse that houses an *ex situ* (off site) population of sentry milk-vetch. Botanists collected seeds from the natural populations but took care to leave some in place for germination in the wild. In 2010-2011, they collected another 2,660 seeds. The park now has an *ex situ* bank of more than 3,000 seeds that will be used to support reintroduction trials.

The Park is also focused on conserving the existing populations and continuing the search for others. It has monitored

the Maricopa Point population regularly since the 1990s and makes yearly visits to assess other populations at Lollipop Point and Grandview. More than 1,000 additional plants were discovered on limestone platforms below the populations on the canyon rim during 2010 spring-summer surveys. We are excited about this find and hope that staff with rock climbing skills and no fear of heights will find additional populations below the rim.

The Service provided additional funds in 2009 to investigate the plant's ecological characteristics. Park staff and dedicated volunteers from the Student Conservation Association studied and documented the species' pollinators (two species of small, native bees and a native species of hoverfly), documented the presence of a natural seed bank at Maricopa Point, and examined the differences in germination and growth of sentry milk-vetch seedlings using tap water and reclaimed water. In July 2010, a mini-reintroduction effort at Maricopa Point was undertaken by planting five sentry milk-vetch plants. Eleven months later, all five plants are still alive! This bodes well for our summer 2011 pilot planting at Maricopa point.

Research scientists at the Arboretum at Flagstaff have also contributed to tasks outlined in the recovery plan. They have been studying the unique soil characteristics associated with the plant to inform our selection of future reintroduction sites. They are also examining the relationship of other plant species that grow in close proximity to sentry milk-vetch to determine if they play a role in promoting seedling germination and survival. Sentry milk-vetch is in the National Collection of the Center for Plant Conservation, of which the Arboretum at Flagstaff is a participating institution.

When the actions outlined in the Sentry Milk-vetch Recovery Plan have been accomplished, the species should be restored and ready for removal from Endangered Species Act protection. Recovery of the sentry milk-vetch will be achieved when there are eight viable populations of 1,000 individuals each growing in protected habitat. Each natural population must be stable or increasing for a 10-year period, and each planted population must be stable or increasing for a 30-year period. There will be many steps to take before recovery is realized, and the Park staff and volunteers, the research community, and the Service will continue to work together to restore "the watchman of the gorge."

Sentry milk-vetch in bloom. *Peter Rowlands, NPS*

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A Second Chance for the Foskett Spring Speckled Dace

Habitat Restoration and Reintroduction as Recovery Tools

by Paul Scheerer and Mark Terwilliger

Foskett speckled dace (*Rhinichthys osculus* ssp.). *Paul Scheerer, ODFW*

The Foskett Spring speckled dace (*Rhinichthys osculus* ssp.) is a small fish known from a single population inhabiting Foskett Spring in south-central Oregon. In 1985, it was listed under the Endangered Species Act as threatened, due to habitat loss and its restricted distribution.

Populations of the Foskett Spring speckled dace were probably distributed throughout prehistoric Coleman Lake in the Warner Basin. The Warner Basin includes portions of southeast Oregon, northern Nevada, and northern California. The dace became isolated in Foskett Spring as the lake began to dry nearly 10,000 years ago. The salt content of the lake water increased and the amount of freshwater habitat available to the dace was reduced to just a few spring systems.

Foskett Spring is a natural system that rises from a springhead pool, flows through a narrow brook into a series of shallow marshes, and then disappears into the soil of the normally dry Coleman Lake.

In 1979, 100 dace from Foskett Spring were introduced into Dace Spring by the U.S. Bureau of Land Management (BLM)—located just half a mile south of Foskett Spring—in an attempt to establish a second population. This attempt failed, however, due to a lack of suitable spawning habitat.

In 1987, BLM acquired, through exchange, a 160-acre (65-hectare) parcel of land containing both Foskett and Dace springs. Both sites were fenced to exclude livestock, thereby minimizing habitat disturbance.

The Oregon Department of Fish and Wildlife's (ODFW) Native Fish Investigations Project then began monitoring the Foskett Spring population on a biannual basis. Its biologists found the population to be healthy and near the carrying capacity of about 3,000 adults. ODFW also documented multiple age-classes and the presence of young-of-the-year fish, which suggested successful recruitment.

However, the population has fallen by approximately 90 percent since 1997. We attribute this decline to a substantial reduction of open water habitat due to encroachment by macrophytes, plants that grow in or near the water. ODFW has worked with the U.S. Fish and Wildlife Service to increase the quantity of open water habitat at Foskett Spring and create an additional population of the fish at Dace Spring.

In 2009, a collaborative project between the Service, BLM, and ODFW was implemented to complete a restoration

Paul Scheerer, a fish and wildlife biologist with the Oregon Department of Fish and Wildlife, introduces Foskett Dace into Dace Spring. *David Banks, ODFW*

project at Dace Spring and create two permanent pools. The following year, 50 dace from Foskett Spring were transferred into these new pools.

ODFW biologists will monitor both the donor and the introduced populations to obtain population estimates, describe the population size structures, and look for evidence of recruitment. Once we are confident that the introduced population is well established, and have documented successful spawning and increasing abundance, ODFW will plan a similar habitat restoration project for Foskett Spring. Ideally, this will result in a stable or increasing population and contribute towards recovery.

One of the two spring-fed ponds constructed at Dace Springs in 2009. *Paul Scheerer, ODFW*

In 2009, the Service completed a 5-year status review for the Foskett Spring speckled dace. Among the recommendations in the review was the collection of demographic information on age structure, age at reproduction, and longevity. In partnership with Oregon State University, ODFW initiated a project in 2010 to gather this information. Validation is the first step in assessing the age structure of a population. In this case, validation involves verifying that growth patterns on ageing structures of individual fish are discernable and deposited annually. Examples of fish ageing structures include scales, otoliths (ear bones), and rays of the pectoral fins.

Annular growth rings, or annuli, are typically deposited on hard structures of the fish, much like annular rings form in trees. In the summer, rapid growth creates widely spaced rings, but the rings become more closely spaced when growth slows down for the winter. In springs, where water temperatures are fairly constant, these differences in fish growth may not be as evident.

In 2010, ODFW biologists marked all of the dace introduced into Dace Spring by exposing them to the antibiotic oxytetracycline (OTC) for six hours. When OTC is incorporated into the dace's hard structures, it forms marks that are visible under ultraviolet light.

ODFW will sample 50 dace to characterize the annual growth patterns since the time of their initial marking. This will allow biologists to validate growth patterns and assign accurate ages. If the patterns are regular and discernable, samples will be collected again in 2012 to describe the age structure, the age and size at reproduction, and the longevity of individuals. This information will be critical to assess the health of these populations and their responses to habitat restoration.

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Editor's note: In 2006, Paul Scheerer was recognized by the Service as a Recovery Champion for his work on the Foskett Spring speckled dace and a variety of Oregon's other endangered and threatened fish species.

Never Giving Up

Work Continues on Mexican Wolf Recovery

by Sarah E. Rinkevich, Wally Murphy, and Sherry Barrett

Minimizing wolf depredations and gaining rancher tolerance of wolves is one of the greatest challenges the Service faces in its efforts to recover the Mexican gray wolf. *Jim Clark, USFWS*

The Mexican wolf (*Canis lupus baileyi*), long recognized as a subspecies of gray wolf, historically inhabited the southwestern United States and Mexico. A government predator extermination program in the late 1800s and early to mid-1900s reduced the Mexican wolf population so much that, by 1970, it was considered extinct in the wild. Fortunately, a few wolves were found in Mexico. They were captured and brought to the U.S. in 1981 to begin a captive breeding program for future reintroduction into the wild. The successful propagation effort has increased the captive population to about 300 Mexican wolves at 49 breeding facilities in the U.S. and Mexico.

In 1998, we began reintroducing Mexican wolves into the wild in Arizona and New Mexico, designating them as a "nonessential experimental population" under section 10(j) of the Endangered Species Act. Such designations are intended to promote support for reintroduction by allowing a greater degree of management flexibility. However, after more than 10 years of reintroduction, the wild population remains fragile. In December 2010, the wild population numbered approximately 50 wolves—half the number needed for our objective to establish a single population of at least 100 wolves pursuant to the 1982 Mexican Wolf Recovery Plan.

The effort to reestablish the Mexican wolf continues. With the black-footed ferret (*Mustela nigripes*) and the red wolf (*Canis rufus*), it is one of only three carnivores in North America to have been eliminated from the wild, bred in captivity, and reintroduced to the wild. Both the Mexican wolf reintroduction in the Southwest and the red wolf reintroduction in the Southeast relied fully on captive-bred animals. In contrast, the U.S. Fish and Wildlife Service's gray wolf programs in the Northern Rockies and Great Lakes states relied on the translocation of wild wolves and/or natural recolonization from adjacent source populations.

The progress of the Mexican wolf recovery program has been hindered by regulations associated with the section 10(j) population boundary. These regulations mandate that Mexican wolves remain in a confined portion of Arizona and New Mexico. Although no single threat is responsible for delaying progress in the reintroduction, the cumulative effects of illegal shooting, removal of wolves because of livestock

depredations, and reduced fitness due to inbreeding depression result in a consistently high level of wolf mortality.

As we struggle to increase the wolf population, we are also working to improve the overall Mexican wolf recovery program. A new recovery team was convened in February 2011 to develop recovery and delisting criteria. The Service's law enforcement officers continue to investigate and prosecute illegal shooting. With regard to the effects of inbreeding, a graduate student at the University of Arizona will investigate the purity of the initial population founders, the extent of inbreeding in the captive and wild populations, the current distribution of genetic variation from the original founders. The student will also examine how to minimize the frequency of mildly deleterious traits that lead to inbreeding depression. Minimizing wolf depredations and gaining rancher tolerance of wolves, however, remains one of the most demanding challenges we face.

Although recent public polling in Arizona and New Mexico shows that most respondents have positive feelings about wolves and support the reintroduction of the Mexican wolf to public land, much of the local ranching community feels otherwise. Ranchers are frustrated primarily because of wolf depredations on livestock. From 1998 to 2009, confirmed depredations by Mexican wolves included 139 cattle, 12 sheep, 3 horses, and 5 dogs. Barriers to the success of the Mexican wolf reintroduction project will continue unless the impacts of wolf depredations are addressed. A proposal is in the works to address this hurdle by providing ranchers and other livestock owners options for managing wolf-livestock interactions.

The Service's Southwest Region has developed what it is calling the "Mexican Wolf-Livestock Interdiction Fund." The objective is to generate funding for long-term financial support to livestock operators within the framework of Mexican wolf recovery. Under a cooperative agreement with the Service, a non-federal organization, the National Fish and Wildlife Foundation, will manage the fund. A Stakeholder Council consisting of local ranchers, county organizations, Native American Tribes, and conservation groups has been created to determine where, when, and how the interdiction funds are to be allocated. The Service will serve as a technical advisor to the council, which met for the first time in April 2011.

This multi-faceted program has three proposed funding avenues: (1) *Interdiction*, which will fund proactive measures that prevent wolf-livestock interactions from occurring such as using guard dogs, range riders, and pasture management; (2) *Incentives*, which will provide upfront payments for potential future livestock losses caused by Mexican wolves; and (3) *Compensation*, which will provide payments for confirmed livestock kills by wolves. The Stakeholder Council will establish guidelines for fulfilling compensation requests and managing payments. Financial support for the Interdiction Fund is still being raised, and the program is expected to eventually be funded by the annual interest generated by the Fund.

What does the Interdiction Fund mean to livestock owners? It means more options for management of wolf-livestock interaction to help keep ranchers on the land. What does the Fund mean for the Mexican wolf reintroduction program? We hope it will offer advances in wolf recovery in that wolves will not have to be translocated or removed if they depredate. The next steps for the Interdiction Fund will be to increase the funding available and assist the Stakeholder Interdiction Council in developing a long-term program that provides for the recovery of the Mexican wolf in the presence of livestock grazing.

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The "Mexican Wolf-Livestock Interdiction Fund" will provide ranchers and other livestock owners with options for managing wolf-livestock interactions. *USFWS*

A Secure Future for the Tennessee Purple Coneflower

by Mike Bender

Tennessee purple coneflower. *©2011 Daniel W Reed, www.2bnTheWild.com*

More than three decades of conservation and protection have paid off well for the Tennessee purple coneflower (*Echinacea tennesseensis*), a distinctive plant once in danger of extinction. On August 12, 2010, the U.S. Fish and Wildlife Service proposed to recognize the wildflower's recovery by removing it from the federal list of threatened and endangered species, and the final decision will be announced this summer.

An array of conservation partners have successfully increased the known number and distribution of populations while managing and protecting the habitat they need for long-term survival.

First collected in 1878, the Tennessee purple coneflower was not described as a distinct species until 1898. It then went unnoticed until it was rediscovered in the late 1960s in Davidson County and in the early 1970s in Wilson County. When first listed in 1979 as endangered, the Tennessee coneflower was found only as small populations in limestone barrens and cedar glades in Davidson, Rutherford, and Wilson counties.

In 1989, a revised recovery plan for Tennessee purple coneflower established a criterion for recovery and delisting. It required that the species exist in five secure or protected populations, consisting of at least three colonies each. There are now 19 secure colonies distributed among six populations, five of which contain three or more colonies. These 19 colonies account for approximately 83 percent of the species' total distribution.

This recovery success story is the result of conservation efforts by many partners who worked more than 30 years to protect and expand the Tennessee purple coneflower colonies. The Service's partners include the Tennessee Department of Environment and Conservation, the Tennessee Division of Forestry, The Nature Conservancy, the U.S. Army Corps of Engineers, the National Park Service, and various private landowners.

Many factors influenced the recovery, including discovering new colonies through surveys of suitable habitat;

researching the life history, genetics, and ecology of the species; and establishing new colonies from seed or nursery propagated plants.

The Tennessee Department of Environment and Conservation was instrumental in buying or securing habitat through other means to restore the species, as well as building fences to protect colonies from recreational vehicle damage, removing competing vegetation, and using prescribed burns to provide open habitat conditions that help this species thrive.

Tennessee purple coneflower is a member of the sunflower family in the genus Echinacea, which includes several purple coneflower species that are commercially marketed for ornamental and medicinal purposes. Purple coneflowers sold commercially are usually hybrids.

If Tennessee purple coneflower is removed from the list of threatened and endangered species, federal agencies will no longer need to consult with the Service to ensure any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of this species. But if the coneflower is delisted, the Service will work with Tennessee Department of Environment and Conservation to implement a post-delisting monitoring plan for at least five years to ensure that this unique wildflower has a secure long-term future.

Mike Bender recently retired after serving over 25 years as Editor of the Endangered Species Bulletin.

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