U.S. Fish & Wildlife Service

ENDANGERED Species BULLETIN

2007 Highlights

On a beautiful Washington, D.C., morning this past June, I was honored to participate in a ceremony on the steps of the Jefferson Memorial celebrating the recovery of the bald eagle. Secretary of the Interior Dirk Kempthorne signed the papers removing this majestic bird from the threatened and endangered species list. Restoring the eagle took decades and required hard work by many agencies, organizations, and citizens. The articles in this issue, highlights from our 2007 on-line editions, illustrate other great collaborative conservation efforts throughout the country. As you read these articles, I hope that you are as energized and excited as I am about efforts like these to achieve our conservation mission.

Bryan Arroyo
Assistant Director for Endangered Species

ENDANGERED Species BULLETIN

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On the Cover
Once endangered, the bald eagle is now a symbol of species recovery.
Photo © Jasper James

Opposite page: On June 28, 2007, at the Jefferson Memorial, Interior Secretary Kempthorne announced the recovery and delisting of the bald eagle.
Photo by Leopoldo Miranda-Castro/USFWS

The Endangered Species Bulletin is now primarily an on-line publication. Three electronic editions are posted each year at www.fws.gov/endangered/bulletin.html, and one print edition of highlights is published each year. To be notified when a new on-line edition has been posted, you can sign up for our list-serv by clicking on "E-Mail List" on the Bulletin web page.

The Bulletin welcomes manuscripts on a wide range of topics related to endangered species. We are particularly interested in news about recovery, consering candidates, habitat conservation plans, and cooperative ventures. Please contact the Editor before preparing a manuscript. We cannot guarantee publication.

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Please send us your comments and ideas! E-mail them to us at esb@fws.gov.

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Measuring Recovery Success

by Krishna Gifford

Most people agree that removing a listed species from the List of Endangered and Threatened Wildlife and Plants due to recovery is a sign of success. The recent delistings of the bald eagle, Eggert's sunflower, and the species mentioned below are excellent examples. However, recovery related delistings currently represent only about one percent of the species currently listed. Some people believe that this means the Endangered Species Act is not succeeding.

But counting only the number of recovery related delistings does not give a true measure of the Act's success. By the end of Fiscal Year 2006, the U.S. Fish and Wildlife Service had the lead for conserving 1,269 listed species throughout all 50 states and other lands under U.S. jurisdiction. Given this large number of species, and the limited staffing and financial resources available to the Service for their recovery, the following statistics provide another measure of recovery success:

- Three species have been delisted this year due to recovery: the bald eagle, Western Great Lakes distinct population segment (DPS) of the gray wolf, and Yellowstone DPS of the grizzly bear. The Service also proposed this year to delist two other species due to recovery: the West Virginia northern flying squirrel and the Northern Rocky Mountain DPS of the gray wolf. *We are making significant progress in recovery-related delistings.*
- The most recent data available indicate that 522 listed species are now stable or improving in status. *Forty-one percent of the species are doing better since they have gained protection under the Act.*
- Most (1,084) species listed for 2.5 years or longer now have final recovery plans, 43 species have draft recovery plans, and 134 species have recovery plans under revision. (Another 12 species are exempt from needing recovery plans.) *This means that 90 percent of listed species now have a recovery plan in place or do not require one.*

But the story is not all about the numbers. There are numerous challenges to recovering listed species. For example, a species' decline often occurs over decades or even centuries, and the road to its recovery can be a long one as well. Addressing threats that have occurred over long periods typically requires substantial time and resources. Some species also face new threats even after receiving protection under the Act. Many bird populations, for example, have been decimated by the introduced West Nile virus. Other animals and plants face danger posed by such invasive, non-native species as the brown tree snake or the zebra mussel. In the face of these continuing challenges, we should remind ourselves that success is measured in the

Brad Bingham

Eggert's sunflower

Olympic National Park

Northern flying squirrel

day-to-day milestones achieved instead of only the ultimate goal of delisting.

Every time a rare species expands its range, a breeding pair produces offspring, a private landowner joins in a new conservation partnership, a research project gains vital information about a species' life history, or a missing plant arises from a seed bank is a time worthy of celebration. All of these, and more, are cumulative steps that eventually lead to recovery. And if we can take action to benefit a listing candidate or other imperiled species before it needs Endangered Species Act protection, so much the better!

From stories about habitat needs for the Page springsnail (a listing candidate), to land purchased by The Nature Conservancy to protect several at-risk and listed species, to habitat clean-ups, and other efforts, the following articles are wonderful examples of recovery milestones, both small and large. The tennis champion Arthur Ashe once said, "Success is a journey, not a destination. The doing is often more important than the outcome." When it comes to the conservation and recovery of listed and imperiled species alike, "the doing" is as "important as the outcome."

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William C. Campbell

Gray wolf

Partnerships Can Conserve Species and a Way of Life

by Jeannie Stafford

Image Omitted

Railroad Valley springfish
© Joseph Tomelleri

Creating partnerships that conserve wildlife as well as economic and social values can be a challenge. Prior to 2002, a partnership between the Duckwater Shoshone Tribe and the U.S. Fish and Wildlife Service did not exist. But taking a cooperative approach brought benefits to the Service's Nevada Fish and Wildlife Office (NFWO), the Tribe, numerous other partners, and a rare fish.

The Duckwater Shoshone Reservation is an isolated rural reservation that contains the largest thermal spring in Nevada. This 3,850-acre (1,560-hectare) reservation is home to 150 residents whose principle land use is agriculture. It also contains a unique hydro-geologic system that is not typical of most arid climates. Geothermal activity carries warm groundwater upward, forming numerous hot springs. The 94° F (34°C) water of Big Warm Spring is considered the most important habitat for a threatened species, the Railroad Valley springfish (*Crenichthys nevadae*).

In 2002, the Tribe granted the NFWO's Partners for Fish and Wildlife Program access to the Reservation, and the result was one of the Service's most successful Tribal partnerships. In early 2003, the NFWO signed a Memorandum of Understanding with the Tribe to begin recovery actions for the springfish while preserving the Tribe's economic, social, agricultural, and cultural way of life. The next year, the Tribe received funding from the Partners for Fish and Wildlife, Tribal Wildlife Grant, and Tribal Land Owner Incentive programs totaling $650,000 to restore Big Spring.

In late 2004, negotiations to decommission a catfish farm and remove all aquaculture facilities that were negatively affecting the springfish were complete. Restoration of the spring system was designed not only to restore the stream

(left): The catfish farm before the restoration of Big Warm Spring.

(right): View of restored Big Warm Spring from visitor platform.
All photos by Bridget Nielson

(above): Bob Williams, NFWO Field Supervisor , Jerry Millet, Duckwater Shoshone Tribal Manager, and Ruby Sam, Duckwater Shoshone Tribal Chairperson, sign the Railroad Valley Springfish Safe Harbor Agreement.

(left): Ruby Sam and Jerry Millet release Railroad Valley springfish into Big Warm Spring.

channels and 68 acres (28 ha) of wetland habitat next to the spring, but also to improve delivery of Tribal irrigation water by constructing a new irrigation intake and pipeline delivery system. The project improved water transport along the main channel and restored the main spring source to accommodate appropriate flow rates. In addition to fencing the newly restored spring and wetland habitat, the partners also restored 45 acres (18 ha) of upland habitat.

The Tribe and the Service met on September 26, 2007, to sign a Safe Harbor Agreement, only the second agreement of this type with a Tribal government, allowing the reintroduction of the fish while use of the irrigation system and cattle grazing continues. All of the partners, including representatives from the Nevada Department of Wildlife, the Natural Resources Conservation Service, the U.S. Geological Survey's Biological Resources Water Resources Divisions, the NFWO, and the Tribe were on hand that day to celebrate and witness the reintroduction of Railroad Valley springfish back into their historical habitat.

This strong partnership will assist in the recovery of one of Nevada's threatened species and, at the same time, help conserve the Tribe's traditional way of life. A quote from Tribal Manager Jerry Millet earlier this year sums up the recovery effort and the partnership this way:

"There is a great sense of joy and fulfillment in my heart seeing the restored spring with the stream channel flowing in the location the Great Spirit intended it to go rather than the man-made direction. Our goal as a Tribe is to continue into the future. Improving health in the land and water for the preservation of the unique and ancient springfish is part of the Duckwater Peoples legacy for our future generations. The success of the Big Warm Spring Restoration projects is founded in the collaborative process and persistent communication involving the Tribe, the individual tribal business owner, the Service, Nevada Department of Wildlife, Bureau of Land Management, Natural Resources Conservation Service, Bureau of Indian Affairs and the State Water Engineer's Office."

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Rare Bird Nests Are Cause for Celebration

by Rachel Levin, Joel Trick, and Mike DeCapita

Scientists and bird lovers are celebrating a milestone in the recovery of the Kirtland's warbler (*Dendroica kirtlandii*), a highly endangered songbird -- the discovery in 2007 of three active nests in Wisconsin and one in Ontario.

The Kirtland's warbler, whose distinctive male song can be heard up to a quarter mile away, nests primarily in jack pine forests in the northern Lower Peninsula of Michigan. However, the species has nested in Michigan's Upper Peninsula since 1994 and has been seen in recent years in Wisconsin and Ontario,

The Wisconsin nests were discovered by a birder in early summer of 2007. Recognizing the significance of the discovery, this private citizen contacted and assisted the U.S. Fish and Wildlife Service and Wisconsin Department of Natural Resources in documenting the presence of Kirtland's warblers in the state.

Ron Austing

To protect the site from disturbance, the Service is not disclosing its precise location.

The single Ontario nest was discovered on Canadian Forces Base Petawawa and was monitored by the Canadian Wildlife Service and cooperators.

"This development is a testament to decades of cooperative conservation among the states of Michigan and Wisconsin, private landowners, and organizations such as the Audubon Society," says Robyn Thorson, Regional Director for the U.S. Fish and Wildlife Service's Midwest Region. "This discovery proves that by working together, recovery and range expansion for an endangered bird are not only possible, but are happening as we speak."

The Wisconsin nests were on land owned by the Plum Creek Timber Company. "Discovering the Kirtland's warbler nesting in managed forests in central Wisconsin is exciting and encouraging, and provides Plum Creek the opportunity to work further with the Service on enhancing Kirtland's warbler habitat in Wisconsin, as we are planning to do in Michigan's Upper Peninsula," says Scott Henker, Plum Creek's senior resource manager for Wisconsin.

The Kirtland's warbler was first described in 1857. Its nesting area was not known until the first nest was discovered in Oscoda County, Michigan, in 1903. Scientists quickly recognized the species as rare and set aside special areas to protect it. Nevertheless, the Kirtland's warbler population plummeted from 432 singing males in 1951 to only 201 males in 1971.

Thanks to recovery efforts by federal, state, and private partners, Kirtland's warbler numbers have increased steadily

George Lou

since 1990, reaching 1,707 singing males in 2007, the highest number since population monitoring began. The 2007 count includes eight males in Wisconsin and two in Ontario.

Prior to 2007's historic nesting in Wisconsin and Ontario, no Kirtland's warblers have nested outside Michigan since nesting occurred in Ontario in the 1940s. In the past two years, several singing males were found in Wisconsin and Ontario, prompting optimism that the species would ultimately nest in those locations.

"Wisconsin is excited about having its first Kirtland's warbler nest, and we congratulate our partners in Michigan who have worked for so long to strengthen the Kirtland's warbler population," says former Wisconsin Department of Natural Resources Secretary Scott Hassett. "Having this rare bird in Wisconsin is an honor and underscores our responsibility to keep providing quality habitat for wildlife. We look forward to working with Michigan in the future management of this rare pine barrens species."

Now that the Kirtland's warbler has been confirmed as a breeding species in Wisconsin, the Service will look for opportunities to work with landowners to encourage management practices that could benefit the species. An added advantage of managing habitat for the Kirtland's warbler is that it would also provide benefits for numerous other bird species, as well as other plants and animals that depend on similar habitats.

The Canadians have been preparing for eventual Kirtland's warbler nesting for several years, having conducted annual searches for the species, written a recovery plan, conducted habitat inventories, including aerial surveys with Michigan experts, and participated in Michigan census work and recovery team meetings.

In Michigan, the Service and its partners, including the Michigan Department of Natural Resources, U.S. Forest Service, and the Michigan National Guard, have seen success with efforts to recover the Kirtland's warbler through restoration and protection of nesting habitat, control of the competing brown-headed cowbird, public information, and the assistance of organizations like the Michigan Audubon Society and Kirtland Community College.

"Management partners in Michigan have worked for decades to restore the Kirtland's warbler population," says Michigan Department of Natural Resources Director Rebecca A. Humphries. "Following this discovery, we look forward to working with our partners in Wisconsin to continue the efforts to conserve this species."

The Kirtland's warbler selects nesting sites in stands of jack pine that are between four and 20 years old. Historically, frequent natural wildfires created these stands of young jack pine. Modern fire suppression programs altered this natural process, reducing Kirtland's warbler habitat.

To mimic the effects of wildfire and ensure the future of this endangered species, state and federal wildlife biologists and foresters annually manage forests through a combination of clear cutting, burning, seeding, and replanting to promote warbler habitat. Approximately 3,000 acres of jack pine trees are planted or seeded annually on state and federal lands in Michigan. These successful cooperative management efforts have restored the Kirtland's warbler throughout much of its historic nesting range in Michigan's Lower Peninsula. The presence of a healthy and expanding core population in this area has resulted in the dispersal and appearance of the birds in the Upper Peninsula, Canada, and Wisconsin.

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Jump Starting a Rabbit's Recovery

by Jack Sparks and Craig Aubrey

A secretive mammal that makes its home in the dense riparian woodlands of California's San Joaquin Valley is the focus of attention at San Joaquin River National Wildlife Refuge. Through intensive habitat restoration and species reintroduction programs at the refuge, the highly endangered riparian brush rabbit (*Sylvilagus bachmani riparius*) may once again flourish in its historical range.

Riparian brush rabbits are endemic to the valley's riparian woodlands, but 95 percent of this important habitat has been lost in California. The last known wild population of the riparian brush rabbit was found in the 1990s along the Stanislaus River in San Joaquin County. Since 2000, the refuge has worked with the Endangered Species Recovery Program at California State University, Stanislaus; the U.S. Bureau of Reclamation; recovery biologists with the Fish and Wildlife Service's Sacramento Office; the California Department of Fish and Game; and others to release and monitor captive-bred rabbits in the refuge's dense riparian woodlands. The goal is to establish three new self-sustaining populations.

Seldom venturing out in the open, the rabbits depend on the heavy cover found in riparian woodlands. Dense thickets of wild rose and blackberry, covered by canopies of oak and willow, protect them from predators such as raptors and coyotes. Using funds acquired through a variety of sources, the refuge has been working with River Partners, Inc.—an environmental organization—to restore riparian habitat by planting over 250,000 native plants on 1,000 acres (405 hectares) of refuge land. Once mature, these riparian plants will provide a safe haven for the rabbits and a vast assemblage of other native wildlife. Since riparian areas are prone to flooding, the planting design is determined by computer modeling that indicates how potential floodwater would move across the landscape, with flexible flood-tolerant plants placed in the direct path of water. Large earthen mounds have been constructed to serve as high ground refugia for the rabbits to escape rising water. The reintroduced riparian brush rabbit population at the refuge is now the largest population in the wild, and the restored woodlands at the refuge are the largest contiguous block of habitat in the rabbit's range.

In addition to activities on Service lands, the refuge worked with the Sacramento Office's recovery biologists to create a unique partnership with a landowner to reintroduce riparian brush rabbits on a private ranch. The 2,048-acre (829-ha) ranch is contiguous with lands being restored by the refuge, and it includes some of the last available remaining privately-owned riparian habitat for the rabbit's recovery. Through the continuing efforts of the Service and its partners, we look forward to the day when the riparian brush rabbit is recovered.

© Moose Peterson/WRP

Riparian brush rabbit

Jack Sparks, an outdoor recreation planner at the San Luis National Wildlife Refuge Complex, can be reached at jack_sparks@fws.gov or 209-826-3508. Craig Aubrey was Recovery Branch Chief in the Service's Sacramento Fish and Wildlife Office until he recently took a job in Charleston, South Carolina.

Conserving a Natural Utah Treasure

by Elaine York

The Nature Conservancy recently announced its purchase of 55 acres (22 hectares) of habitat for rare species in the St. George area of southwestern Utah. This purchase is the first step in an ambitious plan to create a new 800-acre (325-ha) preserve as an oasis for plants, animals, and people.

Working with a diverse range of partners, including the School and Institutional Trust Lands Administration (SITLA), the Bureau of Land Management, the Utah Department of Transportation (UDOT), the U.S. Fish and Wildlife Service, and the City of St. George, The Nature Conservancy has laid out plans for the creation of the "White Dome Nature Preserve." White Dome is one of the few places where the gypsum-laced Moenkopi formation is exposed, and its sparsely vegetated soils are characterized by a rich biological soil crust. The preserve will protect habitat for several at-risk species, including the zebra-tailed lizard (*Callisaurus draconoides*), the loggerhead shrike (*Lanius ludovicianus*), and rare native plants. It will also harbor some of last remaining populations of the threatened Siler pincushion cactus (*Pediocactus sileri*) and the endangered dwarf bear poppy (*Arctomecon humilis*), a plant found only in Washington County, Utah.

The recent purchase was funded through private donations from Conservancy supporters and a Recovery Land Acquisition grant from the Service. It marks the first phase of acquisition in a plan that began in 2005, when SITLA signed an agreement to make 800 acres available for sale to the Conservancy and UDOT to establish a nature preserve with public access.

Ben Franklin, Utah Division of Wildlife Resources

Pediocactus sileri

Additional land acquisitions in the South Block by the Conservancy and UDOT will take place this year and next, with a goal of piecing together all 800 acres of the White Dome Nature Preserve within the next few years. The partners are also creating a long-term management plan, including fencing, maintenance, habitat restoration, and research on the rare plants and their pollinators, as well as the creation of hiking trails and signage that educates visitors about the unique natural features of the preserve. The Nature Conservancy will manage the preserve.

Dwarf bear poppy at The Nature Conservancy's White Dome Nature Preserve.

John Milliken

"We are facing major growth opportunities and challenges in our communities," says Dennis Drake, a Washington County Commissioner. "The White Dome Nature Preserve is a great example of public and private groups working together to ensure we protect and celebrate our natural heritage as we grow."

The next steps for the White Dome Nature Preserve include the Conservancy's work, funded by a Private Stewardship Program grant from the Service, to restore the 55-acre parcel and the rare species that depend upon it. Scientists will study the dwarf bear poppy's life cycle and pollination processes to ensure its long-term viability.

But this effort is bigger than just 800 acres or several rare species. It is about Utahns coming together to ensure that Washington County's future will include places where people can value and enjoy the natural wonders in their own backyard.

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New Hope for the Leon Springs Pupfish

by Nathan Allan and
Jennifer Gumm

The Leon Springs pupfish (*Cyprinodon bovinus*) keeps beating the odds. In spite of threats from hybridization, pollution, and habitat loss, it continues to survive in its desert oasis. Although usually less than 2 inches (5 centimeters) in length, they are not without charisma. During their breeding season, males turn a bright iridescent blue and aggressively patrol their territories with what has been described as a "puppy like energy" (thus the name pupfish). The Leon Springs pupfish was reportedly extinct by the 1950s due to the destruction of its one known habitat, Leon Springs in west Texas. Fortunately, Dr. W.L. Minckley of Arizona State University rediscovered the fish in 1965 in Diamond Y Draw, a small nearby spring system north of Fort Stockton, Texas.

Before the fish was listed as endangered in 1980, extraordinary efforts to prevent its extinction were long underway. In the early 1970s, the Texas Parks and Wildlife Department (TPWD) and the Natural Resources Conservation Service (then called the Soil Conservation Service) teamed up with a private landowner to construct an earthen berm around the source of Diamond Y Spring to divert potential pollution from nearby oil and gas production. However, biologists soon discovered a larger threat to the pupfish. A genetic analysis showed that some of the pupfish had hybridized with sheepshead minnows (*Cyprinodon variegatus*), a related but invasive species native to the Gulf Coast. They presumably were introduced to Diamond Y Draw by a "bait-bucket" release. In 1976, some of the remaining genetically pure Leon Springs pupfish were taken to the Dexter National Fish Hatchery (now a National Fish Hatchery and Technology Center) in Dexter, New Mexico, to establish a genetic reserve. This action would later prove vital to preventing the species' extinction. (It was among the first species brought to Dexter as a refuge population for native fish, but not the last; the hatchery currently maintains 16 native species.) From 1976 to 1978, biologists led by Dr. Clark Hubbs of the University of Texas applied a fish toxicant at Diamond Y Draw to eliminate the hybrid population, then successfully restocked pure Leon Springs pupfish.

Female (left) and male Leon Springs pupfish

Braz Walker

In 1994, Dr. Anthony and Alice Echelle of Oklahoma State University found that the pupfish in Diamond Y Draw were again hybridized with sheepshead minnows. A second round of intensive recovery efforts took place between 1998 and 2001, involving a large group of partners and grants from the Fish and Wildlife Service and TPWD. The hybrid pupfish once again were eliminated from Diamond Y Draw using a combination of chemical and mechanical means before pure Leon Springs pupfish were repatri-

ated from Dexter. Subsequent genetic assessments have shown the restoration efforts succeeded in reducing genetic contamination to acceptable levels at or near zero.

As if the threat from hybridization were not enough, the habitat is surrounded by active oil and natural gas wells. Fortunately, in 1990 The Nature Conservancy (TNC) purchased about 1,500 acres (about 600 hectares) from Mr. M.R. Gonzales and established the Diamond Y Spring Preserve. Immediately, TNC (led by long-time conservation scientist John Karges) initiated on-site stewardship in cooperation with energy production partners, who granted funds for the land purchase and modified their facilities to provide safeguards against contaminants. A matching grant in the mid-1990s from an energy producer and the National Fish and Wildlife Foundation provided funds to remove some oil well pad sites and access roads that had impeded natural surface water flow. More recently, TNC was awarded a Recovery Land Acquisition Grant from the Fish and Wildlife Service and expanded Diamond Y Preserve to more than 4,000 acres (over 1,600 hectares).

Using video surveillance, Dr. Murray Itzkowitz of Lehigh University investigates the fascinating world of social and breeding behavior of the Leon Springs pupfish. He has observed that large territorial males defend areas on rocky shelves in shallow open water. Intermediate- and small-sized males act as "satellite breeders" by sneaking in to mate with females while the territorial male is occupied with fending off neighbors or courting other females. Females then enter the male's territory to spawn. The female lays a single egg at a time, but will repeat the sequence many times before she leaves the territory for another male or leaves the breeding shelf altogether. As many as 25 territorial males can pack into a 30-square-foot (3-square-meter) area. Territorial males also show complex communication among each other known as "dear enemy recognition." This is where territorial males show less aggression to familiar neighbors than to strangers.

USFWS

Nathan Allan collecting a water sample from the Diamond Y Spring, with oil and gas facilities in background.

Other research continues to monitor genetic integrity, as well as document genetic diversity in the wild and captive populations of Leon Springs pupfish. Maintaining high levels of genetic variation is important to the species' recovery objective of ensuring self-sustaining, genetically-uncontaminated populations in Diamond Y Draw.

Behavioral observations in May 2006 revealed a drastically reduced breeding population with very few territorial or satellite males. The Fish and Wildlife Service and TPWD rushed to approve a recovery grant to recreate the necessary spawning shelves. The open water needed for spawning was in short supply due to an increased density of emergent vegetation. In early 2007, with help from TNC, Lehigh University students removed the vegetation by hand and replaced it with hard tiles. By spring, the fish responded positively; males reestablished their territories on the new habitat, and biologists saw increased numbers of juvenile fish.

Overshadowing the local threats from hybridization, pollution, and subtle habitat changes is the pervasive threat to groundwater availability. The potential for loss of spring flows due to regional groundwater pumping is a constant danger. Diamond Y Draw is a small sanctuary within the Chihuahuan Desert. As an oasis in this dry region, it supports much more than just the pupfish. It is home to more than eight rare species, including the threatened Pecos sunflower (*Helianthus paradoxus*), the endangered Pecos gambusia (*Gambusia nobilis*), the endangered Pecos assiminea snail (*Assiminea pecos)*, two other spring snails that are listing candidates, and several other endemic aquatic invertebrates. Many partners have worked hard over the past 40 years to ensure the Leon Springs pupfish survives, but still more work lies ahead to conserve its fragile ecosystem at Diamond Y Draw.

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Sometimes It's the Little Things That Matter

by Shane D. Hanlon and
Wil Orndorff

What is good for a rare, rice-sized crustacean in a Virginia cave system is proving to be good for one of the southern Appalachian region's most biologically diverse and imperiled ecosystems.

The Lee County cave isopod (*Lirceus usdagalun*) is a stygobitic (cave-adapted aquatic) crustacean found on the surface of rocks under swift flowing, shallow water in subterranean streams. Additional specimens are sometimes flushed from springs during floods. This creature is known from only two cave systems and two springs in an area known as the Cedars, located in central Lee County, Virginia. Caves, sinkholes, disappearing streams, and large springs are common topographical features of the Cedars, a terrain called karst that was formed in limestone and dolostone bedrock. The limestone and poor soils of this area support an uncommonly high number of rare plants and animals and a dominant forest community of oak and cedar. The watershed of the Cedars contributes high-quality water to the Powell River, one of the last free-flowing stretches of the Tennessee River system and a river renowned for its rich freshwater mussel and fish diversity.

The cave systems of the Cedars are hydrologically complex. Because of the porous nature of the limestone karst topography, water flows through the system quickly, having little time for pollutants and contaminants to be captured and metabolized through natural filtration. As a consequence, seemingly benign activities can pose a serious threat to the quality of both ground and surface waters.

At a glance, threats to water quality and karst resources in the Cedars would seem negligible; the landscape is sparsely developed, covered by a predominant mix of pasture and forest. However, in 1987, a local sawmill producing a massive amount of sawdust waste caused one of Virginia's most severe cases of water pollution. An estimated 5.8 million cubic feet (165,000 cubic meters) of sawdust resulted in a massive discharge of leachate (the liquid produced when water percolates through any permeable material) rich in lignins and tannins. These contaminants seeped into a cave system known as Thompson Cedar Cave, haven to one of the two populations of the Lee County cave isopod known at the time. Water from the underground stream resurfaces from a spring and joins Batie Creek, a tributary of the Powell

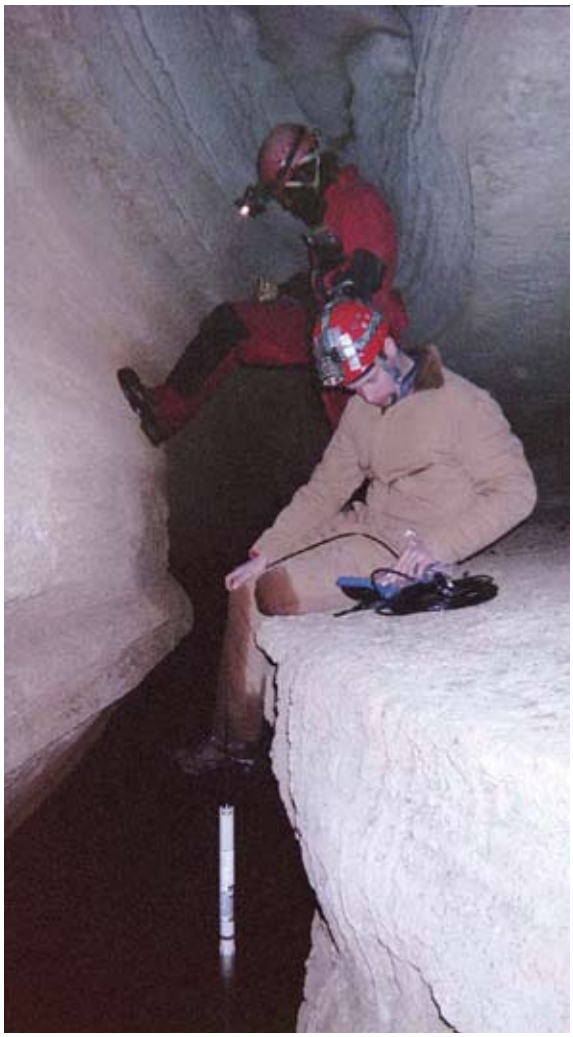
Lee County cave isopod

Shane Hanlon/USFWS

River. Decomposition of the leachate produced an intense biochemical demand for the water's oxygen, exceeding that typically produced by raw sewage, and it plagued the cave stream and Batie Creek for more than 15 years, eliminating nearly all of the aquatic life. Batie Creek was marked by a strong sewage odor and the presence of *Sphaerotilus*, a filamentous fungus associated with sewage. Dissolved oxygen levels at the spring approached zero from the late 1980s through the early 1990s. The Service listed the Lee County cave isopod in 1992 as endangered. In 1998, Virginia added Batie Creek to the state's list of impaired water bodies.

The sobering effect of this disaster prompted cooperative action to remedy the problem and protect the fragile karst ecosystem, and with it the Lee County cave isopod. The Service, The Nature Conservancy, Virginia Department of Conservation and Recreation-Division of Natural Heritage, Virginia Department of Environmental Quality, Cave Conservancy of the Virginias, Virginia Tech University, Upper Tennessee River Roundtable, Tennessee Valley Authority, Virginia Cave Board, and the owner of the sawmill were among the major partners involved. Between 1998 and 2007, the partnership coordinated the removal of approximately 60 percent of the sawdust waste from the site, focusing on the actively decomposing portion generating most of the toxic leachate. Newly generated sawdust was taken to an industrial incinerator in Kingsport, Tennessee, to produce electric power. Older sawdust deemed unsuitable for incineration was used as a soil amendment to accelerate revegetation of reclaimed surface mines.

The cooperative effort was clearly successful. By November 2001, the fauna of Thompson Cedar Cave once again began to thrive. On February 19, 2002, staff from the Virginia Division of Natural Heritage and the Service discovered that the Lee County cave isopod had returned to Thompson Cedar Cave. Since then, the population once thought to be extirpated has progressed towards recovery. We believe that uncontaminated upstream tributaries served as refugia from which Thompson Cedar Cave was recolonized. Concurrently, dissolved oxygen levels in the Batie Creek spring increased dramatically and have stabilized since 2005. As a result, in 2006, the Virginia Department of Environmental Quality removed Batie Creek from its list of impaired waters.



Joey Fagan, Virginia Department of Conservation and Recreation

Wil Orndorff (standing) and Shane Hanlon (sitting) as they monitor water quality in Thompson Cedar Cave.

The Lee County cave isopod serves as a poster child for of the Cedar's unique and diverse ecosystem and became a catalyst for conservation. Because most of the cave fauna depends on constant water quality and quantity, protection efforts have focused on surface elements as well as the biological diversity contained within the caves and springs. Acquiring lands has been seen as the most feasible approach for long-term conservation in this region. Accordingly, The Nature Conservancy and Virginia's Division of Natural Heritage, with help from the Service, secured over 1,000 acres (400 hectares) of prime conservation lands in the Cedars. These partners plan to acquire additional lands to expand the Cedars State Natural Area Preserve. The preserve aims to protect nine significant caves and calcareous glades and woodlands that benefit not only the Lee County cave isopod but 31 other rare species.

The Cedars region does not exist in a vacuum, and land acquisition alone will not be enough to protect its unique biological resources. The cave streams where Lirceus usdagalun lives, for example, are supported to a large extent by surface streams that sink into cave systems along the edge of the Cedars. These streams meander through mostly inaccessible cave passage as they flow under the Cedars and emerge at springs feeding the Powell River. Protecting these streams helps not only the subterranean resources of the Cedars but also the aquatic fauna of the Powell River.

Shane D. Hanlon is an endangered species recovery biologist in the Service's Southwestern Virginia Ecological Services Field Office in Abingdon, Virginia (phone 276-623-1233; shane_hanlon@fws.gov). Wil Orndorff is the Karst Protection Coordinator for the Virginia Department of Conservation and Recreation's Natural Heritage Program in Radford, Virginia (phone 540-831-4056; Wil.orndorff@dcr.virginia.gov).

Cooperative Conservation for the Page Springsnail

by Mike Martinez and Dan Cox

In the legal sense, the term "recovery" applies to species of plants and animals that are listed as threatened or endangered under the Endangered Species Act. However, in practical application, recovery is just as important for imperiled species that are headed towards listing. One such species is the Page springsnail (*Pyrgulopsis morrisoni*), a tiny endemic aquatic snail from central Arizona. The goal for this species is to conserve it so that it will not need listing protection.

The Page springsnail is currently a candidate for listing due to threats from habitat modification, groundwater pumping, water contamination, and predation by exotic species. In 1999, the Fish and Wildlife Service's Arizona Ecological Services Office and the Arizona Game and Fish Department began cooperative efforts to conserve this species. The ultimate goal is to develop a Candidate Conservation Agreement with Assurances with the State and other landowners in order to alleviate threats to the point where listing is not warranted. (For more information on these agreements, go to www.fws.gov/endangered/listing/ccaa.pdf). Although a conservation agreement has not been completed, we have already made significant progress in conserving the species.

Both agencies have pooled our resources to study the basic habitat needs of the species and build a conservation plan. One result of this effort was the first piece of published literature dealing with the Page springsnail's habitat use. Additionally, the Arizona Game and Fish Department fenced important habitats to protect them from inadvertent trampling by people or ungulates, and it installed water gages to monitor any change in spring water discharge that may result from groundwater pumping.

Conservation of the Page springsnail is complicated by the fact that it inhabits many of the same springs used by two Arizona Game and Fish Department fish hatcheries. Working with the hatcheries to balance fish production and snail conservation has presented challenges, but it has also presented opportunities to collaborate on projects that benefit both goals. Another important milestone is the development of a draft survey and monitoring protocol for the springsnail.

Page springsnail

Dan Cox

This is an important step because there has been no standardized methodology for sampling springsnails that has been widely adopted by the conservation community.

Obviously, we have much more ground to cover, particularly in the areas of habitat restoration and reintroductions of the snail into other sites within its former range. But we have already accomplished something very important: demonstrating the collaborative working relationship between the Fish and Wildlife Service and the Arizona Game and Fish Department.

Mike Martinez, a fish and wildlife biologist with the Arizona Ecological Services Field Office, can be reached at mike_martinez@fws.gov. Dan Cox is a biologist with the Arizona Game and Fish Department and can be reached at dcox@azgfd.gov.

Tom Gatz

Biologists examining Page springsnail habitat

A Rare Plant Returns to San Francisco Bay

by Valary Bloom

Margo Bors

Suaeda californica

Suaeda californica, or California sea-blite, is a rare perennial subshrub in the goosefoot family. The Fish and Wildlife Service listed this plant as an endangered species in 1994. The species historically grew along high tide lines in salt marshes of Morro Bay and central and south San Francisco Bay, often on salt marshes bordering sand or shell beach edges.

The species had been absent from San Francisco Bay since about 1960 when several years ago two failed attempts were made to reintroduce it to the San Francisco Bay's western shoreline. Seed dispersal from one of those failed reintroduction attempts resulted in successful spontaneous seedling establishment of *Suaeda californica* nearby. Those plants are now robust and producing abundant seed. In historic East Bay habitat, though, the species remained absent until coastal plant ecologist Peter Baye and I reintroduced it earlier this year near Emeryville, California, in partnership with the East Bay Regional Park District (EBRPD) and with funding through the Service's Sacramento Office.

In March 2007, we introduced 14 transplants along the high tide line of

Suaeda californica ***was reintroduced into this habitat near Emeryville.***

Valary Bloom

Peter R. Baye

Suaeda *transplant*

EBRPD's Eastshore State Park in Alameda County. We backfilled each transplant site with a mixture of sand and partly decomposed leaf/macroalgal litter from nearby drift-lines, then watered with commercial fertilizer. No significant rain fell after the transplanting and a week of warm, dry weather followed. A visit in April revealed the death of only four transplants, presumably from insufficient moisture. The remaining 10 plants, however, were healthy and thriving. Moderate to heavy seed production on at least half the plants is expected later this year, based on observed flowering.

The recovery needs of *Suaeda californica* will be detailed in the recovery plan for tidal marsh species of northern and central California, which is being prepared by the Service's Sacramento Office. This reintroduction project kicked-off implementation of the California Sea-blite (*Suaeda californica*) Reintroduction Plan, San Francisco Bay, California, an effort also funded by the Sacramento Office. Implementation was designed to use volunteers from the general public and non-profit conservation organizations, including local Audubon and California Native Plant Society chapters, to conduct annual monitoring and light maintenance activities. We expect this demonstration project to provide scientifically sound evidence of reintroduction success with *Suaeda californica* in San Francisco Bay, a major milestone on the species' road to recovery. Demonstrating the feasibility and cost-effectiveness of this project may encourage other restoration and reintroduction efforts aimed at declining or regionally extirpated estuarine plants.

So far, the results are encouraging!

Valary Bloom, a fish and wildlife biologist in the Service's Sacramento Fish and Wildlife Office, can be reached at valary_bloom@fws.gov or 916-414-6600.

Fisheries and Habitat Conservation

by Amy DeWeerd and
Tiffany Parson

Helping to Avoid Listing and Promote Recovery

Our mission is to provide leadership in sustaining and enhancing fish, wildlife, and their habitats for the benefit of the American people and to engage citizens in the shared stewardship of our Nation's natural resources.

The Nature Conservancy

The Fish and Wildlife Service's Fisheries and Habitat Conservation (FHC) Program works in a multitude of ways to recover animals and plants listed under the Endangered Species Act and to restore populations of native species to avoid the need for future listings. One of the Service's most diverse programs, FHC works for healthy fish and wildlife populations, healthy habitats, healthy people, and a healthy economy.

Division of Habitat and Resource Conservation

- Branch of Advanced Planning and Habitat Conservation
- Branch of Resource Management Support
- Branch of Habitat Assessment

The Division of Habitat and Resource Conservation implements various programs to conserve and protect endangered species. It works with federal, state, and local partners to develop comprehensive, science-based restoration and/or conservation planning for infrastructure development and other activities that support Endangered Species Program priorities, as well as those for migratory birds and the National Fish Habitat Action Plan. States and other partners use the National Wetlands Inventory's digital wetlands maps and status and trends information for conservation issues. The division also provides support and guidance for Service implementation of the Coastal Barrier Resources Act, Marine Mammal Protection Act, and Sikes Act.

For more information, visit http://www.fws.gov/habitatconservation.

Division of Environmental Quality

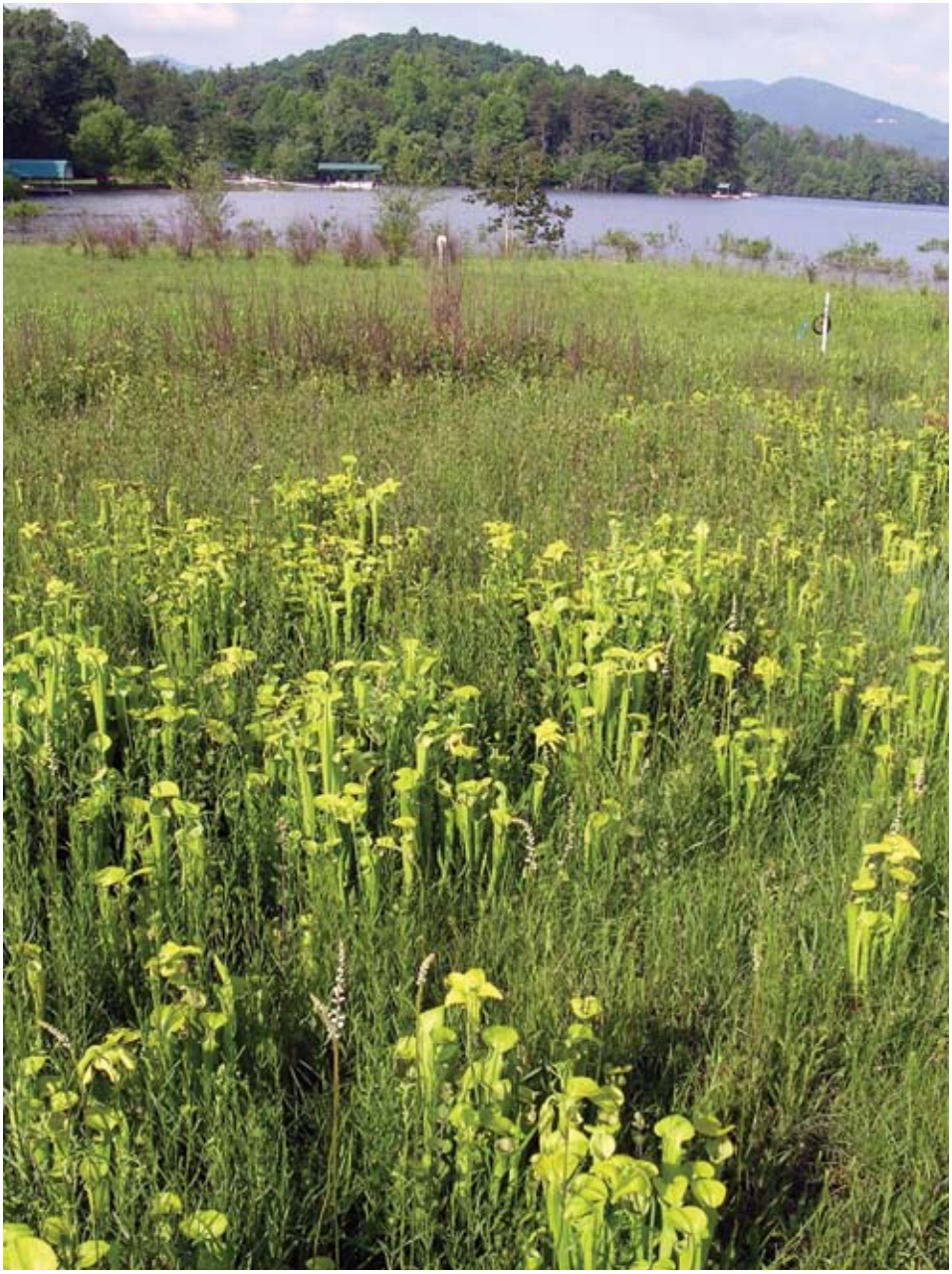
- Branch of Environmental Response and Restoration
- Analytical Control Facility
- Branch of Environmental Contaminants
- Branch of Invasive Species

This division is a national leader dedicated to protecting fish, wildlife, and their habitats from pollution's harmful effects. It works with partners to 1) conserve trust resources and their supporting habitats through contaminant prevention, 2) restore and recover trust resources and supporting habitats harmed by environmental contamination and other stressors, and 3) provide environmental contaminant expertise and high-quality scientific data to support sound management of trust resources. Additionally, we work with partners to 1) prevent the introduction and spread of aquatic nuisance species (ANS), 2) detect and rapidly respond to new introductions, 3) control established ANS where possible, 4) increase public awareness of invasive species issues through education and outreach programs, and 5) through the regulatory process, prevent the importation and interstate transport of injurious wildlife species.

For more information, go to: http://www.fws.gov/contaminants.

Division of Fish and Wildlife Management and Habitat Restoration

- Branch of Fish and Wildlife Management Assistance
- Branch of Habitat Restoration



Pete Pattavina/USFWS

Left photo: The green pitcher plant* (Sarracenia oreophila) *is an endangered carnivorous plant that depends on wetlands.

Opposite page photo: Using National Resource Damage Assessment and Restoration settlement funds from a PCB-contaminated site, the Fox River/Green Bay Natural Resource Trustee Council supported the Nature Conservancy's project to acquire and restore native habitat in the Mink River watershed.

The Fish and Wildlife Management Assistance and Habitat Restoration programs deliver scientific information to federal partners, states, tribes, landowners, and others for cooperative projects. Through the Partners for Fish and Wildlife and National Fish Passage programs, we work with a diversity of interests to restore and improve fish and wildlife habitat. The division also manages Alaska subsistence fisheries, and works with tribes to coordinate fish and wildlife management. The Coastal Program and National Coastal Wetlands Conservation Grant Program are responsible for evaluating and mapping important habitats, restoring degraded habitats, and providing grants to states for coastal wetlands conservation.

For more information, go to: http://www.fws.gov/fisheries/FWSMA.

Division of the National Fish Hatchery System

- Branch of Hatchery Operations and Maintenance
- Branch of Budget and Performance Management
- Branch of the Aquatic Animal Drug Approval Partnership

As the national leader in fish propagation and rearing techniques, genetic and broodstock management, refugia, fish health, and research, the National Fish Hatchery System works with partners to restore and maintain fish and other aquatic organisms, such as toads, salamanders, mussels, insects, and plants. The division manages 70 federal hatcheries. Its seven Fish Technology Centers are leaders in science-based management, developing new technology for aquaculture. Nine Fish Health Centers monitor the health of aquatic animals in hatchery facilities and in the wild. The Aquatic Animal Drug Approval Partnership assists in acquiring drug approvals from the Food and Drug Administration benefiting aquaculture programs, commerce, and conservation.

For more information, go to: http://www.fws.gov/fisheries/nfhs/contact.htm.

The following articles show how these complementary programs work to help prevent the need to list species and promote species recovery.

Amy DeWeerd and Tiffany Parson are fish and wildlife biologists in the Service's FHC Program. They are co-chairs for FHC's 2007 annual Congressional outreach event.

Species Recovery Through Habitat and Resource Conservation

by Dave Stout

Andrew King, USFWS

Conserving hibernating clusters of the endangered Indiana bat will be enhanced through streamlining the environmental review process in Ohio.

The Division of Habitat and Resource Conservation (HRC) is often the first Fish and Wildlife Service program engaged to prevent the decline of species so that they will not need Endangered Species Act protection. But if a species is listed, HRC is also frequently instrumental in its conservation. We accomplish this by ensuring that federal navigation, flood control, energy, and transportation projects are designed to minimize adverse environmental impacts on fish and wildlife and their habitats. A few of our recent environmental successes include:

Bringing Back the Platte

Described by early explorers as "a mile wide and a foot deep," Nebraska's Platte River provided a cornucopia of habitats for species now endangered, like the whooping crane (*Grus americana*), least tern (*Sterna antillarum*), piping plover (*Charadrius melodus*), and pallid sturgeon (*Scaphirhynchus albus*). These creatures and many others occurred commonly in the Platte River valley until people began altering the landscape.

Cities diverted river water to quench the thirst of growing populations, and farmers took more to provide for an expanding agricultural economy. By the early 1980s, more than 70 percent of the river's annual flow was being diverted for human uses. What was once a mile-wide river with countless unvegetated sandbars and wet meadows took on the closed form of an eastern forest. Something clearly needed to happen before the open Platte River environment and the species it supported remained only in history books.

What began as the Platte River Management Joint Study evolved into an agreement among the governors of Colorado, Nebraska, and Wyoming, and the Department of the Interior for the management of endangered species habitats along the central Platte River in Nebraska. The agreement ensures adequate instream flows, enhancement and restoration of degraded habitats, and facilitation of water development activities in the basin.

Tourists throng along the river to view the seasonal spectacle of skies full of cranes and other migratory birds, and they bring more than $30 million a year

USFWS

The once "mile wide and foot deep" Platte River has been reduced in size from upstream water withdrawals. The newly-enacted interstate agreement should bring back much of the habitat used by endangered birds that has been lost to vegetation encroachment.

USFWS

Veazie Dam, one of the dams to be removed to enhance fish passage.

into the local economy. Public attitudes are changing; people no longer see the Platte as simply a source of irrigation water but as a centerpiece of Nebraska's cultural and natural heritage.

Restoring an Atlantic Fishery

Our reviews of Federal Energy Regulatory Commission dam licensing laid the groundwork for restoring Atlantic salmon and other migratory fish in Maine's Penobscot River. The HRC activities have resulted in an innovative agreement involving the Service, the state of Maine, the Penobscot Indian Nation, the dam's owner, and several non-governmental organizations. The Penobscot River Restoration Project calls for three of the dams on the lower part of the Penobscot watershed to be sold to the Penobscot River Restoration Trust, which is made up of non-governmental organizations and the Penobscot Indian Nation. Two of the dams will be removed, and the third will be decommissioned and equipped with a novel fish bypass system. By recycling generating turbines from the removed dams to other projects in the watershed, coupled with other modifications, Pennsylvania Power and Light will replace over 90 percent of the power that would be lost from the dam removals. The project began in 2005, with dam removals and other improvements scheduled to occur as early as 2009.

Streamlining Transportation in Ohio

The Ohio Department of Transportation (DOT) and the Service's Ohio Ecological Services Field Office have worked in recent years to streamline the environmental review of federal transportation projects in Ohio. Interagency consultations evaluated potential effects on endangered species such as the Indiana bat (*Myotis sodalis*). In 2006, they agreed on an approach that eliminates the need for Service review of transportation projects that both parties agree are innocuous. Now, the Ohio DOT coordinates with the Service on only half as many projects, allowing both agencies to focus on higher priority consultations—those more important to fish and wildlife conservation.

Dave Stout, Chief of the Division of Habitat and Resource Conservation in the Service's Arlington, Virginia, national headquarters office, can be reached at 703-358-2161.

Fish and Wildlife Management Assistance

by John Castellano, Jarrad Kosa, Lauren Ris, and Leslie Hartsell

The Fish and Wildlife Management Assistance (FWMA) Program plays a vital role in restoring and maintaining the Nation's fish and wildlife resources. It functions like a general practitioner in the medical field; its biologists monitor the health of fish and wildlife, diagnose ailments, prescribe remedies, refer specific problems to specialists, and coordinate diverse efforts to restore and maintain health. The program helps to avoid the need for listing actions under the Endangered Species Act (ESA)—in other words, it keeps the patient out of the intensive care unit. The American people benefit from healthier ecosystems and enhanced fishing and other recreational opportunities.

In 64 FWMA offices throughout the country, over 300 fish and wildlife biologists work with other federal agencies, states, tribes, foreign governments, and private citizens to restore, manage, and conserve native fish and wildlife and their habitats. Here are a few examples:

Coaster Brook Trout

The "coaster" brook trout (*Salvelinus fontinalis*) spends most of its time in the nearshore waters of the upper Great Lakes, migrating into streams to spawn. Spending part of its life in open waters, it grows much larger than brook trout that live entirely in streams. It once was abundant along the shores and in the tributaries of Lake Superior. However, during the past century, populations were severely depleted and in some cases eliminated, requiring urgent action to prevent the need for listing this fish under the ESA.

To begin the restoration process, FWMA and its partners developed the Brook Trout Restoration Plan for Lake Superior. Guided by the plan, FWMA works with a variety of interests to

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Apache trout

Tim Rothert/Missouri Department of Conservation

Niangua darter

conduct coaster brook trout surveys and habitat assessments, propagate the coasters in the National Fish Hatchery System and state hatcheries, collaborate with the National Wildlife Refuge System to develop the Whittlesey Creek National Wildlife Refuge to protect stream habitat, and restore habitat by funding fish passage projects on two Indian reservations. As a result, coasters are now returning to historic streams in the upper Great Lakes.

Apache Trout

Native Apache trout (*Oncorhynchus apache*) in the southwestern United States were once on the verge of extinction and were listed as endangered. Those populations that remained were found only on lands of the White Mountain Apache Tribe in eastern Arizona.

In cooperation with the tribe and other interests, FWMA biologists initiated activities to locate remnant populations, identify and restore habitat, and work with national fish hatcheries to reestablish self-sustaining stocks. In all, FWMA identified genetics of 13 existing populations of Apache trout, removed non-native trout from parts or entire reaches of 14 streams, identified eight natural barriers that protect existing populations from non-native trout, constructed 30 barriers in 26 streams to protect new populations of Apache trout, established eight new populations in restored habitat, and restored portions of 21 streams.

As a result, self-sustaining Apache trout populations now exist in 21 streams comprising over 140 miles (225 kilometers) of historic habitat. A continuing success story, the Apache trout has improved in status enough to be reclassified from endangered to threatened, and it is on the verge of becoming the first fish species to be delisted through recovery.

Niangua Darter

The Niangua darter (*Etheostoma nianguae*), a Missouri fish, became a threatened species in 1985 when reservoir construction blocked upstream movement and sent it into decline.

Niangua darters live in the riffle-pool complex of clear upland creeks and small rivers in the Osage River basin and rely on continuously flowing streams with silt-free gravel and rock bottoms. Once occurring widely in the southern portion of the Osage River watershed, Niangua darters are now found only in a few small, fragmented populations. Another cause of the population fragmentation was poorly designed low-water road crossings that block Niangua darter movement. These conditions made the darter increasingly sensitive to environmental extremes (primarily drought), and the fragmentation has resulted in reduced or eliminated gene flow and genetic diversity.

Despite these challenges, the Fish and Wildlife Service and its partners are working to protect and increase Niangua darter populations. To date, 16 projects and 54 surveys have been completed within watersheds that support the species. Most have resulted from cooperative efforts with the Partners for Fish and Wildlife Program. Restoration projects include developing or improving riparian areas, stabilizing banks along highly eroded streams, constructing alternative watering sources for livestock, and modifying or replacing stream crossings within the darter's range.

Cooperators across the Nation are looking to the FWMA program to help meet their needs for monitoring, coordinating, and implementing fish and wildlife management and restoration plans. We will continue to work across borders of states, Indian reservations, and other nations to conserve fish and wildlife resources.

John Castellano, Jarrad Kosa, Lauren Ris, and Leslie Hartsell are fish and wildlife biologists in the Fish and Wildlife Management Assistance Program.

Partnerships for Shared Stewardship

by Leopoldo Miranda-Castro

Photo courtesy of the Botanical Society of America

Brighamia rockii ***is one of the listed plants found on Mokapu Island (opposite page).***

Two of the Fish and Wildlife Service's most popular and effective programs for voluntary, citizen and community-based conservation initiatives are the Partners for Fish and Wildlife and Coastal programs. They are a bridge to owners and managers of non-federal lands for development of partnerships to benefit trust species. The approach is simple: engage willing partners to conserve wildlife values on their property through the use of non-regulatory incentives.

The Partners Program is active in all 50 states, the Commonwealth of Puerto Rico, the U.S. Virgin Islands, and other trust territories. It is the Service's premier program for cooperative conservation with private landowners, farmers, ranchers, and resource-based industries. Between 2003 and 2006, the program implemented over 500 projects benefiting threatened and endangered species. The Coastal Program focuses on large-scale, long-term collaborative resource planning and implementation in high-priority coastal areas.

Through our partnerships, we have worked to conserve coastal and interior wetlands, streams and rivers, marshes and estuaries, and upland grasslands and forests from coast to coast. As of 2006, the two programs have:

- restored or enhanced more than 850,000 acres (344,000 hectares) of coastal and interior wetlands;
- restored or enhanced more than 1.9 million acres (0.8 million ha) of coastal and interior prairie, shrub, and forest upland habitat;
- restored or enhanced more than 8,500 miles (13,675 kilometers) of riparian and instream habitat;
- protected more than 1.2 million acres (0.5 million ha) of habitat through conservation easements;
- implemented more than 41,000 landowner and cooperative agreements; and
- leveraged federal tax dollars by a ratio of at least 4 to1 through partnerships.

Most of these projects benefit threatened and endangered species as well as candidates for listing. The following case studies show how the programs work:

Beaver Cave Project

Cave systems in the Southeast provide essential habitat for a number of listed bats, fish, and invertebrates, as well as candidate species. The Beaver Cave beetle (*Pseudanophthalmus major*) is endemic to the Beaver Cave system in Harrison County, Kentucky. Until 2006, it was a candidate for listing under the Endangered Species Act. The landowner approached the Partners Program, Kentucky Department of Fish and Wildlife Resources, and Natural Resources Conservation Service to design and implement a conservation project that removed the need to list this species. This project would not have been possible without planning and collaboration among the landowner, several Service programs, the Natural Resources Conservation Service, the Farm Service Agency, the Kentucky Division of Conservation, the Kentucky Department of Fish and Wildlife Resources, the Kentucky Nature Preserves Commission, and the Kentucky Division of Forestry.

The Partners Program provided technical assistance and funding for a major

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The gate at Beaver Cave protects this underground ecosystem.

stream crossing, built in conjunction with the Farm Service Agency's Conservation Reserve Program, to help exclude cattle from the stream, thereby reducing sediment and animal waste in the water. The landowner reorganized his cattle grazing regime to exclude livestock from Beaver Creek tributaries on his property. The Kentucky Division of Conservation then assisted in installing a feeding area. The Kentucky Department of Fish and Wildlife Resources, using federal funds, provided an additional stream crossing. The Natural Resources Conservation Service partially funded the installation of a gate to protect the cave and cleaned out a sediment-filled sinkhole.

Most of the animal waste and sediments from the dairy operation have been removed and or filtered from the tributary flowing into Beaver Creek. This action greatly improved water quality in the Licking River watershed and aided in restoration of the listed fanshell (*Cyprogenia stegaria*) and clubshell (*Pleurobema clava*) mussels.

Pacific Species

In the U.S. Pacific islands, the Coastal Program works with landowners, nonprofit groups, government agencies, and others on habitat protection and restoration, biological surveys, restoration research and planning, and environmental education. Its area of responsibility includes hundreds of islands distributed over thousands of square miles of ocean and covers over 6,500 miles (10.500 km) of coastline. Pacific island coasts and nearshore environments include over 90 percent of the U.S. coral reefs and a range of unique, tropical habitat types that support many endemic species, hundreds of which are listed as threatened or endangered.

In support of the Service's 2005 Seabird Conservation Plan for the Pacific Region, the Coastal Program played a central role in funding and coordinating projects to eradicate non-native rats on two Hawaii offshore islets, Lehua and Mokapu. Introduced rats eat a wide variety of native organisms, including seabirds, plants, insects, and inter-tidal invertebrates. Rat eradication reduces predation and benefits the following endangered (E), threatened (T), and candidate (C) species that currently inhabit the islets:

- Newell's shearwater (T) *Puffinus auricularis*
- Dark-rumped petrel (E) *Pterodroma phaeopygia sandwichensis*
- *Peucedanum sandwicense* (T) (Mokapu is designated critical habitat for this plant species.)
- Band-rumped storm petrel (C) *Oceanodroma castro*

Both islets are designated state seabird sanctuaries, and they support native plants and invertebrates as well. Mokapu Island is designated critical habitat for three listed plants: *Brighamia rockii* (E), *Tetramolopium rockii* (T), and *Peucedanum sandwicense* (T), although only the latter currently grows on the island. A possible future initiative could include the reintroduction of these species.

The Partners and Coastal programs produce similar accomplishments and share a common vision of citizen-centered conservation through partnerships. Each program has a unique niche and focus for carrying out the Nation's conservation responsibilities. We will continue to work with our public and private partners to assist in reaching national goals for the conservation of federal trust species.

For more information, visit www.fws.gov/partners or www.fws.gov/coastal.

Leopoldo Miranda-Castro is a wildlife biologist in the Service's Arlington, Virginia, headquarters office.

** Case studies narrative information was adapted from project descriptions originally written in the Habitat Information Tracking System (HabITS) by Brent Harrel (Partners Coordinator in Kentucky) and Chris Swenson (Pacific Islands Coastal Coordinator).*

Eric VanderWerf

Introduced rats on Mokapu Island in Hawaii were damaging native bird populations.

The Environmental Contaminants Program

by Cindy Schexnider

Gus Van Viet

Marbled murrelet

The Fish and Wildlife Service has been studying the effects of contaminants on fish and wildlife since the agency's earliest days, but the Environmental Contaminants Program did not began to take form until the 1950s, when increasing awareness of pollution problems spurred the American public to demand action. Then, in 1962, Rachel Carson, a former Service employee, captured national attention with her landmark book, *Silent Spring,* which described the widespread harmful effects of pesticides on the environment. Carson's alarming message—that the effects of these substances on wildlife serve as indicators of what may ultimately jeopardize our own health—struck a chord with the American public.

Many believe that Carson's book inspired the modern environmental movement and prompted the development of many of the pollution prevention laws that are in place today. After her book was published, Congress passed the National Environmental Policy Act and pollution prevention laws such as the Clean Water Act; Clean Air Act; Federal Insecticide, Fungicide and Rodenticide Act; Safe Drinking Water Act; Toxic Substances Control Act; and the "Superfund" toxic waste cleanup law also known as the Comprehensive Environmental Response, Compensation, and Liability Act.

Today, the Service's Environmental Contaminants Program includes contaminants specialists stationed at more than 75 locations around the country. These scientists are on the front lines in the fight against pollution. They specialize in detecting toxic chemicals; addressing their effects; preventing harm to fish, wildlife, and their habitats; and remov-

Olympic Coast National Marine Sanctuary

Old-growth habitat at Cape Flattery is now being protected for the marbled murrelet and other wildlife.

Douglas Zimmer/USFWS

Dancers from the Makah Tribe celebrated the agreement to protect old-growth habitat.

ing toxic chemicals and restoring habitat when prevention is not possible. They are experts on oil and chemical spills, pesticides, water quality, hazardous materials disposal, and other aspects of pollution biology. Integrated into all other Service activities, the Service's contaminants specialists often work in partnership with other agencies and organizations that rely on our expertise.

An example of the program's work can be seen in our response to an oil spill off the U.S. Pacific Northwest coast that posed a serious threat to a population of marbled murrelets (*Brachyramphus marmoratus*). These small seabirds live in nearshore marine environments from California to Alaska and are the only seabird to nest in mature coastal forests. Extensive losses of such habitat led to a decline in marbled murrelet numbers along the West Coast, resulting in the 1992 listing of the Washington, Oregon, and California population as threatened under the Endangered Species Act.

On July 22, 1991, the Chinese freighter *Tuo Hai* hit and sank the Japanese fishing vessel *Tenyo Maru* near the entrance to the Straits of Juan de Fuca, which separates Washington State and Vancouver Island, Canada. The *Tenyo Maru* released much of the 452,600 gallons (1.7 millions liters) of fuel oil and diesel aboard, oiling a large swath of the coasts of Washington and Oregon. The spill killed over 20,000 sea birds, including marbled murrelets.

Under the 1990 Oil Pollution Act (OPA), natural resource trustees (selected Federal agencies, States and Tribes) hold the parties responsible for an oil spill liable for injury to natural resources and to restore those injured resources. The trustees involved in the *Tenyo Maru* spill included the Department of the Interior (represented by the Service's Environmental Contaminants Program), the State of Washington, and the Makah Tribe. Through the natural resource damage assessment and restoration (NRDAR) process under the OPA, the trustees quantified the natural resource injuries and, with public input, determined the appropriate restoration projects.

Because habitat loss is the greatest threat to marbled murrelets, most of the *Tenyo Maru* restoration projects focused on habitat protection and enhancement. The trustees used approximately $4.7 million of the settlement funds to permanently protect and restore over 900 acres (365 hectares) of coastal forest in three parcels. These included 220 acres (90 ha) of rare coastal old growth forest currently supporting nesting marbled murrelets, as well as high-quality second growth forest and younger stands of trees that will serve as a buffer to the old-growth stands and eventually grow into mature forests. One parcel is now a part of the Willapa National Wildlife Refuge, while two others are being managed under a 200-year land use agreement with the Makah Tribe. All of these areas are now protected from logging, development, and other activities detrimental to the recovery of marbled murrelets. The trustees also provided funding to survey potential marbled murrelet nesting areas, which through our partners has resulted in increased protection of another 3,000 acres (1,215 ha) of mature forest habitat in Washington.

In August 2006, the trustees held a commemoration to share completion of the restoration projects with the public and to inform them of the needs of Washington and Oregon's seabirds. Held on the Makah Reservation, where two of the newly protected old-growth forest tracts are located, the ceremony included tribal traditions, complete with a smoked salmon feast, tribal dancing, and blessings for the newly protected land.

A final summary of the entire restoration can be found at http://www.fws.gov/westwafwo/index.html.

Cindy Schexnider is an Environmental Contaminant Specialist in the Service's Western Washington Fish and Wildlife Office.

The National Fish Hatchery System

by Stuart C. Leon

USFWS

The Fish and Wildlife Service's Fisheries Program is steeped in the conservation traditions of America. Throughout a history that spans 136 years, the Fisheries Program has endeavored to respond to the ever-changing challenges in resource conservation wrought by constantly evolving societal demands. This remains true today.

From the earliest beginnings of our Fisheries Program, the Service's National Fish Hatchery System has been a principal asset in responding to emerging conservation challenges. Within the National Fish Hatchery System, captive propagation has been, and continues to be, a valuable and irreplaceable tool in the management, restoration, and recovery of fish and other aquatic-dependent species. Used in the right way at the right time, the System employs captive propagation to restore and replenish aquatic animal populations in ways that no other conservation tool can.

Hatcheries complement habitat conservation and restoration programs. Today, the System's 70 National Fish Hatcheries,

Fish hatcheries raise more than fish. Wyoming toads (above) are being propagated at Saratoga National Fish Hatchery in Wyoming, and the Genoa National Fish Hatchery in Wisconsin produces several species of mussels.

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Andrew Starostka/USFWS

Wells "Geno" Adams with a pallid sturgeon collected in St. Charles, Missouri.

nine Fish Health Centers, seven Fish Technology Centers, and Aquatic Animal Drug Approval Partnership program all play a significant role in conserving our Nation's fish, mussels, aquatic insects and plants, and amphibians. In doing so, we also help provide recreational opportunities to America's 34 million anglers, who spend $36 billion annually in pursuit of America's favorite pastime.

I am honored to be associated with the many outstanding professionals that comprise the Service's Fisheries Program. Our workforce is diverse and among the most technically competent; it includes ecologists, culturists, geneticists, veterinarians, statisticians, disease pathologists, aquaculture drug researchers, and facility maintenance experts. They are vested with the responsibility for recovering species listed under the Endangered Species Act, restoring native aquatic populations, mitigating for fisheries lost as a result of federal water projects, and providing fish to benefit tribes and national wildlife refuges. The National Fish Hatchery System works closely with other Service biologists and with states, tribes, and the private sector to complement habitat restoration and other resource management strategies for maintaining healthy ecosystems that support healthy fisheries.

In the following articles, we highlight a few of the valuable contributions the National Fish Hatchery System makes to species recovery. From the saga of the Lahontan cutthroat trout to the less visible but equally dramatic struggle for survival of the Higgins eye pearlymussel, Service fisheries biologists and our partners are working hard to restore aquatic wildlife for the benefit of future generations.

Dr. Leon is Chief of the Division of the National Fish Hatchery System in the Service's Arlington, Virginia, headquarters office.

A Living Fossil Fights for Survival

by Jeff M. Finley and
Craig Springer

Some call the pallid sturgeon (*Scaphirhynchus albus*) a living fossil. This large fish arose in the Cenozoic Era like a dinosaur, then survived the cold crunch of advancing glaciers and lived to thrive in the big, muddy rivers of middle North America. Only recently has the pallid sturgeon experienced changes so extreme as to threaten its survival. In a century's time, habitat destruction, pollution, dams, changes in river flows, over-fishing, the caviar trade, and hybridization in the Missouri River basin drove the pallid sturgeon to the brink of extinction.

The pallid sturgeon's life characteristics—a long life and slow growth—may contribute to its decline. This fish grows to a size of more than five feet (1.5 meters) and 80 pounds (36 kilograms), and it lives beyond 60 years. But maturity comes slow; it takes females a decade to ripen, and even under ideal conditions, spawning is sporadic and infrequent, perhaps every other year.

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Wyatt Doyle, Branch Chief of the Columbia Fishery Resources Office, holds two stocked fingerling pallid sturgeon after recapture.

The Fish and Wildlife Service listed the pallid sturgeon as an endangered species in 1990. Since then, natural resource agencies, governments and citizens from Louisiana to Montana have joined forces to recover this ancient fish. The Neosho National Fish Hatchery in Missouri is one of six federal and state hatcheries raising pallid sturgeon for stocking into the Missouri River.

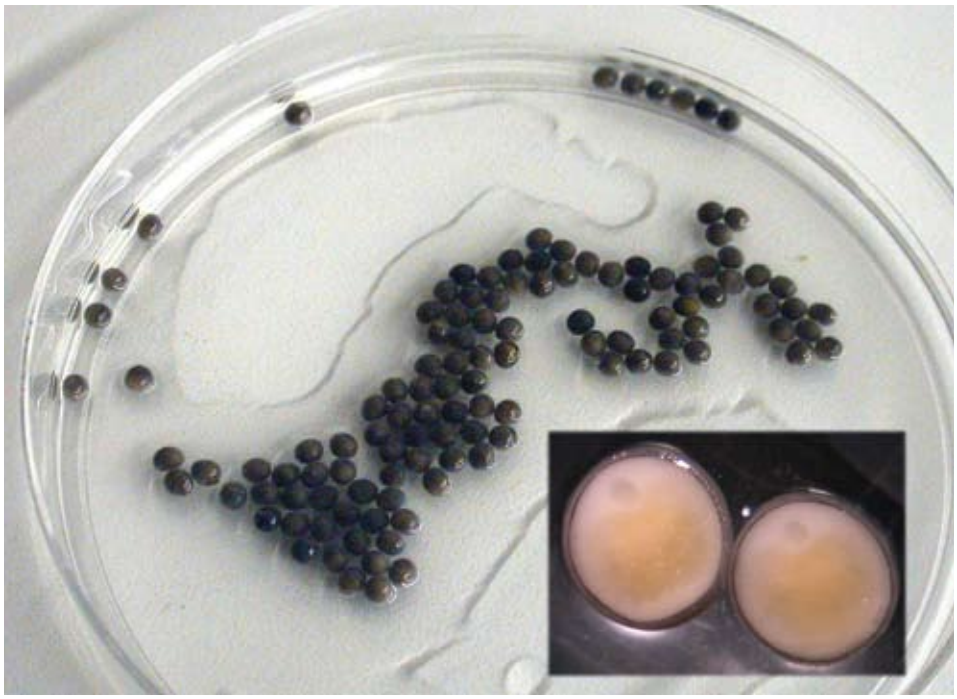
Only in its fifth year of raising pallid sturgeon, Neosho NFH continues to increase its production from wild-caught fish, both by refining culture techniques and increasing the amount of tank space. Like most pallid sturgeon raised at hatcheries, the fish receive either a colored latex tag or coded wire tag along with an individually numbered PIT (passive integrated transponder) tag before stocking. This helps biologists distinguish between wild and hatchery-raised pallid sturgeon, yielding a better understanding of the species in the wild.

"The Middle Basin Workgroup determines how many fish we produce; they set the stocking goal," says Neosho's manager, David Hendrix. "The Service's Columbia Fishery Resources Office in Missouri does the follow-up on survival, and those tags in the fish tell us where they came from. The hatcheries are a management tool to keep the fish from going extinct."

In 2004, Neosho's original sturgeon building was expanded through a partnership with the Army Corps of Engineers. This addition allows the hatchery to spawn and rear an estimated 4,000 pallid sturgeon each year. A building under construction will allow the facility to produce another 10,000 fish per year. The expanded Neosho facility will prove vital in rearing pallid sturgeon, as will the Corps-funded renovation of hatcheries like Miles City State Fish Hatchery in Montana, Gavins Point NFH in South Dakota, and the Blind Pony State Fish Hatchery in Missouri, all of which have expanded to stock pallid sturgeon.

Over 150,000 pallid sturgeon have been stocked since the fish was listed. The efforts to raise pallid sturgeon are the result of cooperation between the Corps and Service to bring the Corps's federal projects into compliance with the Endangered Species Act. "We are committed to protection and recovery of threatened and endangered species like pallid sturgeon," says Brigadier General Gregg Martin, Northwestern Division Commander.

At the lower end of the species' natural range, biologists at Natchitoches NFH in Louisiana have spawned pallid sturgeon for release in the Mississippi River. They stocked nearly 12,000 fish in autumn 2004. No pallid sturgeon have been stocked there since 2004 because biologists believe the fish is doing well enough in the lower basin; these fish tend to grow faster due to warmer temperatures, thus reaching maturity sooner. Assistant Hatchery Manager Dr. Jan Dean continues to advance our understanding of the fish by creating a larval identification series, which allows hatchery and field biologists to identify pallid sturgeon in their rapidly changing early-life forms and distinguish them from the more common shovelnose sturgeon (*Scaphirhynchus platorynchus).* Dean is also on the leading edge of research with the Service's Jackson, Mississippi, Ecological Services Field Office to study



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Pallid sturgeon eggs were collected in the past for the caviar trade.

USFWS

Biologists with the Service and USGS surgically implant a sonic transmitter into a pallid sturgeon for tracking research.

fish movement in the wild. And move they do; one of the fish recently caught by Dean and Paul Hartfield of the Jackson Office was spawned and tagged at the Blind Pony State Fish Hatchery, more than 300 miles (480 kilometers) away.

Next up the Missouri River from Neosho is Gavins Point NFH in South Dakota. This hatchery also was retooled to handle pallid sturgeon. Hatchery Manager Herb Bollig and crew have been spawning pallid sturgeon since the early 1990s. The facility houses the only pallid sturgeon brood stock in the world: 10 year-classes of 88 families, comprising thousands of fish. They are still immature, and Bollig expects a few more years to pass before they start producing eggs. With so few wild fish left in the Missouri River, this brood stock is critical to the species' survival. Inspections by Service biologists at the Fish Health Center in Bozeman, Montana, lend an extra level of security, ensuring that the brood stock remains robust. A new well coming online should ensure the fish get disease-free water.

Farther upstream, wild adult pallid sturgeon are brought to Garrison Dam NFH in North Dakota, spawned, and returned to the wild. Some of the wild adults get a radio transmitter surgically implanted so management biologists can learn more about habits and habitats. Their offspring are eventually released into the Missouri River as well. Hatchery Manager Rob Holm says the adults in the wild are getting old. Some fish that have been caught over time have lost weight, underscoring the need for maintaining a captive brood stock. But the problem for pallids remains one of habitat. Captive propagation and milt (fish sperm) preservation only buy some time to fix habitat problems, says Holm. "Our milt cryopreservation repository captures the existing genetic makeup of the species," Holm says. "If the necessary habitat changes can be made in the next 50 years to facilitate recovery, we want as genetically a diverse group of sturgeon as possible to release back into the wild, and the National Fish Hatchery System makes this possible."

Yvette Converse, Assistant Director of the Bozeman Fish Technology Center in Montana, agrees on the need to address habitat: "In the long-term, we don't want to be dependent on hatcheries for recovery, but want to have the habitat suitable for fish survival in the wild, and that may take decades. Water management may be the biggest obstacle for pallid sturgeon recovery." In the meantime, the Bozeman Center has expertise to offer. Physiologist Dr. Molly Webb has conducted blood assays, using blood chemistry and hormones to identify an optimal time to spawn fish. Those assays could ultimately mean less stress on an aging and obsolescent population of wild fish, as well as on captive stocks, and a greater yield of offspring. Biologist Kevin Kappenman conducts thermal studies, looking at egg maturation, hatching and larval rearing development with changing temperatures—information useful for better captive propagation.

Hatchery-raised pallid sturgeon released into the Missouri River now have a greater chance to find some of the shallow-water habitats that are critical for their survival. The Corps undertook an aggressive effort in 2004 to create an

estimated 1,200 acres (485 hectares) of new habitat in the lower reaches of the Missouri, where habitat loss in the past has been so great. The Columbia Fishery Resources Office (FRO) monitors some of the newly created habitat to see if it is used by both wild and hatchery-raised pallid sturgeon. This information will help guide the designs of future habitat restorations and determine if a greater diversity of habitat types is necessary.

In addition to the habitat work, the Columbia FRO is responsible for pallid sturgeon recovery in some 300 miles of the Missouri River, stretching from Kansas City to St. Louis. Dr. Tracy Hill, Columbia's Project Leader, chairs the Middle Missouri River Basin Pallid Sturgeon Workgroup, a multi-stakeholder forum for coordinating conservation efforts, and is a member of the Pallid Sturgeon Recovery Team. The recovery team is making great strides in scientific and technological breakthroughs.

Since 1999, Columbia FRO biologists have managed to capture only 123 pallid sturgeon in the lower 200 miles (320 km) of the Missouri River. Seventy-four of those fish were produced by state and federal hatcheries. Forty-two fish had no tags and were thought to be wild fish. Seven others were of unknown origin but were suspected to have been stocked.

An important milestone on the road to recovery occurred in 1999 when biologists from the Columbia FRO discovered a freshly hatched larval pallid sturgeon in the naturally formed Lisbon side chute of the Big Muddy National Fish and Wildlife Refuge. This is the only verified case of natural reproduction within the lower Missouri River in more than 50 years. The Lisbon chute, created during the great flood of 1993, has since been a hot spot for collecting pallids.

Columbia FRO collected 44 pallid sturgeon in 2005. However in 2006, it could collect only 21 fish despite a significant increase in the sampling effort. The 2006 results are vexing and perplexing, and they show there is still much to learn. A myriad of complications face this ancient and extremely rare fish. Success is incremental, on the river or in a hatchery.

Jeff M. Finley is a biologist in the Columbia FRO, and Craig Springer is a biologist in the Division of the National Fish Hatchery System in Albuquerque, New Mexico.

USFWS

The Return of a Lake-dwelling Giant

by Craig Springer

Craig Springer/USFWS

Jay Bigelow holds a male Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), one about three years old and 16 inches (40 centimeters) long, and admires the sunlight reflecting off the black-spotted silvery-white flanks. It's part of a unique brood stock he's developing. Bigelow supervises operations at the Lahontan National Fish Hatchery in Gardnerville, Nevada, on the banks of the Carson River. The hatchery is part of a larger integrated fisheries complex that includes the Nevada Fishery Resources Office and Marble Bluff Fish Passage Facility. These stations coordinate programs to plan and implement the recovery of the threatened Lahontan cutthroat trout.

One of 13 cutthroat trout subspecies in the American West, this fish evolved in ancient Lake Lahontan, which at its maximum size inundated about 8,600 square miles (22,300 sq. kilometers) of northwestern Nevada and parts of surrounding states. As glaciers retreated at the end of the last ice age, an attendant climate change dried the basin, and Lake Lahontan receded to form the few isolated lakes found today. With gradual climate change, the Lahontan cutthroat trout developed into a fish able to withstand environmental extremes that today readily kill other fish species. Two forms of the Lahontan cutthroat arose: one accustomed to life in flowing waters; the other, a lake-dweller.

Pyramid and Walker lakes at the bottom of the present-day basin held native Lahontan cutthroat trout. These are terminal lakes, meaning that water leaves them only by evaporation. As a result, their mineral content is extremely high.

A Lahontan cutthroat trout photographed in a shallow stream. In its lake habitats, Lahontan cutthroat trout can grow to larger than 60 pounds.

© Michael Graybrook

Craig Springer/USFWS

Hatchery Supervisor Jay Bigelow feeds the facility's Lahontan cutthroat trout.

Lahontan cutthroat trout not only tolerate this condition, they evolved to thrive in it. These lake-form fish had other remarkable adaptations. The numbers of cartilaginous filaments or gill rakers inside their throat are exceedingly high, indicating a habit of feeding on microscopic animals. The fish also has a digestive track for preying on fish. For eons it was atop the food chain, wreaking havoc on fish like the cui-ui (*Chasmistes cujus*) and tui chub (*Gila bicolor*), and most likely cannibalizing its own. In its lake habitats, the Lahontan cutthroat trout grew to phenomenal size. The largest known specimen tipped the scale at 62 pounds (28 kilograms) in 1916.

In 1905, the Bureau of Reclamation's first water development project, the Newlands Project, altered water availability and flow to Lahontan cutthroat trout. Pyramid and Walker lake levels dropped as farmers diverted water to irrigate fields, and fish lost their access from Pyramid Lake to their spawning gravels in the Truckee River. Due to a lack of available spawning habitat, Pyramid Lake was devoid of the trout by 1939. Although reduced numbers of river-dwelling Lahontan cutthroat trout remained, the native strain of lake-dwelling trout that carried the genes for tremendous growth in the face of harsh conditions appeared to be extinct.

At some point in the past, trout were transferred from Pyramid Lake into a small fishless stream, Morrison Creek, on Pilot Peak in Utah, an event that proved priceless for conservation. When and by whom the transfer was made is unknown. Fast forward to the 1970s. As a precaution against extinction, Bryce Nelson of the Utah Department of Natural Resources later transferred some of the Morrison Creek fish to nearby fishless Bettridge Creek on Bureau of Land Management lands. Genetic studies commissioned by Lisa Heki, Project Leader of the integrated Lahontan NFH Complex, and conducted by Dr. Mary Peacock, University of Nevada-Reno, found that the fish surviving in the Utah streams are pure representatives of the original lake-dwelling form of Lahontan cutthroat trout.

Through Heki's 12 years of recovery work, the Lahontan National Fish Hatchery has moved from a focus on a short-term put-and-take sport fishery to a facility centered on the recovery of a native threatened species, but one with even greater sport fishing qualities. Heki is optimistic. "Yes, it can be done, and quicker than people believe—if there is cooperation," she says. "Twenty years down the road, we could have 20- to 30-pound cutthroat trout running the river right through downtown Reno."

Building brood stocks from wild fish takes time. Bigelow and crew carefully manage the brood stock to maintain a robust line and genetic integrity. To "keep the wild in the fish," fertilized eggs from Morrison Creek trout are brought to the hatchery and infused into the brood stock. The hatchery complex has a partner in Steve Doudy, a conservation-minded citizen who owns the land over which Morrison Creek flows.

In 2001 the hatchery achieved success in its hatching efforts, and in 2004 the hatchery placed 13,197 fish into Pyramid Lake. There they are expected to significantly contribute to the recreational fishery managed by the Paiute Indian tribe.

The hatchery continues to meet rigorous demands for fish health. Some of the fish will be stocked in California's Fallen Leaf Lake and perhaps in Lake Tahoe. The fish culture expertise will be applied as eggs are incubated at the Marble Bluff Fish Passage Facility, located near the terminus of the Truckee River above Pyramid Lake. To imprint the young fish on the river water and get the adults to swim back through the passage into the Truckee to spawn, the eggs will be incubated in Truckee River water. It will be a few years before success can be measured, but now this unique fish has a real chance for recovery.

Hatcheries Are for More Than Fish

by Richard Shelton

USFWS

Mussels collected during a stream survey.

Native mussels may be the most endangered aquatic animals. Here in Arkansas, they were once found in great abundance within many streams. But pollution, over-harvest, impoundments, and dredging changed the character of streams and took a toll on many aquatic organisms.

Native Americans found mussels a dependable food source, and they used the shells for tools, art, and jewelry. From the 1800s until the 1940s, mussel shells were used extensively for buttons until the advent of Bakelite plastics. "Mussel shelling" has seen a resurgence in recent years; they have become valuable not only for their own freshwater pearls but for shipment to Asia for use as "seed" for more valuable saltwater oyster pearls. Mussels occupy a valuable ecological niche; they provide a food source for fish and mammals and provide a natural filtering mechanism, which also makes them excellent biological indicators of aquatic health.

Mussels have a complex life cycle. They begin as larvae, or glochidia as they are called. The glochidia must attach to specific host fish species, upon which they transform and grow until dropping onto the stream bottom and maturing into adults. Each species of mussel has a specific fish host that it must find when it is ready to spawn. Some mussels have developed ingenuous adaptations to lure fish close enough for implantation, such as appendages that resemble worms. When pollutants or other processes cause a decline in either the mussel population or the fish host species, the reproductive cycle is broken and entire mussel communities may collapse.

Perhaps the most insidious threat to all freshwater mussels is the invasive zebra

Hatchery biologist Josh Seagraves (left) and Assistant Manager Dewayne French record data from the aquatic habitat system used to hold fish for mussel host fish research.

Richard Shelton/USFWS

mussel (*Dreissena polymorpha*). A native of Europe, the zebra mussel was accidentally introduced into the Great Lakes in the 1980s when foreign ships dumped bilge water containing zebra mussel larvae. This thumbnail-sized invader has a propensity to attach in huge masses to any hard object, including the hard shells of other mussels. Zebra mussels can cover and even smother beds of native mussels. They have already spread throughout much of the Mississippi River drainage by attaching to the bottom of boats and barges or entering the cooling system of boat motors. Without natural predators, it is a virtual certainty that this pest will eventually inhabit most North American streams, with predictably devastating effects on native mussel populations.

To address the threats to native mussel species, the Mammoth Spring National Fish Hatchery has dedicated its facilities and expertise to helping endangered mussels for the past decade. Its biologists have teamed with Arkansas State University to learn the basic life history of the animals, learning the techniques needed to grow and spawn them. Part of that effort is to discover the specific host-fish species. These fish are often obscure or rare, and much remains to be learned about them as well.

Due to the threats posed by a zebra mussel invasion of southern waters, Mammoth Spring biologists investigated the utility of holding native mussels in ponds, essentially providing refugia against loss of wild populations. Over two years, about 850 mussels of 25 species from the White River system were held while their growth and survival were monitored. Juveniles were reared for release into native habitats to restore depleted populations. As early as 1995, Mammoth Spring staff propagated native mussels and reared them to the juvenile stage for release into Leading Creek.

During these efforts, important life history traits continue to be discovered. We now know more about propagating the endangered speckled pocketbook (*Lampsilis streckeri*), the threatened Arkansas fatmucket (*Lampsilis powellii*), and the threatened Ouachita creekshell (*Viliosa arkansasensis*) for reintroduction. Mammoth Spring biologists are investigating the life histories of two additional endangered mussels, the pink mucket (*Lampsilis abrupta*) and fat pocketbook (*Potamilus capax*), both of which could be affected by future highway projects in Arkansas. The Arkansas Highway and Transportation Department is an important partner with the Fish and Wildlife Service in conserving these native mussels.

The breadth of projects undertaken and the lessons learned show that fish hatcheries are for more than fish. In an ecological sense, the ties that bind fish and mussel are strong, and conserving mussels benefits fish and other animals.

Richard Shelton is the manager of Mammoth Spring National Fish Hatchery in Mammoth Spring, Arkansas.

Richard Shelton/USFWS

Dewayne French studies mussel glochidea.

Dewayne French/USFWS

Dr. Jerry Farris of Arkansas State University (left), Bill Posy of the Arkansas Game and Fish Commission, and diver Josh Seagraves (USFWS) search for endangered mussels in a stream.

The Texas Blind Salamander

by Craig Springer

Joe Fries/USFWS

Cannibalism has been noted with Texas blind salamanders.

Pallid and spindly, eyeless and other-worldly, Texas blind salamanders (*Typhlomolge rathbuni*) make their living in the watery labyrinth of the Edwards Aquifer in central Texas. Top predators, they eat crustaceans, snails, and probably each other in the wild. Their entire lives are spent in water and in the darkness of caves. They have no reason to come into daylight, as indicated by the vestiges of eyes (which begin as tiny black dots and quickly disappear early in life) and by the lack of pigment. It was by accident that they were even discovered and by happenstance that the discoverer launched their conservation.

In 1896, specimens of Texas blind salamanders welled up 190 feet (58 meters) into the light of day via a well casing sunk by the U.S. Fish Commission, the precursor to today's U.S. Fish and Wildlife Service. The well serviced the National Fish Hatchery at San Marcos, Texas. The uniqueness of the habitat and

The Texas blind salamander is a cave-dwelling, unpigmented amphibian with reduced, vestigial eyes. Adults reach an average length of about 4.7 inches (12 centimeters).

Joe Fries/USFWS

its good water influenced renowned U.S. Fish Commission ichthyologist Barton Evermann to locate the hatchery there. He wrote, "The river has its rise in a number of springs at the foot of a limestone ledge or hill just above town. All these springs together form a large, deep stream, from the bottom of which, near the upper end, wells up the principal spring." Four years later, Evermann facilitated the collection and description of the eyeless salamanders from the springs that had so impressed him.

The facility, today known as the San Marcos National Fish Hatchery and Technology Center, works with the Service's Austin Ecological Services Field Office to recover the rare amphibians, arguably among the country's rarest and most unusual animals.

A lifetime naturalist, Barton Evermann served as Chief in Charge of the Division of Scientific Inquiry of the U.S. Bureau of Fisheries from 1891 to 1910 during which time he chose San Marcos, Texas, as the site for a federal fish hatchery. Later Dr. Evermann was Director of the museum at the California Academy of Sciences.

Fish biologist Joe Fries guides conservation initiatives for the species at the Technology Center, maintaining tanks and keeping salamanders collected from different sites separate to ensure genetic diversity. Almost anything learned through the work is new information, he says.

"We know they are highly endemic and rare, but just how rare we can't say for sure," says Fries. "They are hard to research because they are so hard to get to; that's why we're looking into their life-history in captivity."

Keeping salamanders at the facility serves a dual purpose. Maintaining captive populations allows biologists to gain important information about the species—its growth rates, eating habits, temperature tolerances, and reproductive ecology. The facility also serves as a refuge. Captive animals are a back-up population in the event of a dramatic loss in the wild. And that speaks to threats; what goes into the Edwards Aquifer goes through Texas blind salamanders.

The region is known for its karst topography. Karst is a three-dimensional landscape shaped by the dissolution of soluble carbonate bedrock, such as limestone, that is highly fractured and contains subsurface drainage systems, often including caves. Aquifers formed in karst topography are usually quick to recharge from surface drainage. A diesel spill, or other contaminants such as run-off of agricultural chemicals, within the recharge zone of the Edwards Aquifer could cause serious harm to the water quality, and thus to Texas blind salamanders.

Water quality aside, there is the issue of water *quantity*. As the human population grows, so does its demand for water. Reducing the amount of water in the aquifer could reduce available habitat. The threats of pollution and aquifer overpumping were what led to listing the species in 1967 as endangered.

Although salamanders at the Technology Center have laid eggs and produced offspring, the survivors have yet to reproduce. Eggs from the first-generation of captive salamanders have disappeared and were probably cannibalized. In his studies, Fries is striving to fill in knowledge gaps, closely following the species to bring about its recovery in anticipation of its eventual delisting.

Hatchery Breeds Wyoming's Rarest Toad

by Craig Springer

USFWS

Detroit. Toledo. Cincinnati. New York City. Saratoga. They all hold captive populations of an endangered amphibian, the Wyoming toad (*Bufo hemiophrys baxteri*). Small captive populations of the rare toad live in eight city zoos across the country, all participating in the American Zoo and Aquarium Association's Species Survival Plan (SSP), a systematic arrangement to keep the toad from going extinct. But it's near a small Wyoming town where the Saratoga National Fish Hatchery has one of the largest captive populations, which should contribute in large measure to the toad's recovery.

The Wyoming toad's natural range is within roughly a 30-mile (48-kilometer) radius of Laramie. Following a population crash, the toad was listed as endangered, and most of its habitat is now protected as part of the Mortenson Lake National Wildlife Refuge. As is the case with most listed species, the major factor behind the decline was habitat loss. Irrigation out-competed wetlands for water, and matters were made worse by continued drought. Sensitivity to herbicides was a factor, too. Then there's the chytrid fungus (*Batrachochytridium dendrobatidis*). Chytrid infections seem to play a large role in suppressing the animal, says David Paddock, the lead toad biologist at Saratoga NFH.

As part of the recovery program, Wyoming toads were brought to the Saratoga NFH for propagation. Captive breeding began in earnest in 1999. Since that time, an average of 6,863 Wyoming toads have been released each year. Between 1999 and 2003, Saratoga produced an average of 55 percent of the toads released to face the rigors of the wild in the Laramie basin. Just last year, tadpoles from Saratoga were released onto two new private land sites covered under Safe Harbor Agreements, a wonderful arrangement made possible by the Service's Cheyenne Ecological Services Office and the Laramie Rivers Conservation District.

The Saratoga facility also produces trout for restoration into the wild. Paddock is a fish biologist by training and a toad biologist by necessity. But he says animal husbandry is much the same, whether for trout or amphibians. He keeps toads at the hatchery carefully isolated from the fishes in their own environment, and he adheres to strict protocols to prevent the spread of chytrid fungus or other disease-causing pathogens. Toads with chytrid are cared for with antifungal treatments.

He says it's easier to get the toads to breed than one might expect. Of the 150 adult toads kept on station, breed-

Wyoming toad eggs (above) and toadlets at the Saratoga National Fish Hatchery.

USFWS

Tyler Fox

ing pairs are carefully selected from a studbook—one used by all the participating zoos in the SSP—to maintain genetic integrity. He gets it done, he says jokingly, "with a little wining and dining." Selected adults are paired off in tanks in two inches (five centimeters) of water filled with artificial plants, then injected with hormones to induce production of eggs and sperm. He leaves them to their desires while recorded toad calls play in the background to simulate the competitive breeding that exists in nature. And Wyoming toads are fecund. Three days later, some of the 2,000 eggs start hatching, and in a matter of days to a few short weeks tadpoles and toadlets are forming. They also quickly become crowded, and therein lies part of the reason the Saratoga Hatchery is so important to the toad's recovery. The participating zoos have such limited space that breedings are few—maybe four a year. Because of its space and expertise, Saratoga is able to perform many more breedings each year, 20 or more, and that means more toads released into their native habitat. That expertise, Paddock is quick to note, isn't all in husbandry. The physical plant is irreplaceable. The hatchery is plumbed with a good supply of water, and maintenance man Pat Malone takes care of it all.

Most of the toads are released in the tadpole stage, and about six weeks after eggs are laid they enter the toadlet stage. Toadlets are released in August, giving them a chance to acclimate to the wild and find quarters in small-mammal burrows before the cold Wyoming winter arrives.

Paddock and others at the hatchery continue to improve the toad husbandry techniques. The 2006 breeding season saw a 17.8 percent increase in its hatch rate over previous years. It's probably attributed to how they treated their brood stock toads over the winter. Paddock held select pairs of toads in colder temperatures over winter to more closely simulate the harsh weather they face in the wild. That exposure during hibernation may have cued something physiologically to make the animals more fecund. So, another refrigerated hibernation unit is on the way to the hatchery, and Paddock expects the toads to show even greater reproductive success in 2007.

The Saratoga Hatchery has a long and productive history. Established in 1911, it created the first brood stock of the threatened greenback cutthroat trout (*Oncorhynchus clarki stomias*). Now, Saratoga is the first facility in the National Fish Hatchery System to hatch and raise an endangered toad. It's making its mark; after the hatchery put toads into the wild, there is evidence of natural reproduction on Arapaho National Wildlife Refuge, a vital step on the road to recovery.

USFWS

David Paddock examines a Wyoming toad at the Saratoga National Fish Hatchery.

A New Approach for Monitoring Multiple Species

by Brian Powell

The Sonoran Desert Conservation Plan (SDCP) is an innovative and comprehensive strategy to preserve the biological diversity and cultural heritage of Pima County, Arizona, in response to unprecedented human population growth and its associated impacts (see www.pima.gov/sdcp). Pima County is now implementing the SDCP through a host of conservation measures, including development set-asides, purchase and lease of open space, and habitat restoration. The Pima County Multi-species Conservation Plan (MSCP) is an important component of the SDCP. It will ensure that development-related activities comply with the Endangered Species Act (ESA) through issuance of a section 10 "incidental take" permit from the U.S. Fish and Wildlife Service. The Pima County MSCP currently includes coverage for 36 "Priority Vulnerable Species" (PVS): 4 species of plants, 8 mammals, 8 birds, 7 reptiles, 6 fishes, 2 amphibians, and 1 invertebrate. To complete the MSCP package, Pima County is developing a monitoring program.

The Pima pineapple cactus (*Coryphantha scheeri *var.* robustispina*) is an endangered plant native to Pima and Santa Cruz counties in southern Arizona and to northern Sonora, Mexico.

Lorena B. Moore, www.mineralarts.com

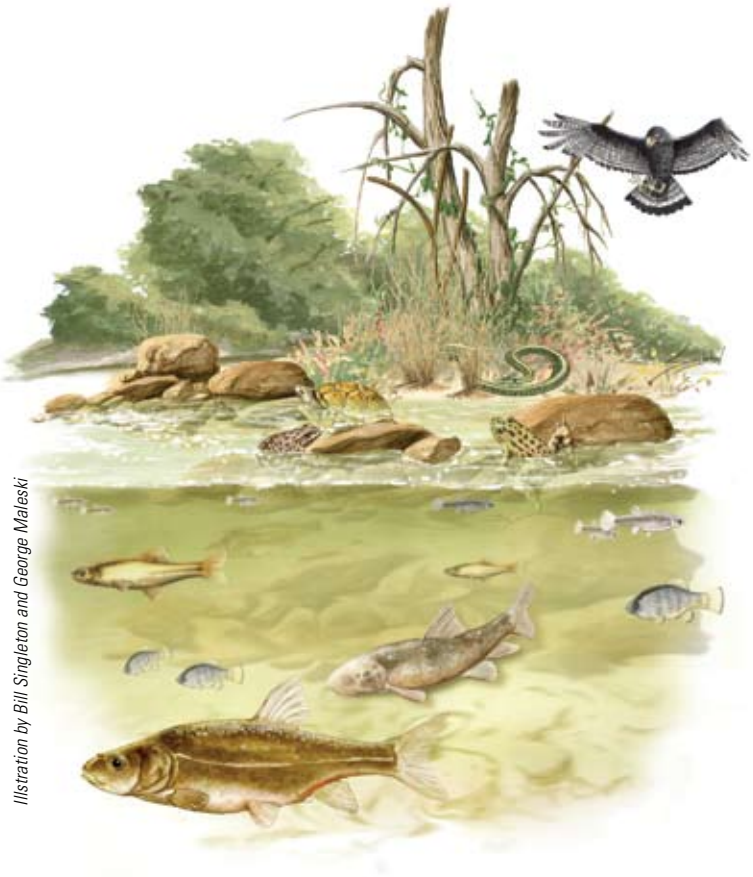
Monitoring for Conservation

Ecological monitoring is one of the most challenging endeavors in ecology and natural resource management. Single-species monitoring can be expensive, and the number and breadth of species covered under most MSCPs, like that being developed for Pima County, creates a financial burden if the goal is to effectively track populations over time. While some efficiency can be gained by monitoring multiple species using similar field methods and employing prudent sampling design elements (see Elzinga et al. 2001), costs can still remain prohibitive, particularly because many vertebrate species covered under MSCP plans are rare and secretive. This expense can lead to increased program costs because of the extra level of survey work needed to estimate population and/or occupancy for these rare species. In addition to cost, monitoring for dozens of species has been problematic from the perspective of adaptive management, in part because causes of observed

population changes are often unknown or ambiguous or, in the case of migratory species, the result of conditions outside the control of a local manager. The high cost and management challenges posed by monitoring multiple species require a new approach for MSCP monitoring in Pima County.

A major focus of the approach being advocated for the Pima County MSCP involves monitoring a broad suite of biotic and abiotic indicators (environmental characteristics) that are known to influence biodiversity over large landscapes. Indicators include climate (temperature and precipitation), vegetation structure and condition, water quality and quantity, and landscape patterns (e.g., land use and fragmentation). Monitoring a select group of these indicators, along with targeted monitoring of threatened and endangered species, will form the foundation of the Pima County program.

Thanks in part to an ESA-section 6 grant from the Service, a design team from Pima County and the University of Arizona will identify the biotic and abiotic indicators that hold the most promise for inclusion into the program. By taking an integrated approach to monitoring—as opposed to a species-level approach—Pima County should have the best chances of detecting and responding to environmental changes resulting from a broad range of stressors at many ecological scales. When compared to monitoring all proposed PVS, this approach will also lead to greater cost efficiency.



Illstration by Bill Singleton and George Maleski

An important focus of the Sonoran Desert Conservation Plan is the protection and restoration of aquatic and riparian systems.

A key design component of this monitoring approach will be to link the habitat needs of PVS to those broader indicators of environmental conditions through development of conceptual models. These linkages are critical to ensure the Service's acceptance of the monitoring plan.

We plan to explore monitoring partnerships with a host of entities in Pima County that are either actively monitoring or engaged in the planning process. We are fortunate to have a number of outstanding partners for this endeavor, such as the National Park Service's Inventory and Monitoring Program, the Bureau of Land Management, Sonoran Institute, and the Nature Conservancy of Arizona. There are many advantages to realizing these partnerships, including shared administrative and field costs and educational and outreach opportunities. In addition, monitoring both on and outside of Pima County lands will put our county's management activities into a broader landscape-level context, thereby better gauging compliance with the terms of the ESA-section 10 permit.

Aaron Flesch

Comprehensive planning for balancing growth and conservation in Pima County began with the listing of the cactus ferruginous pygmy owl (Glaucidium brasilianum cactorum) in 1997. The owl has since been delisted but the conservation plan is moving forward.

Reference

Elzinga, C. L., D. W. Salzer, J. W. Willoughby, and J. P. Gibbs. 2001. Monitoring plant and animal populations. Blackwell Science Inc., Malden, MA. 360 p.

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Refuges Help Recover Rare California Species

National wildlife refuges in California are playing a pivotal role in moving listed species towards recovery. Their contributions focus on restoring and protecting vital wildlife habitats. While many people are aware of the role that the Hopper Mountain NWR Complex has played in the comeback of the California condor (*Gymnogyps californianus*), here are some examples of lesser known recovery activities on California refuges:

Least Bell's Vireo

In 2005, a riparian woodland restoration site on the San Joaquin River NWR attracted some surprise visitors: a nesting pair of endangered least Bell's vireos (*Vireo bellii pusillus*). These birds once were common from Red Bluff southward throughout the Central Valley and into Baja California, Mexico, but widespread loss of riparian habitat led to their decline and eventual disappearance from the area. The last confirmed breeding

Bell's vireo nestlings

Ken Griggs/USFWS

Jon Katz and Meghan Gilbart

A female valley elderberry longhorn beetle.

in the Valley was in 1919, and by the 1940s the bird was no longer detected there at all. This made the 2005 nesting an historic event. The return of a bird long absent from the Valley symbolized the importance of riparian woodland restoration on the refuge. Vireos nested again in 2006 and 2007. Known to exhibit high faithfulness to breeding sites (philopatry), the birds have nested in arroyo willows near the previous years' nest sites. Refuge biologists are carefully monitoring the nests and hope that young birds hatched on the refuge will return to breed.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) was once thought to be restricted to a mere three river drainages in California. After the Service listed this species as endangered, it protected and restored a substantial amount riparian habitat, especially at the Sacramento NWR Complex. As of June 2007, the refuge, The Nature Conservancy, and River Partners (an organization founded by conservation-minded farmers) had planted 117,235 blue elderberry (*Sambucus mexicana*) bushes, which are vital to the beetle, on 4,814 acres (1,948 hectares) of riparian and floodplain habitat. This effort, along with the work of other partners and the discovery of additional beetle populations, may soon lead to delisting the beetle as a recovered species.

A Mouse Relocated

The salt marsh harvest mouse (*Reithrodontomys raviventris*) is an endangered species endemic to pickleweed-dominated habitat along the fringes of tidal marshes of the San Francisco Bay estuary. Over 80 percent of the marsh habitat around the estuary has been modified or destroyed. Protection of the remaining habitat, along with salt marsh restoration and enhancement, are vital to the species' recovery. The efforts of many public and private groups in the Bay area have led to noticeable gains in habitat conservation for the mouse and other wildlife.

One step in the mouse's road to recovery involved a parcel on the Don Edwards San Francisco Bay NWR. Refuge specialists converted acquired agricultural land into salt marsh wetlands covered with pickleweed. With the habitat restored, they translocated salt marsh harvest mice from an off-refuge parcel that was being lost to development. After two years, the numbers of mice are remarkable, but some things just don't show up in the cold hard numbers, such as the several male-female pairs of harvest mice captured in the same trap. (Without going into the scandalous details, let's just say that the biologists nicknamed trap D-22 the "Honeymoon Suite.") The efforts of the refuge biologists and, yes, the mice appear to be successful. Not only are the translocated mice doing well, but the restored habitats are also being recolonized naturally, bringing recovery of the salt marsh harvest mouse another step closer.

Vernal Pools

Many refuges within the San Luis, San Francisco Bay, and Sacramento NWR complexes contain special wetlands called vernal pools. These are seasonally flooded depressions in impermeable soils that hold winter rainwater until evaporation. The pools are home to specialized plants and animals adapted to this wet/dry regime. As the pools dry over summer months, concentric rings of colorful flowers grow in halos around the water edges. These self-contained ecosystems are home to several listed species, including California tiger salamanders (*Ambystoma californiense*), vernal pool tadpole shrimp (*Lepidurus packardi*), vernal pool fairy shrimp (*Branchinecta lynchi*), and plants such as the palmate-bracted bird's-beak (*Cordylantus palmatus*). In addition to restoring the natural hydrology of the pools, Refuge staff control harmful invasive species by using prescribed fire, carefully-monitored herbicide applications, and selective grazing

programs. These management actions are contributing to the recovery of the listed species that live in the unique vernal pool ecosystems.

Light-footed Clapper Rail

Much of the recent success towards the recovery of the endangered light-footed clapper rail (*Rallus longirostris levipes*) is due to determined efforts of the San Diego Bay NWR, Carlsbad Fish and Wildlife Office, California Department of Fish and Game, U.S. Navy, Chula Vista Nature Center, SeaWorld-San Diego, San Diego Wild Animal Park, Port of San Diego, local scientists, and volunteers. Although the species is not out of danger, the rail's population has risen from just 142 pairs in 14 coastal marshes in southern California in 1984 to approximately 408 pairs in 18 marshes. The development of a captive breeding program and translocation of birds to marshes along the southern California coastline were significant steps in the rail's restoration. The San Diego Bay NWR is pivotal to this program by providing a location in which young fledglings are acclimated before translocation to receptor marshes.

Diane Elam (telephone 916-414-6464), Deputy Chief of Listing, Recovery and HCPs for the Service's Region 8 Office in Sacramento, compiled these examples contributed by NWR staff in California.

(top): California tiger salamander
(center): Light-footed clapper rail
(bottom): Riverside fairy shrimp
(left): Salt marsh harvest mouse
All photos © Moose Peterson/WRP

by Ken Burton

Good News for the Amur Tiger

In a world where many animals are under siege, the Amur tiger (*Panthera tigris altaica*) – better known in the West as the Siberian tiger – offers an encouraging message: the population of this huge cat is showing signs of recovery.

During the past 100 years, the Amur tiger population of the Russian Far East was decimated by forest destruction, trophy hunting, and poaching for tiger body parts to use in traditional Asian medicine. By the 1940s, its numbers had dwindled to an estimated 50 tigers. But thanks in part to $611,131 in U.S. Fish and Wildlife Service grants that, combined with partner donations and in-kind contributions, push the total to more than $1 million, the big, distinctive cats appear to be rebounding in Russia.

Recent surveys indicate that 331 to 370 adult tigers and 100 young are living in the Russian Far East, which is home to 95 percent of all Amur tigers in the world.

Service wildlife biologist Fred Bagley, long associated with Amur tiger conservation efforts, says a spike in tiger poaching in the early 1990s was subsequently met by a Russian government crackdown, and the intensified anti-poaching efforts have paid off.

Some estimates place the global tiger population in the 3,900 to 5,100 range, down from perhaps 100,000 more than 100 years ago. The Amur tiger is one of five remaining tiger subspecies in the world. Eight subspecies once roamed the earth, but three became extinct in the 20th century. While most Amur tigers live today in the Russian Far East, a much smaller number are known to inhabit China, and a few may occur in North Korea.

The demand for tiger parts for use in traditional Asian medicine has played a major role in the decline of the Amur tiger population. Despite medical evidence to the contrary, belief persists that tiger parts can curb ailments ranging from impotence to arthritis, skin disease, fever, and more.

During the last period of heightened poaching, Russian conservation workers estimated that as many as 60 tigers were killed each year. But the Amur tigers' situation has shown marked improvement. Local government in the Russian Far East, says Bagley, is committed to helping rescue the tigers, and the Service has remained a firm partner in the effort. Service grants have helped pay for vehicles, uniforms, fuel, and even salaries for Russian game wardens who have had success in deterring poachers. It's a relationship that has had positive results. "It's hard to find another place in the world where tigers are doing as well," Bagley says.

Left alone in the wild, the tigers do well. Amur tigers breed easily, and even though the number of young in the current decade has given cause for some concern, the number of cubs born to each litter has increased slightly, granting some stability to the gradual population increase.

Amur tigers, which can weigh up to 600 pounds (270 kilograms) at maturity, are loners that travel enormous distances in search of prey such as elk and wild boar. While some of the tigers have been known to attack humans, they usually prefer to avoid people. The tigers have been known to kill wolves that venture into their territory.

A remaining threat to the tiger is Russia's own healthy economy. Wildlife law enforcement jobs in the Russian Far East don't pay well, and even the most dedicated Russian game wardens are often easily lured elsewhere by better pay, making it difficult to keep trained personnel on the job.

"In the scheme of international grants, the amount of money we've contributed to this effort has been relatively modest," says Bagley. "But there is no doubt that we've had an impact. This is one of those times when you can point to something and say, yes, we're making a real difference. Applied research, habitat protection, effective law enforcement and the support of local people made possible through conservation education, are advancing the survival of this tiger."

Ken Burton is a public affairs specialist in the Service's Arlington, Virginia, headquarters office.

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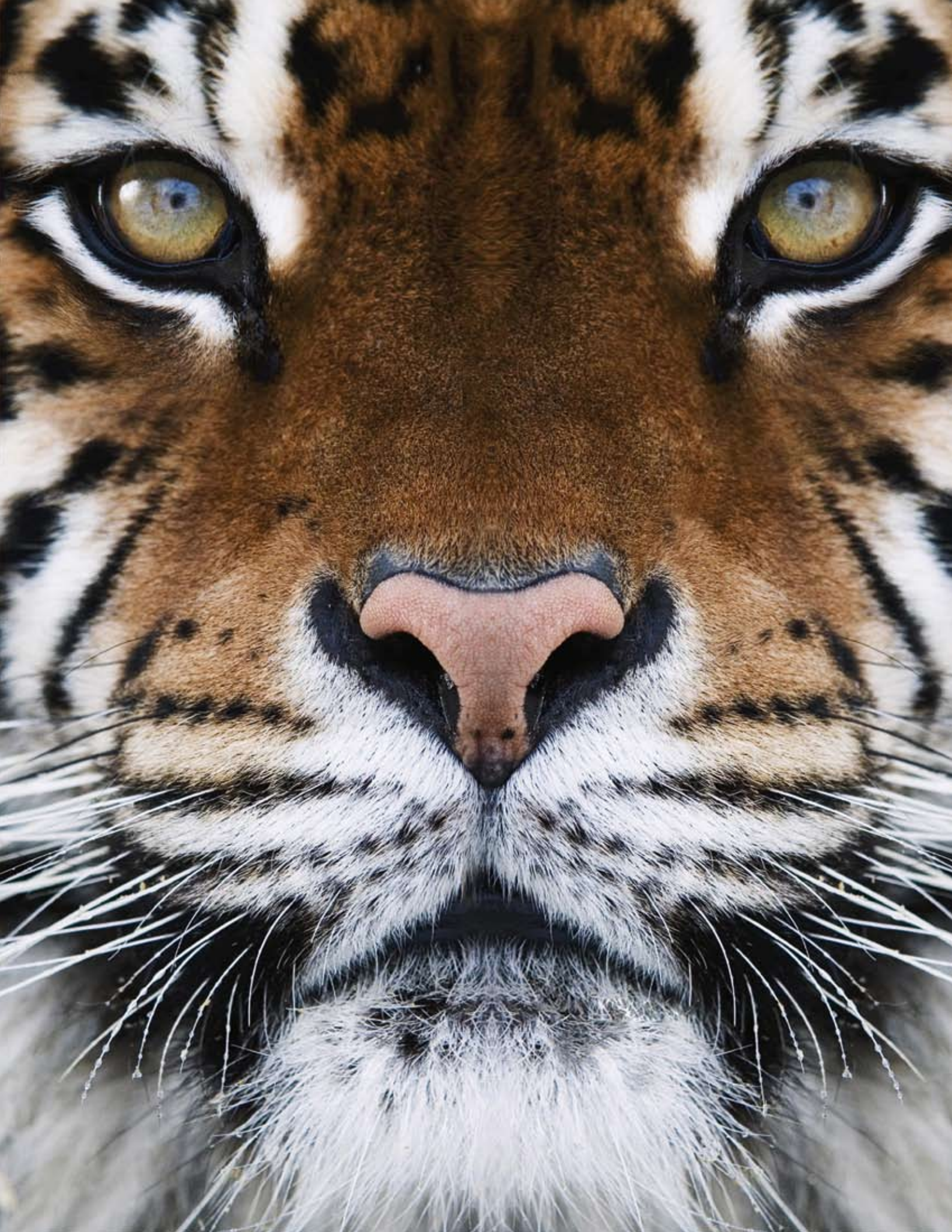

Translocation and Disease Monitoring of Wild Laysan Ducks

by Michelle H. Reynolds
and Thierry M. Work

James H. Breeden, Jr.

Female Laysan duck with ducklings at Midway Atoll.

The Laysan duck (*Anas laysanensis*), also known as the Laysan teal because of its small size, is a critically endangered waterfowl species that once occurred widely across the Hawaiian Archipelago. For the past 150 years, however, it was restricted to a single population on Laysan, a 4-square-kilometer (1.5-square-mile) island with a hypersaline shallow lake. Laysan is part of the Hawaiian Islands National Wildlife Refuge in Papahanaumokuakea Marine National Monument.

Evidence suggests that the Laysan duck's disappearance from the rest of the Hawaiian Islands was partly due to the introduction of predatory non-native rats during human colonization of the Hawaiian Islands about 1,000 years ago. Rats never became established on Laysan Island. However, in the 1800s, people who came to Laysan to harvest guano introduced rabbits that largely denuded the island's native vegetation and led to the extinction of several native species, including the Laysan rail (*Porzana palmeri*) and Laysan millerbird (*Acrocephalus familiaris familiaris*). Fortunately, Laysan ducks survived this onslaught, and subsequently the rabbits were extirpated from the island in the early 1900s.

Small, isolated island populations have high extinction risks. On Laysan, numbers of the duck fluctuate and have seldom exceeded 600 individuals. The Laysan duck is vulnerable to extreme weather, diseases, introduction of mammalian predators, and global sea level

USGS Translocation Project leader, Michelle Reynolds, USGS Biotech James Breeden, and USFWS Assistant Refuge Manager, Matt Brown, band a juvenile fledgling Laysan duck at Midway Atoll NWR.

PEter Leary

rise. In 1993 and 1994, there was a large die-off of Laysan ducks attributed to emaciation and infestation with a worm, *Echnuria uncinata*. Recognizing that the Laysan duck was highly vulnerable to extinction, the U.S. Fish and Wildlife Service (FWS) and U.S. Geological Survey (USGS) developed a partnership to translocate these ducks to Midway Atoll National Wildlife Refuge. After careful consideration, the agencies chose Midway Atoll because they judged that is has the most promising logistical feasibility and potential to support translocated ducks. The translocation was a team effort led by the USGS Pacific Islands Ecosystem Science Center and involving the collaboration of the USGS National Wildlife Health Center-Honolulu Field Station and the FWS. The team took great care not to translocate the internal parasite, *Echinuria,* via Laysan ducks to Midway Atoll, where it has not been documented.

To maximize the chances for success, we chose the healthiest candidates for translocation. Biologists with the project trapped the ducks on Laysan, gave the birds a complete physical exam, and treated them for *Echinuria* worms prior to transport. In October 2004, 20 juvenile and pre-breeding island ducks went on a 2- day, 600-km (370-mile) Pacific voyage by boat from Laysan to Midway Atoll (USGS 2005). In October 2005, an additional 22 ducks made the same trip. All birds survived the translocation with nutritional and veterinary support.

Understanding mortality factors and occurrence of disease is important in managing threatened and endangered species. Post-release monitoring with the aid of radio telemetry helped us determine the fate of the translocated birds and monitor their health during October 2004-2007. Identifying the causes of mortality and disease allows for exploration of management options to address the problems and enhance recovery of the species. The refuge staff sent all carcasses suitable for examination to the USGS National Wildlife Health Center-Honolulu Field Station for complete examination to determine cause of death. In other cases, suspected causes of death were apparent from field signs.

Cindy Rehkemper/USFWS

During the 2005 translocaton of Laysan ducks to Midway Atoll, Therry M. Work and Annie Marshall give one of the birds some nutritional support and a physical exam.

To date, the identified causes of Laysan duck mortality on Midway are varied. Causes of duck mortality on Midway have included egg-bound females, trauma, yolk sac infection, emaciation, and botulism. Field evidence also suggests mortality from attacks by large seabirds and vagrant birds of prey. Fortunately, we have yet to document the presence of *Echnuria* on Midway, although biologists continue to monitor for the disease. Avian pox lesions spread by introduced mosquitoes on Midway Atoll are common in the native Laysan albatross (*Phoebastria immutabilis*) but have not been observed in the ducks, probably because the virus that causes pox is specific to particular types of birds. All mortalities observed in Laysan ducks on Midway are similar to those in any wild waterfowl population.

Despite these mortality incidents, the Laysan duck continues to flourish on Midway Atoll, and the population has increased after only three breeding seasons. Juvenile recruitment has exceeded adult mortality during the first three breeding seasons, and number of eggs laid per female on Midway is higher than of those on Laysan. This reflects the suitability of Midway's habitat for Laysan ducks. Furthermore, the translocation has established a second population of the species and more than doubled its range from four to nine square km (1.5 to 3.5 square miles). All of the 42 founding birds survived the transport to Midway and 90 percent survived their first year post-release, similar to the survival rate on Laysan Island. The ducks bred successfully after the first

James H. Breeden, Jr.

Table. Annual maximum population sizes of the Laysan duck at Midway Atoll National Wildlife Refuge. Post-fledglings include adults and independent, flighted juveniles.

Year	Founders Translocated From Laysan Island	Maximum Potentially Breeding Adult Females	Maximum Post-Fledgling Population Size Midway Atoll
2003	0	0	0
2004	20	0	20
2005	22	6	51
2006	0	18	104
2007	0	49	~192*

* Preliminary count: maximum possible adults surviving from 2006 and total marked juveniles by Oct. 2007.

year of release, and they produced the first generation of fledglings in 2005. On Laysan, one-year-old ducks typically do not successfully breed, so the productive first year at Midway Atoll was a pleasant surprise. The total population size of Laysan ducks on Midway has grown from the original 42 translocated birds to an approximate count of at least 192 post-fledgling juveniles and adults (see Table). Interestingly, we placed the ducks translocated to Midway Atoll onto its two islands (Eastern and Sand), and ducks now routinely fly between the islands. On Laysan, the ducks rarely fly over the ocean.

This story is an example of what can happen when agencies and people work together toward a common goal. In this case, the clear winner is the Laysan duck, whose risks of extinction are less today than three years ago. Depending on habitat suitability and absence of mammalian predators, future translocations may take place on other islands, thus making the future of this endangered species a bit less uncertain with each additional reintroduction. A visitor services program to Midway Atoll NWR is beginning this year (Barry Christenson, FWS Midway Atoll Refuge Manager, personal communication; www.fws.gov/midway/VSP /MidwayVSPindex.html), allowing visitors to see Laysan ducks in the wild during their non-breeding season (October to March). The Laysan duck translocation team was honored with the FWS Recovery Leader Award in 2007 for achieving a milestone toward the species' recovery (see http://www.fws.gov/pacific/ecoservices/ endangered/recovery/LaysanDuckTeam.htm).

Acknowledgements

This is an interagency project. Funding was raised through public and non-profit grants from the National Fish and Wildlife Foundation, USGS Quick Response Program, Friends of Midway Atoll, FWS Pacific Islands Ecological Services, and USGS Pacific Island Ecosystems Research Center. The USGS Pacific Island Ecosystems Research Center, USGS National Wildlife Health Lab, Midway Atoll NWR, Hawaiian Islands NWR, National Oceanic and Atmospheric Administration, the Wildfowl and Wetland Trust, and the FWS Honolulu Ecological Services Office provided staff, volunteer, and logistical support.

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http://www.fws.gov/endangered

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BOX SCORE

Listings and Recovery Plans as of March 19, 2008

GROUP	ENDANGERED U.S.	ENDANGERED FOREIGN	THREATENED U.S.	THREATENED FOREIGN	TOTAL LISTINGS	U.S. SPECIES W/ PLANS
MAMMALS	69	256	12	20	357	56
BIRDS	75	179	14	6	274	85
REPTILES	13	66	24	16	119	38
AMPHIBIANS	13	8	10	1	32	17
FISHES	74	11	65	1	151	101
SNAILS	64	1	11	0	76	69
CLAMS	62	2	8	0	72	70
CRUSTACEANS	19	0	3	0	22	18
INSECTS	47	4	10	0	61	35
ARACHNIDS	12	0	0	0	12	6
CORALS	0	0	2	0	2	0
ANIMAL SUBTOTAL	448	527	159	44	1,178	495
FLOWERING PLANTS	570	1	143	0	714	630
CONIFERS	2	0	1	2	5	3
FERNS AND OTHERS	26	0	2	0	28	28
PLANT SUBTOTAL	598	1	146	2	747	661
GRAND TOTAL	1,046	528	305	46	1,925*	1,156

TOTAL U.S. ENDANGERED: 1,046 (448 animals, 598 plants)
TOTAL U.S. THREATENED: 305 (159 animals, 146 plants)
TOTAL U.S. LISTED: 1,351 (607 animals**, 744 plants)

* Separate populations of a species listed both as Endangered and Threatened are tallied once, for the endangered population only. Those species are the argali, chimpanzee, leopard, Stellar sea-lion, gray wolf, piping plover, roseate tern, green sea turtle, saltwater crocodile, and olive ridley sea turtle. For the purposes of the Endangered Species Act, the term "species" can mean a species, subspecies, or distinct vertebrate population. Several entries also represent entire genera or even families.

** Eleven U.S. animal species and five foreign species have dual status.

ENDANGERED Species BULLETIN

U.S. Department of the Interior
Fish and Wildlife Service
Washington, D.C. 20240

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