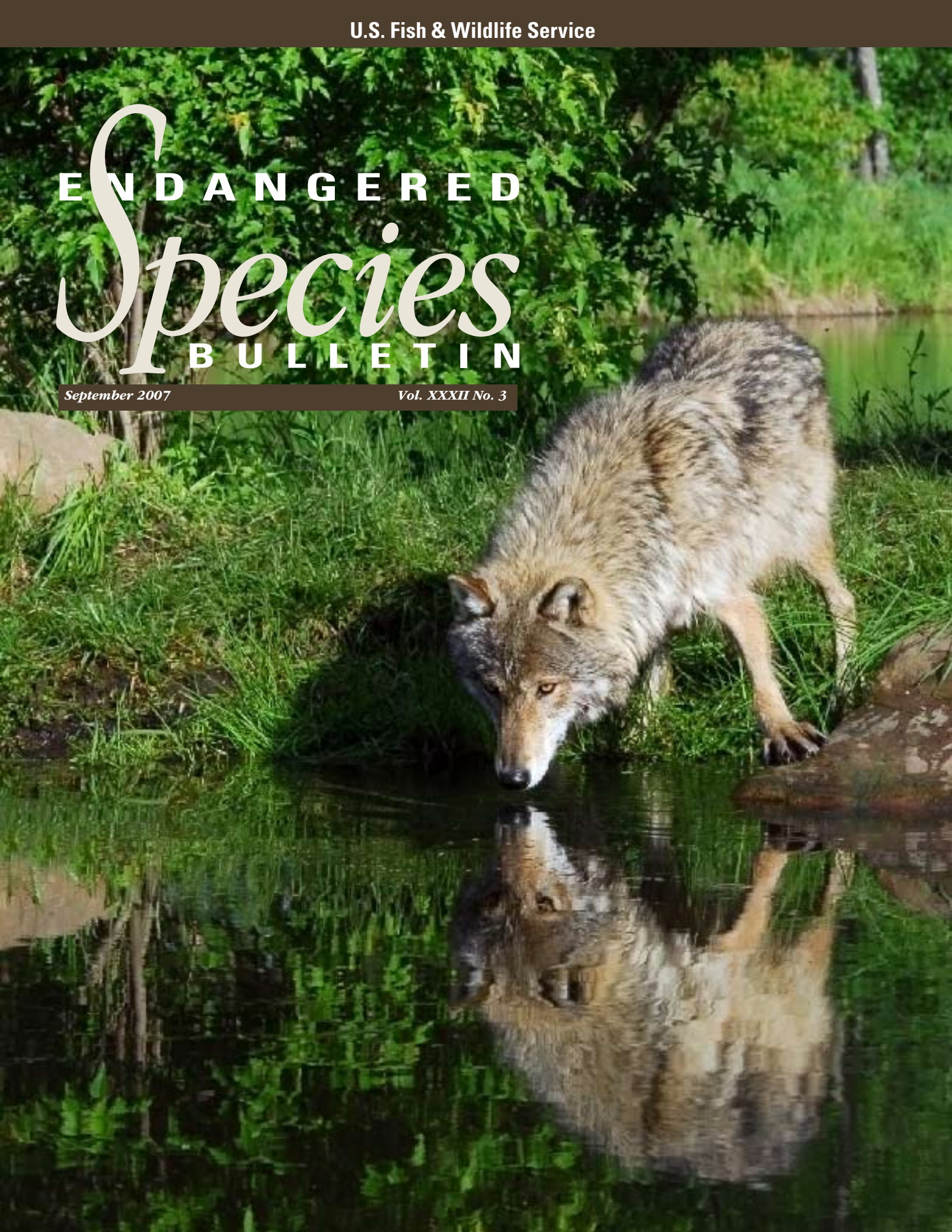



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A bald eagle is perched on the shoulder of a man in a light green shirt. The eagle has a white head and neck, a yellow beak, and dark brown feathers on its body. In the background, an American flag is visible on the left, and a crowd of people, including a young girl in a Girl Scout vest, is seen. The scene is outdoors, likely at a public ceremony.

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

A gray wolf in Minnesota pauses for a drink. The Western Great Lakes population of the gray wolf is now recovered.

©Mike Lentz

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 an on-line publication. Three electronic editions are posted each year at www.fws.gov/angered/bulletin.html, and one print edition of highlights will be 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 activities and conservation partnerships. 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.

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. juris-

diction. 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

Eggert's sunflower



Brad Bingham

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 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."

Krishna Gifford is a biologist with the Washington Office Endangered Species Program, Branch of Recovery and Delisting and can be reached at krishna_gifford@fws.gov.



Olympic National Park

(top): Northern flying squirrel
(below): Gray wolf



William C. Campbell

by Jeannie Stafford

Partnerships Can Conserve Species and a Way of Life



Railroad Valley springfish
© Joseph Tomelleri

Creating partnerships that conserve wildlife as well as economic and social values can be a challenge. Prior to 2002, we lacked a partnership between the Duckwater Shoshone Tribe of Nevada and the Fish and Wildlife Service's Nevada Fish and Wildlife Office. When the Tribe constructed a catfish farm at Big Warm Springs within designated critical habitat of a threatened fish species, it was a matter of significant concern to the Service. But taking a cooperative approach to this issue brought benefits to the Service, the Tribe, and the rare fish.

The Duckwater Shoshone Reservation is an isolated rural reservation that contains the largest thermal spring in Nevada. The reservation has 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 the

most important habitat for the threatened Railroad Valley springfish (*Crenichthys nevadae*).

The 3,850-acre (1,558- hectare) reservation is home to about 150 residents, and their principle land use is agriculture. An irrigation system fed by the spring provides water for alfalfa, broom grass, and grain. The earliest farming on the reservation made use of free-flowing water, or open irrigation.

In 2002, the Tribe granted the Service'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 Service 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 Service not only negotiated an agreement with the Tribe but also

(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



brought funding, other partners, and technical support to the table. In 2004, 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 Warm Spring.

In late 2004, negotiations to decommission the catfish farm and remove all aquacultural facilities were complete. Restoration of the spring system was designed not only to restore the stream channels and 68 acres (28 hectares) 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.

To prepare for reintroduction of the Railroad Valley springfish into designated critical habitat, the Nevada Department of Wildlife, Natural Resources Conservation Service, U.S. Geological Survey's Biological Resources and Water Resources divisions, and the Service treated the spring, removing all non-native fishes. A Safe Harbor Agreement, only the second agreement of this type with a Tribe, was signed September 26,



(left to right): Rick Poore of Streamwise Consulting; Bridget Nielsen, USFWS, Partners for Fish and Wildlife Biologist; Jerry Millett, Tribal Manager; Annette George, Environmental Coordinator; Virginia Sanchez, Grant Writer; and Mitch Maes, Resident Historian.

2007, allowing the continued use of the irrigation system and cattle grazing, and promoting the implementation of actions identified in the species' recovery plan. About 400 Railroad Valley springfish were reintroduced back into their historic habitat the same day.

This strong partnership and a willingness to come to the table will assist in the recovery of one of Nevada's threatened species and, at the same time, preserve the Tribe's traditional way of life. A quote from Tribal Chairman Jerry Millett

earlier this year sums up the species recovery 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 project 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."

Jeannie Stafford, public affairs officer with the Service's Nevada Fish and Wildlife Office, can be contacted at jeannie_stafford@fws.gov; 775-861-6300.



Restored waterfall at Duckwater Bluff

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 recent discovery of three active nests in Wisconsin.

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 singing males have 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. To protect the site from disturbance,

the Service is not disclosing its precise location.

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



Ron Austing



Prior to this year's historic nesting in Wisconsin, 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.

Rachel Levin, a public affairs specialist with the Service's Midwest Regional Office in Fort Snelling, Minnesota, can be reached by telephone at 612-713-5311 or by email at Rachel_levin@fws.gov. Joel Trick, a wildlife biologist in the Service's Green Bay (Wisconsin) ES Field Office, is available at 920-866-1737 or Joel_trick@fws.gov. Mike DeCapita, a wildlife biologist in the Service's East Lansing (Michigan) ES Field Office, can be contacted at 517-351-6274 or Mike_DeCapita@fws.gov.

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.

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.



Laurissa Hamilton

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.

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.

“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.

Elaine York (801-238-2320, eyork@tnc.org) is the West Desert Regional Director for The Nature Conservancy in Salt Lake City, Utah.

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



John Milliken

by Nathan Allan and
Jennifer Gumm

New Hope for the Leon Springs Pupfish

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.

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

Female (left) and male Leon Springs pupfish



Braz Walker

chemical and mechanical means before pure Leon Springs pupfish were repatriated 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



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

“dear enemy recognition.” This is where territorial males show less aggression to familiar neighbors than to strangers.

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.

Nathan Allan (nathan_allan@fws.gov; 512/490-0057 x237) is a fishery biologist in the Service’s Austin, Texas, Ecological Services Field Office. Jennifer Gumm (jmg404@Lehigh.edu), a student at Lehigh University, recently completed a work assignment at the Dexter NFHTC.

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 usdagalum*) 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 recov-



Joey Fagan, Virginia Department of Conservation and Recreation

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

ery. 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.

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.

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by Mike Martinez and
Dan Cox

Cooperative Conservation for the Page Springsnail

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.

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Tom Gatz

Biologists examining Page springsnail habitat

A Rare Plant Returns to San Francisco Bay

by Valary Bloom



Margo Bars

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!

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by Karen Cathey

Restoring Whooping Crane Habitat in Texas

As the warm Texas sun rises, a tall, white bird seems to glow in the sunlight as he moves slowly through the marsh, taking each step with a choreographed grace. He stops, slowly dropping his foot back to the muddy bottom, and opens his wings slightly, as if to shade the water and marsh grasses below, exposing the black tips of his wings. His long, sinuous neck turns his red-blazoned head to one side, searching the thick

reeds. Suddenly, like a bolt of lightning, his head shoots down, and then lifts to reveal his prize—a blue crab—in the tip of his strong, tapered beak. Raising his beak high, he drops the crab into his mouth. Then he spreads his great wings and, with ponderous strokes, lifts just high enough to glide several hundred yards before dropping again near his lifetime mate, who is feeding nearby.

This whooping crane (*Grus americana*) is one of 237 that visited the Texas Coast last winter. Standing nearly 5 feet (1.5 meters) tall, with a wingspan over a whopping 7 feet (2.3 m), the endangered birds return to the coast every year in search of habitat to sustain them before they head back north to their breeding grounds.

Our crane represents a species that was once found throughout Midwestern America. In 1860, the wild population was estimated to be around 1,400 birds, but by 1941 the migrating population had dropped to a mere 16 birds. The Texas wild whooping crane flock summers in Wood Buffalo National Park in Canada, where the birds nest and rear their young. During their fall migration, the birds travel an astounding 2,400 miles (3,860 kilometers) south to spend winter and early spring at the Aransas National Wildlife Refuge, located along the central Texas coast. While hazards such as power line collisions and predators have certainly taken their toll, the main cause of the population drop has been the loss or degradation of its habitat.



Ryan Haggerty



Alcoa-created marsh that will become part of the Aransas NWR complex.

The Fish and Wildlife Service's Corpus Christi Ecological Services Field Office in Texas is seeking to restore and preserve the crane's vital estuarine habitat. Its most recent success was made possible through a cooperative assessment by state and federal trustees and Alcoa (Aluminum Company of America) of natural resource damage caused by the release of contaminants from Alcoa's Point Comfort facility. Mercury and polycyclic aromatic hydrocarbons from this facility damaged wildlife and other natural resources in Lavaca Bay, and the parties recognized the need for compensatory restoration projects.

Alcoa, acknowledging responsibility to the surrounding Lavaca Bay neighbors, entered into a cooperative agreement to restore losses to wildlife populations, groundwater, and surface water resulting from the releases of contaminants. As part of the settlement, a restoration plan developed by the trustees established goals to compensate for the injured natural resources and the lost recreational use of those resources. In this case, the trustees are the Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and three state agencies,

the Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, and Texas General Land Office.

To fulfill the restoration goal, Alcoa created 11 acres (4.5 hectares) of oyster reef in Lavaca Bay to replenish shellfish losses, built three fishing piers, and improved three existing boat ramps around Lavaca Bay to restore lost recreational fishing opportunities. For the endangered whooping crane, it also acquired a 729-acre (295-ha) tract of coastal prairie and wetlands that will

Restored whooping crane habitat.



Kenneth Rice

become part of the Aransas National Wildlife Refuge complex. Included within this acreage are 70 acres (28 ha) of newly created estuarine marsh.

The marsh itself is a marvel of construction. It was built as a matrix of open water ovals and circles, connected by gracefully winding channels that will allow tides to naturally ebb and flow throughout the site. Benthic organisms (plants and animals that live in the top few inches of the ocean's bottom), crustaceans, and fishes common to marsh habitats are already colonizing the area. From the air, the marsh will soon appear as a precious gem, as the blue Gulf of Mexico water mixes with the emerald green of the marsh grasses.

On March 28, 2007, Alcoa joined the trustees in a public celebration of the successful restoration efforts. The celebration culminated in a visit to the marsh restoration site, where Alcoa project managers proudly discussed their approaches to the project. The trustees eagerly await confirmation, which may come next winter, that whooping cranes have begun to use the restoration site.

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by Jim Haas, Jay Bigelow,
and Lisa Heki

Contaminants in Unexpected Places

*F*ish hatcheries are an important tool in the Fish and Wildlife Service's efforts to restore threatened and endangered aquatic species. Unfortunately, these facilities sometimes face the same contaminant risks encountered by commercial hatcheries. When such issues are identified, the Service's Division of Environmental Quality and its environmental contaminants specialists—who have expertise in sampling and analytical methods, ecotoxicology, and risk assessment—are uniquely poised to help.

Concern over potential contaminants in fish raised at Service hatcheries and released for recreational fisheries arose in 2004, when Dr. Ronald Hites of Indiana University and others reported in the

journal *Science* that farm-raised salmon sampled from locations in Europe and North and South America were higher in organochlorine contaminants than wild salmon from the same areas. Hites and his co-authors considered the primary source of exposure in these fish to be commercially-prepared fish feed.

At the time, the Service's Abernathy Fish Technology Center in Longview, Washington, was engaged with the U.S. Geological Survey's Biological Resources Division in a study of contaminants in fish feed at various hatcheries in the Service's Pacific Region. However, no data were then available to evaluate whether fish reared in Service hatcheries were affected to the same degree as commercially-reared salmon. Biologists in our Northeast Region hatcheries initiated a sampling program for contaminants in fish that could be given to states for recreational fishing programs. Service biologists in our Pacific and Mountain-Prairie regions also conducted smaller-scale sampling following the Northeast Region protocols.

The results of this limited program showed that most fish sampled had polychlorinated biphenyl (PCB) and dioxin/furan concentrations within the ranges that could trigger consumption advisories based on Environmental Protection Agency guidelines. The Lahontan National Fish Hatchery (NFH) in Nevada, which produces fish as part of the recovery program for the threatened Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), or LCT, was no exception. Composite samples of LCT from the 2002 and 2003 year classes that were

Contractors applying an environmentally safe coating in an LCT runway at Lahontan NFH.



CCC & Associates, Inc.



The threatened LCT is reared at Lahontan NFH.

submitted for chemical analysis showed concentrations of PCBs and furans that were noticeably higher than in the other Pacific Region samples.

Concern over both public health and the future of the LCT restoration program prompted action to identify and remove the sources of contamination from the hatchery. The possible sources we considered were 1) fish feed, 2) the well water that supplies the hatchery, and 3) components of the water recirculation system. Dioxin and furan compounds are often by-products of PCB formulation, and prior to 1977 many paints and plasticizers were formulated with PCBs to improve water and chemical resistance. Contaminated old paint and other PCB-containing compounds have been implicated at several state and commercial fish hatcheries in the recent past as sources of PCBs in fish.

In June of 2004, we began limited follow-up sampling at the Lahontan NFH of one-year-old LCT, fish feed, well and recirculated water, and paint from different surfaces to evaluate possible sources of contamination.

We found that fish feed samples contained PCBs and dioxin/furans; however, the concentrations were too low to account for the concentrations we observed in the fish. This result was subsequently supported by the Abernathy

study, which found organochlorine contaminants to be ubiquitous at low levels in a variety of commercial fish feeds. While concentrations of contaminants in fish feed remain a concern, a resolution of this problem is beyond our ability to control locally. A national effort is underway to address the issue with feed manufacturers and evaluate the risk to fish.

Our results also eliminated well water as a contaminant source; however, several paint samples were found to have PCB residues, so we focused attention on the water supply system at the hatchery. Working with the Service's Engineering Division during planned maintenance, we conducted additional sampling of paint, gaskets, and caulking used in the water circulation system and raceways to remove or seal possible sources of PCB contamination. At the same time, we evaluated the possible effects of various maintenance activities. We periodically sampled fish reared in fiberglass tanks with minimal exposure to the water distribution system and compared their PCB tissue concentrations to those of same-age fish that were reared in the raceways. As of this year, the maintenance activities (removal or sealing of contaminated paint, gaskets, and caulking) at the hatchery have resulted in lower concentrations of contaminants in LCT from the

raceways, bringing them more in line with the fish reared in fiberglass tanks and under the average levels across the Service. We consider the problem to be largely resolved.

Our experience at the Lahontan NFH underscores the importance of cross-program cooperation in the recovery of threatened and endangered species. While expertise in the biology and recovery of such species resides primarily within the Fisheries and Endangered Species programs, both the Division of Environmental Quality and the Division of Engineering can bring their specialized expertise to unexpected contaminant problems. This cross-program synergy makes the whole recovery effort stronger than the sum of its parts.

Reference:

Hites, R.A., J.A. Foran, D.O. Carpenter, M.C. Hamilton, B.A. Knuth, and S.J. Schwager. 2004. Global assessment of organic contaminants in farmed salmon. *Science* 303:226-229.

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Protecting and Restoring Marbled Murrelet Habitat

by Dolores Savignano,
Daniel Welsh, Judy Lantor,
Cindy Schexnider, and
Mike Szumski

The U.S. Fish and Wildlife Service's Environmental Contaminants (EC) Program is protecting approximately 6,000 acres (2,430 ha) of marbled murrelet habitat in California, Oregon, and Washington.

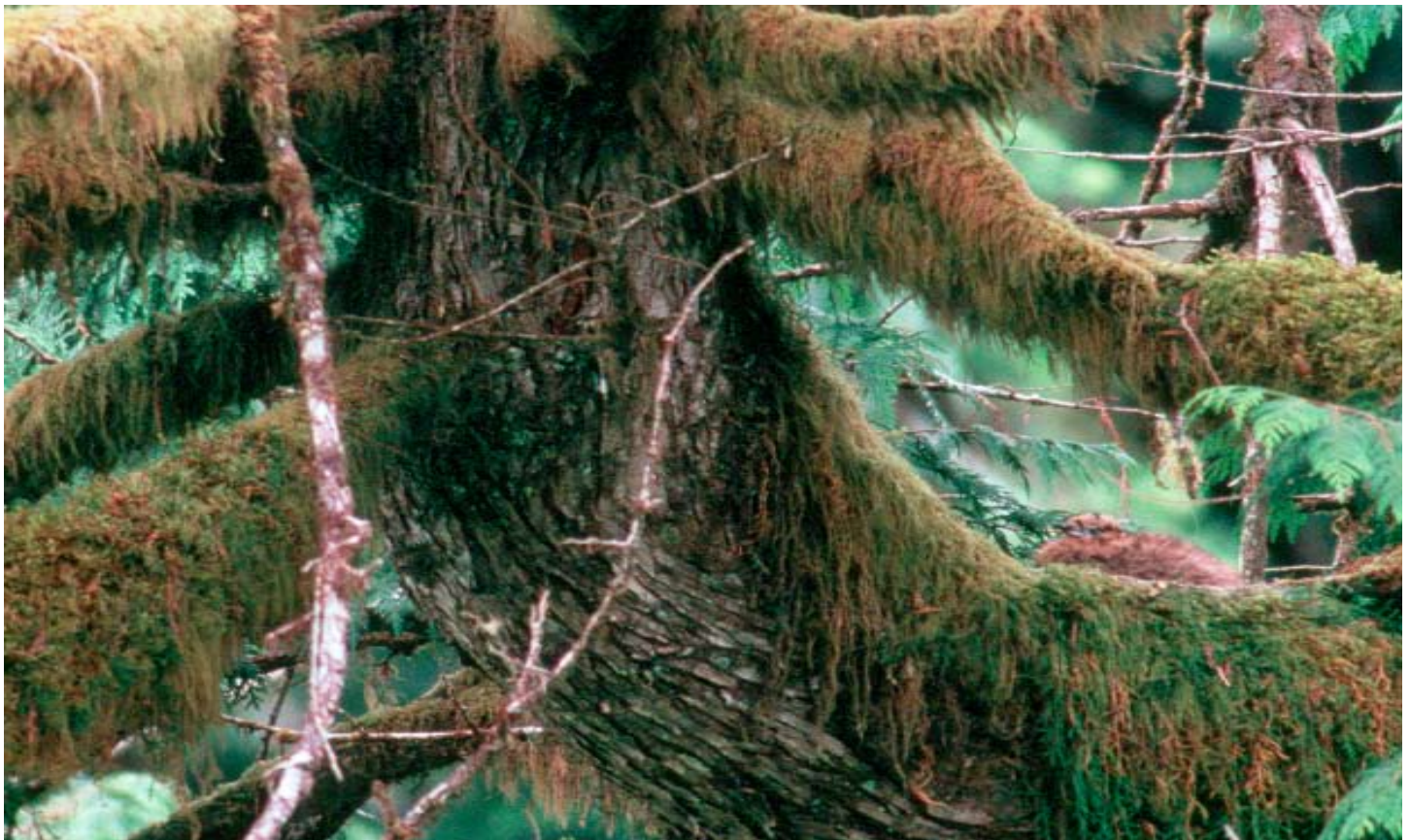
Working with state, federal, tribal and private partners, EC biologists have successfully settled numerous NRDAR cases and begun restoration projects that benefit murrelets and other species.

*E*ndangered species and other natural resources are all too often harmed or killed by oil spills. Under the Oil Pollution Act (OPA), Natural Resource Trustees can obtain restoration of injured natural resources from the parties responsible for the spill. Under the OPA, the Fish and Wildlife Service is a Trustee for endangered and threatened species, migratory birds, inter-jurisdictional fishes, certain marine mammals, and national wildlife refuges. Other federal and state agencies and tribes are Trustees for resources they manage. Using the

Natural Resource Damage Assessment and Restoration (NRDAR) process under OPA, the Trustees quantify the injuries to trust resources, and then, with public input, determine the appropriate restoration.

Since 1986, at least seven oil spills along the coasts of Washington, Oregon, and California have contaminated marbled murrelets (*Brachyramphus marmoratus marmoratus*). These birds forage for fish in coastal waters and reproduce in old growth forests. They do not build nests, but make a shallow depression in

marbled murrelet nesting



John and Karen Hollingsworth

the moss that grows on the large limbs of mature trees, where they lay a single egg. Marbled murrelets are about the size of a robin and have stout wings that are useful for “flying” underwater in search of food but are not as efficient for aerial flight. With the loss of old growth forest habitat in the Northwestern states, marbled murrelet numbers have declined steadily, and in 1992 the Service listed the population in California, Oregon, and Washington as threatened. Below are two examples of oil spills in which portions of the NRDAR settlements are being used to restore or protect marbled murrelet habitat.

In 1998, the tanker *Command* spilled approximately 3,000 gallons (11,350 liters) of fuel oil from a damaged tank while en route from San Francisco to Central America. The spill oiled beaches along the San Mateo County coastline in California and killed hundreds of birds in adjacent ocean waters, including 6 to 12 marbled murrelets. The NRDAR case was settled in 2000, and the *Command* Trustee Council was formed to oversee restoration. The Trustee Council includes representatives from the Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, California Department of Parks and Recreation, and California State Lands Commission. The restoration plan, developed by the Trustee Council with public input, describes restoration projects for marbled murrelets and other resources injured by the spill. Murrelet populations are being restored through the protection of nesting habitat and actions to reduce nest predation in state and county parks within the Santa Cruz Mountains.

Habitat protection was accomplished through acquisition of an 80-acre (32-hectare) property in the Butano Creek drainage of San Mateo County, just north of Butano State Park. This property contains old growth redwood trees suitable for marbled murrelet nesting and is thought to be occupied by nesting murrelets. The property will be managed by the California Department of Parks and Recreation as part of Butano State



Rich MacIntosh

A juvenile marbled murrelet

Park under a management plan that will ensure any future uses of the property are compatible with nesting murrelets.

Ravens, jays, and crows (corvids) are known to prey on young murrelets and eggs. In areas where corvid populations have increased, murrelet nesting success has declined. This problem is particularly acute in campgrounds in redwood parks, where corvids scavenge the garbage and human food left behind by visitors. To reduce predation, the Trustee Council is funding actions to reduce the availability of garbage to corvids at campgrounds. Over 100 lidless garbage cans at Memorial County Park have been replaced with animal-proof dumpsters. Garbage is no longer available to corvids and no longer gets scattered around the campground by raccoons. At Big Basin Redwoods State Park, approximately 40 plastic dumpster lids were replaced with aluminum lids to make them animal-proof; additional dumpsters were purchased to eliminate overfilling problems, and a shed was built to prevent corvid raids on filled garbage trucks. In addition, ravens associated with campgrounds at Big Basin Redwoods and Butano State Parks and Memorial County Park are being removed, where possible.

Recognizing that garbage will only be secured with public cooperation, the Trustee Council funded camper education material and park staff training. The educational (*Continued page 27.*)

Table: US west coast marine oil spills resulting in injury to marbled murrelets since 1986 and restoration projects obtained from the settlement of the natural resource damage assessment claims associated with each spill.

Oil Spill	Location	Year	Oil Spilled	Total Acres Protected	Additional Murrelet Projects	Partners
Apex Beachcom	Pacific Ocean between San Francisco and Monterey, CA	1986	30,000-25,000 gallons of crude oil	111 acres of forest in Gassos Creek Drainage, San Mateo County, CA, including 30 acres of old growth.	Monitoring of murrelet occupancy of the Gassos Creek drainage.	CA Dept. of Fish and Game, NOAA, Sempervirens Fund
Nestucca	Grays Harbor, WA, north to Vancouver Island, British Columbia and south to OR.	1988	230,000 gallons of #6 fuel oil	Not applicable	Forest management on 300 acres to develop nesting habitat for Murrelets in South Willapa Bay on the Willapa National Wildlife Refuge	The Nature Conservancy
Terra Maru	Cape Flattery, WA, south to OR.	1991	Up to 354,880 gallons of intermediate fuel oil and 97,800 gallons of diesel fuel	906 acres of rare coastal old growth forest and buffering younger stands in southwest Washington and on the Makah Indian Reservation in northwest Washington	Murrelet surveys of nesting habitat in coastal Washington identified approximately 2,900 acres of occupied habitat, making it subject to additional protective measures	WA State Dept. of Ecology, Makah Tribe, NOAA, The Nature Conservancy
MV Kure	Humboldt Bay and Pacific Ocean near Eureka, CA	1997	4,500 gallons of intermediate fuel oil	Settlement pending	Settlement pending	CA Dept. of Fish & Game
MT Commercial	Pacific Ocean off San Mateo County, CA	1998	3,806 gallons of intermediate bunker fuel	80 acres in Butano Creek drainage, San Mateo County, CA	Corvid management in State and County communities in the Santa Cruz Mountains	CA Dept. of Fish and Game, CA Dept. of Parks and Recreation, CA State Lands Commission, NOAA
MV Stuyvesant	Pacific Ocean off Eureka, CA	1999	2,000 gallons of intermediate fuel oil	624 acres of forest in Klamath River Drainage, Del Norte County, CA, including 135 acres of old growth.	Corvid management at Redwood National Park	CA Dept. of Fish & Game, Save the Redwoods League
New Carissa	Cove Bay/Waldport, OR.	1999	Up to 140,080 gallons of bunker/intermediate fuel oil and 48,000 gallons of diesel fuel	Purchased 4,296 acres of commercial forest lands on central Oregon coast, including 1,269 acres of occupied and suitable nesting habitat for marbled murrelets. Management will be implemented to increase suitable marbled murrelet habitat to at least 1,938 acres, and retain 1374 acres in conservation forestry.		Oregon Dept. Fish and Wildlife, Siletz Tribe, Coos, Lower Umpqua, and Siuslaw Tribe, USFS, BLM

Note: Many of the restorations for these spills also included projects to restore other impacted species of migratory birds and their habitat, including threatened and endangered species such as the western snowy plover and California brown pelican.

Abbreviations: BLM = Bureau of Land Management, NOAA= National Oceanic and Atmospheric Administration; USFS= U.S. Forest Service



Dan Welsh/USFWS

Close-up of outdoor marbled murrelet outreach display at Memorial Park visitors center.

material includes: 1) a brochure for campers and picnickers; 2) signs posted on picnic tables, food storage lockers, trash disposal areas, and in bathrooms; and 3) a short video for use in visitor centers. The park staff is trained to develop campfire programs on the topic and answer questions from the public. Additional campground workers have been hired for the peak period of campground use to monitor the campgrounds and picnic areas for compliance and to educate visitors. We expect that the reduced availability of human food waste in campgrounds will result in lower corvid populations and reduced predation on murrelets.

The Trustees took a similar approach to restoration after the 1999 M/V Stuyvesant oil spill off the coast of northern California. The spill released approximately 2,000 gallons (760 l) of fuel oil into the ocean near Eureka, California, when the dredging arm of the vessel struck the hull and ruptured a fuel tank. It killed more than 2,000 seabirds, including at least 135 marbled murrelets,

1,600 common murre (Uria aalge), and 670 other seabirds.

To compensate for the damage of the Stuyvesant spill on marbled murrelets, a 634-acre (257-ha) complex, including 135 acres (55-ha) of old-growth redwoods suitable for murrelet nesting, will be protected in perpetuity through a conservation easement. The complex will be managed for murrelets by the Save the Redwoods League under an agreement with the Service, the California Department of Fish and Game, and the timber company that owns the land. The League will also be responsible for monitoring the murrelet population on the property. Additional funding will be provided for corvid management in Redwood national and state parks.

These examples illustrate the types of restoration activities and partnerships conducted by the EC Program through the NRDAR process. The table summarizes restoration actions for these and other oil spills that have injured marbled murrelets.

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Sturgeon Conservation in the Russian Far East and China

by Daniel Erickson^{1,2},
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Andrey Shmigirilov⁵,
Vladimir Belyaev⁶, German
Novomodny⁷, Anastassia
Mednikova⁵, Nikolai
Kazakov¹, Ellen Pikitch²,
and Phaedra Doukakis²

The Amur River is one of the longest free-flowing rivers in the world, extending some 4,400 kilometers (2,700 miles) from the mountains of Mongolia to the Sea of Okhotsk (Figure 1). It is home to approximately 133 species of fish,¹ many of which are endemic.² Two sturgeons endemic to this magnificent river are the kaluga (*Huso dauricus*) and Amur sturgeon (*Acipenser schrenckii*).

Kaluga and Amur sturgeons (Figure 2) are large; kaluga may exceed 1,000 kilograms (2,200 pounds) in weight and 5.6 meters (18.4 feet) in length,^{2,3,4} and exhibit diadromous patterns (meaning that they migrate between fresh water

and salt water).^{2,4,5} Both species require fresh, flowing water over a rocky/sandy bottom for spawning,^{5,6} but they also travel to the estuary or into the Sea of Okhotsk and Tartar Strait (kaluga) for feeding^{2,4,5} (Figure 3). Although precise spawning sites and spawning-migratory behavior for these prehistoric fish are uncertain,⁷ they are known to travel thousands of kilometers above the mouth of the Amur River through Russian and Chinese waters to spawn.⁵

The population sizes for kaluga and Amur sturgeon are uncertain. It is thought, however, that their abundance is extremely low relative to the late 1800s

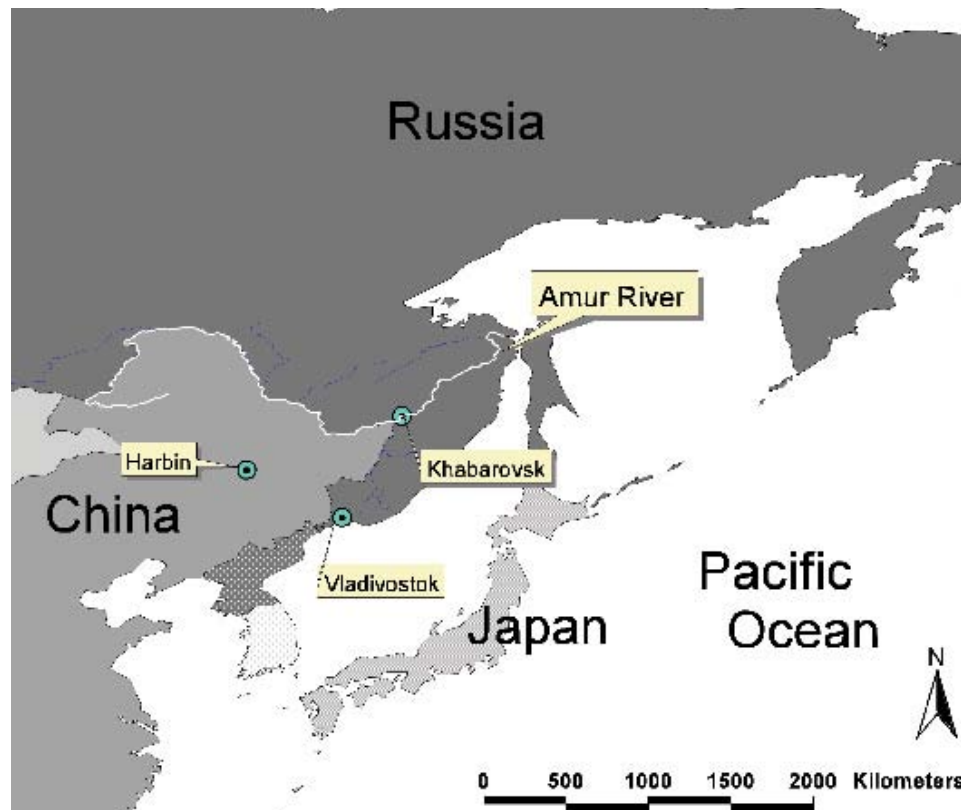


Figure 1. Kaluga and Amur sturgeon are endemic to the Amur River, located in the Russia Far East and China. This river drains into the Sea of Okhotsk. The Amur River (white) and most major tributaries (blue) are shown.



Daniel Erickson

Figure 2. Photos of kaluga (left) and Amur sturgeon (below) on the shores of the Amur River, Russia. These photos were provided by Dr. German Novomodny, Director of Pacific Scientific Research Fisheries Center (TINRO), Khabarovsk.

The kaluga was caught in the Amur River near Khabarovsk during 2001. This female weighed 310 kg. Dr. German Novomodny is in the background.

and early 1900s.^{2,8} Both species have endured decades of over-fishing, pollution, and habitat loss. Commercial harvest for both caviar and meat reached a peak in 1910, when 1.2 thousand mt (2.6 million pounds) were harvested. Since then, the number of fish harvested has declined dramatically each year.² Both species were listed on the IUCN (World Conservation Union) Red List in 1995; kaluga is on its list as endangered and Amur sturgeon is listed as vulnerable.⁹

Amur River Sturgeons Workshop

In August 2006, a workshop funded by the Trust for Mutual Understanding (an American foundation supporting cultural and environmental exchange among the U.S., Russia, and Eastern and Central Europe) was held in Khabarovsk, Russia, in an effort to bring together Russian and U.S. scientists and managers who are experts in sturgeon. The goal of the workshop was to facilitate the planning of joint U.S.-Russian research and education projects to improve management and conservation of kaluga and Amur sturgeon. During this workshop, a plan was developed to undertake unprecedented joint research on the Amur River.

Participants of the Amur River Sturgeons Workshop represented eight institutions from the U.S. and Russia

(Figure 4). The primary organizers were the Amur Ecological Foundation, Pacific Scientific Research Fisheries Centre (TINRO, Khabarovsk), and Wildlife Conservation Society. Other participants were Interdepartmental Ichthyological Commission of Russia, TINRO (Vladivostok), Pew Institute for Ocean Sciences (PIOS, University of Miami), U.S. Fish and Wildlife Service, and World Wildlife Fund (Russian Far East).

Workshop participants developed a list of threats to sturgeon in the Amur River, which include poaching, water pollution, dams, hatcheries, inadequate information, and over-harvest by legal fisheries. Poaching in Russia and excessive legal harvest in China are the largest quantifiable threats to sturgeon in the Amur River at present. Currently, it is

This Amur sturgeon was caught on the lower Amur River during 2003. This fish weighed 8 kg and was released after tagging.



Daniel Erickson

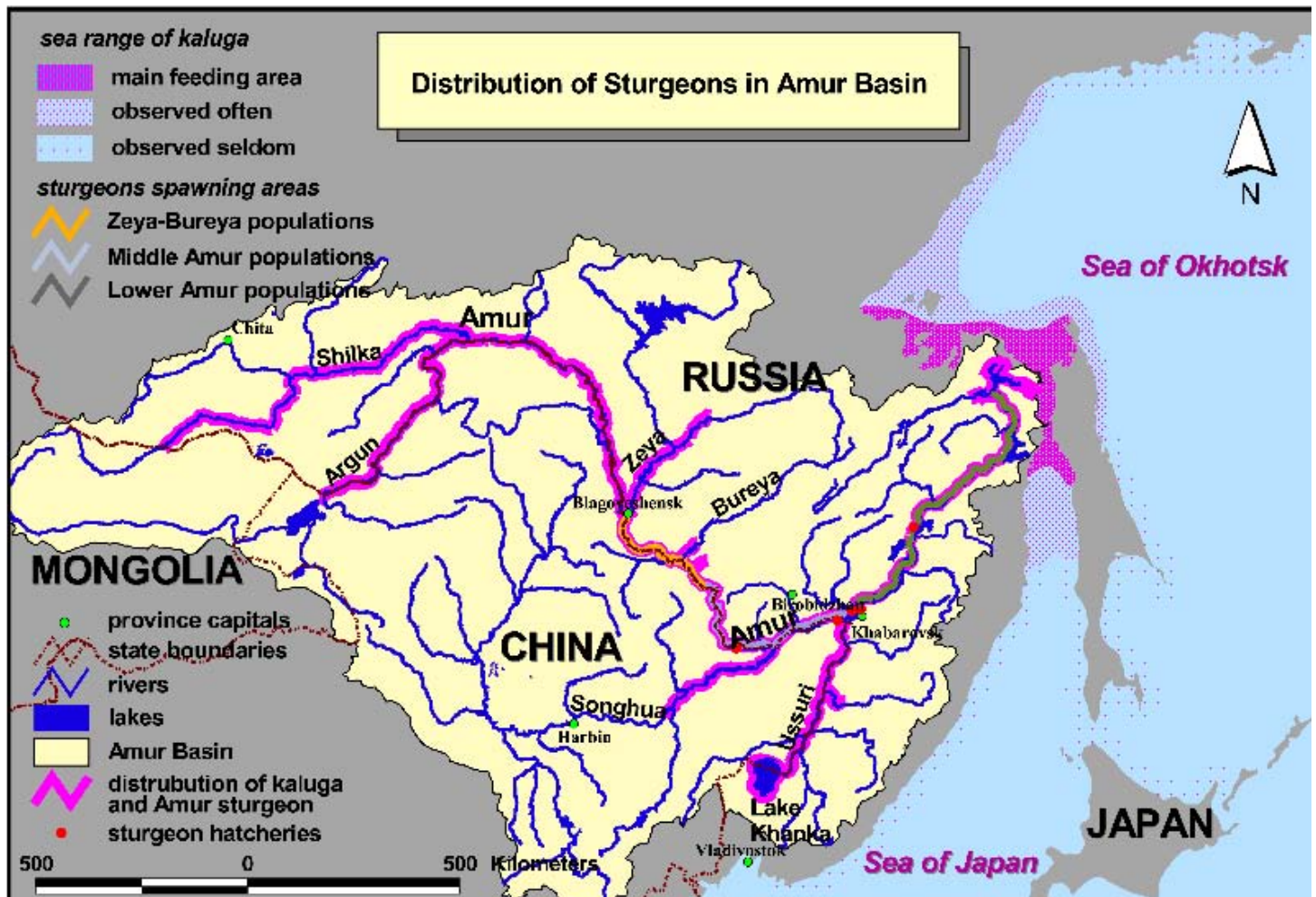
estimated that as much as 750 mt (1.7 million pounds) of sturgeon are poached from the Russian part of the Amur River each year; this level exceeds all other forms of sturgeon harvest in this system by more than four times (i.e., legal harvest in Russia and China and poaching in China).² Fines for poaching sturgeon in Russia have been too small to deter this problem.

Approximately 85 million people live in the Amur River Basin, and their impact on fish and wildlife populations is severe. Pollution levels in the river and their effects on sturgeon, though likely substantial, have not been well studied. The Amur River contains high levels of contaminants, including dozens of chemical (benzene, phenols, and DDT) and organic (untreated sewage) pollutants. One tributary (the Songhua River; Figure 3) is a major source of most pollutants for the Amur River.

The largest single threat to Amur River sturgeons and their ecosystem may be looming in the near future. Although this 4,400-kilometer river is currently unobstructed, there are plans to construct up to 12 dams beginning in 2015 (Figure 5); the lowest may be immediately above the confluence of the Amur and Songhua rivers (Figures 3 and 5). The potential deleterious impacts of these dams to the Amur River ecosystem may be enormous.¹⁰ For example, their installation will completely destroy many important spawning sites for sturgeon (see Figure 3).² Plans and precautions should be made to prevent the construction of unnecessary dams or to minimize the impacts of these structures to the biodiversity of this system.

The most significant outcome of the Amur River Sturgeons Workshop was the planning of a large-scale project entitled "Research of Current Status of Sturgeons in the Amur River Basin." Initially,

Figure 3. Distribution of kaluga in the Amur river basin and coastal waters off Russia, China, and Japan. This map was reprinted from Novomodny et al. (2004)² with permission from Drs. German Novomodny (TINRO, Khabarovsk), Petr Sharov (Far Eastern Health Fund, Vladivostok) and Yuri Darman (WWF Russia, Far Eastern Branch, Vladivostok).



this proposed 5- to 10-year project will involve Russian and U.S. scientists who will conduct projects only in Russian waters (Figure 1). We are, however, soliciting support and involvement of Chinese scientists to jointly conduct projects in transboundary waters and within Chinese waters. If funding is secured, we hope to initiate this program in 2009. Projects we plan to conduct for sturgeons of the Amur River include:

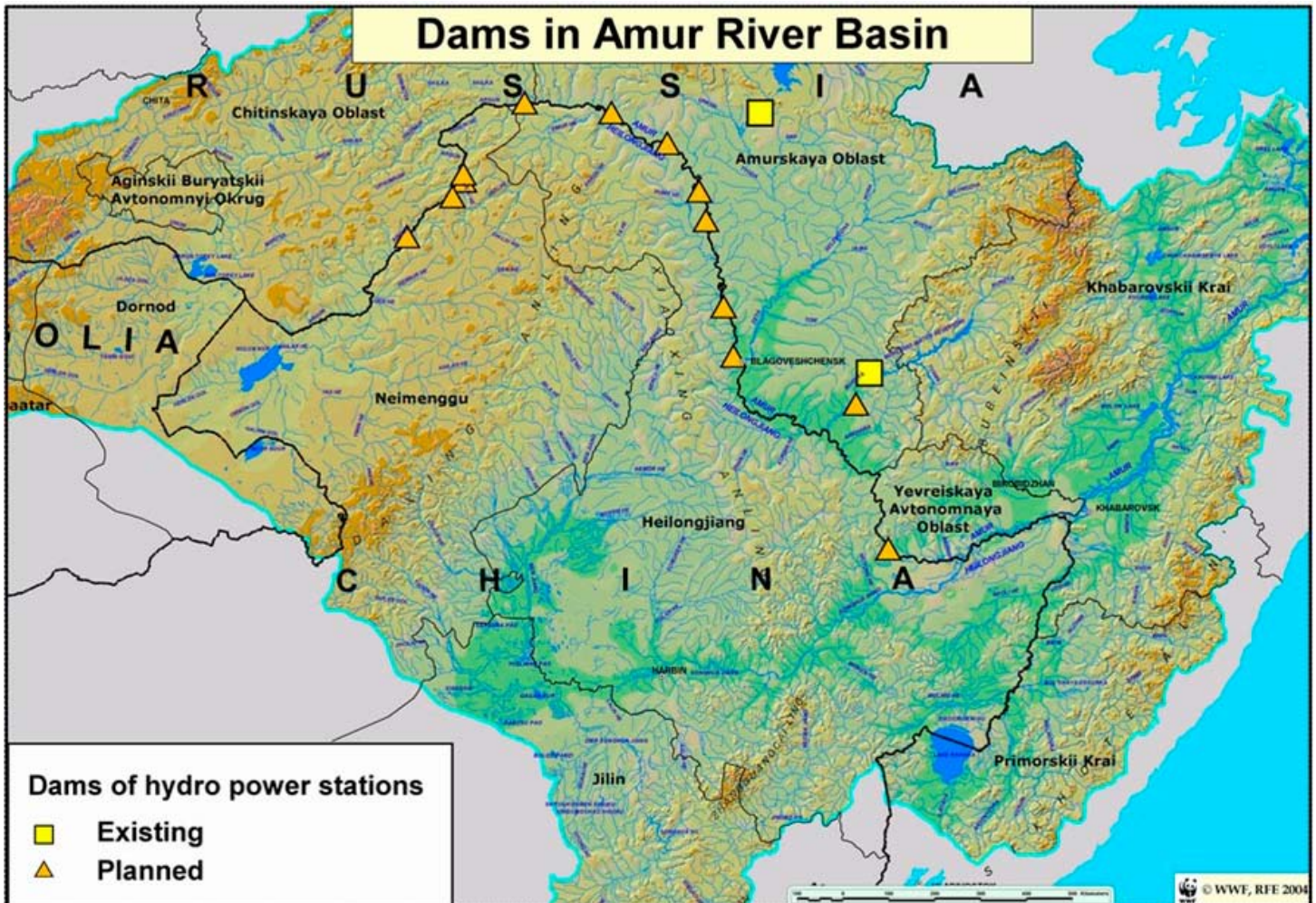
1. Migratory patterns and habitat requirements.
2. Genetics and stock structure.
3. Morphological characteristics.
4. Levels and effects of contaminants.
5. Development of a database for migration research (telemetry and conventional tagging).
6. Assessment of the current status of sturgeons in the Amur River, which will include:
 - a. reproductive structure and sex steroid profiles,

- b. verification of spawning sites, and
 - c. life history characteristics.
7. Development of a conservation and education plan.
 8. Community and public education.

Although the biodiversity of the Amur River is in jeopardy, we anticipate that this project will help restore and conserve sturgeons and other important elements of the ecosystem. For example, understanding migratory behavior, stock structure, and locations of important spawning habitats using telemetry and genetics will enable managers to understand the potential impacts of the proposed dams on specific stocks, and will provide information necessary to mitigate the potential deleterious effects of these dams on sturgeon that are endemic to the Amur River.

More information can be obtained by contacting the Pew Institute for Ocean Science (www.pewoceanscience.org),

Figure 5. Proposed sites for hydropower dams on the mainstem of the Amur River (triangles) and existing dams on tributaries (squares). This map was produced by WWF Russia Far East and printed with permission from Dr. Yuri Darman (WWF Russia, Far Eastern Branch, 18a Verkhneportovaya St, Vladivostok, 690003, Russia). See Simonov et al. (2006)¹⁰ for more details on potential dam construction.



Trust for Mutual Understanding (www.tmuny.org), or Wildlife Conservation Society (www.wcs.org)¹¹.

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Figure 4. Participants of the 2006 Amur River Sturgeons Workshop. Lower (left to right): Viktor Nazarov, Ellen Pikitch, Andrei Shmigirilov, Daniel Erickson, Phaedra Doukakis, Kevin Kappenman, and Anastassia Mednikova. Top (left to right): Nikolay Ryabinin, German Novomodny, Vladimir Belyaev, Sergey Pozdnyakov, Nikolai Kazakov, and Elena Albey. Participants not in the photograph are Nikolai Efimov, Tatiana Shmigirilova, and Molly Webb.



Daniel Erickson, Wildlife Conservation Society

by Craig Springer

Quality Nutrition Improves Kelt Survival

Dr. Ann Gannam has her own lexicon. A nutritionist at the Abernathy Fish Technology Center in Longview, Washington, she leads its Applied Research Program in Nutrition. In her work, she shares her words with scores of fish biologists throughout the Fish and Wildlife Service. As is the case with any profession, scientists engaged in the conservation of America's fisheries have their own jargon for the work they do.

Their words are like little urns. In them you'll find clues from the past that define the present in this plastic thing called "language." Some of the words are commonplace in usage, tame and mundane; they are overused and have no edge anymore, but are plain and smooth like creek stone.

Other terms are a little arcane and mysterious, at least to those who don't use them. One of the words Gannam is apt to use: kelt. Kelt refers to a moment in a fish's life. It is a word of Scottish origin that describes the languid state of steelhead and Atlantic salmon after they have spawned.

The experience is taxing, given that these migratory fish have fasted for months and have spent their energy stores getting to natal spawning habitats miles upriver from the sea. It is Pacific salmon that expire after they spawn for the one and only time in their life. Atlantic salmon and steelhead are multiple spawners, and one of the most taxing and critical points in their life histories is the time they linger in fresh waters, immediately post-spawn, when they are called kelts.

Atlantic salmon come upriver in May to July in advance of spawning in

autumn, and they don't eat the entire time. They lose half of their body weight by winter. Nashua National Fish Hatchery in New Hampshire and the Richard Cronin National Salmon Station in Massachusetts collect Atlantic salmon and spawn them, and the spent adults – the kelts – make their way to North Attleboro National Fish Hatchery in Massachusetts for reconditioning.



Reading a radio tag on an Atlantic salmon.

Nutritionists know that a fit kelt is more likely to contribute additional offspring and promote the species' recovery. One way to promote their health is to use a specially formulated diet. Commercially available broodstock diets do not exactly meet the needs of kelts and are not palatable to them.

The Abernathy Fish Technology Center developed a hand-made fish diet based on a formula used for Atlantic salmon. By using fewer raw ingredients, researchers produced a feed with fewer antinutrients (substances that interfere with the utilization of one or more nutrients). Trials on Atlantic salmon at the North Attleboro hatchery were successful, but labor-intensive and expensive. Dr. Gannam, along with Bill Fletcher of the Fish and Wildlife Service's

Northeast Fishery Center Complex and Dale Honeyfield of the U.S. Geological Survey's Northern Appalachian Research Laboratory improved the formula for Atlantic salmon and adapted it for production by commercial feed manufacturers. The technology they developed is useful to conservation and commerce.

Biologists at North Attleboro NFH now keep about 95 percent of the kelts alive. At the start of the four-week process, the languid fish have to be fed by hand, which has become easier with the development of more palatable foods. The individual females that survive the natural selection process at sea will first yield about 8,000 eggs from the wild. The reconditioned kelts will produce up to an additional 40,000 eggs, thus contributing significantly to future fisheries.

But it is not just Atlantic salmon that are benefiting from this research. On behalf of the Yakama Nation, the Columbia River Inter-Tribal Fish Commission asked Dr. Gannam to create a kelt diet to recondition the threatened winter-run Yakima River steelhead at the Prosser, Washington, tribal hatchery. She worked with tribal biologists and a commercial feed company to change an existing product to meet the needs of their kelt reconditioning program. The modified feed formulation is one that is easier to use, more palatable to the fish, and costs less than the hand-made feeds.

In the end, that means more fish swimming in the water toward recovery.

Craig Springer (craig_springer@fws.gov), a biologist in the Division of the National Fish Hatchery System, is stationed in Albuquerque, New Mexico.

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 packardii*), 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 California/Nevada Operations 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

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