

ENDANGERED *Species* BULLETIN

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The Endangered Species Act (ESA) is sometimes called nature's safety net. When our nation's other conservation laws and management practices fail to maintain healthy plant and animal populations, the ESA serves as a last barrier to extinction.

Once a species comes under ESA protection, it stands an excellent chance of survival. Then, the much more difficult, time consuming, and expensive task of reversing the decline, restoring the species to a secure status, and removing it from the list of threatened and endangered species begins.

The stories in this edition of the Bulletin go beyond the number of delisted species and show the progress being made in the effort to stabilize and recover our imperiled animals and plants.



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On the Cover

After three decades of successful recovery work, the greater Yellowstone population of grizzly bears is once again secure, and it has been proposed for removal from the list of endangered and threatened species.

The Endangered Species Bulletin is now an on-line publication. Three electronic editions are posted each year at www.fus.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, habitat conservation plans, and cooperative ventures. Please contact the Editor before preparing a manuscript. We cannot guarantee publication.

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We also welcome your comments and ideas. Please e-mail them to us at esb@fus.gov.

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Overcoming Challenges to Species Recovery

by Michelle Morgan, Krishna Gifford, Elena Babij, Debby Crouse, Kelly Hornaday, Mary Klee, and Martha Balis-Larsen



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In 1973, when the Endangered Species Act (ESA) became law, the endangered and threatened species list numbered only 77 species, none of which were invertebrates or plants, and iconic species such as the bald eagle (*Haliaeetus leucocephalus*), gray wolf (*Canis lupus*), and grizzly bear (*Ursus arctos*) were very rare and severely reduced in range within the conterminous United States. These creatures symbolize why the ESA was voted into law by an overwhelming majority in Congress, and with such a clear purpose: “to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species”

Now, after 32 years of the ESA, let's take another look at the species mentioned above. The bald eagle can be seen flying throughout all of the lower 48 states again. Gray wolves have met their recovery targets in Idaho, Montana, and Wyoming, as well as Wisconsin, Michigan, and Minnesota. A healthy population of grizzly bears now inhabits Yellowstone National Park, and it has been proposed for removal from the list of threatened and endangered species.

Stabilizing and recovering species is far from easy. There are many biological, financial, and social challenges to overcome. However, we have achieved considerable success in these endeavors, due primarily to the use of creative partnerships. Our partners include foreign governments, other federal agencies, state governments, private landowners, the business community, and various non-governmental organizations.

We also apply an ecosystem-based approach to conservation, addressing a conservation issue at the landscape level rather than just concentrating on specific problems at hand. Each ecosystem contains an interconnected framework of biological and physical processes. Damage to the framework can affect the ecosystem's ability to support a diversity of life. The damage can be caused by natural events, such as hurricanes or volcanoes, and it can take the form of human impacts, such as habitat loss or chemical contamination. These impacts can be serious problems for species. Despite these many setbacks along the road to survival and recovery, we continue to move forward.

One of the biggest challenges the Fish and Wildlife Service faces in recovering listed species is the sheer number of species needing help. In addition to the 1,256 U.S. plant and animal species listed as of November 8, 2005, there are



George Andrejko/Arizona Game & Fish Dept.

For video of the bald eagle and other species, go to <http://www.fws.gov/video/> and click on B-Roll.

286 candidate¹ species. Thousands more are considered “species of concern” or “critically imperiled” by states, environmental groups, and scientists. To plan and implement recovery actions for all listed species, the Service’s Endangered Species Recovery Program received \$58 million in FY 2005, an average of \$46,400 per species. If you subtract the amount of money earmarked for specific projects, that leaves a total of \$44.1 million, or \$36,880 per species.

How do we make progress in the face of overwhelming odds and declining resources? By taking one species at a time, maximizing our partnerships, and promoting creativity. Since 1973, we have removed from the list (delisted) 10 domestic species due to recovery. Some would say that this is a poor success rate. However, success cannot be measured merely in delisting statistics. We have also downlisted 16 species from endangered to the less critical classification of threatened, stabilized or improved another 350 species, and, more importantly, we have prevented approximately 900 species from going over the brink into extinction. That’s actually a good

¹ Candidates are those species for which we have enough information to list as threatened or endangered, but are precluded from doing so by higher priority workload.

success rate! And when we stand back and review the history of species like the bald eagle, gray wolf, and grizzly bear, we know that every small stride adds up over the years.

The following are a few examples of other species faced with interesting recovery challenges and what’s being done to improve their status:

Kemp’s Ridley Sea Turtle

The Kemp’s ridley sea turtle (*Lepidochelys kempii*) spends many of its juvenile years foraging in U.S. waters and was once known to nest only at Rancho Nuevo in Tamaulipas, Mexico. A 1940s film showed a single arribada (mass nesting emergence) of an estimated 40,000 female Kemp’s ridleys on one day. Despite Mexico’s protective efforts, the number of nesting turtles fell to about 5,000 females by 1968. The Kemp’s ridley was listed by the U.S. in 1970 as endangered due to threats that included the take of eggs and adults for human use, and incidental capture and drowning in shrimp trawls.

In 1978, the Service joined Mexico in an international conservation program that has attracted additional partners through the years. Nesting numbers continued to decline, however, to a low of only 702 nests documented for the



National Park Service

Donna Shaver, Chief of the Division of Sea Turtle Science and Recovery at Padre Island National Seashore, releases Kemp’s ridley sea turtle hatchlings there. The public is often invited to observe these hatchling releases.



National Park Service

Kemp's ridley sea turtle hatchlings

entire season in 1985. By the late 1980s, however, nesting numbers had begun to increase. During the 2003 nesting season, more than 8,288 nests were documented in Mexico, with a small scattering of nests in Texas as well. Since Kemp's ridley females nest 2 or 3 times each season, the nests represent perhaps 2,700 to 4,000 females. The Kemp's Ridley Recovery Plan identifies one of the downlisting criteria as attaining a population of at least 10,000 females nesting in a season. After a narrow brush with extinction, the progress towards recovery is heartening.

With slowly maturing species, it can take years to reverse a population decline. The recovery of some species is also "conservation dependent." For them, certain management activities will be needed in perpetuity to address difficult threats and ensure the species does not simply decline again to endangerment if it is delisted. For the sea turtle, both protection of females on the nesting beach, as well as protection from incidental capture and drowning in fishing trawls, will be necessary on a continuing basis in order to ensure long-term recovery.

Tinian Monarch

The Tinian monarch (*Monarcha takatsukasae*), a small bird from the island of Tinian in the Commonwealth of the Northern Mariana Islands, was one of the original species listed under the ESA.² It was listed as endangered due to critically low population numbers caused by the destruction of its habitat from World War II activities and pre-war agricultural practices. However, surveys in the late 1990s showed that the amount and density of forest habitat had increased and the bird's population numbers had rebounded. It was delisted on September 21, 2004.

However, while the original threats to the species had been abated, a new threat looms on the horizon: the non-native, highly invasive brown tree snake (*Boiga irregularis*). While the snake has not established itself on Tinian, there have been several confirmed sightings, and it is responsible for decimating bird populations on other islands

² The Commonwealth is an island group in the western Pacific that is in political union with the U.S. and is therefore covered under the ESA.



U.S. Navy

Tinian monarch

within the Marianas. To counter this potential challenge and to comply with the five-year post-delisting monitoring requirement of the ESA, an aggressive monitoring program has been developed in cooperation with the Commonwealth, the U.S. Geological Survey/Biological Resources Discipline, U.S. Department of Agriculture/Wildlife Services, and the Department of the Navy. The plan includes monitoring the bird's population numbers, monitoring the snake, monitoring land use, and recommendations for increasing efforts to prevent the snakes from spreading. One of the components of the plan includes building a snake barrier around Tinian's port to prevent any snakes that may come in on shipments from leaving the quarantine area. The plan is now being put in place, and the next five years of monitoring will show how successfully we can overcome the challenge of invasive species and keep our recovered species from returning to the list.

Kirtland's Warbler

Migratory birds have their own recovery challenges. These species may travel long distances from wintering grounds in other countries to nest in the U.S. The Kirtland's warbler (*Dendroica kirtlandii*) is one of these. This bird is considered endangered across its entire range. After breeding in the jack pine plains of Michigan's lower peninsula, it winters in the Bahamas. Limited habitat and brood parasitism by brown-headed cowbirds are two reasons why the warbler is endangered. Managing these problems in the warbler's breeding area has been the focus of combined efforts by the Fish and Wildlife Service, Forest Service, Michigan Department of Natural Resources, and non-governmental organizations such as The Nature Conservancy (TNC). Conservation actions have been very successful so far, although continued work is required to maintain the population in the breeding grounds.

However, the Kirtland's warbler spends about eight months of each year in its wintering areas. Little is known

about its wintering biology, and efforts to learn more have been difficult. In fall and winter, this bird has dull brown plumage, making it well camouflaged, and its behavior is inconspicuous. A joint research project involving TNC, the Bahamas National Trust, and the Forest Service is trying to gain a better understanding of the species' winter habitat requirements and conservation needs.

Flies, rats, and beetles—oh, my!

Mention the term "endangered species" and most people think of wolves, grizzly bears, sea otters, and bald eagles, or perhaps even sea turtles or salmon. But the vast majority of listed species aren't large, cute, or showy. In fact, most are downright small and inconspicuous. More than half of the listed species in the U.S. are plants, many with very restricted ranges and specific habitat requirements. Of the 527 listed animals in the U.S. (as of November 17, 2005), more than 170 are invertebrates (including mussels, beetles, crayfish, and spiders, to name a few), 57 species are amphibians and reptiles, and 114 are fish (most of which are small species occurring in only a few drainages or basins). The 90 listed birds include such large and impressive species as the bald eagle and California condor (*Gymnogyps californianus*), but many are small and less well-known. The 78 listed mammals include 29 rodents, 3 rabbits, 1 shrew, and 9 bats.

Less charismatic species often face challenges to recovery not experienced by their more captivating counterparts. Because many species are lesser known, small, and inconspicuous, they are often overlooked by landowners, managers, and potential conservation partners. For species with very restricted ranges, the pool of potential partners and interested public is limited, resulting in fewer opportunities and less funding for recovery. The roles of many non-charismatic species in their environment also are not obvious or easily recognized except to scientists, and the public may not care about or see the benefits of recovery efforts.



Kirtland's warbler

Ron Austing



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Delhi Sands flower-loving fly



© B. Moose Peterson/WRP

Kangaroo rat

Many non-charismatic listed species also have image problems. Bats, spiders, and snakes don't usually elicit popular support. Some species also suffer from unfortunate associations with disliked animals. The six listed species of kangaroo rats, two species of woodrats, and one rice rat bear little resemblance or relationship to a common pest species but tend to suffer because of their common names.

Threats affecting many non-charismatic species also may be less manageable. Banning DDT was a relatively straightforward and successful recovery action for peregrine falcons (*Falco peregrinus*), bald eagles, and brown pelicans (*Pelecanus occidentalis*), and the end of deliberate persecution made it possible to restore gray wolves. But for most species, the loss or degradation of habitat is the major threat, and one that is difficult to reverse.

For example, the Delhi Sands flower-loving fly (*Rhabdomidas terminatus abdominalis*) is an insect endemic to the Colton Dunes ecosystem, which once covered over 40 square miles (104 sq. kilometers) in Riverside and

San Bernardino counties in California. The Colton Dunes were created largely as a result of sand blown by the Santa Ana winds into the canyons of the San Gabriel and San Bernardino mountains. The species surviving in this unusual habitat have had to adapt to an ever-changing substrate, as the winds vary each year. For the Delhi Sands flower-loving fly, spending most of its life underground seems to be the best way to cope with its dynamic environment. As its name implies, this insect depends on wildflower nectar during its brief above-ground phase. Like a hummingbird, the colorful fly hovers at flowers, and it feeds through a long proboscis (tubular protrusion of mouth). Due to widespread loss of habitat, primarily the result of agriculture conversion and urbanization, the Delhi Sands flower-loving fly is now restricted to less than two percent of its former range. Despite its interesting life history, the biggest challenge to recovery of this species is the fact that it is a fly, an insect that many people consider a pest.

Ivory-billed Woodpecker

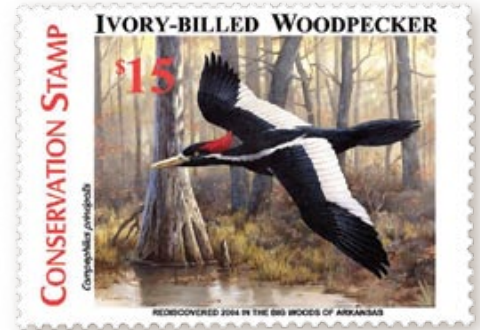
Until its rediscovery on the Cache River National Wildlife Refuge in Arkansas of 2004, most people would have said that the ivory-billed woodpecker (*Campephilus principalis*) was extinct. Despite previous surveys, there had not been a confirmed sighting since the 1930s. How could a species go undetected for so long? There were two main reasons; it was uncommon to begin with, and it inhabits remote, swampy, bottom-land habitats.

The rediscovery led to a partnership that includes the Nature Conservancy of Arkansas, Arkansas Game and Fish Commission, Arkansas Natural Heritage Commission, Cornell University, and the Service. A recovery team was quickly formed and has completed a recovery outline (interim conservation strategy that focuses recovery efforts until a full recovery plan can be drafted). The "Big Thicket" partnership will continue with efforts to carry out additional surveys in other suitable habitat, conserve and manage existing habitat, and conduct necessary research. In the meantime, the rediscovery provides hope that we may have a second chance to recover this and other very rare creatures.

Crafting a Solution

So, how do we garner support for listed species, including the ones "only a mother could love"? Teamwork is probably the most important tool we have at our disposal for overcoming the myriad of challenges facing species' recovery. Working in cooperation with a variety of partners that may have differing views, goals, and timelines is challenging at times. But a diversity of voices, ideas, knowledge, and experience also provides many benefits, as the partners bring their own strengths to the table. The Service's unique role continues to be coordinating and facilitating the efforts of many entities to achieve the common goal of recovering our nation's imperiled flora and fauna.

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Conservation stamps sold at www.ivory-bill-woodpecker.com support state and private work on this extremely rare bird.



USFWS

Biologists sample a pond for larval California tiger salamanders.

by Kelly Hornaday and
Valary Bloom

Multispecies Recovery Planning: Benefits and Challenges



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California clapper rail

A California clapper rail (*Rallus longirostris obsoletus*) passes warily under the boardwalk while a salt marsh harvest mouse (*Rallus longirostris obsoletus*) clings to a clump of pickleweed just a few feet away. A small crowd of people on the boardwalk whisper excitedly, thrilled at the rare opportunity to see these two endangered species. An unusually high spring tide has pushed the animals into the high marsh, uncomfortably close to humans. Humans and endangered species alike wait silently for the tide to go out.

Another less visible event also is underway, one that will have a more enduring effect on these and more than a dozen other endangered, threatened, and special status species: the preparation of the draft Tidal Marsh Ecosystem Recovery Plan.

The development of a recovery plan is the most important milestone for an endangered species; it provides the “roadmap” to a species’ or ecosystem’s recovery, and it defines how we measure our success towards that goal. Of the 1,264 federally-listed species, about 200 still need recovery plans, and many others need to have their recovery plans revised and updated. One way to reach the recovery planning milestone for more species in less time is to prepare multi-species recovery plans. Multi-species plans cover species that face the same threats, occur in the same area, or inhabit the same ecosystems. There are many benefits to multi-species recovery planning, but there are also many challenges.

In the case of the draft Tidal Marsh Ecosystem Recovery Plan, the primary challenge has been to integrate the wide variety of planning efforts already underway in the San Francisco Bay area into a single, cohesive, and practical recovery guide. This task is complicated enormously by the density of human occupation and associated urban infrastructure in and around the bay. However, through continual and effective communication, strong partnerships with interested stakeholders, and the sheer will of those who share the vision of a healthier tidal marsh ecosystem, the challenges are being overcome.

The table below describes some of the more common benefits and challenges of multi-species recovery planning:

When the draft Tidal Marsh Ecosystem Recovery Plan is finalized, it will be one of about 80 multispecies recovery plans covering more than 700 species. The authors of the draft Tidal Marsh Ecosystem Recovery Plan have

Benefits	Challenges
More species get recovery plans	Plans take longer to develop
By addressing threats common among species, the plan provides a comprehensive treatment of an entire ecosystem or geographic area	Plan may be large and difficult to use, or may leave out detail in order to keep the plan small
One recovery team for multiple species	Recovery team may be large and difficult to coordinate
Cost efficiencies for recovery actions that benefit multiple species or an ecosystem.	Cumulative cost estimates for multispecies plans may be large and therefore negatively perceived by the public
Can address conservation of candidate species or species of concern, potentially precluding the need to list in the future	Lack of information on many candidate species and species of concern hampers development of conservation strategies
Provides a single source of information for agencies, stakeholders, and landowners implementing actions for multiple species	For large plans, it may be difficult to avoid describing actions at a scale too large (such as ecosystem restoration, improved regulatory coordination) for individual agencies, stakeholders, and landowners to recognize and implement.
Provides opportunity to address conflicting species needs	Resolving conflicting species needs may be difficult, and information on species interactions may be lacking
Recovery strategies and corresponding actions can address threats and needs at the ecosystem and/or regional level	Larger scope of plan may come at the expense of species-specific and site-specific actions.
May utilize multiple authors to take advantage of species and/or ecosystem expertise.	Large plans with multiple authors may require considerable editing to ensure consistency
If species have similar life histories, may be able to use the same methodology for recovery criteria development.	In some cases, species may require entirely different method for recovery criteria development.

encountered most of the challenges described above. Nevertheless, the draft recovery plan is entering its final stages. Last fall, a series of meetings were held to invite the public, partners, and stakeholders to provide feedback on the draft plan and to encourage participation in its implementation. When viewed in light of the tremendous benefit of a comprehensive recovery plan for tidal marsh species of northern and central California, the challenges have been well worth the effort.

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Salt marsh harvest mouse

by John Schmerfeld

Reversing a Textbook Tragedy



Jess James/USFWS

Tan riffleshell

A recent sunny morning along the Clinch River was the setting for a homecoming years in the making. Local children, media, Fish and Wildlife Service staff, and conservation officials from Virginia Tech University and the Virginia Department of Game and Inland Fisheries (VDGIF) donned hip boots and waders as they released artificially propagated freshwater mussels into a crystal-clear section of river at Cedar Bluff, Virginia. Amid supportive smiles from observers on the riverbank, the group was on the latest leg of a journey that began one day seven years earlier.

On August 27, 1998, the Clinch River turned milky white from the release of over 1,600 gallons (6,060 liters) of a chemical used in foam rubber manufacture. A tanker truck had overturned on U.S. Route 460 and spilled its load into the river, ultimately killing an estimated 18,000 freshwater mussels as well as fish, snails, and other aquatic species. Among the dead were 750 individuals of three

endangered mussel species: the tan riffleshell (*Epioblasma florentina walkeri*), purple bean (*Villosa perpurpurea*), and rough rabbitsfoot (*Quadrula cylindrica strigillata*). One of the most significant kills of endangered species since passage of the Endangered Species Act, this incident was so tragic that it is now often referred to in textbooks. One of the three mussel species, the tan riffleshell, is so rare that it is now believed to exist only near the mouth of Indian Creek, a tributary of the Clinch River. The current total population for the species is estimated at about 400 individuals.

Under the authority of the Comprehensive Response, Compensation, and Liability Act of 1980 (Superfund) and the Clean Water Act, the Service may “assess injury to natural resources resulting from a discharge of a hazardous substance . . . and may seek to recover those damages.” Natural resource damage assessments (NRDA) are separate from the cleanup actions undertaken at a hazardous waste or spill site, and they provide a process whereby the natural resource trustees can determine the

These tanks hold the host fish needed by the endangered mussels during their parasitic larval stage.



Dolores Savignano/USFWS

proper compensation to the public for injury to natural resources. The NRDA process seeks to: 1) determine whether injury to, or loss of, trust resources has occurred, 2) ascertain the magnitude of the injury or loss, 3) calculate the appropriate compensation for the injury, including the cost of restoration, and 4) develop a plan that will restore, rehabilitate, replace, and/or acquire equivalent resources for those resources that were injured or lost.

The Service's Gloucester, Virginia, Field Office Cooperative conducted studies of the resource damage between 1999 and 2002 under an informal funding and participation agreement with Certus Trucking, Inc., and with financial support from the Department of Interior. Disagreements that arose during the damage quantification phase forced the Department of Justice to file a complaint against the company in federal court in the fall of 2002. Working with Interior Department lawyers and Service staff, the company eventually agreed to a \$3.8 million settlement. The consent decree reached with Certus stipulates that the settlement funds are to be "...managed by the DOI for the joint benefit and use of the Federal and State Trustees to plan, perform, monitor and oversee native, freshwater mussel restoration projects within the Clinch River watershed..." According to the "The Final Restoration Plan and Environmental Assessment for the Certus Chemical Spill Natural Resource Damage Assessment," the settlement will be devoted to a 12-year program to help restore native freshwater mussels in the Clinch River.

The injury assessment and damage determination focused on sediment toxicity testing and analytical chemistry within the spill area. Based on data from these studies, Virginia Field Office staff determined in 2003 that river sediments had sufficiently returned to background levels through natural attenuation and were once again able to support freshwater mussels. These data gave the green light to the mussel release program, which kicked off in the fall of 2005.

Landowners York and LaRhonda Lindsay watched last fall's release as officials credited them and many town residents with supporting the efforts of the DGIF, the Service, Virginia Tech, Cedar Bluff town officials, The Nature Conservancy, the Clinch River Headwaters Association, the Tazewell County Soil and Water Conservation District, and other groups in pressing for the settlement and its use in restoring the Clinch River's natural resources.

Cedar Bluff's Town Manager, Jim McGlothlin, said the DGIF and the Service have worked in a low-key manner to reach a point where repopulating the mussels is possible. "I've been impressed with how well they've worked with property owners," McGlothlin said. "Cedar Bluff's citizens have been very pro-environment. This is a very historic town, and we don't have a lot of large business and industrial development, so our cultural, historic, and environmental heritage is very important to us."

The key to this and other mussel restoration projects in Virginia has been the development of mussel-breeding techniques over the past two decades by Dr. Richard Neves of the U.S. Geological Survey's Cooperative Research Unit at Virginia Tech in Blacksburg, Virginia. His work, and that of several other researchers around the country, has been supported through Endangered Species Act section 6 grants and Service funding from Regions 4 and 5.

John Schmerfeld is a biologist with the Service's Virginia Field Office (804/693-6694 x107). (Mike Still of the Richlands News-Press contributed to this article.)



Dolores Savignano/USFWS

"They've been great to work with," LaRhonda Lindsey said of the habitat restoration partners at the release event. "We've only been here since April, but we're trying to learn and help keep the habitat as it should be. I thought today was very interesting."

The Public Role in Conserving Species

by Don Hankins



Elena Delacey

California red-legged frog

Conservation biology is a field that requires the melding of biological and social sciences. This is particularly true when considering the conservation of organisms in areas with high human populations. Although laws and policies direct us to seek public input and consider the needs of people when making regulatory decisions, as scientists, we have sometimes neglected the human factor in our conservation designs. But there is a better chance for success when local citizens are included in conservation planning efforts. In one example, the Fish and Wildlife Service's Sacramento Fish and Wildlife Office is working with the public and private sectors to ensure the conservation of San Francisco's namesake snake.

The San Francisco garter snake (*Thamnophis sirtalis tetrataenia*), listed as endangered by the State of California and the federal government, is a subspecies endemic to the San Francisco

San Francisco garter snakes



Ferry Van Stralen

Peninsula. It has been referred to as one of the most beautiful serpents in North America. Ironically, the San Francisco garter snake relies partly on a threatened species, the California red-legged frog (*Rana aurora draytonii*), for part of its diet. As with many listed species, the snake and frog are threatened primarily by habitat loss, fragmentation, degradation, and inadequate management. The bullfrog (*Rana catesbeiana*), an introduced species, is also known to prey on, and compete with, both species.

The Service prepared a recovery plan for the San Francisco garter snake in 1985; however, few recovery actions were implemented prior to 2002. In light of the snake's dire conservation status, the Service's Sacramento Recovery Program convened an internal working group in 2002 to address conservation needs. Among other actions, the working group identified Laguna Salada and Mori Point (adjacent areas located to the south in Pacifica) as priority areas for the conservation of the San Francisco garter snake and California red-legged frog within this portion of their ranges.

Laguna Salada is a former tidal lagoon that was diked in the early 1900s by the City of San Francisco to alleviate tidal flooding of an adjacent golf course (and later a residential development). As a tidal lagoon, it functioned with freshwater flow by seasonally breaching the natural sand spit to allow full tidal action. Together, Laguna Salada and Mori Point represent one of the northernmost population centers remaining for the San Francisco garter snake. Numerous studies from previous decades indicate the snake and the California red-legged frog extensively use the wetland complex and surrounding uplands, making the continued

management of those areas critical to the survival and recovery of both species.

In 2000, the Trust for Public Land, in cooperation with other partners, purchased Mori Point and transferred ownership to the National Park Service's Golden Gate National Recreation Area. The Service's Sacramento Recovery Program began working in partnership with the Golden Gate National Recreation Area, Golden Gate National Parks Conservancy, and San Francisco Zoo to address the snake's conservation needs. Several key conservation elements were identified, including the enhancement of wetlands to provide secure foraging and breeding habitat for the garter snake and red-legged frog, respectively; creating a "head-start" program to increase survivorship of newborn snakes; and conducting public outreach and education (such as zoological holdings¹ and interpretive signs).

Due to Laguna Salada-Mori Point's urban setting, heavy recreational use, and the on-going threat of poaching from reptile enthusiasts, the partnership recognized that successful conservation of the San Francisco garter snake would require extensive public participation and ownership. One day in October 2002, the public was invited to Mori Point to share knowledge of the site and discuss the preliminary plans to enhance the wetlands. Many of the participants noted their personal observations of the San Francisco garter snake and California red-legged frog. Following this initial public contact, final plans for the wetland enhancement project were developed. Workshops were held to inform the public, solicit its support, and educate volunteers on the biology, ecology, and identification of the snake.

The enhancement project took place in fall 2004, with key participation by volunteers from the Golden Gate National Parks Association's Site Stewardship



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After pond construction, biologists began to notice California red-legged frog egg masses (below).

Program. California red-legged frogs responded two months later by laying eggs in the newly created ponds. In February 2005, tadpoles were observed emerging from their egg sacs and in January 2006, more red-legged frog eggs were laid in the new ponds. Although it is too early to determine if this effort will substantially benefit the San Francisco garter snake, it is evident from press coverage that the public is quite enthusiastic about the project. People in the area are beginning to take ownership in the recovery of the species, and that bodes well for the future status of both the San Francisco garter snake and the California red-legged frog.



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Don Hankins, formerly a fish and wildlife biologist with the Service's Sacramento Field Office, is now a professor at California State University, Chico.

¹ In 2003, the two remaining captively held individuals in the United States died. In June 2005, ten captive-bred snakes were successfully repatriated from European collections and are now on display for educational purposes at the San Francisco Zoo.

by Tom Stehn and
Wendy Brown

Whooping Crane Population Reaches Record High



Whooping Crane Eastern Partnership

A pilot dressed as a crane leads the reintroduced whoopers by ultralight as they learn their new migration route between Wisconsin and Florida.

A record 218 endangered whooping cranes (*Grus americana*) arrived at their Texas wintering grounds (Aransas National Wildlife Refuge) in 2004-05. This is likely the highest number of whoopers wintering in Texas in the last 100 years, and it exceeds the previous winter's record by 22. There is definitely cause to celebrate—the wild population has doubled over the past 18 years.

The increase was due to good nesting production in 2004. The Canadian Wildlife Service reported that 54 nesting pairs fledged a record 40 chicks on their nesting grounds in Wood Buffalo National Park, Canada. The 33 surviving chicks that arrived in Texas set another recovery record.

Flock updates for the 2005-06 winter were not as optimistic. Although a final size estimate has not been made, it looks like the peak population will be 220, only a slight increase. Production was once again very good in Canada with 30 juveniles making it to Aransas in fall 2005; however, higher than average mortality of about 25 birds (11.6 percent of the population) between the spring and fall of 2005 allowed the flock to grow by only a few individuals.

The total flock number would have been higher had two whoopers not been shot while migrating through Kansas in early November, 2004. One died within a week and the second later died from respiratory problems that developed from its injuries. Veterinarians at Kansas State University had surgically repaired the wing of this crane, with hopes that it could survive to contribute to the captive breeding flock. The Kansas Department

of Wildlife and Parks flew the whooper to the U.S.G.S. Patuxent Wildlife Research Center in Maryland, but the bird died after arrival. Charges filed against a party of sandhill crane (*Grus canadensis*) hunters involved in the shooting resulted in a guilty plea with fines of \$3,000 per hunter, additional restitution paying the veterinary bills incurred caring for the injured cranes, community service, and loss of hunting privileges for two years.

Whooping cranes are the tallest birds in North America, standing nearly five feet (1.5 meters) tall with a wingspan wider than most cars. The only remaining natural population nests in Wood Buffalo National Park on the border of Alberta and the Northwest Territories in Canada and migrates 2,400 miles (3,860 kilometers) through the prairie states and provinces to the Texas coast. During the 2004 fall migration, however, two whooping cranes were confirmed at Grulla National Wildlife Refuge in New Mexico. (*Grulla*, appropriately, is the Spanish word for crane.) This sighting adjacent to the border of west Texas was the first confirmed sighting of the Aransas-Wood Buffalo population whooping cranes in New Mexico.

Whoopers winter on the Texas coast on and near the Aransas and Matagorda Island national wildlife refuges about 45 miles (72 km) north of Corpus Christi, Texas. Both their summer and winter ranges are restricted to a 25-mile (40-km) radius. Whooping cranes use a variety of habitats, including coastal and inland marshes, lakes, ponds, wet meadows, rivers, and agricultural fields. Wintering whooping cranes forage

For video of the whooping crane, go to <http://www.fws.gov/video/> and click on B-Roll.

primarily for blue crabs in salt marsh habitat, while in summer they hunt freshwater ponds for minnows, a favorite food. In the 2004-2005 winter, habitat at Aransas was excellent due to high rainfall and large freshwater inflows into the bays throughout the previous spring and summer. The inflows boosted the blue crab population and lowered marsh salinities, allowing cranes to drink directly from the marsh. Unlike most bird species, whooping cranes are territorial in both summer and winter and will defend and chase all other whooping cranes out of their estimated 350-acre (560-km) territories.

Historic population declines resulted from habitat destruction, shooting, and displacement by human activities. In 1941, the species reached a low of only 21 birds. It has been listed as endangered in the United States and Canada since the 1970s. Current threats include limited genetic diversity, loss and degradation of migration stopover habitat, collisions

with power lines, degradation of coastal habitat, and chemical spills.

Although the whooping crane population remains endangered, the population has been growing at four percent annually, and first reached 100 birds in 1986. Whoopers currently exist in the wild at three locations and in captivity at nine sites. The December 2005 total wild population is estimated at 341. This includes 218 individuals in the only self-sustaining population (the Aransas-Wood Buffalo flock), 59 captive-raised individuals released to establish a non-migratory population in central Florida, and 64 introduced individuals in the eastern U.S. that migrate between Wisconsin and Florida. The current breeding captive population at the Calgary Zoo, International Crane Foundation, Patuxent Wildlife Research Center, the Species Survival Center in New Orleans, and the San Antonio Zoo is 135 birds. The total population, wild and captive, in December 2005 was 476.



Pedro Ramirez/USFWS



Whooping Crane Eastern Partnership

The pilot's costume prevents the young cranes from imprinting on people.



Whooping Crane Eastern Partnership

The Whooping Crane Recovery Teams of Canada and the U.S. were combined into the first International Recovery Team in 1995, with five Canadian and five U.S. members. The team decided in 2000 to write a combined international recovery plan. This is the third revision of the U.S. whooping crane recovery plan, which was first completed in 1980. In January 2005, the draft revised recovery plan for the whooping crane was published in the *Federal Register* for public review and comment.

The wild whooping crane population is characterized by low numbers, slow reproductive potential, and limited genetic diversity. The possibility exists that a single catastrophic event could eliminate the wild, self-sustaining Aransas-Wood Buffalo population. Therefore, the principal strategy of the draft revised recovery plan is to augment and increase the wild population by reducing threats and establishing two additional and discrete populations. Offspring from the captive breeding population will be released into the wild in an attempt to establish self-sustaining wild populations. The continued growth of the Aransas-Wood Buffalo population, along with the two additional populations, will also stem the loss of genetic diversity.

Because of the whoopers' low numbers and growth potential, recovery criteria for the current plan have been established only for reclassification (downlisting) of the species. Downlisting can be achieved when 1) there are a minimum of 40 productive pairs in the AWBP and 25 productive pairs in each of two additional self-sustaining populations, or there are 250 productive pairs in the AWBP, and 2) there are at least 21 productive pairs in the captive population.

The increase in whooping crane numbers is a true success story. The beauty of these long-lived birds and their extreme peril of extinction have captured the hearts of many people and ignited the sustained efforts of many individuals and organizations, from international governments to schoolchildren. These efforts have made it possible for the species to not only persist against tremendous odds, but begin to recover.

Tom Stehn, the national whooping crane recovery coordinator (tom_stehn@fws.gov) is stationed with the wintering cranes at Aransas NWR in Texas.

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Endangered Laysan Ducks Thrive at Midway

by Ken Foote and
Michelle Reynolds

Island waterfowl are globally threatened. Hawaii has lost at least six of its nine unique waterfowl species since humans colonized the islands, and the remaining three are endangered. Fortunately, an “insurance policy” set up by the U.S. Geological Survey’s Biological Resources Discipline and the Fish and Wildlife Service attempts to reverse this trend for one of the world’s most vulnerable bird species.

The Laysan duck (*Anas laysanensis*), also known as the Laysan teal, is the rarest native duck in the United States and has one of the most isolated and restricted ranges of any waterfowl species. Until recently, the species consisted of a single population of approximately 500 birds. Then, in October 2004, 20 juvenile and prebreeding island ducks were taken on a 400-mile (645-kilometer) Pacific voyage. They were translocated from Laysan Island in the Hawaiian Islands National Wildlife Refuge (NWR) to Midway Atoll NWR, where their survival and breeding success has surpassed all expectations (Figure 1).

Random catastrophes are among the greatest threats to species that occur as small, isolated, or single populations. Hurricanes, tsunamis, accidental predator introductions, and disease outbreaks are just a few examples of the threats to such populations. To offset these risks, we are attempting to restore a second, wild population of Laysan ducks, essentially an insurance population, since it is unlikely that disaster would strike populations of two islands simultaneously.

Background

Laysan Island is one of the Northwestern Hawaiian Islands and part of the most geographically isolated archipelago in the world. Laysan lies almost 800 miles (1,200 km) to the northwest of Honolulu, and it is unique among the islands because of its large, hypersaline lake. In the 1800s and early 1900s, bird poachers and guano miners had a tremendous impact on the island’s wildlife and its habitat. People also introduced rabbits, which devastated the vegetation, turning the island into a virtual desert and leading to the extinction of three endemic land birds, the Laysan rail (*Porzana palmeri*), Laysan honeycreeper (*Himatione sanguinea sanguinea*), and Laysan millerbird (*Acrocephalus familiaris familiaris*), as well as 10 species of plants. The Laysan duck was eaten by shipwrecked mariners on nearby Lisianski Island in the 1800s, but it was the devegetation caused by the rabbits that drove this species to the brink of global extinction. In 1911, after the Laysan ducks on Lisianski were extirpated, the total species population was 11 birds. After the rabbits were eliminated, the duck population gradually increased to several hundred birds. It was one of the first species listed as endangered.

The Laysan duck was once believed to be endemic to Laysan Island, but sub-fossil (partially fossilized) evidence revealed that it was also found on Lisianski Island, Hawai’i (the “Big Island”), Moloka’i, Maui, O’ahu, and Kaua’i. Midway Atoll



A Laysan duck hen with a brood of ducklings on Midway.

John Klaviter

NWR lacks fossil evidence due to extensive human alterations to the atoll, but it lies within the presumed prehistoric range of the species. Midway was chosen as the first translocation site because rats were eradicated there in 1996, and because the presence of NWR staff makes habitat restoration and post-release monitoring of translocated ducks feasible.

A draft revised recovery plan, developed by the Service and USGS biologists in 2004, is now being completed. To meet the intermediate goal of downlisting the species from endangered to threatened, the plan calls for establishing four or more populations of Laysan ducks on other Hawaiian islands. The 2004 translocation of ducks from Laysan to Midway Atoll marks the first significant step in the recovery process. Forty-two founding birds were translocated during 2004-2005.

In October 2004 and 2005, a team of biologists and refuge managers led by

Dr. Michelle Reynolds, a wildlife biologist with the U.S. Geological Survey's Pacific Island Ecosystems Research Center, captured fledged juvenile birds on Laysan Island for the arduous 2-day boat ride to Midway Atoll NWR. The ducks were captured at night when they are more concentrated around the lake and most active. Selections of founder ducks were made after field biologist monitored the breeding success and identified broods (families). Founders were chosen on the basis of weight, sex, health, age, family history (a single duckling from each brood to maximize genetic diversity), and luck (which duck could be captured). Before their departure from Laysan, the ducks were given a clean bill of health by Dr. Thierry Work, a USGS veterinarian.

Prior to the arrival of the translocated ducks at Midway, Service personnel, refuge staff and more than 40 volunteers,

Top photo: Mark Vekasy and John Klavitter attach a radio transmitter in the aviary prior to the duck's release.

Bottom photo: Kelly Kozar and Michelle Reynolds release translocated Laysan ducks at Midway.



Michelle Reynolds



John Klavitter

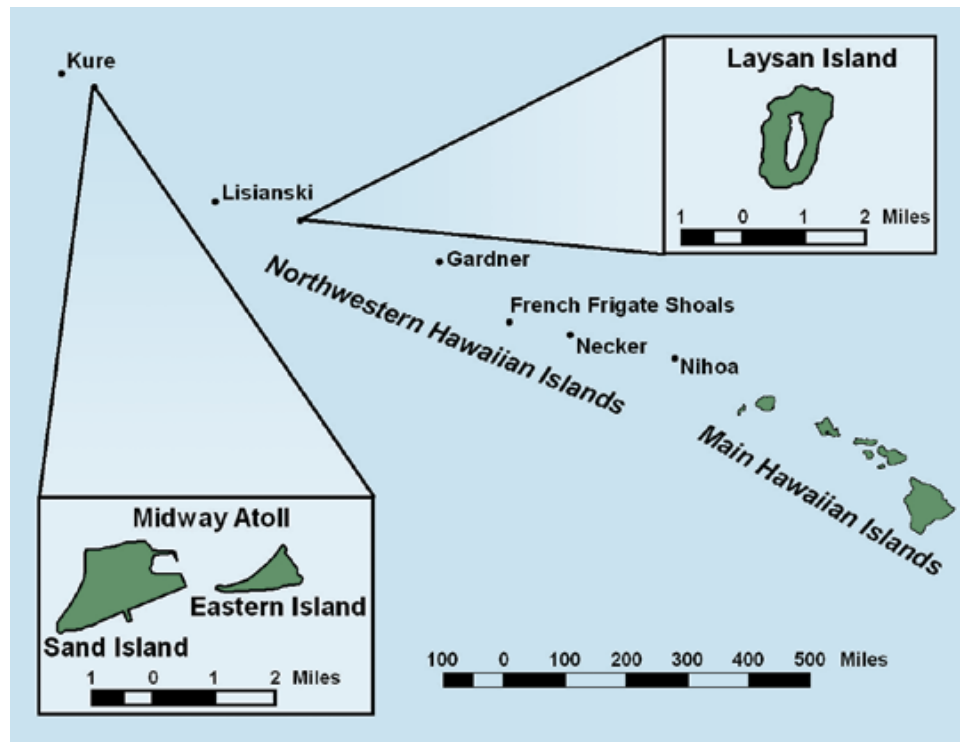
led by refuge biologist John Klavitter, invested 18 months of hard work (10,000 volunteer hours) in site preparation on Sand Island, which is part of Midway Atoll. The first step was the removal of non-native ironwood (otherwise known as Australian pine) trees (*Casuarina equisetifolia*) and golden crown-beard (*Verbesina enceliodes*) plants, followed by the excavation of nine shallow freshwater seeps. They also constructed 16 aviaries and planted more than 5,000 native bunchgrass (*Eragrostis variabilis*) plants to provide cover and nesting habitat for the ducks.

The Ducks Arrive

Prior to release back into the wild, the birds were placed within the aviaries on Sand and Eastern Islands and given high calorie mash, dehydrated flies, and locally occurring live food. Ducks were released with their aviary mates in groups of four and monitored closely via radio transmitters and spotting scopes for 48 hours before the next group was released. They adapted well to life on Midway, many increasing their body weights.

Surprising everyone, five of the six females nested seven months after their release. One of the inexperienced, young females produced infertile nests, and another had difficulty with asynchronous hatches and taking care of young, but three others were successful at their first attempts at motherhood. The ducks have done so well on Midway that the average clutch size is 7 eggs, compared to the average clutch of 3.8 eggs on Laysan. Eleven Laysan ducklings have fledged, becoming the first generation born at Midway in perhaps hundreds of years.

As of January 1, 2005, 40 of the 42 translocated birds were alive and doing well. A single fatality occurred in December 2004 when a male duck suffered head trauma caused by an aggressive Laysan albatross (*Phoebastria immutabilis*). One female with a failed radio transmitter has not been seen since her radio transmitter expired in July 2005.



What's Next?

Service personnel and volunteers have been busy all year improving habitat on Eastern Island, including the creation of three freshwater wetlands. Biologists will intensively monitor the survival and breeding of the translocated population on Midway and Laysan through 2006 to learn more about the species' recovery potential. If the population's persistence on Midway is likely, a translocation of additional birds to improve genetics is planned for 2009. Lisianski Island is the next proposed site for restoration and Laysan duck reintroduction.

The success achieved so far increases the hope that we can save this endangered species. Given the early stages of native habitat restoration, the ducks and their offspring at Midway are thriving and may someday rival the duck population of Laysan.

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Midway Atoll

Rob Shallenberger/USFWS

Bull Trout “Flip” Over Cabinet Gorge Dam

by Larry Lockard

Since 1952, Cabinet Gorge Dam on the Clark Fork River has blocked fish from migrating from Lake Pend Oreille, the largest lake in Idaho, into most of western Montana. Among those fish were hundreds, perhaps thousands, of native bull trout (*Salvelinus confluentus*).

In 1998, the Service listed the bull trout in the Columbia River drainage (including the Clark Fork River) as threatened due to habitat degradation, passage restrictions at dams, and competition from non-native fish. The loss of connectivity between headwater spawning and rearing streams and the productive downstream waters of Lake Pend Oreille was identified as one of the most significant factors limiting the recovery of bull trout in the Clark Fork River drainage.

Bull trout are large migratory char of the Pacific Northwest. They often grow to maturity in lakes and swim upstream, sometimes over 100 miles (160 kilometers), to spawn in the small streams

where they were born. Their life cycle is similar to that of salmon, except that Lake Pend Oreille functions as an inland ocean and bull trout don't die after spawning. The world record bull trout, a 32-pound (14.5-kilogram) fish, was caught at Lake Pend Oreille.

The Clark Fork River is the largest river flowing from Montana, and it drains most of the western landscape of that vast state. For 50 years, fish migrations in the Clark Fork River were blocked by a series of dams. In 1999, however, the Avista Corporation and the Fish and Wildlife Service formed a partnership to develop fish passage methods at Cabinet Gorge Dam. The Service provides the lead biologist, while Avista provides funding and other biologists to carry out a variety of recovery actions. In 2005, after a four-year experiment involving the passage of 140 large adult bull trout upstream over the dam, biologists concluded that the method was successful. The long-term conservation efforts committed to by Avista and the Service in 1999 reflect a mutual desire to recover bull trout while facilitating the production of electricity at dams on the Clark Fork River.

As part of the experiment, radio transmitters were surgically placed inside the bodies of bull trout to allow biologists to follow their movements. From 2001 to 2004, about 35 fish each year were captured below Cabinet Gorge Dam and

Avista biologist tracking signals from a radio tagged bull trout in a spawning tributary to Cabinet Gorge Reservoir.



Larry Lockard

trucked to release sites upstream. The fish then swam upstream to a tributary, the East Fork Bull River, where they spawned, mixing with other bull trout that had resided in the Cabinet Gorge Reservoir throughout their lives. About half of the transported bull trout survived the rigors of spawning. Following the spawning season, biologists used weir traps to recapture some of the survivors. They were given a free ride back downstream and released into the Clark Fork River below Cabinet Gorge Dam. Other bull trout swam back down the Bull River on their own, making their way through the reservoir and the dam turbines back to Lake Pend Oreille. Radio tracking determined, to our surprise, that more than half of the fish that passed through the dam turbines survived.

These fish transfers have increased the number of spawning bull trout in several streams that had extremely depressed populations. Since each adult female can carry as many as 10,000 eggs, the potential boost to the population from just a few large spawners can be significant.

In 2004, the Service used new technology to take the program to a new level. Collaborating with Avista, it developed a rapid response genetic assignment method to determine the stream of origin for bull trout captured below Cabinet Gorge Dam. This method involves rapid processing of a genetic sample from a small piece of fin. Within 48 hours, the results are used to "assign" individual bull trout, based on their genetic profile, to the stream in which they hatched. In the future, this method will allow biologists to transport fish captured below Cabinet Gorge Dam to appropriate release sites above any of the three dams on the lower Clark Fork River. Drs. Don Campton and Bill Ardren from the Service's Abernathy Fish Technology Center developed and manage the genetic program.

The partnership of the Service and Avista on the lower Clark Fork River offers exciting promise in support of the eventual recovery of bull trout. The



Larry Lockard

innovative fish trapping, transport, and genetic assignment techniques developed in this project will have broad application for conservation of bull trout and other rare fish species throughout the country.

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Service and Avista biologists surgically implant a radio tag in an 11-pound (5-kilogram) male bull trout before transporting the fish over Cabinet Gorge Dam.

Ferrets Test Freedom at Vermejo Park Ranch

by Joe Truett



Released ferrets quickly learn the importance of prairie dog burrows for escaping predators and finding their food.

Clouds darkened the evening sky as three trucks skidded down the rain-slick ranch road toward a prairie dog town in northern New Mexico. Among the passengers were Mike McCollum, Southwest Regional Coordinator for the U.S. Fish and Wildlife Service's "Partners for Fish and Wildlife" program; Vermejo Park Ranch Manager Marv Jensen; and Dustin Long and Larry Temple, field biologists with the Turner Endangered Species Fund.

The trucks passed through an electric net fence and stopped after a short distance. All passengers exited and moved across the wet shortgrass prairie on foot or by all-terrain vehicles. The focus of their attention: a welded wire cage sitting on the ground.

One of the men lifted the cage from its attachment to a corrugated plastic tube that projected a few inches above ground. The tube led underground into

the throat of a prairie dog burrow. Under the darkening sky, the group applauded as cages were lifted from two other sites nearby.

This ritual on the Vermejo Park Ranch, some 30 miles (48 kilometers) southwest of Raton, New Mexico, would have perplexed the casual observer. Though seemingly mundane and a bit odd, it marked a historic event. Removal of the cages freed the first black-footed ferrets

Mike McCollum, USFWS, (left) inspects a ferret release cage at Vermejo Park Ranch with ranch manager Marv Jensen and his wife Mary Lynn.



For video of the black-footed ferret, go to <http://www.fws.gov/video/> and click on B-Roll.

Turner Endangered Species Fund photos

(*Mustela nigripes*) to roam New Mexico prairies in more than half a century. The ferrets, however, preferred not to participate in the ceremony, hiding underground until the people and the last daylight had retreated.

Black-footed ferrets largely disappeared from New Mexico with the wide-scale poisoning of their prey species, prairie dogs, in the first half of the 20th century. Thirteen ferret skins in museums, the last collected in 1934, verify the species' historically widespread presence in the state. Elliot Barker, one-time director of the New Mexico Department of Game and Fish, trapped a ferret and saw another in a prairie dog colony near Castle Rock on the Vermejo Park Ranch in 1930. Very few reliable reports of wild ferrets in New Mexico date later than 1950.

The ferret release on Vermejo Park Ranch resulted from close collaboration among the Turner Endangered Species Fund, the New Mexico Department of Game and Fish, and the Fish and Wildlife Service. Other agencies, including the U.S. Geological Survey's Biological Resources Discipline (BRD) and the U.S. Department of Agriculture's Wildlife Services, provided important support and advice.

Unlike other ferret releases that have taken place during the past 15 years, this release was never intended to be permanent. It is an extension of pen-based preconditioning of captive-bred ferrets for release in approved areas elsewhere. The ferrets will be recaptured later for translocation to permanent release sites in Arizona, Wyoming, or perhaps Mexico. The release experiment at Vermejo Park has two important purposes: training ferrets to live in the wild and training biologists to monitor wild ferrets.

Within 10 days after the release, nightly spotlight surveys of the three ferret families began to show cause for worry. Despite pre-release erection of electric netting to exclude coyotes (*Canis latrans*) and other potential ferret predators from the 800-acre (1,280-ha) release area, it turned out that at least three swift

foxes (*Vulpes velox*) remained inside. Ominously, the foxes began to focus their hunting near two of the three newly released ferret families.

Ferrets in these families began to disappear. In desperation, the New Mexico Department of Game and Fish was called for permission to livetrapped and remove the foxes. Everyone hoped it wasn't too late.

The plan was to begin trapping near the fox den site. But before traps could be set, the "lost" ferrets began reappearing. Dean Biggins, the BRD ferret biologist, suggested they may simply have cached enough food for several nights and remained underground.

As if to show how tough they were, some of the ferrets eventually moved into the fox den. The foxes moved elsewhere.

Three weeks after the release, most or perhaps all of the ferrets remained alive and apparently healthy. Biologists hope to recapture the oldest kits before their juvenile hormones stimulate them to disperse. In the meantime, this experiment has proved instructive for the biologists and apparently also for the ferrets. In the ferret world, success is survival.

What are the implications? Perhaps ferrets routinely can be preconditioned in the wild instead of in expensive outdoor pens, as has been the protocol to date. Prairie dog colonies too small to sustain ferret populations over the long term may be useful as short-term ferret training grounds. The demonstrated ability of these ferrets, most of them naïve zoo animals, to prosper on Vermejo Park Ranch, and the ability of biologists to successfully monitor them, suggests that future permanent releases of ferrets at Vermejo may aid in the species' recovery.

Joe Truett is the senior biologist for the Turner Endangered Species Fund, a private, non-profit charity dedicated to conserving biodiversity by ensuring the persistence of imperiled species and their habitats.



This electric fence deters coyotes and other predators from the ferret release area.

The Return of the Clams

by Robert S. Butler and
Paul Hartfield



Dolores Savignano/USFWS

These mussels carry tags that will allow biologists to monitor the success of the reintroduction effort.



Dolores Savignano/USFWS

Monitoring mussels can be a community activity. Here, Maria Clark peers through a device that enables her to see mussels more closely.

A small group of biologists makes its way down the steep, rain-slicked river bank, taking care not to expose their bare legs to the prolific patches of briars and stinging nettle growing there. Finding a path to a remote river shoal, they carry snorkeling gear and small coolers. The coolers contain vials filled with thousands of lab-cultured, weeks-old aquatic snails and mussels waiting to be released.

The young mollusks will soon find a new home in and on the river bottom, where it is hoped they will grow, reproduce, and become self-sustaining members of the aquatic community. This is only one event in ambitious recovery programs to restore populations of critically imperiled species through adult and cultured juvenile translocations into stream reaches scattered about the Cumberlandian Region and the Mobile River Basin of the southeastern United States.

The Cumberlandian Region is an area encompassing the Cumberland and Tennessee River systems within the Mississippi River basin. The Mobile Basin drains portions of the central southern states into the Gulf of Mexico. Together, they encompass portions of seven states and support the highest level of freshwater molluscan biodiversity in the world.

Known widely during the nineteenth century for their large river shoals and unique fauna, these basins served as primary centers of speciation and endemism for mollusks, fishes, crayfishes, and other aquatic organisms. These basins also have the dubious distinction of having lost the highest number of species to extinction in North America. Virtually all of these extinctions were

aquatic species, primarily mussels and snails. Impoundment and channelization eliminated river species from many areas, and modified and fragmented creek and river habitats, leaving their fauna more vulnerable to sedimentation and chemical pollution. Many of the surviving mollusk species are highly imperiled and largely restricted to suitable habitat in relatively few isolated streams. Today, however, federal, state, and other conservation biologists are working diligently to prevent other mussels and snails from being added to that infamous list of bygone species.

Recovery plans for nearly all southeastern mollusks include tasks for propagating juveniles and restoring wild populations through population augmentation and reintroduction activities. Until fairly recently, very little was known about these animals, including their natural history, habitat requirements, and interactions with other aquatics. Since the 1980s, however, biologists have been working to fill these gaps, and information from these efforts has been used in developing the technology needed to culture imperiled mollusks under artificial conditions. The complex and usually poorly known life history of freshwater mollusks—particularly mussels, which

have specialized larvae (glochidia) that are parasites of host fish—was only one stumbling block on the path to achieving this critical recovery goal. Diets to meet the nutritional needs of juvenile mollusks are also poorly known and difficult to develop. Vast experimental networks of tubing, wiring, pumps, and tanks at mussel culture facilities have been refined over time to improve propagation success. Currently, several facilities are conducting propagation related research on snails and mussels of the Cumberlandian Region and Mobile Basin.

The complexity of restoring often highly endemic species of mollusks required the development of augmentation and reintroduction strategies for each basin. The Mobile Basin strategy includes 24 federally listed mussels and snails, along with 10 other endemic species of concern. The Cumberlandian Region strategy focuses only on the most imperiled mussels, which includes 29 federally listed species, 5 listing candidates, and 21 species of concern. Both basin strategies call for coordination with partners to 1) prioritize species based on level of imperilment, 2) identify stream segments with habitat suitable to mussel augmenta-

tion or reintroduction, 3) rank stream segments according to their relative importance for each species' recovery, 4) develop individual site augmentation and reintroduction plans for specific restoration activities, and 5) outline the propagation, restoration, and monitoring activities needed for each species' recovery.

The task of developing these strategies and making augmentation and reintroduction programs a reality has required coordination and cooperation among numerous partners: Fish and Wildlife Service field offices in the northeast and southeast, other federal agencies (U.S. Forest Service, U.S. Geological Survey, and National Park Service), state agencies (Alabama Division of Wildlife and Freshwater Fisheries, Georgia Department of Natural Resources, Kentucky Department of Fish and Wildlife Resources, Mississippi Museum of Natural Science, North Carolina Wildlife Resources Commission, Tennessee Wildlife Resources Agency, and Virginia Department of Game and Inland Fisheries), universities (Tennessee Technological University and Virginia Polytechnic Institute and State

University), and non-governmental organizations (Tennessee Aquarium Research Institute, The Nature Conservancy, and World Wildlife Fund).

These agencies and organizations share the tasks of 1) surveying streams to locate and assess targeted mollusk populations, 2) collecting broodstock for culture activities, 3) identifying stream segments for potential population restoration activities, 4) conducting life history research, 5) developing propagation technologies, and 6) funding the various aspects of the propagation and larger recovery program.

This hard work is beginning to pay off. For example, researchers have determined the fish hosts for dozens of imperiled mussels. Life history studies have led to the development of propagation technologies for a number of species, and hundreds of thousands of juvenile mussels and snails are being produced and released for population augmentations or reintroductions in several states. Restoration activities are beginning to spread to other watersheds and species as well. New facilities are being planned or are soon coming on line to share the increasing workload. Reversing the decline of our unique molluscan fauna has begun.

Biologists with the Service, U.S. Geological Survey, and Virginia Department of Game and Inland Fisheries release mussels in the upper Clinch River.



Jess Jones/USFWS

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First, Acquire Knowledge

by Cathy Pollack



Ron Panzer

Before a recovery plan for an endangered or threatened species can be written and carried out, knowledge of the species' life history is needed. If critical information is missing, recovery efforts can be thwarted. One small, unknown aspect of a species' life history might be the reason it is listed in the first place. A rare Midwestern orchid species provides an example.

The Fish and Wildlife Service listed the eastern prairie fringed orchid (*Platanthera leucophaea*) as a threatened species in 1989. This wildflower has declined to roughly 70 percent of its original range, mainly due to habitat loss (Bowles, 1993). It currently grows in remnant mesic (moist) prairie sites in Wisconsin, Illinois, Michigan, and Ohio. A recovery plan adopted in 1999 identified specific recovery tasks, which included site protection, habitat management, seed introduction and augmentation, and research to support recovery. The research was needed for things that

were not known about the orchid, such as its population genetics and which species serve as its natural pollinators.

What has been learned about the orchid is that it requires pollination by hawkmoths for sexual reproduction (Bowles, 1983; 1985). The flowers of this plant have the longest nectar spur (up to 5 centimeters, or about 2 inches) of any north temperate orchid species, and pollination seems to be restricted to hawkmoths with a proboscis long enough to reach the nectar, which is held at the swollen base of the spur (Bowles, 1983; Sheviak & Bowles, 1986). These insects also extract nectar from flowers of many other plants and travel great distances to find food (Fleming 1970). The moths are likely to visit only those orchid populations that are large enough to provide a nectar resource competitive with that of other plants (Bowles 1983).

The prairie fringed orchid's flowers are fragrant only at night, and pollinia are picked up by the proboscises of



Paul Pratt

hawkmoths as they ingest nectar. Flowers are adapted to outcrossing (pollination with flowers of other individuals), but plants appear to be self-compatible, and self-pollination probably occurs at high levels in small populations (Bowles & Bell 1999). However, fruit set appears to be reduced if the plants are self-pollinated (Bowles 1983). Plants with a large inflorescence (cluster of flowers) that are exposed above the prairie canopy, and away from shrub cover, have the highest potential for pollinator visitation and seed production (Bowles 1985).

To confirm a moth species as a pollinator, it has to be caught with orchid pollinia attached to its proboscis. Previous pollinator identification studies in Michigan, Ohio, and Wisconsin identified the pandorus sphinx (*Eumorphia pandorus*), achemon sphinx (*Eumorphia achemon*), and hermit sphinx (*Sphinx eremitus*) hawkmoths as pollinators (Cuthrell 1994, Cuthrell et al. 1999, Crosson et al. 1999). Because there had not been any research of this kind conducted in Illinois or Iowa, a pollinator identification study was initiated in 2004 and continued in 2005. The first objective of this research was to determine if natural pollinators are still available and to identify them. The next objective was to determine if the host plants upon which the moth caterpillars depend also occur at the orchid sites.

Seven sites were surveyed for a total of 29 survey-nights. Surveying included taking nectar measurements from 10 orchids per site each evening and dawn. Two light sheets were used for moth capture. One or two funnel traps were also used per site. Later in the season, a plant species analysis was performed at each site.

On a typical night, surveyors arrived around 5:00 p.m. They began by taking nectar measurements and setting up the equipment, followed by observing the orchids all night, watching for hawkmoths feeding on the orchids. Visual observation was conducted from about 8:00 p.m. to 4:30 a.m., followed by additional nectar measurements.



Ron Panzer

A museum specimen of a hawkmoth, showing flower pollinia.

The studies confirmed that the hermit sphinx is a pollinator in Illinois and Iowa. Six specimens were caught with orchid pollinia attached to the proboscis. A Carolina sphinx (*Manduca sexta*) also was caught on one orchid, but it is only considered a “nectar thief” since it did not carry orchid pollinia. Pandorus sphinx and achemon sphinx, confirmed as orchid pollinators in other states were also captured, but none carried orchid pollinia. Analyses of the plant species at each site are still being conducted. Larva food of the hermit sphinx includes bee-balm, bugleweeds, mints, and sage.

We anticipate that these studies will give land managers additional knowledge they need to guide the recovery of this spectacular but threatened wildflower.

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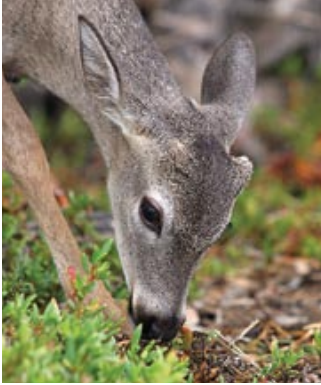
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by Phillip Hughes

Habitat is Key for a Diminutive Deer



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The diminutive Key deer (*Odocoileus virginianus clavium*), like most other mammals of the Florida Keys, is endemic to these island habitats, at least at the subspecies level. The Keys, and these mammals, were isolated from the mainland thousands of years ago by rising sea levels at the end of the Pleistocene Epoch. The Key deer differs from its mainland relatives by its small size, relatively short legs, the lack of a lower rear molar, a black mask across the muzzle and forehead, and looser social bonding.

Key deer numbers bottomed out in about the late 1940s at fewer than 50 individuals, due primarily to excessive hunting and, later on, habitat loss. However, human caused declines began to turn around after the 1946 arrival of Jack Watson. Watson was financed by the Boone and Crocket Club and National Wildlife Federation to be a game warden for the Florida Keys and Everglades National Park. He was eventually hired by the Bureau of Sport Fisheries and Wildlife (forerunner of the Fish and Wildlife Service) after the advent of the National Key Deer Refuge in 1957. During his tenure, the deer population grew to around 200.

Since it was listed in 1967 as endangered, the Key deer population has seen ups and downs. There are currently about 600 deer occurring on 20 to 25 keys. However, the majority of these, about 500, are concentrated on two adjacent Keys, Big Pine and No Name.

Key deer can tolerate brackish water for limited periods, but availability of freshwater limits their numbers and distribution among the keys. Unlike with mainland deer, mangrove foliage may comprise a substantial portion of the

diet of individual Key deer. However, the combination of diverse flora, dense cover, and freshwater sources found among rockland pine and hardwood hammock communities make them the premier habitats. These unique plant communities, which blend the dominant West Indian flora with North American elements, are globally imperiled. The rockland pine flora includes several endemic species, listing candidates, and species that respond favorably to fire. In the absence of fire, plants of the hammock communities proliferate, resulting in hardwood encroachment.

Key deer feed on about 200 species of plants, which provide good nutrition and, especially among hammocks, ideal cover for fawning. The limestone for which the local pine habitat is named contains depressions that collect and retain surface water from precipitation. Of the good habitats that were available for acquisition over the last decade, easements and titles have been acquired for a significant portion by Monroe County, the State of Florida, the Key Deer Refuge, and non-profit organizations.

Much of the Key deer's habitat is in partly urban settings with mixed, often checkerboard ownership patterns. Nonetheless, the refuge has managed its habitat to attain about 90 percent control of invasive exotic plants, and it carries out an active controlled burning program. The Nature Conservancy assists and carries out similar programs on selected private parcels. The checkerboard ownership and landscape pattern often complicate fire management. Urban-imbedded parcels are difficult and expensive to burn. While pinelands require fire to preclude hardwood encroachment, hammocks can be damaged by fire when

vulnerable to burning, such as during dry periods. Land managers seek to strike a balance in order to conserve deer habitat, fire-adapted endemic plants, and a diverse landscape, while simultaneously committing significant resources to fuel reduction at the urban interface.

In the early 1900s, during the initial period of major development in the Lower Keys, mangrove habitats were hit relatively hard as subdivisions were oriented toward coastal areas, including mangrove estuaries. Often, parallel canals were cut, and the resulting spoil was used to expand the buildable area. This development provided some new areas of upland. Once large scale mortality from poaching and other causes was brought under control several decades later, the habitat potential of these areas was realized, and they ultimately carried a significant component of the population as increasingly tame deer foraged among them. However, in the meantime, the advent of wetland regulations shifted development pressure to remaining private upland areas.

Dr. Roel Lopez of Texas A&M University completed his doctoral work on deer population dynamics and ecology in 2001, focusing on Big Pine and No Name Keys. He proposed that the deer population response to urban development may be characterized like a bell-shaped curve. Deer responded positively to a level of increased development, then reached a limit beyond which a decline would follow. The current situation includes a mixture of private lands interspersed with carefully managed refuge habitats, citizens that adhere to reduced speed limits, and land use initiatives by Monroe County that encourage building on already scarified lots. The county also has deer-friendly fencing ordinances. Dr. Lopez's estimate of about 500 deer in the core area reflects a 240 percent increase from 1971, the time of the last major mark-recapture study. Clearly, the deer have taken to the current situation.

A Habitat Conservation Plan (HCP) for Big Pine and No Name Keys is in the final stages of development. The

HCP applicants are Monroe County, the Florida Department of Transportation, and the Florida Department of Community Affairs. The objective of the HCP is to allow for limited additional development in the project area over a 20-year period while maintaining long-term viability of the deer and their habitat. The basic mechanics of the HCP are linked to a population viability analysis developed by Dr. Lopez. The analysis incorporates a matrix model of population dynamics and a spatial habitat model of carrying capacity and secondary impacts.

An important recovery action currently underway is the translocation of deer from the densely populated Big Pine Key, to augment numbers on nearby Sugarloaf and Cudjoe Keys. The translocations began in 2003, and to date, 39 deer—23 females and 16 males—have been moved. Twenty-four

were moved to Sugarloaf Key and 15 to Cudjoe Key. The deer were acclimatized in soft-release pens on the recipient keys prior to release. Two have succumbed to road mortality, and two returned to Big Pine Key. Of those, two had escaped from the pen early. The rest are doing well and still being monitored. A Texas A&M graduate student is studying the translocated deer. This effort will fulfill one of the last major recovery tasks to be accomplished and will aid in the attainment of an outstanding criterion for reclassification: that is, the establishment of two additional, stable populations on the periphery of the range.

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by Britta Muiznieks

Captive Propagation and the Key Largo Woodrat



Clay DeGaynes

Like kangaroo rats, woodrats have an image problem with some people because of their name. Woodrats are not the pest animals you may see skulking around back alley trash cans; instead, they are wild creatures that need natural habitat in which to survive.

The Key Largo woodrat (*Neotoma floridana smalli*), the southernmost subspecies of the eastern woodrat, is only known to occur in the hardwood hammock vegetation of northern Key Largo, Florida. Although habitat has been set aside, fewer than 500 individuals are thought to remain in the wild. The subspecies was listed as endangered in 1984. By 2003, a population viability analysis suggested that the woodrat has a high risk of extinction within the next 10 years.

Biologists are trying to determine the causes for the continuing decline. Possible threats include the effects of feral and free-roaming domestic cats, black rats, fire ants, habitat loss, raccoons, and disease. The Fish and Wildlife Service, in conjunction with the Florida Department of Environmental Protection, initiated a program in 2003 to remove feral and free-roaming cats from public lands containing occupied woodrat habitat. Black rats, although currently not captured in large numbers, are thought to compete with the woodrat and may reduce its productivity. All black rats captured during trapping efforts are removed from woodrat habitat. Although still considered a threat, fire ants appear to have declined as hardwood hammocks have recovered to their pre-disturbance state. Fire ants are associated with disturbed habitats, and much of the land in north Key Largo had at one point been slated for development. The main disturbed area, the County Road 905 right-of-way, is treated twice a year with Extinguish, a slow-acting bait, and areas with visible mounds are spot-treated to control fire ants.

To protect the hammocks and wildlife of north Key Largo from development,

the Service established Crocodile Lake National Wildlife Refuge, and the state of Florida established the Key Largo Hammocks State Botanical Site. Although these lands were set aside for endangered species, they have inadvertently become dumping grounds for unwanted animals (such as cats and raccoons), and active management of these areas is now needed to maintain them as suitable woodrat habitat. Residential development within and adjacent to protected lands, as well as the location of a waste transfer station within the refuge, provides a constant source of black rats for recolonization and contributes to an increase in the abundance of nuisance native and non-native species. A long-term cat and black rat removal program is needed, as well as a study to determine if the apparently high raccoon density in the area is affecting the Key Largo woodrat.

In response to the dramatic decline in woodrat abundance and the undetermined causes for the decline in the wild population, the Service brought two woodrats, one male and one female, into captivity on April 16, 2002, marking the start of Service efforts to work towards recovery through captive propagation. The Service simultaneously began

developing a Key Largo woodrat captive propagation and reintroduction plan. The plan, completed in 2003, established a goal of founding a captive population with six male and six female wild-caught woodrats. All were initially housed at the Lowry Park Zoo in Tampa, Florida.

Today, there are 26 captive Key Largo woodrats in captivity, including the 12 founders and their 14 offspring. Some of the woodrats are at Lowry Park Zoo and some are at another captive facility in Orlando, Florida.

Successful captive propagation has been challenging. While the 14 offspring produced attest to the fact that woodrats can be bred in captivity, there have been many breeding attempts that did not produce young, and the litter sizes in captivity have been consistently smaller than those reported for other woodrat subspecies in the wild. In addition, the breeding attempts can be dangerous for the woodrats, particularly the males. There have been several instances of aggressive encounters when woodrats have been introduced, and some have resulted in injuries. In one instance, a male woodrat died as a result of his injuries.

Maintaining genetic diversity within the captive population was another important consideration during captive propagation planning, and a successful partnership was established with U.S. Geological Survey scientists to conduct a detailed genetic analysis of every woodrat in captivity, as well as all wild-caught individuals. Information from the genetic analyses has allowed us to identify pairings of captive individuals that would best preserve the original genetic diversity of the captive population.

Many hurdles remain before we can consider captive propagation efforts to be effective, and there are also many opportunities to learn from the captive woodrats, both to aid in understanding the wild population and to improve captive breeding efforts. Studies of behavior, social interactions, the role of hormones in determining receptivity and reproductive success, nutrition, and many other aspects have been proposed. By



Clay DeGaynes

far, the greatest hurdle will be developing successful methods of reintroducing woodrats back into natural habitats on Key Largo. For now, the Service plans to continue to maintain woodrats in captivity, grow the captive population, and take every opportunity to learn from the captive animals.

“Overall, I feel pretty good about the captive propagation program” says Cindy Schulz, endangered species program coordinator in the Service’s Vero Beach, Florida, office, although she cites concerns about the logistical issues and challenges that will always be part of these efforts. “I’m excited about the new opportunities, too,” she adds. Many successful partnerships have resulted from the woodrat breeding program, and the opportunities to learn and improve our methods are increasing as more partners become involved.

Britta Muiznieks and Ralph DeGaynor examine a captured Key Largo woodrat.

Britta Muiznieks is a fish and wildlife biologist at the Service’s South Florida Ecological Services Office, Key Largo Sub-office (co-located at the Crocodile Lake National Wildlife Refuge), Florida.

by Brian Czech

Aleutian Canada Goose: Recovered and Still Going Strong



Slade Sapora

The Aleutian Canada goose nests entirely on islands of the Alaska Maritime National Wildlife Refuge. When non-native predators including the arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*) were introduced to these islands as early as the 18th century, the goose population plummeted and eventually reached a low of fewer than 800 (Amaral 1985). Following passage of the Endangered Species Act in 1973, the elimination of foxes, coupled with harvest restrictions and an active translocation program to fox-free islands, resulted in rapid population recovery (Subcommittee on Aleutian Canada Geese 1999).

By 2000, the Aleutian Canada goose population had risen to approximately 30,000. The next year, this intensively managed species was declared a recovery success story and was therefore removed from Endangered Species Act protection. Accordingly, the goose is now managed like most other waterfowl species in the U.S.

The existing population of approximately 60,000 (Trost et al. 2005) uses about 20,000 acres (8,095 hectares) of nesting habitat on the Alaska Maritime Refuge, which also contains approximately 350,000 acres (142,000 ha) of historic and potential nesting habitat that is not currently being used. This remaining potential nesting habitat varies in quality, but a reasonable estimate of nesting capacity is 100,000 adults, according to Vernon Byrd, Aleutian Canada Goose Recovery Team Leader and Alaska Maritime Refuge biologist.

Thousands of geese typically stage at the Sacramento National Wildlife Refuge Complex in California and at several of Oregon's coastal refuges, but the most important spring staging grounds are found around Crescent City, California, on state park lands and adjacent agricultural lands. The National Wildlife Refuge System has worked with the State of California to address the impact of these geese on private agriculture. Growing conflicts between geese and agriculture in this area need to be resolved prior to further increases in the size of the goose population, according to Bob Trost,

Aleutian Canada geese congregating on their California wintering grounds.



Gary Zahm/USFWS



USFWS

Nesting habitat for Aleutian Canada geese in the Alaska Maritime NWR.

Pacific Flyway Representative with the Fish and Wildlife Service in Portland, Oregon. At present, most of the habitat improvement work designed to provide forage for geese in this area is being conducted by California with money from state duck stamps, with the Service providing administrative support.

The Refuge System provides much of the Aleutian Canada goose wintering habitat. The most important unit is the San Joaquin River National Wildlife Refuge, California, which hosted over 90 percent of the population during most of the recovery phase. In recent years the wintering population has become more distributed throughout the San Joaquin Valley, with the San Joaquin Refuge typically hosting about 75 percent of the wintering birds, according to Dennis Woolington, Supervisory Wildlife Biologist for the San Luis National Wildlife Refuge Complex. Wintering flocks with tens to hundreds of birds are also commonly found at 14 other refuges in Washington, Oregon, and California. The degree to which the wintering population could be supported on other lands is unknown. However, substantial goose wintering habitat exists throughout the Pacific coast region.

While refuges provide critical roosting habitat and varying amounts of winter forage, much of the feeding occurs off-refuge, typically in farmers' fields. With the amount of food and roosting habitat available in the Northwest ecosystem, winter carrying capacity is probably in the hundreds of thousands (Trost, personal communication).

The objections of farmers who suffer crop damage caused by geese suggest that the Aleutian Canada goose political carrying capacity will be reached before its biological carrying capacity is reached. The preliminary population objective of 40,000 identified in the Pacific Flyway Management Plan (Subcommittee on Aleutian Canada Geese 1999) is a reflection of this potential conflict. This population objective was set higher than the level required to delist the goose, largely for the sake of providing hunting opportunity, but nevertheless is considered modest and has already been exceeded by approximately 20,000 geese.

It is reasonable to conclude that 40,000-60,000 birds with widespread nesting and wintering habitat comprise an evolutionarily viable population. However, this conclusion is based on

the conservation of an ecosystem, much of which is private agricultural property. History suggests that carrying capacity will decline as private cropland is managed more intensively or converted to uses that provide higher economic returns. As some croplands are converted, concentration of geese on other croplands will increase, causing greater pressure on the remaining agricultural community.

To address the reduction in carrying capacity and reduce the impacts of geese on existing agricultural land, the Refuge System could be supplemented with lands that could then be devoted to food production for the goose. The species would then have virtually all of its needs met by the Refuge System and presumably would gain a more secure future. The amount of additional land needed to support the current population is approximately 2,300 acres (915 ha). Whether or not this will happen depends on Congressional authorization, the availability of funding, and willing sellers. For now, the Aleutian Canada goose is recovered and still going strong.

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BOX SCORE

Listings and Recovery Plans as of March 1, 2006

GROUP	ENDANGERED		THREATENED		TOTAL LISTINGS	U.S. SPECIES W/ PLANS
	U.S.	FOREIGN	U.S.	FOREIGN		
 MAMMALS	68	254	11	20	353	55
 BIRDS	77	175	13	6	271	78
 REPTILES	14	64	22	16	116	33
 AMPHIBIANS	12	8	9	1	30	16
 FISHES	74	11	42	1	128	98
 SNAILS	24	1	12	0	37	29
 CLAMS	62	2	8	0	72	69
 CRUSTACEANS	19	0	3	0	22	13
 INSECTS	36	4	9	0	49	32
 ARACHNIDS	12	0	0	0	12	5
ANIMAL SUBTOTAL	398	519	129	44	1,090	428
 FLOWERING PLANTS	571	1	143	0	715	584
 CONIFERS	2	0	1	2	5	3
 FERNS AND OTHERS	24	0	2	0	26	26
PLANT SUBTOTAL	599	1	146	2	748	615
GRAND TOTAL	987	520	275	46	1,838*	1,043

TOTAL U.S. ENDANGERED: 997 (398 animals, 599 plants)

TOTAL U.S. THREATENED: 275 (129 animals, 146 plants)

TOTAL U.S. LISTED: 1,272 (527 animals**, 745 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 animal species have dual status in the U.S.

ENDANGERED *Species* BULLETIN

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