ENDANGERED Species BULLETIN

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Although the continuing loss or degradation of habitat is the primary threat to most endangered plants and animals, many of these species also face danger in a variety of other forms. Among these additional factors are environmental contamination from the misuse of pesticides and other chemicals, disease, invasions of harmful non-native species, and the loss of genetic diversity in small populations. This edition of the ***Endangered Species Bulletin*** *takes a look at these other threats which, like habitat loss, are often the result of human-related changes in the environment. The solutions usually are not obvious or easy to carry out, but cooperative public and private efforts offer hope that they may eventually be overcome.*

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On the Cover and Left
The Florida panther, which suffers the affects of reduced genetic viability, may soon benefit from the introduction of panthers from Texas.
John and Karen Hollingsworth©
Opposite Page
A mountainside of dead Fraser firs in the southern Appalachians killed by an exotic insect.
Scott Schlarbaum

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

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IN THIS ISSUE

Pesticide Impacts

by Linda Lyon

The relatively low population sizes of many threatened and endangered species often precludes using them for studies to assess the effects of pesticides and other pollutants. In some cases, FWS biologists use surrogate species for study. For example, in North Carolina, a non-endangered mussel, the eastern elliptio *(Elliptio complanata)*, serves as a surrogate species for research into pesticide effects on the endangered Tar spinymussel *(E. steinstansana)*. This work grew out of the 1990 investigation of a Tar spinymussel die-off that researchers linked to the use of insecticides.

Land managers sometimes use pesticides to *protect* endangered species. For example, careful use of selected herbicides can control the rampant spread of exotic weeds that degrade natural habitats. In these situations, the herbicides may be applied with hand-held equipment to direct the chemical onto the target plant. Such pesticide use often is done in conjunction with other Integrated Pest Management (IPM) methods, such as biological controls. Biological control includes techniques such as selected grazing or releasing insect herbivores

Environmental contaminants from such sources as hazardous waste sites, mines, urban runoff, and oil spills pose significant threats to endangered and threatened species. The Fish and Wildlife Service's (FWS) Environmental Contaminants Program works with other FWS programs, as well as other Federal and State agencies and the private sector, to prevent losses of endangered species and other organisms from pollutants. This article, the first in a series describing the effects of environmental contaminants on endangered species, discusses some of the threats associated with pesticides.

Now that the pesticide DDT has been banned in the United States, it no longer poses a hazard to our endangered species. True or false? To the surprise of many, the correct answer is false. Although it is true that DDT can no longer be used legally in the U.S., many of our wildlife species are still being affected by this chemical. DDT and its breakdown products can persist

Pesticides applied by air can drift into waterways and affect aquatic organisms.
Thomas Maurer/FWS

in the environment for decades. Also, there are stocks of DDT remaining in private hands, and container leakage or usage from these stocks can release DDT into the environment. Old production and disposal sites provide further sources of DDT. In addition, residues of DDT and other pesticides can be transported to the U.S. through air currents. These compounds, many of which are still widely used in Central and South America, can be picked up during the winter by migratory species.

In addition to the lingering effects of certain banned pesticides, endangered species potentially can be affected by some of the thousands of pesticide products currently registered for use in the U.S. (see sidebar on pesticide consultation). The domestic application of these pesticides totals about 2 billion pounds of active ingredients annually. Although many of these pesticides are designed to kill organisms, pesticides actually have a much broader range of intended effects. According to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), a pesticide is "... any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, and any substance or mixture of substances intended for use as a plant regulator, defoliant, desiccant."

Pesticides are used in myriad settings, including farms, rangeland, forests, rights-of-way, industrial sites, and homes. The types of pesticides available are as varied as the organisms for which they are intended. Among the most common pesticides are insecticides and herbicides, which are also the categories to which listed species are most likely to be exposed. However, effects may also result from other types of pesticides, including rodenticides, fungicides, and avicides (compounds used to control birds).

Pesticides are used for many beneficial purposes. When a pesticide is highly selective for a specific pest, it generally does not pose notable hazards to endangered species. However, many widely used pesticides are not particularly specific for the "target" organism. Such pesticides can cause unintended and unwanted effects to "non-target" resources. Endangered species can be exposed to pesticides by many routes, with the simplest form being direct contact. Animals can ingest pesticides indirectly through contaminated foods such as leafy material, seeds, and prey (including insects and other animals), or by water contamination through precipitation and irrigation. For example, birds, mammals, amphibians, and invertebrates may use contaminated puddles in a farm field for drinking, bathing, or breeding. Aquatic organisms can be exposed to pesticides entering water bodies through runoff and groundwater infiltration. Measurable amounts of pesticides have even been detected in rainwater.

Under FIFRA, pesticides may be used only in accordance with product labels that accompany or are affixed to the product from the point of manufacture. The labels may contain public health and safety warnings or other environmental limitations on the manner in which the pesticides can be applied. When pesticides are used according to the product label and in a specialized manner, such as spot treatment of weeds with herbicides, exposure of non-target organisms may be avoided. However, there are many pesticides that are not specific in their toxicity or exposure potential, and these compounds can pose threats to endangered species and other non-target organisms. Many poisonings of listed species are unintentional and related to normal uses of pesticides.

Indirect effects of pesticides can also have significant implications to endangered species. For example, herbicide drift can harm plants and consequently damage the habitat upon which an endangered animal depends. A given pesticide can be relatively non-toxic to an endangered species, but may be

that are specific for the exotic plant. IPM also can include cultural techniques such as managing soil fertility to favor native plants and select against exotic invaders.

FWS works with other government agencies and the private sector to mitigate the effects of pesticides on endangered species. In eastern Wyoming, a task force with members from FWS, the Environmental Protection Agency, State and municipal agencies, environmental organizations, and the ranching community collaborated on a successful plan that allowed for mosquito control while protecting the Wyoming toad *(Bufo hemiophrys baxteri)*. In southern Texas, the Cameron County Wildlife-Agriculture Coexistence Committee works to protect endangered species such as the aplomado falcon *(Faico femoralis septentrionalis)* from pesticides in the agricultural lands surrounding Laguna Atascosa National Wildlife Refuge. (See *Bulletin* Vol. XX, No.4.) In North Dakota, the FWS, the Environmental Protection Agency, and the State's Department of Agriculture have a formal agreement addressing the protection of endangered species from pesticide threats.

Pesticide Consultations

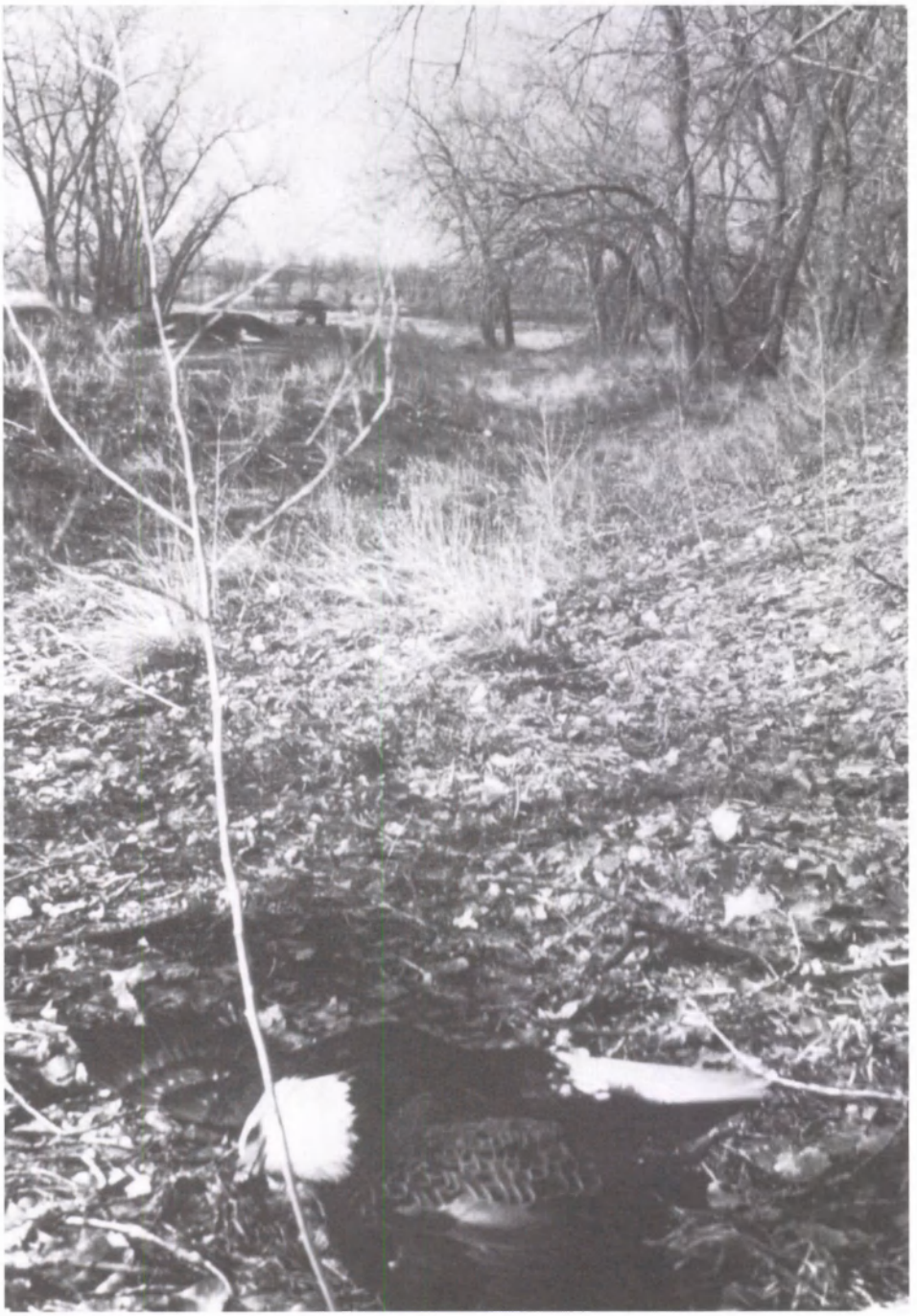
Under section 7 of the Endangered Species Act, all Federal agencies must ensure that any actions they fund, authorize, or carry out do not jeopardize the survival of any endangered or threatened plant or animal. This requirement applies to Federal agencies (including the Fish and Wildlife Service) that use, or authorize the use of, pesticides. Accordingly, before any insecticide, herbicide, or other pesticide can be used on a national wildlife refuge, the effect of that use on any listed species must be considered.

Similarly, the Environmental Protection Agency (EPA) must evaluate the effects that pesticides they register for use may have on listed species. Considering the hundreds of chemicals registered by the EPA, the myriad uses of these compounds (insect and rodent control, weed eradication, etc.), and the broad geographic areas in which the chemicals may be applied, completing the evaluations of their effects on listed species is an arduous task. The FWS and EPA are working together to streamline the review process and recommend ways the pesticides can be used without jeopardizing listed species.

lethal to its prey or food plants. Similarly, an insecticide can indirectly harm an endangered plant that may depend upon a specific insect pollinator.

There are few cases showing a singular link between a given pesticide and the status of a particular endangered species. However, because these compounds are designed to be toxic and are widely present in the environment, a strong program of research, education, interagency consultation, and careful management of pesticide use is vital for the conservation of many endangered and threatened species.

Linda Lyon is a biologist with the FWS Division of Environmental Contaminants in Washington, D.C.



One of at least seven bald eagles unintentionally killed in 1988 on a South Dakota farm after secondary exposure to the pesticide phordate. The eagles were poisoned by feeding on waterfowl that died at a contaminated wetland.
Diane Fries/FWS

Candidate Notice is Revised

by Rick Sayers

*I*n the February 28, 1996, *Federal Register*, the Fish and Wildlife Service (FWS) issued a revised and updated notice of review on the plant and animal species that are candidates for listing as endangered or threatened under the Endangered Species Act (ESA). The revised notice, part of a commitment to improve implementation of the ESA, results from a thorough review of the scientific information available on these species. The notice of review also asks for any new information that may exist on the status of the candidate species.

The revised notice identifies 182 species as candidates for future listing action. "Candidate species" are plants and animals for which the FWS has enough information to warrant proposals for listing as endangered or threatened under the ESA. The revised candidate list replaces an old system that listed nearly 4,000 species as candidates under three separate categories. The old system led many people to the mistaken conclusion that the addition of thousands of species to the endangered list was imminent. Under the revised notice, only those species for which there is sufficient information to support a listing proposal will be classified as candidates. In former notices, these species were referred to as "category 1 candidates." Although the FWS encourages the formation of partnerships to conserve these species, they do not have legal protection under the ESA.

The FWS will no longer maintain a list of the species formerly known as "category 2 candidates." These species remain of concern to the FWS but scientific information to support a listing proposal is not available. The FWS will continue working with the States and other partners and organizations like The Nature Conservancy to gather information on the status of these species.

Copies of the revised notice of review are available from the FWS Regional Offices (see *Bulletin* page 2 for addresses). This notice has been added to the FWS Endangered Species Home Page on the World Wide Web at http:/www.fws.gov/~r9endspp/endspp.html.

Rick Sayers is a wildlife biologists in the FWS Division of Endangered Species, Washington, D.C.

by Stefanie Barrett

Disease Threatens Green Sea Turtles

When the green sea turtle *(Chelonia mydas)* was listed under the Endangered Species Act in 1978, biologists cited numerous threats to its survival, including habitat loss, human exploitation, artificial lighting on nesting beaches, and incidental take during commercial fishing operations. Since that time, scientists have identified another significant threat—a disease known as green turtle fibropapillomatosis.

This disease may turn out to have a severe impact on the long-term survival of green turtles, and possibly other sea turtle species, throughout the world. Researchers are working hard in a cooperative effort to identify the causes and mechanisms responsible for its spread.

Green turtle fibropapillomatosis was first described over 50 years ago in an adult green turtle found near Key West, Florida, but its significance to sea turtle populations was not realized at the time. Following this discovery, the disease was reported in the Gulf of Mexico and the Pacific, west Atlantic, Caribbean, and Indian Oceans. A significant increase in cases has been reported over the last decade in well-monitored areas, particularly Florida and Hawaii. For example, since 1989, incidence of green turtle fibropapillomatosis at Kaneohe Bay on the Hawaiian island of O'ahu has

Right

A green turtle showing the fibrous tumors caused by fibropapillomatosis.

Reproduced with the permission of Dr. Lawrence H. Herbst and Dr. Paul A. Klein, University of Florida, Gainesville, Florida.

ranged from 49 to 92 percent of turtles captured. The disease generally strikes large juveniles, but adults can also be affected.

The disease is characterized by one or more non-cancerous fibrous tumors, which are commonly located on areas of soft skin, such as the neck, chin, mouth, eyes, flippers, and base of the tail. These tumors can be debilitating and are often fatal in severe cases. The disease may cause an increased susceptibility to marine parasites, obstructed feeding and swimming, greater vulnerability to fishing net entanglement, disorientation, and impaired vision or blindness. Similar lesions have been reported in flatback *(Natator depressus)*, loggerhead *(Caretta caretta)*, and olive ridley *(Lepidochelys olivacea)* sea turtles.

The cause of the disease is unknown at this time, but researchers at the University of Florida suspect it is most likely caused by a viral infection. Through a cooperative agreement with the Fish and Wildlife Service (FWS), the researchers have been able to narrow down the possible disease agents, ruling out most bacteria and trematode (parasitic flatworm) eggs. Evidence of a herpes-like virus was found, but researchers are unclear whether it is a primary or secondary infection. Once the cause of the disease is identified, a monitoring program can be implemented to determine an individual or population's exposure, the route of transmission in the wild, potential vectors or disease reservoirs, and the possible role of other environmental factors.

In a recent paper, Drs. L.H. Herbst and P.A. Klein of the University of Florida's Department of Comparative and Experimental Pathology described the challenges involved in assessing the influence of environmental factors on the incidence of the disease. Previous studies show significant variations in its occurrence, even between locations that are relatively close. For example, juvenile green turtles in the Indian River lagoon on Florida's Atlantic coast have shown a long-term average incidence of 50 percent, while a population on the ocean side of the barrier islands, less than a kilometer away, showed no evidence of the disease. Previous studies suggest that turtles in near-shore habitats with nearby human disturbance (industrial, agricultural, and urban development) have a higher incidence. Some researchers speculate that environmental contaminants may suppress the turtles' immune systems, but more study is required before any conclusions can be made.

There are still many questions about the disease and no proven solutions. However, ways to reduce its incidence and impacts may exist. First, habitat quality can be improved in areas where occurrence of the disease is high. Second, the potential to transmit the disease can be minimized. Handlers of affected turtles should use strict hygienic techniques and minimize the translocation of turtles or contaminated equipment. Third, surgical removal of tumors for the purpose of rehabilitation is a possibility for captive individuals, although not a practical option for wild populations. Experience has shown that tumors frequently regenerate. Researchers may someday develop an effective vaccine, but vaccinating turtles in the wild also would be impractical.

Despite the progress that has been made, there is still a long way to go in the struggle to control the disease's threat to green turtles and other sea turtle species. Through continued cooperation between the FWS, University of Florida, and other agencies and research facilities, scientists hope the gap between the knowns and unknowns of green turtle fibropapillomatosis will steadily close.

Until recently, Stefanie Barrett was a Cooperative Education student working with the FWS Jacksonville, Florida, Field Office. She now attends the University of Florida at Gainesville.

by Dennis B. Jordan

New Hope for the Florida Panther

The Florida panther (*Felis concolor coryi*), like most other endangered species, is threatened by a number of problems. Habitat loss or fragmentation, automobile collisions, environmental contaminants, reduced prey availability, and human disturbance have all taken a toll. Many scientists also believe that the panther likely suffers from a compromised immune system. But perhaps the most serious threat to the Florida panther is that of genetic viability.

Reduced to a single population of 30-50 adults, the Florida panther has been isolated from genetic interchange with other populations for a century or longer. Biologists believe that close inbreeding and erosion of the gene pool account for such medical problems as reproductive or cardiac abnormalities and increased suspectibility to infectious diseases in the panther's population.

The Fish and Wildlife Service (FWS) approved the first recovery plan for this severely endangered animal in 1981. That same year, the Florida Game and Fresh Water Fish Commission launched a radio-tracking effort with FWS funding support. Panther recovery activities initially were directed toward 1) protecting and enhancing the remaining animals and habitats and 2) research on biological, demographic, and genetic data needed to carry out the recovery program. A significant boost in the recovery effort came in 1986 with formation of the Florida Panther Interagency Committee, which coordinates recovery activities among the various Federal and State agencies cooperating in the effort. The recovery plan was revised in 1987 and again in 1995 to incorporate genetic restoration as part of the recovery program.

By early 1989, biologists had captured and radio-collared 29 panthers, enough to provide the data needed for a population viability analysis. That year, at a 1989 workshop sponsored by the FWS, computer-modeled demographic projections indicated that 1) the panther population was continuing to decline, 2) the population was losing genetic diversity at a rate of 3-7 percent each generation, 3) genetic diversity would continue to erode even if the population was stabilized, and 4) a reduction in fitness may have already occurred as reflected in the high incidence of reproductive abnormalities. The conclusion was that, under existing demographic and genetic conditions, the Florida panther would likely become extinct in 25-40 years.

Four subsequent workshops evaluated additional data on population viability and potential strategies to prevent the panther's extinction. The initial plan called for establishing a large captive-breeding population to help preserve the remaining genetic diversity and to produce animals for release into the wild. As a start, biologists removed six panther kittens from the wild in 1991 and another four in 1992.

By mid-1992, biologists had captured, examined, and radio-tracked more than 50 wild panthers, gaining a great deal of information on panther health, reproduction, mortality, and genetics. These data confirmed that the population's health continued to deteriorate significantly.

In response, the participating agencies convened another workshop in October 1992 to reevaluate options

for ensuring the panther's survival. They decided to cease the removal of panther kittens from the wild and put the captive breeding program on hold. Data presented at the workshop indicated that aggressive action to restore genetic viability might be the only way to save the Florida panther.

Biologists at the workshop considered various options for restoring genetic health to the Florida panther. The strategy eventually recommended by workshop participants, and accepted by the Interagency Committee, was to restore the flow of genetic material into the Florida population that would have occurred naturally if human impacts on the panther and its habitat had not resulted in its isolation. The decision was to introduce genetic material from the closest remaining *F. concolor* population that historically overlapped the range of the Florida panther--the Texas subspecies *(F. c. stanleyana)*.

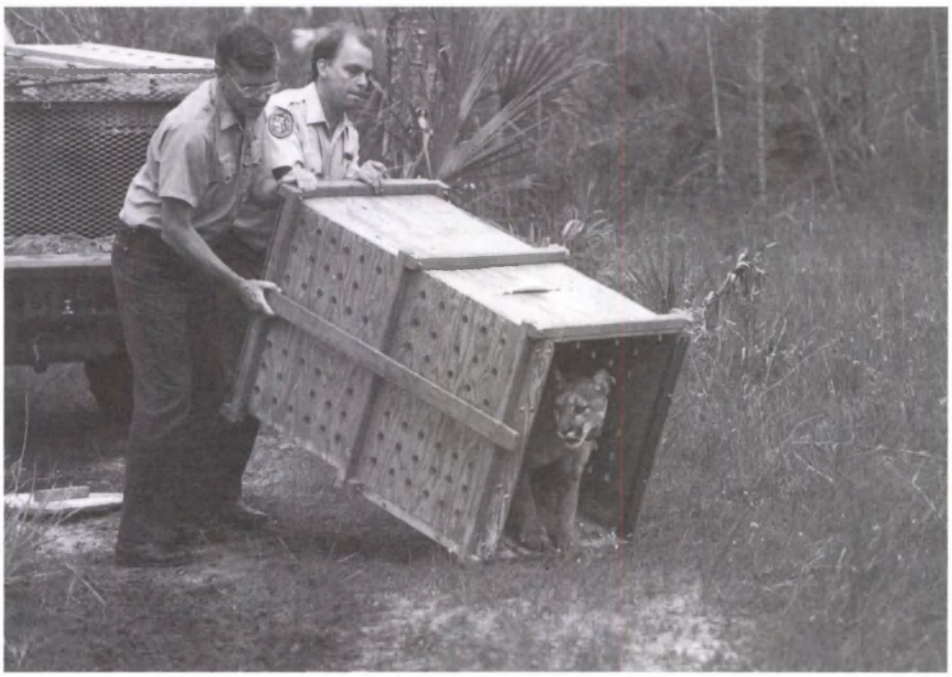
Biologists at the 1992 workshop decided that the introduction of 6 to 10 new breeding females was needed to reverse the effects of inbreeding and genetic loss in the Florida panther population. The participants also concluded that this would not swamp the existing gene pool, which may be adapted to local environmental conditions. A workshop in September 1994 put together a detailed plan for genetic restoration and management of the Florida panther. The FWS also produced an environmental assessment on the restoration program and alternatives.

The genetic restoration effort for the Florida panther began in 1995 with the translocation of eight females from the Texas population into the Florida population. Two of these panthers were released into the 70,000-acre (28,300-hectare) Fakahatchee Strand State Preserve in central Collier County, four went to various units of the 600,000-acre (243,000-ha) Big Cypress National Preserve, and the final two were placed into the Long Pine Key area of Everglades National Park.

State and Federal biologists will monitor the *F.c. stanleyana* females and their offspring closely to determine if they promote fertility, genetic diversity, and overall health in the Florida panther population. Although it is too soon to know if the program will succeed, the outlook for the Florida panther appears brighter today than at any time in recent history.

Dennis Jordan, the FWS Florida Panther Recovery Coordinator, is with the Gainesville, Florida, Field Office.

The introduced panthers seem to have adapted to their new homes. Two intercross litters have been produced as of early 1996. The first litter, born north of the the Big Cypress National Preserve at the end of September 1995, contained one kitten of each sex. The sire is an uncollared male Florida panther. The second litter, consisting of a single female kitten, was born at the end of November. It was produced by one of the females released into the Fakahatchee Strand State Preserve and a collared a male Florida panther (known to biologists as #51). All young have been marked with transponders and will be radio-collared after reaching 6 months of age. Another adult female released In the Big Cypress Preserve was struck by a vehicle and killed in September 1995 while crossing a road in Hendry County. A necropsy revealed that she was carrying three fetuses.



Left

Texas cougar female being released in Big Cypress National Preserve.

Bill Greer/Florida Game and Fresh Water Fish Commission

by Faith Thompson Campbell

The Invasion of the Exotics

An invasion, not from a foreign army but from an array of exotic plants and animals, threatens many of the nation's native species. Invading exotic plants, for example, already occupy at least five percent of our lands and fresh or brackish waters, and they are spreading rapidly. While invasions have occurred in virtually all States, the most serious documented impacts have occurred in the Hawaiian Islands, Florida, wetlands and riparian areas in other parts of the country, and the grasslands of the intermountain West.

The Australian tree *Melaleuca quinquenervia*, for example, occupies nearly a quarter of the remaining Florida Everglades ecosystem. When this non-native plant forms dense stands, the endangered snail kite *(Rostrhamus sociabilis plumbeus)* and wood stork *(Mycteria americana)* can no longer use the changed ecosystem (Maffei 1994). Between one-third and one-half of southern Florida's undeveloped coastal areas are lined by the Australian pine *(Casuarina equisetifolia)*, and its roots interfere with nesting by threatened sea turtles and the endangered American crocodile *(Crocodilus acutus)* (Macdonald 1989). On the Pacific coast, the endangered California clapper rail *(Rallus longirostris obsoletus)* will not live in marshes when marsh grass is displaced by pampas grass *(Jubata* spp.*)*, according to C.C. Bossard of the California Exotic Pest Plant Council.

Native animals are not the only victims of exotic species. Invading non-indigenous plants can also threaten endemic plants by crowding or other factors. Kathy Craddock Burks of the Florida Department of Environmental Protection has noted that dense shade cast by Brazilian pepper *(Schinus terebinthifolius)* and Australian pine is a factor in the decline of such rare plants as the endangered beach jacquemontia *(Jacquemontia reclinata)* and four-petal pawpaw *(Asimina tetramera)*. Invasions of Cogon grass *(Imperata brasiliensis)* are encroaching on the habitats of the endangered Florida golden aster *(Chrysopsis floridana)* and threatened Florida bonamia *(Bonamia grandiflora)*. The

Below

A mountainside of Fraser firs in Great Smoky Mountains National Park devastated by the introduction of a non-native insect.

Scott Schlarbaum

habitat of the endangered Miccosukee gooseberry *(Ribes echinellum)* is near spreading infestations of Chinese privet *(Ligustraum sinense)*. Japanese climbing fern *(Lygodium japonicum)* and other exotic species are invading the wet savannas of the Appalachicola National Forest, posing a threat to the habitat of more than 30 rare plant species. Cogon grass and Chinese tallow tree *(Sapium sebiferum)* are moving in on Eglin Air Force Base, which is home to many listed plant species.

Recovery efforts for threatened and endangered species also can be hampered by exotics. For example, prescribed burning to benefit five federally listed fern species in the pine rocklands of Dade County has been hindered by Burma reed *(Neyraudia reynaudiana)* and Old World climbing fern *(Lygodium microphyllum)*, which spread to the areas cleared by fire.

The exotic horned poppy *(Glaucium flavum)* is advancing along the beaches of Nantucket and other islands of the eastern seaboard. By stabilizing the sand, the poppy enables native beach grass to take root. However, the endangered piping plover *(Charadrius melodus)*, a beach-nesting bird, is usually found in areas with little or no vegetation.

Other exotic species pose threats as well. Some native plants are imperiled by introduced pathogens, fungi, or insects. (See "Killer Pigs, Vines, and Fungi" in *Bulletin* Vol. XIX, No. 5.) Butternut or white walnut *(Juglans cinera)* formerly grew in scattered populations from New England to Minnesota, and as far south as North Carolina and northern Alabama. Since the late 1960's, butternut canker caused by the fungus *Sirococcus clavigignenti-juglandacearum* has infested populations in most if not all of the species' range. Butternut will not sprout from the root crown when the top is killed by cankers, so time to find a cure is rapidly disappearing (Campbell and Schlarbaum 1994). Since 1989, the U.S. Forest Service has led a cooperative program in which scion wood is collected from trees that appear to be resistant. Grafted stock from 148 trees is now being grown in 14 States.

Two native fir species found only on mountain tops in the southern Appalachians are threatened with extinction by an introduced insect, the balsam woolly adelgid *(Adelges piceae)*. The northern bracted balsam fir *(Abies balsamea* var. *phanerolepsis)* is restricted to two mountain tops in northern Virginia. Because of the adelgid infestation, the fir's only mature population extends less than one acre (Campbell and Schlarbaum 1994). Similar devastation has struck the Eraser fir *(Abies fraseri)*, found at high elevations in the mountains of North Carolina and Tennessee. Mature trees have been eliminated from many locations. Although immature trees still persist in significant numbers, these are attacked as they age, and the Fraser fir thus may have lost its reproductive potential.

Various other types of exotic organisms also imperil many species of plants and animals. In isolated ecosystems such as Hawaii or the islands off the coast of California, intentionally introduced ungulates (e.g., pigs, goats, and sheep) threaten native birds and plants. Rats, mongoose, and feral cats also threaten birds and native lizards from the Virgin Islands to Kaua'i. Brown tree snakes *(Boiga irregularis)* accidentally introduced to Guam have devastated that island's avifauna, and ornithologists fear it could do the same if it becomes established in Hawaii or on other Pacific islands. The survival of many native animals and plants may depend on our ability and commitment to control the spread of exotic species.

Dr. Campbell is with the National Association of Exotic Pest Plant Councils (NAEPPC), an organization devoted to improving efforts for minimizing the impacts of invading alien plant species.

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by Amy J. Benson

The Exotic Zebra Mussel

Zebra mussels can grow to a maximum length of about 50 millimeters (1.9 inches) and live 4–5 years. Their common name was inspired by their dark, zebra-like rays. Although they are freshwater animals, zebra mussels have recently been found living in brackish water with salinity levels of 1–2 parts per thousand. Females generally reproduce in their second year. More than 40,000 eggs can be laid in a reproductive cycle and up to 1 million in a spawning season. The larvae emerge within 3–5 days after the eggs are fertilized and are free-swimming for up to a month. Dispersal of larvae is normally passive downstream. The mussels begin their juvenile stage by settling to the bottom, where they crawl about by means of a foot searching for a suitable firm surface or substratum upon which to anchor. Although hard, calcareous materials, such as limestone, concrete, and the shells of other mussels are preferred substrates, they will attach to various surfaces, including water intake valves and pipes, and have even been found on vegetation. Juvenile zebra mussels attach themselves by an external organ called a byssus, which consists of many threads. Adult zebra mussels filter about 1 liter (2.1 pints) of water per day while feeding primarily on algae.

The word "exotic" conjures up thoughts of faraway places where strange animals inhabit sun-drenched islands. But in the biological sciences arena, this word has come to be associated with unwelcome visitors to our shores. Over the past 500 years, more than 4,500 foreign species, including many harmful plants, vertebrates, invertebrates, and pathogens, have established populations in the United States.

One of these newcomers, the zebra mussel *(Dreissena polymorpha)*, poses widespread ecological and economic threats. This small freshwater mollusk originated in the Balkans, Poland, and the former Soviet Union. By the late 18th and early 19th centuries, the construction of extensive canal systems enabled the spread of zebra mussels to almost all major drainages of Europe.

In the United States, the first account of an established population came in 1988 from Lake St. Clair, located between Lake Huron and Lake Erie. By 1990, zebra mussels had been found in all the Great Lakes. The following year, they made their way into the Illinois and Hudson Rivers. By 1992, zebra mussels had established populations in the Arkansas, Cumberland, Hudson, Illinois, Mississippi, Ohio, and Tennessee Rivers. As of 1994, the following States had reported zebra mussels within, or in waters adjacent to, their borders: Alabama, Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, West Virginia, and Wisconsin.

Zebra mussels probably entered the Great Lakes when ships arriving from Europe discharged ballast water containing a variety of aquatic organisms, including zebra mussel larvae. The species' rapid dispersal throughout the Great Lakes and major river systems was due to its ability to attach to boats navigating these waters. Zebra mussels have an even more troubling characteristic: the ability to stay alive out of water for several days under moist and reasonably cool conditions. Thus, overland dispersal is another possible means of range expansion. An increasing number of small lakes near, but not connected to, the Great Lakes are now inhabited by zebra mussels. In 1993, several trailered boats crossing into California were found to have zebra mussels attached to their hulls. These mussels, discovered at agricultural inspection stations by informed officials, were removed before the boats were allowed to continue.

Most of the biological impacts of zebra mussels in North America are not yet known. However, information from Europe tells us they have the potential to harm native mussels by interfering with their feeding, growth, movement, respiration, and reproduction. Researchers are observing some of these effects as they study interactions between zebra mussels and native mussels in the Great Lakes. In one study, biologists found that where zebra mussel densities were highest, in Lake St. Clair and in the western basin of Lake Erie, native mussels had declined after only two years of zebra mussel colonization. Other studies have shown an inverse correlation between zebra mussel biomass and the density of native mussels. Scientists in the Great Lakes region are using models that may

predict the degree of loss based on zebra mussel densities. Unfortunately, research shows zebra mussels prefer to attach to the shells of live mussels rather than to dead ones or to stones. Some native mussels have been found with more than *10,000* zebra mussels attached to them. Native species may not survive if zebra mussels continue to colonize Lake St. Clair.

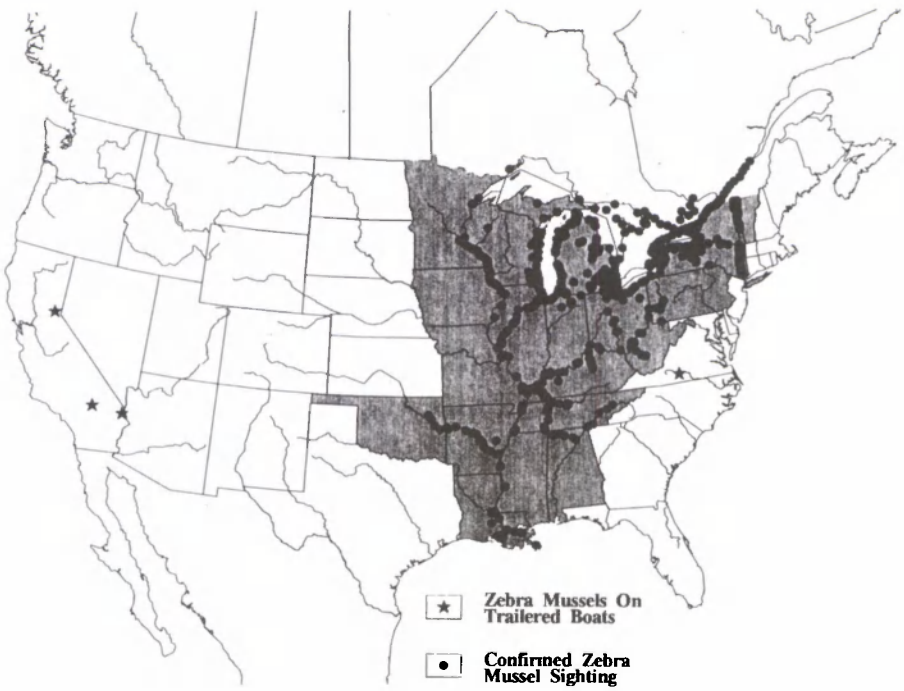
The National Park Service is very concerned about the St. Croix River, a National Wild and Scenic River in the upper Mississippi River basin, because it contains the only viable population of the winged mapleleaf clam *(Quadrula frugosa)*. Zebra mussels could wipe out this already endangered species if they become established in the river. In an attempt to save these native mussels, biologists are placing them in temporary refugia or transplanting them into waters free from zebra mussels.

Another exotic invader, the quagga mussel *(Dreissena bugensis)*, probably arrived at the same time as the zebra mussel. Although the quagga mussel closely resembles its cousin, it is not expected to have as great an impact on native mussel species because it does not show a preference for using them as substrates.

The zebra mussel's rapid spread has researchers working together to help track this invading exotic. Many government and private organizations are cooperating with National Biological Service researchers at the Southeastern Biological Science Center in Gainesville, Florida, by reporting information on new sightings. This information becomes part of the Nonindigenous Aquatic Species Information System, which distributes general information available to government agencies, private groups, and the public. The system also provides sound scientific information to State and Federal agencies responsible for the management of public lands. It is available by Internet on the World Wide Web (http://www.nfrcg.gov). By working together, it may be possible to control the continued spread of non-native pests like the zebra mussel.

Amy J. Benson is a fishery biologist at the National Biological Service's Southeastern Biological Sciences Center in Gainesville, Florida.

The threats posed by zebra mussels are economical as well as ecological. These exotic mollusks attach themselves in great numbers to water intake valves and pipes, and many millions of dollars have been spent by cities and industries in the United States for their removal. Estimates of economic impacts over the next decade run into the billions of dollars. The environmental and economic threats from zebra mussels and other exotic species prompted Congress to pass the Nonindigenous Aquatic Nuisance Species Prevention and Control Act of 1990. This law had a fourfold purpose: 1) prevent unintentional introductions through ballast water management; 2) coordinate federally conducted or funded research; 3) develop environmentally sound control methods; and 4) promote awareness of, and minimize the impacts from, nonindigenous aquatic nuisance species.



by Richard Neves

Rescuing Ohio River Mussels

Field work conducted at eight Ohio River sites in 1995 revealed zebra mussel densities ranging from 4 per square meter (1.2 square yards) at the upstream station to almost 4,000 per square meter at downstream sites. Mortality of native mussels was as high as 73 percent. The prognosis is for continued high mortality in 1996 and 1997 if zebra mussel densities continue at current levels.

Below
A native mussel encrusted by zebra mussels.

Right
Glassware storage racks provide a home to mussels during biological research.
photos by Richard Neves/FWS

At the turn of the century, the Ohio River basin was home to 127 of the 297 freshwater mussel species native to North America. Since that time, however, human changes in the environment have taken their toll; 11 mussel species are extinct, and 46 others are listed as endangered or are species of concern. Now there is a new threat to these already distressed mollusks—the zebra mussel.

The spread of this non-native species, the worst pest to invade the waterways of North America, puts native mussels in the entire Ohio River at great risk. The lower Ohio River downstream of Louisville, Kentucky, already is heavily infested. Zebra mussels severely encrust most native mussels in this area. Among the approximately 35 native mussels in the lower Ohio River are 5 endangered species: the pink mucket pearlymussel *(Lampsilis abrupta)*, orange-foot pimpleback pearlymussel *(Plethobasus cooperianus)*, fat pocketbook *(Potamilus capax)*, clubshell *(Pleurobema clava)*, and fanshell *(Cyprogenia stegaria)*.

The Fish and Wildlife Service's (FWS) Ohio River Valley Ecosystem Team has identified mussels as one of its highest resource priorities. A subgroup of the team helped create new partnerships in 1995 among the FWS, nine States, and numerous private cooperators, and developed a plan that identifies immediate and long-term actions needed to achieve mussel conservation goals.

A group of concerned State and Federal biologists began a mussel salvage operation in the summer of 1995. With support from West Virginia, Kentucky, and Ohio, and assistance from the FWS and National Biological Service (NBS), two teams of State and Federal divers led by Janet Clayton (West Virginia Department of Natural Resources) and Patty Morrison (Ohio River Islands National Wildlife Refuge) began collecting animals from the West Virginia portion of the Ohio River, where zebra mussel densities are now low. They collected about 3,000 native mussels of numerous species, including

one pink mucket pearlymussel, and brought them ashore to an assembly line of biologists and volunteers participating in the rescue effort. The mussels were scrubbed to remove zebra mussels and debris, marked with numbered tags, measured and logged into the record book, and transported to a quarantine facility at the refuge. Refuge personnel volunteered space in a barn for large tanks where the mussels were monitored for 30 days to make certain that they were free of zebra mussels.

Following quarantine, the 3,000 native mussels were transported to two locations in West Virginia: the NBS Leetown Science Center and the White Sulphur Springs National Fish Hatchery. Those being held in 4 ponds at Leetown are part of a cooperative NBS-funded research project involving Virginia Tech (Drs. Bruce Parker and Richard Neves) and NBS staff. Catherine Gatenby, currently working on a graduate degree at Virginia Tech, coordinated and supervised all phases of the collection and quarantine program, and will evaluate the survival and growth of these mussels. They are being held in suspended pocket nets, used in the Japanese pearl culture industry, and in cafeteria-style glass racks on the pond bottom. Previous studies by the Virginia Cooperative Fish and Wildlife Research Unit at Virginia Tech confirmed the suitability of ponds for holding riverine mussels.

Another objective of the research is to determine whether these mussels will spawn and produce juvenile mussels for the recovery of species that are vulnerable to zebra mussels. The third objective of Gatenby's research will be to develop suitable algal diets for rearing juvenile mussels in captivity. Biologists at the NBS Leetown Science Center are monitoring the condition of these animals, and survival has been greater than 95 percent.

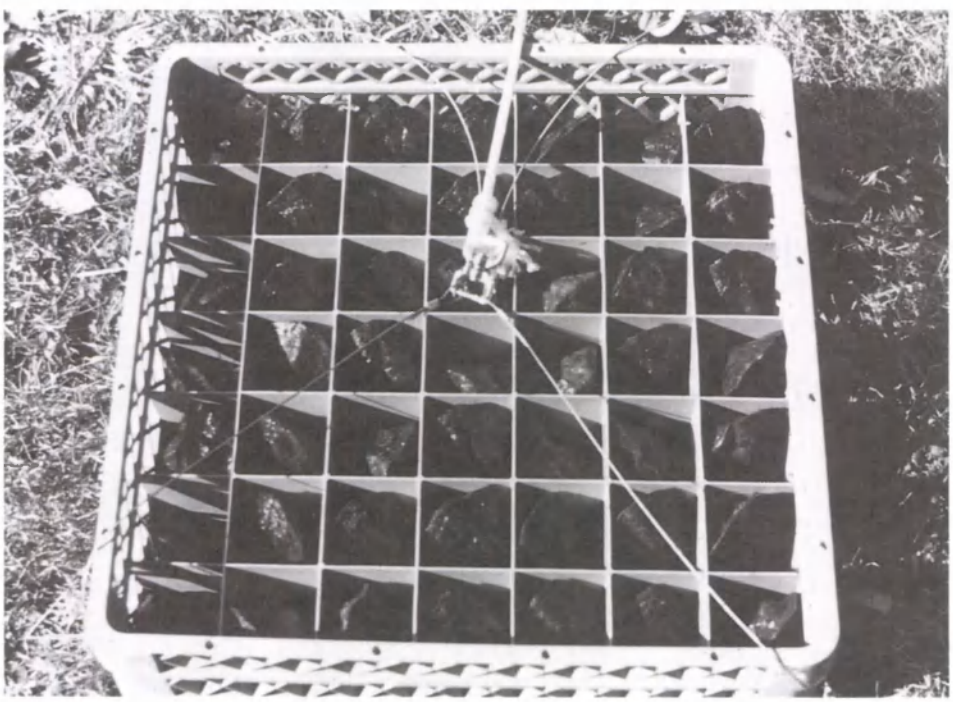
The native mussels being held at White Sulphur Springs also will be monitored for reproductive success. Part of the research is an experimental project that involves using the host fish that mussel larvae parasitize to produce metamorphosed juveniles, which will be raised in outdoor facilities. The mussels are being held in glass racks at the bottom of a fenced pond.

The freshwater mussel subgroup also has focused on public education to highlight the value of Ohio River resources that could be lost, not only from zebra mussels but other impacts to the river basin. With an outreach plan in preparation, the team has funded a native mussel display at an Ohio museum, has initiated conservation lectures to groups throughout the Ohio River basin, and is planning a zebra mussel fact sheet for boaters.

Without an ecosystem approach to resource management in the Ohio River basin, most of these initiatives and partnerships would not have been possible. This project exemplifies the cooperative spirit that can be mustered for wildlife conservation, even for invertebrates like freshwater mussels.

Dr. Neves is Leader of the Virginia Cooperative Fish and Wildlife Research Unit at Virginia Tech in Blacksburg.

During the summer of 1995, Kari Duncan, Hatchery Manager at White Sulphur Springs, recruited another partner into this cooperative research effort. Chi Chi's Restaurants, Inc., has donated surplus glassware storage racks to the cause. Racks that once held margarita glasses are now serving as condominiums for pink heelsplitters and elephant ear mussels. Dr. Parker of Virginia Tech also has secured the assistance of the Martek BioSciences Corporation in Columbia, Maryland, and Omega Tech of Boulder, Colorado, to donate algal species for testing as possible food for the native mussels. In addition to these corporate sponsors, many volunteers of all ages have assisted with the collection, quarantine, and transportation of native mussels to their new homes in the West Virginia ponds.



by Paul Hartfield and
Robert S. Butler

Fishing Mussels

Freshwater mussels are the most imperiled large group of organisms in North America, with 70 percent of the fauna in need of protection. As many as 36 species have apparently disappeared in historical times. Among them are 14 endemic mussels from the Mobile River basin of Alabama, Mississippi, Georgia, and Tennessee that biologists recently concluded are extinct, based on a 4-year status review by the Fish and Wildlife Service's (FWS) Jackson, Mississippi, Field Office. Seventy other mussels are listed as endangered or threatened, or are proposed for listing, and even some of the more hardy and abundant commercial species are declining. Since mussels are relatively immobile and filter water for food and oxygen, they are especially susceptible to changes in water quality or stream channel stability. The disappearance or decline of most freshwater mussels can be attributed directly to habitat alteration and/or pollution.

With only a few exceptions, the larvae of native freshwater mussel species must pass through a phase in which they are parasites on the fins or gills of fishes. When the larvae contact a portion of a fish gill or fin, the two valves or shells snap together, clamping to the fish's tissue and soon becoming completely encysted. The larvae absorb nutrients from the fish until, after an appropriate length of time (usually 2-3 weeks), they metamorphose into juvenile mussels. This parasitic relationship is the primary means by which mussels disperse throughout their range. When the cyst wall ruptures and the juvenile mussel drops to the bottom, it may have been transported some distance by the host fish. The host/parasite relationships between most native mussel and fish species are very poorly known.

Biologists from the FWS Jacksonville, Florida, and Jackson, Mississippi, Field Offices and the U.S. Forest Service recently identified a previously unknown strategy used by the orange-nacre mucket *(Lampsilis perovalis)*, a threatened species restricted to the Mobile River basin in Alabama, to attract its host fish. This mussel species deposits all of its 75,000 to 100,000 larvae in a single package that mimics a minnow in size, shape, and behavior. The minnow mimic, termed by biologists a superconglutinate, is attached to the female mussel at the end of a transparent mucous strand that can measure up to 8 feet (2.4 meters) in length. Extruded from one of the mussel's siphons and dangling in the current, it is used to attract fish like an angler uses a line and lure. When predaceous fish attempt to feed on the minnow-like lure, the mussel larvae break away and attach to the fish. Two other imperiled southeastern mussels, the shinyrayed pocketbook *(Lampsilis subangulata)*, currently proposed for endangered status, and the southern sandshell *(Lampsilis australis)*, another rare species, are known to use the

superconglutinate strategy. Another species, the threatened fine-lined pocketbook *(Lampsilis altilis)* is believed to produce this extraordinary fish lure as well.

The superconglutinate strategy provides an important clue to the decline of species known or suspected to use it. Once widespread in a variety of flowing water habitats of the Mobile River basin, the orange-nacre mucket has disappeared progressively from large rivers to small streams. Today, the species is common only in creeks with clear water. It reaches its highest densities in creeks originating in, and flowing through, National Forest lands, where water quality is the highest. Reductions in the distributions of the species using the superconglutinate strategy appears to follow historic increases in turbidity levels within their watersheds. Early land use practices in the region resulted in soil erosion and chronic turbidity of large to moderate-sized rivers. Today, even many small streams experience extended seasonal turbidity. Unfortunately, the mussels concentrate their fishing activities during the spring and early summer when erosion and turbidity are at their highest. As visibility in a stream decreases, so does the ability of the fish to see the lures. Each mussel produces only a single lure each year. A reduction in turbidity levels may be vital to the long-term survival and recovery of these species.

Although the number and variety of activities contributing to turbidity appears daunting, reducing levels of suspended sediments in a stream is not insurmountable when considered at the local or watershed level. Minor changes in local agricultural, silvicultural, and construction activities, along with protecting riparian buffers, can reduce sediment-laden runoff significantly and economically. Improvements in silvicultural practices already has helped to reduce erosion and silt in many southeastern streams. Such environmental gains also benefit local citizens by enhancing water quality, recreational opportunities, and even property values. The survival and recovery of these unique mussels will depend on an understanding that improving water quality is in everybody's best interests.

Paul Hartfield and Robert S. Butler are fish and wildlife biologists in the FWS Jackson, Mississippi, and Jacksonville, Florida, Field Offices, respectively. *For more information on this subject, see "An extraordinary reproductive strategy in freshwater bivalves: prey mimicry to facilitate larval dispersal" by W.R. Haag, R.S. Butler, and P.D. Hartfield in* ***Freshwater Biology*** *(1995) 34.471-476.*

Left
A superconglutinate being released from the excurrent siphon of an orange-nacre mucket.
Paul Hartfield/FWS

by Denise Pengeroth

Long-term Planning for Owls

Under section 7 of the ESA, Federal agencies—in consultation with the U.S. Fish and Wildlife Service (FWS)—must ensure that actions they fund, authorize, or carry out are not likely to jeopardize the continued existence of threatened and endangered species or destroy/adversely modify critical habitats. This section requires the appropriate action agency to prepare a biological assessment that identifies the affected species and/or critical habitat and the extent of the proposed action's impacts on them. The FWS analyzes this and other information, and formally reports its findings in a document called a biological opinion. Traditionally, this process involved many individual project-level biological assessments, often limited in scope. Because conducting multiple biological assessments and consultations could be very time-consuming, a different approach was necessary to expedite ESA section 7 requirements for the Northwest Forest Plan.

When the threatened northern spotted owl *(Strix occidentalis caurina)* winged its way into the spotlight in the 1980's, it came to symbolize the controversies over forest management that have gripped the Pacific Northwest. In an effort to find a balance between the needs of people in the region and the conservation of forest resources, President Clinton commissioned a Forest Ecosystem Management Assessment Team in 1993. The team was charged with developing a Northwest Forest Plan that would set a foundation for future management of national forests in the Pacific Northwest. This plan was completed April 13, 1994, and implementation began May 19, 1994. One aspect of the Northwest Forest Plan involves enhancing interagency cooperation procedures under the Endangered Species Act (ESA).

The 1995/1996 Timber Sale Program for the Mt. Hood National Forest, located in the northern Oregon Cascades, provides an example of how agencies are working together to make the Northwest Forest Plan a success. The approach: interagency consultation that incorporates long-term planning and landscape-level analysis.

During the winter of 1994/1995, Rob Huff (until recently, the Threatened, Endangered, and Sensitive Species Coordinator for the Mt. Hood National Forest) and Joe Burns (a biologist with the FWS Oregon State Office in Portland) met to coordinate a long-term, landscape-level approach to biological assessments and interagency consultation. Forest Service planners, foresters, and biologists convened in January 1995 to discuss the entire 1995/1996 Mt. Hood National Forest timber sale program. Key elements were identified for inclusion in the biological assessment: assessing wilderness and late-successional reserves outside of the project areas for their suitability as spotted owl habitat, and securing owl movement corridors and dispersal capabilities in the matrix land between these designated reserves. (A *late-successional reserve* is a forest in its mature or old growth stage that is designated under the Northwest Forest Plan for management to protect or enhance existing ecosystem values. *Matrix lands* are the primary areas designated for timber production.)

The result of this process was a biological assessment that addressed the effects of forest-wide programs on spotted owls over a 2-year period. The assessment revealed that spotted owl habitat would be degraded as a result of the 1995/1996 Mt. Hood National Forest Timber Sale Program, and that some spotted owl pairs would be taken. (Taking, in this case, means to significantly impair a species' behavioral patterns, such as breeding, feeding, or sheltering as a result of habitat degradation). The habitat damage from timber harvest would be confined to matrix land, in compliance with the Northwest Forest Plan.

From this "bird's eye" view, the FWS concluded that although take would occur, the Mt. Hood National Forest's 1995/1996 Timber Sale Program was not likely to jeopardize the species or adversely modify its critical habitat. As

part of the biological opinion, the FWS identified "reasonable and prudent measures" designed to minimize take by preventing disturbance of spotted owl pairs and their progeny during the nesting season, and protecting the nest trees of active spotted owl pairs. These measures included the following non-discretionary terms and conditions: First, prohibit timber harvest activities within at least a 0.25-mile (0.4 kilometer) radius of an owl nest site or activity center between March 1 and June 15, during the year of harvest. Within all types of habitat, prohibit harvest and any other activity with the potential to disturb nesting spotted owls. Second, if an active spotted owl nest is located within a timber harvest unit, modify the timber sale to establish a 300-foot (91-meter) no-harvest buffer around the nest tree. Prohibit timber harvest activities between March 1 and September 30, or until agency biologists determine that nesting has failed or young are no longer present.

The compromise achieved through the consultation process in the above example reflects the spirit upon which the Northwest Forest Plan was crafted, which is to provide both timber and spotted owl habitat. The affected spotted owl acres and pairs are on matrix lands. Elsewhere on the Mt. Hood National Forest, spotted owl habitat is provided within wilderness areas and late-successional reserves to ensure the species' viability.

What lessons can we learn from this experience? Long-term planning and landscape-level analysis represent good science and management, especially for species like the northern spotted owl that have large home ranges. This approach to the interagency consultation process can meet ESA requirements faster and more efficiently. The keys to success included strong leadership, coordination, and a determination to transcend traditional biological assessment processes and administrative boundaries.

Denise Pengeroth is the Threatened, Endangered, and Sensitive Species Coordinator for Mt. Hood National Forest in Oregon.

U.S. Forest Service

Wolf Recovery Progresses

Progress in the effort to recover the gray wolf *(Canis lupus)* in the Rocky Mountains continues at a pace far better than biologists and managers had expected. In January of this year, another 37 gray wolves collected from healthy populations in Canada were taken to Idaho and Wyoming, where the species is listed as endangered. Twenty of this year's wolves were radio-collared and released immediately into a National Forest wilderness area in central Idaho. The other 17 were taken to Yellowstone National Park and placed in acclimation pens until their release later this spring. If they fare as well as the wolves reintroduced last year, additional releases planned for next year may not be needed.

Most of the wolves reintroduced in 1995 have adapted well to their new homes. The 15 Canadian wolves released in central Idaho last year travelled widely, but none left the designated "experimental population" area and all primarily used National Forest lands. No wolf predation on livestock has occurred in Idaho. Although several of the Idaho wolves have died, losses have been well below the level projected when the reintroduction project was planned. One wolf was killed illegally shortly after release, another died of undetermined causes in January 1996, and a third has not been located since March 1995. The most hopeful sign is that, of the 12 Idaho wolves from the 1995 release still being monitored, 5 breeding pairs apparently have formed. Wolves in Idaho are managed primarily by the Nez Perce Tribe with funding provided under a cooperative agreement with the U.S. Fish and Wildlife Service (FWS).

The wolves released in Wyoming last year are faring even better. Fourteen wolves comprising three packs left their acclimation pens in March 1995 and are being monitored by the National Park Service. They are feeding almost exclusively on the park's large elk population and have regularly been killing coyotes, which the wolves see as a competitor in their territory. All three packs stayed together after their release and two packs produced a total of nine pups. (See *Bulletin* Vol. XX, No. 4.) Four adult wolves have died as of March 1996 and biologists have not located another for about one month. Two of the wolves were killed illegally,

one was struck by a truck, and the fourth was ordered destroyed by the FWS after it went outside the park and attacked livestock for a second time. It had already been moved once for taking two sheep. Defenders of Wildlife, an independent wildlife conservation group, compensated the rancher for the sheep that were killed and for two others reported missing. Currently, two packs and a new breeding pair (totalling 15 wolves) live almost entirely within Yellowstone National Park. Another pack of four wolves occurs along the park's northwestern border.

Under the terms of the reintroduction program, gray wolves in both Yellowstone and central Idaho are designated as "experimental, nonessential" populations. This classification gives them protection but allows managers additional flexibility in the control of problem animals. Fortunately, wolf predation on livestock remains lower than expected. Defenders maintains a large fund to reimburse ranchers for livestock lost to wolves in Wyoming, Idaho, and Montana. The Wolf Education and Research Center (an organization in Boise, Idaho), Defenders, and other organizations also contributed to the recovery program by providing nearly $80,000 to this year's wolf reintroduction effort.

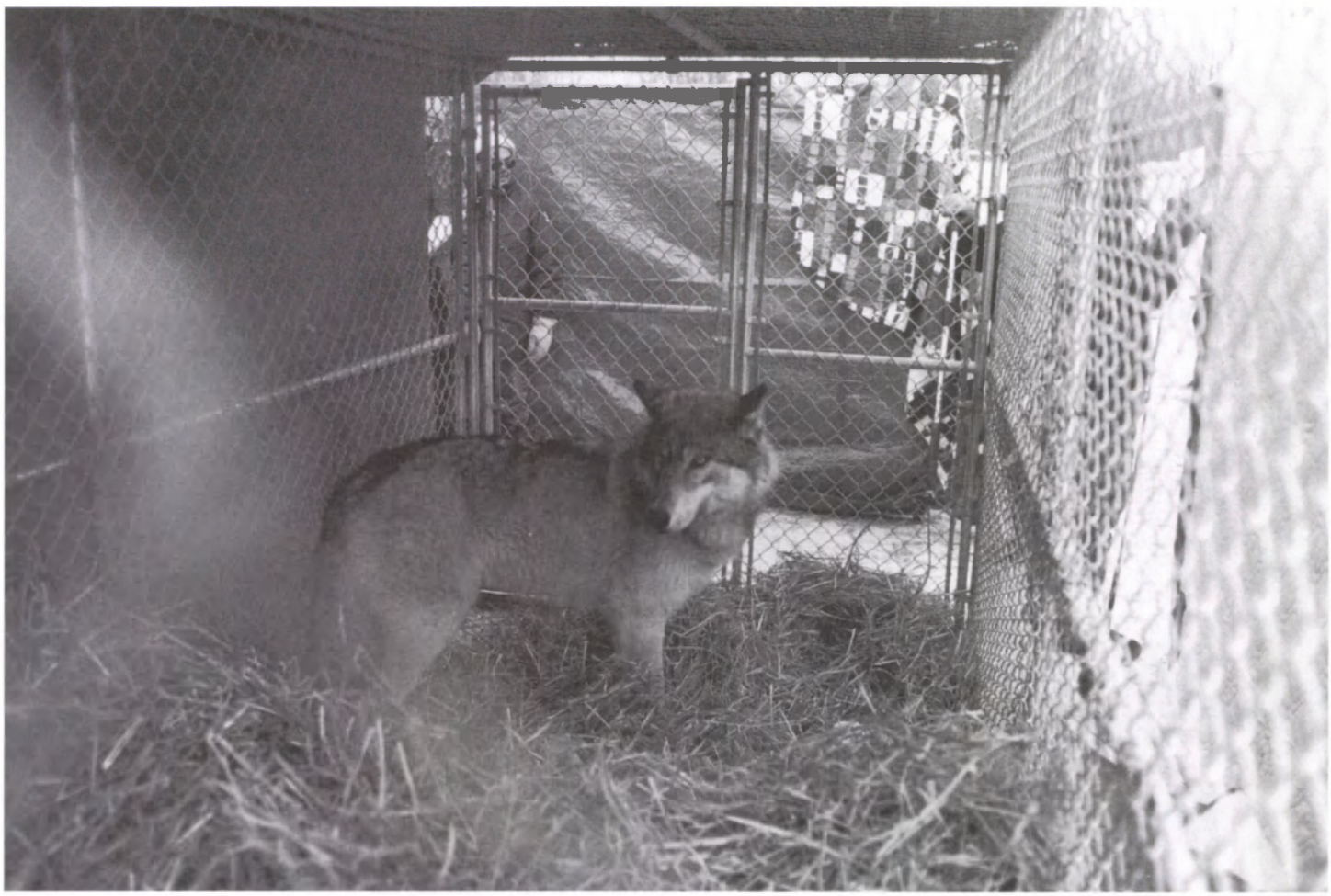
In northwestern Montana, where the gray wolf is recovering on its own, the population continues to grow. Biologists have detected 9 or 10 packs in this region, depending on how wolves in the Canadian border area are counted.

If progress continues at its current pace, recovery and delisting goals for wolves in the Rocky Mountains will be reached sooner and cheaper than originally projected.

Below

A gray wolf awaits its new home in Yellowstone National Park.

Pedro Ramirez, Jr/FWS



by Michael A. Homoya

The Return of Short's Goldenrod

In the autumn of 1840, while surveying for plants on an island of fossilized Devonian coral in the middle of the Ohio River, Dr. Charles W. Short noted an unfamiliar goldenrod growing in one of the rock crevices. He promptly collected a sample and sent it away for identification. Little did he know that his discovery was a species new to science and one of the rarest of all native plants. The species, Short's goldenrod *(Solidago shortii)*, is now listed by the Fish and Wildlife Service (FWS) as endangered.

Below
The wire mesh will help anchor newly planted goldenrod during flooding until roots establish.
photos by Richard Fields

Named in honor of Dr. Short by venerable botanists John Torrey and Asa Gray, *Solidago shortii* was collected only a few times following Short's discovery. All were from the "Falls of the Ohio," an exposed outcrop of limestone bedrock that spans the Ohio River bed between Clarksville, Indiana, and Louisville, Kentucky. By the late 1860's, the species had apparently disappeared and was presumed extinct. Nearly seven decades passed without evidence of the goldenrod, and then, as if resurrecting the species from the dead, renowned botanist and ecologist E. Lucy Braun discovered the only other known population of Short's goldenrod in the world. This population, found in a rocky barrens near Blue Licks, Kentucky, remains viable today.

Located approximately 100 miles (160 kilometers) east of the Falls locality, the Blue Licks population may have given rise to the Falls population, or vice versa. This theory arose because of a discovery that the two sites are connected by what was once a major bison trace. The animals possibly

transported goldenrod seed from one site to the other on their hooves or hides. Botanists have searched other localities along the ancient pathway and elsewhere, but to no avail.

On June 29, 1995, staff of the Indiana Department of Natural Resources' Divisions of Nature Preserves and State Parks and the Kentucky Nature Preserves Commission, in cooperation with the FWS, U.S. Army Corps of Engineers, and Shooting Star Nursery (which donated cultivated plants), returned seven clumps of Short's goldenrod to historic habitat on the Indiana side of the Falls. This group effort resulted in a rare and noteworthy event, in which an endangered species was at once reestablished to all of its historic range. Few recovery efforts have been conducted with such ease.

The goldenrod clumps, seedling progeny of the Blue Licks population, were planted in crevices of limestone bedrock within Falls of the Ohio State Park. The land, leased from the Corps of Engineers, appears to provide excellent habitat for the species. Although the site is inundated by torrents of river water in the winter and spring months, the scouring effect presumably is critical to maintaining the sunny, well-drained environment needed by the plant. As Dr. Short stated in a letter dated 1842, "They [the goldenrod] occupy almost exclusively a tract of rocky waste which is submerged for half the year, during which time it is swept over by a furious current, under which no plant could maintain a footing but by sinking its roots deep into the fissures in the rocks." Without the scouring, trees and shrubs might become established and shade out the goldenrod.

The restoration site appears to be appropriate not only in habitat but in location as well. Until recently, it was assumed that all collections of Short's goldenrod were taken from the Kentucky portion of the Falls of the Ohio, namely from Rock Island. Inspection of a collection journal of Dr. Asahel Clapp, a New Albany, Indiana, physician and botanist, revealed that the goldenrod was noted by him on September 18, 1844, from the "N. shore of the falls near Jeffersonville" [Indiana]. The replantings could be within just a few feet of his original observations.

Why did the original populations at the Falls disappear? The current recovery site, even though now appearing suitable for growth of the goldenrod, may have had past episodes of pollution, altered water flow, and severe disturbance that killed the plants. Now in the confines of a State park, the new plantings will be tended and monitored by park naturalists and Division of Nature Preserves staff. We are hopeful that next season will reveal a thriving, recovering population of Short's goldenrod.

Michael A. Homoya is a botanist with the Natural Heritage Data Center, Indiana Division of Nature Preserves.

Below

Rocky shoreline at Falls of the Ohio State Park, where the goldenrod was re-established.

New Scientific Policy Guidelines

Three documents addressing scientific policy issues under the Endangered Species Act (ESA) were released recently by the Fish and Wildlife Service (EWS) and the National Marine Fisheries Service (NMFS), an agency of the Department of Commerce.

The documents include:

- **a proposed rule on the treatment under the ESA of intercrosses and intercross progeny,**
- **a proposed policy to establish consistency in controlled propagation (captive breeding) programs for species listed as endangered or threatened, and**
- **a notice of policy designed to clarify the definition of "distinct population segments" for the purposes of listing, delisting, or reclassifying species under the ESA.**

All three documents were published in the February 7, 1996, *Federal Register*. Additional information on the vertebrate population policy is available via the World Wide Web in the "Policies" section of the Endangered Species Home Page (http://www.fws.gov/~r9endspp/endspp.html).

The policies are part of a continuing effort to make certain that implementation of the ESA is grounded in sound science. They address three subjects: the treatment of species intercrosses, the use of controlled propagation as a conservation tool, and the question of when "distinct population segments" qualify for ESA protection. Although they bring additional clarity to some important scientific aspects of species conservation, none will alter the protection now afforded to listed plants and animals.

Intercross Policy

This proposed policy would allow the protection of intercross progeny of a listed species, but only under specific and limited circumstances. When approved, this policy will help biologists identify the potential or actual use of intercrossing as a recovery tool. Techniques available for species recovery are improving as scientific research enhances our understanding of conservation needs in the field. For example, cougars from eastern Texas *(Felis concolor stanleyana)* have been released in Florida to help stem the decline of the endangered Florida panther *(Felis concolor coryi)* by increasing its genetic diversity. (See *Bulletin* page 10.) The offspring will be protected as part of the Florida panther recovery effort. The subspecies interbred naturally when *F. concolor* had a distribution that included most of North America.

The document uses the terms "intercross" and "intercross progeny" to reflect genetic interchange within a species. The proposed intercross rule would reflect advances in genetic science, but would apply to only a few species while clarifying an area that has been an occasional problem both for biologists and legal interpretations through the years. The intent is to define how to treat intercrosses when conserving *listed* species.

Controlled Propagation Policy

The proposed policy on controlled propagation establishes consistency in programs that involve the captive propagation of listed species. This proposal supports controlled propagation 1) when recommended in an approved recovery plan and supported by an approved genetics management plan and 2) when efforts to recover species or reduce threats to populations in the wild are insufficient.

The approved purposes of controlled propagation include avoiding extinction, conserving genetic vigor, maintaining populations of nearly-extinct animals or plants on a temporary basis until threats are alleviated, providing individuals for establishment of new self-sustaining populations, producing stock for release to augment wild populations, and holding offspring

development or through a life stage that cannot be supported in the wild. Captive propagation is usually a last resort, but it may be the key to recovering such species as the California condor *(Gymnogyps californianus)* and the black-footed ferret *(Mustela nigripes)*.

Distinct Population Segments Policy

The notice of final "distinct population segment" policy is designed to clarify that term for listing, delisting, or reclassifying populations of vertebrate animals that may be endangered or threatened in part of their range but more numerous elsewhere. The ESA authorizes the protection of imperiled species, subspecies, and ". . . any distinct population segment of any species of vertebrate fish or wildlife . . . ." Examples of listed vertebrate populations include the gray wolf *(Canis lupus)*, grizzly bear *(Ursus arctos)*, woodland caribou *(Rangifer tarandus caribou)*, and Florida population of Audubon's crested caracara *(Polyborus plancus audubonii)*. Bald eagle *(Haliaeetus leucocephalus)* populations, for example, are healthy in Alaska, but in many places in the lower 48 States they nearly became extinct and generally remain threatened.

The FWS and NMFS have worked for several years to ensure consistency in listing vertebrate populations under the ESA. The policy notice is the result of several rounds of discussion and review, and it includes comments from private citizens as well as scientists (including work accomplished by the National Academy of Sciences). The distinct population segment policy will govern interpretations under the ESA for both U.S. and foreign species.

Under the new policy, three elements—discretness, significance, and status—will be considered in any decision to add a distinct population segment to the official list of endangered and threatened species.

A population segment can be considered "discrete" if:

1) it is separated from other populations as a consequence of physical, physiological, ecological, or behavioral factors; or

2) it is delineated by an international political boundary that coincides with differences in control of exploitation, habitat management, conservation, or wildlife regulation.

A population segment can be considered "significant" if there is evidence that its loss would leave a significant gap in the range of a species or if there is evidence that it differs markedly from other populations of the species in its genetic characteristics.

"Status" refers to the question of whether the population segment, when treated as if it were a species, is biologically endangered or threatened.

Below

The Florida population of Audubon's crested caracara is protected as a "distinct population segment."

A. Cruickshank/VIREO

50 Years and Counting!

by Sally Valdes-Cogliano

Rachel Carson's *Silent Spring*

Concern about the effects of pesticides on wildlife is not new. Few books have stirred more interest and action than one published in 1962: *Silent Spring*, by Rachel Carson. This influential work is filled with examples of the serious consequences certain pesticides were having for both wildlife and people. But it is the book's introduction, the vision of a tomorrow where no birds sing, that brought her message to the conscience of the Nation.

The book had such an impact because Rachel Carson had a strong background in science, a poet's command of the English language, and a reputation for being able to convey science to the general public. In 1936, after earning a masters degree in biology from Johns Hopkins University, she joined the U.S. Bureau of Fisheries, the predecessor of the Fish and Wildlife Service (FWS). She first worked as a writer and eventually as editor-in-chief of the U.S. Fish and Wildlife Information Division. Her popular books about the ocean, including *The Sea Around Us* and *The Edge of the Sea*, won national acclaim in the 1950's.

Through her 17 years of experience as a government biologist, Rachel Carson was familiar with FWS studies

In 1945, an Office of River Basin Studies was established to evaluate the effects of the extensive post-war water development plans of the Army Corps of Engineers and the Bureau of Reclamation on wildlife resources. The office later became an important part of the Fish and Wildlife Service (FWS). In the 1960's, after the warning in Rachel Carson's book *Silent Spring*, the FWS established a National Pesticides Monitoring Program, which evolved into the more comprehensive Environmental Contaminants Program.

Also beginning in the 1960's, a series of endangered species laws culminating in the Endangered Species Act of 1973 gave the FWS responsibility for protecting and recovering the nation's most imperiled plants and animals. The 1972 Clean Water Act's provisions for stronger controls on filling navigable waters (including wetlands) intensified FWS efforts to ensure that the values of wildlife habitats were considered as decisions about wetlands were made. The FWS consolidated these and other responsibilities into the Ecological Services Program in the mid-1980's, recognizing that these activities give the FWS an important leadership role in natural resource assessment and conservation.

The overall goal of the Ecological Services Program--to help conserve the Nation's fish and wildlife resources--has not changed much in 50 years, but the tools available to do the job have. Under the authority of various laws, Ecological Services is responsible for:

- conserving threatened and endangered species through various approaches, including regulating the take of listed species, developing recovery plans, consulting with Federal agencies to prevent jeopardy to listed species, and working within communities to develop Habitat Conservation Plans (Endangered Species Act);

- preventing a variety of contaminants from entering the environment; investigating sources, pathways, exposures, and effects of contaminants on trust resources;

and assessing damages to responsible parties for injury to trust resources (Federal Insecticide, Fungicide, and Rodenticide Act; "Superfund;" and Oil Pollution Act);

- preparing or reviewing environmental planning documents on Federal actions significantly affecting wildlife resources (National Environmental Policy Act);

- advising the Army Corps of Engineers of the effects on wildlife from permits issued under the Corps' wetlands program, including permits for discharges of dredged or fill materials into waters of the United States (Section 10 of the Rivers and Harbors Act and section 404 of the Clean Water Act);

- reviewing environmental impacts of hydropower projects that require a license from the Federal Energy Regulatory Commission, and making recommendations for ensuring fish passage and the conservation of other wildlife resources (primarily the Federal Power Act but also the Endangered Species Act, Fish and Wildlife Coordination Act, National Environmental Policy Act, and Clean Water Act);

- administering a grant program to assist States in protecting and restoring wetland habitats (Coastal Wetlands Planning, Protection and Restoration Act);

- coordinating restoration of coastal ecosystems through cooperative efforts with other Federal, State, and local agencies and the private sector (Coastal Program);

- maintaining official maps of the Coastal Barrier Resources System and consulting with Federal agencies that propose spending Federal funds within the System (Coastal Barrier Acts of 1982 and 1990);

- maintaining a National Wetlands Inventory, producing wetland maps, and evaluating the status and trends of wetlands;

- providing regulatory and technical support to the Department of Agriculture for implementing conservation provisions of the 1985 and 1990 Food Security Acts (Farm Bills), such as "Swampbuster," the Wetlands Reserve Program, and conservation easements; and

- providing technical and financial assistance to private landowners to restore and enhance habitats (Partners for Wildlife Program).

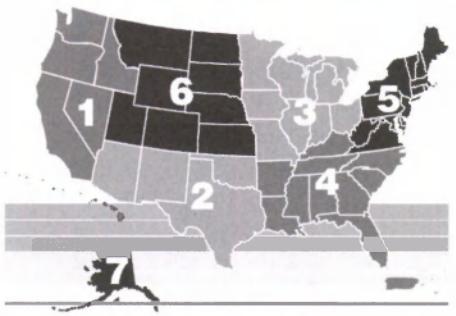
The Ecological Services Program has made a difference for wildlife conservation from the start. Its successes result from the scientific expertise and hard work of FWS employees in more than 80 Field and Regional offices across the nation. As it begins its 51st year, the program will continue its focus on multi-disciplinary, cooperative efforts for a more ecosystem-based approach to resource management.

Sally Valdes-Cogliano is a biologist with the FWS Division of Habitat Conservation in Washington, D.C.

on the negative effects of the pesticide revolution, but little of this information had filtered into the popular press. Her decision to educate the public about the dangers to wildlife and possibly human health may have been influenced by reports of bird die-offs sent to her by a friend. Rachel Carson spent five years researching and writing *Silent Spring*. She also fought a very private battle with cancer, one that she lost in 1964.

Our country is still recovering from persistent pesticides like DDT. Rachel Carson's message came none too soon for bird species on the top of the food chain. Populations of bald eagles, peregrine falcons, and brown pelicans, for example, had plummeted because of the damaging effects of organochlorine pesticides on reproduction. The good news is that many of these top predators are now recovering, due in part to Rachel Carson and others who helped sound the alarm about dangers in the environment before it became too late.

Courtesy Rachel Carson Foundation



Region 1

Delhi Sands Flower-loving Fly ***(Rhaphiomidas terminatus abdominalis)*** The Fish and Wildlife Service (FWS) recently released a draft Delhi Sands Flower-loving Fly Recovery Plan for public comment. This unique nectar-eating insect, has a long, tublar proboscis, and mimics hummingbirds with its feeding habits and hovering flight. It apparently has very specific habitat needs, and is restricted to approximately 155 acres (63 hectares) of habitat distributed among 8 sites within San Bernardino and Riverside counties in southern California. Before wide-scale habitat alteration in this region, the flower-loving fly likely occupied much of the Colton Dunes, encompassing 40 square miles (104 square kilometers) of soils in the Delhi Sands geological formation. About 1,200 acres (485 ha) of suitable habitat remain. The recovery plan focuses on protecting eight existing or established populations within three recovery units. The plan also recommends establishing a captive breeding program for this highly endangered animal.

Delhi sands flower-loving fly
Greg Ballmer

Region 2

Gulf Coast Animals The Native Gulf Coast Prairie "Safe Harbor" Plan exempts private cooperators in 19 Texas counties from the Endangered Species Act's habitat protection regulations if their management activities attract endangered species to their property. The plan is part of a broader agreement with the Sam Houston Resources Conservation and Development Area, Inc., which provides cost-sharing funds for certain habitat restoration, enhancement, and maintenance activities to participating landowners. Some prairie restoration and range management activities are beneficial, both for grazing animals and for a variety of wildlife, including the endangered Houston toad *(Bufo houstonensis)* and Attwater's greater prairie chicken *(Tympanuchus cupido attwateri)*. Three cooperators have signed up for the program so far, with land totalling 1,303 acres (527 ha). Potential interest has been voiced by 43 other property owners whose land totals over 130,000 acres (52,610 ha).

Houston toad
Robert Thomas/FWS

Texas Plants The FWS Clear Lake, Texas, Field Office secured funding and landowner cooperation to selectively clear invasive shrubs from 20 acres (8 ha) of historic and current habitat of an endangered plant, the white bladderpod *(Lesquerella pallida)*, and a listing candidate, the Texas golden gladecress *(Leavenworthia texana)*. Both species, native only to Texas (and primarily to only one county), are restricted to exposed outcrops of the Weches geologic formation. This formation consists of a layer of calcareous marine sediments overlying an impermeable layer of clay, resulting in areas that are seepy and wet much of the year but hard and dry during summer. These open islands of thin, alkaline soils support specialized plant communities.

Previously damaged by road construction and overgrazing, the primary threat to these areas now is extensive encroachment by non-native shrubs. Besides manual clearing of the exotic plants, the FWS has worked with the State's Department of Agriculture to develop reasonable restrictions on the use of a herbicide commonly applied by area landowners. The effort involved more fully identifying the areas of concern, and developing time of usage and application alternatives that would allow landowners to control shrub encroachment without jeopardizing rare native species.

Region 3

Website Region 3 now has its own site on the World Wide Web. Although much of the site is under construction, one important and evolving component is an endangered species section. Future plans call for including photos, maps, and facts for listed and candidate species. Recovery progress reports and official announcements may also be added. You can visit this site at http://www.fws.gov/~r3pao/r3home.html.

Region 7

Aleutian Canada goose ***(Branta canadensis leucopareia)*** Because of continuing progress in the recovery of this subspecies, it may no longer need Endangered Species Act protection. When the recovery program was initiated almost 20 years ago, the subspecies probably numbered only about 800 birds, nesting primarily on Buldir Island in the Aleutian chain. Years of effort were devoted to removing the arctic fox *(Alopex lagopus)*, an introduced predator, from former nesting islands, and to protecting the geese from hunting on their wintering grounds in Oregon and California. The overall population has now grown to more than 20,000 birds, with self-sustaining nesting populations on three Aleutian islands. Reestablishment of nesting geese is underway at five other islands.

The second year of successful long-distance translocations occurred in 1995, when 184 Aleutian Canada geese were captured on Buldir Island and released on Skagul and Yunaska Islands. On Alaid-Nizki Island, biologists discovered 124 nesting pairs. This is the second reintroduced nesting population, after Agattu Island, to become self-sustaining.

Items for Recovery Updates and Regional News are provided by endangered species contacts in FWS regional and field offices.

DO YOU HAVE A STORY?

Because of its increasingly diverse audience, the *Bulletin* is seeking to diversify and expand its coverage of endangered species issues. With the Endangered Species Act due for reauthorization, the *Bulletin* also will become more important as a means of public outreach. We need your help in bringing broader coverage of endangered species issues and activities to the public.

Material on a wide range of topics relating to endangered species is welcome and may be semi-technical or popular in nature. We are particularly interested in success stories and news about recovery (both the development of recovery plans and their implementation). Material is also needed on inter-agency consultations (including biological opinions rendered, reasonable and prudent alternatives identified, etc.); Habitat Conservation Plans; other cooperative ventures with Federal and State agencies, conservation organizations, business, and private landowners; changes in a species' status; and new threats.

Before preparing a manuscript, please contact the *Bulletin* Editor (703/358-2390) to determine the proper length, focus, and timing of proposed articles. We welcome submissions but cannot guarantee their publication in the *Bulletin*. (Authors will be notified if their material is not used.) Manuscripts will be circulated to reviewers for technical content and consistency with FWS policies. They may also be edited for length, style, and clarity. The *Bulletin* staff will consult with authors on changes that may affect the content of a manuscript, and authors will have an opportunity to review edited material before publication. Credit will be given for all articles and illustrations.

Style

When preparing a manuscript, follow the *GPO Style Manual* if available. Keep in mind the diversity of the *Bulletin* audience. People from many different backgrounds are added to the mailing list each month, and discussing the context of an issue is an important aid to new readers.

As a general rule, feature articles should be three or four double-spaced pages in length (using a 12-point font in Letter Gothic or equivalent). Shorter items can be sent to the appropriate Regional endangered species specialist for inclusion in the Regional News column. Notices and announcements may be mailed directly to the Editor.

Because the *Bulletin* recipients include scientists and foreign subscribers, please include in all material:

- Scientific and common names of *all* species mentioned (listed and non-listed species).
- Metric equivalents for *all* measurements.
- Celsius and Fahrenheit equivalents for temperatures.
- Complete names or terms to accompany the first use of all abbreviations and acronyms.

Submissions should always include the author's name, position, duty station, address, and telephone and fax numbers.

Illustrations

Photographs and/or line drawings are very important, and should be submitted with all articles as available. Photographs are particularly welcome, and can be provided as transparencies, prints (black-and-white preferred), or negatives. Include the photographer's name and material for a caption. If the material is copyrighted, please obtain in advance the necessary permission for the *Bulletin* to publish the illustration(s). Material will be returned upon completion.

Submission Format

Manuscripts for the *Bulletin* can be submitted several ways. We prefer to receive computer files in Wordperfect 5.1 or 6.1 format. Please transmit them via CC:MAIL (send to R9FWE_DES.BIM), or via Internet at R9FWE_DES.BIM@mail.fws.gov. You may also mail DOS-formatted diskettes to Endangered Species Bulletin, U.S. Fish and Wildlife Service, 452 ARLSQ, Washington, D.C. 20240. Submissions by FAX can be sent to 703/358-1735 (703/358-2390 to confirm). In all cases, please mail a double-spaced hard copy.

Printing Schedule

The *Bulletin* is on a bimonthly printing schedule, with six issues per year and an index.

We welcome contributions at any time, but material not received by the "Article Due" date will be held for a future issue.

Issue Date	Article Due Date
July/August 1996	April 22, 1996
September/October 1996	June 24, 1996
November/December 1996	August 30, 1996
January/February 1997	September 27, 1996
March/April 1997	November 22, 1996
May/June 1997	January 24, 1997
July/August 1997	March 28, 1997

BOX SCORE

Listings and Recovery Plans as of February 29, 1996

GROUP	ENDANGERED U.S.	ENDANGERED FOREIGN	THREATENED U.S.	THREATENED FOREIGN	TOTAL LISTINGS	SPECIES W/ PLANS
MAMMALS	55	252	9	19	335	40
BIRDS	74	178	16	6	274	73
REPTILES	14	65	19	14	112	31
AMPHIBIANS	7	8	5	1	21	11
FISHES	65	11	40	0	116	72
SNAILS	15	1	7	0	23	13
CLAMS	51	2	6	0	59	42
CRUSTACEANS	14	0	3	0	17	4
INSECTS	20	4	9	0	33	20
ARACHNIDS	5	0	0	0	5	4
ANIMAL SUBTOTAL	320	521	114	40	995	310
FLOWERING PLANTS	405	1	90	0	496	197
CONIFERS	2	0	0	2	4	1
FERNS AND OTHERS	26	0	2	0	28	12
PLANT SUBTOTAL	433	1	92	2	528	210
GRAND TOTAL	753	522	206	42	1,523*	520**

TOTAL U.S. ENDANGERED: 753 (320 animals, 433 plants)
TOTAL U.S. THREATENED: 206 (114 animals, 92 plants)
TOTAL U.S. LISTED: 959 (430 animals, 525 plants)***

*Separate populations of a species listed both as Endangered and Threatened, are tallied twice. Those species are the argali, leopard, gray wolf, piping plover, roseate tern, chimpanzee, green sea turtle, and olive ridley 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.

**There are 419 approved recovery plans. Some recovery plans cover more than one species, and a few species have separate plans covering different parts of their ranges. Recovery plans are drawn up only for listed species that occur in the United States.

***Four animals have dual status.

ENDANGERED Species BULLETIN

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