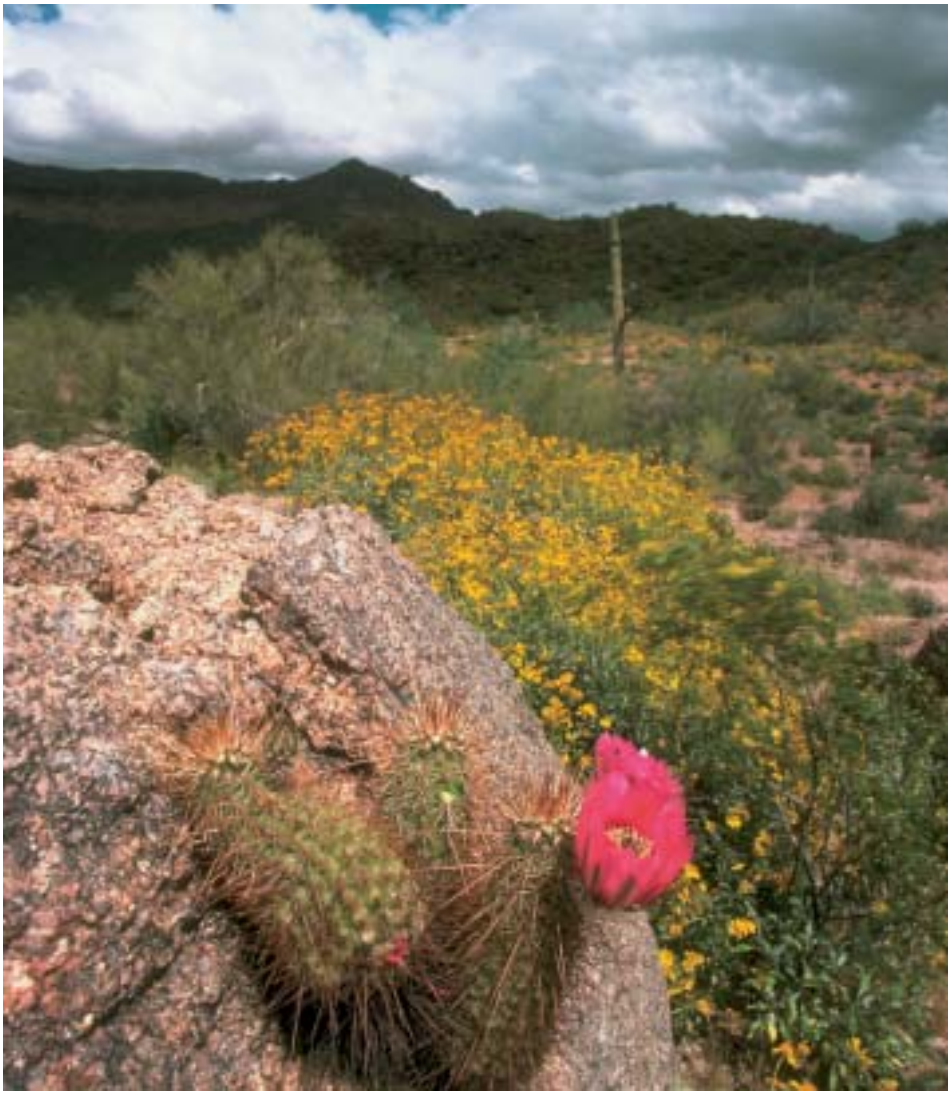
U.S. Fish & Wildlife Service

ENDANGERED Species BULLETIN

March/June 2002 Vol. XXVII No. 2



Desert: the word conjures images of vast, barren landscapes of sand, rocks, and a few twisted, thorny plants baking under an unrelenting sun. Contrary to appearances, however, deserts can harbor surprising biological diversity, although much of it is not readily apparent. In response to extreme environmental conditions, many species are secretive, nocturnal, or active only seasonally. These conditions have led to a high number of endemic species, or those found only within a restricted range. Desert habitats also can be surprising; many are quite fragile and, once damaged, difficult to restore. Such characteristics make deserts challenging but intriguing places for us to conserve endangered species and the ecosystems upon which they depend.

U.S. Fish & Wildlife Service

Corel Corp. photo

WASHINGTON D.C. OFFICE *Washington, D.C. 20240*

Steve Williams, *Director*
Gary Frazer, *Assistant Director for Endangered Species*
Elizabeth H. Stevens, *Deputy Assistant Director*

Claire Cassel, *Chief, Division of Partnerships and Outreach* *(703)358-2390*
Rick Sayers, *Acting Chief, Division of Consultation, HCPs, Recovery, and State Grants* *(703)358-2106*
Chris L. Nolin, *Chief, Division of Conservation and Classification* *(703)358-2105*
Kathy Walker, *Chief, Office of Program Support* *(703)358-2079*
`http://endangered.fws.gov/`

REGION ONE *Eastside Federal Complex, 911 N.E. 11th Ave, Portland OR 97232*

California, Hawaii, Idaho, Nevada, Oregon, Washington, American Samoa, Commonwealth of the Northern Mariana Islands, Guam and the Pacific Trust Territories

Anne Badgley, *Regional Director* *(503)231-6118*
`http://pacific.fws.gov/`

REGION TWO *P.O. Box 1306, Albuquerque, NM 87103*

Arizona, New Mexico, Oklahoma, and Texas

H. Dale Hall, *Acting Regional Director* *(505)248-6282*
`http://southwest.fws.gov/`

REGION THREE *Federal Bldg., Ft. Snelling, Twin Cities MN 55111*

Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin

William Hartwig, *Regional Director* *(612)715-5301*
`http://midwest.fws.gov/`

REGION FOUR *1875 Century Blvd., Suite 200, Atlanta, GA 30345*

Alabama, Arkansas, Louisiana, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Florida, Tennessee, Puerto Rico, and the U.S. Virgin Islands

Sam Hamilton, *Regional Director* *(404)679-7086*
`http://southeast.fws.gov/`

REGION FIVE *300 Westgate Center Drive, Hadley, MA 01035*

Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia

Mamie Parker, *Regional Director* *(413)253-8300*
`http://northeast.fws.gov/`

REGION SIX *P.O. Box 25486, Denver Federal Center, Denver CO 80225*

Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, and Wyoming

Ralph O. Morgenweck, *Regional Director* *(303)236-7920*
`http://mountain-prairie.fws.gov/`

REGION SEVEN *1011 E. Tudor Rd., Anchorage, AK 99503*

Alaska

Dave Allen, *Regional Director* *(907)786-3542*
`http://alaska.fws.gov/`

ENDANGERED Species BULLETIN

Telephone: (703)358-2390
Fax: (703)358-1735
E-mail: esb@fws.gov

Editor
Michael Bender

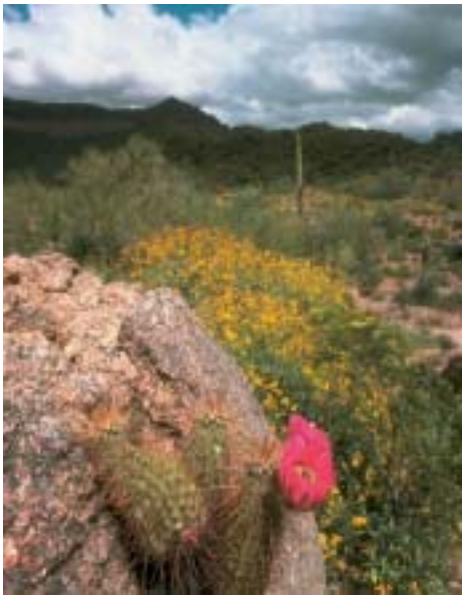
Associate Editor
Susan D. Jewell

Editorial assistance provided by
Ann Haas

Art Director
David Yeargin

Subscriptions Manager
Germaine Kargbo

Contributors
Jim Rorabaugh
Ray Bransfield
Susan D. Jewell
Mark Dimmitt
Richard C. Brusca
Chuck Huckelberry
Cathryn A. Hoyt
Jody Fraser
Cynthia Martinez
Linus Chen
Mike Richardson
Jeff Humphrey
Craig Springer
Randi Thompson
Marty Jakle
Antonia Nevarez
Ben Ikenson
Dario Bard
LaRee Brosseau
Tracy A. Scheffler
Jim Brooks
Shane Jones



On the Cover
The Sonoran Desert is an area of surprising biological richness and beauty.
Corel Corp. photo

The Endangered Species 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.

The Fish and Wildlife Service distributes the Bulletin primarily to Federal and State agencies, and official contacts of the Endangered Species Program. It also is reprinted by the University of Michigan as part of its own publication, the Endangered Species UPDATE. To subscribe, write the Endangered Species UPDATE, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115; or call (734) 763-3243.

Printed with vegetable-based ink on recycled and recyclable paper. If you do not keep back issues, please recycle the paper, pass them along to an interested person, or donate them to a local school or library.

IN THIS ISSUE

4 **Lands of Contrast, Diversity, and Beauty**

8 **Endangered Species and the Arizona-Sonora Desert Museum**

12 **The Sonoran Desert Conservation Plan**

16 **The Chihuahuan Desert: Diversity at Risk**

18 **Restoring a Desert Oasis**

20 **Desert Fish: Life on the Edge**

22 **Life in Mauna Kea's Alpine Desert**

24 **The Tarahumara Frog: Return of a Native**

27 **Leading-edge Science for Imperiled Bonytail**

28 **Las Vegas Places its Bets on Habitat Plan**

30 **Arizona Tribal Partnerships for Wildlife**

32 **New Mexico's Little Known Treasures**

34 **Rio Grande Silvery Minnow**

36 **Black-footed Ferrets Return to Mexico**

Departments

38 Regional News and Recovery Updates

40 Listing Actions

44 Box Score

Lands of Contrast, Diversity, and Beauty

by Jim Rorabaugh and
Ray Bransfield

A rare dusting of snow in the normally hot, dry Sonoran Desert
Corel Corp. photo

Despite their popular image as hot, dry, virtually lifeless wastelands, deserts support a deceivingly rich level of plant and animal life with a high degree of biological diversity. But just what is a desert?

Mark Dimmitt of the Arizona-Sonora Desert Museum (see the following article) has coined a concise nontechnical definition of a desert as "a place where water is severely limiting to life most of the time." Deserts generally receive less than 10 inches (25 centimeters) of annual precipitation and are characterized by high evaporation rates. As a result, desert plants and animals must be especially efficient at capturing water and thrifty in its use. To further complicate matters for living things, precipitation is often highly variable in terms of time and place. For example, in the Sierra del Rosario of the Gran Desierto in the state of Sonora, Mexico, no measurable precipitation fell during a 34-month period in the early 1970s. In contrast, rainfall from a single torrential storm event can exceed the mean annual precipitation. Other characteristics that help define deserts include high maximum temperatures and daily temperature variation, low soil fertility, and extremely low cover by perennial plants.

Deserts cover up to one third of the earth's land surface. In western North America, 386,000 square miles (one million square kilometers) are considered desert. The United States has four desert regions: the Great Basin, Mojave, Sonoran, and Chihuahuan (see map). In the Great Basin Desert, snowfall and freezing temperatures are common in winter, whereas frost occurs only 2 to 5 percent of the time in the Mojave and Chihuahuan deserts and 1 percent or less of the time in the Sonoran Desert.

Although deserts are harsh environments in many ways, species richness can be high. In a recent assessment (*Terrestrial Ecoregions of North America: A Conservation Assessment,* T.H. Ricketts *et al.*, Island Press, 1999) of biodiversity in 116 U.S. and Canadian biomes (major life zones of interrelated plants and animals determined by climate), the Chihuahuan Desert had the greatest diversity of birds, mammals, reptiles, and butterflies, and placed eleventh in vascular plant diversity. The Sonoran Desert ranked second in avian species diversity and third in mammalian diversity. All four North American deserts also had high rates of endemism (where species have locally restricted ranges) as well, which reflects specialized adaptations to habitat niches.

Contributing to the diversity of desert organisms are those species that live in pockets or oases of less arid environments. Riparian or streamside environments, in particular, support an array of species found nowhere else in desert regions. The Rio Grande and Pecos River of the Chihuahuan Desert, the San Pedro and Colorado rivers of the Sonoran Desert, and the Mojave River of the Mojave Desert contribute enormous

diversity to these otherwise arid environments. Also important are mountain tops or "sky islands," and in some cases deep, shady canyons, that support chaparral, woodlands, or other communities that are relics of more temperate periods.

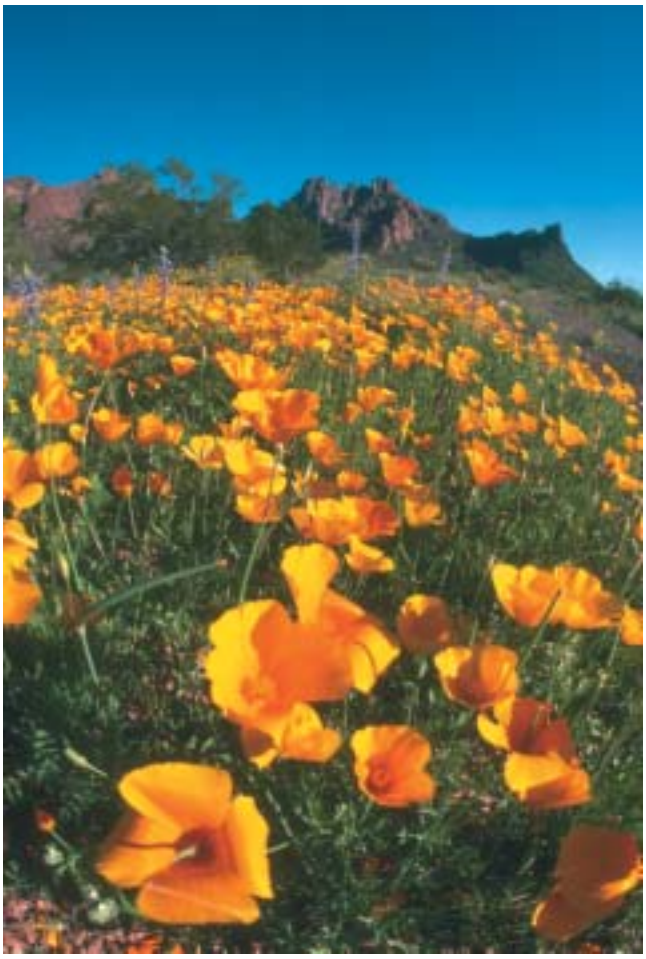
Plants and animals are often exquisitely adapted to living in the desert. The concept that species struggle to survive in the desert is inaccurate. Desert residents employ various behavioral and physiological adaptations to thrive in this harsh environment. Some species simply avoid aridity by living in riparian habitats, or by being active or growing only during the desert's brief wet periods. For example, more than 40 percent of desert plants are annuals that germinate and grow only when enough rain has fallen. Spadefoot toads *(Scaphiopus* and *Spea* spp.*)* and some other amphibians wait out the desert's heat and aridity in subterranean retreats until summer rains create standing water for breeding and feeding. Sometimes they must wait a year or more for the rains to come. Other species are simply adapted to living with aridity. Plants, for example, employ a variety of strategies to minimize evaporative water loss: some drop their leaves in dry periods; some develop succulent stems, leathery leaves, or tubers that store water; and others lack leaves entirely.

Our deserts are relatively intact and undisturbed compared to most other North American ecosystems, many of which have been logged, farmed, urbanized, or otherwise changed in many ways by human activities. The harshness of the desert, and the perception that deserts are wastelands, kept people away for a long time. But deserts did not escape human influence even historically, and today humanity affects even the most remote desert locales. Urbanization and agriculture have consumed large tracts of desert in recent years, such as in the rapidly growing urban centers of Phoenix and Las Vegas, and certain military activities have degraded thousands of acres. Even where large-scale habitat loss has not occurred, off-road vehicles and other forms of recreation, cattle and sheep grazing, roads and canals, introduced invasive plants, and a myriad of other human-caused problems can degrade and fragment desert ecosystems.

Desert soils and their biota are fragile, often overlooked resources. Crypto-biotic crusts, which are soil communities of lichens, algae, and mosses, are very important. They benefit native plant and animal communities by stabilizing desert soils, contributing nutrients, and increasing water infiltration. These crusts are especially well-developed in desert soils but are easily destroyed by cattle grazing, off-road vehicles, and other sources of surface disturbance. Once destroyed, the crusts may take centuries to fully recover. Tank tracks from General Patton's World War II military training are still visible in the Mojave Desert. Cryptobiotic crusts have been observed growing in undisturbed soils around the tracks, but 60 years

Map adapted from "Deserts" by K. Bruce Jones, in* Inventory and Monitoring of Wildlife Habitat, *U.S. Department of the Interior, 1986.

Pronghorn in Great Basin desert
Photo by Curtis Carley/USFWS



If enough rain falls, desert wildflowers can erupt from seeds that may have been produced years ago.
Corel Corp. photo

later, the crusts are still absent from the tracks themselves. The disturbance of desert crusts by vehicular activity results in erosion and the movement of particulate matter, sometimes far beyond its source area. In some areas, these wind-blown particulates are a hazard to human health; in others, newly formed sand dunes bury existing habitats and alter biotic communities.

Historically, mining and cattle grazing were the primary uses of desert lands. Cattle were introduced over 300 years ago, but were not common on the landscape until the railroads arrived and encouraged large-scale ranching in the late 1800s. Cattle have had a profound effect on desert scrub communities, including the depletion of native grasses, introduction of nonnative plants, destruction of cryptobiotic crusts, and compaction of soils. Changes in plant communities have led to decreased diversity and numbers of lizards and other wildlife. Evidence of mining in the desert is often historical, but interest in "hard rock" minerals, especially gold, has undergone a resurgence in some areas due to new technologies that can extract minerals from old tailings or other low-yield sources.

Invasive nonnative plants, such as red brome *(Bromus rubens)*, filaree *(Erodium cicutarium)*, and split grass *(Schismus* spp.*)*, are now common and widespread across the North American deserts. Bufflegrass *(Pennisetum ciliare)*, a perennial bunch grass from Africa introduced as cattle feed, has been planted in rangelands in Texas, occupies more than 2 million acres in Sonora, Mexico, and is invading other desert lands in Arizona and Texas. Its expansion to the north and into higher elevations has been limited by winter cold. However, the "frio" variety, recently released in Texas, tolerates colder climates and is sure to pose an even greater threat to the desert's biodiversity. Another African invader, Sahara mustard *(Brassica tournefortii)*, has in recent years spread rapidly across the Mojave Desert in California and in sandy areas in the Sonoran Desert.

In abundant rainfall years, nonnative annual plants can be dense enough to carry fire when they dry and cure. The perennial bufflegrass can carry fire during any dry period. Most native species are poorly adapted to fire, because fire was historically absent or very rare in many parts of North American deserts. Fire fueled by nonnative plants is converting scenic stands of columnar cacti and leguminous trees in the Sonoran Desert, and creosote and yucca in the Mojave Desert, to grasslands dominated by nonnative annual grasses and herbs.

Some human impacts to the desert are more difficult to detect by casual observation. Vanadium, a by-product of oil production in the Central Valley of California, has increased in air samples collected in the northern Mojave Desert. In Death Valley National Park, sulphur compounds have been found to occur at elevated levels in tree rings dating to the years following World War II. High levels of heavy metals have been detected in some desert tortoises. At this time, we do not know how these elements will affect biological diversity in the desert.

Some of the most contentious issues in the desert southwest center around the development and use of water. In the southwest, we have an old saying: "Whiskey's fer drinkin' and water's fer fightin' over." As a scarce commodity, water in the desert has been the subject of considerable "fightin' " for a long time. Virtually every major river in our deserts has been dammed and diverted, many have been channelized and lined with levees, and others have been pumped dry.

Our desert rivers and streams are also awash in nonnative fishes, invertebrates, amphibians, and plants. As a result, a high percentage of native riparian species in the deserts are in some danger of extinction. Most of the native fishes are listed as threatened or endangered, and the roster of other listed and candidate riparian species continues to grow.

Despite considerable threats to desert biodiversity, many public and private agencies and institutions have stepped up to the plate to meet the challenge of conserving arid land resources. Lands administered by the Bureau of Land Management support numerous sensitive habitats and species, although the Department of Defense, National Park Service, Fish and Wildlife Service, and Forest Service also manage key areas of biodiversity. The Navajo, Hopi, Tohono O'odham, and many other Native American Tribes also are stewards of desert lands across the West. State parks and wildlife areas, particularly in California and Texas, have protected key areas. Many private groups and individuals, too numerous to mention here, have been instrumental in bringing about needed changes in land management and in preserving special places in the desert. Some ranchers and other landowners are modifying their activities to conserve native plants and animals as well. The articles that follow illustrate some of the many programs and projects that have contributed to the preservation of the unique species and subtle beauty that characterize our North American deserts.

Death Valley, California, in the Mojave Desert
Corel Corp photo

(At right) Florida scrub jay
USFWS photo

Jim Rorabaugh is Supervisory Fish and Wildlife Biologist in the Arizona Ecological Services Field Office in Phoenix; 602/ 242-0210 ext. 238; jim_rorabaugh@fws.gov. Ray Bransfield is a Wildlife Biologist in the FWS Ventura, California, Field Office; 805/ 644-1766 or at ray_bransfield@fws.gov.

Florida's Desert

by Susan D. Jewell

Most people are familiar with the deserts of the American southwest. But who ever thinks of a desert in Florida?

In scattered patches, particularly across central Florida, there are sandy scrub habitats so dry that only desert-like animals can survive. The best example is the Lake Wales Ridge, 100 miles (160 km) long and up to 25 miles (40 km) wide. It is a remnant of the prehistoric shoreline, left after wind and waves piled the sand into high dunes. Now the sand lies hundreds of feet thick below the ground. Rainfall percolates through these deposits so quickly that plants and animals must survive on little moisture. Nutrients also quickly leach through.

Some of the animals found there, such as the Florida scrub-jay *(Aphelocoma coerulescens)* in the photo above, are similar to ones found in the southwest desert. Mole and sand skinks, scrub lizards, and many fossorial (digging) insects have adapted to life on the shifting sands. Agaves and thorny plants also thrive here.

The Lake Wales Ridge has one of the highest concentrations of endemic species in North America, including 22 listed plants and 4 animals.

Endangered Species and the Arizona-Sonora Desert Museum

by Mark Dimmitt and
Richard C. Brusca

Mexican gray wolf
Photo by Jim Clark/USFWS

The Arizona-Sonora Desert Museum, a nonprofit research and education institution located in the city of Tucson, is a combination zoological park, botanical garden, nature center, and museum. Our multiple functions are reflected in our memberships in the American Zoo Association (AZA), American Association of Botanical Gardens and Arboreta, American Association of Museums, and Center for Plant Conservation, among others. Our primary mission is to understand and interpret the natural history and ecology of the Sonoran Desert and its surrounding habitats, and to promote conservation in the region.

Nursery Horticulturist John Wiens marks developing fruits on hand-pollinated, cultivated specimens of Nichol's Turk's head cactus. The fruit and seed counts will determine the maximum fecundity for this endangered cactus, known from only three populations in Arizona and Sonora. ASDM Research Associate Bob Schmalzel is two decades into a multifaceted ecological study of this plant. The plants shown here are second generation cacti in the Desert Museum's collection.
Photo: Mark Dimmitt.

The Sonoran Desert covers about 100,000 square miles (260,000 square kilometers) in the United States and Mexico. In contrast to the other three North American deserts, the Sonoran is tropical in origin and most of its area is frost-free. Half of its flora and a similar proportion of the fauna are descended from tropical ancestors. This fact is visually evident in two plant life forms that are characteristic of both the Sonoran Desert and dry tropical forests: legume trees and columnar cacti. The other three North American deserts have few trees and no columnar cacti.

Numerous biological communities occur adjacent to and within the Sonoran Desert proper. Representatives of all of the biomes can be found within this region, from alpine tundra near Flagstaff, Arizona, to tropical forests in southern Sonora, Mexico.

The wide variety of habitats and the biseasonal rainfall pattern in the Sonoran Desert support great biological diversity. Its flora contains about 2,000 species of vascular plants, and the whole region interpreted by the Desert Museum has at least 5,000. The desert proper supports approximately 600 species of vertebrates. The invertebrates have not been enumerated, but there are estimates for some taxa. Arizona alone boasts 40 species each of scorpions and velvet ants, and 250 butterflies; the Sonoran Desert has 40 species of termites. The area around Tucson has 1,000 species of native bees, and an equal number of moth species occurs in a single canyon in the Huachuca Mountains of southern Arizona.

Most of our exhibits at the Arizona-Sonora Desert Museum are outdoors and integrate native, live animals and plants in natural settings. Our interpretive focus is as much on ecological processes as it is on individual species. For example, our Pollination Gardens interpret the interaction of animals and plants and the reciprocal benefits of pollination ecology rather than simply talking about, say, hummingbirds or flowering ocotillos.

We mainly promote *in situ* conservation (that is, conservation of nature in place as opposed to in botanical gardens or zoos), and we focus on the protection of natural communities more than on preservation of individual species. For example, research on the ecology and population dynamics of desert ironwood trees *(Olneya tesota)* revealed just how important this plant is to the ecological health of the Sonoran Desert and its wildlife. These findings attracted the attention of the Department of the Interior and provided the scientific underpinnings for the creation of the Ironwood Forest National Monument in 2000. The ironwood studies and other research results have also been used by Pima County in developing its Sonoran Desert Conservation Plan (see the following article).

The Desert Museum also maintains *ex situ* or museum-based populations of several endangered species. The animals bred as part of our participation in AZA's Species Survival Plan program include the Mexican gray wolf *(Canis lupus baileyi)*, thick-billed parrot *(Rhynchopsitta pachyrhyncha)*, and ocelot *(Leopardus pardalis)*. Our Botany Department maintains populations of several endangered plants, including the Nichol's Turk's head cactus *(Echinocactus horizonthalonius* var. *nicholii)*, Pima pineapple cactus *(Cory-*

A field-netted lesser long-nosed bat is about to surrender a small tissue sample for DNA analysis before being released. Studies of this endangered nectar-feeding bat species are part of the Desert Museum's Migratory Pollinators Program.
Photo by Karen Krebbs

This San Esteban chuckwalla* (Sauromalus varius) *provides* in situ *blood samples for analysis as part of a long-term study (photo shows Curator of Herpetology Craig Ivanyi in 1997). The Desert Museum has also maintained a captive breeding population of this speciesfor more than 20 years. This chuckwalla is abundant on tiny San Esteban Island in the Gulf of California, but occurs naturally nowhere else.
Photo by Gary P. Nabhan

phantha scheeri var. *robustispina)*, and Kearney blue-star *(Amsonia kearneyana)*.

We have numerous other rare plant and animal species in our collections. Our list of Species of Conservation Concern for the Sonoran Desert region totals 195 rare or vulnerable plant taxa, of which 125 are in our collections. Some of these are plants that our field botanists have located within the Sonoran Desert region for the first time, and some were previously unknown to science. Of 90 vertebrate species of concern, specimens of 44 species are on exhibit or in breeding programs at the Desert Museum.

Members of our Conservation and Science Department staff are involved in several field research projects that involve endangered and threatened species. The largest is the Migratory Pollinators Program, which is being funded by the Turner Foundation, Turner Endangered Species Fund, and National Fish and Wildlife Foundation. One of the species under investigation is the endangered lesser long-nosed bat *(Leptonycteris curasoae)*. Among the non-listed species we're studying are the rufous hummingbird *(Selasphorus rufus)*, white-winged dove *(Zenaida asiatica)*, and monarch butterfly *(Danaus plexippus)*. There is evidence that the latter three species are declining due to habitat destruction. Our Migratory Pollinators Program seeks to map the migration corridors of these species from the southwestern United States to the state of Jalisco, Mexico. We are also identifying the major plant resources that fuel the migrations, recommending the preservation of important habitat that we identify in Mexico and the southwestern U.S., and providing information to the public about the loss of pollination services in nature and agriculture due to habitat destruction and excessive pesticide use

Working beyond species boundaries, the Desert Museum has been a leader in research and public education about endangered ecological processes. Gary Nabhan, the Museum's former Director of Conservation and Science, worked on the ecology of the desert ironwood tree (see sidebar) and revealed its status as a keystone species upon which numerous other plants and animals depend. Through a grant from the National Fish and Wildlife Foundation, we are conducting exhaustive studies on the ecology and population dynamics of the Pima pineapple cactus, including its pollination biology, fecundity, growth rates, seed dispersal, and predators. Rick

Brusca, our new Director of Conservation and Science, conducted research in the Gulf of California and its coastal habitats. His findings have played a key role in developing conservation strategies for critical coastal and island habitats in the Gulf and the Colorado River Delta region, including protection of coastal wetlands and of the endangered Gulf miniature porpoise or vaquita *(Phocoena sinus)*, a fish known as the totoaba *(Totoaba macdonaldi)*, and others. Brusca was co-Principal Investigator on the construction of an All-Animal Database for the Gulf of California (accounting for more than 6,000 species) that is currently being used to identify the most imortant conservation priorities in the region.

There is an urgency to conservation in the Sonoran Desert region because southern Arizona and Sonora, Mexico, are among the fastest developing areas in North America. Conducting all of these projects puts tremendous demands on our small staff of 110 employees, even with the help of several hundred docents and volunteers. We maintain the grueling pace because we love this land and want to keep the best parts of it healthy and beautiful for the benefit of future generations.

Mark A. Dimmitt (520/883-3008; mdimmitt@desertmuseum.org) is the Museum's Director of Natural History and Rick Brusca (520/883-3007; rbrusca@desertmuseum.org) is the Director of Conservation and Science.

Illustration by Bill Singleton

The Arizona Sonora Desert Museum has had a long-standing interest in the wellbeing of the desert ironwood tree. This legume, the only species in its genus, has no close relatives. It is a dominant tree in much of the Sonoran Desert and is nearly endemic to this region. Desert ironwood trees are slow growing and live up to 800 years. The wood is so dense that it sinks in water, and it contains toxins that render it nearly non-biodegradable. Because dead wood is immune to termites and wood-rotting fungi, large trees can take a millennium to weather away after dying.

Gary Nabhan discovered ironwood's role as a keystone species in the Sonoran Desert ecosystem. Most desert plants cannot become established in the harsh, open desert environment; they must germinate beneath a "nurse plant." In some regions of the Sonoran Desert, ironwoods are the most important nurse trees, sheltering more species within their canopies than any other plants. The diversity of associates is greatest in the Silverbell Mountains and adjacent ranges west of Tucson, Arizona.

Although it is not classified as endangered, desert ironwood is greatly threatened by human activities. For example, the trees have been locally depleted by the ironwood carving industry. Begun by the Seri Indians of Sonora, Mexico, in the 1960s, the carving of ironwood into animal figures created a growing demand for these items that many other Mexicans carvers now seek to fill. A greater threat is the demand for firewood and charcoal. The main tree cut for these uses is mesquite *(Prosopis* spp.*)*, but ironwoods are often indiscriminately cut as well. The damage is increased by changes in cutting techniques. When felled by axe, ironwood trees resprout from the stump. But today they are most often cut to ground level with chain saws, causing them to die. Major components of the desert community die with the nurse trees. This information was gathered and publicized by the Ironwood Alliance, a conservation organization in which Desert Museum staff members are actively involved.

The above studies led to creation of the Ironwood Forest National Monument in 2000. This monument encompasses the Silverbell Mountains and four other desert ranges and intervening valleys. The Desert Museum will continue to be involved in this new monument, which is practically in our back yard, and the Bureau of Land Management has contracted us to conduct the vegetation analysis and baseline faunal studies needed to develop the monument's management plan. The monument is expected to be an important part of the proposed Sonoran Desert Conservation Plan's system of habitat reserves.

The Sonoran Desert Conservation Plan

by Chuck Huckelberry

When the tiny cactus ferruginous pygmy owl was listed as endangered, its presence in Pima County focused the need to address the impacts of development on Sonoran Desert ecosystems.
Photo by Glenn Proudfoot

(Opposite page) One of the treasures of the Sonoran Desert is Organ Pipe Cactus National Monument, which is managed by the National Park Service.
Corel Corp. photo

Pima County, Arizona, covers a vast land base in the southwestern United States and includes a community of diverse cultures and interests. Within the boundaries that encompass our nearly 6 million acres (2.4 million hectares) of Sonoran Desert, we are proud to count as neighbors the country's second largest Native American Nation, the Tohono O'odham, ranch communities, federal land managers of every stripe, and urban communities that are enriched by our Hispanic origins and energized by the 20,000 new residents who move here each year.

We have consistently sought ways to express a love of, and concern for, the unique Sonoran Desert ecosystem that surrounds us with such unparalleled beauty. Until recently, translating that passion into a comprehensive land use plan has been a losing battle. Five decades of steady population growth outpaced the county's ability to establish and implement an effective regional planning tool. In 1998, however, we found the approach we were looking for in the promise of the Sonoran Desert Conservation Plan.

The need to address Pima County's growth issues intensified when the community experienced its first Endangered Species Act (ESA) listing that affected development in upland areas. The cactus ferruginous pygmy-owl *(Glaucidium brasilianum cactorum)* gained federal protection as an endangered species in 1997 after biologists found only 12 of the tiny birds in Pima County. We responded early by forging partnerships with federal land managers to address the regulatory expectations of the ESA and to meet the larger spirit and intent of that law. Tucson, Pima County's largest city, is a place where both entrepreneurial and conservation land ethics find extraordinary expression. Therefore, we set out to formulate a new kind of conservation plan, one tailored to the unique pressures we face here in Pima County.

Section 10 of the ESA allows for the kind of flexibility and balance we need. The economic certainty gained by regulatory assurances that are provided under a section 10 incidental take permit will meet the requirements of the business community, and the science-based conservation aspects of the planning process will allow us to address the problems that led to the owl's listing in the first place. In fact, we seek to reverse the decline of a host of vulnerable species by conserving and restoring large-scale natural systems in the Sonoran Desert ecoregion.

Origins

In 1998, the Pima County Board of Supervisors initiated discussions on land use planning and conservation. We broadened the vocabulary of the growth debate to include biological and scientific concepts, and reframed the elements of regional planning to encompass the relation that the land has to natural and cultural resources. This was a bold

stroke by the board: to undertake science-based land use planning and depart from the practice of placing political considerations at the front of the conversation. Pima County has asked fundamental questions about resource capacity and the impacts of land and water uses. Answers to these important questions suggest reforms, strategies, and solutions that encompass the region without regard to the administrative constraints of governmental entities.

The proposed Sonoran Desert Conservation Plan steps away from conventional metropolitan and regional planning theory. It uses a concept that can be called "bio-planning," or natural resource assessment and planning, as a necessary first step in determining urban form. Our method assumes that urbanizing areas are endowed with certain natural, cultural, and historical resources that should receive protection. This is the basic principle upon which the plan is based.

For the past several decades, Arizona has been one of the fastest growing states in the country. Between 1990 to 2000, the population in Arizona grew from 3.6 million to 5.1 million, an increase of 40 percent. Pima County has shared in this rapid population expansion. The county's annual growth rate varies from 15,000 to 30,000 persons each year, and at the current rate the county consumes approximately seven to 10 square miles (18 to 26 square kilometers) of the desert each year. The Sonoran Desert, rich in biodiversity, provides habitat for more than 2,500 known pollinators and 500 migrating or resident bird species—a figure that represents almost two-thirds of the bird species in the United States, Canada, and northern Mexico, according to The Nature Conservancy.

Elements of the Proposed Plan

Most urban areas have plans or programs that give at least some protec-

An endangered plant, the Pima pineapple cactus* (Coryphantha scheeri *var.* robustispina) *is roundish to oval in shape and can grow up to 18 inches (45 cm) in height. It occurs in low densities within southern Arizona and northern Sonora, Mexico. Threats to this rare cactus include urban and agricultural development, off-road vehicle use, overgrazing, mining, nonnative grasses, and illegal collecting.
Photograph by Jim Rorabaugh

Harris hawk* (Parabuteo unicinctus) *nesting on a saguaro* (Carnegiea gigantea) *cactus, an indicator species of Sonoran desert.
Corel Corp. photo

tion to natural, historic, and cultural resources. Pima County was no exception even prior to the Sonoran Desert Conservation Plan proposal. What is different now is that all of the sometimes independent natural resource planning and protection activities have been integrated into the proposed Sonoran Desert Conservation Plan. The six elements of the plan are:

1) Ranch Conservation

Ranching is a significant historical and cultural land use in Pima County. Ranch lands have largely determined the urban boundary in eastern Pima County, and ranching continues to maintain open space and other natural resources. But many ranchers in Pima County are under economic pressure to sell their land for subdivision and urbanization. By helping ranchers stay in ranching and by promoting good land management principles, we can better protect the open space of Pima County.

2) Riparian Restoration

Riparian areas in a desert environment are very important natural resources, but they are the most vulnerable habitats in Pima County. Sixty to 75 percent of all species in Arizona rely on a riparian environment (including aquatic habitats) during at least part of their life cycle. Decades of unintended destruction, primarily in urban areas, should be reversed through some level of riparian restoration.

3) Mountain Parks

Protecting the open and scenic beauty of the west has long been recognized as important. Tucson Mountain Park was established by the Board of Supervisors in 1929 and has been expanded periodically ever since. New mountain parks are still being created, primarily to protect scenic views from encroachment and destruction. Preservation of these vast tracts of mountain lands also protects their biological resources.

4) Historical and Cultural Preservation

Pima County is rich in history, culture, regional character, and diversity. Unfortunately, continued urban expansion threatens our cultural and historic resources. It is important to preserve our past in order to face our future.

5) Critical Habitat and Biological Corridors

The two elements that express the biological basis of the plan are critical habitats[1] and biological corridors. When work began on the proposed Sonoran Desert Conservation Plan, the scientific community did not have a list of vulnerable species of concern, a set of biological standards, or even a vegetation map that could serve as a starting point to determine which of the regions' species need protection or are in decline. These two elements of the original plan, now combined into one, recognize the need for biological interconnectivity between the areas that will be identified for conservation in the plan.

Each of these independent planning elements is being woven carefully into the Sonoran Desert Conservation Plan to provide the most comprehensive and scientifically defensible set of natural resource, historical, and cultural preservation goals.

6) A Conservation Reserve and Development Reserve

The proposed Sonoran Desert Conservation Plan combines short-term actions to protect and enhance the natural environment with long-range planning to ensure that our natural and urban environments not only coexist but enhance each other.

The Conservation Plan is not about *whether* development in the county continues to grow but *where* it grows. Growth should occur in areas with the fewest natural, historic, and cultural resource values. The end product of the Sonoran Desert Conservation Plan will be to create a regional conservation reserve using the best science available. A conservation reserve will be formed by

combining a biological reserve with a historic and cultural reserve.

The Science Technical Advisory Team for the Sonoran Desert Conservation Plan has outlined a preliminary conceptual reserve based on the land needed to stabilize and recover plants and animals that are currently imperiled, threatened, and/or endangered. Land uses that are compatible with biological goals within the conservation reserve will be further defined in upcoming months. At this time, we do not know which lands within Pima County will be incorporated within the conservation reserve or how much acreage it will include.

Lands outside of the conservation reserve will become possible sites for establishment of a development reserve. Development reserve lands also will be defined in more detail later in the comprehensive planning effort. These areas do not have the values previously described within the conservation reserve and should be considered as preferred areas for urban conversion.

Conclusion

The Sonoran Desert Conservation Plan has become increasingly innovative, inclusive, and comprehensive as it develops. Two independent experts, conservation biologist Dr. Reed Noss and Laura Hood Watchman, the author of a book and numerous studies analyzing habitat conservation plans around the country, have conducted an independent review of the Sonoran Desert Conservation Plan and praised it as "a credible, science-based process designed to achieve clear and laudable goals for the long-term conservation of biodiversity in Pima County."

Pima County is designing its plan for the urban environment to work within a natural and cultural resource protection ethic, which in turn will give the issues of urban design and a sustainable economy new life. I believe Tucson will grow into itself through this planning initiative, shedding its limitations and realizing its potential. It is our love of the Sonoran Desert that will ultimately allow Pima County residents to turn the most ambitious habitat conservation effort in the United States into the grandest of community plans. Our efforts to date were recently recognized by the American Planning Association, which awarded the proposed Sonoran Desert Conservation Plan its Outstanding Award for a Plan. We hope to have the approved plan in place by December 2002.

The Sonoran Desert Conservation Plan website, `http://www.co.pima.az.us/cmo/sdrp/`, contains a wealth of information about the proposed plan as it stands now and the process guiding its development.

It has been a privilege to work with the U.S. Fish and Wildlife Service, other federal agencies, and the local community as we establish the Sonoran Desert Conservation Plan and together find a mechanism for creative problem solving.

Chuck Huckelberry is the Pima County Administrator. For more information about the plan, contact Maeveen Behan, Assistant to the County Administrator, at 520/740-8015 or mbehan@exchange.co.pima.az.us.

[1]For the purposes of the Sonoran Desert Conservation Plan and this article, the term "critical habitat" refers not only to regulatory designations of critical habitat under the ESA but also other habitats important to the conservation of species covered in the plan. In addition, the term recognizes unique Sonoran Desert habitat associations, such as ironwood stands, that are critical to sustaining the desert's biodiversity.

(Left) A herbaceous, semi-aquatic perennial, the Huachuca water umbel* (Lilaeopsis schffneriana *ssp.* recurva) *occurs in cienegas, springs, and healthy riverine systems in southern Arizona and northern Sonora, Mexico. Widespread loss of riparian habitats led to the decline of this endangered plant.

(Above) The Gila chub* (Gila intermedia)*, a dark-colored minnow that can reach a maximum length of about 10 inches (25 cm), historically inhabitated headwater streams of the Gila River in Arizona and New Mexico and likely the San Pedro and Santa Cruz river systems in Sonora, Mexico. This fish is on the Arizona threatened list and is a candidate for federal listing.

Illustrations by Bill Singleton

The Chihuahuan Desert: Diversity at Risk

by Cathryn A. Hoyt

Photo by Michael Bender

The Chihuahuan Desert is a land of superlatives. Covering nearly 250,000 square miles (647,500 square kilometers), it is the largest of the North American deserts. Jutting mountains and low basins form a range of habitats suitable for a broad spectrum of terrestrial and freshwater species. In fact, the Chihuahuan Desert is considered to be one of the most biologically diverse arid regions in the world. It is also one of the most endangered.

The Landscape

The Chihuahuan Desert stretches from southern New Mexico through the Rio Grande drainage of west Texas/northern Mexico and spreads southward over the Mexican Plateau into the states of Chihuahua, Coahuila, southwestern Nuevo Leon, northeastern Durango, and San Luis Potosí. The desert is bounded to the east and west by the ranges of the Sierra Madre Oriental and the Sierra Madre Occidental, respectively. The northern and southern boundaries, more difficult to define, are usually based on such diagnostic indicators as climate, vegetation, or animal communities.

Basin and range topography predominates the Chihuahuan Desert, with fault-block mountains separated by down-faulted basins. Typically, the basins are internally drained, resulting in the formation of saline ephemeral lakes known as playas. Dune fields, composed of quartz or gypsum sand, are common throughout the desert, while volcanic features add additional complexity to the landscape.

The varied geology of the Chihuahuan Desert supports a mosaic of vegetation communities, ranging from desert shrubs such as creosote *(Larrea tridentata)* and tarbush *(Flourencia cernia)* at lower elevations to conifer woodlands at higher elevations. Two features make the Chihuahuan Desert region unique: the vast temperate grasslands that skirt the mountain flanks at mid-elevation and the diversity of yuccas and agaves. One of the agaves, lechuguilla *(Agave lechuguilla)*, is considered the primary diagnostic species of the Chihuahuan Desert.

Modification of the Environment

While some of the inaccessible, montane parts of the Chihuahuan Desert region have floral and faunal communities that are at least relatively intact, much of the desert has been heavily disturbed by human land use. Overgrazing, water diversion, aquifer "mining" (pumping at an unsustainable rate), and overcollecting of native plants and animals are considered the greatest threats to biodiversity in the Chihuahuan Desert ecoregion.

Spanish ranchers and, later, American settlers were drawn to the Chihuahuan Desert region by the lush grasslands and potential for grazing. Once, grasses in the Big Bend region of Texas were said to have been tall enough to brush the bellies of horses. Ranchers believed that the supply of grass to feed livestock was unlimited. By the mid-19th century, the stocking of desert grassland ranges with cattle, sheep, and goats was progressing at a phenomenal rate. In 1900, the desert grasslands of west Texas supported over 9 million herd animals, up from 500,000 head in 1830. The ranges of the southwest were soon stocked to capacity with no overflow ranges in case of drought.

What ranchers could not know is that the luxuriant grasslands of the 19th century were the expression of a cooler, wetter period that was to end abruptly at the turn of the century. After 1900, droughts became more frequent, and grass cover on heavily grazed ranges declined by up to 70 percent. As warmer, drier conditions prevailed and heavy grazing continued, thousands of acres of Chihuahuan Desert grasslands were converted to desert shrubland, a process that continues to this day.

In addition to climate change and overgrazing, certain water-use practices are having significant impacts on the desert. The Chihuahuan Desert is punctuated by large lake basins and crisscrossed by drainages—indicators of a time thousands of years ago when water was more plentiful and lakes and flowing rivers were abundant. With climatic warming and drying over the past 10,000 years, water sources dried up, tributaries became isolated from the main rivers, and headsprings that once supported interconnected pools and

Some desert grasslands have survived overgrazing.
CDRI photo

perennial streams shrank to form small, isolated pools and marshy wetlands known as cienegas. Water, once relatively abundant in the Chihuahuan Desert, is now a precious—and very limited—resource.

Problems arise as urban areas in the desert continue to expand and fertile desert soils are put into agricultural production. Up to 99 percent of the water in the perennial rivers of the Chihuahuan Desert is diverted to municipal water supplies or to irrigate fields. The consequences of current water-use practices include the loss of native fish populations and the replacement of diverse riparian forests with monocultures of tamarix *(Tamarix* spp.*),* an invasive tree introduced in the 1800s.

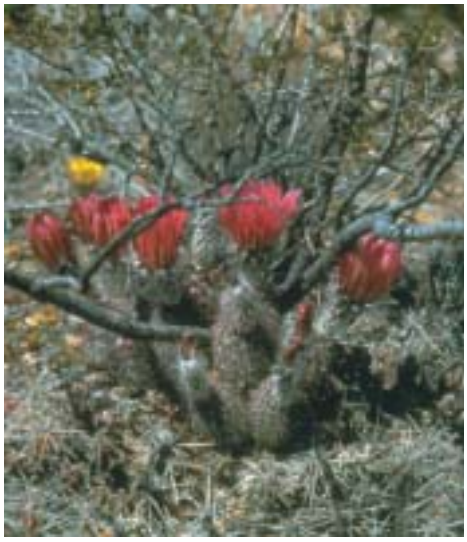
In addition to water diversion, mining of aquifers is a serious threat to freshwater species. Groundwater pumping can significantly lower the water table, reducing—or often completely eliminating—spring flow. Many cienegas of the Chihuahuan Desert once supported an amazing array of endemic fish, snail, and other invertebrate species. However, these hotspots of biodiversity are rapidly being lost as groundwater pumping lowers the watertable, reduces springflow, and significantly decreases the number of intact cienegas.

Some inhabitants of the Chihuahuan Desert are imperiled simply because people want to possess their own little piece of the desert in the form of a wild plant or animal. The Chihuahuan Desert is recognized for the extraordinary diversity of cacti and succulents found there. According to the World Wildlife Fund, more than one-third of all cacti species are found in Mexico, with many of the 345 Chihuahuan Desert species found only in small areas. Because the entire range of a particular cactus species may be confined to a single rock outcrop, species can be rendered extinct all too easily because of overcollecting, especially for the commercial trade.

Conservation and Education

Conservation efforts in the Chihuahuan Desert are complicated by the fact that the ecoregion extends across an international border and numerous state boundaries, both in Mexico and the United States. Nonetheless, attention is being focused on the Chihuahuan Desert through the international, multidisciplinary efforts of organizations such as the World Wildlife Fund, the Nature Conservancy, the Instituto de Ecología in Mexico, and federal agencies such as the National Park Service and the U.S. Fish and Wildlife Service.

In addition, private organizations like the Chihuahuan Desert Research Institute (CDRI) are devoted to promoting an awareness of the desert through research and education. Founded in 1973, the CDRI encourages student research through scholarships and the W. Frank Blair Student Paper competition, maintains a regional research library, and serves as a clearinghouse for information about Chihuahuan Desert research. Research data are presented to the general public through interpretive programs centered at the CDRI's 507-acre (205-hectare) site. Here, visitors can participate in seminars or stroll through the 20-acre (8-ha) arboretum, where over 100 species of Chihuahuan Desert trees and shrubs—representing communities from the desert lowlands through the conifer highlands—are grown. One of the highlights of a visit to the CDRI is a tour of the Cacti and Succulent Greenhouse, which houses over 300 species of Chihuahuan Desert cacti and succulents. The more energetic visitor can hike into a protected canyon where permanent springs and pools support a diverse freshwater ecosystem, or climb to the top of an igneous outcrop to enjoy spectacular views of the surrounding desert grasslands.



The endangered Chisos Mountain hedgehog cactus
Photo by Tom Alex

For more than 20 years, the Chihuahuan Desert Research Institute has propagated endangered species of cacti for revegetation.
CDRI photo

Coordinated efforts of public and private organizations in both Mexico and the United States is leading to a broader understanding of the Chihuahuan Desert and the threats to its ecosystems. With this understanding will come a greater appreciation of the desert and new ways of addressing human needs while maintaining the biodiversity characteristic of the Chihuahuan Desert.

Dr. Hoyt is Executive Director of the Chihuahuan Desert Research Institute in Fort Davis, Texas. For more information, call Dr. Hoyt at 915/364-2499 or email her at manager@cdri.org. You can access the CDRI website at `www.cdri.org`.

Restoring a Desert Oasis

by Jody Fraser and
Cynthia Martinez

Restoring natural vegetation along Ash Meadows creek.
Photo by D. Ledig/USFWS

Kings Pool, before (above) and after restoration
USFWS photos

Just east of Death Valley, where a mere 3 inches (7.5 centimeters) of rain falls annually, lies the oasis of Ash Meadows, Nevada, an unusual system of wetlands, springs, and seeps. Plentiful sources of water in this part of the vast Mojave Desert are rare, and Ash Meadows has drawn humans since prehistoric times. A rich variety of aquatic and terrestrial species also depend on this fragile, isolated ecosystem.

The perennial surface waters of the region are supplied by an extensive ground water system that discharges about 17,000 acre-feet (2,100 hectare-meters) each year in Ash Meadows. This distinct desert ecosystem supports hundreds of plant and animal species that are closely associated with, and often dependent upon, the area's unique wetland and aquatic habitats. Among these species, 24 are found only in Ash Meadows, constituting the largest concentration of endemism for an area this size in the continental United States. Twelve species are currently listed under the Endangered Species Act.

Around 1850, a wave of settlers moved into the region, initiating dramatic changes in the Ash Meadows area. Several boom and bust cycles ensued over the course of decades, with mining and agriculture being the focus of the early homesteaders. They altered the landscape and water courses with a series of impoundments, ditches, and diversions. Various nonnative fishes, amphibians, plants, and invertebrates were introduced. The construction of a railroad inspired the establishment of freight and mercantile businesses, and farmers grew fields of hay for horses and other pack animals. Clay mining operations were active from about 1916 to 1940, and the nuclear testing program at the nearby Nevada Test Site provided a source for jobs in the 1950s, increasing the demand for water.

In Ash Meadows, the springs system comprises seven major springs and over 20 smaller ones. The pools and outflows in the Kings Spring and Point of Rocks Springs areas, in particular, were heavily manipulated in the 1950s for aesthetic and agricultural purposes. Farmers diverted water from Kings Spring into a concrete ditch and removed riparian vegetation to grow crops. The Ash Meadows naucorid *(Ambrysus amargosus)*, an aquatic insect, and the Ash Meadows speckled dace *(Rhinichthys osculus nevadensis)*, a small fish, were extirpated from the Kings Spring system shortly after people modified the landscape and water courses. In the 1960s, large-scale agriculture and peat mining at Carson Slough in the northern part of Ash Meadows caused the most significant changes to the landscape, destroying extensive wetlands and degrading valuable habitat for endemic species.

The loss of habitats and species diversity would have continued unchecked but for the concern of conservationists over the plight of the Devils Hole pupfish *(Cyprinodon diabolis)*. In the early 1970s, intensive water use associated with development in the Ash Meadows area degraded wetland habitats and lowered the water table in Devils Hole, the endangered species' only habitat. It became clear that the fate of this tiny fish was at stake. In 1976 the U.S. Supreme Court limited the amount of ground water pumping in Ash Meadows to ensure enough water for the Devils Hole pupfish, if not for the area's

other vulnerable species. (See accompanying article.)

Lands in Ash Meadows were later sold to a development company and targeted for municipal and residential use. Development had already begun to degrade important habitats when, in 1984, the company decided to abandon its project and sold most of its holdings and water rights to The Nature Conservancy. Subsequently, the U.S. Fish and Wildlife Service purchased the land and the water rights to establish the Ash Meadows National Wildlife Refuge.

The Recovery Plan for the Endangered and Threatened Species of Ash Meadows was developed in 1990. Its primary objective is to recover the listed species and their habitats through an ecosystem approach focusing on habitat restoration and the removal of threats. Listed species addressed in the recovery plan include an endangered plant, the Amargosa niterwort *(Nitrophila mohavensis)*; six threatened plants, the spring-loving centaury *(Centaurium namophilum)*, Ash Meadows ivesia *(Ivesia eremica)*, Ash Meadows blazing star *(Mentzelia leucophylla)*, Ash Meadows milkvetch *(Astragalus phoenix)*, Ash Meadows sunray *(Enceliopsis nudicaulis* var. *corrugata)*, and Ash Meadows gumplant *(Grindelia fraxino-pratensis)*; a threatened invertebrate, the Ash Meadows naucorid; and four endangered fishes, the Devils Hole pupfish, Warm Springs pupfish *(Cyprinodon nevadensis pectoralis)*, Ash Meadows Amargosa pupfish *(C. n. mionectes)*, and Ash Meadows speckled dace.

The most important action for the long-term protection of the listed species was the initial purchase of land and water rights to establish the refuge. It ended activities detrimental to the species and their habitats, such as residential and agricultural development, surface mining, and grazing by wild horses. Restoration of historic stream flows was also identified as a key element in the recovery of the spring system and its aquatic species.

Ash Meadows blazing star
Photo by John & Karen Hollingsworth/USFWS

After agriculture fields were abandoned, an infestation by cattails *(Typha domingensis)* prevented the regeneration of other riparian species, and the aquatic habitat remained fragmented. A comprehensive program of spring restoration on the refuge is underway, including filling of small artificial ponds, removing water diversion features, and rehabilitating the sites to reflect the natural slope and stream flow. Restored channels include such key habitat features as riffles, gravel substrate, and appropriate more natural water velocities.

In 1997, the first significant habitat restoration project in Ash Meadows was undertaken in the Kings Spring drainage, an area severely affected by decades of agricultural activities. The project was designed to mimic historic conditions by returning the spring outflow and drainage channel to a meandering stream, returning Kings Pool to its original dimensions, replacing cattails with species more appropriate for inhabitants of the aquatic and terrestrial habitats, and reconnecting ephemeral washes to the outflow channel. Restoring the entire watershed was essential to improving the status of the listed fishes and the naucorid in this spring system.

The summer following restoration, 22 naucorids were reintroduced into the outflow of Kings Spring, and an additional 17 were introduced the next year. This restoration and reintroduction effort has been a great success. Prior to the project, naucorid populations were limited to the upper 50 feet (15 meters) of the Point of Rocks Springs system. Since the reintroduction into Kings Spring, the population has grown to thousands of individuals occupying about 850 feet (260 m) of stream habitat. Similarly, the Ash Meadows Amargosa pupfish population in this system has more than tripled.

While much of the Ash Meadows ecosystem is returning to a balance reminiscent of its past, the job is not done. A challenge facing resource managers throughout the country is the invasion of natural landscapes by nonnative species, and Ash Meadows is no exception. Efforts to control nonnative species will be carried out well into the future as we work to bring back Ash Meadows. The continued cooperation of state and other federal agencies, as well as a concerned public, will enable Ash Meadows to remain a rich source of unique biodiversity for generations to come.

Jody Fraser (775/861-6300; jody_fraser@fws.gov) is a Botanist with the Service's Nevada Fish and Wildlife Office. Cynthia Martinez (702/515-5230; cynthia_t_martinez@fws.gov) is Assistant Field Supervisor with the Service's Southern Nevada Field Office.

Ash Meadows naucorid
Photo by John & Karen Hollingsworth/USFWS

by Linus Chen

Desert Fish: Life on the Edge

Ash Meadows speckled dace
Photo by John & Karen Hollingsworth/USFWS

Fairbanks Springs, a small oasis in the Nevada desert, resembles a large hot tub from the bottom of which someone forgot to scrub the algae. Fortunately, algae thrive in this spring pool, for they are integral to the life cycle of the Ash Meadows Amargosa pupfish *(Cyprinodon nevadensis mionectes)*.

The subspecies name "mionectes" is derived from the Greek, meaning "one having less." In this case, it refers to a reduced number of scales and fin-rays. Besides laying their eggs in the algae, these 1.3-inch (3.4-centimeter) long pupfish feed on algae (and the occasional insect or snail in the algae). With its inviting sapphire- colored bottom and warm temperature, which ranges from 81 to 88° F (27 to 31° C), the spring-fed pool might be seen as an appealing place to take a bath. But as tempting as it would be, wading into Fairbanks Springs would be a bad idea because the pupfish, an endangered species, could accidentally be harmed.

A few miles away, in Scruggs, Indian, Marsh, and School springs, lives the Warm Springs Amargosa pupfish *(C. n. pectoralis)*. The Ash Meadows speckled dace *(Rhinichthys osculus nevadensis)* may still be found at Jack Rabbit and Bradford springs, and the only natural population of the Devils Hole pupfish *(C. diabolis)* occurs at, well, Devils Hole. Some Devils Hole pupfish are being held in refugia to form new populations in case anything happens to the species' native habitat.

All 16 desert pupfish taxa native to the American Southwest, in addition to 16 species from Mexico (6 of which have not yet been described scientifically), are considered to be endangered, threatened, or of special concern. Pupfish were named for their active, puppy-like behavior. But behind that playful behavior lurks the ferocity of a junkyard dog, at least when it comes to males defending their territory from other male pupfish. (The Devils Hole pupfish, the smallest at 3/4 inch (1.9 cm), is the only pupfish not to show aggressive territorial behavior.) During the year-round breeding season, the more colorful and deeper-bodied males of most pupfish taxa will pursue females into an area with fine sand, silt, and perhaps algae. After an elaborate courtship display by the male pupfish, the female deposits one or two eggs, which the male immediately fertilizes. Large female pupfish can lay about 25 eggs per day and may spawn with different males each day. The eggs may be protected by the territorial behavior of males, but in general there is no parental care of the eggs. In warmer springs, pupfish can reach sexual maturity at 2 to 4 months, and live for 6 to 9 months after reaching the free swimming stage. Pupfish living in cooler waters grow more slowly, but they may live for 2 to 3 years.

Tens of thousands of years ago, in a much different climate, Nevada's Mojave Desert was a region of interconnected rivers and lakes. In recent millennia, as the region became drier, waters receded and many kinds of fish were unable to survive the harsher conditions. With very few competitors, pupfish thrived and later evolved into different species as groups became isolated in scattered springs and streams. This situation is analogous to that of the Galapagos Islands, where Darwin drew inspiration for his theory of evolution, except that the pupfish evolved in "islands" of water within a desert "sea."

But after surviving for thousands of years, these "living fossils"—Ash Meadows Amargosa pupfish, Warm Springs pupfish, and Devils Hole pupfish—face serious threats to their future. Although some of the early identified threats (such as development of the springs within Ash Meadows) have been resolved, continuing development near Las Vegas, Nevada, has created more demand for groundwater near the refuge. Because much of the desert area receives less than 2.5 inches (10 cm) of rain annually, virtually all of the water at and around Ash Meadows is "fossil" water, or water that is believed to have entered the aquifer thousands of years ago. When it is extracted from the ground at a rate faster than rainfall enters the ground, less water bubbles up from the springs for the pupfish. What little water there is in Ash Meadows for the pupfish is being invaded by nonnative species. Some of these species, such as largemouth bass, bullfrogs, and crayfish, may prey on pupfish, while exotic fishes such as mosquitofish *(Gambusia affinis)* and sailfin mollies *(Poecilia latipinna)* may compete with the pupfish for space and food (and prey upon the baby pupfish "pups"). Invasive plants such as saltcedar *(Tamarix* spp.*)*, an exotic plant from Asia and Europe, drain the springs with their thirsty roots and concentrate salts in their leaves, transforming valuable desert streams and ponds into dry, salty basins.

Over the past few years, however, the tide has turned in favor of these endangered pupfish. Vigilant volunteers and biologists from the U.S. Geological Survey's Biological Resource Division, the Nevada Division of Wildlife, and the U.S. Fish and Wildlife Service have been removing exotic species and taking other actions to rehabilitate the spring habitats. As a result, the Service hopes to be able to propose delisting the Ash Meadows Amargosa pupfish and three Ash Meadows plants before long. With improvements in habitat and exotic species control, the future of some pupfish may no longer be going down the drain.

Life on the Ledge

The future of another Ash Meadows species, the Devils Hole pupfish, is still perched precariously upon a narrow ledge. Devils Hole, the only natural habitat for this pupfish, is akin to a community swimming pool with a shallow section and a deep end. The shallow "kiddie" section is a 10 by 20-foot (3 by 6-meter) limestone shelf 0.4 to 27 inches (1 to 70 cm) under water. Beyond the ledge lies a second, deeper shelf with a surface area of 10 by 33 feet (3 by 10 m). Past the second shelf lies the real deep end of Devils Hole, which extends to unknown, abyss-like depths. Divers from the U.S. Geological Survey once descended 300 feet (91 m) into the waters of Devils Hole but they never touched bottom.

Although Devils Hole pupfish have been found as deep as 80 feet (24 m), life for this species centers on the shallowest ledge, where the fish lay their eggs and feed on the algae that cover the shelf. The number of pupfish in Devils Hole fluctuates seasonally between 200 and 700 individuals.

In 1976, a Supreme Court decision stopped local pumping that was lowering the water table and threatening the Devils Hole pupfish. The Nature Conservancy purchased Ash Meadows in 1984 and later sold it to the Service to establish a National Wildlife Refuge. This protected the aquifer and ensures that the shallow ledge in Devils Hole, so vital to the pupfish, will not become a "sunbathing deck."

Linus Chen is a Presidential Management Internship Fellow and the National Listing Litigation Coordinator for the Endangered Species Program's national office in Arlington, Virginia; 703/358-2106; linus_chen@fws.gov.

Ash Meadows pupfish (male at top, female at bottom)
USFWS photo

by Mike Richardson

Life in Mauna Kea's Alpine Desert

*H*igh above the sunny beaches, rocky coastline, and lush, tropical forests of the Big Island of Hawai'i lies a unique environment unknown even to many residents. The harsh, barren, cold alpine desert is so hostile that it may appear devoid of life. However, a few species existing nowhere else have formed a precarious ecosystem-in-miniature of insects, spiders, other arthropods, and simple plants and lichens. Welcome to the summit of Mauna Kea!

Rising 13,796 feet (4,205 meters) above sea level, Mauna Kea is the highest island mountain in the world. It is a gigantic classic shield volcano, and the broad landscape of its summit is an alpine desert composed of cinder cones on a lava plateau. The upper summit forms an alpine lava community sparsely vegetated with leafy lichens and moss. Prior to the 1980s, most people believed the summit was essentially a lifeless desert. However, starting in 1979 with the discovery of the wekiu bug *(Nysius wekiuicola)*, an entire aeolian (wind-dependent) community of arthropods was uncovered at the summit.

Aeolian ecosystems are usually found within alpine deserts. They are characterized by a low number of primary producers, except for a few algae, mosses, and lichens, and a community of mostly arthropod predators and scavengers that feed on organisms blown up from lower elevations. The unique aeolian ecosystem on Mauna Kea's summit is composed of at least 12 endemic arthropods, including omnivorous, day-flying *Agrotis* moths, voracious *Lycosa* wolf spiders, a centipede that preys on moribund insects that are blown to the summit, and the unique, flightless wekiu bug.

A candidate for federal listing as an endangered species, the wekiu bug was first discovered in 1979 by entomologists on Pu'u Wekiu, the summit cinder cone. "Wekiu" is Hawaiian for "topmost" or "summit." The wekiu bug belongs to the family Lygaeidae within the order of insects known as Heteroptera (true bugs). Most of the 26 endemic Hawaiian *Nysius* species use a tube-like beak to feed on native plant seed heads, but the wekiu bug uses its beak to suck the hemolymph (blood) from other insects. Excluding its close relative *Nysius a'a* on the nearby Mauna Loa, the wekiu bug differs from all the world's 106 *Nysius* species in its predatory habits and unusual physical characteristics. The bug possesses nearly microscopically small wings and has the longest, thinnest legs and the most elongated head of any Lygaeid bug in the world.

The wekiu bug, about the size of a grain of rice, is most often found under rocks and cinders where it preys diurnally (during daylight) on insects and even birds that are blown up from lower elevations and have died of exposure. Both nymph and adult wekiu bugs remain active all year, and use snow to their advantage by feeding on insects that are either preserved or immobilized by the cold. They emerge from the cinders to feed and mate when the sun has warmed the rock surfaces, particularly at the margins of snow fields. Apparently, they will remain along the narrow melting perimeter of a snowfield to take advantage of any frozen insects that drop from the receding snowfield.

Should a shadow cross the sun when wekiu bugs are foraging in this moist, food-rich habitat, they will quickly retreat deep into the cinders.

Threats to Mauna Kea Arthropods

Because of ideal atmospheric qualities and weather conditions, the University of Hawaii's Institute for Astronomy has developed the summit as the Mauna Kea Science Reserve for astronomical study. Environmental impacts include road construction, parking areas, tourist facilities, temporary storage areas, substrate removal, oil spills, and constant traffic to the summit (with the resulting trash and debris). Tephra cinders, the preferred substrate of the wekiu bug and other Mauna Kea arthropods, are easily crushed into dust-sized particles, and vehicular traffic can quickly change a rocky cinder habitat to one of compacted silt and mud. Since 1963, when the first modern road was bulldozed to the summit, some researchers estimate approximately 62 acres (25 hectares) of potential arthropod habitat have been lost to astronomy-related development on the summit. Currently, more than two thirds of the wekiu bug's potential range is unprotected from this development.

The wekiu bug now competes for prey with at least one introduced species of Linyphiidae spider (small sheet web spiders) that has become established on the summit. Furthermore, global warming may potentially threaten all of the endemic Mauna Kea arthropods. The summit has been warmer and has had reduced snowfall since 1982. In addition, if available habitat is seriously reduced by summit development, the wekiu bug will likely be less capable of responding and surviving during climatic changes.

Protecting Mauna Kea Arthropods

A Candidate Conservation Agreement (CCA) to provide long-term protection for endemic Mauna Kea arthropods, including the wekiu bug and its habitat, is in the early planning stages. The Fish and Wildlife Service's Pacific Islands Ecological Services Office is developing the CCA to facilitate voluntary cooperation with the Office of Mauna Kea Management (the state office that oversees activities and development), the University of Hawaii Institute for Astronomy, and the numerous agencies and organizations involved in astronomical activities on the Mauna Kea summit.

Wekiu bug
Photo by Dr. Bill Mull

(Opposite page) Sunset at the alpine desert of Mauna Kea's summit
Photo by Mick Castillo/USFWS

Such protection will include monitoring of species status trends and habitat quality, removing some of the known threats, educating field personnel and permittees, habitat restoration, and incorporating species conservation measures into planning and management activities. If successful, this CCA would remove the need to list the wekiu bug under the Endangered Species Act and would also conserve several other endemic species, including the wolf spider and the *Agrotis* moths. The CCA complements the Pacific Islands Office's Ecosystem Conservation Plan for preservation, protection, and management of native habitat on the summit of Mauna Kea, which the plan has identified as a Biodiversity Landscape.

Mike Richardson is the Pacific Invertebrates Coordinator with the Service's Pacific Islands Ecological Services Office in Honolulu, Hawaii; (808) 541-3441; mike_richardson@fws.gov.

The Tarahumara Frog: Return of a Native

by Jim Rorabaugh and
Jeff Humphrey

For almost two decades, the Tarahumara frog *(Rana tarahumarae)* has been absent from the southern Arizona canyons and deep plunge pools to which it had adapted over millennia. Today, the Tarahumara Frog Conservation Team, a consortium of researchers, interested members of the public, and representatives from state and federal wildlife and land management agencies, is making strides toward returning this extirpated species to Arizona.

The Tarahumara frog is known historically from 63 localities within montane canyons from extreme southern Arizona south to northern Sinaloa and southwestern Chihuahua, Mexico. Its range is thought to be centered in the northern Sierra Madre Occidental of Mexico, but the eastern and southern distributional limits are not clear. Most localities are in the mountains of eastern Sonora. In the United States, the frog was known historically from only six locales in Arizona near the Mexican border, including three in the Santa Rita Mountains and three in the Atascosa-Pajarito-Tumacacori mountain complex, but it became extirpated from all six. The last observation of a Tarahumara frog in Arizona was in May 1983 in Big Casa Blanca Canyon in the Santa Rita Mountains, Arizona.

Throughout its range, the Tarahumara frog is typically associated with canyons and deep plunge pools formed among boulders or in bedrock. Plunge pools in canyons with low mean flows (less than 0.2 cubic feet/second or 5.6 liters/second) and relatively steep gradients (more than 196 feet/mile or 60 meters/kilometer of stream) provide the best breeding sites. Permanent water is probably necessary for metamorphosis. Suitable Tarahumara frog habitats are located within oak and pine-oak woodlands and in the Pacific coast tropical area (Sinaloan thornscrub and tropical deciduous forest) on the edge of the desert.

Why the Tarahumara frog disappeared from Arizona is not clear. Probably a combination of factors is responsible, including winter cold, flooding, severe drought, competition, predation, disease, and heavy metal poisoning. Airborne pollutants from copper smelters or acidic rain that mobilizes naturally-occurring metals near streams may have resulted in toxic levels of cadmium. Chytridiomycosis, a fungal disease implicated in global declines of frogs and toads, was found recently in populations of the Tarahumara frog, and has likely contributed to observed declines and extirpations. Predation by nonnative fishes and bullfrogs was probably an important factor in the disappearance of the species from Pena Blanca Spring and portions of Pena Blanca Canyon, Arizona.

Steve Hale, an expert on the Tarahumara frog, and Kim Field, Arizona Game and Fish Department, examine the frog's historic plunge pool habitat in Sycamore Canyon, Arizona, near the Mexican border.
All photos by Jim Rorabaugh

A restoration program developed by the Tarahumara Frog Conservation Team calls for reestablishing the frog into at least two of its historic localities in Arizona. The team has identified Big Casa Blanca Canyon in the Santa Rita Mountains and Sycamore Canyon in the Pajarito Mountains as the two favored sites. Because the factors leading to the frog's extirpation at these sites may still exist, the reestablished populations will be considered experimental and will be monitored carefully to identify any persistent problems.

In May 2000, part of a Tarahumara frog egg mass was collected from the Sierra La Madera in northern Sonora (the closest known population to historic localities in the United States.) and imported to Arizona under permit for initial rearing by the U.S. Fish and Wildlife Service in Phoenix. The egg mass contained about 850-900 eggs and hatched 8 days after collection. The tadpoles grew rapidly, and many were moved to other rearing facilities in Arizona, including aquaria and more natural settings at the Arizona-Sonora Desert Museum, San Bernardino National Wildlife Refuge, Buenos Aires National Wildlife Refuge, Coronado National Memorial, and Arizona State University.

The first young metamorphosed frogs were observed outdoors at the Buenos Aires Refuge only 86 days after hatching. This was a surprise because we thought the tadpoles normally took at least a year to become frogs. Perhaps warm water and an abundance of high quality food resulted in faster development. However, only a portion of the tadpoles metamorphosed rapidly; others grew more slowly. As of September 2001, a few were still tadpoles. Could some tadpoles be "programmed" to metamorphose rapidly, while others are not? This phenomenon has been observed in other frogs and may be an adaptation for maximizing frog production and survival under a variety of environmental conditions. Many of the frogs that metamorphosed early are now adults, and some have bred at the Arizona-Sonora Desert Museum. In the summer of 2001, the Detroit Zoo's National Amphibian Conservation Center joined as a cooperator in the project and is now rearing young Tarahumara frogs.

Because all of our captive frogs originated from a single egg mass, we will need additional collections from the wild to establish genetically strong populations. Even then, we must breed the frogs selectively to maximize genetic diversity. Recent successes with captive breeding at the Arizona-Sonora Desert Museum are encouraging.

If this approach turns out to be successful in the long run, captive breeding will reduce the need to remove additional animals from wild populations in Sonora. Today, we have about 350-400 frogs and tadpoles, which we'll hold until we have approval to release them into historic habitats.

With funding from the Fish and Wildlife Service's North American Free Trade Agreement Borderlands Program, the Tarahumara Frog Conservation Team and the Arizona Game and Fish Department are pursuing approval from the Arizona Game and Fish Commission (a separate state entity) to reestablish the frog in Big Casa Blanca and Sycamore canyons in 2002. Several releases will likely be needed to establish viable populations of the frog.

The Tarahumara frog lacks the bold, distinct dorsolateral folds characteristic of related leopard frogs and other ranid species. The larvae are greenish-yellow with small dark spots over the dorsum and larger spots on the tail, and they grow as large as 3.8 inches (97 millimeters) prior to metamorphosis. Juvenile and adult frogs of both sexes have a call consisting of a low grunt of about one-half second in duration, uttered once or twice or sometimes more.

For more information about the ecology, status, rearing, and conservation of the Tarahumara frog, visit the Service's Arizona Ecological Services Office website at `http://arizonaes.fws.gov/T-frog3.htm`.

Jim Rorabaugh is Supervisory Fish and Wildlife Biologist in the Arizona Ecological Services Field Office in Phoenix; (602) 242-0210 ext. 238; jim_rorabaugh@fws.gov. Jeff Humphrey is the Public Outreach Specialist at the same office; (602) 242-0210 ext. 222, jeff_humphrey@fws.gov.

Leading-edge Science for Imperiled Bonytail

by Craig Springer

The grasslands of southeastern New Mexico, known mostly for cattle, crops, and an occasional UFO crash report, seem an unlikely place for leading-edge biotechnology. But the little town of Dexter, essentially a service center for ranchers and farmers, is host to a state-of-the-art National Fish Hatchery and Technology Center. Good water led to the center's founding in 1931, and game fishes were the focus then, but since 1990 its primary mission has been technology development for managing rare fish species such as the bonytail chub *(Gila elegans)*.

The bonytail chub is one of the most imperiled vertebrates in North America. The not-so-gentle hand of nature has shaped the body of this fish over eons to fit its environment. A keel on its nape and a tightly fusiform body have allowed it to prevail in the harshest of conditions: turbulent and turbid water that is warmed by the intense southwestern sun. It was built for survival in a region where life can be a continuing struggle. The bonytail chub occurred historically throughout the Colorado River and its main tributaries, but its range has been reduced to a few larger channels of the Colorado River system and to lower parts of the Virgin River in Nevada. Changes in stream flows and water temperatures, direct loss of free-flowing habitat due to inundation by reservoirs, blockage of migration routes, and the introduction of non-native fishes are the primary factors responsible for the species' decline.

The bonytail hangs on, if only by a thread. That thread is a lifeline cast at the technology center. Scientists there have developed a brood stock, a captive population of adults, to produce offspring that ultimately will make their way back into the wilds of the Colorado River and its many large tributaries, which comprise the fish's native habitat.

"With so few adults left in the world, it is of paramount importance that scientific principles guide bonytail chub management," says U.S. Fish and Wildlife Service geneticist Connie Keeler-Foster. Toward that end, she has employed leading-edge technology to manage the bonytail chub stock on the genetic level. The center's laboratory was recently equipped with a DNA sequencer, an apparatus that allows her to identify individual fish by their genes.

The work can be likened to fingerprinting. Knowing the genetic makeup of the entire brood stock, essentially having a pedigree chart, permits the center scientists to selectively pair up males and females for mating. And therein lies the crux for survival, the strands in the thread. Picking mates that are most genetically divergent produces offspring that are more fit to face the rigors of life in the wild. "Mates well suited for each other may produce young that are less prone to disease," notes Keeler-Foster. "They themselves are more likely to reach adulthood and produce their own young in the wild. And that's what we want."

The end product, a reproducing population in the wild, is far removed from the day-to-day work of the technology center. But having sound science is the first step in conserving a species that stares extinction squarely in the face.

Craig Springer is a Fishery Biologist with the Division of Fisheries in the Service's Albuquerque Regional Office; 505/248-6867; craig_springer@fws.gov.

The Dexter facility is unique. It's one of 70 hatcheries operated by the Fish and Wildlife Service around the country, but is the only one dedicated entirely to the conservation of endangered fish.

Injecting bonytail chub for spawning
Photo by Peter J. Carboni/USFWS

Bonytail chub
Photo by Craig Springer/USFWS

Las Vegas Places its Bets on Habitat Plan

by Randi Thompson

More than 100 people gathered at the Red Rock National Conservation Area near Las Vegas, Nevada, on November 1, 2000, to celebrate the approval of the Clark County Multi Species Habitat Conservation Plan (MSHCP). The U.S. Fish and Wildlife Service has been working for more than 10 years with a wide array of interests to conserve habitat around Las Vegas for the threatened Mojave population of the desert tortoise *(Gopherus agassizii)*. The Desert Conservation Plan this group crafted was signed in 1995. But Clark County soon initiated the MSHCP process to broaden the scope of the conservation plan, addressing the needs of many other sensitive species that could be affected by urban development.

The goal of the 5-million-acre (2-million-hectare) MSHCP is to conserve healthy functioning ecosystems and the species supported by them (see sidebar). It is one of the most far-reaching Habitat Conservation Plans in the nation, covering 78 species, 11 ecosystems, and 145,000 acres (58,000 ha) that are subject to development over the next 30 years.

The committee that developed the MSHCP was composed of federal, state, and local government agencies; environmental groups such as The Nature Conservancy, Sierra Club, and Conservation Fund; university and independent scientists; and resource users such as the Southern Nevada Home Builders Association, Southern Nevada Water Authority, mining and grazing interests, and off-highway vehicle enthusiasts. To meet the goals of the MSHCP, the plan incorporates all lands, both federal and non-federal, in a reserve design. The Bureau of Land Management, National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife Service are critical participants in the plan's implementation.

The plan incorporates a science-based adaptive management process that provides a flexible, interactive approach to long-term management of biological resources. Monitoring will be used to evaluate and periodically modify, as necessary, management techniques and specific objectives. The plan will provide an analysis of all land use trends to ensure that take and habitat disturbance are balanced with solid conservation.

Clark County will continue to collect a $550 per-acre fee established under the original Desert Conservation Plan and will expend those funds, approximately $2 million a year, on actions to minimize

The Clark County MSHCP area includes all of Clark County, Nevada's most populated county (more than 1.4 million people, or about 70 percent of the state total). The 11 ecosystems it addresses are:

1. Alpine—herbaceous, high-altitude tundra vegetation, generally above timberline; characteristically sparse with low vegetation adapted to winter snowfalls and generally cold temperatures. Provides habitat for 10 covered species.

2. Bristlecone pine—found in Spring and Sheep mountains, ranging in elevation from 9,000 to 11,500 feet (2,740 to 3,500 meters) on exposed, dry, rocky slopes and ridges; comprises evergreen conifer woodland dominated by bristlecone pine. Provides habitat for 24 covered species.

3. Mixed conifer—includes white fir, ponderosa pine, and ponderosa pine/mountain shrub community types; found in Spring and Sheep Mountains on generally north- and east-facing slopes. Provides habitat for 33 covered species.

4. Pinyon-juniper—mountain shrub, pinyon, pinyon-juniper, and juniper community types at elevations ranging from 4,900 to 8,200 feet (1,500 to 2,500 m). Provides habitat for 30 covered species.

5. Sagebrush—sagebrush/perennial grass community types, found in the Spring, Sheep, and Virgin Mountains, typically ranging from 4,900 to 9,200 feet (1,500 to 2,800 m). Provides habitat for 20 covered species.

6. Blackbrush community—typically considered part of the Mojave desert scrub ecosystem but managed at the ecosystem level; occurs on upper bajadas (alluvial fans), slopes, and valleys below 5,900 feet (1,800 m). Provides habitat for 11 covered species.

7. Salt desert scrub—occurs between 3,250 and 5,800 feet (990 and 1,770 m) in a mosaic pattern within stands of creosote-bursage and blackbrush communities. Provides habitat for 16 covered species.

8) Mojave Desert—smallest of the four North American deserts, although most widespread ecosystem in Clark County. Shrublands occur below 4,000 feet (1,220 m) and include two major plant communities, Mojave mixed scrub and creosote-bursage. Provides habitat for 24 covered species.

9. Mesquite and catclaw community—nested within Mojave desert scrub biogeographically but managed at the ecosystem level, the mesquite and catclaw community provides habitat for 11 covered species.

10. Desert riparian/aquatic—associated with rivers and streams, generally below 4,000 feet; primarily includes Virgin and Muddy rivers, Las Vegas Valley Wash, and Colorado River. Provides habitat for 14 covered species, half of which are water dependent.

11. Perennial springs—Over 500 known springs are widely distributed from high mountains to low deserts; most are cold-water springs and vary from small, isolated pools with short spring-brooks to larger spring-fed rivers such as Muddy River. One covered species is associated with springs.

and mitigate the effects of incidental take on listed species under the MSHCP.

Randi Thompson is the Public Affairs Officer in the Nevada Fish and Wildlife Office in Reno; (775)861-6300; randi_thompson@fws.gov.

(Opposite page) Valley of Fire State Park, part of the Clark County MSHCP reserve.
Photo by Carol McKim

(At right) Desert tortoise
Photo by Beth Jackson/USFWS

Arizona Tribal Partnerships for Wildlife

by Marty Jakle and
Jeff Humphrey

Arizona's 23 Native American tribes own 20 million acres (8 million hectares), or about 28 percent of the state. Most of these holdings are relatively undeveloped, making tribes an important focus of the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program in Arizona.

The Partners program provides financial and technical support to private landowners who want to improve fish and wildlife habitat on their land. To date, we have worked with the Hualapai, Hopi, Tohono O'odham, Navajo, White Mountain and San Carlos Apache, Zuni, and Colorado River Indian Tribes to restore important habitat. The projects have run a wide gamut, from installing barriers to protect Apache trout *(Oncorhynchus apache)* from nonnative fishes, to restoring wetlands, to developing native tree nurseries for use in replanting riparian habitats.

Tohono O'odham Nation

In 1999, the Partners program joined the Tohono O'odham Nation in a unique project to protect an endangered plant. The rare Nichol's Turk's head cactus *(Echinocactus horizonthalonius* var. *nicholii)* is known to grow in small patches in only three desert mountain "islands" within the Sonoran Desert of southern Arizona and one in Sonora, Mexico. One of these sites is in the Schuk Toak District of the Tohono O'odham Nation in southern Arizona.

During a survey for the cactus in 1997, biologists found evidence that javelina *(Pecari tajacu)* or desert bighorn sheep *(Ovis canadensis* var. *mexicanus)*, or both, were eating the Nichol's Turk's head cactus in parts of its range. To protect the cactus, tribal members erected exclosures in rugged terrain on two mountain peaks on Tohono

Apache trout
USFWS photo

(Counter-clockwise from upper left) Javelinas* (Tayassu tajacu) *are known to eat some species of cacti, including the Nichol's Turk's head.
Photo by Tom Stehn/USFWS

Jose Enriquez of the Tohono O'odham Nation packed material high into the cactus' mountain habitat to fence out javelinas.
Photo by Bob Schmalzel

The Nichol's Turk's head cactus in bloom
Photo by Bob Schmalzel

Schuk Toak District Chairman Joe Juan, cactus expert and private consultant Bob Schmalzel, Schuk Toak Distrct Vice Chairman Ron Widener, and Jose Enriquez stand in front of a Partners for Fish and Wildlife sign on the fence around a cactus patch.
Photo by Marty Jakle

O'odham Nation lands. The project required transporting 39-inch (1-meter) wide fencing and 6-foot (2-m) metal T-posts to remote sites by horseback. To follow up on this project, tribal biologists are collecting information about conditions such as droughts that may lead wildlife to consume the cactus.

Pueblo of Zuni

Along the Little Colorado River, about 250 miles (400 kilometers) to the north, the Pueblo of Zuni is restoring an 80-acre (32-ha) site where Zuni spirits and ancestors reside. The Partners program is contributing to the use of earth-moving equipment and water-control structures for restoring riparian and wetland habitats along a river dried by decades of groundwater pumping, reservoir construction, and unrestricted livestock grazing. In the future, when Pueblo leaders make their quadrennial religious pilgrimage to the area, they'll find the valley once again shared by neotropical migratory birds, including waterfowl and shorebirds, rails, yellow-billed cuckoos *(Coccyzus americanus)*, and the endangered southwestern willow flycatcher *(Empidonax traillii extimus)*.

Native American approaches to the management of natural resources can be quite different from the scientific and regulatory approaches used by other land managers. However, through partnerships with tribes, the cultural and biodiversity values of the land can be protected and restored.

Marty Jakle is the Arizona coordinator for the Service's Partners for Fish and Wildlife Program; 604/242-0210 ext. 213; marty_jakle@fws.gov. Jeff Humphrey is the Public Affairs Officer in the Arizona Ecological Services Field Office, Phoenix; 602/ 242-0210 ext. 222, jeff_humphrey@fws.gov.

The yellow-billed cuckoo and other neotropical migratory birds should benefit from restored riparian habitat on the Pueblo at Zuni.
Photo © B. Moose Peterson/WRP

New Mexico's Little Known Treasures

by Antonia Nevarez

Many of the 27 plants and 13 animals in New Mexico that are listed nationally as endangered or threatened species can be considered desert natives. The types of challenges facing these species are illustrated by two of our state's lesser known creatures, the Pecos sunflower and Socorro isopod.

Pecos Sunflower

The Pecos sunflower *(Helianthus paradoxus)* is an annual that looks much like the common sunflower seen along roadsides and other disturbed areas throughout North America. This plant is also called the puzzle sunflower or paradox sunflower. It flowers from July to October, generally later in the year than the common sunflower.

Pecos sunflower is the only sunflower in the Southwest that requires permanent wetlands for its survival. It grows around the outflow of springs, in marshes, or sometimes at the edges of lakes or streams in soils that are usually somewhat saline. The abundance of plants at each location depends on the availability of water; the sunflowers will disappear if a site dries out.

The Pecos sunflower is found at 25 sites within five areas in New Mexico and Texas. In New Mexico, it grows near the town of Grants, along the Rio San Jose, in and around the town of Santa Rosa, and near the Pecos River from just north of Roswell to just north of Dexter. In Texas, it is found just north of Fort Stockton and in Balmorhea. Most sites contain only a few acres of wetland habitat, but several are more extensive. The number of plants at each site varies from only a few to many thousands.

Much of the wetland habitat on which Pecos sunflower depends has been lost or degraded. Many springs, particularly in Texas, are now dry due to ground water pumping for irrigation. The free flow of many remaining springs has been captured for domestic uses, reducing the size of wetlands. Nonnative tamarisk or saltcedar *(Tamarix* spp.*)* has invaded many wetlands, and others have been drained and filled. Wetland losses, although probably slower than in the past, still continue. Livestock also will eat the Pecos sunflower and can eliminate a population if grazing is continuous.

Sites where the Pecos sunflower occurs are owned and managed by a variety of federal, state, tribal, municipal, and private interests. Six sites are on lands managed by the U.S. Fish and Wildlife Service, Bureau of Land Management, or National Park Service; one site

Pecos sunflower
USFWS photo

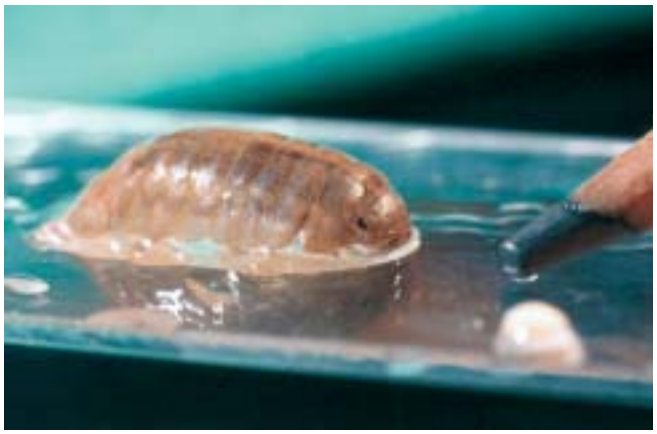
is on a state park; four sites are managed by the town of Santa Rosa; one site is managed by the Pueblo of Laguna Tribe; and 12 sites are managed by private individuals or organizations. Some other sites are within state or federal highway rights-of-way. New Mexico lists the Pecos sunflower as endangered under the state's own Endangered Plant Species Act.

Significant populations of the Pecos sunflower occur on Bitter Lake National Wildlife Refuge near Roswell, New Mexico, and at The Nature Conservancy's Diamond Y Preserve near Fort Stockton, Texas. Both areas are being managed as natural ecosystems to benefit native wildlife, including endangered species.

As part of the recovery effort for the Pecos sunflower, the State Land Office and the New Mexico Energy, Minerals and Natural Resources Department are teaming up to plant seeds near Roswell and Fort Sumner, with support from a $5,000 federal grant. Grazing lease holders on state trust land have volunteered to set aside several small areas for the project.

Socorro Isopod

The Socorro isopod *(Thermosphaeroma thermophilus)* is one of only seven freshwater species in the Sphaeromidae, an otherwise marine family of isopods. This small crustacean is similar to the terrestrial pill bug but is aquatic and is found in only one thermal spring near Socorro, New Mexico. Temperatures in the spring range from 88 to 90 degrees F (31 to 32 degrees C). In the late 1970s, the water flowing from the thermal spring was diverted for the development of a spa. The spa has since gone out of business; however, the diversion confined the animal to two small concrete-lined troughs, where it appears to be persisting. This is the only site in the wild where Socorro isopods can be found. A refugium population is being maintained at a facility near Socorro, New Mexico, to provide stock for reintroduction into the wild in the event that the wild population is lost due to drought, contaminants, or habitat degradation.



Socorro isopod, shown next to a pencil point for scale
Photo by Brian Lang/New Mexico Department of Game and Fish

The Socorro isopod is a member of the order Isopoda, which is distinguished from other orders of the class Crustacea by its flattened body and seven pairs of legs. It differs from other isopods in New Mexico by being aquatic and having two pairs of oar-like appendages (uropods) attached to the abdomen. Socorro isopods are grayish-brown, marked with black spots on the dorsal surface, and are bone colored beneath. In some individuals, the exposed edges of the body can be tinged with orange.

The primary food sources for the Socorro isopod are bacteria, algae, detritus, and aquatic worms. The Socorro isopod is primarily crepuscular (active at dawn and dusk), swimming as well as crawling. During the day, it burrows into the substrate and seeks shaded cover.

This species is ovoviviparous, meaning that the eggs develop within the female and the young are born alive. The gestation period is approximately 30 days. Females are able to produce broods every 2 months, depending on food and temperature. The number of gravid females peaks in April and once again in late summer, but reproduction occurs year round.

The survival of the isopod depends on an uninterrupted flow of thermal water. This species is known to occupy only one spring system, but in the past it may have occurred in others in the vicinity of Socorro, New Mexico, including two that have been capped. The current population in Sedillo Spring is extremely limited by the extent of habitat. Even with a continuing flow of thermal water in its native habitat, the Socorro isopod is in a very precarious situation. As a precaution, as well as for research purposes, a population of the Socorro isopod is also being housed at the Albuquerque Biological Park.

Conservation measures prescribed under the Socorro Isopod Recovery Plan include: 1) maintenance and enhancement of the Sedillo Spring habitat; 2) reintroduction into suitable former habitat; 3) captive propagation; 4) continued legal protection; 5) public education; and 6) continuing reviews of the isopod's status. During the past 20 years, conservation efforts have for the species focused on these tasks with varying degrees of success.

The biggest problem for both the Socorro isopod and the Pecos sunflower, as well as New Mexico's other 38 listed species, has been habitat loss. Conserving enough quality habitat for these plants and animals to regain a secure future will be our greatest challenge.

Antonia Nevarez is an Office Automation Specialist and Outreach Specialist in the Service's Albuquerque, New Mexico, Ecological Services Field Office.

Rio Grande Silvery Minnow

by Ben Ikenson

Rio Grande silvery minnow
USFWS photo

In contrast to some fish eggs that take months to incubate, Rio Grande silvery minnow *(Hybognathus amarus)* eggs hatch in about 24 hours into larvae that can swim in just 3 to 4 days. It is no surprise that a species so programmed for survival once dominated a biological niche that spanned 3,000 meandering miles (4,825 kilometers) from Colorado to Texas.

Now that habitat changes have brought the minnow to the very edge of extinction, its remarkable reproductive strategy is less favorable, largely because its eggs are semi-buoyant. They often drift down the Rio Grande until they are deposited into the deep and inhospitable waters of the 36,000-acre (14,570-hectare) Elephant Butte Reservoir, where we believe the eggs are consumed by predatory fish. In short, the minnow's biological proficiency does little to foster its survival in the modified world to which this fish desperately clings.

In 2000, the U.S. Fish and Wildlife Service initiated a silvery minnow egg salvage pilot project. Biologists from the Service, Bureau of Reclamation, and University of New Mexico collect minnow eggs as well as reproductively-ready adult minnows near Elephant Butte, where these efforts do not disturb upstream populations. Captured adult minnows are induced to spawn, either at the Albuquerque Biological Park or the Service's New Mexico Fishery Resources Office. Biologists then either return the resulting fish to the Rio Grande or hold them for captive propagation.

On May 10, 2001, after an increase in the river's flow (a natural spawning cue for the silvery minnow), biologists deployed devices that rescued more than 100,000 egg from the waters above Elephant Butte. The eggs were added to a captive population of silvery minnows at the Albuquerque Biological Park.

Steven Platania, a research biologist under contract to the Bureau of Reclamation, coordinated this year's egg collections. He says, "In addition to salvaging Rio Grande silvery minnow eggs for transport to refugia and use at breeding and rearing facilities, this year's work will provide important preliminary information on the timing and duration of spawning of the Rio Grande silvery minnow. We believe that in the future, monitoring the level of reproduction of this species will be paramount if we are to assess the success of planned reintroduction efforts."

Chris Altenbach, Assistant Curator of Fishes for the Biological Park, manages one of the captive propagation facilities that have proven instrumental in sustaining the species. "We hold a significant portion of the captive population here," he says. "Part of the success of the

captive rearing project has been the cooperation between the Fish and Wildlife Service and the city of Albuquerque, and the city is looking to continue funding these kind of efforts."

Only in the past half century has the minnow's floating egg become its Achilles' heel. The species' steady decline coincided with flood-control and river channelization projects that began in the 1940s and eventually converted much of the Rio Grande from a wide, shallow, meandering river to a much narrower and deeper one fragmented by dams. The minnow's range likely ebbed as insulated oxbows and shallow pools gradually disappeared.

Today, as fertilized minnow eggs drift downstream, adult minnows cannot move upstream past the three diversion dams. Consequently, an estimated 90 to 95 percent of the minnow's population is believed to be in the 60-mile (96-km) portion of the river downstream of the San Acacia Dam. To make matters worse, this reach of the river is the one now most likely to run dry in any given year because of diversions for crop irrigation and other factors. For both minnow and biologist, the sum of these conditions can be daunting.

Soon after the minnow was listed as endangered in 1994, biologists began collecting and relocating minnows upstream as well as conducting minnow rescue operations when the San Acacia reach went dry. In the past, these efforts have been no more than desperate measures to stave off extinction. The idea of ferrying minnows from lower reaches of the river to higher reaches on a regular, ongoing basis is under debate. The balancing act will continue, but the eventual goal, of course, is to remove human hands from the picture so that the species can sustain itself.

"The recent collection of minnow eggs is a landmark accomplishment for the project," said Service biologist Jude Smith, "but it fulfills only one aspect of recovery, which is to maintain the population of the species. In the end, these efforts will only be meaningful if done in concert with habitat restoration and water quality improvements."

Some of the improvements needed by the minnow are a sustained supply of water in the Rio Grande, solutions to the barriers to fish passage posed by dams, and a general restoration of riverine habitat, especially upstream of San Acacia Dam, to recreate historic conditions such as slow-moving, shallow water with a shifting, sandy bottom. With these improvements, the outlook for future generations of silvery minnows like those hatched from the recently rescued eggs will become more hopeful.

Although these endeavors may seem like a large price to pay for a tiny minnow, Smith says that "by trying to save the minnow, we are really working to save the river. The minnow is an indicator species that suggests the overall health, or sickness, of the entire river ecosystem." If parts of the river dry up today, then not only does the minnow suffer, habitat is displaced for a number of species, from other fishes, to birds, beavers, and muskrats.

There is a saying in the Southwest: *agua es vida*, water is life. If a formerly abundant native species is barely hanging on in the Rio Grande, New Mexico's artery of life, there are obvious implications for the quality of life for all creatures, including people. Our goal is to improve conditions for not only the Rio Grande silvery minnow but all of us.

Ben Ikenson, a Writer/Editor in the Service's Albuquerque Regional Office, can be reached at 505/248-6457 or by email at ben_ikenson@fws.gov.

Black-footed Ferrets Return to Mexico

by Dario Bard

Photos by Dario Bard/USFWS

This past October 2, on a moonlit night outside the town of Janos in the state of Chihuahua, Mexico, a captive-bred black-footed ferret *(Mustela nigripes)* peered out of his cage, reluctant to venture into the vast Chihuahuan Desert. For two days, he had been cooped up in the back of a government van with 33 others of his species. They traveled the highways from Laramie, Wyoming, to Janos, with an overnight respite at the El Paso Zoo, finally arriving at a secluded ranch off a dirt road. By chance, he was chosen as the first of the group to be released. His cage door was opened and, as a group of U.S. and Mexican biologists anxiously waited for him to emerge, he shrank back into his artificial prairie dog burrow—a synthetic rubber tube—while the real thing lay before him less than a foot away.

It was almost as though he knew what the biologists knew: that he was about to become one of the first black-footed ferrets to return to a country that hadn't seen a member of his species for as long as anyone could remember.

The black-footed ferret, North America's only native ferret, suffered tremendous population declines as a result of rural development and disease, two factors that also adversely impacted prairie dogs *(Cynomys* spp.*)*, which are vital to the ferret's survival. Black-footed ferrets prey almost exclusively on prairie dogs and den in prairie dog burrows. With the death of a captive ferret in 1979, the species was thought to be extinct. Just two years later, however, a rancher found a lone ferret near Meeteetse, Wyoming, which led to the discovery of a small colony. Soon after, even this last remaining population fell victim to disease.

In a last-ditch effort to save the species, the U.S. Fish and Wildlife Service, together with the Wyoming Game and Fish Department, captured 18 disease-free individuals and initiated a captive breeding program. In 1996, the Service rallied interested parties and established the Black-footed Ferret Recovery Implementation Team, a 27-member multi-agency partnership that includes representatives from federal and state governments, Native American tribes, zoos from the U.S. and Canada, and non-profit organizations throughout North America. Through this tremendous collaborative effort, the captive breeding program has been remarkably successful. Today, approximately 700 black-footed ferrets live in captive breeding facilities and in wild populations reintroduced into Wyoming, South Dakota, Montana, Arizona, Utah, and Colorado. Although roughly half have been reintroduced into the wild, reestablishing self-sustaining wild black-footed ferret populations has not been easy. One of the factors making the species' return into the wild difficult is the scarcity of sufficiently large, disease-free prairie dog populations.

Biologists are optimistic about the Janos location, a grassland area of the Chihuahuan Desert. The release site contains the largest remaining prairie dog complex in North America, with an estimated 500,000 healthy prairie dogs. A diverse assemblage of species coexists at the site, including the pronghorn *(Antilocapra americana)*, burrowing owl *(Athene cunnicularia)*, ferruginous hawk *(Buteo regalis)*, badger *(Taxidea taxus)*, kit fox *(Vulpes macrotis)*, and a bird the Service has proposed for listing as a threatened species, the mountain plover *(Charadrius montanus)*.

"We hope they do well enough in Mexico so that one day we can bring a few back to the U.S. to help us with re-establishment efforts here," says Mike Lockhart, the Service's black-footed ferret recovery coordinator. "The idea is to breed more and to spread them out."

In all, Service biologists made the trip to Janos four times this past fall, releasing a total of 91 ferrets. The October 2 release marked the first significant release of ferrets into Mexico, preceded only by a release of four ferrets a few weeks earlier as a test run conducted by Lockhart and Mexican biologists.

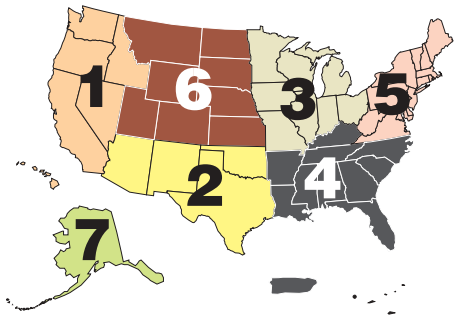
Dr. Gerardo Ceballos, a professor with the Universidad Nacional Autonoma de Mexico (UNAM), one of the Service's Mexican partners in this endeavor, and the leader of the effort in Janos, believes the ferrets will fare well and, as a result, will help him and his colleagues protect the grasslands of the region.

"Having a high-profile endangered species like the black-footed ferret will help us establish a biological reserve in the area," says Dr. Ceballos. He would like to see the grasslands in the region conserved, as would many of the local residents, including the owner of the ranch where the ferrets are being released. "If we don't protect this area from the desertification process, the land won't be any good for wildlife, for ranching, for farming, for anything. It is important to keep the grassland ecology healthy."

On October 2, Lockhart, Ceballos, and Service wildlife biologist Paul Marinari arrived in Janos in the dark of night, having spent the greater part of the day navigating the documentation and permitting process required to bring the 34 ferrets across the U.S./Mexico border. At the release site, they were joined by participants at a grasslands conservation conference, who were on hand to witness the historic moment. Everyone waited patiently for the first ferret to take his first steps on Mexican soil. When it became clear he was not about to overcome his fears any time soon, Marinari reached into the cage, lifted the tube with the ferret still inside, and laid it down in front of the prairie dog burrow. Almost instantly, the ferret regained his species' renowned curiosity. He looked around, wandered across the feet of one of the gathered biologists, and, after seeming to contemplate a return to his cage, turned his back on his life in captivity and slipped down the prairie dog burrow. He had found his freedom and a new home in Mexico.

Dario Bard is a Public Affairs Specialist in the Service's Washington, D.C. office. He can be reached at 202-219-7499 or dario_bard@fws.gov. *A video clip of the release of the first black-footed ferret on October 2 is available on the Service's website at* `http://video.fws.gov`.

USFWS photo by LuRay Parker



Regional endangered species staffers have reported the following news:

Region 1

Conboy Lake National Wildlife Refuge The U.S. Fish and Wildlife Service has received approval to expand the Conboy Lake National Wildlife Refuge (NWR) in southern Washington state by 40 acres (16 hectares) to encompass the Gamble Tract. Addition of the Gamble Tract will protect habitat for sandhill cranes *(Grus canadensis)*, which are considered by the state of Washington as endangered, and Oregon spotted frogs *(Rana pretiosa)*, a species also considered endangered in Washington and a candidate for federal listing, as well as migratory birds and other wildlife.

Sandhill crane
USFWS photo

The Gamble Tract is adjacent to two active sandhill crane nesting territories and one of the largest Oregon spotted frog breeding sites on the refuge. It contains historic wetlands that could be restored to provide important habitat for sandhill crane nesting and foraging as well as Oregon spotted frog breeding habitat.

Approximately one-third of the tract is timbered with ponderosa pine, lodgepole pine, and Douglas fir; the rest is Camas prairie. The land is routinely used by elk, many small mammals, and birds. Geese use the open grass areas during spring migration.

California condor
USFWS photo

California Condor *(Gymnogyps californianus)* The Hopper Mountain NWR and adjacent Sespe Condor Sanctuary in the Los Padres National Forest of eastern Ventura County in southern California continues to be the area of focus for reintroduced California condors. Biologists are continuing a supplemental feeding program on the refuge and monitoring condor activities closely.

Due to continuing problems of low flying aircraft over Hopper Mountain NWR and the Sespe Condor Sanctuary, notices for pilots were posted at Oxnard, Camarillo, and Santa Paula airports. The notices reminded pilots to maintain a 3,000-foot (915-meter) terrain clearance when flying over or near the Sespe and Sisquoc condor sanctuaries. Information regarding this requirement will also be published in the Ventura County's Department of Airports newsletter.

Reported by LaRee Brosseau of the Service's Portland Regional Office.

Region Two

Rio Grande Silvery Minnow *(Hybognathus amarus)* The Rio Grande silvery minnow has been the focus of intensive interagency negotiations and recovery planning lately, as a newly developed multi-stakeholder program comprising public and private entities collaborates with the Service in its recovery activities for the critically endangered fish. Once an abundant species found throughout the Rio Grande basin and its tributaries, the silvery minnow has suffered from habitat loss and alteration due to water diversion for agricultural irrigation. The silvery minnow is currently found only in the middle Rio Grande from Cochiti Dam to the headwaters of the Elephant Butte Dam in New Mexico, a stretch of the Rio Grande that represents approximately five percent of the minnow's historic habitat. (See related article in this edition of the *Bulletin*.)

The multi-stakeholder team will focus on several recovery issues related to habitat loss and alteration, including identification and implementation of channel restoration activities, water quality improvements, and long-term water management strategies. Additionally, captive propagation and reintroduction programs for the silvery minnow will be continued and augmented at Service, state, and local facilities.

Gila Trout *(Oncorhynchus gilae)* The Gila trout, a fish native to the rivers of the southwestern United States, is being considered for reclassification from endangered to the less critical category of threatened. When the trout was initially listed in 1966, it existed in only five small populations. Recovery work over the past three decades has included captive propagation from these relict populations and reintroduction of fish into historic stream habitat in New Mexico and Arizona. Less than 10,000 in 1992, the population in 1998 was estimated at 37,000 and is considered stable.

To ensure the success of reintroduced Gila trout, recovery work has focused on the causes of the original decline: habitat fragmentation and alteration (including streamside vegetation loss and erosion, sedimentation, and lowered water tables)

Gila trout
USFWS photo

and competition and interbreeding with non-native trout. Planning is underway with the New Mexico Department of Game and Fish and the U.S. Forest Service for a large-scale habitat restoration project on the West Fork Gila River. Completion of the project will double the number of stream kilometers available for occupation by Gila trout.

A revised recovery plan, which outlines recent conservation efforts, reports new biological data, refines reclassification criteria, and proposes delisting criteria, should be available for public review soon.

Texas Plants The Service has been working with the Stephen F. Austin State University (SFASU) and the Texas Nature Conservancy to establish populations of several federally listed and candidate species within the recently established Pineywoods Native Plant Center at SFASU. As an anticipated accredited partner of the Center for Plant Conservation, the Pineywoods Center will house seeds and populations of two listed species (Texas trailing phlox, *Phlox nivalis* ssp. *texensis*, and the white bladderpod, *Lesquerella texensis*), two listing candidates (Texas golden gladecress, *Leavenworthia texana*, and Neches River rosemallow, *Hibiscus dasycalyx*), and a number of additional plant species of concern. These populations will be used for research purposes and for reintroduction efforts within suitable habitat in East Texas.

Reported by Tracy A. Scheffler and Jim Brooks, of the Service's Albuquerque Regional Office and Kathy Nemec of our Clear Lake, Texas, Field Office.

Region 5

West Virginia Species The Service's West Virginia Field Office has updated the 1990 recovery plan covering the two endangered Appalachian subspecies of northern flying squirrels. The updated plan amends the guidelines for habitat identification and management for the endangered Virginia northern flying squirrel *(Glaucomys sabrinus fuscus)* in West Virginia. The amendment was a collaborative effort between the Service, Monongahela National Forest, George Washington/Jefferson National Forest, West Virginia Division of Natural Resources, and Appalachian Northern Flying Squirrels Recovery Team.

The new guidelines will provide better management for the northern flying squirrel in West Virginia and expedite its recovery. Promulgation of the amended guidelines into the management plans of the Monongahela National Forest, which supports almost all of the squirrel's populations, will in all likelihood result in reclassification of the northern flying squirrel to a threatened and possibly a delisted species.

West Virginia has been awarded two grants totaling approximately $250,000 to determine baseline population levels and habitat conditions in the state for the Virginia northern flying squirrel, Cheat Mountain salamander *(Plethodon nettingi)*, and flat-spired three-toothed land snail *(Triodopsis platysayoides)*. The information will be used to assist in development of a Habitat Conservation Plan (HCP) with the Intrawest Corporation at Snowshoe Ski Resort and development of a Safe Harbor Agreement (SHA) with the West Virginia Division of Forestry. Both grants were issued from the Cooperative Endangered Species Conservation Fund authorized under section 6 of the Endangered Species Act.

Cheat Mountain salamander
Photo by C.K. Dodd, Jr.

Atlantic Salmon *(Salmo salar)* The Ducktrap Coalition, a private conservation group dedicated to the protection of riparian habitat along the Ducktrap River in Maine, has announced that 80 percent of the streamside habitat is now protected either through fee title or conservation easement. The Ducktrap is one of the rivers that support the listed Gulf of Maine Distinct Population Segment of Atlantic salmon. Similar efforts are underway to protect other rivers in the area that harbor the listed salmon. The Service recently announced a Recovery Land Acquisition Grant to Maine under section 6 of the ESA to obtain an easement from the International Paper company for protecting much of the habitat adjacent to the Machias river, another DPS component.

Peregrine Falcon *(Falco peregrinus)* Since the peregrine's recovery and removal from the endangered and threatened species list in 1999, monitoring indicates it is continuing to do well in New York and New England. Preliminary reports in June for the 2001 season from Vermont showed a total of 26 pairs, the best year yet for that state. New Hampshire also reported a record 12 sites with falcon pairs present, all with incubating birds confirmed by June 2001. In Boston, two resident pairs of peregrine falcons produced four chicks each, and two additional pairs, one with three chicks and one with two chicks, were reported at other sites in Massachusetts. For New York, 2001 was another record year, with 45 breeding pairs producing 96 young.

Reported by Shane Jones in the Service's West Virginia Field Office.

From September through November 2001, the Fish and Wildlife Service published the following proposed and final Endangered Species Act (ESA) rules in the *Federal Register*. The full text of each action can be accessed through our website: `http://endangered.fws.gov`.

Emergency Listing Rules

Columbia Basin Pygmy Rabbit *(Brachylagus idahoensis)* On November 30, we gave protection to the Columbia Basin pygmy rabbit under the emergency rule provisions of the ESA. This population of the pygmy rabbit, the smallest species of rabbit in North America, consists of fewer than 50 individuals in Douglas County, Washington.

The Columbia Basin pygmy rabbit is threatened with imminent extinction because of recent significant population declines, continuing disturbances to its sagebrush habitat, disease, predation, and loss of genetic diversity. An emergency listing under the ESA provides immediate federal protection for 240 days while we publish a proposed rule under normal procedures to give the population long-term protection as an endangered species. The listing proposal was also published on November 30.

The Columbia Basin pygmy rabbit is a distinct population of native rabbit that once occupied Douglas, Grant, Lincoln, Adams, and Benton counties in central Washington. Pygmy rabbits occur in other areas of the West, but the Columbia Basin population is genetically unique, having lived in isolation from other rabbit populations for thousands of years.

Pygmy rabbit
Washington Department of Fish and Wildlife

In the spring of 2001, the Washington Department of Fish and Wildlife began a captive breeding program for the Columbia Basin pygmy rabbit to provide animals for release into the wild to augment the natural population. As of early December, 12 pygmy rabbits had been captured from the Columbia Basin population as an initial source for captive breeding efforts. Biologists have observed reproductive behavior in these animals, including the birth of five offspring that were conceived in the wild. Washington already has listed the pygmy rabbit as endangered under state law and has undertaken various management efforts to protect the Columbia Basin population. Currently, the species only occurs on state land.

Carson wandering skipper
USFWS photo

Carson Wandering Skipper *(Pseudocopaeodes eunus obscurus)* On November 29, we also gave emergency protection to the Carson wandering skipper, a small, tawny-orange butterfly found in only two counties in northwestern Nevada and northeastern California. The same day, we published a proposal to give the butterfly long-term protection as an endangered species.

The two Carson wandering skipper populations—one in Washoe County, Nevada, and one in Lassen County, California—face imminent extinction from water export projects, grazing, development activities, and invasions of nonnative plants. A population once found in Carson City, Nevada, has already been lost.

Adult skippers feed on flower nectar and females lay their eggs exclusively on salt grass. The habitat of both remaining skipper populations is threatened by pending water export proposals that would likely lower the ground water and contribute to the loss of salt grass, the skipper's larval food source.

Scientists believe the Carson wandering skipper was once more widely distributed at sites between the remaining populations before habitat degradation and fragmentation damaged other salt grass habitats.

Proposed Listing Rules

Rota Bridled White-eye *(Zosterops rotensis)* We proposed on October 3 to list the Rota bridled white-eye, a small forest bird with a distinctive ring of white feathers around its eyes, as an endangered species. It is a small (approximately 4 inches or 10 centimeters) yellowish bird with a yellow-orange bill, legs, and feet. Found in the Mariana archipelago of the western Pacific Ocean, this bird exists only on the island of Rota.

Population estimates for the Rota bridled white-eye have declined dramatically since the early 1980s, when it numbered almost 11,000 birds. Today, fewer than 1,200 birds probably remain on Rota, an 89 percent decline. Once numerous and found at low elevations on the island, current populations are concentrated in four areas of the island in old-growth native limestone forests more than 650 feet (200 meters) in elevation. In 1991, the Commonwealth of the Northern Mariana Islands government listed the Rota bridled white-eye as threatened or endangered under local law.

The exact causes for the sharp decline in Rota bridled white-eye populations are unknown. Possible factors contributing toward the decline include degradation or loss of habitat due to development, agricultural activities, and naturally occurring events such as typhoons; avian disease; predation by nonnative rats *(Rattus* spp.*)* and the black drongo *(Dicrurus macrocercus)*, an introduced bird species from Taiwan; and pesticides.

Sacramento Mountains Checkerspot Butterfly *(Euphydryas anicia cloudcrofti)* The high mountain meadows of native flowering plants outside the Village of Cloudcroft in southern New Mexico are the only place to find Sacramento Mountains checkerspot butterflies in the wild. Their limited range and threats to the remaining butterflies led to our September 6 proposal to list the Sacramento Mountains

checkerspot as endangered. The proposal also called for designating 5,000 acres (2,025 hectares) in Otero County as critical habitat for the butterfly. Half of the proposed critical habitat is public land managed by the U.S. Forest Service; the rest is privately owned.

The Sacramento Mountains checkerspot butterfly has a wingspan of approximately 2 inches (5 cm). It inhabits mountain meadows and other openings within the mixed-conifer forest between an elevation of 8,000 to 9,000 feet (2,450 to 2,750 m).

Extensive surveys for larvae and the adult butterflies throughout the Sacramento Mountains led us to conclude that this butterfly is found only within a 33-square-mile (85.5-square-kilometer) area. Within this small area, the butterfly's distribution is patchy and unconnected. Currently, the best information available shows that many areas of suitable habitat may be small, supporting few numbers of butterflies. Isolated populations are more vulnerable and less likely to survive over the long term.

Much of the remaining habitat is threatened by the direct and indirect effects of residential development, certain development projects in the Lincoln National Forest, highway reconstruction, off-highway vehicle use, trampling, and overgrazing. Conifers and other nonnative vegetation are encroaching on the meadows due to the suppression of periodic wildfires, impeding the survival of the native plants used by the butterfly. The resulting growth has also increased fuel loads, contributing to the threat of more catastrophic, high-intensity wildfires.

We are also concerned about continued illegal netting from unscrupulous butterfly collectors, by whom specimens of rare butterflies are highly prized. To help protect the Sacramento Mountains checkerspot butterfly, the Forest Service banned collecting the butterfly without a permit in portions of the Lincoln National Forest in 1999. Collection of illegally captured butterfly species has led to several arrests and convictions for violation of federal wildlife laws.

Final Listing Rules

Vermilion Darter *(Etheostoma chermocki)* This small fish, named for its reddish-orange coloration, is found only in the Turkey Creek drainage, a tributary of the Locust Fork of the Black Warrior River, in Jefferson County, Alabama. The vermilion darter's current known range is limited to 7.2 miles (11.6 kilometers) of the Turkey Creek mainstem and the lower 0.5 mile (0.8 km) of Dry and Beaver creeks where they intersect Turkey Creek. Extensive surveys in similar habitats have failed to locate this species outside its current drainage.

Impoundments in the upper Turkey Creek mainstem and its tributaries, along with water quality degradation, have altered the stream's dynamics and reduced the darter's range significantly. The surviving population is threatened by pollutants (i.e., sediment, excess nutrients, pesticide and fertilizer runoff) that wash into the streams from land surfaces. Because the vermilion darter is in danger of extinction, we listed this species as endangered on November 28.

Spalding's Catchfly *(Silene spaldingii)* A member of the carnation family (Caryophyllaceae), Spalding's catchfly is a long-lived perennial herb with small greenish-white flowers. It is currently known from a total of 52 populations scattered over west-cental Idaho, northeastern Oregon, western Montana, eastern Washington, and a single site in British Columbia, Canada. This plant is threatened by a variety of factors, including habitat destruction and fragmentation from agricultural and urban development, grazing and trampling by domestic livestock and native herbivores, herbicide treatments, and competition from invasive nonnative plant species. On October 10, we listed Spalding's catchfly as a threatened species.

Scaleshell Mussel *(Leptodea leptodon)* A freshwater mollusk once found in many rivers of the eastern U.S., the scaleshell mussel has declined to the point that we listed it on October 9 as an endangered species. Nearly 75 percent of historically known populations have disappeared. The species once inhabited 55 rivers or streams in

Scaleshell
USFWS photo

13 states, but now is limited to 14 rivers in Arkansas, Missouri, and Oklahoma.

Threats to the scaleshell, as with many other mussel species, include poor water quality due to pollution and sedimentation; loss and alteration of habitat through damming of waterways, dredging and channelization of rivers, and sand and gravel mining; and competition with nonnative species like the zebra mussel.

Ohlone Tiger Beetle *(Cicindela ohlone)* The Ohlone tiger beetle, an insect that exists only in Santa Cruz County, California, received final protection as an endangered species on October 3. It currently exists only in remnant stands of native grassland on coastal terraces in four small

Ohlone tiger beetle
Photo by Michael Rigsby and David Kavanaugh

geographic areas near or within the cities of Santa Cruz, Scotts Valley, and Soquel. The beetles inhabit fewer than 20 acres (8 ha) on a combination of private lands and lands owned by the University of California at Santa Cruz, the city of Santa Cruz, and the California state parks system. The tiger beetle inhabits some of the last remaining patches of a coastal prairie ecosystem that once

spanned coastal Santa Cruz County and extended into San Mateo County and Monterey counties.

The primary threat to the Ohlone tiger beetle is habitat destruction and fragmentation caused by urban development. Other threats include habitat changes caused by invasive nonnative plants, overcollection, impacts from recreational activities, pesticides, and vulnerability to extinction from natural events such as disease, fire, drought, or flood.

Ohlone tiger beetles measure no more than one-half inch (1.2 cm) long. They have large, prominent eyes, and metallic green leathery forewings with small light spots and coppery-green legs. Active by day, adults are swift and ferocious predators that seize small prey with powerful sickle-shaped jaws. Even their larvae are predatory. Tiger beetle larvae live in small vertical or slanting burrows from which they lunge and seize passing invertebrates.

Two Southwestern Plants The Holmgren milk-vetch *(Astragalus holmgreniorum)* and the Shivwits milk-vetch *(Astragalus ampullariodes)*, a pair of rare plants found only near the Utah/Arizona border, were listed September 28 as endangered. Both are perennials in the pea family (Fabaceae).

Only small numbers of these species remain. The Holmgren milk-vetch population varies from 5,000 to 10,000 plants, depending upon rainfall, and is native to Washington County, Utah, and adjacent Mojave County, Arizona, near the city of St. George, Utah. The Shivwits milk-vetch, numbering fewer than 1,000 plants, grows only in southern Washington County.

Both species grow on state and private land, as well as land administered by the Bureau of Land Management. The Shivwits milk-vetch is also found on the Shivwits Reservation of the Paiute Tribe. The numbers of both plants are rapidly decreasing due primarily to rapid urban expansion and population growth in the St. George area, where much of the plants' habitat has been destroyed or degraded by the construction of new roads, power lines, and other development. Off-road recreational vehicle use, the spread of noxious weeds, overgrazing, and mineral development also threaten the plants' survival.

Shivwits milk-vetch
USFWS photo

Proposed Critical Habitat Rules

Critical Habitat Critical habitat, as defined in the ESA, is a term for a geographic area that is essential for the conservation of a listed species. Critical habitat designations do not a establish a wildlife refuge, wilderness area, or any other type of conservation reserve, nor do they affect actions of a purely private nature. They are intended to delineate areas in which federal agencies must consult with the Service to ensure that actions these agencies authorize, fund, or carry out do not adversely modify the designated critical habitat. Within designated critical habitat boundaries, federal agencies are required to consult except in areas that are specifically excluded, such as developed areas within the boundaries that no longer contain suitable habitat. Maps and more specific information on critical habitats are contained in the specific *Federal Register* notice designating each area. For more information on critical habitat designations in general, go to the website for our Endangered Species Listing Program (`http://endangered.fws.gov/listing/`) and click on "About Critical Habitat."

Three Central California Plants We proposed on November 15 to designate critical habitat for three native California plant species on about 66,830 acres (27,050 ha) in San Luis Obispo and Santa Barbara counties.

About 44,315 acres (17,935 ha) of critical habitat are being proposed for the La Graciosa thistle *(Cirsium loncholepis)*, 8,495 acres (3,440 ha) for the Lompoc yerba santa *(Eriodictyon capitatum)*, and 14,020 acres (5,675 ha) for the Gaviota tarplant *(Deinandra increscens* ssp. *villosa)*. The plants are found only in coastal areas of San Luis Obispo and Santa Barbara counties.

The La Graciosa thistle, a member of the sunflower family (Asteraceae), forms a mound of spiny plants with white flowers. Each plant can reach 40 inches (100 centimeters) or more in height. The thistle occurs in coastal dune habitat and wetlands in areas of northern Santa Barbara County and southern San Luis Obispo County, including the Guadalupe-Nipomo Dunes National Wildlife Refuge.

The Lompoc yerba santa, a shrub in the waterleaf family (Hydrophyllaceae), produces lavender flowers on sticky stems that can reach heights of 10 feet (3 meters). It grows in maritime chaparral and southern bishop pine forests in western Santa Barbara County. Three populations occur on Vandenberg Air Force Base, and one is on private land near the city of Orcutt.

The Gaviota tarplant, a gray-green annual in the sunflower family, has yellow flowers and can grow to a height of 35 inches (89 cm). It occurs in rare needlegrass grasslands between Point Arguello and Gaviota on coastal terraces and along ridgeline saddles in the Santa Ynez Mountains. One population occurs on Vandenberg Air Force Base.

Santa Cruz tarplant *(Holocarpha macradenia)* Also on November 15, we proposed designating critical habitat for the threatened Santa Cruz tarplant on about 3,360 acres (1,360 ha) in California's Contra Costa, Santa Cruz, and Monterey counties.

The Santa Cruz tarplant is an aromatic annual herb native to California's central coast. A member of the aster family, the Santa Cruz tarplant can reach a height of 20 inches (50 cm) and displays heads of yellow daisy-like flowers in summer, long after most other annual plants have begun to fade. It typically grows on coastal terrace prairies where sandy clay soils hold moisture well into the growing season.

Once found along the central coast from Marin County south to Monterey County, the Santa Cruz tarplant now occurs on public, county, state, and private lands in Monterey and Santa Cruz counties. Populations of the plant grown from experimental seeding also occur at Wildcat Canyon Regional Park in Contra Costa County in the San Francisco Bay area. The loss or alteration of habitat, livestock grazing, and displacement by nonnative annual grasses led to the plant's decline and listing as a threatened species.

Purple Amole *(Chlorogalum purpureum)* We proposed on November 8 to designate critical habitat for two varieties of the purple amole, a threatened bulb-forming perennial in the lily family (Liliaceae), on about 21,980 acres (8,895 ha) in Monterey and San Luis Obispo counties, California. About 17,210 acres (6,965 ha) of critical habitat are being proposed for the purple amole variety *(Chlorogalum purpureum* var. *purpureum)* and 4,770 acres (1,930 ha) for the Camatta Canyon amole variety *(Chlorogalum purpureum* var. *reductum)*. Both varieties have bluish-purple flowers along the length of the stalk that bloom during the day.

Loss or alteration of habitat, livestock grazing, and displacement by nonnative annual grasses contributed to the decline of both varieties.

Kneeland Prairie Penny-cress *(Thlaspi californicum)* On October 24, we proposed to designate critical habitat for the Kneeland Prairie penny-cress, an endangered native California plant, on about 74 acres (30 ha) of serpentine outcrops in the grasslands of Kneeland Prairie in Humboldt County, California.

Kneeland Prairie penny-cress
USFWS photo

A perennial herb in the mustard family (Brassicaceae), the Kneeland Prairie penny-cress produces white flowers and can grow to 5 inches (12.5 cm) tall. Approximately 5,300 plants are distributed in five colonies in one general location. The colonies are bisected by the Kneeland Airport and a county road. The population is threatened with habitat loss due to construction, maintenance and development activities, hydrologic changes, and other activities that could further disturb the habitat.

Final Critical Habitat Rules

Kootenai River white sturgeon
Kootenai Tribe of Idaho photo

Kootenai River White Sturgeon *(Acipenser transmontanus)* A final designation of critical habitat was published on September 6 for 11.2 miles (18 km) of the Kootenai River in northern Idaho to benefit the endangered Kootenai River white sturgeon.

The area is entirely within Boundary County and begins 31 miles (50 km) downstream from Libby Dam at Bonner's Ferry, extending downstream to river mile 141.4, below Shorty's Island. It contains the only known spawning and early-life stage rearing sites for the species.

In December 2000, we called for limits on rapid water level fluctuations in the Kootenai River caused by operating Libby Dam to meet peak electricity demands. Reducing these large fluctuations is expected to benefit endangered sturgeon by ending the cycle of flooding and dewatering of their spawning grounds. Levee owners in the Kootenai Valley should also benefit because levee erosion will be reduced. We do not expect the critical habitat designation to affect our flow management recommendations.

Recreational fisheries on the river and the activities of the Kootenai Tribe of Idaho, including the Tribe's aquaculture program, in which juvenile Kootenai River white sturgeon are raised for release into the wild as part of the species' recovery program, also should not be affected by the critical habitat designation.

Wenatchee Mountains Checker-mallow *(Sidalcea oregana* ssp. *calva)* Also on September 6, we designated 6,135 acres (2,485 ha) of seasonal wetlands on state, federal, and private lands in central Washington as critical habitat for an endangered plant, the Wenatchee Mountains checker-mallow.

Most of the approximately 3,600 checker-mallow plants are found on about 95 acres (38 ha) of seasonal wetlands on the Washington Department of Natural Resources' Camas Meadows Natural Area Preserve in Chelan County. Other checker-mallow plants are scattered on adjacent Forest Service land and on a small parcel of private property in Pendleton Canyon.

Wenatchee Mountains checker-mallow
Photo by Ted Thomas/USFWS

BOX SCORE

Listings and Recovery Plans as of May 31, 2002

GROUP	ENDANGERED U.S.	ENDANGERED FOREIGN	THREATENED U.S.	THREATENED FOREIGN	TOTAL LISTINGS	U.S. SPECIES W/ PLANS
MAMMALS	65	251	9	17	342	53
BIRDS	78	175	14	6	273	75
REPTILES	14	64	22	15	115	32
AMPHIBIANS	11	8	8	1	28	12
FISHES	71	11	44	0	126	95
SNAILS	21	1	11	0	33	27
CLAMS	62	2	8	0	72	56
CRUSTACEANS	18	0	3	0	21	12
INSECTS	35	4	9	0	48	29
ARACHNIDS	12	0	0	0	12	5
ANIMAL SUBTOTAL	387	516	128	39	1,070	396
FLOWERING PLANTS	568	1	144	0	713	555
CONIFERS	2	0	1	2	5	2
FERNS AND OTHERS	26	0	2	0	28	28
PLANT SUBTOTAL	596	1	147	2	746	585
GRAND TOTAL	983	517	275	41	1,816*	981

TOTAL U.S. ENDANGERED: 983 (387 animals, 596 plants)
TOTAL U.S. THREATENED: 275 (128 animals, 147 plants)
TOTAL U.S. LISTED: 1,258 (515 animals***, 743 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.

** Nine 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