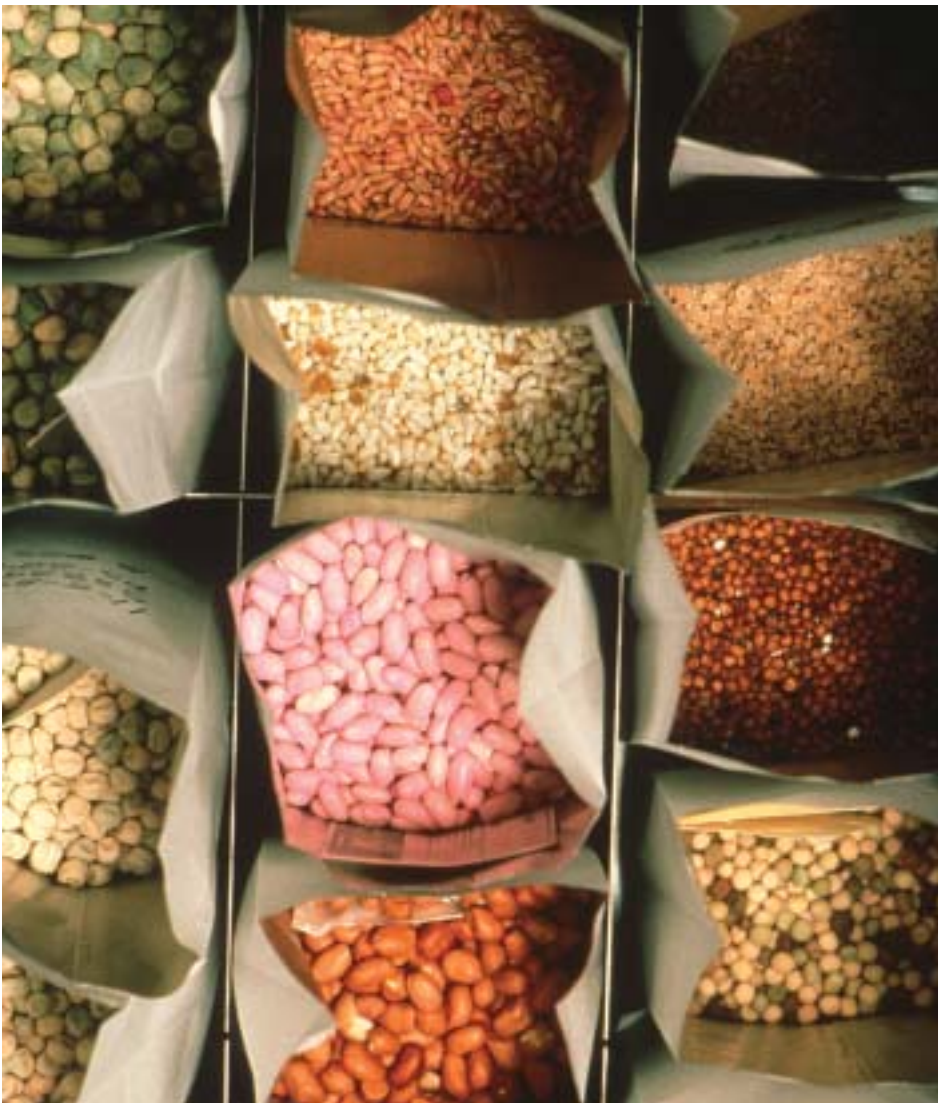


ENDANGERED *Species* BULLETIN

July/August 2002

Vol. XXVII No. 3



In the work that we and our partners undertake to conserve and recover vulnerable species, awareness of the efforts we take for native plants is often overshadowed by the interest received by animal species. Too often overlooked is the fact that plants provide the foundation upon which animal life, including our own, depends. Plants are not only of aesthetic value, they provide us with food, many medicines, vital ecosystem services, and a variety of other products that are essential to our economy and well being. Fortunately, we have an important partner in the protection of our nation's imperiled flora, the Center for Plant Conservation. This edition of the Endangered Species Bulletin features some of the Center's progress in restoring these rare plant species.



Photo by Kenneth Heil

U.S. Fish & Wildlife Service

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On the Cover

Many of the seeds stored at the National Center for Genetic Resources Preservation (formerly the National Seed Storage Laboratory), a U.S. Department of Agriculture facility, were deposited by Center for Plant Conservation member institutions.

Center for Plant Conservation photo

Opposite page

The tiny Davis' green pitaya (*Echinocereus vividflorus* var. *davisii*), an extremely rare cactus, is one of the species being researched at the Desert Botanical Garden.

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.

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Partners in Plant Conservation

by Steven A. Williams



USFWS Director Steven A. Williams
USFWS photo

I am pleased to introduce this issue of the *Endangered Species Bulletin*, which is dedicated to the conservation efforts of the member institutions of the Center for Plant Conservation. Since its founding in 1984, the Center has been an important partner with the Fish and Wildlife Service in the conservation of our imperiled native plants.

Our nation is a vast land that stretches from above the Arctic Circle to below the Tropic of Cancer, and it spans nearly a third of the globe from eastern Maine to the tip of the Aleutian Islands in Alaska. This enormous geographical expanse supports over 20,000 species of plants in more habitats than any other nation on earth. From the deciduous forests of the Appalachian Mountains to California's coastal sage, and from Alaska's tundra to the tropical forests of Puerto Rico and Hawaii, plants define our landscapes, and many species are truly unique. Among our plant treasures are the giant redwoods of coastal California, the world's tallest trees, with individual specimens rising as high as a 35-story office building. And some bristlecone pines are arguably the oldest living organisms on earth.

Plants are also essential to the well-being of the animal world in both familiar and fascinating ways. Many plants depend on animals such as hummingbirds, bats, beetles, bees, and butterflies for pollination. Unfortunately, among our threatened and endangered species are 23 butterflies. Some have become imperiled in part by the loss of host plants for their larvae or nectar species required by adults. One endangered butterfly, the Fender's blue (*Icaricia icarioides fenderi*), depends on a threatened plant, the Willamette Valley

or Kincaid's lupine (*Lupinus sulphureus* var. *kincaidii*), a relationship that demonstrates the intimate and sometimes fragile interdependence of life.

Recently, biologists discovered that Pinnacles National Monument in California supports over 400 species of native bees, more than any other place in North America. Many bees are very selective in their choice of forage plants, and some are the sole pollinators of specific species of plants. However, in the midst of such a unique diversity of bee and plant species, the presence of introduced plants poses a serious threat. Exotic plants can crowd out native plant species, ultimately reducing or causing the loss of highly selective pollinator species. Conversely, declines in pollinator populations can result in the decline or loss of native plant species. Besides habitat loss, nonnative and invasive plant species are the second most significant threat to native plants. Nowhere is this threat more of an issue than in Hawaii.

The Hawaiian Islands are home to about 1,500 native species of plants, with 90 percent being endemic. Habitat modification and loss, as well as threats from nonnative species of plants and animals, have made Hawaii the global epicenter of plant extinction, with more than 100 plant extinctions over the past 200 years. Similar situations are found in parts of California, Florida, Puerto Rico, and elsewhere around the Nation.

It is against these challenges that our partnerships with the Center for Plant Conservation, its member institutions, and the dedicated people that conserve and recover our native plant species stands out.

Dr. Williams is the Director of the U.S. Fish and Wildlife Service.

The Center for Plant Conservation

by Kathryn Kennedy

For the past 10 years of my work with imperiled plants, I have kept a talisman in my office: a big campaign-style button that says “Visualize Recovery.” Oddly enough, whenever I glance at it, the image that springs to mind is not robust populations of plants basking in the sunshine but intent groups of people in the field working their fingers to the bone! I visualize the process, and being able to get the work done—the monitoring, seed-banking, life history research, genetic analysis, range-wide planning, site-specific prescriptions, and restoration work for imperiled populations and their supporting communities.

As of May 1, 2002, there were 743 plant species or varieties in the United States federally listed as threatened or endangered. There are an additional 139

candidates believed to qualify for listing. Together, these numbers approach 5 percent of our flora (considered to include about 20,000 species). Recovery for so many is a big job. It will take time and resources. In my years of work with endangered species at the state and federal levels, the limiting factor was always the lack of focused, sustained assistance. Recovery work involves diverse and challenging issues, so an effective recovery program clearly required teamwork. Government budgets nearly always fell short of the support needed to put those professional teams together and get the work done.

After working in government conservation agencies, I was drawn to the work of the Center for Plant Conservation (CPC), not only because of its accom-



Kathryn Kennedy, Executive Director of the Center for Plant Conservation
Photo by Dave Kennedy



Plants like the Kodachrome bladderpod (*Lesquerella tumulosa*), an endangered species growing in the colorful Kodachrome Basin of Kane County, Utah, may be recovered with the assistance of the CPC and other partners.

Photo by James Reveal/Smithsonian Institution



San Antonio Botanical Garden botanist Paul Cox collects seeds of the endangered Texas poppy-mallow (*Callirhoe scabriuscula*).

Photo by Patty Leslie/San Antonio Botanical Garden

Seeds collected in the wild become the basis for ex situ populations of rare plants, such as this plant in the genus *Plantago*, grown at the Denver Botanic Gardens.

CPC photo

plishments but because it still has so much potential to help through focused, productive partnerships. The CPC, established in 1984, is an independent nonprofit organization whose mission is nothing less than to conserve and restore the rare native plants of the United States. It consists of a network of 33 participating institutions (arboreta, botanical gardens, university programs, and museums) that have made a long-term commitment to assist in this mission, usually in partnership with other agencies and groups. The CPC is supported by donations and grants.

Participating institutions must agree to follow CPC standards and protocols, which the CPC establishes in cooperation in academia and conservation agencies. We have convened technical

groups for advice on plant conservation issues, held symposia to investigate theoretical and applied issues that affect plant recovery, and produced two technical books.

The CPC has a small professional staff at our national office in St. Louis, hosted by the Missouri Botanical Garden. Our national office provides technical assistance within and outside the network, maintains a website and database with entries on over 8,000 taxa of conservation concern, coordinates the derivation and dissemination of best conservation practices, and provides assistance to the participating institutions in building their conservation programs. We also administer a plant sponsorship program and small endowment. The sponsorships and endowment support

modest annual payments to institutions working on sponsored species and help further the CPC's collective objectives. The national office works to promote action for plant conservation in the United States as a whole, and seeks to focus attention on biodiversity hotspots and regional needs as well.

Initially, CPC's emphasis was in conservation horticulture off site (*ex situ*). Fifteen founding botanical institutions that dedicated time from their professional horticultural staff initiated a coordinated campaign. *Ex situ* work continues today. Botanists with CPC institutions carefully collect genetically representative samples of imperiled plant species, and they secure and maintain these curated collections (usually as seed). They conduct horticultural

research to figure out the often unique germination requirements of these species, and they develop growth to maturity protocols so that plant material can be produced consistently for restoration work. In some species, small populations of plants were no longer reproducing in the wild, and CPC's *ex situ* work with hand pollination, cuttings, and tissue culture has resulted in restored reproductive material that makes reintroduction into the wild possible.

The collection of imperiled plant material held in our participating institutions, known as the National Collection of Rare and Endangered Plants, is regarded as one of the world's largest conservation collections. It now contains material representing nearly 600 plant taxa. Approximately 85 percent of plant recovery plans note that reintroduction or augmentation of existing populations will be necessary to achieve recovery. The CPC's *ex situ* work to preserve and learn to produce plant material is clearly an essential recovery tool and a unique accomplishment.

As the organization has matured, many CPC institutions have expanded their work to assist with critical recovery work in the wild (*in situ*) as well. CPC botanists are monitoring wild populations, restoring habitat, and reestablishing plants in the wild. In 2000, the CPC mission was revised expressly to encourage comprehensive, integrated recovery planning and hands-on restoration work. Currently, CPC institutions are involved in about 60 restoration projects. Many CPC institutions are involved in preserving and providing stewardship of natural areas as well.

The network is effective. We have no doubt that the CPC's work has forestalled extinction for many species. Because the botanists are staff members in existing institutions, it is also cost-effective and efficient. Participating institutions have access to committed, well-trained, and supervised volunteers and interns that serve as field and lab technicians and help stretch precious conservation funds.

Each CPC institution is based in an area where plant recovery work is needed. Perhaps as importantly, each is a community-based organization with a multi-service mission that includes education. Collectively, visitors number in the hundreds of thousands. Through institutional interpretation of their conservation work to visitors, we hope most Americans will better understand the importance and challenges of plant conservation. If we can convey this message, we will ensure support from communities for conservation of their local floras far into the future.

We know our imperiled plant species can be saved. Nevertheless, current needs are greater than the resources and action being brought to bear. The CPC works to assist in meeting those needs, and to help establish "circles of care" across the nation through effective local conservation partners, linked with agency efforts.

Kathryn Kennedy is the Executive Director of the Center for Plant Conservation. To learn more about the Center and its work, go to www.mobot.org/CPC or call (314) 577-9450. The mailing address is Missouri Botanical Garden, Center for Plant Conservation, P.O. Box 299, St. Louis, MO 63166-0299.

Botanists plant *Stephanomeria malheurensis*, an endangered plant, in the CPC's National Collection of Endangered Plants.

Photo by Cheryl McCaffrey/Bureau of Land Management



A Safety Net for Hawaii's Rarest Plants

by Marie M. Bruegmann,
Vickie Caraway, and
Mike Maunder

The Hawaiian Islands are the most isolated high islands in the world, located over 2,000 miles (3,220 kilometers) from the nearest continental land mass. Their isolation, together with a high diversity of habitat types, makes the Hawaiian flora one of the most unique in the world. Approximately 1,500 plant species are indigenous to the Hawaiian Islands, and nearly 90 percent of these are found nowhere else. This represents one of the highest levels of endemism anywhere in the world.

The narrow geographic range of many native Hawaiian species makes them very susceptible to decline from a loss of habitat quantity and quality. A growing human population already has damaged or destroyed much of Hawaii's native plant habitat. The additional harmful effects of introduced plants and animals have driven many species even closer to the brink of extinction. So far, approximately 100 native Hawaiian plant species of historical times are no longer thought to exist in the wild, with only a handful saved in cultivation. Of the remaining 552 Hawaiian plant species that are rare, approximately 150 have fewer than 50 individuals remaining in the wild. These statistics are just a symptom of the larger problem of ecosystem decline that ultimately reduces ecological stability and jeopardizes the survival of unique island biota. Hawaii shares this pattern of decline and extinction with many island groups.

Until these threats can be managed, the status of endemic species in Hawaii will continue to decline and more species will become threatened with extinction. Habitat conservation and the control of harmful nonnative species are necessary for the survival and ultimate

recovery of Hawaii's native plants and animals. However, for many Hawaiian plants, these approaches will not be implemented quickly enough to prevent extinction. Immediate action must be taken before they are lost forever.

We have dubbed Hawaiian plant species that number fewer than 50 individuals the "Genetic Safety Net" (GSN) species of Hawaii. Currently, there are approximately 150 GSN species, although the numbers change rapidly as more individuals and/or populations are located and other populations disappear. We view emergency actions for these species as temporary but essential measures to prevent extinction until enough suitable habitats can be secured.

The Hawaii Rare Plant Restoration Group—a coalition of Center for Plant Conservation participating institutions, other botanical gardens, federal and state agencies, private organizations, and independent botanists—is developing a GSN program aimed at preventing the loss of Hawaii's most endangered plant species. The objectives are to 1) obtain comprehensive genetic samples of the surviving wild plant populations for the most critically endangered species in Hawaii; 2) store or cultivate samples collected from these plant species; 3) propagate every high priority species in sufficient numbers to maintain genetic diversity and provide stock for reintroduction into native habitat; 4) integrate *ex situ* (off site, or in cultivation) and *in situ* (on site, or in native habitat) conservation projects; and 5) produce an information management system that tracks the complex actions in the *ex situ* arena and disperses data promptly to involved stakeholders and *in situ* managers.

(Opposite page) *Clermontia peleana* ssp. *peleana*, is extinct in the wild, but the only tree in cultivation flowered and fruited recently, raising hopes that viable seeds can be obtained for propagation and reintroduction into natural habitat.

Photo by Thomas Lammers/University of Wisconsin-Oshkosh.



We are already making progress. Two field collectors from the National Tropical Botanic Garden (NTBG) on the island of Kaua'i are collaborating with partners from the Hawaii Rare Plant Restoration Group and private land owners to gather genetic representation of every individual of each of the GSN species throughout the islands. A pilot project to monitor a natural population, manage threats in a small area, and gain full genetic sampling of 33 of the GSN species is also underway on the island of O'ahu. Botanists will collect seeds and/or vegetative samples from every remaining individual from the small remnant populations covered under both projects in order to guarantee capturing all existing genetic variation. Detailed data are collected on phenology (time and amount of flowering and fruiting) and the immediate threats to identify needed management and provide data for future efforts.

The long-term storage options for the GSN propagation material are 1) *in vitro* storage of seeds, embryos, tissues in culture, or plantlets in media at University of Hawaii's Lyon Arboretum Micropropagation Lab, with a potential backup storage site; 2) conventional seed storage at the Lyon Arboretum and NTBG; and 3) cryogenic storage at the U.S. Department of Agriculture's National Seed Storage Laboratory in Fort Collins, Colorado. A recent inventory revealed that only about 50 percent of the approximately 150 species on the GSN list have been incorporated into the Lyon Arboretum's tissue culture lab or other storage facilities. The limitations to this form of storage include lack of space, the expense of repeated culturing, and the lack of knowledge of the mutations that may occur in long-term storage. Cryogenic storage is in the early research and development stage at the National Seed Storage Laboratory, but it promises to be a cost-effective method of long-term storage.

The GSN program invests in the three types of medium and short-term storage, typically used for the provision of

materials for reintroduction: 1) germplasm banks (for example, seed banks and *in vitro* storage), 2) living collections at botanical gardens, and 3) remote "field gene banks" housed in a network of small nurseries. Partnerships will be vital to the continued funding and operation of these storage facilities. The Volcano Rare Plant Facility on the Big Island is a shining example of what can be done on a very limited budget for dozens of endangered plant species. Currently, the Volcano Facility is growing thousands of Mauna Kea and Mauna Loa silverswords (*Argyroxiphium sandwicense* ssp. *sandwicense* and *A. kauense*) for reintroduction into the wild. In addition, the facility houses some of the rarest of Hawaii's endangered plant species, including the last known individual of *Clermontia peleana* ssp. *peleana*, a tree that is extinct in the wild.

Data management is a large component of the GSN program. The Hawaii Rare Plant Restoration Group is planning to develop a relational database manage-

ment system intended to 1) monitor all natural populations of critically endangered Hawaiian plant species, 2) track all genetic samples of rare plant species and populations, and 3) monitor the survivorship of reintroduced propagules generated by the *ex situ* facilities.

The concerted efforts of a partnership such as the Hawaii Rare Plant Restoration Group makes it possible to achieve the primary GSN objectives, which would be daunting for the Fish and Wildlife Service or a state agency to implement on their own. Full implementation of the GSN program will provide adequate storage options for genetic material, ensure the necessary management of living collections, and complete the network of nurseries needed to propagate and cultivate species for storage and reintroduction. Such a program allows us time to plan and undertake habitat protection programs and make appropriate material available for plant restoration and reintroduction.

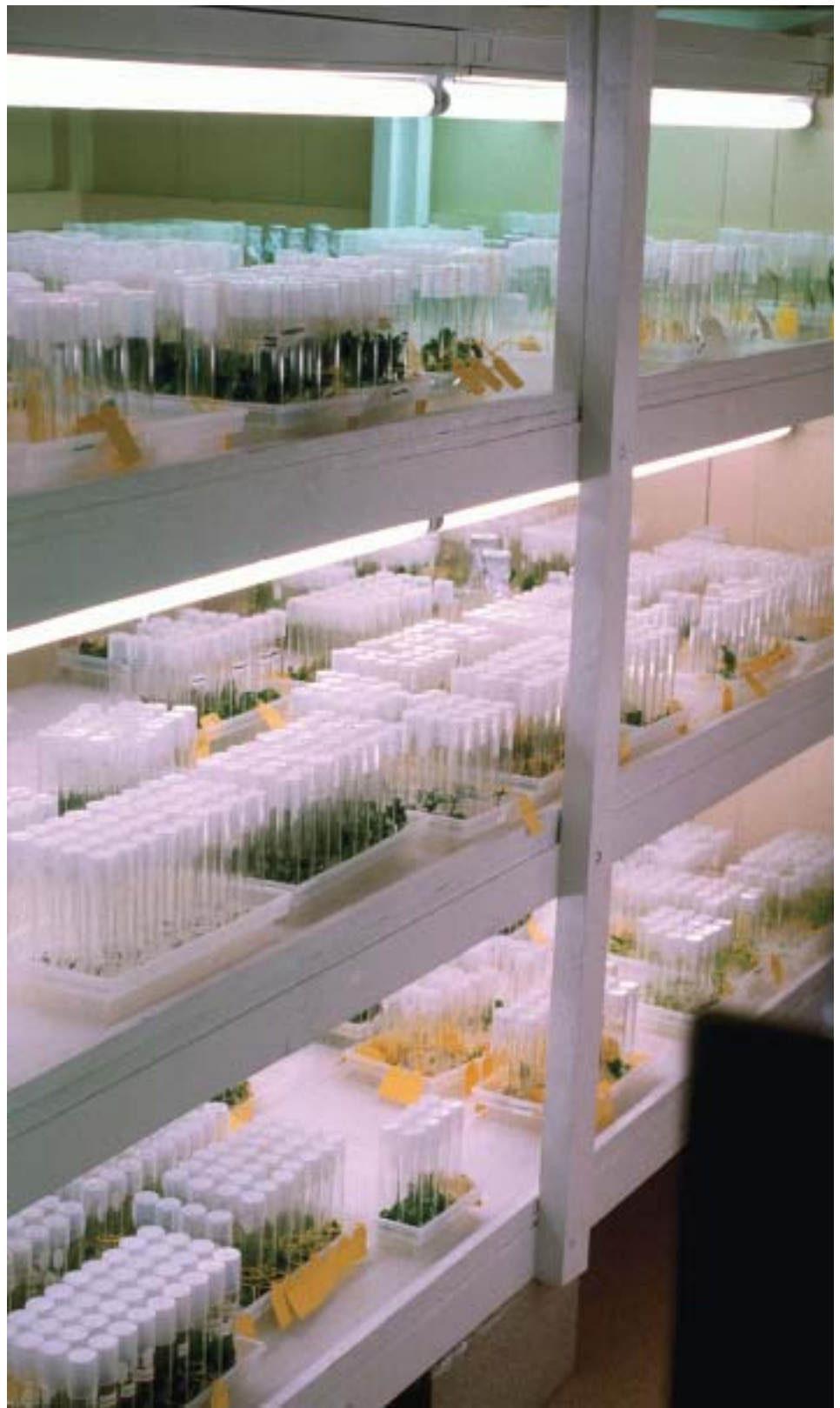
The member agencies of the Hawaii Rare Plant Restoration Group represent a broad range of agencies and organizations.

Amy B.H. Greenwell Ethnobotanical Garden (CPC garden)
Bernice P. Bishop Museum
Center for Plant Conservation
Harold L. Lyon Arboretum (CPC garden)
Hawaii Natural Heritage Program
Hawaiian Ecosystems at Risk project (USGS/BRD/PIERC/HFS/HEAR)
Honolulu Botanical Garden (CPC garden)
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U.S. Forest Service
Waimea Arboretum and Botanical Garden (CPC garden)

In situ and *ex situ* conservation efforts should proceed in combination to ensure that the habitat suitable for reintroduction has protection when the propagated plants are ready for reintroduction. Managers of protected habitats also need to be assured that the plants reintroduced on their lands will be of the highest quality (non-hybrid and disease free), represent conservation priorities, are from appropriate source populations, are species suitable for the habitats being managed, and are conducted as part of a species recovery plan. The cooperative efforts for the recovery of the Hawaiian silversword, as described in volumes 13(2-3), 23(4-5), and 25(3) of the *Endangered Species Bulletin*, are exactly what are needed for the numerous other endangered Hawaiian plants. The Service, state, and CPC, through the Service's Hawaii and Pacific Plant Recovery Coordinating Committee and with input from the Hawaii Rare Plant Restoration Group, are cooperating in the development of a plan for the recovery of all Hawaiian plants.

Without an intensive restoration and protection effort, a large proportion of the Hawaiian flora will not survive for long other than as seed samples or specimens in botanic gardens. Unfortunately, Hawaii's crisis is the future for many oceanic ecosystems. The lessons we learn in the salvage and, ultimately, the restoration of Hawaii plant species will be important to islands throughout the world.

Marie M. Bruegmann is the plant recovery coordinator with the Service's Pacific Island Office in Honolulu, Hawaii. Vickie Caraway is a botanist with the state of Hawaii's Division of Forestry and Wildlife. Mike Maunder is Director of Conservation and Curator of Living Collections at the National Tropical Botanical Garden, Hawaii.



Lyon Arboretum has more individuals of most GSN species than are growing in the wild. This is currently our most reliable medium-term storage method.

Photo by Greg Koob/U.S. Fish and Wildlife Service

An Alpine Plant Comes Back

by William E. Brumback



Photos by Susi von Oettingen/USFWS

The New England Wild Flower Society, which celebrated its 100th anniversary in 2001, is the oldest plant conservation organization in the country. Although conservation has been part of the Society's heritage from the beginning, several milestones in its history are worth noting.

In the 1980s, the Society helped form the Center for Plant Conservation, becoming one of the original participating institutions in this national plant conservation effort. The Society formalized its own regional conservation efforts in 1990 by initiating the New England Plant Conservation Program, a voluntary collaboration between botanists and private and public agencies established to preserve and recover the rare plants of New England. Through six state task forces, comprised primarily of professional conservationists and academics, the program targets hundreds of rare plants for status updates each year.

It soon became apparent that the task was too great for professionals alone, and the Society instituted the Plant Conservation Volunteers Corps to assist in rare plant surveys, habitat management, invasive plant identification and control, and botanical surveys. In addition, the Society has also received funding to produce Conservation and Research Plans for the 100 rarest plants of the region, and has also initiated herbarium research in over 25 major and minor herbaria to help quantify the status of regionally rare (or potentially rare) plants in New England.

Since 1982, the Society has been involved in the recovery of several listed plant species. One of these plants, Robbins' cinquefoil or dwarf cinquefoil (*Potentilla robbinsiana*), has been

proposed for removal from the federal endangered species list. The plant, an alpine species found only at two locations on the cold slopes of the White Mountains in New Hampshire, grows in perhaps the harshest conditions found anywhere in New England. Not only is the plant able to survive severe cold, but it grows only in areas where phenomenal winds blow the snow cover off the rocky soil. During the winter, temperatures average around 0° F (-18°C), with a record low of -47° F (-44°C), and winds regularly average over 45 miles per hour (72 kilometers per hour), with peak gusts averaging over 150 miles per hour (240 kph) each winter. Its ability to survive without snow cover under these rugged conditions gives it an edge over other species within a relatively small area of habitat.

Besides its choice of habitat, this species has a few other quirks. First, like many other members of the rose family (including apples), it is apomictic. This means that the plants set seed without fertilization; in the case of dwarf cinquefoil, it also means that every seedling is an exact replica of its parent. Second, all the plants are almost genetically identical. Essentially, there is a genetically identical population producing plants that are all genetically identical.

The main threat to this plant was not the weather, but a hiking trail (which also carried horses at one time) running through the middle of the largest population on Mt. Washington. This trail, combined with collection of the plants for herbaria and for sale by nurseries, reduced the species' limited numbers. Through a collaboration of the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the Appalachian Mountain

Club, the trail was eventually relocated, eliminating the major threat to the plants, and the Society instituted a reintroduction/augmentation program.

For the past decade, the Society has received seeds from the Mt. Washington plants collected under federal permit by the Appalachian Mountain Club, the organization that has taken the lead on monitoring the plants in the wild. At our botanic garden, Garden in the Woods in Framingham, Massachusetts, we have successfully produced seedlings by treating the seeds with gibberellic acid before sowing. Sowing seed outside in late fall, subjecting the seeds to ambient temperatures and natural freezing and thawing over winter, also works well. The seeds germinate in May, and the tiny seedlings are left in seed flats for one to two years before repotting in well-drained soil. Because we are growing an alpine species at near sea level with accompanying heat and humidity, mortality of seedlings is relatively high. Those that survive, however, often bloom in their pots in the spring of their third year. These mature blooming plants in our nursery are usually much larger than their counterparts in the wild, which need eight to 12 years of growth to reach blooming size (about the diameter of a quarter) in the harsh conditions of the alpine zone.

Initial transplant efforts involved holding plants in freezers at our botanic garden from the beginning of thaw in Framingham (end of February to mid-March) until just after snowmelt on Mt. Washington, when the plants began to bloom (early June). We had mixed success with this method, and our recent transplants, held in cold frames outside over winter and placed in the wild in mid to late July, have proven more successful, showing nearly complete survival over their first winter in the wild. The mid-summer transplants have another advantage. Because the transplants often have bloomed by the time they are transplanted, they may also be producing seeds. These seeds fall in the immediate area of the transplants and

often produce seedlings the next growing season.

There are now over 14,000 of the plants growing on Mt. Washington. Additionally, we were able to introduce more than 150 plants, which have now grown to over 300 individuals, to Franconia Ridge, an area where the plant



Robbins' cinquefoil habitat

occurred historically. The objectives outlined in the recovery plan have essentially been met.

For now, Robbins' cinquefoil seems secure, but the insidious threat of global warming could greatly affect this species in the future. Perched in inhospitable (to us) territory on top of an alpine peak, it will probably not be able to migrate northward in response to warmer temperatures.

William E. Brumback is Conservation Director for the New England Wild Flower Society, headquartered in Framingham, Massachusetts. He can be reached at 508/877-7630 ext. 3201 or bbrumback@newfs.org.

Reintroducing Pitcher's Thistle

by Timothy J. Bell,
Marlin Bowles,
Jenny McBride,
Kayri Havens,
Pati Vitt, and
Kathryn McEachern



Pitcher's thistle was listed as threatened in 1988 because of population decline due to destruction of shoreline sand dune habitat. This species is being restored to the Illinois shoreline of Lake Michigan by planting propagules grown from seeds collected in the wild.

Photos by Marlin Bowles

Opposite page (from top): Restoration planting began in 1991, but flowering and reproduction from natural recruitment did not occur until 1998.

All plants in the restored populations are monitored annually to determine their growth and reproduction.

Although reintroduction has been used as an effective conservation tool for many endangered and threatened animals, most recovery efforts for plant species have focused on population protection and habitat management as the primary recovery objectives. One reason is that, since habitat destruction is one of the leading threats to plants, appropriate habitat for reintroduction is often scarce. Another reason is that the reintroduction of rare plant species is an emerging science that remains in its infancy, and little information is available to guide restoration design or the quantitative analysis of restoration success. Research on the reintroduction of Pitcher's thistle (*Cirsium pitcheri*), a threatened plant, is helping us define and measure success.

Pitcher's thistle is restricted in distribution to the western Great Lakes shoreline, where it inhabits open sand dunes. Individuals of this species reproduce only once, reaching a threshold flowering size after three to eight years, then disperse their seeds and die. As a result, viable populations require frequent recruitment of new seedling cohorts, and population structures are highly variable, depending upon cohort demographic histories and successional stages of vegetation. Because dynamic shoreline processes may cause the elimination of entire populations, this species also appears to depend on gene flow among populations or colonization of new habitats.

Pitcher's thistle was extirpated from the Illinois shoreline of Lake Michigan in the early 1900s. Reintroduction began in former habitat at Illinois Beach State Park in 1991. This park is located 43 miles (70 kilometers) north of Chicago

along the west shoreline of Lake Michigan. It has a 0.9-mile (1.5-km) wide sand deposit with low dunes that extends for more than 12.4 miles (20 km). Secondary dunes were found to replicate appropriate habitat for this species and were free from shoreline erosion and recreational impacts. Two localities separated by less than 0.6 miles (1 km) were used to establish populations north and south of the Dead River, which drains into Lake Michigan. Our goals include creating two viable populations that would be stable or increasing in size and unlikely to go extinct in the next 100 years.

Cirsium pitcheri propagules used for reintroduction were grown from seeds collected from natural thistle populations in Indiana, southern Wisconsin, and southern Michigan. Thistle cohorts were usually propagated for one season, overwintered, and then transplanted at the restoration site. More than 100 plants were established south of the Dead River by 1993, and the first two of these plants flowered in 1994. The first flowering of naturally recruited plants occurred in 1998, and seedlings from these flowering plants are now replacing artificial cohorts. More than 140 naturally recruited seedlings have been observed but, to date, only eight have flowered. The total number of plants shared between both populations has been maintained between 100 and 200 plants, but the population established north of the Dead River is younger and does not yet have naturally recruited seedlings.

The restoration has successfully reached a number of short-term goals. Plants have completed their life cycles and proportions of seed, seedling, juvenile, and flowering plant stages are comparable to a natural population at



the Indiana Dunes National Lakeshore at West Beach (Bell et al. 2003).

To assess the growth rate of the population south of the Dead River, we developed demographic models from monitoring data. For populations that are increasing in size, the rate of population growth (λ) is greater than 1, for stable populations $\lambda = 1$, and for decreasing populations λ is less than 1. The older Illinois Beach restoration has an overall stable population growth rate ($\lambda = 1.03$) that varies from year to year, ranging

from 0.66 to 1.21. These are similar to the values of λ calculated for the natural Indiana Dunes population, which ranged from 0.87 to 1.21. Both the restoration and natural populations have high variation in stage class numbers compared to natural populations of 11 other plant species reviewed by Eric Menges (1998). The high variation indicates that a relatively high population size is required to reduce extinction probability. Encouragingly, the restored population had a year with a very low population growth rate that was followed by a relatively high growth rate the next year, indicating that it has sufficient size to recover from some fluctuations in population size.

Our long-term goal is to create two populations, each with an extinction probability less than 5 percent for the next 100 years. Using the demographic models, we estimated minimum viable population size (MVP) with this extinction probability for *Cirsium pitcheri* to be approximately 500 plants for the Illinois Beach population south of the Dead River. Using this projection for populations north and south of the Dead River, both need to be increased to a viable level of 500 individuals. Matrix models for the Illinois Beach restoration also indicate that at least 150 times as many seeds as seedlings need to be

planted to reach the same establishment goal. Using seeds to establish a population of *Cirsium pitcheri* is the least efficient method of restoration, presumably due to high seed mortality. Therefore, we plan to introduce additional plants over the next several years. We also hope to see natural population expansion into nearby available habitat.

Although some measures of viability indicate that the *Cirsium pitcheri* restoration has been successful, others indicate that long-term persistence of the population is still in doubt. Many additional plants need to be reintroduced to bring the population numbers up to the estimated MVP and to test our models. An estimation of the genetic variability of these populations will also be useful to evaluate the evolutionary potential of this restoration.

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Bringing Back a Fugitive

by Johnny Randall



On a recent visit to Huntington Beach State Park in South Carolina, just south of the heavily developed Myrtle Beach commercial zone, I stumbled upon a seabeach amaranth (*Amaranthus pumilus*) restoration site. While admiring the plants, I felt hope for this rare plant species, which is relegated to a tenuous and widely discontinuous ribbon of beach habitat along the Atlantic coast.

The seabeach amaranth was listed as a threatened species in 1993 and is perhaps the only globally rare member of the typically weedy and economically important amaranth family (Amaranthaceae). It is what ecologists sometimes call a “fugitive” species, one that “flees” from competition and finds new habitats as they become available.

The original recorded range of the seabeach amaranth stretched from Charleston, South Carolina, to Cape Cod, Massachusetts, but it has been reduced to about one-third of this historical distribution. About a decade ago, Weakly and Bucher (1992) indicated that the species had been eliminated from six of the states in its original range and was down to approximately 55 populations: 13 in New York, 34 in North Carolina, and 8 in South Carolina. It has, however, just been rediscovered in New Jersey, and the National Park Service has reestablished the species at Assateague Island National Seashore, which straddles the Maryland/Virginia border. Population numbers continue to increase thanks to the efforts of federal and state agencies, university researchers, botanical gardens, and nonprofit conservation organizations like the Center for Plant Conservation. Thanks also goes to writers like Janet Marinelli, who used her seabeach amaranth forays with botanist Stephen Clemments (both

of the Brooklyn Botanic Garden) as the conceptual basis for her book, *Stalking the Wild Amaranth: Gardening in the Age of Extinction*.

The seabeach amaranth is a profusely branched annual whose crown can reach a meter (39 inches) in diameter. It has fleshy pinkish-red stems and small rounded green, notch-tipped leaves that resemble those of spinach, its cultivated cousin. Seabeach amaranth typically occurs on sparsely vegetated areas such as interdunal flats, overwash flats, lower foredunes, and points of non-eroding beaches. It can, however, also be found on suitable sites within estuaries. It is both vulnerable to, and dependent on, habitat disturbances such as beach erosion, dune movement, and storms, but it is primarily at risk of extinction because of human activities. Unnatural disruptions to its habitat include shoreline hardening structures such as groins, seawalls, and sand fences that cause unnatural rates of beach accretion or erosion; hotel and beach house construction; off-road vehicles; beach grooming and raking; and herbivory by feral animals and webworms.

The profligate production of fruits containing small seeds is a typical adaptation of plants that colonize open coastal habitats that are subject to the actions of wind and water. Weakly and Bucher (1992) observed that the seed

does not fully fill the small bladder-like fruit, an adaptation that promotes buoyancy and allows it to float well in both salt and fresh water. Seeds released from the fruits also float because of an apparent waxy coating.

The annual cycle of hurricanes is probably a major influence on the natural distribution of this species. Blown-out dunes and overwash areas just above the tidal zone create suitable habitat for this pioneering species. Hurricane action can also uncover buried seeds lying dormant and is perhaps the reason for the recurrence of populations after the 1996 hurricanes Fran and Bertha.

The recovery plan for seabeach amaranth calls for the development of habitat models, identification of suitable habitat, and the development of reintroduction methods. Claudia Jolls and her students at East Carolina University are using remote sensing and geographic information systems data to predict suitable habitat locations on Cape Hatteras and Cape Lookout national seashores. The collaboration of Steve Roth, Education Coordinator at Huntington Beach State Park, South Carolina, and Dickie Hamilton of the South Carolina Department of Natural Resources has resulted in several successful reintroduction projects. Roth, in addition to Weakley and Bucher (1992), noticed that numerous shorebirds, including the least tern (*Sterna antillarum*), Wilson's plover (*Charadrius wilsonia*), black skimmer (*Rhynchops niger*), Caspian tern (*Sterna caspia*), and the endangered roseate tern (*Sterna dougallii dougallii*), nest in seabeach amaranth stands.

Population genetics research by Alan Strand and his graduate student, Susan Fox, at the College of Charleston shows

that there is very little genetic diversity among populations from New York to South Carolina. These data have broad implications for restoration activities where local seed sources are not available and for the biogeographic history of the taxon.

At the North Carolina Botanical Garden, we hold approximately 10,000 seeds in the CPC national collection. We originally found this species difficult to germinate, but the work of amaranth expert David Brenner of the Plant Introduction Station at Iowa State University's Department of Agronomy showed that approximately 90 percent synchronized germination occurs after 3 months of cool moist stratification. Brenner curates approximately 3,500 amaranth taxa of all sorts—crops, ornamentals, and wild species.

Seabeach amaranth might seem to be particularly vulnerable to extinction given its low population number, extensive habitat loss, and the ironic nature of its weedy but easily disrupted

life history. But as long as hurricanes blow and coastal sanctuaries exist, there is a chance that this fascinating fugitive species will continue to run from competition while clinging to its capricious niche.

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Opposite page: Seabeach amaranth in its habitat at Huntington Beach State Park

Photos by Steve Roff/Huntington Beach State Park, South Carolina

Right: Seabeach amaranth about to bloom.

Photo by Helen Hamilton/National Park Service

Battlefield Harbors a Rare Tennessee Plant

by Kimberlie McCue and
Andrea Shea



Pyne's ground-plum
Photo by Kim McCue

**Opposite page (from upper left):
Seedlings in Missouri Botanical
Garden greenhouse**
Photo by Vera Alexander

**National Park Service employees and
volunteers transplant Pyne's ground-
plum to glade habitat in Stones River
National Battlefield.**
Photo by Kim McCue

**Newly transplanted seedlings are
tagged and covered with wire mesh
to protect them from herbivores.**
Photo by Kim McCue

*P*yne's ground-plum (*Astragalus bibullatus*) is a rare wildflower endemic to limestone cedar glades in the Central Basin of Tennessee. Last year, this species took a step toward recovery with the establishment of a new population at Stones River National Battlefield in Murfreesboro, Tennessee. Seedlings were transplanted into suitable habitat within the Civil War battlefield in the spring and fall of 2001. The project was made possible by a partnership among the Tennessee Department of Environment and Conservation, Missouri Botanical Garden, U.S. Fish and Wildlife Service, and National Park Service.

Although the first collections of the ground-plum likely took place in the late nineteenth century, nearly 100 years passed before the plant regained attention. Milo (Guthrie) Pyne, a local botanist, rediscovered the unusual plant in 1980 in a cedar glade in Rutherford, Tennessee. In 1984, Edwin Bridges of the Tennessee Heritage Program went to the site and collected specimens, which he sent to Dr. Rupert Barneby at the New York Botanical Garden in 1985. Dr. Barneby accompanied Bridges and Pyne to the site in 1986 to confirm his suspicions that this plant was an undescribed species. The unusual fruit type, a "double bubble" or "bilocular bubble," gave rise to the name *A. bibullatus*. The ground-plum produces showy purplish flowers in early spring, followed by small, plum-shaped, reddish fruits in summer.

Since 1987 when it was scientifically classified, two populations of *A. bibullatus* have been extirpated, one by urban development and the other by a reservoir project. Just four years after its description as a species, *A. bibullatus* was listed as endangered. Today, there is

a grand total of three known wild populations. One is permanently protected by the state and The Nature Conservancy. The other two populations are on privately owned land; one is threatened by development, while the other is being protected by the landowner. For a number of years, the Tennessee Department of Environment and Conservation had hoped to establish a new population of *A. bibullatus* in protected habitat, but the project was delayed because of a lack of plant material. Although seeds of the ground-plum were available, protocols for consistently growing the plants had not been developed.

Coincidentally, the Missouri Botanical Garden (MBG) had begun working on the problem of *A. bibullatus* propagation in the spring of 1999. As a Participating Institution of the Center for Plant Conservation, the Garden not only builds *ex situ* germplasm collections of rare Midwestern plants but also conducts research relevant to the conservation and restoration of these species.

Work with the ground-plum proved challenging. Multiple trials yielded the same results, good seed germination followed by rapid mortality of all seedlings. Perseverance, however, paid off when attempts to mimic the ground-plum's native soil conditions resulted in a 60 percent survival rate for seedlings. The key to propagation appeared to be providing "poor" soil conditions by mixing three parts filter sand with only one part organic material, along with a minimal watering regime. Young *A. bibullatus* do not like to get their feet wet!

With a reliable propagation protocol in hand, MBG entered into a contract with the Tennessee Department of



Environment and Conservation to grow *A. bibullatus* for the purpose of establishing a new population. The Fish and Wildlife Service provided funding for the project. Suitable and secure habitat was found at the Stones River National Battlefield, and the National Park Service agreed to allow the project on the site.

Seeds were collected from all of the remaining populations in June 2000, and propagation of the plants began the following month. Because the environmental conditions on cedar glades, the habitat of *A. bibullatus*, can be harsh and unpredictable, we decided that propagated seedlings would be introduced into the national battlefield at two times during the year, early spring and fall.

The first transplant of ground-plum seedlings took place at the battlefield in March 2001. Two-thirds of the available seedlings were transplanted at that time. Each seedling received a unique number and tag to facilitate monitoring. Seedlings were placed into five glade areas within the battlefield. The remaining one-third of the original seedling cohort was transplanted into the same five glade areas in September 2001.

Members of the Stones River National Battlefield staff began informal monitoring of the seedlings the day after the first transplanting in March. This was fortunate since many of the transplants fell victim to herbivory, presumably by rabbits. In one of the five plots, all of the seedlings were lost. Staff immediately constructed chicken wire exclosures to protect the remaining plants. Formal monitoring of the spring planted seed-



lings began in June 2001. At that time, each individual (or the remaining tag) was observed and recorded as alive or dead. Thirty-three percent of the original transplants had survived. When the sites were again visited in September 2001, only three plants had perished since the June observations. The exclusion of herbivores seemed to play an important role in the survival of the transplants. All seedlings transplanted in September 2001 were immediately enclosed in chicken wire.

The sites will continue to be monitored periodically. We hope that some of the plants will flower in their second season of growth, bringing Pyne's ground-plum that much closer to recovery.

Kimberlie McCue is the Conservation Coordinator of the Missouri Botanical Garden in St. Louis (314-577-9497) and Andrea Shea is the Rare Species Protection Coordinator for the Tennessee Department of Environment and Conservation in Nashville (615-532-0439).



The Search for *Coryphantha ramillosa*

by Kathleen C. Rice



On an early fall morning in 1997 in west Texas, our small group was eating breakfast at the Basin Lodge restaurant in the Chisos Mountains of Big Bend National Park. Surrounded by spectacular views of the limestone cliffs and crags, lush with juniper, pines, and grasses, we watched the pale orange of the early sun angle against the rocks, delicately spotlighting each plant. We had driven down from the Desert Botanical Garden in Phoenix, Arizona, to survey the single known occurrence of a rare cactus at the park. Although we'd visited the site on several previous occasions, we were now intending to set up permanent monitoring transects and establish a species seedbank.

The bunched cory cactus (*Coryphantha ramillosa*) was listed in

1979 as threatened under the Endangered Species Act. Small population numbers, patchy distribution, restricted habitat, and collection were cited as the primary threats. *Coryphantha ramillosa* was discovered in 1936 by A.R. Davis and was described by Ladislaus Cutak in 1942. It is a multi-headed cactus, with stems that can grow up to about 3 inches (7.5 centimeters) in diameter. The flowers are pale pink to deep rose, and the fruits are green and juicy at maturity.

Dr. Ted Anderson led our expedition, assisted by Bob Schmalzel, a research associate, and me. Dr. Anderson had been regularly visiting the Big Bend area since 1953, and he was very active in monitoring rare cacti in Mexico. This lifelong botanist, a professor of botany at Whitman College, Washington, for

decades and a senior research botanist at the Desert Botanical Garden since 1992, had a passion for species of little cacti. Dr. Anderson was internationally renowned for his work on the IOS Cactus Consensus Initiatives and his contributions towards implementation of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, better known as CITES. An accomplished and productive writer, he was most famous for his books, *Plants and People of the Golden Triangle*, *Threatened Cacti of Mexico*, *Peyote: The Divine Cactus*, and *The Cactus Family*, which was published just last year. Bob and I were indeed fortunate to be assisting him in this fieldwork.

That morning at the Basin Lodge restaurant, we discussed the potential

that *C. ramillosa* might occur on nearby private ranches. We speculated wistfully that if only we could gain access to some of these areas, we may be able to make a case for getting this and perhaps another of the area's other cacti delisted. Maybe landowners would then become more open to botanical surveys. A man soon appeared at our table. "My name is Jim Talbot," he said, "and I couldn't help overhearing your conversation. I've had a long-time interest in botany, and think I can help you get onto some of the privately owned land closeby." Talbot was a banker from Sanderson, Texas, who happened to have a B.S. degree in botany. He was excited about being able to help.

We arranged to meet Talbot the following day and, with permission, drive onto some privately owned land. He guided us to the properties, and we all searched at each location for *C. ramillosa* plants. Generally we were able to find them once we had a feeling for the type of sites the plants prefer. The species was surprisingly common in characteristic habitats. We had permission to obtain voucher specimens, and we collected several live plants to be studied and propagated at the Desert Botanical Garden. Seed was collected from each plant for similar purposes. We

documented each location with photographs and took GPS (Global Positioning System) readings to indicate five new sites. The information we gained suggests that populations may extend even farther east than previously believed.

Two permanent transects are now established, and heights and diameters of plants in the study area are measured. Growth rates were formerly estimated by painting the tips of apical spines and noting the location of marked spines as plants increased in size, but now size of plants is measured. Reproductive capacity is assessed by counting flowers and fruits per plant, and numbers of seeds per fruit. Long-term monitoring of *C. ramillosa* is required to determine if there is a link between growth or size and fruit production.

For over a year, we continued regular correspondence with Talbot until we were contacted by Mrs. Talbot in December 1998. She told us of Jim's sudden accidental death by a fall from a ladder. Stunned by this news, we realized what it also meant for our continued chances of exploring for *C. ramillosa* on private land. Since then, we have also lost Dr. Anderson to a sudden death resulting from health complications. Those of us who assisted him are struggling to reformulate ways to



The late Dr. Ted Anderson at one of the *Coryphantha ramillosa* sites.

continue the work without Ted's guidance and contributions. Monitoring and attempts to access unexplored sites are ongoing, but new alliances must be made.

Fresh approaches, incentives, and inventive cooperative agreements will spearhead future attempts to learn more about the wonderfully diverse and unique flora of Texas. In order to personally relate botanical exploration to landowners, the example set forth by Dr. Edward Anderson should be a model for those who follow. An honest, open, friendly approach is essential. Efforts will be further extended by attempting to become accepted into the social network of landowners in a more personal context.

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***Coryphantha ramillosa* in cultivation (opposite page) and in the wild (left).**

Photos by Kathleen C. Rice



Cultivating Partnerships for the Yellow Larkspur

by Holly Forbes



Photo © Robert Potts/California Academy of Sciences

The picturesque coast of California north of San Francisco is the only home for a rare but beautiful wildflower, the yellow larkspur (*Delphinium luteum*). Although the species was probably never widely distributed, several factors, including habitat loss due to quarrying and development, livestock grazing, and overcollecting, have reduced its distribution to two rocky areas within the region's coastal scrub zone. Both of the remaining sites are on privately owned land. This herbaceous perennial was listed as rare under the California Endangered Species Act in 1979 and as endangered under the federal Endangered Species Act in 2000.

The University of California Botanical Garden at Berkeley is a participating institution in the Center for Plant Conservation (CPC). As such, the garden accepted responsibility to work toward the conservation of rare plants in central and northern California. The yellow larkspur was added to the CPC national collection in 1990.

Yellow larkspur makes a spectacular horticultural subject, especially in a rock garden, as long as it is kept dry during the summer for its natural dormancy period. The beautiful flowers are pollinated by hummingbirds. Its attractiveness and the ease of its culture work both for and against its survival in natural habitats. One factor in the decline of the yellow larkspur was overcollecting for the horticultural trade in the 1940s and 1950s. However, plants can be grown easily in cultivation for future reintroductions.

Mrs. Betty Guggolz and her husband Jack, longtime members of the Milo

Baker Chapter of the California Native Plant Society, have been monitoring the two wild populations for over 20 years and growing plants on their property from one of them. Mrs. Guggolz is eager to use plants from her cultivated population to supplement the natural populations and introduce the species into suitable habitat to create another population. The U.C. Botanical Garden, which is growing plants in cultivation from the other wild population, is working with Mrs. Guggolz toward these conservation goals.

Mrs. Guggolz's plans to introduce the yellow larkspur to appropriate habitats and to augment an existing population depended on determining that the *ex situ* (cultivated) populations were not contaminated by hybridization with other larkspur species. This would help satisfy concerns of the California Department of Fish & Game (CDFG) that our end result would meet the strictest of genetic conservation standards.

It was clear that more partners were needed to work on this project. When then-graduate student Jason Koontz* approached me for assistance with his dissertation project on the gypsum-loving larkspur (*Delphinium gypsophilum*), our meeting became a perfect opportunity to get him involved with our efforts to study the yellow larkspur. Diana Hickson and Roxanne Bittman, of the CDFG Plant Conservation Program and Natural Diversity Data Base, respectively, provided a research permit and field assistance. Jason, in collaboration with his major professor, Dr. Pamela Soltis** of Washington State University, designed a protocol to examine the genetic variability of the species and the potential hybrid contamination of the *ex situ* populations. They found that while the two *ex situ* populations have somewhat reduced genetic variability in comparison to one of the natural populations, it wasn't significant enough to bar us from using them in a future introduction effort, nor was there any evidence of hybridization in cultivation.

The results of their study were published in the December 2001 issue of *Conservation Biology* ("Genetic Diversity and Tests of the Hybrid Origin of the Endangered Yellow Larkspur"). The article was dedicated to the memory of Jack Guggolz, who passed away in October 2001.

Local land trusts have expressed support for a reintroduction effort, and we are working with Mrs. Guggolz to survey for potential sites. More information on this species' life history, environmental requirements, pollination biology, and seed dispersal will be needed,

*Dr. Jason Koontz is now a Plant Systematist for the Center for Biodiversity of the Illinois Natural History Survey and an Affiliate Assistant Professor of Plant Biology, University of Illinois at Urbana-Champaign.

**Dr. Pamela Soltis is now a curator at the Florida Museum of Natural History, Gainesville.

however, to promote a successful reintroduction effort.

Holly Forbes is Curator of the University of California Botanical Garden at Berkeley.

University of California, Berkeley, Botanical Garden photo



Collaborative Conservation of the Beach Clustervine

by Cynthia Lane,
Elena Pinto-Torres,
Hannah Thornton, and
Sam Wright

Coasts are areas of overlap—natural interfaces between the well-defined systems of land and sea. Although this mingling of terrestrial and marine habitats makes coastal zones difficult to categorize, it can also encourage a special brand of biological “collaboration.”

In a coastal zone, marine and terrestrial ecosystems interact constantly; they exchange nutrients, modify weather patterns, alter terrain, and support specialized flora and fauna. As with any collaboration, the interface that is a coastal system could not exist without the contributions of each participant.

Following nature’s example, Fairchild Tropical Garden initiated a collaborative effort in 2000 to restore the beach clustervine (*Jacquemontia reclinata*), an endangered plant in the morning glory family (Convolvulaceae), to the coastal dune system of southeastern Florida. This project brings together researchers, horticulturists, restoration ecologists, students, and land managers from different agencies and institutions, including Fairchild Tropical Garden; Broward, Miami-Dade, and Palm Beach counties; City of Boca Raton; and Florida International and Valdosta universities. The team is conducting the research necessary to make informed management decisions, and will work together to plan and construct a network for long-term management. The U.S. Fish and Wildlife Service, Fairchild Tropical Garden, Florida International University Tropical Biology Program, Florida Native Plant Society, and Garden Club of America/Center for Plant Conservation have provided funding.



South Florida’s coastal dunes and the beach clustervine

It is easy to see why the beauty of coastal areas in southern Florida—the rolling, white sands, bright wildflowers, waving grasses, and soothing ocean—have been attractive to so many people. But the popularity of this environment threatens its survival. Intense coastal development and recreational use have drastically reduced the extent of the once contiguous coastal dune ecosystem. Activities associated with human use and development (including beach renourishment, raking, pollution, and sand mining) have further degraded remnant habitats. Additionally, competition with nonnative, invasive species like Brazilian pepper (*Schinus terebinthifolius*) and Australian-pine (*Casuarina* spp.) threatens some native species. As these invasive species

encroach on native shoreline vegetation, they eliminate the open, sunny habitat patches that the beach clustervine and many other native coastal dune plant species require.

Subsequent to habitat loss and degradation, the beach clustervine, a terrestrial vine with small, white flowers and many spreading stems, suffered severe reductions in both numbers and distribution. It was placed on the federal endangered species list in 1993. Currently, about 800 individuals persist in nine sites spread over a 90-mile (144-kilometer) stretch of coastline. Extensive mapping and surveying efforts have revealed that most individuals are located in just two sites, making the beach clustervine especially vulnerable to catastrophic events such as hurricanes and intense fires.



Several of Florida's state-listed endangered species share coastal habitat with the beach clustervine. Populations of the beach peanut (*Okenia hypogonaea*), beach star (*Cyperus pedunculatus*), and wild-lime (*Zanthoxylum coriaceum*) are vulnerable to the same forces threatening the beach clustervine. Although the central goal of this collaboration is recovery of the clustervine, the team is also addressing general restoration and management of coastal dune habitat.

Recovery efforts

To examine several of the processes important for the maintenance of healthy beach clustervine habitat, the team is taking a multifaceted approach to research by:

- coordinating studies to describe associated vegetation, soil characteristics, sand accretion, and salt spray;
- evaluating the effect of foot traffic on the plant and its habitat;
- determining optimal methods and conditions for beach clustervine propagation and seed storage, and evaluating the most effective protocols for outplanting;

- studying the genetic structure of the remnant populations;
- identifying the most successful management techniques for maintaining genetic variation;
- identifying the plant's insect pollinators and determining their role in the plant's reproductive success;
- testing the influence of mycorrhizal fungi on beach clustervine growth and survival; and
- determining various aspects of the species' demography, including the population growth rate.

The team of collaborators gathers annually at planning meetings to exchange information and develop goals for the upcoming year. The meetings have created a forum for land managers and researchers to share knowledge and help direct each other's work. Land managers contribute information about specific opportunities and constraints for habitat management at each site, including the possibility of carrying out prescribed burns, the ability to remove invasive species, the availability of irrigation and other essential equipment, and the numbers of personnel available to implement future management plans. Land managers also provide information

Opposite page (from top): Planting beach clustervine at Bill Baggs Cape Florida State Recreation Area

Photo by Sam Wright

Beach clustervine in bloom

Photo by Hanna Thornton

At left (clockwise from upper left):

Typical beach clustervine dune habitat

Photo by Dena Garvue

There are many threats to clustervine habitat:

1) beach raking, which damages native coastal dune vegetation

Photo by Tony Pernas

2) Development threatens Florida coastal ecosystem

Photo by Sam Wright

3) Nonnative invasive Australian pine (*Casuarina equisetifolia*) displaces native coastal dune vegetation

Photo by Tony Pernas

about site history and current land use. This kind of information, in combination with research findings, is essential for effective management planning.

In our work to recover the beach clustervine, the project team members of Fairchild Tropical Garden, Florida International University, and city, county, and state land management agencies are occupying an area of overlap—the natural interface between the well-defined systems of biological research and natural resource management. Management goals based on research results alone, set with little consideration of actual resources, can be impossible to implement. Teamwork is essential to finding effective management strategies. As in any collaboration, the interface that is this project could not exist without the contributions of every partner.

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Private Property, Public Interest

by Eric M. Winford



The Fish and Wildlife Service would like to recognize and thank Steve and Margaret Cunningham (above), Bud Clayborne, Gary Moore, Pat Rakes, and members of the Barrens Topminnow Working Group for their efforts to recover the Barrens topminnow.

Opposite page: Springs on the Cunningham (left) and Clayborne farms were set aside as habitat for the Barrens topminnow (inset).

USFWS photos

A joke told around farming communities goes something like this: A farmer is hard at work in his field when a man drives up to his house. The farmer goes over to shake the man's hand and see what he wants. The man notices how hard the farmer is working and says he would like to help. Then he identifies himself as a government employee and the farmer turns around and runs away.

Steve and Margaret Cunningham didn't run away when they were approached by representatives of the U.S. Fish and Wildlife Service (FWS) for the possible use of their land. Why? "We're willing to do what's right if people approach us right," Steve says. What is right used to be the operation of their 400-acre (160 hectare) farm in Coffee County, Tennessee, and the 350 head of cattle that live on it. Now it includes the welfare of an extremely rare fish.

The Barrens topminnow (*Fundulus julisia*), recognized by the FWS as a species of management concern, exists only in the headwaters and tributaries of the Duck, Elk, and Caney Fork rivers in the Barrens region of Coffee, Cannon, and Warren counties in Tennessee. It was first identified as a distinct species in 1983 by University of Tennessee professor David Etnier. At that time, it was known to exist in 14 areas, but by 1997, only two sites were known to have viable populations. Both sites are on private property in Coffee County.

The Barrens topminnow is usually found in calm, spring-fed headwaters with water temperatures around 60° F (15° C). This fish uses aquatic vegetation found in the springs as sites to lay its eggs. The increased use of the springs by cattle, the construction of ponds, and

development in the area have all contributed to the deterioration of water quality and the destruction of topminnow habitat. Periodic droughts and increased use of ground water for irrigation have also been linked to the reduction in the number of suitable sites.

"The Barrens topminnow is very rare and we are looking for ways to work cooperatively with private landowners to protect the fish and its habitat," says Brad Bingham, Tennessee Coordinator of the Partners for Fish and Wildlife Program. Bingham works for the FWS in the Cookeville, Tennessee, Ecological Services Field Office.

Private landowners often believe that the presence of a rare species on their property will require costly changes to their land use activities. "Through our efforts with the topminnow and other species, we are trying to eliminate this misconception," Bingham says.

The Cookeville office was already working in the watershed to protect the Cumberland pigtoe mussel (*Pleurobema furvum*), an endangered species, and recognized several possible sites that could provide habitat for the topminnow. Combining resources with the Tennessee Wildlife Resources Agency, the Tennessee Chapter of The Nature Conservancy, and the Natural Resources Conservation Service (NRCS), the team started contacting landowners for potential interest in conserving topminnow habitat. Gary Moore of the NRCS was instrumental in approaching farmers in Coffee County and arranging face-to-face meetings.

The Cunninghams would probably never have worked with the program if Moore had not taken the time to reach them on a personal level. "It wasn't the



program, it was the people we were working with,” Steve says.

Once initial contact was made with the Cunninghams and other farmers in the region, the next step was to show the farmers how their joint interests in the environment could work together. If the springs on their property were to be used for the topminnow, the cattle would have to drink elsewhere. With the help of the FWS and NRCS, tanks were installed at various locations around the Cunningham’s farm.

“If you show farmers that your goals and their goals are the same, a lot of people will do these things,” Steve says. The Cunninghams not only wanted to preserve their farm but also the environment and associated wildlife. “We’re trying to look at everything in a long-term view,” Steve says. Now Margaret is thinking about bringing school classes to the restored site to show children a little slice of nature.

Five other landowners within the watershed have joined in the partnership to establish habitat for the topminnow and improve water quality for the endangered Cumberland pigtoe mussel. One of the other partners is Bud Clayborne. Clayborne raises cattle on the 70-acre (28-hectare) farm that he grew up on near the town of Viola in Coffee County. Memories of his early life on the farm make it special to him. When he volunteered for the topminnow program, he saw an opportunity to recreate the

farm of his childhood. Clayborne remembers drinking water from a spring near his house and decided that the unused spring could be turned back into his water supply.

In the summer of 1998, a severe drought in the region forced Clayborne to water his cattle at the spring. He dug a shallow pool beside the spring to trap and keep water during the drought. In 1999, the FWS saw the possibility of turning Clayborne’s spring and the adjacent pool into topminnow habitat. In return for the use of Clayborne’s property, the FWS paid for a fence to exclude cattle from the spring and installed water tanks for Clayborne’s cattle.

Clayborne was glad to allow the FWS the use of his spring. The cattle now use the water tanks while Clayborne can use the spring for his own water. “It’s pretty much a win-win situation for both of us,” Clayborne says. “To me, it’s help.”

At Clayborne’s property, one of the first springs that the topminnow will be introduced to, the FWS dug three pools of varying depths in order to see what type of habitat the topminnow prefers. To reduce competition for the topminnow, most of the western mosquitofish (*Gambusia affinis*), a non-native species that had been introduced earlier into the spring, were removed. The mosquitofish is the topminnow’s main competitor for food and living space.

In addition to the two populations in the wild, the topminnow is now being

held and bred at Conservation Fisheries, Inc. (CFI), a Knoxville-based non-profit firm that deals with rare fish in the southeast; the Tennessee Aquarium; and the Dale Hollow National Fish Hatchery. In the summer of 2001, Pat Rakes, co-director of CFI, will stock 40 to 50 topminnows in Clayborne’s spring. The FWS hopes to eventually have five viable populations in each of the region’s three river systems. The goal is to establish suitable habitats throughout each watershed to allow the topminnow to migrate from one site to another. After the release of the topminnow into these areas, efforts will be made to monitor the fish to determine the success of the reintroductions.

“We’re hoping that if water quality improves enough, they’ll be able to compete without any help,” Rakes says. The topminnow is a good water-quality indicator, and having the species back in the environment will show that the area is healthy.

It will also prove that private landowners and government agencies can work together to accomplish their common goals.

Eric M. Winford, a journalism major at the University of Tennessee, is a FWS volunteer.

We're Glad to Have Glades

by Kim Mitchell



Photo by Jim Rathert/Missouri Department of Conservation

The Missouri bladderpod (*Lesquerella filiformis*), a beautiful yellow-flowering plant from the open glades of the Ozark mountains, has an impressive story to tell—story of hope for the future of our wild heritage.

Named for its bladder-like seedpods, the Missouri bladderpod was listed in 1987 as an endangered species. At the time, this Ozark endemic was known only from a few glades that were threatened by urban expansion, encroachment by woody vegetation, competition from nonnative species, overgrazing, and possibly overcollecting.

What is a glade? Phyllis Modeland provides a good description on her website (<http://www.runningriver.com/modeland/>). “The word glade comes

from the Old English ‘glad,’ meaning a shining place. In the Ozarks, glades are truly ‘sunlit islands’ in the forest. A parklike bench on a hillside where the bedrock is exposed or nearly so, a glade resembles a miniature prairie perched among the hills. The old-timers referred to a hilltop glade, or ‘knob,’ as a bald, a word that describes the glade’s most recognizable characteristic: treeless and brushless.”

In Missouri, some glades do resemble prairies, with plants that include big and little bluestem, Indian grass, Indian paintbrush, prairie larkspur, purple

coneflower, and blazing stars. Other glades are drier and resemble a bit of the southwestern desert dropped into the middle of the Ozarks. These hot and dry rocky slopes support scorpions, tarantulas, collared lizards, pygmy rattlesnakes, roadrunners, and prickly pear cacti.

Historically, the openness of the glades was a result of frequent burning caused by lightning or fires purposely set by Native Americans.

After the Missouri bladderpod was listed as endangered, the Missouri Department of Conservation (MDOC), The Nature Conservancy, and the U.S. Fish and Wildlife Service joined forces to save the species. Recovery actions centered on protecting and properly managing the glades. The Nature

Conservancy and the MDOC have purchased and permanently protected 400 acres (160 hectares) of glade habitat at 9 sites. They have also developed outreach material and worked one-on-one with landowners on partnerships for managing glades. Research on the ecology and life history of the Missouri bladderpod has provided the necessary data to restore and enhance glade habitats. At the same time, botanists have surveyed for new bladderpod sites and monitored known populations. The species was recently discovered for the first time in Arkansas, and the number of known extant sites rangewide has increased from 11 in 1987 to 64 today.

Although not glitzy or exciting, work to save the Missouri bladderpod has been coordinated and consistent. More important, it’s been successful! Today, we believe the Missouri bladderpod is no longer in imminent danger of extinction, and we expect to propose reclassifying it soon from endangered to the less critical category of threatened. Thanks to the concerted efforts of land owners and federal, state, and private agencies, the Missouri bladderpod should survive for future generations to enjoy. It’s an encouraging story and a lesson for us all as we work to save rare species.

Kim Mitchell is the Endangered Species Information and Outreach Coordinator for the Service’s Twin Cities, Minnesota, Regional Office.

From December 2001 through January 2002, the Fish and Wildlife Service published the following proposed and final Endangered Species Act (ESA) rulemakings in the *Federal Register*.

Emergency Listing

Tumbling Creek Cavesnail (*Antrobia culveri*)

On December 27, under the emergency provisions of the ESA, we gave immediate protection to the Tumbling Creek cavesnail, a unique aquatic snail found only in one cave stream in southwest Missouri. The Tumbling Creek cavesnail's population has declined significantly in recent years, and biologists believe that the species may face imminent extinction. Our action places the cavesnail on the endangered species list for 240 days. During this time, we will evaluate a proposed listing rule, which we also published on December 27; if approved, it would give the species long-term protection under the standard provisions of the ESA.

The Tumbling Creek cavesnail measures only about one-tenth of an inch (2.5 millimeters), is white, and is blind. Tumbling Creek Cave supports a high diversity of species. Several species of invertebrates, previously unknown, have been discovered there, and the cave also hosts colonies of gray bats (*Myotis grisescens*) and Indiana bats (*Myotis sodalis*), both of which are already listed as endangered. The cave itself is privately owned, while the land in the surrounding watershed is in both public and private ownership.

Biologists monitoring cavesnail populations in Tumbling Creek Cave over recent years have noted a sharp decline. The specific cause is unknown, but biologists believe that deteriorated water quality is a likely cause. Species such as the cavesnail that depend on underground water systems are highly vulnerable to changes in water quality and quantity. These underground systems are recharged by water filtering down from the surface, and land-use activities on the surface can affect water quality below. Water entering Tumbling Creek Cave from the land surface around the cave may contain silt or pollutants.

Proposed Listing Rules

Island Fox (*Urocyon littoralis*) Four rare subspecies of the tiny, docile island fox inhabiting four of the Channel Islands off of the southern California coast may receive ESA protection. On December 10, we proposed to list the Santa Cruz Island fox (*U. l. santacruzae*), Santa Rosa Island fox (*U. l. santarosae*), San Miguel Island fox (*U. l. littoralis*), and Santa Catalina Island fox (*U. l. catalinae*) as endangered.

Fox populations on each of the islands, including the three within Channel Islands National Park, have dropped dramatically since 1995. On Santa Cruz Island, the population decreased from 1,300 to fewer than 100 animals. Island foxes on San Miguel and Santa Rosa islands no longer exist in the wild, and captive breeding programs are underway on both islands. Fewer than 200 foxes occur in the wild on Santa Catalina Island and the fox is being bred in captivity. Based on studies conducted as recently as 1999, the four subspecies of Channel Island foxes have a 50 percent chance of extinction over the next five to 10 years.

The primary causes of the decline of these island fox subspecies are predation by golden eagles (*Aquila chrysaetos*), the rapid spread of canine distemper through the Santa Catalina island subspecies, and habitat degradation caused by the introduction of sheep, goats, rabbits, deer, elk, cattle, pigs, and horses.

Biologists speculate that island foxes, which are smaller than house cats, may have gotten to the islands more than 18,000 years ago by floating on debris from the mainland during a storm, earthquake, or other natural event. At that time, when ocean levels were lower, the foxes inhabited one land mass called Santarosae that consisted of what later became San Miguel, Santa Rosa, and Santa Cruz islands. As sea levels rose and the northern Channel Islands separated, each fox population became genetically distinct. Foxes arrived between 2,200 to 3,800 years ago on the southern Channel Islands of Catalina, San Clemente, and San Nicolas, and were likely introduced by Native Americans, who may have kept them as pets.



Island fox

Photo © B. Moose Peterson/WRP

Island foxes are inquisitive and generally show little fear of humans. They are grayish-white and black on the back and dull white on the underbelly. The base of the ears and sides of the neck and limbs are cinnamon-rust colored. As opportunistic foragers, island foxes — the largest native carnivore on the islands — will eat a wide variety of plants and small animals. They live in a wide variety of island habitats. When a female is ready to give birth in the spring, she will find a rock crevice or hollow stump and deliver from one to five pups, which are cared for by both the male and female for several months.

In October 2001, we awarded \$504,000 in grants to the state of California to develop and put into effect a Candidate Conservation Agreement for the Santa Cruz Island fox. This grant will fund recovery actions for the fox that are identified in the state's draft recovery plan for the species. These actions include relocating golden eagles from Santa Cruz Island back to the mainland, undertaking captive breeding of the foxes, monitoring, and tracking causes of mortality. We also provided a \$10,800 grant to fund the development and initial implementation of a Candidate Conservation Agreement for the Santa Catalina Island fox and the island loggerhead shrike.

In addition, we are working in partnership with The Nature Conservancy and the Santa Cruz Predatory Bird Research Group, with a Landowner Incentives Program grant and matching funds from the Conservancy, to provide financial assistance to private property owners who are willing to conserve listed and proposed species. This money has helped fund the removal of golden eagles from the island. We are also investigating the feasibility of reintroducing bald eagles

(*Haliaeetus leucocephalus*), which historically nested on the islands. Bald eagles are territorial and, if reestablished, could keep golden eagles away from the islands. Bald eagles feed primarily on marine mammals and fish and would not be a threat to the foxes. The bald eagle population on the islands was eliminated by DDT poisoning in the early 1960s.

Proposed Delisting Rule

Two Guam Birds On January 25, we proposed to remove two birds native to the Mariana Islands of the western Pacific Ocean from the list of threatened and endangered species, the Mariana mallard (*Anas platyrhynchos oustaleti*) and the Guam broadbill (*Myiagra freycineti*). Both species are now believed to be extinct.



Mariana mallard

Photo by Eugene Kridler/USFWS

The Mariana mallard was known only from the islands of Guam, Tinian, and Saipan. It was probably never abundant due to limited habitat availability; there have never been extensive freshwater marshes or swamps in the Mariana Archipelago. The last confirmed sighting of a Mariana mallard was in 1979. Its reduction in range and eventual extinction has been attributed to habitat loss and hunting, especially during, and immediately after, World War II. After intensive and systematic searches carried out from 1983 through 1989, investigators concluded that the Mariana mallard was extinct.

Like the Mariana mallard, the Guam broadbill also was probably never abundant. As its name

indicates, it was endemic to the island of Guam. By the time the Guam broadbill was listed as endangered in 1984, its population was already critically low. In fact, there have been no confirmed sightings of this bird since 1984. The main cause for its decline was predation by the nonnative brown tree snake (*Boiga irregularis*), which was accidentally introduced to Guam shortly after World War II. This voracious predator has decimated Guam's other native forest birds. The Guam broadbill was presumed by 1985 to be extinct.

Final Listing Rules

Golden Sedge (*Carex lutea*) On January 23, we listed the golden sedge, a perennial in the family Cyperaceae, as an endangered species. This plant has yellowish green, grass-like leaves, and its fertile stems may reach three feet (0.9 meter) or more in height and produce many yellow flowers. Biologists have located only eight populations within coastal savannas in Onslow and Pender counties, North Carolina. Most are small, with three populations composed of fewer than 50 individual plants.

Little of the species' coastal plain habitat remains. Historically, wildfires controlled undergrowth and kept coastal grasslands and surrounding longleaf pine forests relatively open. These fires are suppressed now, making the habitat less favorable for the golden sedge and numerous other species of plants and animals. Drainage ditching, mining, bulldozing, and road-building also have harmed the species in the past, and they continue to pose a threat. Logging, if done with care, does not harm the plants.

Mississippi Gopher Frog (*Rana capito sevosa*)

We gave final protection to the Mississippi gopher frog on December 4 by listing it as an endangered species. Found only at a single site in Mississippi, the Mississippi gopher frog is a distinct population segment of the wider-ranging gopher frog. The Mississippi gopher frog has genetic characteristics that are distinct from those of all other gopher frogs, and is isolated from other populations by 125 miles (200 km) of unoccupied habitat and the Mobile River delta.



Mississippi gopher frog

USFWS photo

The Mississippi gopher frog formerly occurred in the once extensive longleaf pine forests of the lower coastal plain from east of the Mississippi River in Louisiana to the Mobile River delta in Alabama. Today, only about 100 adult frogs remain, all located at one site in the DeSoto National Forest in Harrison County, Mississippi. Biologists believe loss and degradation of habitat is the primary reason the species has declined. Because of the small number of remaining frogs, the population is extremely vulnerable to extinction from natural processes such as drought and floods, and to any additional loss, damage, and fragmentation of its habitat.

Final Reclassification

Large-flowered Skullcap (*Scutellaria montana*) On January 14, we reclassified the large-flowered skullcap, a plant from Georgia and Tennessee, from endangered to the less critical category of threatened.

The skullcap was listed as endangered in 1986. Its upgrade to threatened status is a result of dedicated work by partners including natural resource agencies in Tennessee and Georgia, the Tennessee River Gorge Trust, the University of Tennessee, the Tennessee Aquarium, and the Tennessee Valley Authority. Since 1986, many federal and state agencies and private organizations have searched for, and protected, populations of this plant. The Tennessee Valley Authority annually surveys known populations and conducts searches for additional populations. The National Park Service also monitors populations on its lands. Both the Tennessee and Georgia Natural Heritage

Inventories have conducted surveys that discovered new populations. The Tennessee River Gorge Trust now owns and protects some of the largest populations.

The large-flowered skullcap is a perennial herb that produces a blue and white flower. It is found on rocky, dry slopes, ravines, and stream bottom forests in the Cumberland Plateau of northwestern Georgia and adjacent southeastern Tennessee. The biggest threat to the species continues to be habitat loss and alteration. We will work with our partners to manage known populations and seek new ones.



Large-flowered skullcap
USFWS photo

Critical Habitat Rules

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 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/index.html>) and click on "About Critical Habitat."

Newcomb's Snail (*Erinna newcombi*) We proposed on January 28 to designate segments of nine streams and tributaries on the Hawaiian island of Kaua'i as critical habitat for the Newcomb's snail, a freshwater snail listed as a threatened species. The segments proposed for protection total 16.3 miles (26.3 km) in length and are located at mid-elevation valleys in relatively remote areas. The proposed critical habitat areas are found largely on state land already managed for conservation purposes.

Although biologists estimate that between 6,000 and 7,000 Newcomb's snails exist on Kaua'i, more than 90 percent of the snails are found in two populations in small areas along the Kalalau Stream and Lumahai River. This makes these animals very susceptible to catastrophic events such as hurricanes, landslides, and invasions of



Newcomb's snail critical habitat
USFWS photo

nonnative predators, including snails, flies, fish, and frogs. Habitat loss and degradation through water diversion and well drilling are suspected to have caused the historical decline of the snail.

O'ahu 'Elepaio (*Chasiempis sandwichensis ibidis*) On December 10, we designated approximately 65,880 acres (26,660 ha) of critical habitat on the Hawaiian island of O'ahu for the en-
















O'ahu 'elepaio critical habitat.
USFWS photo

dangered O'ahu 'elepaio, a forest bird once considered the most common native land bird on the island. The five designated areas are concentrated in the Wai'anae and Ko'olau mountains.

Today, an estimated 1,982 O'ahu 'elepaios exist in scattered locations, with their current range less than 4 percent of their original range. The five critical habitat units include almost all of the currently occupied land and enough unoccupied historical habitat to support a self-sustaining population. The designated areas approximate the species' distribution in 1975, when extensive surveys showed that 'elepaio populations were larger and less isolated.

BOX SCORE

Listings and Recovery Plans as of August 31, 2002

GROUP	ENDANGERED		THREATENED		TOTAL LISTINGS	U.S. SPECIES W/ PLANS
	U.S.	FOREIGN	U.S.	FOREIGN		
 MAMMALS	65	251	9	17	342	53
 BIRDS	78	175	14	6	273	75
 REPTILES	14	64	22	15	115	32
 AMPHIBIANS	12	8	9	1	30	13
 FISHES	71	11	44	0	126	94
 SNAILS	21	1	11	0	33	21
 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	388	516	129	39	1,072	390
 FLOWERING PLANTS	569	1	144	0	714	566
 CONIFERS	2	0	1	2	5	2
 FERNS AND OTHERS	26	0	2	0	28	28
PLANT SUBTOTAL	597	1	147	2	747	596
GRAND TOTAL	985	517	276	41	1,819*	986

TOTAL U.S. ENDANGERED: 985 (388 animals, 597 plants)

TOTAL U.S. THREATENED: 276 (129 animals, 147 plants)

TOTAL U.S. LISTED: 1,261 (517 animals**, 744 plants)

* Separate populations of a species listed both as Endangered and Threatened are tallied once, for the endangered population only. Those species are the argali, chimpanzee, leopard, Stellar sea lion, gray wolf, piping plover, roseate

tern, green sea turtle, saltwater crocodile, and olive ridley sea turtle. For the purposes of the Endangered Species Act, the term "species" can mean a species, subspecies, or distinct vertebrate population. Several entries also represent entire genera or even families.

** 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*

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