

ENDANGERED
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The Year of the Frog

The Association of Zoos & Aquariums in North America, the world's other professional zoo and aquarium associations, other conservation organizations, and government agencies have joined in a global effort to save imperiled amphibians. To raise global awareness of the plight of frogs, other amphibians, and activities to conserve vulnerable species, these partners have named 2008 as "The Year of the Frog."

The Year of the Frog



ENDANGERED *Species* BULLETIN

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The Panamanian golden frog (cover) and the Mississippi dusky gopher frog (opposite page), both of which are imperiled with extinction, illustrate the dangers facing many of the world's amphibian species.
photos © Michael Redmer

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The Bulletin welcomes manuscripts on a wide range of topics related to endangered species. We are particularly interested in news about recovery actions and conservation partnerships.

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The Global Amphibian Crisis

by Paul Boyle and Shelly Grow

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A crisis of enormous proportions faces the world's amphibian species. At present, we estimate that about one-third of the more than 6,000 known amphibian species are at risk of extinction. This likely underestimates the real number since data are lacking on many species from Africa, Southeast Asia, and other regions. Several causes underlie this massive decline, but a crucial element is the very nature of amphibians; their skin must always be moist and it literally breathes, so they are especially vulnerable to environmental contaminants. Habitat destruction, disease, pollution, climate change, and other expanding human-related impacts have an entire class of the animal kingdom in serious decline.

Frogs hold great cultural significance. They figured prominently in ancient Egyptian and Greek mythology, as well as more recent folklore. Today's well-known

character Kermit the Frog, whose motto is "It isn't easy being green," may have had an early premonition of the crisis frogs face today. Frogs were traditionally used for studying anatomy, physiology, neurobiology, and pharmacology, and were used globally in the 20th century for pregnancy tests. Today, as we see amphibian species in serious decline, frogs are like the "canary in the coal mine" – a class of animals more sensitive than most, potentially signaling an impending environmental calamity.

The severe decline of amphibians occurring today can be compared with the mass extinction of dinosaurs 65 million years ago. Yet, while most people know of the sudden disappearance of dinosaurs, few remember that when the dinosaurs disappeared, almost 70 percent of the other species on Earth disappeared with them. There could be truth in the notion of amphibians as an early indicator

*The Mississippi distinct population segment of the dusky gopher frog (*Rana capito sevosa*) is listed as endangered.*



© Michael Redner

of environmental chaos. However, unlike the demise of dinosaurs, many of the impacts that threaten amphibians are of human origin.

The most serious threat to amphibians is habitat loss and widespread habitat fragmentation. Loss of rainforest and other crucial habitats to agricultural and other human development is devastating habitats crucial to amphibian survival worldwide. Pollution from mine drainage, pesticides, fertilizers, and other organic compounds is present in every earthly ecosystem. Amphibians are particularly susceptible to the effects of organic molecules since their skin is so much more permeable than that of other animals. A disease caused by the pathogenic fungus *Batrachochytrium dendrobatidis* is spreading undaunted, with few amphibian species showing resistance. The chytrid disease typically results in mass die-offs where often more than 50 percent of amphibian species are extirpated within six months, while other species persist with relatively minor reductions. Meanwhile, amphibians are also affected by harvesting for food and the pet trade, predation, and invasive introduced species.



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The flatwoods salamander (Ambystoma cingulatum) is a threatened amphibian native to parts of the U.S. lower southeastern Coastal Plain.

What is Being Done?

The Amphibian Specialist Group of the World Conservation Union (IUCN), the World Association of Zoos and Aquariums, and IUCN's Conservation Breeding Specialist Group have formed a partnership called the Amphibian Ark.



The Oregon spotted frog (Rana pretiosa) is a candidate for listing under the Endangered Species Act.



Dana Payne



Peruvian stubfoot harlequin frog (*Atelopus peruensis*). Described as new to science in 1985, this species underwent massive declines in the 1990s, and is now possibly extinct.

The mission of the Amphibian Ark is ambitious: “working in partnerships to ensure the global survival of amphibians, focusing on those that cannot be safeguarded in nature.” As explained on its Web site (www.amphibianark.org), it coordinates *ex-situ* (off-site or captive-breeding) programs by partners around the world, along with efforts to protect or restore species in their natural habitats. The Association of Zoos & Aquariums (AZA) in North America and the world’s other professional zoo and aquarium associations have joined in this massive effort, working in partnership with other conservation organizations to save imperiled amphibians.

In one of the largest collaborations of its kind, these organizations have called for a global effort to save amphibians and have named 2008, a leap year, as “The

2008 | YEAR OF THE FROG

Year of the Frog.” The Year of the Frog is a global awareness and fundraising campaign to support long-term amphibian conservation and to change the human behaviors that threaten amphibians.

Zoos and aquariums offer unique expertise to the Amphibian Ark effort because of their history of successfully managing captive populations of animals. They also have broad experience with reintroducing captive-bred animals into the wild, translocating animals for conservation purposes, and developing the infrastructure and facilities required to safely quarantine, breed, and maintain amphibian populations for the long term.

This special issue of the *Endangered Species Bulletin* shares some examples of what zoos and aquariums, the Fish and Wildlife Service, and other agencies and organizations are doing, and plan to do over the next several years, to fight the loss of amphibians. We seek to engage as many partners in the effort as possible and to target hotspots where amphibian extinction is on the rise. We are also working to increase both the physical infrastructure required to conserve amphibians in captive populations, through which the living genetic stock of imperiled species can be saved while conditions in the wild are improved, and the professional capacity to keep these precious representatives of the amphibian world safe for future generations.

Like its professional counterparts around the world, the AZA is working

to expand the capacity of its 219 accredited member institutions to respond vigorously to amphibian declines locally, regionally, and around the world. We also seek to support the efforts of government conservation agencies in responding to the global amphibian crisis. All of this work aims to build strong partnerships, increase the professional and structural capacity for saving amphibians, and ensure the success of this crucial worldwide effort.

Dr. Paul Boyle is Senior Vice President for Conservation at the AZA, where he leads its animal conservation and conservation education programs. Shelly Grow (SGrow@aza.org; 301-562-0777) is a conservation biologist with AZA focusing on increasing the capacity and the diversity of partnerships for responding to the amphibian crisis. The AZA is headquartered at 8403 Colesville Road, Suite 710, Silver Spring, Maryland 20910.

Project Golden Frog

by Vicky Poole



The brilliantly colored golden frogs native to the cloud forests of Panama are culturally significant to the people of that nation, as revered as the bald eagle is in the United States. They have long been considered lucky by Panamanians, who commonly use figurines and live frogs to promote hotels and restaurants.

Panamanian golden frogs (*Atelopus zeteki*), or PGF's, have been recognized as a distinct species from the similar-looking harlequin frog (*Atelopus varius*) based on a unique skin toxin, zetekitoxin, and bioacoustical differences. In addition to

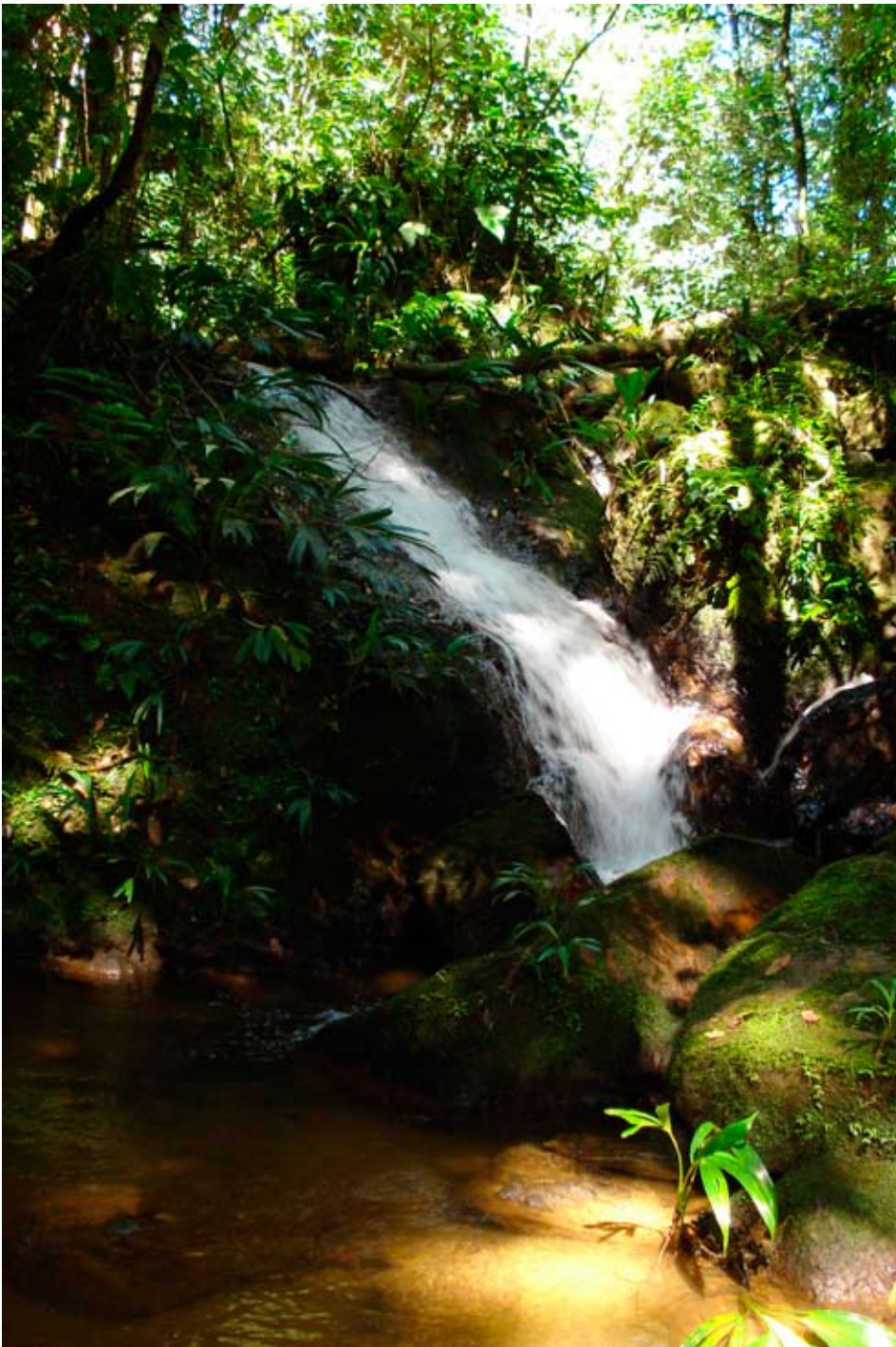
vocalizing, PGF's communicate by "semaphoring," a limb-waving behavior that may have evolved to allow these frogs to locate others near waterfalls for breeding, where loud background noise renders their gentle vocalizations inaudible.

A. zeteki has been listed in Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) since 1975 and as endangered (as *A. varius zeteki*) under the U.S. Endangered Species Act (ESA) since 1976. Factors affecting golden frog populations include collecting for



John Kast

Two golden frogs in amplexus, a form of sexual reproduction seen in frogs wherein the male grasps the female from behind and externally fertilizes the eggs as they are deposited.



Paul Crump/Houston Zoo, Inc.

The “semaphoring” behavior golden frogs use near waterfalls may allow them to locate other individuals for mating.

Panamanian zoos and hotels, as well as for the illegal pet trade; deforestation; and stream sedimentation resulting from logging and farming. An even greater threat is the amphibian disease chytridiomycosis, which is caused by the pathogenic fungus *Batrachochytrium dendrobatidis*. This disease was first observed in the mountains of central Costa Rica, where it may have caused the extinction of the golden toad (*Bufo*

periglens). It has since advanced southeastward through the cooler mid- to high-elevation mountain forests of Central America, decimating entire populations of amphibians. As of 2007, the disease in Panama was documented as far eastward as El Valle de Anton, the type locality (the location from where the first described specimen was collected) of *A. zeteki*, raising the odds that both golden frog species may soon be extinct in the wild.

In response to the impending chytrid crisis, a group of concerned biologists convened in 1998 to form Project Golden Frog/Proyecto Rana Dorada (PGF/PRD), a conservation consortium involving numerous Panamanian and U.S. institutions. The primary goals of PGF/PRD are to preserve the golden frog by establishing a captive breeding colony and to use the attractive frog as a flagship species for spotlighting general amphibian decline issues. Specific initiatives of PGF/PRD include field studies, captive management, education, and financial support of other related efforts. PGF/PRD field studies have led to natural history information, genetics research, and population monitoring, all of which has also benefitted the management of golden frogs in captivity (Lindquist, et al., 2007; Zippel et al., 2007).

As the first step, *ex situ* populations of both golden frog species were established in zoos and aquariums in the U.S. and Canada. To ensure genetic viability, permits were first obtained in 1998 from Autoridad Nacional del Ambiente de Panamá (ANAM) to collect and export specimens from unprotected remnant populations outside two national parks where these frogs occur. Since 2001, 20 pairs of adults and more than 70 juvenile golden frogs have been collected and imported under two CITES/ESA permits issued to the Maryland Zoo in Baltimore (formerly the Baltimore Zoo) and the Cleveland Metroparks Zoo. As a result of breeding at 10 Association of Zoos and Aquariums (AZA) institutions, including significant successes at the Detroit Zoological Gardens and the two facilities

permitted to collect and import the frogs, there are now more than 2,000 captive-bred golden frogs in breeding groups at almost 50 institutions in the U.S. and Canada. Breeding recommendations and specimen placement for both species are coordinated by the Population Manager at the Maryland Zoo in Baltimore. A regional studbook is maintained for three distinct populations of golden frogs to track genetic relatedness. (Due to permit restrictions, individuals of *A. zeteki* are available only to AZA-accredited institutions.)

Project Golden Frog uses a variety of strategies to inform the public and educate herpetologists. The bilingual Web site www.projectgoldenfrog.org offers information about the species, the project, and captive husbandry. Through U.S. and local students and zoo/aquarium personnel, PGF/PRD offers opportunities for training in applied field techniques in Panama. The 2003 national educators' conference in Panama featured a golden frog conservation workshop for school teachers, where classroom curricula developed by the PGF/PRD education specialist at SeaWorld-Orlando was distributed. Golden frog graphics have been created and installed at two zoos in Panama, and brochures warning about chytrid fungus, and explaining techniques for disinfecting field gear and equipment, have been posted in areas where the fungus was found as a means to help minimize the disease's spread.

Although most PGF/PRD personnel costs have been underwritten by many AZA institutions and universities in the U.S. and Panama, members have obtained more than 20 grants to fund specific field and education program needs. These included the acquisition of a designated field vehicle, which sports the color and pattern of the golden frog to help foster public awareness. With the decline of golden frogs in Panama, PGF/PRD has also become a granting program, using golden frog fundraising surplus to offer awards to other related frog initiatives under the umbrella of the Atelopus Conservation Trust (ACT).



Paul Crump/Houston Zoo, Inc.

A lone Panamanian golden frog in habitat.

Once captive husbandry techniques for golden frogs were established by AZA institutions in the U.S., PGF/PRD recognized the need to develop a facility in Panama that could replicate the project's efforts for golden frogs and house "insurance" colonies of 12 other critical endemic amphibians impacted by the chytrid fungus. The Houston Zoo committed to building and staffing this much-needed facility, which will serve as a center for rescue, quarantine, treatment, and public education. Construction of the El Valle Amphibian Conservation Center (EVACC), situated on the grounds of the small, private El Nispero Zoo in the village of El Valle de Anton, was completed in 2007.

Beginning in the summer of 2006, zoo and aquarium personnel and volunteers from around the world have come together in El Valle to collect amphibians for EVACC. They tested and treated all specimens they collected for chytrid. The golden frogs at EVACC will be included in the studbook along with the U.S. specimens so that genetic diversity can be maximized throughout the entire *ex situ* population. The long-term goal is to cre-



Paul Crump/Houston Zoo, Inc.

The El Valle Amphibian Conservation Center in Panama is a center for rescue, treatment, research, and conservation.

ate a zoo population from which golden frogs can be returned to the wild if all *in situ* (wild) populations become extinct and when the chytrid fungus is no longer a threat to these species. We estimate this goal to be 5 to 10 years away. EVACC is a potential site for staging reintroductions prior to release and/or establishing in-country breeding pairs from which offspring can be used. Current research by the Cleveland Metroparks Zoo and Mount Union College in Ohio on the development of chytrid-resistant bloodlines of golden frogs, which would be based on antimicrobial skin peptides, may also prove valuable to any repatriation efforts.

Although many organizations and individuals have contributed to the golden frog program achievements listed above, the cooperation between U.S. and Panamanian government agencies and personnel has been vital to success. We hope that the communication and cooperation among program coordinators and government agencies can serve as a model for developing responses to

the continuing crisis of global amphibian declines.

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Chiricahua Leopard Frog Inches Towards Recovery

by Jim Rorabaugh, Melissa Kreutzian,
Mike Sredl, Charlie Painter, Roberto
Aguilar, Juan Carlos Bravo, and
Carter Kruse

Recovery – it is the most important part of endangered species conservation. For most species, considerable funding and staff resources are needed to overcome years of population declines and habitat degradation. Despite the limited resources available, and with a lot of help from our friends and partners, such as state wildlife agencies, federal land managers, ranchers and other private landowners, Turner Enterprises, Phelps Dodge Corporation, the Phoenix Zoo, Arizona-Sonora Desert Museum, the Fort Worth Zoo, Nature Conservancy, Sky Island Alliance, and universities, we have put together a recovery program for the threatened Chiricahua leopard frog (*Lithobates chiricahuensis*). To augment the scarce funds available for recovery activities, we have engaged the Fish and Wildlife Service's Partners for Fish and Wildlife Program (see the story on page 36) and applied for grants from foundations. We and our very dedicated host of partners are slowly making progress towards the recovery of this species.

The Chiricahua leopard frog is a large, often green, spotted frog that historically was common in the mountains and high valleys of central and southeastern Arizona, west-central and southwestern New Mexico, and southward in the Sierra Madre Occidental and associated sky islands of northeastern Sonora and western Chihuahua, Mexico. We know of 469 historical localities. Declines were first noted in the early to mid-1970s, and today the species is only known to exist at about 41 localities in Arizona and 30 to 35 locali-

ties in New Mexico. Its status in Mexico is poorly known, but Chiricahua leopard frogs have declined to some extent there as well. The Mexican government lists it as *amenazada* (threatened).

The causes of the decline are not always clear, and several interacting factors are often at play, but experts on the Chiricahua leopard frog generally agree that predation by introduced species (especially American bullfrogs, sport fishes, and crayfish) and an apparently introduced fungal skin disease (chytridiomycosis) that is killing frogs and toads around the globe are the leading causes.

A Chiricahua leopard frog from the Pajarito Mountains in Arizona near the Mexican border.



Jim Rorabaugh

Other problems, such as loss and degradation of wetlands, recent catastrophic wildfires, drought, and contaminants, have contributed to the decline.

The Chiricahua Leopard Frog Recovery Plan was completed in early 2007. It was developed in an open process with a technical team that provided top-notch scientific expertise, while three stakeholder groups kept the process grounded in the social, economic, and nuts-and-bolts realities of achieving recovery on the ground. Key elements include protecting the remaining populations and habitats, establishing new populations, monitoring progress, research, public outreach, and adaptive management.

The primary threats – introduced predators and chytridiomycosis – are not easily addressed. We can control predators at small sites, but eliminating them from large, complex systems is often impossible with current technology. Except for taking precautions not to spread the disease ourselves, we are only beginning to understand how we might deal with chytridiomycosis. Some frog populations are persisting with the disease, especially at warmer and lower sites, and they could provide key insights into how to manage the disease. We are looking into several questions: are the frogs developing resistance to the disease, are there environmental factors allowing their persistence, or both? We

Duke Klein (Forest Service biologist), at left, and Mike Sredl (Arizona Game and Fish Department) build pond habitat for Chiricahua leopard frogs in the Tonto National Forest, Arizona.



Jim Rorabaugh

have experimented with eliminating the disease from habitats but are a long way from solving that problem. Our strategy for now has been to try to maintain the remaining populations and begin reestablishing populations and improving habitats in places where introduced predators and disease are absent or manageable. These reintroductions typically involve collecting egg masses from the wild, hatching the eggs and head-starting tadpoles at the Phoenix Zoo or other facilities, and releasing late-stage tadpoles or metamorph frogs. Limited wild-to-wild movements of egg masses and frogs, as well as captive propagation, have also been employed. We have honed our techniques and protocols over the past 12 years (see Tara Sprankle's following article), and most reestablishments now successfully result in breeding populations.

These recovery actions have been facilitated by 1) a special rule under section 4(d) of the Endangered Species Act that allows incidental take of frogs resulting from operation and maintenance of livestock waters on non-federal lands, 2) Safe Harbor Agreements with the Arizona Game and Fish Department and the Malpai Borderlands Group (a progressive group of conservation ranchers), and 3) programmatic grazing consultations with involved federal agencies on public lands. The 4(d) rule and Safe Harbor Agreements help us build trust with ranchers and private landowners, while the programmatic consultations provide a framework within which we can move forward on recovery with the Forest Service, Bureau of Land Management, and livestock grazing permittees. Artificial water sources developed for cattle have become important habitats for Chiricahua leopard frogs, so tools that help us work in partnership with ranchers are critical to recovery.

On Ted Turner's Ladder Ranch in New Mexico and at a high school in Douglas, Arizona, captive propagation and head-starting facilities are under construction. Thanks to the Arizona Game and Fish Department, Tonto

National Forest, and Phoenix Zoo, aggressive efforts to restore habitats and reestablish populations are rebuilding a metapopulation (a group of spatially separated populations that exchange individuals through immigration and emigration) of Chiricahua leopard frogs near Young, Arizona. Meanwhile, the Phoenix Zoo and the Arizona-Sonora

Combining outreach and recovery, students and their parents from Sierra Vista, Arizona, assist in a release of frogs that were head started at the Phoenix Zoo.



Jim Florabaugh



Elizabeth Slown

Anna Slown (left) and Hannah Jacobsen (right) model the Chiricahua leopard frog tattoo that was produced for outreach about this threatened amphibian.

Desert Museum near Tucson are cautiously breeding the last remaining frogs from the Coconino National Forest and the Santa Rita Mountains in Arizona for reestablishment at multiple sites. Major habitat restoration programs underway at two sites in southeastern Arizona and one in the bootheel of New Mexico will benefit Chiricahua leopard frogs and other imperiled wetland species. We are also working with Mexican partners to build capacity for amphibian conservation in northwestern Mexico. In August 2008, we will hold a workshop at a private reserve in northern Sonora owned by Naturalia (a Mexican conservation group) to instruct Mexican biologists on survey protocols and techniques for captive husbandry, propagation, and headstarting of amphibians.

Restoring an imperiled species is not an easy process, but with hard work from many partners, we are beginning to see how the Chiricahua leopard frog might one day be secure again. Recovery is still a distant destination, but the journey has begun.

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Giving Leopard Frogs a Head Start

by Tara Sprankle

Despite being one of the most arid states, Arizona is home to a wide variety of amphibians. There are 25 native species as well as a few introduced species. Unfortunately, populations of many of our native amphibians have declined dramatically. The primary threats include disease (chytridiomycosis, a fungal infection attacking amphibians around the world), habitat loss and fragmentation, and introduced predators such as bullfrogs, several crayfish species, and non-native sport fish. Because of these threats, all six species of Arizona's native leopard frogs are protected by the state

and one, the Chiricahua leopard frog (*Lithobates chiricahuensis*), is also listed at the federal level as threatened.

The Phoenix Zoo has been working with state and federal agencies and private groups for over 10 years to recover several species of native leopard frogs. These partnerships began in the late 1990s when native leopard frogs were experiencing dramatic declines. Some populations had dwindled to fewer than 100 animals.

Because of high mortality rates in the wild for eggs and small tadpoles, we decided to collect egg masses from the

Chiricahua leopard frog



Tara Sprankle

wild and rear them to large tadpoles or small frogs, life stages that provide a greater chance of survival when reintroduced. In the wild, only about five percent or fewer of the eggs in a mass survive to metamorphosis. In captivity, we have gone well beyond that and have had over 90 percent of an egg mass survive to be released as froglets or late-stage tadpoles. Releasing a large number of animals back into a site greatly increases the chance that more will survive to adulthood and reproduce. In the small, isolated populations in Arizona, releasing a large number of individuals at one time also helps ensure that the “founding population” contains as much genetic diversity as possible.

To that end, the zoo constructed the Montane Anuran Conservation Center as a temporary rearing facility for native amphibians. It was built from two insulated cargo carriers that were outfitted with air conditioning units, full spectrum lighting, and aquaculture tubs for rearing large numbers of tadpoles. The facility worked well for many years despite its limited amount of space. Recently, we have begun using a new system that uses smaller polycarbonate boxes stacked on shelves. These lower density containers allow us to more closely monitor the health of individual animals and make minor adjustments to captive conditions.

Our head-start planning cycle begins prior to the start of the field season. At

that time, the recovery teams identify donor and recipient sites for release of head-started individuals. Once the breeding season begins, volunteers and state and federal biologists monitor donor sites for breeding and spawning activity. Once they find an egg mass, they notify the zoo. Whole or partial egg masses are transported to the zoo and set up in a tank to hatch. Zoo staff then raise the tadpoles until they become large tadpoles or small metamorphs, at which time they are released back into the wild. Between 1995 and 2007, the zoo head-started over 7,000 tadpoles and frogs! This year, we will move into a new facility built on the zoo grounds called the Native Species Conservation Center (NSCC). The pur-

Staff from the Phoenix Zoo and the Forest Service release captive-produced frogs into the wild.



Tara Sprankle

pose of the NSCC is to head-start native Arizona species for release as well as to provide short-term housing for populations or individuals in jeopardy. The facility will also educate the public about local and global conservation issues. Moving into the NSCC will give us more space and flexibility as well as allow us to work with multiple populations of frogs at the same time.

Since 2001, some populations of the Chiricahua leopard frog have recovered enough that hundreds of egg masses have been laid in the wild. This increase allows us to shift towards the more natural approach of supplementing current populations by translocating wild egg masses or tadpoles rather than only releasing head-started captive stock. The number of ponds where Chiricahua leopard frogs

have become or are becoming established has increased four-fold. This project is a great example of how various government agencies and private groups can work together to help stabilize a declining population.

Although the Phoenix Zoo's primary contributions to southwestern frog conservation have been head-starting of egg masses, developing and improving captive husbandry techniques, and captively rearing frogs, members of the zoo staff have also participated in population surveys, habitat restoration, and presentations to educate the public about the plight of amphibians. In 2008, we plan to bring back the Tadpole Taskforce, a group of volunteers used in the early 1990s to help with the daily care of the tadpoles. Their help was invaluable, and

it gave interested people a way to become directly involved with conservation. We hope that the zoo's continued efforts will make a difference in the survival of the Chiricahua leopard frog as well as Arizona's other native amphibians.

Tara Sprankle (tsprankle@thephoenixzoo.com) is the senior keeper for reptiles at the Phoenix Zoo.

Chiricahua leopard frogs hatching at the Phoenix Zoo



Tara Sprankle

Building Conservation Partnerships with Zoos

by Diane Barber

More than 143 million people visit Association of Zoos and Aquariums (AZA) accredited facilities every year, a number greater than the combined attendance at all professional sports events in this country. Recent studies show that after a visit to a zoo or aquarium, people often think about their role in environmental problems and begin to see themselves as part of the solution. These facts make zoos and aquariums capable of reaching millions of people who desire to connect with animals in a positive manner.

AZA institutions have been directly involved in developing and implementing hundreds of recovery programs for threatened and endangered species

around the globe. The recovery program for the Puerto Rican crested toad (*Peltophryne lemur*) is an example of one such program, and it exemplifies how zoos and aquariums can directly contribute to amphibian conservation and become effective partners with local and regional agencies.

The Puerto Rican crested toad, which is easily distinguished by its unique head crest, is the only toad native to Puerto Rico. Individuals spend most of their lives underground in moist caverns of karst limestone and are rarely seen throughout the hot, dry months of the year. Habitat loss and competition from introduced species, including the marine toad (*Bufo marinus*), are the major causes for the toad's decline and led to its listing as a threatened species in 1987 by the U.S. Fish and Wildlife Service. In 2004, the Puerto Rican crested toad was also listed by the IUCN (World Conservation Union) as a critically endangered species. Although distinct northern and southern populations of crested toads existed as recently as 1992, the last remaining wild population is located in an ephemeral pool precariously close to the ocean. The site, located in the Guanica Commonwealth Forest, doubles as a parking lot during the busy summer season.

The Puerto Rican Crested Toad Species Survival Plan (SSP), the first amphibian SSP created by the AZA, has been active for more than 25 years. Strong partnerships for the recovery of this species have been formed among 21 zoos and aquariums in the United States,

Puerto Rican crested toad



John Kast

Canada, the United Kingdom, and Puerto Rico; the Fish and Wildlife Service; the Puerto Rico Department of Natural and Ecological Resources (DNER); the University of Puerto Rico; the Puerto Rican National Park Company at Juan Rivero Zoo; Iniciativa Herpetológica, Inc.; and Citizens of the Karst.

Recovery efforts are directed through a Memorandum of Understanding among the Service, the DNER and the AZA, and are coordinated through the Puerto Rican Crested Toad Recovery Plan and the Population and Habitat Viability Analysis Working Group. Recovery group members and other biologists meet annually in Puerto Rico to share new information. Creation of new ponds to support six self-sustaining metapopulations of reintroduced animals (three in the north and three in the south), expansion of ecological research, protection and restoration of existing habitat, and island-wide educational outreach are primary conservation goals.

A reintroduction program is a large part of the recovery plan. Between 1987 and 2007, more than 100,000 tadpoles from zoos and aquariums in the U.S. and

Canada were released in Puerto Rico. Although captive breeding and reintroduction efforts by zoos and aquariums have been identified as major components of recovery efforts, the SSP has contributed to the program in many other ways throughout the years. Partner zoos and aquariums continue to offer the services and expertise of their geneticists, reproductive physiologists, veterinarians, pathologists, endocrinologists, nutritionists, statisticians, education specialists, and biologists to conduct research, raise funds, and garner community support for the recovery of the crested toad and its karst habitat.

Zoos and aquariums represent a tremendous untapped potential in long-term recovery programs for amphibian species. This is not meant to downplay the critically important roles of the Service and other agencies in recovery efforts. Involvement and commitment from local universities, zoos, private individuals and government agencies are vital to the recovery of the Puerto Rican crested toad and other threatened and endangered amphibians. These partnerships are the reason for the success of the program

and will outlive the individuals currently involved in the Puerto Rican crested toad recovery effort.

When developing new amphibian conservation programs, consider reaching out to local AZA facilities to see what types of resources they have to offer. For more information regarding amphibian conservation programs, we invite you to visit www.aza.org/ConScience/Amphibians_Intro/. To learn more about the Puerto Rican crested toad program, go to www.crestedtoadssp.org.

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Puerto Rican Crested Toad Recovery Group partners releasing tadpoles in Guanica Commonwealth Forest.



Eduardo Valdes

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Conserving Missouri's Hellbenders

by Jeff Ettl



Fon Goellner



Mark Wanner

Upper photo: Ozark hellbender
Lower photo: A simulated stream used in hellbender breeding efforts

The hellbender (*Cryptobranchus alleganiensis*) is the largest species of salamander native to North America. It is represented by two subspecies, the eastern hellbender (*C. a. alleganiensis*), which ranges from southern New York state south to northern Georgia and west to Missouri, and the Ozark hellbender (*C. a. bishopi*), which occurs only in south-central Missouri and adjacent north-central Arkansas. (For more on the Ozark subspecies, see the following article.) Missouri is the only state where both subspecies occur. These salamanders are perfectly adapted for spring-fed stream and river habitats with their flattened head and body, short stout legs, long rudder-like tail, and tiny eyes.

Over the last 30 years, biologists have collected extensive data on the Missouri populations of both the eastern and Ozark hellbenders. These studies indicate that there has been an approximately 80 percent decline in the hellbender population, with a major shift in the age structure to one composed of larger, older animals. The lack of young in these populations indicates either reproductive failure or high mortality of juvenile hellbenders. In addition, researchers have been finding increasing numbers of adult hellbenders with missing toes, limbs, and eyes as well as open lesions and tumors. At present, we know of no single cause for the observed decline, although habitat alteration resulting from dams, gravel mining, and increased recreational use appears to play a significant role. In addition, chemical contamination, other types of water quality problems, disease, and illegal collection have contributed to the decline.

In 2006, at the request of the Saint Louis Zoo, the Conservation Breeding Specialist Group (part of the Species Survival Commission of the World Conservation Union (IUCN), facilitated a workshop that produced a population and habitat viability assessment for the Ozark and eastern hellbenders. The workshop was hosted by the Saint Louis Zoo and attended by 30 invited individuals. The participants worked to explore threats to hellbender populations and develop management actions to halt the hellbender's precipitous decline. Workshop participants developed recommendations addressing biological and human-induced threats, land use issues, and captive reproduction. Their final report was published in early 2007.

The aging population of hellbenders in Missouri and the strong shift in age structure over the years highlight the need for more information on the general health of adult hellbenders and the lack of young age classes. With funding from the Saint Louis Zoo's Field Research for Conservation program, Dr. Yue-Wern Huang and colleagues at the University of Missouri – Rolla have provided preliminary information on hematology and serum chemistry, reproductive hormones, and chemical and nutrient assessments. Their research produced insight as to the next steps needed to help recover hellbenders in Missouri. Investigating and understanding health conditions, reproductive hormones, and heavy metals in hellbenders is important in assessing if this aging population can successfully reproduce in the wild, and in determining the feasibility of capturing wild specimens for long-term propagation efforts.

Representatives from the Saint Louis Zoo's Ron Goellner Center for Hellbender Conservation, Missouri Department of Conservation, U.S. Fish and Wildlife Service, Wonders of Wildlife, and several universities have joined forces to form the Ozark Hellbender Working Group (OHWG), which is focused on learning more about the causes of the hellbender's decline and finding a way to conserve the species. The OHWG has launched a number of research projects that range from evaluating the health of free-ranging hellbenders to measuring the effects of native and non-native fish on larval hellbenders. In 2008, in collaboration with the University of Missouri – Columbia and the Missouri Department of Conservation, 40 juvenile Ozark hellbenders being head-started at the Saint Louis Zoo will be outfitted with radio-transmitters and released at the site where the eggs were collected in south-central Missouri. This project will help to assess the feasibility of augmenting wild populations with the release of captive-raised specimens.

In addition to intensive *in situ* (on site, or in the wild) research, the OHWG is developing a captive breeding program. Hellbenders raised at zoos and/or fish hatcheries could be used for research or to replenish wild stocks. We believe it is possible that without artificial propagation, the hellbender may not survive in Missouri.

The Saint Louis Zoo has constructed a facility in the basement of the Charles H. Hoessle Herpetarium to work towards propagating hellbenders in captivity (a feat that has not yet been achieved in any zoological institution) and to serve as a holding area for rearing juvenile hellbenders. The room features a 32-foot (9.7-meter) long simulated stream that houses eight adult Ozark hellbenders, the nucleus of our potential breeding group. Three large aquarium rack systems with separate life support systems are used for rearing young hellbenders. On October 13, 2007, a female laid a clutch of 150 to 200 Ozark hellbender eggs in our simulated stream. We believe that this



Karen Goellner

Saint Louis Zoo and Missouri Department of Conservation staff collecting data on wild hellbenders.

represents the first time eggs have been laid in captivity using only environmental cycling (seasonal fluctuations in photoperiod, water temperature, etc.). Although the males did not fertilize the eggs, this is a major milestone in the Saint Louis Zoo's efforts to captive reproduce hellbenders.

The hellbender's decline may provide a key indication of the region's ecological health, which supports not only wildlife but all Missourians. Our collective effort to address this problem is designed to ensure the future of a native species, but

it may also help chart a more conscientious course for the management of Missouri's other natural resources.

Jeff Ettling (314-646-4827) is the Curator of Herpetology at the Saint Louis Zoo.

An aquarium rack system used for rearing juvenile hellbenders.



Mark Wanner

by Jill Utrup and Kim Mitchell

The Ozark Hellbender: Out from Under a Rock

What lurks below the clear waters of Ozark streams? Well, it's not pretty, but it is pretty cool. The Ozark hellbender (*Cryptobranchus alleganiensis bishopi*), which can reach a length of about 2 feet (0.6 meters), is one of the largest salamanders in the world.

These strictly aquatic salamanders are found only in Ozark streams of southern Missouri and northern Arkansas. Most of their life is spent beneath rocks in fast-

flowing streams. They come out from under their rocks at night to eat crayfish and in the fall to mate. It takes them 5 to 8 years to reach sexual maturity, and they live 25 to 30 years in the wild (55 years in captivity). Males and females may prey upon their own and others' eggs.

With numerous threats to these amphibians and their habitat, Ozark hellbenders are declining in numbers throughout their range. Because of the

The Ozark hellbender is one of the largest salamanders in the world.



Jill Utrup/USFWS



Jill Utrup/USFWS

hellbender's long lifespan, it took some time before researchers recognized the rapidity of the decline. Even in areas that until recently were thought to have healthy, stable populations, numbers have plummeted. Particularly disconcerting is the fact that most populations have only older individuals. The lack of juveniles indicates that there has been little to no reproduction for several years.

What happened? The Ozark area is famous for its beauty and fast, clear rivers, which are fun to canoe, kayak, and fish. But that clear water and pretty scenery can be deceiving. The story of the Ozark hellbender's decline is an all too familiar one – increased siltation, water quality degradation, and increased impoundments.

To add insult to injury, the highly infectious chytrid fungus is proving fatal to an ever-increasing number of amphibians throughout the world. Over 75 percent of hellbender deaths that occurred in the St. Louis Zoo's captive population from March 2006 through April 2007 were due to this disease. This prompted the testing of Missouri's wild Ozark hellbenders.

The results showed that the chytrid fungus was present in all remaining populations of the Ozark hellbender in Missouri. Testing continued in Missouri during the 2007 field season and began in Arkansas. Researchers view chytrid as one of the most, if not the most, challenging threat to the survival of this subspecies, whose population size is estimated at no more than 590 individuals.

Additionally, abnormalities in Ozark hellbenders are becoming increasingly more severe. Although these abnormalities have not been linked conclusively with the presence of chytrid, considering that the types of abnormalities documented (e.g., lesions, digit and appendage loss, epidermal sloughing) are similar to the symptoms of the chytrid fungus, it is possible that there is a connection.

In 2001, the Ozark hellbender was designated a candidate for Endangered Species Act protection. Even though this subspecies is on a path to extinction, with the current budget situation and listing backlog, it is not likely to be considered for listing under the Act within the next few years.

There is hope for the Ozark hellbender, however, because conservation efforts have already begun. A group of dedicated professionals formed the Ozark Hellbender Working Group shortly after the species became a listing candidate. Original members were researchers and agency personnel with common interests in hellbender conservation. Staff from hatcheries, zoos, and other interested parties later joined. The group has collaborated on field work and initiated research projects, including studies to determine the primary threats. It is also developing a comprehensive conservation strategy that will include a captive propagation protocol, an outreach strategy, and a watershed protection plan.

Growing interest in the species' status has spurred the establishment of biennial Hellbender Conservation Symposiums. Three have been held so far, with the first in 2003 and the latest in 2007. They provide opportunities for conservationists to share information and discuss topics such as status and distribution reports, current research, captive breeding programs, survey and monitoring protocols and techniques,



and other efforts. Focused research and collaboration between researchers and natural resource managers are necessary to reverse the decline of hellbender populations, and the symposiums are a perfect venue for kick-starting that collaboration.

Several ongoing research projects are directed at learning how best to decrease threats and increase hellbender survival in the wild and in captivity. Researchers at the University of Missouri-Rolla are evaluating overall health conditions, reproductive hormones, and contaminants present in adult and juvenile hellbenders through hematology and serum chemistry work. Survival and movements of resident adult and released captive-reared hellbenders are being studied by researchers from the University of Missouri (Columbia) and Missouri Department of Conservation. The Missouri Department of Conservation

and the St. Louis Zoo have been collaborating in developing a propagation protocol for the Ozark subspecies (see the preceding article).

Missouri protects hellbenders by requiring a permit for their collection, and in 2003 the state listed the hellbender as endangered. As part of the public outreach program, there are now signs throughout the range of the hellbender alerting recreationists that hellbenders are harmless and should be left alone or released unharmed if caught by anglers.

The recovery of aquatic species is particularly challenging because the threats are usually difficult to identify and address. The Ozark hellbender's situation is also a sign of the times in endangered species conservation, as global threats such as climate change add to local environmental problems. Conservationists are rising to these

challenges by looking beyond agency and geographical boundaries to collaborate and share resources, make the most of limited dollars, and persevere.

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Conserving Columbia Spotted Frogs in Nevada

by Chad Mellison

Columbia spotted frogs (*Rana luteiventris*) in the Great Basin of Nevada have been a candidate for Endangered Species Act protection since 1993. Most populations in this region are small and highly fragmented, and are highly vulnerable to changes in their environment. Development of water sources, poor grazing practices, certain mining activities, and the introduction of non-native species have contributed to habitat degradation and fragmentation. Emerging fungal diseases such as chytridiomycosis and the spread of parasites also threaten some populations, as do the effects of climate change (such as drought) and random events like wildfires. The potential for listing the Columbia spotted frog as a threatened or endangered species prompted an array of interests to develop a multi-party

conservation agreement and strategy in order to make listing unnecessary.

Columbia spotted frogs are found at scattered locations from southeast Alaska down through British Columbia, eastern Washington and Oregon, as well as in northern Idaho, Montana, Wyoming, Utah, and Nevada. In Nevada, populations occur in three distinct areas: the Toiyabe Mountain Range in Nye County (Toiyabe subpopulation), the Ruby Mountain and Jarbidge-Independence Ranges in Elko County (Northeast subpopulation), and the Deep Creek drainage in White Pine County, Nevada, and Toole County, Utah (West Desert population). The West Desert population is managed by the Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service's Utah Fish and Wildlife Office.

Columbia spotted frogs are closely associated with clear, slow-moving or ponded surface waters with little shade and relatively constant water temperatures. Reproducing populations occur in habitats characterized by springs, floating vegetation, and larger bodies of pooled water (e.g., oxbows, lakes, stock ponds, beaver-created ponds, seeps in wet meadows, backwaters). In colder portions of their range, Columbia spotted frogs will use areas where water does not freeze, such as spring heads and undercut streambanks with overhanging vegetation. Females usually lay egg masses in the warmest areas of a pond, typically in shallow water, and clutch sizes vary in size from 150 to 2,400 eggs. Successful egg production and metamorphosis into adult frogs are susceptible to habitat variables such as temperature, depth and

A Columbian spotted frog using its newly created habitat.



Jim Harvey/Humboldt-Toiyabe National Forest

pH of water, the amount of cover, and the presence of predators.

Adult Columbia spotted frogs measure 2 to 3 inches (5 to 8 centimeters) from snout to vent, with females being larger than males. They are light brown, dark brown, or gray dorsally, with small spots. Ventral coloration can differ among populations and may range from yellow to salmon; however, very young individuals

may have very pale, almost white ventral surfaces. The head may have a dark mask with a light stripe on the upper jaw, and the eyes are turned slightly upward. Male frogs have swollen thumbs with darkened bases.

Conservation Agreement and Strategy

A 10-year Conservation Agreement and Strategy (CAS) was signed in September 2003 for both the Northeast and the Toiyabe subpopulations of the Columbia spotted frog in Nevada. Signatories included the Bureau of Land Management, Nevada Department of Wildlife, Nevada Natural Heritage Program, Nye County, U.S. Fish and Wildlife Service, U.S. Forest Service, and the University of Nevada - Cooperative Extension. The partners agreed to conduct inventories to establish distribution and abundance, assess threats, maintain legal protection for the frog, implement conservation actions identified in the agreement, conduct research to support conservation of the species, and increase public awareness of, and appreciation for, the Columbia spotted frog.

The conservation agreements and strategies identify actions that federal, state, and local agencies will take to reduce threats, improve degraded habitat, and restore natural functions associated with riparian systems. While directly improving frog habitat, these actions will also benefit other aquatic species and improve natural hydrological functions.

By the end of 2007, 8 percent of the tasks listed in the Northeast CAS were completed and an additional 74 percent of the tasks had been initiated at some level. Additionally, 22 percent of the identified tasks listed in the Toiyabe Mountains CAS were completed and an additional 68 percent of the tasks had been initiated at some level. For example, the availability of adequate habitat was identified as a limiting factor for the Toiyabe Mountains subpopulation. In response, a habitat enhancement project completed in the fall of 2004 included the construction or improvement of 22 ponds in Indian Valley Creek. A variety of designs were used to

*Upper photo: Construction of Horseshoe Pond begins.
Lower photo: Horseshoe Pond after completion.*



Chad Mellison/USFWS



Chad Mellison/USFWS



Chad Mellison/USFWS



Chad Mellison/USFWS

Upper Photo: Newly created pond habitats can be seen in this valley on Warners Ranch. Lower photo: Columbia spotted frogs are already benefitting from the new ponds.

create breeding, rearing, and over-wintering habitat. Biologists are monitoring the effectiveness of this habitat enhancement project.

Since the CASs were signed, annual egg mass surveys have been conducted and mark-recapture surveys have been performed during the summer. These surveys are a collaborative effort of all signatories to the agreements. Data gathered during the annual surveys will be used to track population trends, assess threats, determine the effectiveness of habitat restoration projects, and provide

information on survival, growth, and movement of Columbia spotted frogs in the Great Basin. If the agreements are successful, it may become unnecessary to list these frogs as threatened or endangered.

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by Ashley Bradley

A Leap Forward for the Mountain Yellow-Legged Frog

Fifty years ago, mountain yellow-legged frogs (*Rana muscosa*) basked along the rocky banks of creeks and lakes in the mountains of California and Nevada. But scientists around the world have noticed sharp declines in amphibians, and the mountain yellow-legged frog is no exception. Fewer than 200 adults of this critically imperiled species remain in three southern California mountain ranges. In 2002, the Fish and Wildlife Service listed the southern California “distinct population segment” (DPS) as endangered. The Service considers the only other DPS, which inhabits the Sierra Nevada of California and Nevada, a candidate for listing.

It appears that a “perfect storm” of factors – including chytrid fungus outbreaks, habitat destruction, water pollution, and global climate change – is hastening the range-wide decline of the mountain yellow-legged frog. On top of that, the frog must contend with predation by non-native trout that were introduced into mountain waters for recreational fishing.

A multi-disciplinary team involving the U.S. Fish and Wildlife Service, California Department of Fish and Game, U.S. Forest Service, U.S. Geological Survey (USGS), and San Diego Zoo is working to restore the mountain yellow-legged frog. Research biologist Robert Fisher of the USGS Western Ecological Research Center and his team first stepped in to take population surveys around southern California, including San Diego County, and they became concerned about continued declines of mountain yellow-legged frogs. The southern California fires in late 2003 raised a final red flag; Fisher knew that flows of fire-related debris would degrade mountain waterways. He and representatives of other agencies charged with protecting the frogs thought it was important to establish a captive breeding population. The team collected 11 tadpoles from the wild, and 7 later morphed into frogs.

In February 2006, the San Diego Zoo received the frogs, which Research Coordinator Jeff Lemm and his team hoped to breed and then release into the wild. But when the frogs arrived, they were affected by chytrid fungus, bacteria, and calcium absorption issues. The stress

Mountain yellow-legged frog



©Jeff M. Lemm

of the move and the disease were too much, and the frogs died.

In mid-August 2006, Fisher's survey team rescued tadpoles from a streambed in the San Jacinto Mountains that was certain to become dry. Sixty-two are now metamorphosed frogs. Lemm had a second chance to raise, breed, and hopefully reintroduce the mountain yellow-legged frog.

The San Diego Zoo has 10 tanks for frogs at various stages in their life cycle. In addition to ultraviolet (UV) lights to simulate night and day, it regulates water and air temperatures in each tank through chillers, filters, and a UV sterilizer. The tadpole tanks hold 50 gallons (189 liters) and the sub-adult tanks hold 100 gallons (378 l). Lemm and research assistant Frank Santana monitor water quality daily, checking for ammonia, nitrates, nitrites, pH, and water hardness. The USGS provides habitat information so the system can be set to what's most natural, including water quality, pH, and temperature.

In the tanks holding the froglets, lights are set to the winter cycle, and the water level is set so that they can be in or out of the water. They have rocks and plants, as in their native environment. In the breeding tanks, the water and light levels are also set to winter, with 8 hours of simulated sunlight and water temperatures close to 50 degrees Fahrenheit (10 degrees Celsius). During the spring and summer, the water level in the breeding tanks is lowered to simulate the breeding season, when the frogs typically lay eggs under rocks or behind small waterfalls. There is also a spotlight to simulate the strong sunshine they'd receive in the wild.

While these frogs can take up to three years to metamorphose in the wild, including spending the winter under a layer of ice in mountain pools, the San Diego Zoo's frogs live in an environment free of predation, with an abundance of crickets and worms to speed their growth. The 39 sub-adults are showing signs of mating, although there has not yet been any successful breeding.

"However, they still have a lot of growing to do before they reach their full adult size," says Santana. "We are hopeful that we will have some fertilized eggs by this summer."

From the initial rescue efforts, the team hoped that at least 16 frogs would survive to adulthood. They've exceeded that with a survival rate of about 90 percent, an overwhelming success. Now that the program is raising a larger colony than anticipated, the San Diego Zoo is looking for help from other breeding programs with appropriate facilities. Despite things going right the second time around, Lemm is constantly concerned that something could go wrong, from over-chilling the tank to a change in the water source to a chemical that wasn't quite right. "It wouldn't be so stressful if these weren't the last of the last."

This program is aligned with the conservation mission of the San Diego Zoo by "working to save a species in the wild, through the synergy of field biologists and our researchers here," says Dr. Ron Swaisgood of the Zoo's Applied Conservation Division. "This capacity building is a critical component of our increased focus on developing a larger conservation program in our own backyard, by adding species that are important in southern California."

In our own backyards, or rather our local mountain ranges, the mountain-yellow-legged frog team is bringing a species back from the brink of extinction.

Ashley Bradley was a science writer at the San Diego Zoo until leaving for a new position.

Research Coordinator Jeff Lemm tests the water quality in a breeding tank. The successful breeding of mountain yellow-legged frogs requires close monitoring to replicate and maintain conditions similar to those in the wild.



© Jeff M. Lemm



© Jeff M. Lemm

A mountain yellow-legged frog feeding on phoenix worms.

by Kate Symonds

Ranchers Restore Amphibian-friendly Ponds

East of the San Francisco Bay area, in the arid hills of California's inland Coast Ranges, ponds have become magnets for wildlife, large and small. Two small but notable inhabitants of these ponds are the California red-legged frog (*Rana draytonii*) and California

tiger salamander (*Ambystoma californiense*). Both species are federally listed as threatened amphibians and are endemic to California, where they have adapted to seasonal and historic changes in their habitat.

The California tiger salamander, marked by a striking black-and-yellow pattern, spends all but a few months

California red-legged frog



USFWS

each year in the uplands, deep in rodent burrows. When enough rain falls, they emerge from the uplands and sometimes travel as far as 2 miles (3.2 kilometers) to seek breeding ponds.

California red-legged frogs are the largest native frog in the western United States and are believed to be the inspiration for Mark Twain's short story, "The Celebrated Jumping Frog of Calaveras County." They breed in ponds and creeks with slow-moving water, and remain there year-round. They will, however, travel up to 3.2 miles (5.1 km) in search of a moist shelter.

Livestock ponds

The Alameda County Resource Conservation District (RCD) estimates that nearly all of the 650 ponds in eastern Alameda were created by cattle ranchers prior to the 1960s. As natural streams and freshwater wetlands were lost to intensive agricultural practices and development, tiger salamanders and red-legged frogs have increasingly come to rely on livestock ponds for breeding habitat. Ponds also provide breeding habitat for other amphibians, including the Pacific tree frog (*Hyla regilla*) and western toad (*Bufo boreas*), as well as habitat for mammals, reptiles, and birds.

Not all livestock ponds provide favorable conditions for amphibians. Some are small and dry out before amphibian breeding cycles are complete. Others are large and retain water year round, but support non-native predators such as warm water fishes and bullfrogs. Many ponds, having reached the end of their usefulness for livestock, are filling in with sediment and have become choked with cattails, while others have spillways and berms that are eroding or have washed out altogether.

Livestock pond repair projects can require permits from up to six regulatory agencies. The rising costs to obtain environmental permits and repair livestock ponds to current standards often cause ranchers to abandon the ponds in favor of less expensive options, such as installing

solar power pumps, tanks, and troughs. With natural habitat reduced, allowing livestock ponds to fail could have serious consequences for the future of California tiger salamanders and red-legged frogs, as well as for many other pond-dependent species.

Ranchers and pond restoration

Several Alameda ranchers have become interested in pond restoration because they continue to value the ponds as an important part of the landscape and recognize their value to wildlife. In the past year, the Alameda County RCD and the federal Natural Resources Conservation Service (NRCS) have been working with regulatory agencies to develop a coordinated permit-streamlining program for pond restorations. Ranchers now have "one-stop shopping" to obtain permits and funding for pond projects and other rangeland projects. The Fish and Wildlife Service's permit incorporates a wildlife-friendly pond design and describes management measures such as keeping ponds free of fish and bullfrogs, protecting ground squirrel burrows as aestivation (a period of inactivity during summer months) habitat for salamanders and frogs, and continuing managed grazing, as well as measures to reduce impacts to listed species during pond repair projects.

Safe Harbor Agreement

To help alleviate ranchers' concerns that restoring amphibian-friendly livestock ponds may increase their regulatory burden under the Endangered Species Act (ESA), the Service has worked with the RCD, NRCS, and Environmental Defense to issue one of its first programmatic Safe Harbor Agreements. Ranchers who participate in this program have assurances they will incur no extra regulatory obligations under the ESA if they restore and maintain ponds and surrounding uplands in a way that benefits the red-legged frog and the tiger salamander.

Service assistance

To help offset the ranchers' costs of paying for pond-repair projects, the Service's Sacramento Fish and Wildlife Office is providing technical and cost-share assistance to the RCD through the Endangered Species Recovery Program, the Partners for Fish and Wildlife Program, and the Private Stewardship Grant Program. Funding is also provided by the NRCS, California Coastal Conservancy, and National Fish and Wildlife Foundation. To date, eight livestock ponds have been restored, and several more restorations are planned for 2008 and beyond.

The support for pond restoration underscores the importance of rangeland habitats to the recovery of imperiled amphibians and many species of plants, invertebrates, reptiles, birds, and mammals in California.

Kate Symonds is a fish and wildlife biologist with the Service's Sacramento Fish and Wildlife Office, Santa Rosa duty station, and can be reached at 707-578-8515 or kate_symonds@fws.gov.



The restored Alameda Sweet Pond.

Kate Symonds

by Della K. Snyder-Velto

Moving Quickly Saves a Breeding Season

On December 7, 2006, Robert Fisher of the U.S. Geological Survey (USGS) notified me of a biological emergency at San Francisquito Canyon in the Angeles National Forest. Several pools created there by the U.S. Forest Service (USFS) to assist in the recovery of the California red-legged frog (*Rana aurora draytonii*) had filled with sediment, eliminating breeding habitat for the rare frogs.

San Francisquito Canyon, located approximately 30 miles (48 kilometers) north of Los Angeles, is the only known site in the Angeles National Forest occupied by the California red-legged frog. We know of no other healthy population from this site south to the Mexican border. Biologists from the USGS have been monitoring the frogs in the canyon since the population's discovery there in 1999.

A California red-legged frog tadpole



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San Francisquito Canyon has experienced dramatic habitat alteration resulting from a combination of fire in 2002, debris flows (2003, 2004, 2005), and flooding in 2005. These changes, together with the introduction of exotic predators and some continuing illegal take by people with a taste for frog legs, reduced the frog's population in San Francisquito Canyon from 300 to 400 individuals in 1999 to fewer than 10 in 2006.

In 2002 and 2004, the USFS created artificial breeding pools within the frog's habitat. The pools proved to be a great success in both years. Nearly all of the breeding at the site occurred within the artificial pools. In 2005, however, sediment from floods filled all the artificial pools except one, which was successful in 2004 with eight egg masses but had become filled with sediment later that same year.

Our data show that this population of frogs breeds between December and February each year. Therefore, it was critical that new breeding pools within the canyon be excavated immediately to secure the 2006-2007 breeding season. Since it was less than three weeks before Christmas, we faced the daunting challenge of getting this urgent project done with limited staff, time, and funding.

Before digging could begin, both agencies had to overcome a number of regulatory and non-regulatory obstacles that included amending the USGS recovery permit, completing National Environmental Policy Act compliance, writing a Biological Assessment, completing an informal inter-agency consultation, consulting with the Army Corps of Engineers, satisfying the forest hydrologist and implementing his Best Management Practices, determining the best locations for the artificial pools, securing funding, hiring a backhoe operator, digging the pools, and, finally, getting a badly stuck and sinking backhoe out of a rapidly filling pool!

Due to the extraordinary cooperation among the Service, USGS, and USFS, we were able to create four new pools in the canyon by December 28, 2006 -- before



Della K. Snyder-Velto

Heavy equipment helped in restoring the frog habitat.

the rains started and the breeding season began. The largest pool produced four red-legged frog egg masses during the 2007 breeding season. The USGS, USFS, and the Ventura Fish and Wildlife Office are continuing our cooperative partnership to promote the recovery of the California red-legged frog in San Francisquito Canyon.

Della K. Snyder-Velto, a fish and wildlife biologist in the Service's Ventura Fish and Wildlife Office, can be reached at 626-574-5254 or della_snyder-velto@fws.gov.

Evaluating Amphibian Abnormalities on Wildlife Refuges

by Christina Lydick

In 1995, a group of middle school students in Minnesota discovered large numbers of frogs with misshapen, extra, or missing limbs. Their find focused national attention and concern on amphibian abnormalities. In recent years, scientists have observed an increasing number of frogs and toads with severe abnormalities throughout the United States and other parts of the world. Researchers are addressing the problem in many ways, including conducting surveys and studies in both the field and laboratory. Several federal agencies also are involved, including the U.S. Fish and Wildlife Service, which benefits from the scientific expertise provided by its Environmental Contaminants (EC) program.

The Service helps to conserve habitat through the National Wildlife Refuge System, the world's largest and most diverse collection of lands set aside specifically for wildlife conservation. To ensure the health of these habitats, Service EC specialists monitor the effects of contamination on fish and wildlife. Many amphibian species are sensitive to a variety of environmental stressors and may serve as early indicators of environmental health. The Service is interested in determining to what extent abnormal frogs occur on national wildlife refuges and investigating the potential causes.

What is the Difference Between Malformation and Deformity?

Many people use the phrases abnormality, malformation, and deformity

interchangeably. For our purposes, we define abnormality as missing, extra, or unusual body parts based on field observations. A malformation occurs when something goes wrong during developmental stages, causing an organ or body part to form improperly. A deformity occurs when a body part that already exists becomes disfigured.

The potential causes of amphibian abnormalities include the following: 1) climate change (e.g., increased ultraviolet-B light due to ozone depletion, acid rain, drought); 2) predators (e.g., fish, bullfrogs, invertebrates); 3) pathogens (e.g., parasites, bacteria, fungi, viruses); and 4) chemical contaminants (e.g., pesticides, heavy metals, fertilizer). Many scientists believe frog abnormalities have a number of possible causes. In some areas, more than one factor may be causing the abnormalities. It is also possible that the cause(s) may differ from one area to another.

Have We Found Frog Abnormalities on Refuges?

Due to the especially high incidences of frog abnormalities reported in Minnesota and Vermont, the Service's Northeast and Midwest Regions began assessments in 1997 to document the extent of abnormal frogs on national wildlife refuges. The Service's EC and refuge biologists found abnormal frogs on several refuges in both regions. In 1999, the Northeast Region conducted a second set of assessments and discovered abnormal frogs on nine of its refuges. In 2000, the Service expanded its efforts

A malformed northern leopard frog (Lithobates pipiens)



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to refuges nationwide. The objectives of this program are to 1) determine if refuges have sites with a high frequency of abnormal frogs, 2) evaluate whether abnormality frequencies at a site are consistent within a season and among years, and 3) investigate possible causes of the abnormalities. As of December 2006, 137 refuges in 46 states were monitored at least once for abnormal frogs, and many refuges have been visited more than once. The Service has found abnormal frogs on refuges in all of its regions.

Although our nationwide assessment continues, we have already found abnormal frogs at greater than expected frequencies at some sites. We also have found that the presence of abnormal frogs on refuges varies. Abnormality frequencies have varied among years, between refuges, between ponds on individual refuges, and even within a single pond over the course of one sampling season. These differences may be due to normal fluctuations in amphibian populations, changing levels of environmental stressors, or some combination.

In addition to our field assessments, we have provided abnormal frogs to

other researchers for additional diagnostic evaluations. Researchers from the U.S. Geological Survey's National Wildlife Health Center and from Indiana University have examined and radiographed some of our abnormal frogs in an attempt to differentiate between deformities and malformations. We also have worked with parasitologists from the University of Wisconsin-La Crosse and the University of Colorado.

What Will the Service Do with the Information?

Data in the scientific literature suggest that abnormalities in amphibians normally occur at low frequencies (zero to two percent) in wild populations. Therefore, the Service set three percent as the abnormality frequency at which we would consider additional sampling for this project.

As of December 2006, 58 refuges had a frequency of three percent or more abnormal frogs in at least one pond during at least one sampling period, and several refuges had three percent or more abnormal frogs for at least two sampling seasons. The Service is considering these



Robin McWilliams-Munson

This northern leopard frog exhibits polymelia (extra limb).

refuges for more intensive field studies as part of our continuing abnormal amphibian efforts. EC biologists have already conducted investigations at refuges in New Hampshire, New Jersey, and Alaska. Other government, educational, and private institutions around the U.S. and abroad are conducting additional laboratory and field studies. As scientists make cause and effect linkages, refuge managers can take action to mitigate the effects of their management practices on amphibians and other wildlife. If data indicate that land use practices on private property adjoining refuges are the likely cause of amphibian abnormalities, the Service will work closely with the landowners to help determine whether there are other cost-effective and efficient remedies available.

For more information on amphibian abnormalities and declines, we invite you to visit the Service's amphibian Web site at www.fws.gov/contaminants/Issues/Amphibians.cfm.

Christina Lydick (christina_lydick@fws.gov; 703-358-1782), a biologist in the Division of Environmental Quality in Arlington, Virginia, is the national coordinator for the Service's abnormal amphibian surveys.

Refuge bio-technician Jon Krapfl catches a frog at Horicon National Wildlife Refuge in Wisconsin.



Robin McWilliams-Munson

by Joe Milmo

Partnerships to Conserve Amphibian Habitat

Amphibians are highly sensitive to changes in their environment, and are thus regarded as a top indicator species. They are vulnerable to invasive species, pollution, and other threats attributed to global climate change, such as changes in precipitation, drought, increased UVB radiation, and acid precipitation. However, loss of wetland habitat is the

largest contributor to amphibian declines throughout the United States. The Partners for Fish and Wildlife Program recognizes the significance of amphibians and places a high priority on conserving their wetland habitats.

The Partners Program is the premier voluntary habitat restoration program within the U.S. Fish and Wildlife Service. It provides technical and financial assistance to private landowners throughout the nation to support the habitat needs of federal trust species. The Partners Program recently celebrated its 20th anniversary. Since its establishment in 1987, the Partners Program has supported more than 41,000 private landowners and developed partnerships with over 3,000 nationwide organizations. Working together, these partners have restored and enhanced 800,000 acres (324,000 hectares) of wetlands, 2 million acres (800,000 ha) of uplands, and 6,500 miles (10,500 kilometers) of stream habitat.

The following examples highlight some of the work of the Partners Program to restore and enhance amphibian habitat:

Iniciativa Herpetologica (Arecibo, Puerto Rico)

The Puerto Rican crested toad (*Peltophryne lemur*) is listed as a threatened species. A cooperative partnership between Iniciativa Herpetológica Puertorriquena (a local conservation organization) and the Partners for Fish and Wildlife Program was designed and implemented in accordance with the Puerto Rican Crested Toad Recovery

Silmarie Padron, Partners for Fish and Wildlife Coordinator in the Caribbean, holds an endangered Puerto Rican crested toad.





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This fence around the breeding pond created for the Puerto Rican crested toad protects it from the invasive cane toad (*Bufo marinus*).

Plan. Working with private landowner Finca Tallonal, and with the help of the Puerto Rico Department of Natural Resources and the Association of Zoos and Aquariums, this project aims to establish three separate breeding ponds for the threatened toad. (See related story on page 18.) In May 2006, 4,000 tadpoles were deposited on the site in order to establish a new sustainable population. The Partners Program plans to annually assist in the releases for the next 10 years.

Douglas High School Ranarium and Wetland Project (Douglas, Arizona)

Working with the Douglas High School, the Partners for Fish and Wildlife Program is restoring 4.5 acres (1.8 ha) of wetland habitat for the establishment of an outdoor classroom. This project was developed to protect the threatened Chiricahua leopard frog (*Lithobates chiricahuensis*) and two endangered fish species, the Yaqui chub (*Gila purpurea*) and Yaqui topminnow (*Poeciliopsis occidentalis sonoriensis*). In addition to wetland restoration for the outdoor classroom, a ranarium (in this case, a small pond) will be established to protect the tadpoles during their fragile metamorphic stages. Students at the high school will complete water quality analyses to ensure that the frogs remain disease free.

Cloverdale Ranch Pond Enhancement Project (San Mateo, California)

The ponds found throughout this 6,000-acre (2,430-ha) ranch are breeding habitat for the threatened California red-legged frog (*Rana aurora draytonii*). This species also serves as a critical food source for the endangered San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). The project was developed in order to restore habitat within two failing ponds on the Cloverdale Coastal Ranch. These ponds, which total approximately three acres (1.2 ha) in size, were in need of berm repair to prevent them from washing out. Enhancement of this habitat will directly benefit both federally listed species.

Joe Milmoe, a fish and wildlife biologist in the Partners for Fish and Wildlife program, can be reached at Joe_Milmoe@fws.gov and 703-358-1879.

Case study narrative information was adapted from project descriptions originally written in the Habitat Information Tracking System (HabITS) by Kate Symonds (Sacramento Field Office), Kris Randall (Arizona Ecological Services Field Office), and Silmarie Padron (Boqueron Ecological Services Field Office).

A California red-legged frog tagged for study.



US Forest Service photo

by Lianne Ball

ARMI Detects What Isn't Always Obvious

The story of world-wide declines of amphibian populations has become familiar to many, though the fact that these declines are greater than those documented for any other animal, including birds and mammals, may not be. Amphibians are susceptible to changes in environmental conditions because of physiological and life-history traits, such as moist permeable skin and the use of both terrestrial and aquatic habitats. As these traits are superimposed onto changes in their environment such as habitat fragmentation, water availability, chemicals, diseases, and invasive species, the places in which these species can find refuge and reproduce decreases.

In 2000, to address mounting concerns for amphibians, the U.S. Department

of the Interior launched the Amphibian Research and Monitoring Initiative (ARMI). The ARMI is a national program of the U.S. Geological Survey (USGS), composed of researchers from the biology, water, and geography disciplines. ARMI's goals are to estimate the status of amphibian populations on public lands, conduct research on population declines, and identify potential management strategies that protect amphibians and their habitat. One of the intriguing questions ARMI scientists are investigating is whether threats facing amphibians on private or developed lands are also occurring on protected public lands. Public lands offer refuge to many wildlife species, yet that protection alone may not be enough to maintain wildlife populations. ARMI scientists have found that amphibian populations are affected by stressors in our protected areas, and these stressors are often not directly observable.

Dr. Larissa Bailey (Northeast ARMI) works in the Washington, D.C., area and has examined the effects of local urbanization on the vernal pools used by spotted salamanders (*Ambystoma maculatum*) and wood frogs (*Rana sylvatica*) within such protected areas as national parks and wildlife refuges. Her team found that ecosystem properties and amphibian occupancy of vernal pools was heavily influenced by local hydrology (e.g., pH, pool area) and changes in land management and use. Consistent with other studies, they found that occupancy of vernal pools by both species had a strong positive relationship to the proportion of forest land within these

Spotted salamander (Ambystoma maculatum)



John D. Wilson

protected areas. They also found that occupied pools may be influenced by development outside the protected lands or by the proximity of the pools to roads and rivers that transect these protected areas. Evan Grant (Northeast ARMI) is extending this work to explore how location and size of stream networks and their proximity to park boundaries influences the occupancy, local abundance, and movement of stream salamanders.

Small water bodies, such as vernal pools, are not always protected by pesticide label requirements for no-spray buffer zones, and the occurrence of pesticides in these areas is poorly documented. ARMI hydrologist William Battaglin (USGS Colorado Water Science Center) sampled vernal pools and adjacent flowing waters from protected areas in the Washington, D.C. area, Maryland, Iowa, and Wyoming for pesticides in 2005 and 2006. His team chose these sites because the herbicide glyphosate (the active ingredient in the herbicide “Roundup”) was being used near the vernal pools for agricultural purposes or the control of non-native plants. They detected 28 pesticides or pesticide degradation products in one or more samples and as many as 11 compounds in one sample. Atrazine, another widely used herbicide, was detected most frequently, and concentrations exceeded that chemical’s freshwater aquatic life standard (1.8 grams/liter) in samples from two ditches in a protected area in Iowa. They measured the highest concentration of glyphosate (328 g/l), in excess of its freshwater aquatic life standard (65 g/l), in a sample from a vernal pool within a protected area in Washington, D.C.

Some chemicals can have impacts far from where they are applied. Several frog and toad species have undergone dramatic declines in the western U.S. in the last 10 to 15 years. These declines are not restricted to areas of obvious landscape modification but occur in the relatively undisturbed mountains of



John D. Wilson

Wood frog (*Rana sylvatica*)

the Sierra Nevada. ARMI scientist Dr. Gary Fellers and his colleagues found that summertime winds from the San Joaquin Valley in California transported organochlorine and organophosphorus pesticides (OPs) such as endosulfan and chlorpyrifos into the mountains. California red-legged frogs (*Rana draytonii*) in the mountains had reduced cholinesterase (i.e., a nervous system enzyme) activity, a bio-indicator of exposure to OPs. However, those in areas upwind (west) of the agricultural activity in the San Joaquin Valley did not have depressed cholinesterase levels and had not undergone sharp declines. Recently, Fellers and Dr. Don Sparling (Southern Illinois University) reported that chemicals called oxons, the breakdown products of some OPs, were 10 to 100 times more toxic than their parent compound.

Sometimes the things that stress amphibian populations are not significant individually but produce a different outcome in combination (e.g., *Batrachochytrium dendrobatidis* and contaminants). Drs. Walt Sadinski (Midwest ARMI) and Alisa Gallant (USGS National Center for Earth Resources Observation and Science) are

developing geospatial models to identify amphibian populations at risk of decline from multiple stressors at coarse spatial scales. These models will help scientists identify amphibian populations facing emerging threats.

There is uncertainty associated with large-scale issues such as climate or land use changes that can directly or indirectly affect amphibians. ARMI scientists are working to anticipate, detect, and evaluate factors affecting amphibian populations, and will strive to provide management options to address these new environmental conditions. Most importantly, ARMI will continue to work with our partners to understand the stressors that are easily observable as well as those that are not so easily observable, just like the amphibians we study.

To learn more or to contact regional ARMI scientists, please visit the ARMI Web page (<http://usgs.armi.gov>).

Dr. Ball, the ARMI National Coordinator for the U.S. Geological Survey, can be reached at 703-648-4028.

by Jim Knox

The Scientist Within Us All

Virtually all of us in the field of wildlife conservation owe our respective career paths to select adults who took time out of their busy lives to kindle our spark of interest in wildlife. If we reflect, we can remember their impact.

I was in third grade. Aware of my growing fascination with wild creatures, my sister's homeroom teacher, Mr.

Muccio, encouraged me to tag along and attend a free flight raptor presentation "with the big kids" in the middle school's auditorium. I still remember two things with great clarity: the ease with which the Harris hawk banked over my head and the patience with which the presenter answered my question as she secured her birds for travel.

It is this sharing – this spirit of encouragement and cooperative learning – that is the human link between our conservation efforts and our public's desire, and ability, to assist these efforts. This "shoulder to shoulder" approach to conservation, the lifeblood of citizen science, levels the field of play for the expert and the devoted novice alike. It establishes common goals for all and engenders the kind of teamwork that can surmount the most formidable barriers. Citizen science embodies the pledge and the partnership we extend to every person who passes through our gates.

For 10 years, Connecticut's Beardsley Zoo has been a proud participant in the Connecticut Amphibian Monitoring Project (C.A.M.P.). Conservation professionals and volunteers from ages 8 to 88 have slogged through wetlands season after season in a comprehensive, 15-year effort to document amphibian presence and diversity throughout Connecticut. Zoo staff and volunteers have joined forces with fellow professional/citizen teams representing conservation partners such as the Connecticut Department of Environmental Protection (DEP), Ansonia Nature and Recreation Center, and Yale University's Peabody Museum of Natural History.

A young citizen scientist at work.



Chris Clark/Connecticut's Beardsley Zoo

The benefits to such citizen science are numerous: data acquisition; augmentation of knowledge; enhanced ability to implement sound conservation policy; strengthened ties among communities, conservation facilities, and agencies; improved public conservation literacy and advocacy...even scientific discovery.

In fact, C.A.M.P. citizen scientists, including students, scouts, and families, have verified an astounding 127 new town records representing 22 amphibian species throughout Connecticut, 12 species of salamanders and 10 species of frogs and toads. Under the expert eyes and mentoring of conservation professionals, hundreds of volunteers have compiled this revised and comprehensive statewide amphibian distribution record that had eluded the most accomplished individual herpetologists. Furthermore, thanks to these citizen scientists, full locality data for endangered, threatened, and special concern species have been submitted to Connecticut's Environmental and Geographical Information Center for inclusion in its Natural Diversity Database.

Citizen science is frequently a matter of perspective. When we walk through the door at the end of our day, we shed our roles as directors, curators, educators, and keepers to assume roles like dad, mom, neighbor or friend. Ultimately, however, we all assume the role of citizen. How many times have we been tapped to speak to a civic group or share some of our expertise with a local conservation or school group? In the supermarket, in the post office, or on the street, we pass our anonymous counterparts: countless individuals who possess invaluable experience, skills, and resources to offer conservation and education initiatives. In the absence of citizen science, this collective wellspring of talent, ability and energy remains largely untapped.

As all conservationists know, field conservation is ultimately, only as effective as the acceptance and participation of the local people. Why should "backyard"



Chris Clark/Connecticut's Beardsley Zoo

Citizen science volunteers of all ages are the lifeblood of numerous amphibian conservation projects nationwide.

conservation be any different? From Bridgeport to Borneo, local people have always, and will always, make all the difference. It is this duality of science and citizenship, or "the human side of things," that transforms conservation from the abstract to the tangible for so many.

Gregory Watkins-Colwell, Museum Assistant in the Division of Vertebrate Zoology at Yale University's Peabody Museum of Natural History, provides the perspective of both scientist and father.

"I got involved with C.A.M.P. because appreciation of biodiversity begins in your own backyard. It is important to me that my children grow up knowing the sounds of spring peepers and the joy of finding a red elf in the woods. One doesn't have to go to Panama to find amphibians in peril."

Similar sentiments are echoed by other contributors. When she's not serving as the Registrar for Connecticut's Beardsley Zoo, Linda Tomas volunteers her time and organizational expertise as a C.A.M.P. Site Coordinator and Search Leader. For Linda, the benefits are all too tangible.

"I find this project to be several things to me: fun, enriching, a great learning

experience, a great way to get children and their parents outside working as a team. I feel honored to be able to help with the research. Amphibians are an important indicator of the environment's health. I feel this project, with its hands-on approach, helps connect people with the environment around them. I look forward to the final results but I will definitely miss the early Saturday morning searches with the volunteers I have truly come to know and appreciate."

Citizen-based conservation efforts hold enormous potential to establish mutually beneficial partnerships, promote conservation literacy and advocacy, and produce discovery. Yet there is one more benefit, and it is no small matter. Every once in a great while, we achieve something wonderful and far-reaching. We return the favor we received so long ago when we share our love of wildlife to touch the life of a child.

Jim Knox is a Zoo Educator at Connecticut's Beardsley Zoo and hosts Wild Zoofari, a new PBS children's wildlife series filmed at the world's premiere zoos and aquariums.

by Jeff Servoss

Introducing Students to Endangered Species



USFWS

Students from Thunderbird High School assisting in frog surveys along the Hassayampa River.

B iologists in the U.S. Fish and Wildlife Service's Arizona Ecological Services Office (AESO) teamed up with Thunderbird High School in Phoenix to assist with a pilot curriculum that introduces urban public high school students to the Endangered Species Act (ESA) and the plight of Arizona's threatened, endangered, and sensitive species.

Three classes of freshmen and sophomores in an accelerated biology curriculum were asked to choose a native plant or animal species to research and integrate into a year-long project and final oral presentation. This pilot curriculum also included a history of the ESA and how the pioneering legislation has been used to conserve and recover listed species.

Section 7 of the ESA is used as a framework in this curriculum. The curriculum required each student to complete several individual writing assignments during the academic year, addressing historical and current threats to their chosen species and the current status of their species. It also asked students to create a hypothetical proposed action affecting their species, the environmental baseline in the area of their proposed action, and their recommendations on how to minimize effects to their species. In essence, each student completed a section 7 biological opinion on their chosen species. In addition, students were required to contact or interview professional biologists in the public, private, or academic sectors to hone communication skills and get additional information on their project.

This pilot curriculum was designed as a backdrop with which to integrate other major topics covered in the Glendale Unified High School District's accelerated biology curriculum throughout the school year. Topics include cell biology, cellular respiration, photosynthesis, genetics, evolution, ecology, animal behavior, biochemistry, and mammalian physiology. The fact that many or all of these topics pertain directly to issues affecting students' chosen species reinforces their understanding of the connectivity of ecosystems and the cause and effect dynamics of actions on the landscape.

To help reconnect urban students with nature, several students were granted the opportunity to join AESO biologists in the field to learn more about native ecology and wildlife and gain insight into the professional careers of Service biologists. For example, students participated in electro-shocking surveys for native fish in a pristine canyon stream, conducted Yuma clapper rail surveys in marshland habitat, conducted nocturnal ranid frog surveys and identifications, conducted northern Mexican gartersnake surveys, and collected specimens for a captive propagation and release conservation project.

Jeff Servoss, a fish and wildlife biologist in the Arizona Ecological Services Office, can be reached at 602-242-0210 or jeff_servoss@fws.gov.

Since January 1, 2008, the Fish and Wildlife Service has announced the following proposed and final rules in accordance with the Endangered Species Act:

Final Rules

Northern Rocky Mountain Wolves Delisted

The gray wolf (*Canis lupus*) population in the Northern Rocky Mountains is thriving and no longer requires the protection of the Endangered Species Act, Deputy Secretary of the Interior Lynn Scarlett announced recently. As a result, the Service published a final rule in the February 27, 2008, Federal Register removing this distinct population segment (DPS) from the federal list of threatened and endangered species.

“The wolf population in the Northern Rockies has far exceeded its recovery goal and continues to expand its size and range. States, tribes, conservation groups, federal agencies, and citizens can be proud of their roles in this remarkable conservation success story,” said Scarlett, noting that there are currently more than 1,500 wolves and at least 100 breeding pairs in Montana, Idaho, and Wyoming.

Service-approved state management plans will provide a secure future for the wolf population, and the states assume full management of wolf populations within their borders. The Endangered Species Act requires the Service to work with state agencies to monitor the population and threats to a species for at least 5 years after it is delisted. If a species’ population decreases or the threats

change, it can be considered for relisting under the Endangered Species Act.

The northern Rocky Mountain DPS covered by the delisting rule includes all of Montana, Idaho, and Wyoming, as well as the eastern one-third of Washington and Oregon, and a small part of north-central Utah.

The minimum recovery goal for wolves in the northern Rocky Mountains was set at a minimum of 30 breeding pairs (a breeding pair represents a successfully reproducing wolf pack) and a minimum of 300 individual wolves for at least three consecutive years. This goal was achieved in 2002, and the wolf population has expanded in size and range every year.

“These wolves have shown an impressive ability to breed and expand -- they just needed an opportunity to establish



John and Karen Hollingsworth

themselves in the Rockies. The Service and its partners provided that opportunity, and now it's time to integrate wolves into the states' overall wildlife management efforts," said Service Director H. Dale Hall.

Gray wolves were previously listed as endangered in the lower 48 states, except in Minnesota, where they were listed as threatened. The wolf population in the western Great Lakes was delisted due to recovery in early 2007. The Service will continue to oversee the only remaining endangered gray wolf recovery program, which covers the southwestern U.S. wolf population. The February 27 delisting affects only the northern Rocky Mountain population of gray wolves. Gray wolves found outside of the Rocky Mountain and Midwest recovery areas, including the southwest wolf population, remain protected under the Endangered Species Act and are not affected by the delisting rule.

Desert Bald Eagle Listed as Threatened

Due to a recent court order, bald eagles (*Haliaeetus leucocephalus*) in the

Sonoran Desert of central Arizona are again protected under the Endangered Species Act as threatened. The Service will soon publish an emergency interim rule in the Federal Register to comply with the court order.

On October 6, 2004, the Service received a petition to reclassify the Sonoran Desert population of bald eagles in central Arizona and northwestern Mexico as a distinct population segment (DPS), to list that DPS as an endangered species, and designate critical habitat. A DPS must be geographically discrete from other populations and also be significant to the survival of the species. Discrete refers to the isolation of a population from other members of the species and is evaluated based on specific criteria. On August 30, 2006, the Service announced a 90-day finding stating that the petition did not present substantial scientific or commercial information indicating the petitioned action may be warranted. On January 5, 2007, the petitioners filed a legal challenge against the Service's 90-day finding decision.

As a result of that lawsuit, on March 6, 2008, the U.S. District Court for the

District of Arizona ordered the Service to: 1) conduct a status review of the "bald eagle population of the Sonoran Desert region of the American Southwest" (desert bald eagle) to determine whether recognizing the desert bald eagle population as a DPS is warranted, and if so, whether listing the DPS as threatened or endangered pursuant to the Endangered Species Act is warranted; and 2) issue a 12-month finding on whether recognizing the desert bald eagle population as a DPS is warranted, and if so, whether listing the DPS as threatened or endangered is warranted. The court ordered the Service to issue this finding by December 5, 2008.

Based on the court order and the description of the bald eagle population in the original petition, the desert bald eagle population is defined as those eagles in the Sonoran Desert residing in central Arizona and northwestern Mexico. Since bald eagles in northwestern Mexico were never protected under the Endangered Species Act, only those bald eagles found in the Sonoran Desert of central Arizona are reinstated to federal protection under the Endangered Species Act. The remainder of formerly listed bald eagles will not be placed back on the list of threatened and endangered species.

The Service first listed the bald eagle as endangered in 43 States and threatened in 5 others on February 14, 1978. Bald eagles were never listed in Alaska where they are abundant, and they are not found in Hawaii. On July 12, 1995, the Service reclassified the bald eagle from endangered to threatened in the lower or contiguous 48 States. The Service published the final rule to delist the bald eagle in the lower 48 states on July 9, 2007. This action was based on a thorough review of the best available data, which indicated that the threats to the species have been eliminated or reduced to the point at which the species



Laura L. Whitehouse

had recovered and no longer met the definition of threatened or endangered.

In order to ensure the public is notified of the effects of the recent court order, the Service will soon publish an emergency interim rule amending the regulations for the Federal List of Endangered and Threatened species at 50 CFR 17.11 to designate the desert bald eagle as threatened in accordance with the Endangered Species Act. The emergency interim rule will be effective until the Service makes a new final determination as to the appropriate status of the Sonoran Desert bald eagle, or until the March 6, 2008, court order is either stayed or reversed in any subsequent judicial proceedings. No decision has been made as to whether the government will appeal that order.

For more information on this court order and bald eagle recovery in the U.S., please visit <http://www.fws.gov/migratorybirds/baldeagle.htm>.

Six Foreign Species of Birds Listed as Endangered

Six species of birds from Mexico, Southeast Asia, and the South Pacific were listed by the Service on January 15, 2008, as endangered.

The birds include the Socorro mockingbird (*Mimus graysoni*) of Socorro Island in Mexico, the black stilt of New Zealand (*Himantopus novaezelandiae*), the caerulean paradise-flycatcher (*Eutrichomyias rowleyi*) on Sangihe Island in Indonesia, Gurney's pitta (*Pitta gurneyi*) of Myanmar and Thailand, the long-legged thicketbird (*Trichocichla rufa*) of Viti Levu Island in Fiji, and the giant ibis (*Pseudibis gigantea*) of Cambodia, Laos, and Viet Nam. Most of these birds have wild populations so small that scientists are concerned about the loss of genetic variation among the remaining birds, which can decrease their ability to survive disease or other catastrophes.



Black stilts

Dick Veitch

Granting the birds protection under the Endangered Species Act means import or export of any of the species (or their parts) into the U.S., as well as their sale in interstate commerce, would be prohibited. The only exception to the prohibitions would be for scientific purposes or to aid in efforts to enhance the propagation or survival of the species.

These birds have suffered from a variety of threats including habitat fragmentation, predation and competition from invasive species, unregulated hunting, and trafficking. The Service hopes that designation as endangered species will help garner added international support for conservation efforts in the countries where these species live.

The Socorro mockingbird is found only on Socorro Island in the Rivillagidedo archipelago of Mexico. Mostly brown with white underparts, this bird stands just 10 inches (25 centimeters) tall. In 1925, it was considered to be the most abundant land-based bird on the island, but today it is believed to number only around 400 birds in the wild. The species is threatened by habitat loss from overgrazing by non-native sheep, agricultural conversion by farmers, and defoliation

by locust swarms, and by predation by introduced predators.

The black stilt, known only from New Zealand, is a wading bird up to 16 inches (40 cm) tall, with long red legs, a slender bill, and black plumage. In the 1950s, its population was estimated between 500 and 1,000 birds, but the current wild population includes only 87 adults, with just 17 breeding pairs. New Zealand has managed the species since 1981. Recovery plans have focused on increasing the species' low breeding success, which is largely attributed to human-induced habitat alteration, including the introduction of non-native predators.

The caerulean paradise-flycatcher was believed to be extinct until 19 individuals were observed between 1998 and 1999 in a small part of a forest on Sangihe Island in Indonesia. Colored a bright caerulean blue (which can be likened to a deep blue sky) and growing up to 5 inches (12 cm) tall, this bird prefers primary rainforest habitat and has an estimated population of 19 to 135 birds. The island on which it lives has been nearly deforested for timber, pulp, or conversion to agriculture. Additional risks to the species include inadequate protection, unregulated hunting, and the risks associated with small population size.

The 8-inch (20-cm), blue and turquoise Gurney's pitta is a terrestrial bird that hops around the floor of lowland, semi-evergreen secondary rainforest, consuming insects, snails, and earthworms. Once known throughout the Thai-Malay peninsula of Thailand and Myanmar, the bird had not been seen in the wild for more than 30 years when it was rediscovered in 1986 -- ironically, with the help of a wildlife smuggler. Trapped in the wild for sale in the pet trade, Gurney's pitta was first placed in Appendix III of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1987 and transferred in 1990 to CITES Appendix I because the population was no longer viable and could



P.D. Round/Birdlife

A male Gurney's pitta.

not sustain commercial trade. Known only from a single, declining population in Thailand since 1986, the species was rediscovered in 2003 in Myanmar; the current population may stand at just 180 birds. Gurney's pitta suffers from habitat loss, capture for the pet bird trade, inadequate protection, and possibly predation.

The long-legged thicketbird, of Viti Levu Island in Fiji, is just 6 inches (15 cm) tall, with long blue legs, a short black bill, and a long tail. Described as a reclusive island endemic, it was believed extinct after an absence of sightings since 1894. But the bird was rediscovered in 2003, when 12 pairs were located in the remote Wabu Forest Reserve. Threats to the species are not well known, but include loss of habitat and possible predation by the mongoose, an introduced predator.

True to its name, the giant ibis stands up to three feet (0.9 meter) tall. Once found in Cambodia, Laos, Thailand, and Viet Nam, the species was believed to be extinct in all but Cambodia. Recent rediscoveries confirm its existence in small numbers in all but Thailand, with an estimated population of just 100 pairs of birds. Deforestation, dam construction, and other forms of habitat

degradation, as well as indiscriminate hunting, pose threats to the survival of this species.

Proposed Rules

Brown Pelican Proposed for Delisting

Celebrating the recovery of the brown pelican (*Pelecanus occidentalis*), the Service proposed on February 20, 2008, to remove this bird range-wide from the federal list of threatened and endangered species.

In 1985, the Service delisted the brown pelican in Alabama, Georgia, Florida, and northward along the Atlantic Coast states due to its recovery in those areas. The new proposal would delist the species' remaining populations in Mississippi, Louisiana, and Texas, along the U.S. Pacific Coast, in the Caribbean, and along the Atlantic and Pacific coasts of Central and South America. There are now more than 620,000 brown pelicans range-wide.

The brown pelican's recovery is due in large measure to the federal ban on the general use of the pesticide DDT in 1972, after former Service biologist Rachel Carson published *Silent Spring* and alerted the nation to the dangers of unrestricted pesticide use. As DDT

accumulated through the food chain, it interfered with the pelican's eggshell production. Once residues of the pesticide declined after the ban, recovery actions began to succeed.

Louisiana, long known as the "Pelican State," has been a key partner in efforts to recover the pelican in the Gulf Coast region. For example, the Louisiana Department of Wildlife and Fisheries and the Florida Game and Fresh Water Fish Commission jointly carried out a restoration project. A total of 1,276 young pelicans were captured at sites in Florida and released at three sites in southeastern Louisiana during the 13 years of the project.

Efforts to protect the brown pelican led to the birth of the National Wildlife Refuge System more than a century ago in Florida, where a German immigrant named Paul Kroegel was appalled by the indiscriminate slaughter of pelicans for their feathers. His impassioned pleas to President Theodore Roosevelt led Roosevelt to create the first National Wildlife Refuge at Pelican Island in 1903 and name Kroegel its first refuge manager. More than a century later, there are 548 national wildlife refuges, many of which have played key roles in the brown pelican's recovery.

In the southwest, the Texas Parks and Wildlife Department, The Nature Conservancy, and numerous other conservation organizations helped purchase important nesting sites and developed monitoring programs to ensure pelican rookeries were thriving. Other habitat protection and restoration efforts within the U.S., Mexico, and some Central and South American countries also contributed to the pelican's recovery. The legal protections provided by the Endangered Species Act, coupled with the banning of DDT in 1972, provided the means for the Service and its partners to accelerate the pelican's recovery. State wildlife agencies, universities, private ornithological groups, and individuals participated in

reintroduction efforts and helped protect nest sites during the breeding season.

If the brown pelican is removed from the list of threatened and endangered species, other federal laws, such as the Migratory Bird Treaty Act and the Lacey Act, will continue to protect the pelican, its nests, and its eggs from harm. Further, the Service is working with state wildlife agencies in the pelican's range to develop cooperative management agreements for continued monitoring and protection. The Endangered Species Act also requires the Service to work with the state agencies to monitor the population and threats to a species for at least 5 years after it is delisted. If a species' population decreases or the threats change, a species can be relisted for protection under the Endangered Species Act.

Hawaiian Plant Proposed for Listing

A Hawaiian plant known to botanists as *Phyllostegia hispida*, a species so rare it has no common name, was proposed on February 19, 2008, for listing as endangered. These plants are found only in the

wet forests of eastern Moloka'i at elevations between 2,300 and 4,200 feet (700 to 1,280 meters).

Phyllostegia hispida, a nonaromatic member of the mint family (Lamiaceae), is a loosely spreading, many-branched vine that forms large tangled masses. The most significant threat to its survival is its low numbers, which make it particularly susceptible to extinction from random events such as hurricanes and disease outbreaks. Other major threats are predation and habitat degradation by feral pigs, competition with invasive non-native plants species, and possible predation by invertebrates such as slugs.

Phyllostegia hispida has rarely been seen in the wild. From 1910 to 1979, a total of eight occurrences were recorded. Since 1979, individual plants have been discovered periodically, but in subsequent years they have died for various reasons.

In April 2007, 10 new wild plants were discovered within the Pu'u Ali'i Natural Area Reserve on Moloka'i, including one mature individual. Seeds were collected from the mature plant and sent to the University of Hawaii's Lyon Arboretum

on O'ahu, and cuttings were taken from some of the other plants for propagation.

In addition, 12 *Phyllostegia hispida* plants grown in captivity were outplanted within the natural area reserve in April. A check on the plants two months later found 11 healthy plants. In June 2007, another 12 individuals were outplanted into an enclosure at The Nature Conservancy's Kamakou Preserve, bringing the total number of plants in the wild to 10 naturally occurring and 23 recently outplanted individuals.

Conservation measures have been taken and continue today to protect the species. Propagules from this species that may be used for outplanting into suitable habitat are maintained by the Lyon Arboretum, the National Tropical Botanical Garden on Kaua'i, and Kalaupapa National Historical Park on Moloka'i.

Four of the plants recently discovered within the Pu'u Ali'i Natural Area Reserve are protected from feral pigs by a fenced enclosure, and there are no signs of feral ungulate activity in the vicinity of the other six plants. The Nature Conservancy of Hawai'i continues to control feral pigs and alien plants within the Kamakou Preserve.

A brown pelican flies over islands near Pismo Beach, California.



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Details on these rulemaking actions, and on proposed and final designations of critical habitat, are available by accessing the Service's centralized library of Federal Register notices at <http://www.fws.gov/policy/frsystem/default.cfm>.

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BOX SCORE

Listings and Recovery Plans as of May 13, 2008

GROUP	ENDANGERED		THREATENED		TOTAL LISTINGS	U.S. SPECIES W/ PLANS
	U.S.	FOREIGN	U.S.	FOREIGN		
 MAMMALS	69	256	12	20	357	56
 BIRDS	75	179	15	6	275	85
 REPTILES	13	66	24	16	119	38
 AMPHIBIANS	13	8	10	1	32	17
 FISHES	74	11	65	1	151	101
 SNAILS	64	1	11	0	76	69
 CLAMS	62	2	8	0	72	70
 CRUSTACEANS	19	0	3	0	22	18
 INSECTS	47	4	10	0	61	35
 ARACHNIDS	12	0	0	0	12	6
 CORALS	0	0	2	0	2	0
ANIMAL SUBTOTAL	448	527	160	44	1,179	495
 FLOWERING PLANTS	570	1	143	0	714	630
 CONIFERS	2	0	1	2	5	3
 FERNS AND OTHERS	26	0	2	0	28	28
PLANT SUBTOTAL	598	1	146	2	747	661

TOTAL U.S. ENDANGERED: 1,046 (448 animals, 598 plants)
TOTAL U.S. THREATENED: 306 (160 animals, 146 plants)
TOTAL U.S. LISTED: 1,352 (608 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.

** Eleven U.S. animal species and five foreign species have dual status.

ENDANGERED Species BULLETIN

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