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CONSERVATION METAMORPHOSIS: Innovative Strategies for In-range Country Programs

Major zoological organizations around the world have been charged with developing and implementing conservation strategies for 443 critically endangered species. Traditional conservation approaches are still needed (*ex-situ* captive breeding programs), but are inadequate to meet the challenges due to lack of space and resources. Several zoos have begun to channel funding to others for the development of amphibian conservation centers in range countries by sharing expertise and "piggy-backing" with existing programs and infrastructures.

THE ATLANTA AMPHIBIAN CENTER PILOT STUDY FOR EMERGENCY INTERVENTION TO AMPHIBIAN CRISES

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After two decades of observing declines of amphibians and speculating about the causes, a series of recent papers has brought the realization that the scale of global amphibian extinctions is massive, that their occurrence and effects are to some degree predictable, and that maverick conservation efforts will be required in order to mitigate losses of biodiversity.

While amphibians face a variety of threats, the emerging infectious disease chytridiomycosis is responsible for many of the declines and extinctions that were previously referred to as "enigmatic." This fungal pathogen, (*Batrachochytrium dendrobatidis*, "*Bd*") moves readily across landscapes and is capable of causing extinctions of populations and species. This realization of disease-induced extinction on such a broad geographic and phylogenetic scale fundamentally changes the arena of modern conservation efforts. As we develop data-based models that may predict biodiversity catastrophes, there is an urgent need to respond in the short-term, so that the requisite long-term conservation response may remain possible. In terms of conservation action, outside of scenarios of dams filling valleys with water, this represents something of a new paradigm of conservation action – infectious diseases are capable of directly causing extinctions.

Based on new data from Panama in December, 2004, a group of international stakeholders met in Atlanta, Ga., to initiate conversations of what would be required to respond to a suddenly predictable crisis. Because we now have the ability to somewhat predict the arrival and catastrophic consequences of the arrival of *Bd* into a naïve community, we realized that we have entered a new era in the history of amphibian extinctions and conservation action. Where the arrival of *Bd* is predictable and inevitable, emergency extraction of amphibians into captive care is the only practical conservation measure. Such a program is only a stop-gap operation to preserve species and some genetic diversity until the threat of *Bd* can be mitigated.

We were unaware of any precedent in conservation action for the purposeful collection of large numbers of healthy individuals from well-protected habitats, and also a co-lateral program to test field-based triage treatments of potentially diseased individuals. So, we worked at a site that had recently been decimated by *Bd* (El Copé, Panama) and at a site 50 km eastward (El Valle) that was predicted to be affected in 2006. Our goal was to develop a model of a preemptive conservation program that may be modified and implemented in other areas. We would develop triage procedures to treat infected animals, and novel pre-emptive extractions of amphibians using local facilities and staff.

Our pilot-project faced many challenges of logistics, bureaucracy, and husbandry. Consequently, our general questions were:

1) Can local-based husbandry operations be managed, such that amphibians may be extracted from diseased and non-diseased sites?

2) Is it possible to rapidly implement a treatment and extraction program at a scale reasonable to preserve any local amphibian diversity?

Results:

The project was conceived in December, 2004, start-up funding was secured in March, 2005, and permit applications were filed in April, 2005. An initial visit to Panama was made to meet with government officials, to assess available facilities, and identify local biologists. The consensus of Panamanian officials was that there currently was no facility in place capable of maintaining long-term captive colonies of amphibians. So, we used makeshift local facilities for our triage facilities and exported animals to facilities at Atlanta Botanical Garden and Zoo Atlanta. Animals were maintained there so we could discover the husbandry challenges that would be faced by the staff working to develop the Houston-Zoo sponsored El Valle Amphibian Conservation Center. Field work began in late May and resulted in the collection of about 600 animals, representing 35 species.

In summary, this pilot project demonstrated the following major points:

- It is possible to treat *Bd*-positive amphibians from collected from the Wild, and bring them safely into long-term captive programs.
- Timing is critical: only seven months after the arrival of Bd at El Copé, too few individuals of most species existed to form captive colonies.
- Proper procedure and diplomacy can secure permission for unprecedented collections from protected reserves, but a medium-term public awareness and media campaign is advised to prevent misinterpretation and public resentment to the concept of exporting amphibians to the USA.
- It is possible to maintain notoriously delicate amphibians in "sub-optimal" facilities with newly trained staff for many months at a time.
- The expense, bureaucracy, logistics, and diplomacy of exporting amphibians from their native country that may lack facilities is not necessary – animals can be maintained at acceptable costs for prolonged periods of time, while local facilities are developed.
- Working under emergency conditions, with dozens of species could have resulted in near-complete failure. However, the result now is hopeful: some species are thriving and reproducing in captivity, some species are thriving but not yet reproducing, and a few species have not survived in captivity.
- Thus, given the reality of near-complete decimation in the wild, programs such as this are useful in safeguarding at least a subset of the species and population-level diversity of a site predicted to become infected by Bd (or other predictable influences, e.g., habitat loss). As long as the resources

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required to conduct such an operation do not infringe on the basic research and/or habitat protection that are the long-term solution, such rapid-response programs are viable.

EMERGENCY RESPONSE TO A DEADLY DISEASE: THE EL VALLE AMPHIBIAN CONSERVATION CENTER

Bill Konstant, *Director of Conservation and Science* and Paul Crump, *Reptile and Amphibian Keeper*, Houston Zoo


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The El Valle Amphibian Conservation Center (EVACC) is a near complete, 2,400 square-foot facility situated in the crater of an extinct volcano in central Panama. Very soon it will house several dozen species of frogs, toads, and salamanders, all of which are affected by the advance of the deadly chytrid fungus through Central America and some of which are actually threatened with extinction due to this disease. The plan to construct EVACC emerged largely as the result of the international zoo and aquarium collaboration known as Project Golden Frog and the Amphibian Recovery and Conservation Coalition project led by the Atlanta Botanical Gardens and Zoo Atlanta. The need for such a facility became apparent to herpetologists when chytrid recently appeared in Panama's El Cope National Park and decimated the amphibian fauna in that protected area.

In April 2005, staff from the Houston Zoo conducted an inspection of El Nispero Zoo, a small private zoo located in the village of El Valle de Anton, which just happens to be the type locality of the Panamanian golden frog. It was determined that the site was suitable for a facility that could house native amphibian species and serve as a center for rescue, quarantine, treatment, and public education. The original plan was to construct EVACC prior to the arrival of chytrid in the region, but the fungus appeared in surrounding forests sooner than expected and essentially threw the project into over-drive. Very quickly, about a dozen AZA institutions joined forces, providing the project with financial resources, essential equipment and supplies, and volunteers.

Last summer, zoo and aquarium volunteers came together in El Valle to collect as many live specimens as possible of 13 species that are considered the highest conservation priorities: Panamanian golden frog (*Atelopus zeteki*), lemur leaf frog (*Phyllomedusa lemur*), Tabasara robber frog (*Eleutherodactylus tabasarae*), Panamanian robber frog (*E. museosus*), Bob's robber frog (*E. punctariolus*), rusty robber frog (*E. bufoniformis*), Heredia treefrog (*Hyla fimbrimembra*), crowned treefrog (*Anotheca spinosa*), La Loma treefrog (*Hyla colymba*), Palmer's treefrog (*H. palmeri*), casque-headed treefrog (*Hemiphractus fasciatus*), horned marsupial frog (*Gastrotheca cornuta*), and the Panama poison frog (*Dendrobates vicentei*). These species were selected for conservation action based on rigorous criteria that evaluated known distribution and population sizes, the vulnerability of wild populations to the advancing fungus, and any cultural or political importance.

While construction of the permanent facility continues, frogs, toads, and salamanders collected from surrounding forests are being housed temporarily in several rooms at the nearby Hotel Campestre, thanks to the owner's generosity and concern for Panama's natural heritage. Close to 250 animals comprise the current collection, all of them having been tested and treated for chytrid. Fortunately, even animals that have contracted the disease will recover fully if treated early enough with the anti-fungal drug Itraconozole.

The Houston Zoo expects to complete construction of EVACC's laboratory and quarantine sections very shortly and to move the captive animals there as soon as electrical power is available. Work will then resume on exhibits in the public area. Even when the facility is up and running, however, this project will represent something of a holding pattern in the long-term conservation strategy for threatened Central American amphibians. At the current time there is no indication that the chytrid fungus can be removed from the environment once an area has become infected, yet breeding programs will be undertaken to ensure the viability of captive populations and in preparation for reintroduction efforts, should that become feasible. Research is underway to determine why some species – such as the golden frog – quickly succumb to the effects of the fungus, while others – such as the marine toad and red-eyed tree frog – can become infected, but apparently do not succumb to the disease. Until conservationists learn how to control the fungus in nature or identify a way to induce immunity, facilities such as EVACC could very well become the final strongholds for a number of rare and threatened species.

How Can Your Zoo Help?

- Financial support for in-country staff
- Donate laboratory equipment and supplies
- Send staff to help work at the center
- Support and participate in applied research projects

SAINT LOUIS ZOO'S WILDCARE INSTITUTE COLLABORATION WITH ECUADOR

Mark Wanner, *Zoological Manager/Reptiles, Amphibians & Aquatics*, Saint Louis Zoo


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While working in the Galapagos Islands on a long-standing project, Saint Louis Zoo staff learned of a biologist in Ecuador who was creating a conservation center for amphibians. A meeting was arranged by the Saint Louis Zoo with Dr. Luis Coloma in Quito, Ecuador and a partnership was instantly formed.

Ecuador is truly a unique country with 70 percent of the world's flora and fauna species. To date there are over 448 known species of amphibians in Ecuador. Ecuador is lucky in having one of the world's finest amphibian biologists, Dr. Luis Coloma as a resident. Dr. Coloma, staff and students manage over 1,000 specimens and of those nearly 100 are native, imperiled species. This makes their *ex-situ* assurance population of amphibians the most significant and largest in the western hemisphere.

The first week of December 2006, Dr. Coloma and staff hosted the first amphibian training workshop at Catolica University in Quito. Dr. Kevin Zippel of CBSG spoke on several issues and was impressed by Dr. Coloma's program. The staff at Pontificia Universidad del Catolica are resourceful, building all of their

aquariums, a majority of the life support systems as well as raising native invertebrates for feeding their amphibian population.

The Saint Louis Zoo's main support for this partnership has come in the way of funding. The first two years of collaboration, the Saint Louis Zoo's Wildcare Institute matched funds given to Dr. Coloma by the university. An aspect of this partnership that made it an obvious conservation choice is that all work is being done in country and is supporting a large number of species. Ecuador does not allow the export of amphibians. This enables the Saint Louis Zoo to participate in amphibian conservation in a meaningful way by supporting Dr. Coloma's Balsa del los Sapos program and help build an *ex-situ* assurance population.

How Can Your Zoo Help?

- Provide additional funding to Dr. Coloma's De los Sapos program
- Spread the word about the amphibian crisis
- Support more amphibian programs

SOUTHEAST COASTAL PLAIN PROJECT: DEVELOPING HUSBANDRY PARAMETERS AND REPRODUCTIVE TECHNIQUES FOR NATIVE THREATENED AMPHIBIANS

Scott Pfaff, *Curator of Herpetology*, Riverbanks Zoo and Garden


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During the early 1990s Riverbanks Zoo and Garden began a cooperative endeavor with the South Carolina Department of Natural Resources to establish captive populations of rare South Carolina amphibians and attempt to ascertain basic husbandry parameters and reproductive techniques for these taxa.

Four species of native amphibians were selected – Pine Barrens treefrogs (*Hyla andersonii*), Carolina gopher frog (*Rana c. capito*), broad-striped dwarf sirens (*Pseudobranchus striatus*) and flatwoods salamanders (*Ambystoma cingulatum*).

These species were selected because they were considered to be a state threatened species or a species of special concern whose populations were thought to be in decline.

All of the specimens obtained were to be collected from the wild while still in the larval stage. Small captive colonies of *Pseudobranchus* and *Hyla andersonii* were established in the first year of the project. Establishing a managed population of *Rana capito* proved to be more problematic. Although a few tadpoles and young adults were collected a captive colony could not be established and we failed to locate any additional specimens. *Ambystoma cingulatum* also proved to be very difficult to locate and not a single specimen was located in South Carolina in twelve years.

Six *Pseudobranchus* were collected in 1994. The specimens were ~15mm in length and were thought to be hatchlings. The salamanders were established in semi-wild conditions in outdoor aquaria and attained near adult size in less than a year, however reproduction did not occur until the *Pseudobranchus* were five years old. During two breeding seasons, no fewer than 99 (61, 38) *P. s. striatus* were produced. Considering the difficulty of locating the hatchlings among the dense vegetation and substrate in the aquaria, and how rapidly any dead hatchlings could be consumed or decompose, the actual number of offspring produced may have been much higher. It is likely that two females are responsible for all of the reproduction.

The age at first reproduction for the wild caught specimens collected as juveniles was five years. This may have been due to the specimens being maintained under conditions that would not stimulate reproduction until their 5th year. Nevertheless, F-1 dwarf sirens kept under identical conditions to those under which the adults bred also did not reproduce until their 5th year even though they were near adult size after only a few months.

Maintaining a reproductive colony of sirens in semi-wild conditions in outdoor aquaria was not too difficult once preferred environmental parameters were established. A minimal amount of manipulation was needed and the colonies just required supplemental feeding and predator exclusion. *Pseudobranchus* are very hardy as captives and mortality is minimal. Indeed, we had no mortality at all for the first 5 years and even now after 12 years the only mortality we have seen in adult *Pseudobranchus* has been due, we assume, to predation. Large numbers of offspring *Pseudobranchus* can be produced, but only under conditions that are not favorable to continuous, frequent observations.

Nine *Hyla andersonii* were collected as tadpoles. The relatively well developed tadpoles underwent metamorphosis within two weeks of collection and were subsequently moved to semi-wild conditions in heavily planted outdoor terrariums requiring little more than supplemental feedings. The colony was moved indoors for the first winter and reproduction occurred the next spring during which a single female produced 300 tadpoles. Husbandry for the tadpoles was not problematic and mortality can be very low if adequate attention is paid to water quality. The f^1 *Hyla andersonii* reached sexual maturity in eleven months.

As with *Pseudobranchus*, establishing a captive colony of *Hyla andersonii* and breeding multiple generations was not difficult. The treefrogs proved not to be delicate as captives and each females is capable of producing hundreds of offspring per year.

Riverbanks will continue to maintain captive colonies of both *Pseudobranchus* and *Hyla andersonii*. If specimens can be obtained we will also try to establish a colony of *Rana capito*. *Ambystoma cingulatum* is now a federally listed threatened species and the species may be functionally extinct in South Carolina, hence attempts to establish a captive colony will be abandoned.

How Can Your Zoo Help?

- Develop husbandry protocols for local threatened or sympatric species
- Collaborate with local agencies to develop conservation strategies for amphibians in peril

AMPHIBIAN CONSERVATION IN SOUTH AFRICA THROUGH CAPACITY BUILDING

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In a perfect situation every state, province, and country would be responsible for saving their regional endangered amphibian species. However many places around the globe face challenges

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that make this scenario impossible, but it is through skill transfer and capacity building that many countries can over come those challenges. In 1997, Dr. Nadia Loskutoff, Omaha's Henry Doorly Zoo, and the Johannesburg Zoo of South Africa began a collaboration focusing on assisted reproductive technologies for mammal species. At the beginning of 2006 this partnership developed further to hit the global amphibian extinction crisis head on.

The IUNC Red Data Book lists four South African species as critically endangered, eight as endangered and eight as threatened. The response to this problem was to design and construct a holding facility for captive assurance populations in South Africa based on management and husbandry techniques developed at Omaha's Zoo. Using the old director's house on Johannesburg Zoo grounds, with recently converted rooms for lab facilities, the South African Amphibian Conservation Center was born. In February of 2006, staff from Omaha was sent to Johannesburg to oversee the establishment of the Amphibian Conservation Center.

During the initial stages of the project it was ascertained that most of the endangered frogs in South Africa were not bred *ex-situ* and therefore obtaining information regarding their breeding in captivity was difficult to find or not available. With the lack of information, it was decided to concentrate on five sympatric species of frogs, which had similar breeding habits as those that were critically endangered. This approach would allow the Johannesburg Zoo staff to acquire the appropriate skills and knowledge to breed the endangered species of frogs if needed in the future. The establishment of the captive rearing systems was completed using equipment obtained in South Africa to guarantee that the equipment could be updated and maintained as needed without relying on sources from abroad. After designing the first isolated amphibian system, all the South African team members of the amphibian project participated in the construction of the remaining systems.

Between 21 and 24 February 2006, the Johannesburg Zoo's Amphibian Conservation Project took a major leap forward with the first amphibian collection trip to Grasskop, Mpumalanga Province in South Africa. The collection team, assisted by Mr. Jerry Theron, Mpumalanga Parks Board, spent many hours in wet conditions, searching for frogs and tadpoles that would form the nucleus of the breeding program. During the trip, water parameters were measured and collection sites recorded. Strict hygiene practices for staff collecting frogs were implemented to reduce the possibility of disease transfer from one site to the next.

The Amphibian Conservation Centre currently holds multiple isolated amphibian systems. Staff is able to adequately care for the amphibians and equipment at the center through training via their partnership with Omaha Zoo.

With challenges such as lack of expertise, insufficient organization and poor funding facing many countries where amphibian declines are taking place, not all regions are equipped to handle recovery of endangered species. In many cases, it is only through capacity building and skill transfer from outside sources that the global community is going to be able to meet these challenges.

How Can Your Zoo Help?

- Donate funds to the South African Amphibian Conservation Center
- Develop similar programs with existing projects from your facility