



Action Plan for *Ex Situ* Amphibian Conservation in the AZA Community

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For more information about AZA and its amphibian programs, visit
http://www.aza.org/ConScience/Amphibians_Intro/

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Background

Frogs are going extinct. So are toads, salamanders, newts, and the intriguingly unusual caecilians. The World Conservation Union's (IUCN) Global Amphibian Assessment (GAA), a comprehensive conservation status and distribution assessment of 5,918 amphibian species, has shown that almost one-third (32% or 1,896 species) of amphibians worldwide are threatened with extinction and that 165 amphibian species may have already been lost to extinction (IUCN, 2006). North America is not immune to this decline; in fact, in addition to its threatened species, North America has the dubious claim of being the only region with a species listed as Extinct in the Wild.

Globally and in North America, habitat degradation and destruction, chemical pollutants, invasive species, and climate change have been the driving culprits behind species declines. A new threat, the rapidly dispersing infectious disease chytridiomycosis ("chytrid") is now being identified as the responsible agent behind many declines, including those found in relatively pristine and protected habitats.

The IUCN is calling on zoos and aquariums to participate in the global response to this conservation crisis. Recognizing that the rate of decline far outpaces the ability to respond to environmental problems *in situ*, captive assurance populations have been recognized as the only hope for survival for many amphibian species and will buy time to respond to threats in the wild.

The IUCN, WAZA (World Association of Zoos & Aquariums), CBSG (Conservation Breeding Specialist Group), the ASG (Amphibian Specialist Group), and regional zoological associations have hosted a series of workshops and helped develop a number of documents to support the zoological community's *ex situ* response to this crisis. Key among these initiatives and resources are:

- IUCN Technical Guidelines on the Management of *Ex Situ* Populations for Conservation (IUCN, 2002).
- *CBSG/WAZA Amphibian Ex Situ Conservation Planning Workshop - Final Report* which was held in El Valle, Panama and includes best practices recommendations for quarantines and housing (Zippel *et al.*, 2006).
- The development of the Amphibian Ark, a joint initiative of WAZA, the CBSG, and the ASG, to implement the *ex situ* components of the *Amphibian Conservation Action Plan* (ACAP). Amphibian Ark's web site (www.amphibianark.org) is a great resource.
- The ACAP, published in 2007 in response to the 2005 Amphibian Conservation Summit in Washington, D.C. is a comprehensive response to amphibian population declines, of which *ex situ* captive breeding is one component.
- Regions are identifying their priorities and action steps. Species prioritization workshops have occurred in Europe and Madagascar, a regional action plan was published for the Australasian zoological community in June 2007, and a Costa Rican Amphibian Conservation Strategy was released in July 2007.

The Association of Zoos & Aquarium (AZA) community has been directly and indirectly active in many of these efforts. AZA and its members have attended and helped sponsor some of these workshops, AZA has partnered with the Amphibian Ark, and AZA's Amphibian Taxon Advisory Group (ATAG) and AZA-supported organizations such as the Zoo Conservation Outreach Group (ZCOG) have paid for international colleagues to attend workshops and be trained at AZA's *Amphibian Biology and Management* course. The ATAG has also responded to the IUCN's call that regional associations provide strategic direction for addressing their regions conservation concerns and in July 2007 the Fort Worth Zoo hosted an Amphibian Species Prioritization for *Ex Situ* Conservation Workshop. This report presents the findings of

that workshop and provides AZA facilities with a North American amphibian conservation action plan.

Introduction

The captive rearing of amphibians in Canada and the US is not new. In 1982, six wild Puerto Rican crested toads were captured, brought into AZA-accredited zoos and aquariums, and managed under AZA's first amphibian Species Survival Plan® (SSP). US Fish and Wildlife Service-developed Recovery Plans dating back to 1991 include captive rearing components, and captive populations are also housed at universities, local and national government facilities, and in private collections.

However, until now there has been no strategic approach to the use of *ex situ* captive rearing for conservation management purposes. Some communities have developed captive rearing programs to respond to local concerns and the participation of AZA-accredited zoos and aquariums in captive rearing programs has frequently reflected the interests of individual facilities and the needs of state wildlife agencies. This document describes the development of a strategic blueprint for the creation of new and the expansion of existing captive rearing programs at AZA facilities to address North American conservation objectives.

In July 2007, twenty-one participants came together in Fort Worth, TX for an Amphibian Species Prioritization for *Ex Situ* Conservation Workshop (Appendix 1). The purpose of this workshop was to utilize a prioritization tool developed by the Amphibian Ark to examine which of the critically endangered, endangered, data deficient, and phylogenetically unique amphibian species in Canada and the US could benefit from captive rearing programs. The list of species generated from this process (Appendix 2) will help guide AZA facilities engage in strategic North American amphibian conservation. Critically endangered species in the Caribbean and Mexico were also examined using this tool to provide strategic conservation direction to AZA facilities already working in those regions (Appendices 3 and 4, respectively). Facilities interested in working with these species need to work in collaboration with the appropriate in-country stakeholders and local regional zoological associations.

Based on the list of species generated from this process, members of the ATAG and regional experts drafted preliminary taxon management actions plans for species that received high listings and had existing *ex situ* mandates. These draft plans describe the goals, objectives, and necessary actions for each program, as well as identifies a coordinator responsible for implementing the plans.

As described in the IUCN's *Amphibian Conservation Action Plan (ACAP)*, *ex situ* conservation is only one component of amphibian conservation. All captive rearing programs must be developed in coordination with appropriate government agencies and partners and must be integrated with *in situ* research and management activities that specifically address and mitigate the threat(s) that caused the population's original decline. Some AZA-accredited zoos and aquariums are already actively engaged in these *in situ* efforts; the partnership building associated with *ex situ* conservation will bring even more opportunities to participate in these efforts. Participation in activities such as population monitoring, research, and habitat management will help integrate the *ex situ* and *in situ* conservation activities, as well as improve and expand on-ground education and public awareness efforts.

The Amphibian Ark Prioritization Tool for *Ex Situ* Conservation

Amphibian Ark's *Prioritisation and Implementation Process for Ex Situ Conservation of Amphibians* (Appendix 5) was based on a draft initially developed at the February 2006 CBSG/WAZA Amphibian *Ex situ* Conservation Planning Workshop in El Valle, Panama and

was further refined through the widespread solicitation of comments and finalization by Amphibian Ark staff. The Fort Worth meeting was the first time this tool was used in its final form for prioritization purposes.

The tool asks a set of questions about each species and assigns points to each answer. These points form the prioritization rankings at the end of the process. Questions cover new and emerging conservation threats not incorporated in the GAA listing, threat mitigation possibilities, socio/economic importance, phylogenetic uniqueness, scientific and biological importance, and other factors.

The tool differentiates among captive rearing programs and their primary conservation purpose:

- *Ark* programs are few and far between, requiring that the target species is already extinct (or functionally extinct) in the wild. Under this scenario, any survivors discovered would be candidates for an emergency captive rearing program.
- *Rescue/supplementation* captive programs support populations who are in imminent danger of going extinct and whose wild population would benefit from *ex situ* management as part of its recommended conservation action.
- *Farming* programs provide individuals to replace a demand for wild harvested specimens. This situation has not been identified for any Canadian or US species.
- *Conservation research* programs are meant for species whose conservation could benefit from specific applied research or that could provide needed insight for the conservation and management of a related species.
- *Conservation education* captive programs are for species selected and bred specifically for their educational impact.

Many benefits accrue from using this tool to identify appropriate species for captive rearing programs. One benefit is that the ranking is based on discrete scores that can be discussed among experts and can change as new information (i.e., the presence of chytrid or the initiation of conservation management) arises. This transparency is helpful for discussions with conservation partners that may be skeptical about a facility's interest in a particular species. A second benefit is that the process can be replicated; the subjectivity of answers is minimized through the use of strictly and clearly defined terms. A replication test will be done in September 2007 when the Mexican Association of Zoos and Aquariums (AZCARM) uses the same process and tool to prioritize Mexican amphibians for *ex situ* captive rearing programs. After that meeting, the results from both regional associations' meetings can be compared. A third benefit is the potential to compare rankings across regions. The urgency of a captive program has the potential to be shown in relation to the needs of other regions, making resource allocation more efficient.

After analyzing biological and socio/economic criteria, the tool states that further action is contingent on the existence of both an official captive rearing mandate and range state approval. If either of these items is lacking, the first step is to develop the relationships necessary for these requirements to be met or for the zoo and aquarium community to understand the reasons for why a captive program is not an appropriate conservation measure. Additional questions evaluate program feasibility and readiness for program implementation.

Conservation status of Canadian and US amphibians

According to the GAA (IUCN, 2006), of the two hundred and sixty-five known amphibian species in Canada and the US, two species have already gone extinct, one species is extinct in the wild, three species are critically endangered, and another fifteen species are endangered (Figure 1). This means that over 7% of US/Canadian amphibian species are threatened with

extinction, while 13% are considered vulnerable. The US Fish and Wildlife Service (USFWS) lists twenty-one species in the US and its territories as threatened or endangered under the Endangered

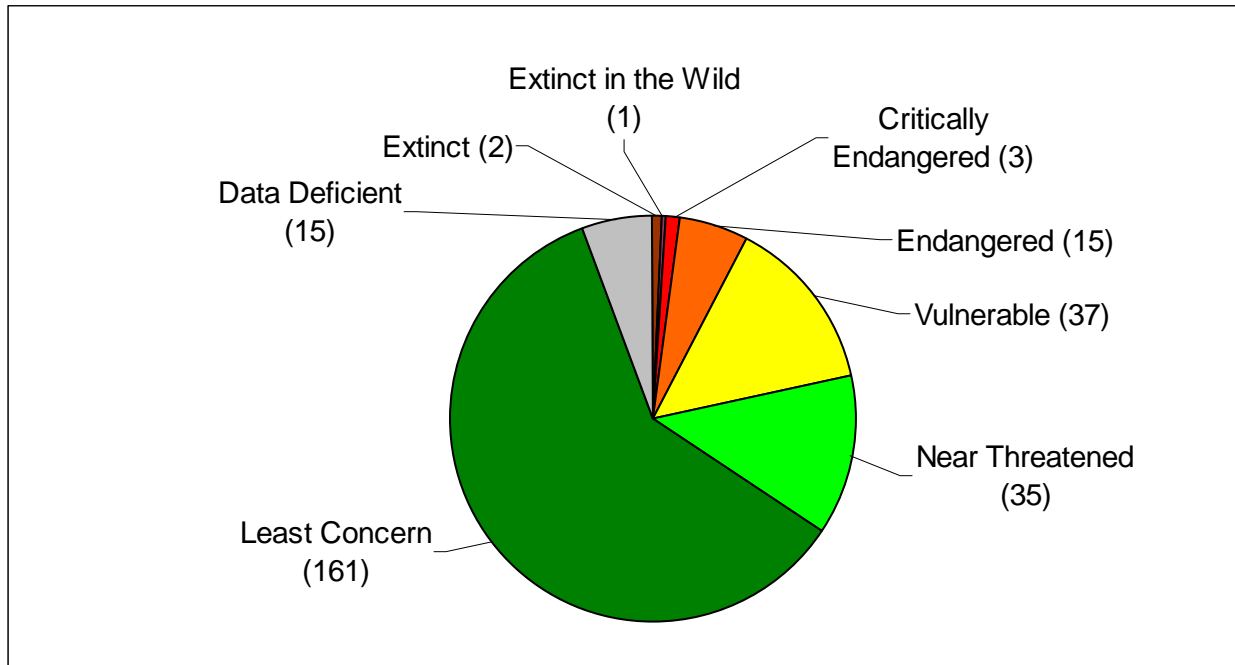


Figure 1. The Conservation Status of Amphibians of the United States and Canada.

Species Act (ESA) and of these, sixteen have finalized recovery plans or are in the midst of the plan's final revision. An additional ten amphibians are listed as candidate species for listing under the ESA.

The causes of amphibian declines are large and diverse and scientists are only beginning to understand the cumulative impacts of multiple environmental changes. Habitat loss and degradation is the most critical threat facing amphibian populations in the US (Muths *et al.*, 2006). However, the type of habitat change affects amphibians differently; agriculture and urban development have the largest impacts on anurans while timber harvesting/silviculture is the predominant land use threat facing caudates (Bradford, 2005). High levels of pollution (pesticides, nitrates from fertilizers, endocrine disruptors, etc.) are known to affect amphibians, but the effect of sub-lethal levels and the impact of pollutants acting synergistically with other threats is only beginning to be studied (Halliday, 2005). Chemical contaminants such as pollution, mine water pollution, and acid mine drainage is the second most frequently cited threat facing caudates (Bradford, 2005). The introduction of non-native species particularly fishes, American bullfrogs, and crayfish have been implicated as a significant threat, particularly in the Southwest (Muths *et al.*, 2006) and is the second more frequently cited threat facing anurans (Bradford, 2005). Disease has been implicated in the declines of some amphibian declines in the US (Muths *et al.*, 2006). Finally, amphibian declines in "protected" areas has drawn widespread attention, but Halliday (2005) points out that protected status only addresses one major threat, habitat destruction, and does nothing to mitigate the impacts of climate change, pollution, increased ultraviolet B radiation, and disease.

The GAA calls for captive rearing programs for three species and indicates that a fourth species already has a captive program in place. A reintroduction program is recommended for an additional species (Table 1). The GAA does not specifically recommend captive rearing

or reintroduction programs for the remaining thirteen critically endangered and endangered species in the US and Canada.

Captive rearing programs are explicitly recommended in two USFWS recovery plans, while maintaining the capability for refugia populations in the case of an emergency event is called for in an additional two recovery plans. One plan calls for augmenting populations through translocations while another plan calls for restoring toad populations to its historic range through introductions, but does not specify the source of the individuals (Table 1).

Table 1. Species with captive program, reintroduction, or translocation recommendations

Source of Recommendation	Species	Comments
USFWS Recovery Plan/GAA	<i>Bufo baxteri</i>	Captive program recommendation
USFWS Recovery Plan/GAA	<i>Bufo houstonensis</i>	USFWS: Calls for introductions GAA: Captive program in place and is needed
GAA	<i>Bufo lemur</i>	Captive program in place
USFWS Recovery Plan	<i>Eurycea sosorum</i>	Captive program recommendation
USFWS Recovery Plan	<i>Eurycea nana</i>	Maintain refugia capabilities
USFWS Recovery Plan	<i>Typhlomolge rathbuni</i>	Maintain refugia capabilities
USFWS Recovery Plan	<i>Rana chiricahuensis</i>	Augmentation through translocation
GAA	<i>Rana onca</i>	Reintroduction recommendation
GAA	<i>Rana sevosa</i>	Captive program in place and is needed
GAA	<i>Rana subaquavocalis</i>	Reintroduction program in place; captive program needed

Current amphibian *ex situ* activities in Canada and the US

Species in captivity

The GAA lists 265 species in Canada and the US. Workshop participants evaluated six additional taxa not described at the time of the GAA (*Ambystoma bishopi* [split from *A. cingulatum* by Pauly *et al.*, 2007], *Rana* sp. [to be split from *R. chiricahuensis*, according to Sredly and Jennings, 2005], *Rana sierrae* [split from *R. muscosa* by Vredenburg *et al.*, 2007]), *Batrachoseps aridus* [recognized in Hansen and Wake (2005)], and a cannibalistic morph of *Ambystoma tigrinum* from Iowa (Mike Lannoo, pers. comm.). Workshop participants analyzed the Ozark Hellbender as if it were a full species *Cryptobranchus bishopi*.

Of the 271 taxa of amphibians native to the US and Canada, 111 (~41%) are represented in captivity in AZA institutions. Only 54 (~20%) species are present in captivity in numbers of 10 or more individuals. Of the approximately 18,549 specimens of amphibian in AZA institutions 7,670 (~41%) specimens are native to North America. About 77%, or 5,910 specimens, of those native amphibians belong to ten species (ISIS, 2007). Of those ten native amphibian species one is extinct in the wild (*Bufo baxteri*), one is endangered (*B. houstonensis*), one is vulnerable (*Rana pretiosa*) and seven are least concern (*B. marinus*, *B. americanus*, *R. sylvatica*, *R. catesbiana*, *Hyla cinerea*, *H. versicolor*, and *Notophthalmus viridescens*) according to the GAA (IUCN, 2006).

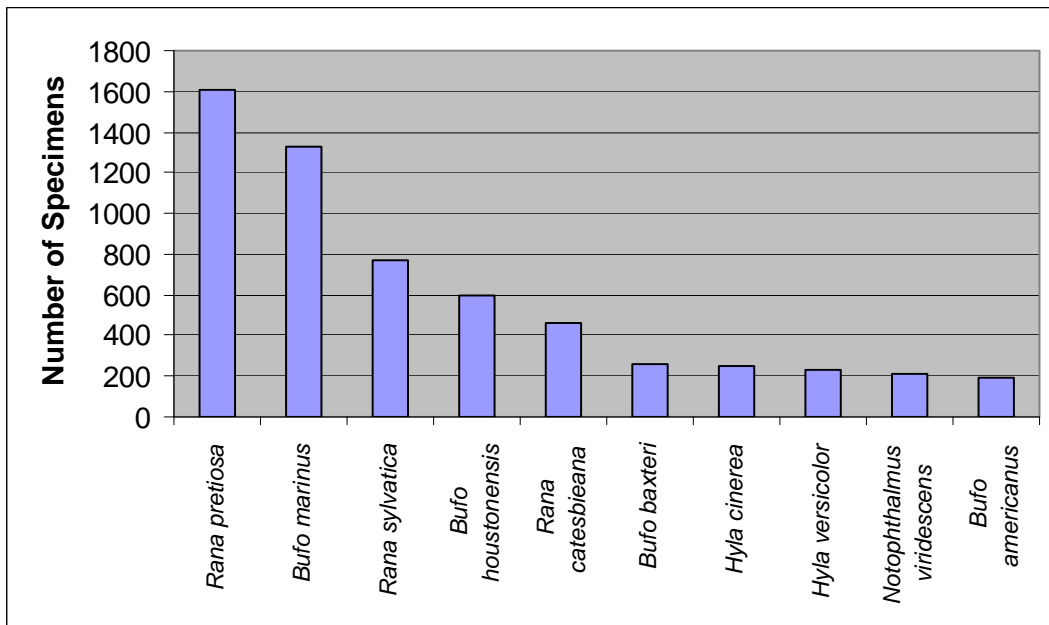


Figure 2. Ten most common amphibian species in AZA collections

At the species level, major gaps exist in AZA collections. Approximately 60% of amphibians native to the US and Canada do not exist in captivity at this time. Even with the most liberal estimates (~10%, IUCN threat category EW, CR, EN and USFWS Recovery Plans) most do not, or are unlikely to require *ex situ* management as part of the recommended conservation action in the immediate future. Investment of amphibian resources has been biased towards species that are considered stable in the wild and classified as Least Concern (~63%) by the IUCN accordingly (Figure 3).

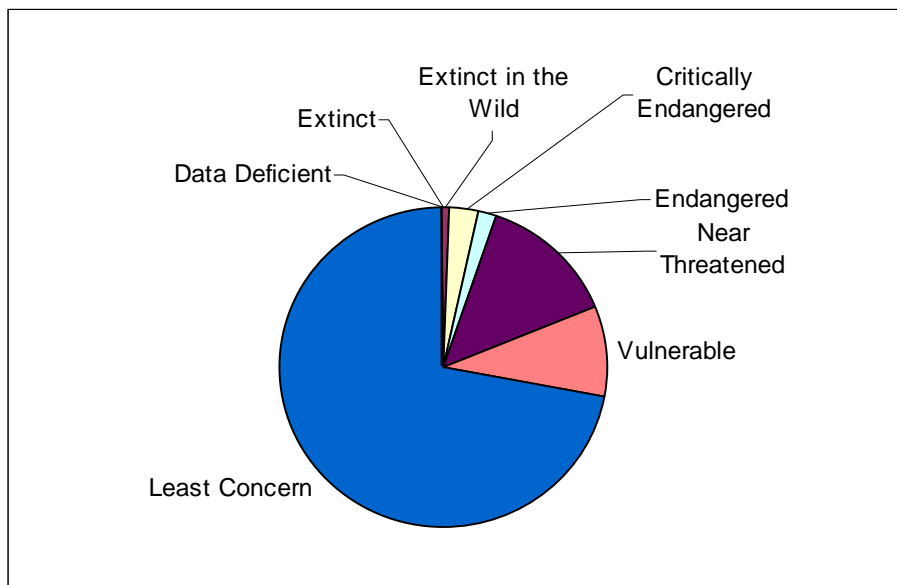


Figure 3. Conservation status of AZA amphibian collections (species distribution)

Of the thirty-nine currently recognized genera of amphibians in the US and Canada thirty (~75%) are represented in AZA collections. The nine genera not represented are *Craugastor*, *Eleutherodactylus*, *Haideotriton*, *Hydromantes*, *Hypopachus*, *Leptodactylus*, *Rhinophrynus*, *Rhyacotriton*, and *Stereochilus*. The lion's share (~75%) of the space dedicated to native amphibian species by AZA institutions are given to four genera (*Bufo*, *Hyla*, *Notophthalmus* and *Rana*), with the remaining twenty-five genera sharing 25% of the resources. Fifteen genera are represented by fewer than thirty individuals of one or a few species (*Aneides*, *Ascaphus*, *Batrachoseps*, *Desmognathus*, *Dicamptodon*, *Ensatina*, *Gastrophyrne*, *Gyrinophilus*, *Hemidactylum*, *Pheognathus*, *Plethodon*, *Pseudacris*, *Scaphiopus*, *Smilisca*, and *Typlotriton*). The remaining fifteen genera are well represented however, a few genera contain many specimens but they are all of the same species. For example, AZA institutions hold close to 100 *Necturus maculosus* but the four other species of this genus are unrepresented.

Seventeen amphibian families are found in the US and Canada. Three of them, Leptodactylidae, Rhinophrynidae and Rhyacotritonidae lack representatives in AZA collections, although one of those families (Leptodactylidae) is represented by species from outside the region. Two of the fourteen families with species in AZA collections, Bufonidae and Ranidae, constitute 73% of AZA amphibian collections, representing 34% and 39% of the collections, respectively (Figure 4).

Of the two amphibian orders present in the US and Canada, 1035 (~14%) caudates and 6393 (~86%) anurans are currently maintained in captivity. Of the diversity of amphibians in the US and Canada, ~65% are caudates and ~35% are anurans.

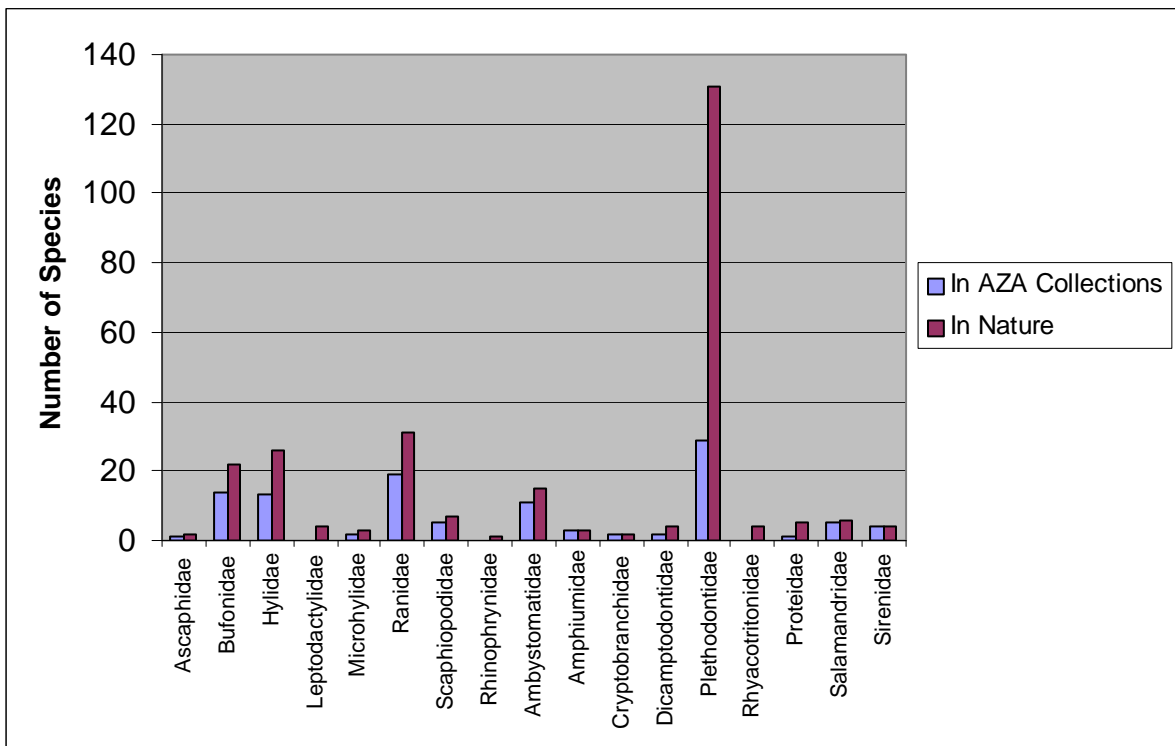


Figure 4. Diversity of amphibian families in nature and in AZA collections

When a species is in captivity, it is assumed that there exists at least a minimal ability to meet the spatial, nutritional, and microhabitat requirements necessary for its *ex situ* management. This assumption does not extend to reproduction and a more accurate picture would require

a species by species analysis. However, given the basic assumption, about 40% of the amphibians native to the US and Canada could be kept in captivity to some degree. It is worth noting that prior to recent taxonomic revisions, specimens of each the extinct in the wild and critically endangered species in Canada and the US existed in captivity, although in numbers that make starting a meaningful conservation program impossible. The situation is not the same for the Endangered species, with twelve of the fifteen taxa being unrepresented.

Of the 111 species held in AZA collections, 24 species (~21%) have been bred to some degree in captivity. Of the species recommended for some type of *ex situ* conservation, only five have been bred in captivity by AZA institutions: the Wyoming toad (*Bufo baxteri*), Houston toad (*Bufo houstonensis*), San Marcos salamander (*Eurycea nana*), Barton Springs salamander (*Eurycea sosorum*), and the Texas blind salamander (*Eurycea rathbuni*).

Institutional capacity

During the ATAG's February 2006 Institutional Space Survey, 44 responses from close to 200 AZA institutions were received. A 22% response rate is too low to effectively plan a regional conservation action plan, but is currently the best information available for determining AZA amphibian conservation capacity. The response highlights the need for AZA institutions to expand commitments and cooperation with regional space surveys planning.

Of the 22% of AZA institutions that responded to the survey it was determined that the following space could be dedicated to amphibians. All space has been converted into "US Gallons," the survey calculated in gallon equivalents.

- Between ~6000 (existing) and 14000 (total potential, including existing) gallons for education, exhibits, and research;
- Between ~18000 (existing) and 36000 (total potential) gallons for off-exhibit research and holding;
- Between ~6000 (existing) and 19000 (total potential) gallons for Species Survival Programs; and
- Between ~2000 (existing) and 6000 (total potential) gallons for biosecure, quarantined programs.

Compared to other larger vertebrate taxa (e.g. elephants, gorillas, etc.), the spatial requirements of amphibians are relatively small. However, the scale in terms of the number of species that require serious, biosecure *ex situ* conservation measures is quite large. If a maximum of 6000 gallons (300 twenty gallon aquariums) of quarantined space is available in all AZA institutions then only two or three species of small to medium-sized anurans can be maintained *ex situ*. Given that this document presents the top *ex situ* priorities amphibians of the US and Canada, and two of those taxa are aquatic salamanders approximately one meter in length, AZA institutions need to expand current quarantine capacity approximately eight times, from ~6000 gallons to ~81000 gallons (based on small to medium sized anurans and caudates needing a total population size of 300 individuals and 3000 gallons of space, and large aquatic caudates needing 6000 gallons of space).

Not all facilities will be able to provide quarantined conservation space but with planning and cooperation, these institutions can still assist the conservation of native amphibians by dedicating space to captive husbandry and reproductive research. Protocols could be developed at these facilities and implemented *en masse* at institutions with biosecure facilities for reintroduction purposes.

Finally, and certainly no less important, valuable exhibit space is, and should continue to be, utilized to shift perception of amphibians in the public eye.

Conservation Priorities

Regional Priorities

Given the relatively low number of amphibian species threatened with imminent extinction in Canada and the US, the few existing captive rearing programs addressing these needs, and the IUCN mandate for *ex situ* amphibian captive rearing programs for all critically endangered species, preferably in their range-country, AZA must first promote the conservation of its local critically endangered amphibian species above the priorities of other regions. This North American focus will allow AZA facilities to expand its institutional capacity and personnel expertise while working within domestic infrastructure, permitting, and partnership confines, and to decrease the financial resources required for effective conservation. In addition, a regional focus allows AZA members to demonstrate commitment to local communities and minimizes cultural and public relations conflicts related to the export of biodiversity from other regions. Once the AZA community has a handle on addressing the local North American amphibian population declines, it will be better prepared to support the programs and priorities of other regions around the world.

New World species are more threatened than Old World species, and within the New World, Mesoamerica has the highest number of critically endangered amphibians. Of the 442 species of critically endangered amphibians across the globe, 349 (~80%) occur in the New World and 93 (~20%) occur in the Old World. Amphibians themselves are more evenly distributed, with 3138 species (~53%) in the New World and 2762 (~47%) in the Old World. Of the 349 critically endangered species in the New World, three (<1%) occur in North America, 142 (~40%) occur in Mesoamerica, 140 (~40%) occur in South America, and 65 (~19%) occur in the Caribbean (Table 2). A country breakdown and ranking (Appendix 8) should help guide institutions interested in developing relationships outside of the US and Canada.

Table 2. Distribution of critically endangered amphibians in the New World (IUCN, 2006).

	North America	Mesoamerica	South America	Caribbean
Total Amphibian Species	265	710	2119	204
% of Global Biodiversity	~4	~12	~36	~3
Total Critically Endangered Species	3	142	140	65
% of New World CR Species	<1	~40	~40	~19
% of Global CR Species	<1	~32	~31	~15
Size of Region (square miles)	~8,500,000	~965,000	~6,900,000	193,000

As AZA amphibian conservation capacity grows and expands, support will be offered next to Mesoamerica, South America, and the Caribbean. Three AZA-accredited facilities are located in these regions (two in Mexico and one in Argentina) and there are a number of on-going amphibian conservation projects, specifically the Puerto Rican Crested Toad SSP®, Project Golden Frog/Atelopus Conservation Trust, and El Valle Amphibian Conservation Center, that will facilitate additional amphibian conservation projects and partnerships throughout the regions. Chytrid fungus has been documented throughout this region and its spread may require emergency collections and evacuations. Support from AZA should prioritize the testing and monitoring of this disease, as well as the creation of in-country facilities and capacity to house these emergency assurance populations.

Species Priorities

The number of amphibians and the causes of their decline in Canada and the US are large and diverse, complicating conservation measures. Because of this diversity and the need to

allocate the AZA community's limited amphibian conservation resources efficiently, the use of Amphibian Ark's *Prioritisation and Implementation Process* was particularly helpful. Because no US federal or state government agency has systematically assessed the potential of captive rearing programs to support at-risk species and because recovery plans have been developed over three decades and by various offices, workshop participants assessed all amphibian species in Canada and the US ranked as either critically endangered or endangered by the IUCN, those species listed under the Endangered Species Act, and species identified with a high degree of phylogenetic uniqueness. Species identified as extinct were not included in the review (Appendix 2). Workshop participants drafted basic taxon management action plans (TMAPs) for species regarded as priority species for *ex situ* conservation programs (see Appendix 6 for a sample TMAP) and assigned species coordinators to these plans to ensure implementation (Appendix 7).

Species prioritizations for critically endangered amphibians in the Caribbean and Mexico were completed at the Fort Worth Workshop, as well (Appendices 3 and 4, respectively). The lists that have emerged from this process are meant to guide the conservation activities of AZA facilities with ongoing partnerships, relationships, and projects in the regions. The Mexican Association of Zoos and Aquariums will be completing a similar process in September 2007 and the outcomes of both meetings should be taken into consideration. AZA-accredited facilities have a long history of amphibian conservation in Puerto Rico as a result of the Puerto Rican crested toad SSP®. Additional activities in the region may stem from the partnerships developed through this program. Any project in Mexico and the Caribbean must be implemented in cooperation and collaboration with local experts, partners, and governments and should incorporate a plan to help develop in-range facilities and capacity to accommodate captive populations.

Table 3. *Ex situ* priorities for US and Canada

Species	IUCN Status	USFWS Status	AARK Score	Ex situ Recommendation		Purpose	Presently in captivity			Captive-Bred
				IUCN	Other*		AZA	US Private	Other	
<i>Cryptobranchus bishopi(a)</i>	Near Threatened (NT)	Candidate	68		+	Res; Research; Edu	+			
<i>Rana muscosa</i>	Critically Endangered (CR)	Endangered	66	+	+	Insur	+			
<i>Rana sierrae</i>	Critically Endangered (CR)	Not Listed	66		+	Insur				
<i>Rana sp. (b)</i>	Critically Endangered (CR)	Not Listed	66	+	+	Insur				
<i>Necturus alabamensis</i>	Endangered (EN)	Candidate	59					+		
<i>Bufo californicus</i>	Endangered (EN)	Endangered	58							
<i>Rana sevosa</i>	Critically Endangered (CR)	Endangered	56	+	+	Insur	+			
<i>Rana subaquavocalis (c)</i>	Critically Endangered (CR)	Not Listed	51		+	Insur	+			
<i>Bufo baxteri</i>	Extinct in the Wild (EW)	Endangered	50	+	+	Ark	+		+1	+
<i>Cryptobranchus alleganiensis</i>	Near Threatened (NT)	Not Listed	50				+			
<i>Eurycea tonkawae</i>	Endangered (EN)	Not Listed	50			Insur		+	+2	
<i>Eurycea chisholmensis</i>	Vulnerable (VU)	Candidate	48			Insur;	+			
<i>Eurycea sosorum</i>	Vulnerable (VU)	Endangered	46		+	Insur	+		+2	+
<i>Eurycea waterlooensis</i>	Vulnerable (VU)	Candidate	46		+	Insur			+2	
<i>Rhyacotriton olympicus</i>	Vulnerable (VU)	Not Listed	45							
<i>Amphiuma pholeter</i>	Near Threatened (NT)	Not Listed	44				+			
<i>Eurycea naufragia</i>	Endangered (EN)	Candidate	42							
<i>Rana chiricahuensis (d)</i>	Vulnerable (VU)	Threatened	38				+			
<i>Rana pretiosa</i>	Vulnerable (VU)	Candidate	38				+			
<i>Eurycea nana</i>	Vulnerable (VU)	Threatened	38		+	Insur	+		+3	+
<i>Eurycea rathbuni</i>	Vulnerable (VU)	Endangered	38		+	Insur	+		+3	+
<i>Dicamptodon ensatus</i>	Near Threatened (NT)	Not Listed	37				+			
<i>Rhyacotriton cascadae</i>	Near Threatened (NT)	Not Listed	37							
<i>Rhyacotriton kezeri</i>	Near Threatened (NT)	Not Listed	37							
<i>Ascapus truei</i>	Least Concern (LC)	Not Listed	34			Research	+			
<i>Bufo canorus</i>	Endangered (EN)	Candidate	34							
<i>Rana onca</i>	Endangered (EN)	Candidate	34							
<i>Ambystoma californiense</i>	Vulnerable (VU)	Endangered	33				+			
<i>Dicamptodon aterrimus</i>	Least Concern (LC)	Not Listed	33							
<i>Dicamptodon copei</i>	Least Concern (LC)	Not Listed	33							
<i>Batrachoseps aridus</i>	Critically Endangered (CR)	Endangered	33	+		Insur				
<i>Bufo houstonensis</i>	Endangered (EN)	Endangered	32		+	Reintro; Insur	+			+

Table 3 Notes.

* US Fish and Wildlife Service, local and state government agencies

(a) The Ozark Hellbender (*Cryptobranchus alleganiensis bishopi*) was evaluated as a full species based on unpublished comments in the USFW candidate assessment form.

(b) *Rana* sp. is a form of the Chiricahua Leopard Frog (*Rana chiricahuensis*) from North of the Mogollon Rim, this likely represents an undescribed species (Sredl and Jennings, 2005).

(c) The Ramsey Canyon Leopard Frog (*Rana subaquavocalis*) was recently synonymized with the Chiricahua Leopard Frog (*Rana chiricahuensis*) (Goldberg et al., 2004)

(d) The Chiricahua Leopard Frog (*Rana chiricahuensis*) is currently a complex of at least two taxa (Goldberg et al., 2004).

1 - Saratoga National Fish Hatchery and Sybille Wildlife Research Center, WY.

2 - Austin Watershed Development and Protection Review Department, TX.

3 - San Marcos National Fish Hatchery and Technology Center, TX.

The priority list contains all species that scored above 32. This score represents the lowest taxa with an existing *ex situ* mandate.

Characteristics shared among priority species

North America is a heterogeneous environment with amphibians in different regions declining due to a synergistic combination of varying threat processes, some not fully understood. However, almost all of the species listed in Table 3 are threatened due to water use practices and/or habitat loss. As opposed to different regions of the New World, specifically the higher elevation tropics, disease is less of a single significant threat. Although chytrid is clearly affecting some of the *Rana* and *Bufo* species (e.g., Vredenburg *et al.*, 2007), its role in the decline of the caudates is less clear. Ranavirus could potentially affect Californian Tiger salamanders (*Ambystoma californiense*) (Brunner *et al.*, 2003; Picco *et al.*, 2007) and a perkinsus-like virus could have had a role in the decline of the Mississippi gopher frog (*Rana sevosa*) (Green and Dodd, 2007).

Seven species of Edwards Plateau *Eurycea* are listed in Table 3. Water use practices in this area, as well as the potential risk of a contaminate spill, threaten all aquifer dwelling species. Introduced predators impose serious threats to the Californian Ranids *Rana muscosa* and *R. sierrae*, as well as to *R. onca* from Nevada, and *R. chiricahuensis* from New Mexico and Arizona. The Cryptobranchids, Proteids, and Sirenids are all threatened by water quality reduction associated with pollution and habitat degradation around water bodies (IUCN, 2006).

Surrogate Species

Only a handful of species-specific husbandry protocols have been developed, but the ecological requirements of each species, even within a genus, can vary and complicate captive rearing efforts. Low numbers of individuals in wild populations or challenges with breeding species in captivity may make it necessary to develop husbandry protocols on more common surrogate species before collecting the target species from the wild (Table 4). Working on a surrogate species allows techniques to be perfected with less of a conservation cost, as well as increases institutional and staff skills and capacity. These benefits will likely lead to a more successful captive rearing program on the higher risk species in the future.

Species with particularly challenging life histories and those that have not bred in captivity in the US and Canada, such as species in the genera *Necturus*, *Batrachoseps*, and *Cryptobranchus* should only be introduced into *ex situ* captive management programs at experienced facilities.

Husbandry manuals are currently available for the Panamanian golden frog (*Atelopus zeteki*), boreal toad (*Bufo boreas boreas*), Kihansi spray toad (*Nectophrynoides asperginis*), Wyoming toad (*Bufo baxteri*), mountain yellow-legged frog (*Rana muscosa*), hellbender salamander (*Cryptobranchus alleganiensis alleganiensis*), and Puerto Rican crested toad (*Bufo lemur*) (ATAG, 2007).

Table 4. Priority species for *ex situ* conservation requiring research on a surrogate species

Target species	Potential surrogate species (if identified)
<i>Batrachoseps campi</i>	<i>Batrachoseps major</i>
<i>Gyrinophilus palleucus</i>	<i>Gyrinophilus porphyriticus</i>
<i>Necturus alabamensis</i>	<i>Necturus beyeri</i> or <i>N. maculosus</i>
<i>Ambystoma californiense</i>	<i>Ambystoma tigrinum</i>
<i>Rana onca</i> ,	<i>Rana yavapiensis</i>
<i>R. chircahuensis</i> , <i>R. subaquavocalis</i> , <i>R. spp.</i> ,	TBD
<i>Rana seivosa</i>	<i>Rana capito</i>
<i>Rana muscosa</i> , <i>R. sierrae</i>	TBD
<i>Cryptobranchus spp.</i>	No surrogates available
Blind Central Texas <i>Eurycea</i> species	No surrogates available
Central Texas <i>Eurycea</i> species	<i>Eurycea neotenes</i>
<i>Bufo canorus</i> , <i>B. californicus</i>	TBD
<i>Bufo houstonensis</i>	<i>Bufo americanus</i>

Broader Biodiversity Considerations

The Amphibian Ark's *Prioritisation and Implementation Process* focuses on those species whose populations are currently threatened with extinction. However, meeting participants were adamant that AZA should be proactive with regards to North American amphibians and identify those that should be targeted for an *ex situ* captive rearing program because of their phylogenetic uniqueness. It was suggested that learning husbandry protocols for some of these highly significant species while their populations were not currently at risk, might lead to successful programs in the future if they were to become threatened. As a result of these discussions, meeting participants discussed thirty-one species in the US and Canada and three species in Mexico with high evolutionary distinctiveness as ranked by the Zoological Society of London's Evolutionarily Distinct and Globally Endangered (EDGE) program. The large majority of these species are currently listed as least concern by the IUCN, but seven of them were ranked as either vulnerable or near threatened and a number of these species are included as *ex situ* priorities in Table 3.

Fifteen of species listed in Table 3 are already represented in AZA collections. Three other species are present in the private sector or at other non-AZA facilities. Other species, such as *Bufo californicus*, *B. canorus*, and *Rana onca* are on the priority list but lack *ex situ* mandates from the appropriate source. Consideration should be given to the necessary conservation measures needed for these species. If it is determined that *ex situ* tactics would benefit the species and the mandate is acquired, they should be brought in, in part based on the rankings generated when using the *Prioritisation and Implementation Process*.

The species in Table 5 were identified during the prioritization process of being species of potential educational value within the range of the taxa. This may have impact because of cultural significance, a conservation success story, or because of their impact on other species.

Table 5. Species targeted for regional conservation education programs

Species	Region
<i>Notophthalmus meridionalis</i>	Texas
<i>Rana catesbeiana</i>	Western US
<i>Rana aurora</i>	California

Research

There are many unanswered research gaps regarding North American amphibians and associated population declines. Because research begets additional questions, scientific literature tends to be biased toward species that have already received some study. As a result, a lot is known about a few species and but very little is known about many species

(Lannoo, 2005). Another cause of species bias is the challenge of observation, such as those that spend most of their time underground or underwater (Lannoo, 2005). Research with *ex situ* populations has the potential to address some of these gaps due to focusing on species because of their conservation status, rather than questions generated through previous research and due to manipulations in captive set-ups. *Ex situ* populations can address both species-specific and more general questions.

A few of the topics that can be explored with *ex situ* management and breeding programs are:

- Husbandry and reproductive biology
- Experimentation and evaluation of translocation, supplementation, and reintroduction programs
- Research on diseases and specifically the effect of the chytrid fungus on species. Epidemiological research can guide *in situ* research in regions either affected by or those facing the arrival of new diseases
- Provision of individuals for supplementation and reintroduction programs or additional research

Species-specific research should address questions raised by federal recovery plans and state agencies, emerging threats facing vulnerable species, and tackle other questions that will help stabilize populations in the wild.

Institutional capacity of the AZA community

Facilities

Dedicated amphibian facilities exist at very few AZA institutions. Detroit Zoological Institute, San Antonio Zoo, Cincinnati Zoo, the National Aquarium in Baltimore, Toledo Zoo, St. Louis Zoo, Central Park Zoo, Riverbanks Zoo and Garden, Omaha's Henry Doorly Zoo, Phoenix Zoo, Arizona-Sonora Desert Museum, ZooAtlanta, Toronto, and San Diego's CRES are among those that have separate amphibian buildings or departments. The Dallas Zoo, Ft. Worth Zoo, Houston Zoo, Columbus Zoo, San Diego Zoo, North Carolina Zoological Park, the Maryland Zoo at Baltimore, and Kansas City Zoo have plans to create biosecure quarantine space for amphibian reintroduction and rescue programs.

Most institutions are principally geared to maintaining amphibians for display, usually in small numbers, and lack the experience and expertise of breeding and/or maintaining large numbers of amphibians.

Expertise and Personnel

There are numerous people throughout the AZA community with amphibian husbandry expertise, however that expertise is limited in breadth and scale. In terms of breadth, only a small percentage of institutions have staff experienced with amphibians in captivity. Steps have been taken to expand this and since 2004, the AZA Professional Development Course *Amphibian Biology and Management* has been educating about 20 students each year in, among other things, the requirements of amphibians in captivity. The course has proved so successful that it will be offered twice in 2007, doubling the teaching capacity to over 40 students. In addition, institutions with more experience have served as training grounds for personnel from smaller institutions in an unofficial capacity. A "mentorship" program such as this offers many advantages and is encouraged. Institutions wishing to act as training facilities or those interested in obtaining expertise from another institutions are asked to contact either the institution they wish to work with directly, or a representative from the ATAG.

In terms of scale, very few individuals or institutions have experience working with amphibians in large numbers. Frequently, amphibians of a given species are shared among

multiple institutions to reduce the risks associated with all the specimens being housed in the same place. It is likely that for regional initiatives specimens will be concentrated at fewer facilities and techniques will have to be developed for dealing with large numbers of amphibians. European and Australian colleagues have experience with managing larger amphibian populations and will be a good resource as the AZA community expands its population sizes.

Quarantine protocols

While the specific quarantine and management protocols of each program will be determined by the needs and objectives set forth by the coordinators of that program, consideration should always be given to biosecurity. Primary goals of any program should always be to: 1) minimize the effects of the *ex situ* program on the native amphibians living in the region where the program is operated (e.g. by treatment of waste water [Lynch, 2001]) and 2) eliminate the chance of transmission of novel pathogens from indigenous amphibian fauna or a cosmopolitan collection housed at zoological institutions into the *ex situ* colony and then back into the wild during reintroduction programs.

Biosecurity recommendations range from isolated rooms to modified shipping containers that prevent the transmission of diseases via vectors such as rodents or cockroaches, and keep specimens within them separated from the surrounding environment. Routine screening and subsequent treatments for known diseases is recommended and thorough pre-release screening protocols should be in place for reintroduction programs (Daszak *et al.*, 2001). It is recognized that by recommending stringent biosecurity regulations for every program, some institutions may be excluded from participating.

The most convincing hypothesis that explains the emergence of chytrid across the globe is that of Weldon *et al.*, (2004). The hypothesis is that chytrid spread to Australia, Europe, and North America during the large-scale international trade in African clawed frogs (*Xenopus laevis*) from South Africa during the 1930's for use in pregnancy assays. *X. laevis* is thought to be relatively resistant to the disease and upon arriving in a novel environment, may have transmitted the pathogen to another locally adapted, resistant vector, such as American bullfrogs (*Rana catesbeiana*) in North America, and spread regionally. The practical message for zoological managers is that unknown diseases exist and it is our duty, as conservationists to, above all, do no harm.

Collection management

Management of populations for *ex situ* conservation purposes over long periods of time has its challenges (Snyder *et al.*, 1996; Lynch and O'Hely, 2001). The IUCN Policy Statement on Captive Breeding (1987) suggests establishing a captive colony while the total population size of the focal vertebrate taxa number in the thousands. However, consent or resources for *ex situ* conservation are rarely provided with this much forethought and planning. A more typical event is crisis response, and during such an event significant components of the natural genetic diversity of a species can be lost, potentially resulting in a genetic drift-effect during the founding process. Genetic management of the population and the insurance of adequate founder representation in subsequent generations can be an arduous tasks, as is balancing the need to minimize the spatial demands of the program with genetic objectives (Earnhart *et al.*, 2001).

New captive husbandry and reproductive research protocols should emphasize data collection and fine tuning of efficient systems with the ultimate goal, at least for reintroduction programs, being the ability to produce large quantities of healthy amphibians in as short amount of time as possible. Data such as egg laying events, egg size, time until hatching and associated water parameters at which this took place, size at hatching, time

until metamorphosis is complete, size at metamorphosis, age and size at first reproduction, and number of eggs. For direct developing and neotenic species, similar but appropriate life history data should be recorded. Maximum advantage should be taken from the *in situ* research links, as increasing the knowledge the species in the wild as it applies to *ex situ* management will ultimately yield some rewards. Conversely, data obtained from *ex situ* research should be made readily available for *in situ* researchers.

In summary, genetic management and data collection is essential to ensure the success of the *ex situ* program.

Recommendations and Actions

The Amphibian Species Prioritization Workshop resulted in a number of clear recommendations and action items. These actions will ensure progress on the development of captive rearing programs for high-priority species; maximize the energy, attention, and resources currently focused on amphibians and the related conservation crisis; and facilitate the management and coordination of amphibian conservation within the AZA community by the Amphibian Taxon Advisory Group (ATAG).

- *Implement taxon management action plans.* Species coordinators were identified for most of the species that were ranked as high priorities for an *ex situ* captive project and coordinators need to be identified for the remaining species (Appendix 7). These coordinators are responsible for ensuring continued momentum on the development of captive programs and will report each completed action to the ATAG and AZA staff. Coordinators will work with AZA staff to identify USFWS staff specializing in specific species to ensure that work is done in collaboration at the federal level, as well as with other appropriate government agencies.
- *Maximize participation in amphibian conservation through top-down directives and bottom-up education.* The ATAG needs AZA, the AZA Board of Directors, and other senior members of the AZA community to expect widespread participation in amphibian conservation from AZA members. Directors are more likely to commit resources to new and expanded conservation programs when it is part of an AZA-backed initiative, rather than the recommendation of curatorial or keeper staff. Directors, curators, and keepers need to be educated about what to expect from a captive rearing program focused on critically endangered species and be ready to initiate new programs, rather than relying on tapping into existing programs. One of the most important lessons will be to understand that partnership-building comes before any amphibians will be available for rearing or display. Most of these amphibians are not currently held in captive programs and acquiring the trust and permits necessary to collect animals are the basic first steps. The ATAG will assist facilities as they develop these new programs but will rely on the facility to take the lead.
- *Ensure coordination of amphibian conservation efforts in the AZA community by AZA's ATAG.* AZA-accredited facilities have a long, proud history of developing captive rearing programs for amphibians. However, these programs have frequently reflected the interests of a single person, rather than a strategic conservation effort and have been biased towards maintaining small populations for exhibit. While species champions are necessary for successful programs, partner agencies and organizations will only see the zoological community as a trusted conservation leader when programs contribute to strategic conservation goals.

- *Maintain transparency throughout the prioritization process.* AZA members will share both the process used to develop these recommendations and the outcomes with Caribbean and Mexican regional zoological associations, US government agencies, and amphibian conservation networks such as Partners in Amphibian and Reptile Conservation (PARC). Amphibian Ark will be enlisted to assist in communicating the process and outcomes to other regional zoological associations to ensure consistency of messages and to increase trust. The recommendations for each region (Canada, US, Mexico, and Caribbean) will be submitted to the Amphibian Specialist Group (ASG) by the Amphibian Ark after input from other regional zoological associations have been incorporated.
- *Respect the recommendations and the Global Amphibian Assessment as living documents and processes.* Regional experts at the Workshop were aware of status changes or new information that had not been incorporated into the GAA's report. This information will be presented to the Amphibian Ark, CBSG, and the ASG to be reviewed for inclusion in the GAA.
- *Promote field research in addition to ex situ captive rearing programs.* Two areas of field research were identified as high priorities: mapping the distribution of the chytrid fungus throughout the Caribbean and surveys of areas where species were thought to be extinct in the wild or are known to have high concentrations of biodiversity but have not been adequately monitored.
- *Raise funds to support amphibian conservation within the AZA community.* The amphibian crisis is different than other conservation responses; the rate and extent of species lost is unprecedented in human history. As such, the response needs to match the severity of this crisis. Funds should be raised so that the ATAG, with review from AZA staff or Board of Directors, can provide grants to support emergency responses and the expansion of amphibian conservation throughout the AZA community.

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(July 30- August 3, 2007)

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Appendix 2. List of prioritized species from Canada and the US

Genus	Species	Common name	Distribution	Extinction Risk (IUCN, 2006)	Prioritization Score
<i>Cryptobranchus</i>	<i>bishopi</i>	Ozark hellbender	United States of America	Near Threatened (NT)	68
<i>Rana</i>	<i>muscosa</i>	Mountain Yellow-Legged Frog	United States of America	Critically Endangered (CR)	66
<i>Rana</i>	<i>sierrae</i>	Sierra Nevada Yellow-legged Frog	United States of America	Critically Endangered (CR)	66
<i>Rana</i>	<i>sp.</i>	North of Mogollon Rim	United States of America	Critically Endangered (CR)	66
<i>Necturus</i>	<i>alabamensis</i>	Alabama Waterdog	United States of America	Endangered (EN)	59
<i>Bufo</i>	<i>californicus</i>	Arroyo Toad	Mexico, United States of America	Endangered (EN)	58
<i>Rana</i>	<i>sevosa</i>	Dusky Gopher Frog	United States of America	Critically Endangered (CR)	56
<i>Rana</i>	<i>subaquavocalis</i>	Ramsey Canyon Leopard Frog	United States of America	Critically Endangered (CR)	51
<i>Bufo</i>	<i>baxteri</i>	Wyoming Toad	United States of America (Extinct)	Extinct in the Wild (EW)	50
<i>Cryptobranchus</i>	<i>alleganiensis</i>	Hellbender	United States of America	Near Threatened (NT)	50
<i>Eurycea</i>	<i>tonkawae</i>	Jollyville Plateau Salamander	United States of America	Endangered (EN)	50
<i>Eurycea</i>	<i>chisholmensis</i>	Chisholm Trail Salamander	United States of America	Vulnerable (VU)	48
<i>Eurycea</i>	<i>sosorum</i>	Barton Springs Salamander	United States of America	Vulnerable (VU)	46
<i>Eurycea</i>	<i>waterlooensis</i>	Austin Blind Salamander	United States of America	Vulnerable (VU)	46
<i>Rhyacotriton</i>	<i>olympicus</i>	Olympic Torrent Salamander	United States of America	Vulnerable (VU)	45
<i>Amphiuma</i>	<i>pholeter</i>	One-Toed Amphiuma	United States of America	Near Threatened (NT)	44
<i>Eurycea</i>	<i>naufragia</i>	San Gabriel Springs Salamander	United States of America	Endangered (EN)	42
<i>Rana</i>	<i>chiricahuensis</i>	Chiricahua Leopard Frog	Mexico, United States of America	Vulnerable (VU)	38
<i>Rana</i>	<i>pretiosa</i>	Oregon Spotted Frog	Canada, United States of America	Vulnerable (VU)	38
<i>Eurycea</i>	<i>nana</i>	San Marcos Salamander	United States of America	Vulnerable (VU)	38
<i>Eurycea</i>	<i>rathbuni</i>	Texas Blind Salamander	United States of America	Vulnerable (VU)	38
<i>Dicamptodon</i>	<i>ensatus</i>	California Giant Salamander	United States of America	Near Threatened (NT)	37
<i>Rhyacotriton</i>	<i>cascadae</i>	Cascade Torrent Salamander	United States of America	Near Threatened (NT)	37
<i>Rhyacotriton</i>	<i>kezeri</i>	Columbia Torrent Salamander	United States of America	Near Threatened (NT)	37
<i>Ascaphus</i>	<i>truei</i>	Coastal Tailed Frog	Canada, United States of America	Least Concern (LC)	34
<i>Bufo</i>	<i>canorus</i>	Yosemite Toad	United States of America	Endangered (EN)	34
<i>Rana</i>	<i>onca</i>	Relict Leopard Frog	United States of America	Endangered (EN)	34

<i>Ambystoma</i>	<i>californiense</i>	California Tiger Salamander	United States of America	Vulnerable (VU)	33
<i>Dicamptodon</i>	<i>aterrimus</i>	Idaho Giant Salamander	United States of America	Least Concern (LC)	33
<i>Dicamptodon</i>	<i>copei</i>	Cope's Giant Salamander	United States of America	Least Concern (LC)	33
<i>Batrachoseps</i>	<i>aridus</i>	Desert slender salamander	United States of America	Critically Endangered (CR)	33
<i>Bufo</i>	<i>houstonensis</i>	Houston Toad	United States of America	Endangered (EN)	32
<i>Pseudobranchus</i>	<i>axanthus</i>	Narrow-Striped Dwarf Siren	United States of America	Least Concern (LC)	31
<i>Pseudobranchus</i>	<i>striatus</i>	Dwarf Siren	United States of America	Least Concern (LC)	31
<i>Ambystoma</i>	<i>cingulatum</i>	Flatwoods Salamander	United States of America	Vulnerable (VU)	28
<i>Ascaphus</i>	<i>montanus</i>		Canada, United States of America	Least Concern (LC)	26
<i>Rana</i>	<i>luteiventris</i>	Columbia Spotted Frog	Canada, United States of America	Least Concern (LC)	26
<i>Phaeognathus</i>	<i>hubrichti</i>	Red Hills Salamander	United States of America	Endangered (EN)	24
<i>Necturus</i>	<i>lewisi</i>	Neuse River Waterdog	United States of America	Near Threatened (NT)	24
<i>Necturus</i>	<i>punctatus</i>	Dwarf Waterdog	United States of America	Least Concern (LC)	23
<i>Rhyacotriton</i>	<i>variegatus</i>	Southern Torrent Salamander	United States of America	Least Concern (LC)	23
<i>Ambystoma</i>	<i>bishopi</i>	Frosted flatwoods salamander	United States of America	Vulnerable (VU)	20
<i>Amphiuma</i>	<i>means</i>	Two-Toed Amphiuma	United States of America	Least Concern (LC)	20
<i>Amphiuma</i>	<i>tridactylum</i>	Three-Toed Amphiuma	United States of America	Least Concern (LC)	20
<i>Rana</i>	<i>draytonii</i>	California Red-Legged Frog	United States	Near Threatened (NT)	19
<i>Desmognathus</i>	<i>folkerti</i>	Dwarf Black-Bellied Salamander	United States of America	Data Deficient (DD)	19
<i>Gyrinophilus</i>	<i>gulolineatus</i>	Berry Cave Salamander	United States of America	Endangered (EN)	19
<i>Gyrinophilus</i>	<i>subterraneus</i>	West Virginia Spring Salamander	United States of America	Endangered (EN)	19
<i>Plethodon</i>	<i>stormi</i>	Siskiyou Mountains Salamander	United States of America	Endangered (EN)	19
<i>Ambystoma</i>	<i>tigrinum stebbinsi</i>	Sonora tiger salamander	United States of America (Native and Introduced)	Least Concern (LC)	18
<i>Batrachoseps</i>	<i>diabolicus</i>	Hell Hollow Slender Salamander	United States of America	Data Deficient (DD)	18
<i>Batrachoseps</i>	<i>gabrieli</i>	San Gabriel Slender Salamander	United States of America	Data Deficient (DD)	18
<i>Batrachoseps</i>	<i>incognitus</i>	San Simeon Slender Salamander	United States of America	Data Deficient (DD)	18
<i>Batrachoseps</i>	<i>kawia</i>	Sequoia Slender Salamander	United States of America	Data Deficient (DD)	18
<i>Batrachoseps</i>	<i>minor</i>	Lesser Slender Salamander	United States of America	Data Deficient (DD)	18
<i>Batrachoseps</i>	<i>relictus</i>	Relictual Slender Salamander	United States of America	Data Deficient (DD)	18

<i>Eurycea</i>	<i>chamberlaini</i>	Chamberlain's Dwarf Salamander	United States of America	Data Deficient (DD)	18
<i>Eurycea</i>	<i>pterothila</i>	Blanco River Springs Salamander	United States of America	Data Deficient (DD)	18
<i>Eurycea</i>	<i>robusta</i>	Blanco Blind Salamander	United States of America	Data Deficient (DD)	18
<i>Eurycea</i>	<i>troglydytes</i>	Eurycea Troglodytes Complex	United States of America	Data Deficient (DD)	18
<i>Plethodon</i>	<i>aureolus</i>	Tellico Salamander	United States of America	Data Deficient (DD)	18
<i>Plethodon</i>	<i>sequoyah</i>	Sequoyah Slimy Salamander	United States of America	Data Deficient (DD)	18
<i>Plethodon</i>	<i>shenandoah</i>	Shenandoah Salamander	United States of America	Vulnerable (VU)	17
<i>Bufo</i>	<i>nelsoni</i>		United States of America	Endangered (EN)	16
<i>Batrachoseps</i>	<i>campi</i>	Inyo Mountains Salamander	United States of America	Endangered (EN)	16
<i>Plethodon</i>	<i>welleri</i>	Weller's Salamander	United States of America	Endangered (EN)	16
<i>Notophthalmus</i>	<i>meridionalis</i>	Black-Spotted Newt	Mexico, United States of America	Endangered (EN)	16
<i>Necturus</i>	<i>beyeri</i>	Gulf Coast Waterdog	United States of America	Least Concern (LC)	15
<i>Ambystoma</i>	<i>macrodictylum croceum</i>	Santa Cruz Long-Toed Salamander	United States of America	Least Concern (LC)	13
<i>Plethodon</i>	<i>nettingi</i>	Cheat Mountain Salamander	United States of America	Near Threatened (NT)	9
<i>Ambystoma</i>	<i>tigrinum ssp.</i>	Dickinson Co, Iowa Tiger Salamander	United States of America		8
<i>Plethodon</i>	<i>kiamichi</i>	Kiamichi Slimy Salamander	United States of America	Data Deficient (DD)	8
<i>Rana</i>	<i>catesbeiana</i>	American bullfrog	Canada and United States of America (Native and Introduced), Puerto Rico (Introduced)	Least Concern (LC)	5
<i>Hyla</i>	<i>andersonii</i>	Pine Barrens Treefrog	United States of America	Near Threatened (NT)	4

Appendix 3. List of prioritized species from the Caribbean

Genus	Species	Distribution	Extinction Risk (IUCN, 2006)	Prioritization Score
<i>Eleutherodactylus</i>	<i>schmidti</i>	Dominican Republic, Haiti	Critically Endangered (CR)	76
<i>Eleutherodactylus</i>	<i>semipalmatus</i>	Haiti	Critically Endangered (CR)	76
<i>Eleutherodactylus</i>	<i>albipes</i>	Cuba	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>amadeus</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>apostates</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>bakeri</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>brevirostris</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>caribe</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>chlorophenax</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>corona</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>cubanus</i>	Cuba	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>darlingtoni</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>dolomedes</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>eunaster</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>fowleri</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>furcensis</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>glandulifer</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>glanduliferoides</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>jugans</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>lamprotes</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>leoncei</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>mariposa</i>	Cuba	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>nortoni</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>oxyrhynchus</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>parabates</i>	Dominican Republic, Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>parapelates</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>paulsoni</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>poolei</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>rufifemoralis</i>	Dominican Republic	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>sciagraphus</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>tetajulia</i>	Cuba	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>thorectes</i>	Haiti	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>turquinensis</i>	Cuba	Critically Endangered (CR)	72
<i>Eleutherodactylus</i>	<i>ventrilineatus</i>	Haiti	Critically Endangered (CR)	72
<i>Leptodactylus</i>	<i>fallax</i>	Dominica, Martinique, Montserrat, Saint Kitts and Nevis	Critically Endangered (CR)	71
<i>Eleutherodactylus</i>	<i>juanriveroi</i>	Puerto Rico	Critically Endangered (CR)	61
<i>Eleutherodactylus</i>	<i>junori</i>	Jamaica	Critically Endangered (CR)	61
<i>Eleutherodactylus</i>	<i>locustus</i>	Puerto Rico	Critically Endangered (CR)	61
<i>Eleutherodactylus</i>	<i>richmondi</i>	Puerto Rico	Critically Endangered (CR)	61
<i>Eleutherodactylus</i>	<i>unicolor</i>	Puerto Rico	Critically Endangered (CR)	61
<i>Eleutherodactylus</i>	<i>orcutti</i>	Jamaica	Critically Endangered (CR)	60
<i>Eleutherodactylus</i>	<i>wightmanae</i>	Puerto Rico	Critically Endangered (CR)	57
<i>Bufo</i>	<i>fluviaticus</i>	Dominican Republic	Critically Endangered (CR)	56
<i>Mannophryne</i>	<i>olmonae</i>		Critically Endangered (CR)	56
<i>Phyllodytes</i>	<i>auratus</i>	Trinidad	Critically Endangered (CR)	56
<i>Plectrohyla</i>	<i>acanthodes</i>	Guatemala, Mexico	Critically Endangered (CR)	56
<i>Plectrohyla</i>	<i>avia</i>	Guatemala, Mexico	Critically Endangered (CR)	56

<i>Plectrohyla</i>	<i>ixil</i>	Guatemala, Mexico	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>alticola</i>	Jamaica	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>bartonsmithi</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>blairhedgesi</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>bresslerae</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>cavernicola</i>	Jamaica	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>fuscus</i>	Jamaica	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>griphus</i>	Jamaica	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>iberia</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>jaumei</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>lucioi</i>	Haiti	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>orientalis</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>pezopetrus</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>rhodesi</i>	Haiti	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>rivularis</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>sisyphodemus</i>	Jamaica	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>symingtoni</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>tonyi</i>	Cuba	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>warreni</i>	Haiti	Critically Endangered (CR)	56
<i>Eleutherodactylus</i>	<i>jasperi</i>	Puerto Rico	Critically Endangered (CR)	55
<i>Eleutherodactylus</i>	<i>eneidae</i>	Puerto Rico	Critically Endangered (CR)	50
<i>Eleutherodactylus</i>	<i>karlschmidti</i>	Puerto Rico	Critically Endangered (CR)	50
<i>Plectrohyla</i>	<i>hartwegi</i>	Guatemala, Mexico	Critically Endangered (CR)	49
<i>Bufo</i>	<i>lemur</i>	Virgin Islands (British), Puerto Rico	Critically Endangered (CR)	46
<i>Bufo</i>	<i>tacanensis</i>	Guatemala, Mexico	Endangered (EN)	41
<i>Bufo</i>	<i>tutelarius</i>	Guatemala, Mexico	Endangered (EN)	37
<i>Eleutherodactylus</i>	<i>cooki</i>	Puerto Rico	Endangered (EN)	21

Appendix 4. List of prioritized species from Mexico*

Genus	Species	Common name	Extinction Risk (IUCN, 2006)	Prioritization Score
<i>Bufo</i>	<i>cristatus</i>	Large-Crested Toad	Critically Endangered (CR)	76
<i>Rana</i>	<i>pueblae</i>		Critically Endangered (CR)	61
<i>Charadrahyla</i>	<i>trux</i>		Critically Endangered (CR)	60
<i>Ambystoma</i>	<i>mexicanum</i>	Axolotl	Critically Endangered (CR)	59
<i>Plectrohyla</i>	<i>calthula</i>		Critically Endangered (CR)	56
<i>Plectrohyla</i>	<i>ephemera</i>		Critically Endangered (CR)	56
<i>Plectrohyla</i>	<i>psarosema</i>		Critically Endangered (CR)	56
<i>Plectrohyla</i>	<i>thorectes</i>		Critically Endangered (CR)	56
<i>Ambystoma</i>	<i>taylori</i>	Taylor's Salamander	Critically Endangered (CR)	54
<i>Plectrohyla</i>	<i>siopela</i>		Critically Endangered (CR)	53
<i>Bromeliohyla</i>	<i>dendroscarta</i>		Critically Endangered (CR)	45
<i>Charadrahyla</i>	<i>altipotens</i>		Critically Endangered (CR)	45
<i>Ecnomiohyla</i>	<i>echinata</i>		Critically Endangered (CR)	45
<i>Ecnomiohyla</i>	<i>valancifer</i>		Critically Endangered (CR)	45
<i>Megastomatohyla</i>	<i>mixe</i>		Critically Endangered (CR)	45
<i>Megastomatohyla</i>	<i>pellita</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>calvicollina</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>celata</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>cembra</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>crassa</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>cyanomma</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>hazela</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>pachyderma</i>		Critically Endangered (CR)	45
<i>Plectrohyla</i>	<i>pycnochila</i>		Critically Endangered (CR)	45
<i>Rana</i>	<i>omiltemana</i>	Guerreran Leopard Frog	Critically Endangered (CR)	45
<i>Rana</i>	<i>tlaloci</i>	Tlaloc's Leopard Frog	Critically Endangered (CR)	45
<i>Ambystoma</i>	<i>amblycephalum</i>		Critically Endangered (CR)	44
<i>Ambystoma</i>	<i>andersoni</i>		Critically Endangered (CR)	44
<i>Ambystoma</i>	<i>dumerilii</i>		Critically Endangered (CR)	44
<i>Ambystoma</i>	<i>leorae</i>	Leora's Stream Salamander	Critically Endangered (CR)	44
<i>Ambystoma</i>	<i>lermaense</i>	Lake Lerma Salamander	Critically Endangered (CR)	44
<i>Bufo</i>	<i>gemmifer</i>	Jeweled Toad	Endangered (EN)	41
<i>Plectrohyla</i>	<i>chryses</i>		Critically Endangered (CR)	41
<i>Plectrohyla</i>	<i>cyclada</i>		Endangered (EN)	41
<i>Ambystoma</i>	<i>bombypellum</i>	Axolotl	Critically Endangered (CR)	39
<i>Ambystoma</i>	<i>granulosum</i>	Granular Salamander	Critically Endangered (CR)	39
<i>Bufo</i>	<i>cavifrons</i>	Mountain Toad	Endangered (EN)	37
<i>Bufo</i>	<i>spiculatus</i>		Endangered (EN)	37
<i>Charadrahyla</i>	<i>chaneque</i>		Endangered (EN)	37
<i>Plectrohyla</i>	<i>mykter</i>		Endangered (EN)	37
<i>Ptychohyla</i>	<i>erythromma</i>		Endangered (EN)	37
<i>Ambystoma</i>	<i>rivulare</i>		Data Deficient (DD)	37
<i>Rana</i>	<i>chichicuahutla</i>		Critically Endangered (CR)	36
<i>Plectrohyla</i>	<i>labedactyla</i>		Data Deficient (DD)	33
<i>Bufo</i>	<i>perplexus</i>		Endangered (EN)	32
<i>Plectrohyla</i>	<i>ameibothalame</i>		Data Deficient (DD)	29
<i>Ptychohyla</i>	<i>acrochorda</i>		Data Deficient (DD)	29
<i>Ptychohyla</i>	<i>zophodes</i>		Data Deficient (DD)	29

<i>Rana</i>	<i>dunni</i>		Endangered (EN)	25
<i>Ptychohyla</i>	<i>leonhardschultzei</i>		Endangered (EN)	21
<i>Plectrohyla</i>	<i>sabrina</i>		Critically Endangered (CR)	20
<i>Exerodonta</i>	<i>chimalapa</i>		Endangered (EN)	16
<i>Bufo</i>	<i>pisinnus</i>		Data Deficient (DD)	8
<i>Rana</i>	<i>catesbeiana</i>	American bullfrog	Least Concern (LC)	5

* Excludes prioritization of the *Plectrohyla* and *Thorius* genera

Appendix 5. Draft AArk Prioritisation and Implementation Process for *Ex Situ* Conservation of Amphibians

Based upon draft prepared by: Taxon selection and prioritisation working group – CBSG/WAZA Amphibian Ex situ Conservation Planning Workshop, El Vallee, February 2006.

Further developed by Richard Gibson, AArk Taxon Officer, with input from AArk officers and widely solicited comments compiled by Bob Lacy.

Rationale

Ex situ conservation of a threatened amphibian species should be considered as an alternative when the absolute imperative of *in situ* amphibian conservation cannot by itself ensure the survival of a species and its ecosystem.

When *ex situ* management of an amphibian species is considered necessary and appropriate, the priority should be to establish the initiative within the range State of ecological origin. Emphasis should therefore be placed on developing appropriate capacity within the range State where this does not exist.

Data derived from *ex situ* management of amphibians should be made openly available to workers involved in the *in situ* conservation of the species (or similar species) and *vice versa*.

An *ex situ* initiative should be viewed as just one of the tools that can help in the overall conservation of a species. It therefore follows that strong links between *ex situ* and *in situ* components are fundamental to the long-term success of species conservation. Full integration between *ex situ* and *in situ* conservation approaches should be sought wherever possible. This is normally best highlighted through the establishment of a formal Species Action Plan that explicitly states the short, medium and long term goals of each component of the conservation initiative.

In cases where an *ex situ* conservation initiative has been established prior to or in the absence of a concurrent *in situ* initiative (e.g. where a political situation currently prohibits *in situ* conservation measures, or where a disease problem currently invalidates measures to protect wild populations.), emphasis should be placed on establishing the appropriate *in situ* links as soon as it becomes possible to do so.

This prioritisation tool has been structured in three sections:

The first section concerns **Prioritisation** of species for *ex situ* conservation initiative - i.e. with limited resources (space, staff, money etc.) which species should have *ex situ* programmes established ahead of others. It takes the form of a series of questions with weighted scores. The total score for a species indicates how 'important' an *ex situ* programme for the species is in relation to others. Some questions may not be straightforward to answer and will require consultation with colleagues, taxonomic experts and other individuals/groups working with the species.

The second section includes just two questions ensuring that there is **Authorisation** for the proposed *ex situ* conservation programme.

The third and final section represents **Implementation** of a programme and considers the practical feasibility of initiating and maintaining a priority *ex situ* programme – a sort of check list of essential elements prior to initiation.

This prioritisation tool should be an evolving protocol. The criteria and their rankings will be adjusted as we gain experience with the process and continue to work with the broader amphibian conservation community to identify goals, threats, and conservation options. In addition, the selection and prioritisation of individual species will be revised as we gain knowledge and as the threats to the species change. Thus, there will be a need to constantly assess species status and monitor threats, so that emerging critical situations are responded to sufficiently quickly.

SECTION ONE – TAXON PRIORITISATION

1. **Extinction risk:** What is the current IUCN Red List category for the taxon?

Critically endangered	Score 20
Endangered	Score 16
Vulnerable	Score 12
Data deficient*	Score 8
Near threatened	Score 4
Least concern	Score 0

(*taxon has been regionally or nationally recognised as ‘at risk’ despite data deficiency)

2. **Chytrid risk:** Is there good reason to suspect that the taxon is likely to be affected by chytrid in the near future (<3yrs)?

Which of the following criteria (a-d) apply:

- a. This or related taxon known to be susceptible to chytrid
- b. Temperate/alpine/tropical highland distribution
- c. Aquatic aspects to life history
- d. Chytrid recorded within 100km of distribution

a,b,c&d	Score 20
a&d	Score 16
b,c&d	Score 12
a,b&c	Score 8
b&c	Score 4
d only	Score 4

3. **Other emerging risks:** Is there good reason to suspect that the taxon is imminently threatened with extinction owing to new or changing threat(s) (excluding chytrid fungus) not considered in its IUCN Red List assessment?

e.g. sudden/expected habitat destruction, new/renewed trade, introduction of a predator^[Z1].

Yes	Score 20
No	Score 0

4. **Threat mitigation**^[Z2]: Are the threats facing the taxon potentially reversible?

Threats cannot/will not be reversed in time to prevent likely species extinction	Score 20
Threats are being managed - conservation dependant	Score 10
Threats unknown	Score 10
Threats cannot be reversed	Score 5
Threats are reversible in time frame that will prevent further decline/extinction	Score 0

5. **Primary conservation role**: What is the primary intended conservation role (see Appendix 1) of the target taxon?

NB – taxon may have other secondary roles which should not be scored

Ark	Score 20
Rescue/Supplementation	Score 16
Conservation Research:	Score 8
Farming:	Score 4
Conservation Education:	Score 0

6. **Phylogenetic significance**: What is the taxon's Evolutionary Distinctiveness (ED) score, as generated by the ZSL EDGE programme?

ED score >10	Score 10
ED score 5 - 10	Score 7
ED score 2 - 5	Score 3
ED score <2	Score 0

7. **Biological distinctiveness**: Does the taxon exhibit, for example, a distinctive reproductive mode, behaviour, aspect of morphology or physiology, among the Class Amphibia?

Aspect of biology identified that is unique to species	Score 10
Aspect of biology shared with <6 other species	Score 5
No aspect of biology known to be exceptional	Score 0

8. **Cultural/socio-economic importance**: Does the taxon have a special human cultural value (e.g. as a national or regional symbol, in a historic context, featuring in traditional stories) or economic value (e.g. food, traditional medicine, tourism) within its natural range or in a wider global context?

Yes	Score 5
No	Score 0

9. **Scientific importance**: Is the species vital to current or planned research? (e.g. human medicine, climate change, environmental pollutants and conservation-related studies)

Research dependent upon species	Score 5
Research dependant upon <6 species (incl. this taxon)	Score 3
Research not dependant upon species	Score 0

SCORE = _____ (HIGHER SCORE INDICATES HIGHER PRIORITY)

SECTION TWO – PROGRAMME AUTHORIZATION

10. Mandate: Is there an existing conservation mandate (see Appendix 2) recommending the *ex situ* conservation of this taxon?

Yes: Go to question 11.

No: Insufficient authorisation for an *ex situ* initiative at this time.
SEEK MANDATE FROM ASG/AARK OR OTHER AUTHORITY

11. Range State approval: Is the proposed *ex situ* initiative supported by the range State (either within the range State or out-of-country *ex situ*)?

Yes: Go to Section 3, question 12.

No: Insufficient authorisation for an *ex situ* initiative at this time.
SEEK APPROVAL FROM RANGE COUNTRY (WITH HELP FROM AARK/ASG AS REQUIRED) BEFORE PROCEEDING

SECTION THREE – PROGRAMME IMPLEMENTATION

Section Three considers the feasibility of undertaking an ex situ programme for priority, authorised species. It functions as a form of evaluation/planning with respect to readiness to implement a programme.

POPULATION ESTABLISHMENT

12. Founder specimens: Are sufficient animals of the taxon available or potentially available (from wild or captive sources) to initiate the **specified** *ex situ* program?

Yes: Go to question 13

No: Insufficient potential founder specimens to initiate the *ex situ* program.
EVALUATE OPTIONS FOR ALTERNATIVE CONSERVATION STRATEGY INCLUDING GAMETE CRYOPRESERVATION

PROGRAMME STABILITY

13. Financial security: Is there sufficient financial support for the anticipated life of the *ex situ* initiative? Or is there good reason to believe that further financial support is realistically achievable?

Yes: Go to question 14

No: Inadequate resources.
EXPLORE POSSIBILITIES FOR FINANCIAL SUPPORT BEFORE INITIATING PROGRAMME (WITH HELP FROM AARK AS APPROPRIATE)

14. Organisational and political security: Is the stability of the

institution/region/State etc. sufficient to ensure a continued commitment to the *ex situ* program over its anticipated lifespan?

Yes: Go to question 15

No: Insufficient stability.

CONSIDER ALTERNATIVE LOCATION/INSTITUTIONS AND PARTNERSHIPS

TAXON KNOWLEDGE

15. Background *ex situ* species knowledge: Is there a history of keeping and breeding this taxon successfully in captivity?

Yes: Go to question 18

No: Go to question 16

16. Background *in situ* species knowledge: Is there sufficient understanding of the ecology, behaviour and reproductive mode of the taxon to infer the likely *ex situ* requirements?

Yes: Go to question 18

No: Go to question 17

17. Analogous species: Despite a lack of direct knowledge of the *ex situ* requirements of the target taxon, can they be inferred with a reasonable degree of confidence from similar/related taxa?

Yes: Go to question 18

No: Insufficient knowledge of the taxon and its requirements at this time.

EX SITU PROGRAMME SHOULD BE DELAYED, WHERE POSSIBLE, WHILE RELEVANT EXPERIENCE/INFORMATION IS GATHERED – E.G. BY WORKING WITH ANALOGUE SPECIES

ACCOMMODATION

18. Current facilities: Is the appropriate quality and quantity of facilities (in country or out of country) currently available? Not just for founder animals, but also for captive bred offspring of all life-stages/sizes (consider space; heating & cooling; water supply, quality, treatment & disposal; lighting; ventilation etc).

Yes: Go to question 20

No: Go to question 19

19. Planned facilities: Are there confirmed plans – within a specified timeframe - to develop the appropriate quality and quantity of facilities to permit the full development of the planned *ex situ* program (in country or out of country)?

Yes: Go to question 20

No: Insufficient infrastructure available or planned to permit the likely successful development of the *ex situ* program for this taxon.

CONTACT AARK WITH RESPECT TO POSSIBLE IMPLEMENTATION OF RAPID RESPONSE WHERE URGENT ACTION IS NECESSARY AND/OR WITH RESPECT TO IDENTIFYING SUITABLE PARTNERS/SUPPORTERS

HUSBANDRY & MANAGEMENT

- 20. Personnel:** Are adequate numbers of skilled staff available with the appropriate *ex situ* amphibian experience?
Yes: Go to question 22
No: Go to question 21
- 21. Training:** Can adequate numbers of skilled staff be made available for training in the appropriate *ex situ* amphibian skills?
Yes: Go to Question 22
CONTACT AARK TRAINING OR PROGRAMME OFFICER FOR HELP
No: Suitable personnel not available.
CONTACT AARK WITH RESPECT TO POSSIBLE IMPLEMENTATION OF RAPID RESPONSE WHERE URGENT ACTION IS NECESSARY AND/OR WITH RESPECT TO IDENTIFYING SUITABLE PARTNERS/SUPPORTERS
- 22. Food supply:** Is there a reliable food supply – in both quality and quantity – for adult, immature and larval stages of the taxon?
Yes: Go to question 23
No: Inadequate resources.
EXPLORE FOOD SUPPLY OPPORTUNITIES BEFORE PROCEEDING
- 23. Management:** Is the appropriate standard of record-keeping and knowledge of small population management available to help minimise the risk of potential deleterious effects such as loss of genetic diversity, artificial selection, pathogen transfer, hybridisation etc. (This expertise does not necessarily have to be held at the facility itself, but access to these skills is essential).
Yes: Go to question 24
No: Shortage of skills to support the *ex situ* programme.
SEEK SUPPORT FROM AARK AND/OR REGIONAL ZOO&AQUARIUM ASSOCIATIONS BEFORE, OR SOON AFTER, PROCEEDING
- 24. Veterinary care and health screening:** Has provision been made for the routine health monitoring of the population and is the appropriate level of veterinary care available?
Yes: Go to question 25
No: Inadequate resources.
SEEK VETERINARY SUPPORT THROUGH UNIVERSITIES, ZOOS&AQUARIUMS OR OTHERS BEFORE PROCEEDING

QUARANTINE & BIOSECURITY

- 25. Escapes:** Are measures in place to minimise the risk of animal escapes and introduction of an invasive species?
Yes: Go to question 26
No: Animal security measures not sufficient.
REVIEW AND IMPROVE BIOSECURITY – REFER TO AARK GUIDELINES – BEFORE PROCEEDING

26. Species isolation: Are appropriate measures in place at the proposed *ex situ* facility to minimise the risk of possible disease transfer to or from other *ex situ* or wild amphibian populations?

Yes: Go to question 27

No: Insufficient measures currently in place to prevent disease transfer. **REVIEW AND IMPROVE BIOSECURITY – REFER TO AARK GUIDELINES – BEFORE PROCEEDING**

27. Water treatment: Are the appropriate waste water treatment regimes in place to eliminate the possibility of disease transfer from the *ex situ* population to the external environment?

Yes: *Ex situ conservation programme currently feasible and ready for implementation*

No: Bio-security measures inadequate.
REVIEW AND IMPROVE BIOSECURITY – REFER TO AARK GUIDELINES – BEFORE PROCEEDING

If you have answered ‘Yes’ to questions 10 through 27 you are ready to implement your AARK *ex situ* conservation breeding programme. Good luck.

Appendix One – Conservation Role

Defined Conservation Role

Simply keeping and breeding threatened amphibian species in captivity does not in itself equate to *conservation*. As part of a genuine amphibian conservation initiative, the *ex situ* captive management should not only form part of the recommended conservation action for the species but must also have a clearly defined role in the conservation of the species or its habitat:

- a) **Ark** – An amphibian species that is extinct in the wild (locally or globally) and which would become completely extinct without *ex situ* management.
- b) **Rescue** – An amphibian species that is in imminent danger of extinction (locally or globally) and requires *ex situ* management as part of the *recommended* conservation action.
- c) **Supplementation** – An amphibian species for which *ex situ* management benefits the wild population through breeding for release as part of the *recommended* conservation action.
- d) **Farming** – An amphibian species threatened through wild collection (e.g. as a food resource), which is being bred in captivity – normally in-country, *ex situ* - to replace a demand for wild harvested specimens. *This category generally excludes the captive-breeding of pet and hobbyist species, except in exceptional circumstances where coordinated, managed breeding programs can demonstrably reduce wild collection of a threatened species.*
- e) **Conservation Research** – An amphibian species undergoing specific applied research that directly contributes to the conservation of that species, or a related species, in the wild (this would include clearly defined ‘model’ or ‘surrogate’ species).
- f) **Conservation Education** – An amphibian species that is specifically selected for management – primarily in zoos and aquariums - to inspire and increase knowledge in visitors, in order to promote positive behavioural change. For example, when a species is used to raise financial or other support for field conservation projects (this would include clearly defined ‘flagship’ or ‘ambassador’ species).

Appendix Two – Ex situ Mandate

Mandate for Ex situ Conservation

The decision about which species should be protected in *ex situ* conservation programmes should not be made by the AARK community alone because such programmes must be part of broader plans for species conservation. The AARK community needs to respond to needs identified by appropriate conservation authorities, especially since the decision to safeguard species in *ex situ* programmes needs to follow from a careful assessment of which species cannot currently be assured of adequate protection *in situ*. A recommendation for an *ex situ* population of a threatened amphibian species can come from a number of recognised sources, such as:

- An IUCN/SSC Global Amphibian Specialist Group (GASG) recommendation.
- The Global Amphibian Assessment (www.globalamphibians.org) - the authority on IUCN Red List status for all amphibian species and which recommends *ex situ* conservation action for at least 240 species.
- The IUCN - the IUCN Technical Guidelines for the Management of *Ex situ* Populations recommends *ex situ* populations for all Critically Endangered species.
- An IUCN/SSC Conservation Breeding Specialist Group (CBSG) Population and Habitat Viability Assessment (PHVA) workshop process. (www.cbsg.org/toolkit/phvas.scd)
- An IUCN/SSC Conservation Breeding Specialist Group (CBSG) Conservation Assessment and Management Plan (CAMP) process. (<http://www.cbsg.org/toolkit/camps.scd>)
- An IUCN/SSC regional amphibian (and reptile) specialist group recommendation (Madagascar & Mascarene, Europe or China).
- A published Species Action Plan.
- A local, regional or national government request.

Appendix 6. Sample draft Taxon Management Action Plan

AArk Taxon Management Plan –	
Date of completion:	August 2, 2007 DRAFT
Author(s):	ATAG Steering Committee
BACKGROUND	
Species (common/scientific names):	<i>Cryptobranchus bishopi</i> - Ozark hellbender
Distribution:	The Ozark species occurs in northern Arkansas and southern Missouri.
Conservation status (IUCN, CITES other):	<i>Cryptobranchus bishopi</i> had not been recognized by the IUCN as a separate species from <i>Cryptobranchus alleganiensis</i> . <i>C. alleganiensis</i> is listed as Endangered.
Threats:	Habitat degradation, eradication efforts, collecting.
Proposed ex situ roles (Ark; Rescue; Supplementation; Research; Education):	Rescue/supplementation; research; education
 Husbandry guidelines (Y/N, if yes give details and/or hyperlink):	Taxon management account – Bill Flanagan
Co-ordinator and contact details:	Mark Wanner (Andy S will confirm 8/15/07)
Programme Goal:	To be able to establish successful captive assurance colony – long term Increase public awareness in local stakeholders To further understand health threats to wild population
ACTION PLAN	
Ex situ population management	
Current population (no. of individuals and/or institutions):	St. Louis Zoo: 3.3.54 (approx)
Target population (no. of individuals and/or institutions):	10.10+young (confirm with St. Louis) Minimum of 2 institutions

Objectives (clearly defined and measurable):
Find additional institution – Confirm with Omaha, Wonders of Wildlife, MO fish hatchery (Jessi K 8/21/07) Determine extent of institutional interest Grow from current to target population Distribute offspring
Proposed actions and respective time frames:
Work with MO Fish and Game to determine availability of additional individuals (up to 7.6) (Jeff Ettling and/or Mark Wanner) ATAG assistance with above action step Confirm space availability at additional institutions for holding, further interest in AZA region (Confirm with Omaha, WoW, MO FH - Jessi)
Ex situ Research
Current research objectives and expected time frames:
Husbandry (ongoing) Health (i.e., chytrid) (ongoing) Habitat use (ongoing) Dietary studies (ongoing) --All taking place at St. Louis, see PHVA
Proposed research objectives and expected time frames:
Effects of hormonal pollutants (Ft. Worth Zoo on analogous species) Hormone-assisted reproduction on surplus offspring (Toledo worked on sister species)
Actions necessary to meet research objectives:
Acquire animals Identify facilities to take surplus offspring post-hormone pollutant studies
Ex situ Education
Educational message:
America's largest salamander Not poisonous/venomous History of name What's killing them Where they occur Water quality/human link Responsible water use practices
Objectives (clearly defined and measurable):
Proposed actions to meet above Educational Objectives with time frame:
See RCP Produce educational materials (CD, fact sheets, poster, etc.) (To be accomplished by CIG) Link educational materials to state educational guidelines
Any other information:

1-country/field initiatives
Current activities:
Surveys Chytrid monitoring FWS-candidate species Introduced predator research (otters and trout)
Objectives (clearly defined and measurable):
Proposed actions and respective time frames:
Reintroductions Ongoing surveys
Long term goal (exit strategy):
Recover the species – refer to PHVA numbers and strategies Change local stakeholder behaviors/perceptions
References
Publications/reports:
PHVA Taxon management account Missouri recovery plan/strategy
Bibliography:
See GAA listing.

Appendix 7: Species Coordinators

If interested in working with any of the following species, all identified as high priorities for *ex situ* conservation programs, contact the listed coordinator. If no coordinator is listed, consider taking on the challenge of developing this program – and its related partnerships – at your facility.

Species: *Ambystoma californiense*
Common name: California tiger salamander
Coordinator: Andy Snider
Fresno Chaffee Zoo
Director of Animal Care and Conservation
559-498-5914
asnider@fresnochaffeezoo.com

Species: *Ambystoma mexicanum*
Common name: California tiger salamander
Coordinator: TBD

Species: *Ambystoma taylori*, *A. amblycephalum*, *A. andersoni*, *A. dumerilii*, *A. leorae*, *A. lermaense*
Coordinator: Luis Carrillo
Africam Safari
Curator of Reptiles and Amphibians
52-222-281-7000 x231
lcarrillo@africamsafari.com.mx

Species: *Ascaphus truei*
Common name: Coastal tailed frog
Coordinator: TBD

Species: *Atelopus zeteki*
Common name: Panamanian golden frog
Coordinator: Vicky Poole
Exhibit Manager - *FROGS! A Chorus of Color*
National Aquarium in Baltimore
Phone: (410) 576-1193
vpoole@aqua.org

Species: *Batrachoseps aridus*
Common name: Desert slender salamander
Coordinator: Andy Snider
Fresno Chaffee Zoo
Director of Animal Care and Conservation
559-498-5914
asnider@fresnochaffeezoo.com

Species: *Bufo baxteri*
Common name: Wyoming toad
Coordinator: Bruce Foster, SSP
Coordinator
Central Park Zoo, Wildlife Conservation Society
Collection Manager - Animal Department
212-439-6505
bfoster@wcs.org

Species: *Bufo canorus*
Common name: Yosemite toad
Coordinator: TBD

Species: *Bufo houstonensis*
Common name: Houston toad
Coordinator: Paul Crump
Houston Zoo, Inc.
Reptile and Amphibian Keeper
713-533-6655
pcrump@houstonzoo.org

Species: *Bufo lemur*
Common name: Puerto Rican crested toad
Coordinator: Diane Barber, SSP
Coordinator
Fort Worth Zoo
Curator of Ectotherms
817-759-7180
dbarber@fortworthzoo.org

Species: *Cryptobranchus bishopi*
Common name: Ozark hellbender
Coordinator: Mark Wanner
Saint Louis Zoo
Zoological Manager
(314) 781-0900 x272
wanner@stlzoo.org

Species: *Eleutherodactylus locustis*, *E. richmondi*, *E. wightmanae*
Coordinator: Dr. Rafael Joglar
University of Puerto Rico - Rio Piedras
Professor
787-764-0000 x3567
rjoglar@uprrp.edu

Species: *Eurycea chisholmensis*
Common name: Salado Springs salamander
Coordinator: Jessica Crowley
Dallas Zoo
Reptile and Amphibian Keeper
(214) 670-7573
yessie12@hotmail.com

Species: *Eurycea naufragia*
Common name: Georgetown salamanders
Coordinator: Jessica Crowley
Dallas Zoo
Reptile and Amphibian Keeper
(214) 670-7573
yessie12@hotmail.com

Species: *Eurycea sosorum, waterlooensis, nana, rathbuni, tonkawae*
Common name: Barton Springs, Austin Blind, San Marcos, Jollyville Texas Blind salamanders
Coordinator: Paul Crump
Houston Zoo, Inc.
Reptile and Amphibian Keeper
713-533-6655
pcrump@houstonzoo.org

Species: *Necturus alabamensis*
Common name: Black warrior water dog
Coordinator: Erik Keyster
Cincinnati Zoo
Lead Amphibian Keeper
513-487-3306
erik.keyster@cincinnati.org

Species: *Rana chiricahuensis*
Common name: Chiricahua Leopard frog
Coordinator: Paula Swanson
Phoenix Zoo
Manager of Reptiles
602-273-1341 x7610
Pswanson@thephxzoo.com

Species: *Rana muscosa*
Common name: Mountain yellow-legged frog
Coordinator: Andy Snider
Fresno Chaffee Zoo
Director of Animal Care and Conservation
559-498-5914
asnider@fresnochaffeezoo.com

Species: *Rana onca*
Common name: Relict leopard frog
Coordinator: Paula Swanson
Phoenix Zoo
Manager of Reptiles
602-273-1341 x7610
Pswanson@thephxzoo.com

Species: *Rana pretiosa*
Coordinator: TBD

Species: *Rana sevosa*
Common name: Mississippi gopher Frog
Coordinator: Steve Reichling
Memphis Zoo
Curator of Reptiles, Amphibians, Nocturnal
901-333-6711
sreichling@memphiszoo.org

Species: *Rana sp.*
Common name: Mogollon Rim form leopard frog
Coordinator: Paula Swanson
Phoenix Zoo
Manager of Reptiles
602-273-1341 x7610
Pswanson@thephxzoo.com

Species: *Rana subaquavocalis*
Common name: Ramsey Canyon leopard Frog
Coordinator: Paula Swanson
Phoenix Zoo
Manager of Reptiles
602-273-1341 x7610

Appendix 8. Priority ranking of New World countries based on the conservation status of their amphibian species

Country	EW (=20)	CR (=20)	EN (=16)	VU (=12)	DD (=8)	NT (=4)	LC (=0)	Total	Score	Rank
Colombia	0	54	82	82	119	45	198	723	4508	1
Mexico	0	71	85	42	48	22	95	363	3756	2
Ecuador	0	33	72	58	63	23	198	449	3104	3
"Caribbean"	0	65	64	23	1	6	45	204	2632	4
Brazil	0	6	6	13	215	22	489	752	2180	5
Peru	0	21	32	28	107	12	211	411	2172	6
Venezuela	0	19	23	27	80	8	141	299	1744	7
Guatemala	0	27	30	19	26	12	142	138	1504	8
Costa Rica	0	24	26	21	22	10	87	199	1364	9
Panama	0	23	27	14	25	8	108	221	1292	10
Honduras	0	30	24	1	4	8	49	118	1060	11
United States	1	3	15	35	14	33	162	265	945	12
Argentina	0	2	15	12	14	9	105	157	572	13
Chile	0	9	4	7	18	4	13	55	488	14
Bolivia	0	5	6	10	17	6	165	209	476	15
Suriname	0	4	4	3	6	1	95	132	232	16
Guyana	0	0	0	6	14	0	98	118	184	17
Nicaragua	0	2	3	5	2	2	55	69	172	18
El Salvador	0	4	4	1	1	1	21	32	168	19
Belize	0	1	3	2	1	6	25	38	124	20
Uruguay	0	0	2	2	0	3	36	43	68	21
French Guiana	0	0	0	3	3	0	98	104	60	22
Paraguay	0	0	0	0	2	3	69	74	28	23
Canada	0	0	0	1	0	3	41	45	24	24

Values for each IUCN category are consistent with those used in the Amphibian Ark prioritization tool.