Association of Zoos and Aquariums Amphibian Taxon Advisory Group Regional Collection Plan

3rd Edition, June 2014

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with assistance from the ATAG Steering and Advisory Committees

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ATAG Definition and Scope

Mission Statement

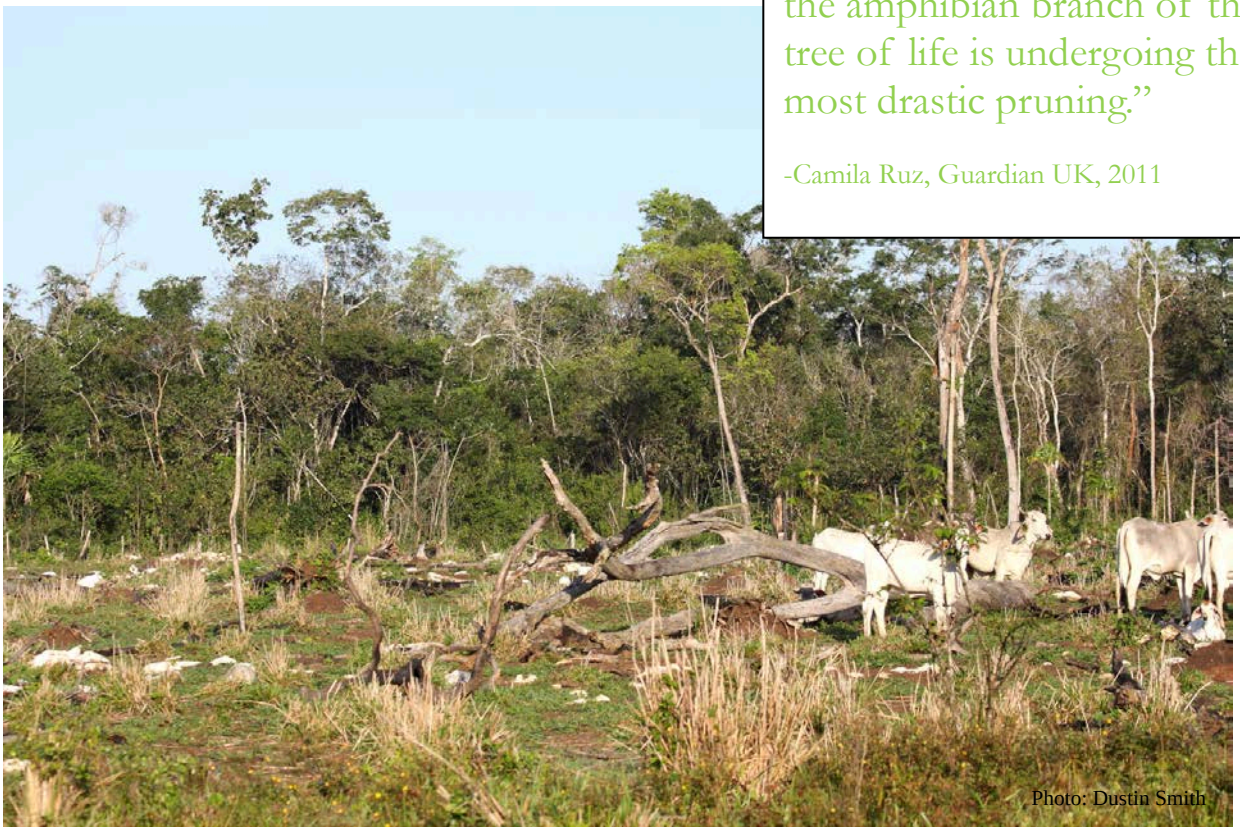
To support the conservation of amphibians, both *in situ* and *ex situ,* through scientific management of assurance colonies, education and research.

Amphibians are in Trouble!

In 2008, the International Union for Conservation of Nature (IUCN) conducted the Global Amphibian Assessment (GAA), which evaluated the status of 6,285 amphibian species. The GAA reported that the sizes of more than 43% of all measured amphibian populations had declined and less than 1% of populations had increased, indicating a troubling trend. Almost one-third (32%) of amphibians are threatened with extinction globally and 159 amphibian species may have already been lost. The majority of threatened amphibians reside in the New World, with the highest numbers in Columbia, Mexico and Ecuador. Nevertheless, the bulk of endemic species in rapid decline (80-90%) are from the Dominican Republic, Haiti, Cuba and Jamaica (IUCN, 2014).

Bolitoglossa sp.

> "If the current rapid extermination of animals, plants and other species really is the "sixth mass extinction," then the amphibian branch of the tree of life is undergoing the most drastic pruning."
>
> -Camila Ruz, Guardian UK, 2011



Globally, habitat degradation, chemical pollutants, invasive species, climate change and disease have been the driving culprits behind amphibian declines.

Addressing the Amphibian Crisis at a Global Level

The IUCN, WAZA (World Association of Zoos & Aquariums), CBSG (Conservation Breeding Specialist Group), the ASG (Amphibian Specialist Group) have called on zoos and aquariums to join in the global response to this conservation crisis. Recognizing that the size of the problem far outpaces our ability to respond with *in situ* programs, captive assurance populations have been recognized as the only hope for survival for many amphibian species. The *Amphibian Conservation Action Plan* (ACAP) (Gascon, et. al., 2007) was published in response to the 2005 Amphibian Conservation Summit in Washington, D.C. It is a comprehensive global response to amphibian population declines, of which *ex situ* captive breeding is one component.

The Association of Zoos & Aquariums (AZA) community has been directly active in this global initiative on multiple levels. In addition to trying to build capacity for species in AZA facilities, the ATAG has produced numerous materials to aid in the immediate development of successful amphibian conservation and/or research programs (either *in situ* or *ex situ*; internationally or domestically). These publications include the *Action Plan for Ex Situ Amphibian Conservation in the AZA Community* (2007), a detailed description of current amphibian collections and spaces within the AZA community; the *Conservation Resource Manual* (2007) to aid in the development of successful amphibian conservation programs that fit into institution's collection plans, which are appropriate for different levels of resources, and provides species specific action plans and husbandry manuals; and the *ATAG Amphibian Husbandry Resource Guide* (2012) a user-friendly source for amphibian husbandry and captive management. The AZA has also published *Amphibian Conservation: Highlights and Accomplishments* annually since 2010, which provides excellent examples of *in situ* and *ex situ* amphibian programs/techniques that can be applied to new programs as they arise. All of these resources can be accessed at: www.aza.org/amphibian-population-planning. Additionally, the ATAG awards up to $2,000 per grant cycle for projects that focus on amphibian conservation, contributing over $20,000 since 2006 (download application at www.saveamphibians.org). Furthermore, the ATAG recommends the AZA Amphibian Management Course at: www.aza.org to improve amphibian husbandry techniques and to benefit from interacting with other amphibian herpetologists, as well as participate in networking opportunities at the annual ATAG meetings. The ATAG also requests more involvement in implementation of RCP initiatives through the appointment of Institutional Representatives (IRs) that can effectively communicate and actively contribute.

Metamorphosis of the ATAG Regional Collection Plan (RCP)

Since the completion of the first edition of the RCP in August 2000, much of the ATAG's direction has changed due to increased awareness about the extent and causes behind rapid amphibian population declines and the role zoos and aquariums can aid in this crisis by developing assurance colonies of at-risk species. Current data indicate that the general trend of amphibian extinctions is accelerating at an unprecedented rate and future catastrophic loses are inevitable. Within this context, the ATAG's RCP reflects a more tightly defined scope for suggested amphibian programs in AZA institutions that will enable colleagues to utilize their resources to their fullest potential and respond in chorus with the rest of the global amphibian community. While using this RCP to develop institutional collection plans and conservation programs, keep in mind that resources are limited and space is at a premium for managed programs. Never before has the zoological community been tasked with the conservation of so many species at such a rapid pace. The global amphibian crisis has been and will continue to be a challenge for

us all, but we must remain optimistic, as we know AZA institutions are up to the task. Please help conserve these unique and important creatures by following the recommendations of this RCP to expand space and develop new amphibian programs and strategies through collaborative partnerships.

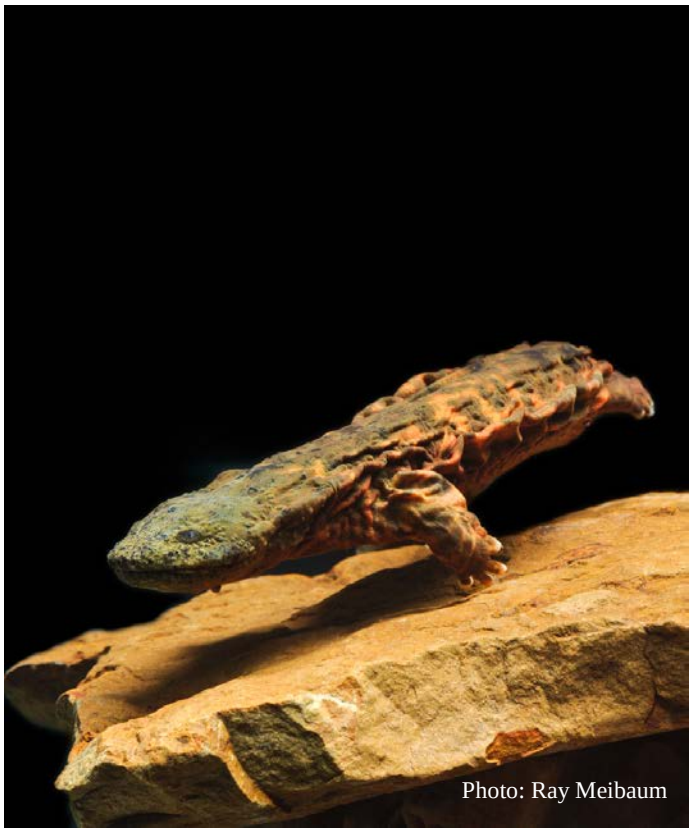
Due to the quarantine and spatial requirements of amphibian assurance colonies, the ATAG considers exhibit space to be outside of the periphery of usable space for program species with reintroduction potential (except for those deemed surplus to the SSP may be used for display/education) . Therefore, while this RCP will provide limited guidance regarding institutional exhibiting of amphibians, the primary focus is centered on building capacity for species of immediate conservation concern.

Taxa within ATAG Purview

Priority Species and Regions

In accordance with the global *Amphibian Conservation Action Plan*, critically endangered species in need of immediate conservation concern action should be subject to *ex situ* management, as appropriate, to insure recovery of wild populations. Under this directive, ATAG was originally engaged by IUCN/ASG to prioritize and help manage the 353 Critically Endangered amphibian species found in the Caribbean and North, Meso, and South America. Due to limited space in AZA facilities and the presence of other zoological associations within Meso and South America, the ATAG is asking AZA institutions to focus amphibian conservation efforts towards New World species with a governing mandate for *ex situ* management, the majority of resources being committed to North America and the Caribbean.

The ATAG recognizes that AZA institutions have commitments to other regions of the world and does not discourage those institutions from continued involvement in those areas and programs. However, the ATAG encourages and will endorse/support programs developed for North America and the Caribbean above all other regions until there is adequate space for program species. Without increased capacity, we simply cannot continue to choose species for large scale conservation efforts in a haphazard manner. As additional species from the Caribbean, Meso America and South America continue to be assessed, new species may be identified for priority action by zoos and aquariums which can be integrated into the RCP if additional space is created.



Cryptobranchus bishopi

Throughout the world, there are zoological organizations that have agreed to follow global initiatives set forth by IUCN/ASG. These organizations have been asked to support species in need within their individual regions and to assist adjacent neighbors without resources. If AZA institutions fail to care for species within their own backyards, then who will?

Priority Conservation Activities

The zoological community has endeavored for the past thirty years to gain credibility and recognition as a key conservation leader. We are finally reaching audiences with important conservation messages and have strong programs in place, but exhibiting an SSP species is no longer enough to aid amphibians. Zoos must continue to raise the bar and dedicate conservation resources equally to a wide variety of taxa-even those that do not produce revenue. Amphibians are important. They are needed in our ecosystems. They are rapidly disappearing and they require our immediate assistance. Simply put, we must increase capacity to save our amphibians!

First and foremost, isolation rooms for species with reintroduction programs need to be created (see examples in Appendix II). AZA zoos and aquariums should continue providing long-term financial, technical, physical and logistical support to programs and projects identified as priorities in the ATAG RCP. It is also encouraged to pool resources with other facilities, or consortia formed to address regional amphibian concerns. Every effort should be made to reach out to local agencies and to form partnerships for amphibian conservation. Additional *in situ* amphibian conservation centers, such as El Valle Amphibian Conservation Center (EVACC) in Panama, should be created and funded and biologists conducting field research should be supported. Capacity building at home institutions and in range countries should be expanded and amphibian facilities should be updated to reflect the needs of conservation-oriented collections. Staff should receive appropriate training, which can be obtained by attending AZA's *Amphibian Management Course*, or by participating in internships at institutions with existing capacity. The ATAG's *Amphibian Husbandry Resource Guide* (Poole and Grow, 2012) can be used to reinforce lessons learned.

Institutional Capacity of AZA Communities

In response to the amphibian crisis, we are encouraged by individuals and institutions that have dedicated resources to aid amphibians at various levels. A growing number of institutions are participating in amphibian conservation and some institutions have built dedicated rooms and buildings for amphibians. In addition, we have increased community awareness, expanded educational graphics and programs, supported *in-situ* recovery efforts across a wide variety of regions, increased monitoring and research efforts, and developed new programs. However, we did not increase our overall capacity for managed programs and this effort is a critical piece of the RCP.


Wyoming Toad SSP

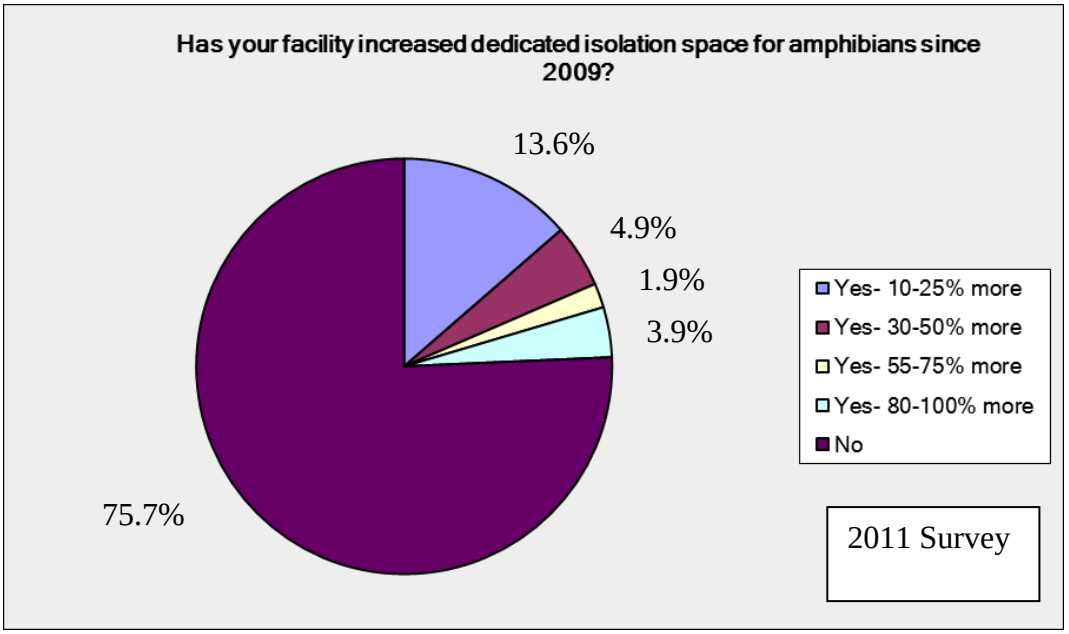
Space needed for Amphibians

The first ATAG space survey conducted in 1999 showed the potential for AZA institutions to collectively manage ten SSP populations. However, this estimate was made before isolation space was required for species with reintroduction programs. In the 2000 RCP, ATAG Chair, Dr. Kevin Wright, wrote:

"…*In these same institutions there is enough space allocated for mammals to accommodate at least 57 SSPs and the majority of these mammals have a body mass of more than 10 kg and significant space requirements. If each AZA institution allocated an additional 400 square foot building to amphibian management and provided keeper support for the facility, the number of taxa that could be managed at a PMP or SSP level would easily exceed 100 taxa. If AZA is to "Keep all the Pieces", the theme of its 1996 annual conferences, then a wave of dedicated amphibian facilities must be built. Amphibians need dedicated space and should not be simply incorporated into Reptile Houses or included as a small part of biome or zoogeographically themed facilities. If this dedicated space is lacking, zoos will never play a major role in maintaining amphibian biodiversity.*"

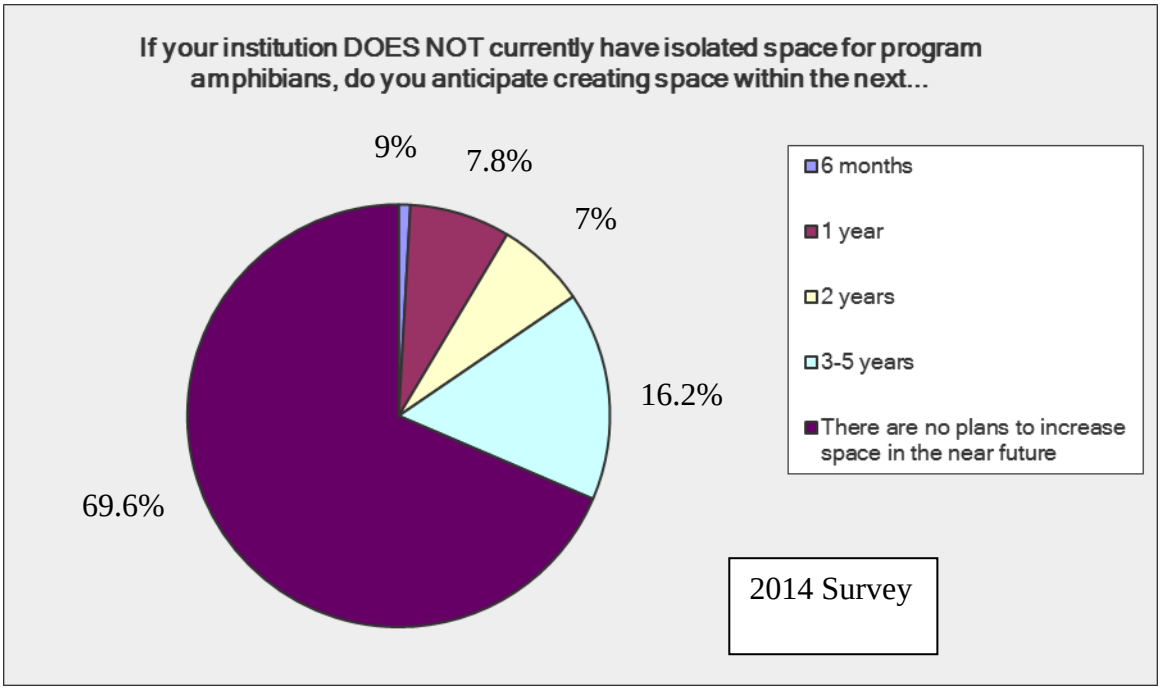
Sadly, Dr. Wright is no longer with us, but it is imagined he would be sorely disillusioned to learn that we are still paddling in the same boat some 15 years later, even when a global amphibian crisis has been declared by scientists- one that has no equal in the past 65 million years.

Three years after the 2008 *Year of the Frog* campaign, another space survey was sent out to ATAG IRs (n=104) to gauge if we had increased capacity within AZA institutions. Only twenty-four percent of respondents (n=25) reported creating new isolation space for amphibians in 2009 and 2010. Fifty-seven percent of respondents reported having no dedicated isolated space for amphibians, and out of those institutions, 75% (n=51) expressed that they did not anticipate creating new isolated space within the next five years. Thirty-two institutions reported having dedicated isolation space, totaling 51 individual rooms. Three institutions reported that they would build new rooms within the next year. This would add an additional nine rooms, bringing the total to 60 individual isolation rooms for amphibians in AZA institutions by January 2012.



At the time of a survey conducted in 2011, over 85% of the individual rooms were already occupied by the four SSP species in captivity and every program manager needed additional rooms/participation. The other rooms that were occupied were being used for local species of concern or for institutional initiatives. The last question on the 2011 survey asked participants what types of resources were needed from the ATAG to help with future conservation initiatives. Thirty-eight of the respondents answered

the question. Out of those, the most common response was "Provide more information to sway, or apply pressure to Directors to become more involved". The second most common request was for funding.



The most recent survey was distributed in 2014 and represents data from 80% of ATAG IRs (n=131). Thirty-eight percent of respondents (n=50) reported having dedicated isolation space for amphibians. Of those institutions, 101 individual rooms are currently in use for amphibians. However, only 50% (52) are actually being used for recommended SSP program species and 19 rooms are currently vacant, or can be used for species in the future. Sixty-nine percent of IRs (n=80) indicated that there is no intent to create space for amphibians at their institution within the next five years. This represents a total of 71 rooms that are available for ATAG SSP programs for the next five years. Since 73% of those rooms are already in use, and four of the five SSP Coordinators are pleading for more participating institutions to expand and accomplish current reintroduction/recovery efforts, there is little to no space available for new SSP programs. There are currently eight additional species that are recommended within this RCP for SSP formation (Table 2) using the global assessment and AZA standards for program sustainability processes.

Out of Space

The horrid truth is that some species programs and AZA sustainability programs will not succeed despite our best efforts. Some species will never have an effective champion or enough resources to reverse threats in wild in time to save them from extinction. Other programs will be successful and species will be recovered in the wild only expending decades of effort and millions of dollars. USFWS Species Recovery Plans include definitions of successful recovery for individual species in order to delist, or deem a species *recovered*, but what about those species that are most likely not going to recover? Due to space and resource constraints, and an increasing number of threated species identified each year, it is imperative that program leaders address exit strategies BEFORE initiating or joining new programs. Plans should be developed to evaluate and quantify "success" or "failure" of short and long-term goals. There are many examples of captive programs that are foundering due to the participants' inability to "concede defeat". There is typically no exit strategy for species programs now and extinction may be the outcome for many species that we try to save. It is our responsibility to try to reverse declining population trends, particularly if human activities are to blame, but the reality is that there are not enough resources and time for every amphibian in need. Being savvy and efficient is vital to do more with less.

It is essential that stakeholders streamline projects by being clear and up-front regarding resource limitations, the expected level of participation from partners and the duration of projects.

At the next RCP revision, it is predicted that we will most likely still have 75% of the priority species listed without a champion, with little to no increased capacity for our program species, and another 20-30 new amphibians recommended for *ex situ* management in the wings. All programs should include an exit strategy as a component of recovery management.

What does it mean?

If we do not commit to creating more space for amphibians and we don't have an "out" for those programs that are not effective, we will NOT be able to manage more than our current six SSP programs, much less the ten for which were originally estimated in 2000.

The ATAG has endeavored to support global initiatives by increasing support for prioritized amphibians within our assigned region and providing institutions with multiple resources and a "road map" with which to navigate. Individuals are encouraged to actively participate in and develop new programs on a regional and global scale along the way. The ATAG has hosted two AArk amphibian prioritization meetings for North American species and has used the results from those workshops as the basis for a sound RCP. This process has enabled the ATAG steering committee to be more selective in regards to forming and maintaining priority amphibian programs for extremely limited regional space and resources. However, there has been a less than expected response for increasing capacity within the zoological community the past eight years; there remains a major disconnect between our global initiatives and implementation of recovery efforts, particularly in regards to the species selection process at the local and federal levels.


Rana aurora Photo: Ian Recchio

Despite the ATAG's ability to demonstrate the need and offer options for institutions to create space and resources (Appendix II), state and federal agencies have a different process of choosing species and allocating resources that do not always align with our current focal species selection criteria. Increasingly, these agencies are reaching out directly to local zoos and aquariums, as well as the ATAG, asking for assistance with the development of and participation in new captive amphibian programs. Although participation in local recovery efforts for amphibians is encouraged, those species identified for recovery efforts at the state level, may actually be considered stable throughout the majority of the population's range, taking up valuable space in zoos for species that may not be in dire straits compared to others.

In order to be successful on a global scale when committing space and resources to priority species, there must be a cohesive species prioritization method aligned with governing agencies that is realistic in terms of number of species zoos and aquariums have the capacity to recover long-term. If capacity cannot expand and the way species are identified for *ex situ* management is transformed, new programs will continue to be developed at the local level, based on personal interests, or by lobbyists. Ultimately, this will deflect resources from more imperiled or truly unique species, undermining global species prioritization efforts. Amphibians favored by individuals will continue to be the species that are driven to program status in zoos and aquariums rather than those that have been identified as most important.

Although the AZA amphibian community has made great strides in terms of coming together to follow a global plan and is a model for other taxa, the current path remains daunting and time is of the essence. For example, the Ainsworth's Salamander, *Plethodon ainsworthi*, is excluded from our Priority I species list since none are in captivity and is categorized as *Extinct in the Wild* (last seen in Mississippi in 1964). Two other species of coqui from Puerto Rico (golden coqui, *Eleutherodactylus jasperi* and stream coqui, *E. karlschmidti*) remain on our priority list, but have not been observed in the wild since the 1980's. Hope remains that unknown populations of these frogs will be discovered and that there will be space in captivity to aid them before they, too, go extinct.

Table 1: Space Analysis Summary of Managed SSP Programs

Common Name	Scientific Name	Current Population Size	Target Population Size	Space In Use/Available (Isolation Rooms*)	Additional Space Needed (Isolation Rooms*)	Purpose of Isolation Space
Puerto Rican Crested Toad	*Peltophryne lemur*	832 (NXS and southern)	700 (NXS and southern)	15	6	Reintroduction & Assurance
Wyoming Toad	*Anaxyrus baxteri*	562 (including headstarts for release)	500 - 600	10	2	Reintroduction & Assurance.
Panamanian Golden Frog & Harlequin Golden Frog[1]	*Atelopus zeteki* & *Atelopus varius*	*A. zeteki* – 1400 *A. varius* – 162	*A. zeteki* – 1500 *A. varius* – 400	7	14	Repatriation & Assurance
Dusky Gopher Frog	*Lithobates sevosus*	554	1000	5	11	Reintroduction & Assurance
Houston Toad	*Anaxyrus houstonensis*	656	1,000	3	3	Reintroduction & Assurance
Total Regional Space Needs (Isolation rooms*)					**36**	

*Isolation levels are defined and may vary based on each program need, but implies isolation from main institutional collection; space needed is estimated for within a 5 year period (goal) to meet current needs for captivity and is defined as that needed to maintain both SSP and release programs.

[1] Since these species are from the same region, they typically occupy the same isolation space for management purposes.

Species Selection Criteria

The Global Prioritization Process

The captive rearing of amphibians in Canada and the United States is not new. In 1982, six wild Puerto Rican crested toads (*Peltophryne lemur*) were captured, brought into AZA-accredited zoos and aquariums, and managed under AZA's first amphibian Species Survival Plan® (SSP). U.S. 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 the second version of the ATAG RCP in 2008, had been no strategic approach to the use of *ex situ* captive rearing for conservation management purposes and the majority of programs grew from the interests of individual facilities and the needs of state wildlife agencies.

The ATAG hosted two Amphibian Conservation Needs Assessment Workshops in July 2007 and March 2012 to determine which of the amphibian species in the United States, Canada and Puerto Rico were in need of assistance. Goals were to assess all species for their conservation requirements, prioritizing those that require immediate *ex situ* actions and to include those species that could benefit from *in situ* efforts. The results from these workshops, as well as from additional assessments that were conducted later in range countries, were used to select species for the current RCP (Appendix I).


Plethodon glutinosus Photo: R.A. Odum

Ex situ conservation is only one component of amphibian recovery efforts, for which zoo and aquariums are particularly adept. All captive rearing programs should 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 cause 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 brings opportunities to contribute to an integrated approach of conservation. 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.

Selection Tool: Amphibian Ark's Prioritization Tool for *Ex situ* Conservation

Amphibian Ark's *Prioritization and Implementation Process for* Ex Situ *Conservation of Amphibians* (Appendix I) 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 the current tool was finalization by Amphibian Ark staff in 2012. 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 original GAA listing; threat mitigation possibilities; socio/economic importance; phylogenetic uniqueness; scientific and biological importance; and other factors. Additional questions evaluate program feasibility and readiness for program implementation.

Management Categories

SSP Taxa (Species Survival Plan): Studbook required, intense management to maintain captive population, compliance by participating institutions required, breeding and transfer recommendations communicated through a Master Plan, program managed by a Species Coordinator, non-member participants must be approved, conservation of the species a consideration, institutional input through IRs.

Green SSP: Greater than 50 individuals, ≥90% projected genetic diversity at 100 years or 10 generations, studbook and full participation in AZA SSP Policy required.
Yellow SSP: Greater than 50 individuals, <90% projected genetic diversity at 100 years or 10 generations, studbook required, full participation in AZA SSP Policy is NOT required.
Red SSP: Greater than 20 Individuals, maintained at ≥3 facilities; OR listed as EX, CR or E by IUCN, studbook required, full participation in AZA SSP Policy is NOT required, ATAG has developed 3 goals.

DERP Taxa (Display, Education or Research Populations): DERPs are not managed under the auspices of AZA or its programs and are not guaranteed population management advice or support from SPMAG/PMC. No studbook or long-term genetic or demographic management is required for these species, but TAGs may choose to identify species champions who may track DERPs through registries.

PIP Taxa (Phase-in Populations): Taxon not currently in AZA institutions but for which the TAG plans or hopes to initiate a captive population; they have no studbooks and are not guaranteed population management advice or support from SPMAG/PMC. Once in captivity, the taxon will be reassigned to another category as appropriate.

ISE Taxa (Populations in need of *In situ* Effort): Taxon for which mitigation of threats in the wild may still bring about their successful conservation and that further research in the wild is required as part of the conservation action for these taxa. Educational outreach and/or biobanking may also benefit.

NC (No Category): Taxon is no longer placed in a managed category.

TMAP (Taxon Management Account Plan): Former Category from previous RCP. Taxon was monitored as taxa of concern. Taxon Management Plans were developed by a Taxon Champion.

Rana pretiosa Photo: Michael Durham

Results of Species Selection Process

Species included on Tables 2-4 were evaluated during prioritizations for North America and Puerto Rico.

Key to Categorical Designations in Tables 2-4:

A. **Ark/Rescue Role:** Species that are extinct in the wild or in imminent danger of extinction (locally or globally), and require *ex situ* management as part of an integrated program, to ensure their survival.
B. ***In situ* Conservation Role:** Species for which mitigation of threats in the wild may still bring about their successful conservation.
C. ***In situ* Research Role:** Species that for one or more reasons require further *in situ* research to be carried out as part of the conservation action for the species. One or more critical pieces of information is not known at this time.
D. ***Ex situ* Research Role:** Species currently undergoing, or proposed for specific applied research that directly contributes to the conservation of the species, or a related species, in the wild (this would include clearly defined 'model' or 'surrogate' species).
E. **Conservation Education Role:** Species that are specifically selected for management – primarily in zoos and aquariums - to inspire and increase knowledge in visitors, in order to promote positive behavioral 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).
F. **Biobanking Role:** Species for which the long-term storage of sperm or cells to perpetuate their genetic variation is urgently recommended, due the serious threat of extinction of the species.

Notophthalmus meridionalis

Photo: Patty Scanlan

Priority I Taxa for *Ex situ* Management

Priority 1 taxa include current SSP programs, as well as species identified through the species selection process that are currently listed in PIP categories. Each species require *ex situ* management for survival and should be kept in permanent isolation.

Table 2: Priority I Taxa - Species with mandates for *ex situ* conservation listed alphabetically by scientific name (Ark/Rescue Role recommended because threats CANNOT be mitigated in time).

Common Name	Scientific Name	Category	Program Leader	IUCN Status	A/B	C	D	E	F
Reticulated Flatwoods salamander	*Ambystoma bishopi*	PIP - *Isolation*	Mark Beshel	VU	**A**	C	D		
California Tiger Salamander	*Ambystoma californiense*	PIP - *Isolation*	Kate Gore	VU	**A&B**	C			
Flatwoods Salamander	*Ambystoma cingulatum*	PIP - *Isolation*		VU	**A**	C	D		
Wyoming Toad	*Anaxyrus baxteri*	SSP-Yellow	Coordinator: Val Hornyak Studbook Keeper: Sarah Armstrong	EW	**A**			E	F
Houston Toad	*Anaxyrus houstonensis*	SSP-Green	Coordinator/Studbook: Tyler Parker	CR	**A&B**	C		E	F
Panamanian Golden Frogs[2]	*Atelopus zeteki* & *A. varius*	SSP-Yellow	Coordinator: Vicky Poole Studbook Keeper: Kevin Barrett	CR	**A&B**	C	D	E	F
Elegant Coqui	*Eleutherodactylus eneidae*	PIP - *Isolation*	Dr. Raphael Joglar	CR	**A**			E	F
Cricket Coqui	*Eleutherodactylus gryllus*	PIP - *Isolation*	Dr. Raphael Joglar	EN	**A**			E	F
Golden Coqui	*Eleutherodactylus jasperi*	PIP - *Isolation*	Dr. Raphael Joglar	CR	**A&B**		D	E	F
Stream Coqui	*Eleutherodactylus karlschmidti*	PIP - *Isolation*	Dr. Raphael Joglar	CR	**A**		D	E	F
Upland Coqui	*Eleutherodactylus portoricensis*	PIP - *Isolation*	Dr. Raphael Joglar	EN	**A**	C		E	F
Richmond's Coqui	*Eleutherodactylus richmondi*	PIP - *Isolation*	Dr. Raphael Joglar	CR	**A**		D	E	F
Dusky Gopher Frog	*Lithobates sevosus*	SSP-Yellow	Coordinator: Steve Reichling Studbook Keeper: Deanna Lance	CR	**A**	C		E	F
Puerto Rican Crested Toad	*Peltophryne lemur*	SSP-Green	Coordinator: Diane Barber Studbook Keeper: Dustin Smith	CR	**A**		D	E	F

Ambystoma bishopi Photo: Mark Beshel

[2] The only exception to the geographical/political region of the RCP, two Panamanian golden frog species (PGFs) have been included on the list of ATAG RCP species, list as the program, founded in 1997, predates this global delineation for species conservation focus by IUCN/ASG/Amphibian Ark established in 2007, and the population is >50 specimens requiring the elevation to an SSP by WCMC standards.

Priority II Taxa for *In situ* and *Ex situ* Management

The ATAG is recommending that a Taxon Champion/Contact be assigned to each of these taxa to assess their *in situ* conservation needs and advise the ATAG on any necessary future support. At this time, it is only advised to work with *ex situ* groups of Priority II taxa for recommended research purposes (see summary table links Appendix I) and to aid with necessary *in situ* actions. Populations kept in captivity DO NOT require isolation.

Table 3: Priority II Taxa listed alphabetically by scientific name (B & D - *In situ* conservation needed, along with a recommendation for *ex situ* research since threats CAN be mitigated in time).

Common Name	Scientific Name	Category	Species Contact	IUCN Status	A/B	C	D	E	F
One-Toed Amphiuma	*Amphiuma pholeter*	DERP- *No Isolation*	Jennifer Pramuk	NT	**B**		D		
Boreal Toad	*Anaxyrus boreas*	DERP- *No Isolation*		NT	**B**		D		
Eastern Hellbender	*Cryptobranchus alleganiensis*	DERP- *No Isolation*	Joe Greathouse	NT	**B**		D	E	
Ozark Hellbender	*Cryptobranchus bishopi*	DERP- *No Isolation*	Mark Wanner	NE[3]	**B**		D	E	
Pygmy Salamander	*Desmognathus wrighti*	PIP- *No Isolation*		LC	**B**	C[4]	D		
Cook's Robber Frog	*Eleutherodactylus cooki*	DERP- *No Isolation*	Dr. Raphael Joglar	VU	**B**		D	E	
Chisholm Trail Salamander	*Eurycea chisholmensis*	DERP- *No Isolation*		VU	**B**		D		
San Marcos Salamander	*Eurycea nana*	DERP- *No Isolation*	DeAnn Chamberlain	VU	**B**		D		
Texas Salamander	*Eurycea neotenes*	PIP- *No Isolation*		VU	**B**		D		
Texas Blind Salamander	*Eurycea rathbuni*	DERP- *No Isolation*	Nick Hanna	VU	**B**		D		
Blanco Blind Salamander	*Eurycea robusta*	DERP- *No Isolation*		DD	**B**	C	D		
Barton Springs Salamander	*Eurycea sosorum*	DERP- *No Isolation*	DeAnn Chamberlain	VU	**B**		D		
Grotto Salamander	*Eurycea spelaea*	PIP- *No Isolation*		LC	**B**		D		
Jollyville Plateau Salamander	*Eurycea tonkawae*	DERP- *No Isolation*		EN	**B**		D		
Georgia Blind Salamander	*Eurycea wallacei*	PIP- *No Isolation*		VU	**B**		D		
Crawfish Frog	*Lithobates areolatus*	PIP- *No Isolation*	Dr. Michael Lannoo	NT	**B**		D		
Gopher Frog	*Lithobates capito*	PIP- *No Isolation*		NT	**B**		D		
Chiricahua Leopard Frog	*Lithobates chiricahuensis*	DERP- *No Isolation*		VU	**B**		D		
Alabama Waterdog	*Necturus alabamensis*	DERP- *No Isolation*	Eric Keyster	EN	**B**		D		
Neuse River Waterdog	*Necturus lewisi*	DERP- *No Isolation*		NT	**B**		D		
Red Hills Salamander	*Phaeognathus hubrichti*	DERP- *No Isolation*		EN	**B**		D		
Illinois Chorus Frog	*Pseudacris illinoensis*	PIP- *No Isolation*		NE	**B**		D		
Mountain Yellow-Legged Frog	*Rana muscosa*	DERP- *No Isolation*		EN	**B**		D		
Sierra Nevada Yellow-legged Frog	*Rana sierrae*	DERP- *No Isolation*	Victor Alm	EN	**B**		D		
Western Spadefoot	*Spea hammondi*	PIP- *No Isolation*		NE	**B**		D		
Patch-nosed Salamander	*Urspelerpes brucei*	PIP- *No Isolation*		LC	**B**	C	D		

[3] *Cryptobranchus bishopi* was not a species during either IUCN or AArk Prioritization assessment, so assessed under *C. allegeniensis*.
[4] The **C** role comes from *D. organi* which may be broken out genetically as the northern population of *D. wrighti*.

Priority III Taxa for *In situ* Management

The ATAG is recommending that a Taxon Champion/Contact be assigned to each of these taxa to assess their *in situ* conservation needs and advise the ATAG on any necessary future support. These species DO NOT require collaborative *ex situ* management at this time.

Table 4: Priority III Taxa listed alphabetically by scientific name (B - *In situ* conservation recommended, without a recommendation for *ex situ* research (D); C, E & F recommended roles for *in situ* research, conservation education, and/or biobanking may still apply).

Common Name	Scientific Name	Category	Species Contact	IUCN Status	A/B	C	D	E	F
Arroyo Toad	*Anaxyrus californicus*	ISE	Kim Lovich	EN	**B**				
Yosemite Toad	*Anaxyrus carnorus*	ISE		EN	**B**				
Black Toad	*Anaxyrus exsul*	ISE		VU	**B**				
Amargosa toads	*Anaxyrus nelsoni*	ISE		EN	**B**	C			
Oak Toad	*Anaxyrus quercicus*	ISE		LC	**B**				
Clouded Salamander	*Aneides ferreus*	ISE		NT	**B**				
Black Salamander	*Aneides flavipunctatus*	ISE		NT	**B**				
Sacramento Mountain Salamander	*Aneides hardii*	ISE		LC	**B**	C			
Wandering Salamander	*Aneides vagrans*	ISE		NT	**B**				
Seepage Salamander	*Desmognathus aeneus*	ISE		NT	**B**				
Hedrick's Coqui	*Eleutherodactylus hedricki*	ISE	Dr. Raphael Joglar	EN	**B**			E	
Locust Coqui	*Eleutherodactylus locustus*	ISE	Dr. Raphael Joglar	CR	**B**			E	
Rivero's Coqui	*Eleutherodactylus juanriveroi*	ISE	Dr. Raphael Joglar	NE	**B**			E	
Melodious Coqui	*Eleutherodactylus wightmanae*	ISE	Dr. Raphael Joglar	EN	**B**			E	
Junaluska Salamander	*Eurycea junaluska*	ISE		VU	**B**				
Cascade Caverns Salamander	*Eurycea latitans*	ISE		VU	**B**				
San Gabriel Springs Salamander	*Eurycea naufragia*	ISE		EN	**B**				
Blanco River Springs Salamander	*Eurycea pterophila*	ISE		DD	**B**				
Comal Blind Salamander	*Eurycea tridentifera*	ISE		VU	**B**				
Eurycea Troglodytes complex	*Eurycea troglodytes*	ISE		DD	**B**				
Oklahoma Salamander	*Eurycea tynerensis*	ISE		NT	**B**				
Austin Blind Salamander	*Eurycea waterlooensis*	ISE	DeAnn Chamberlain	VU	**B**				
Berry Cave Salamander	*Gyrinophilus gulolineatus*	ISE		EN	**B**				
Tennessee Cave Salamander	*Gyrinophilus palleucus*	ISE		VU	**B**				
Relict Leopard Frog	*Lithobates onca*	ISE		EN	**B**				
Tarahumara Frog	*Lithobates tarahumarae*	ISE		VU	**B**				
Black-Spotted Newt	*Notophthalmus meridionalis*	ISE	Bradley Lawrence	EN	**B**				
Striped Newt	*Notophthalmus perstriatus*	ISE		NT	**B**				
Big Levels Salamander	*Plethodon sherando*	ISE		VU	**B**				
Southern Zigzag Salamander	*Plethodon ventralis*	ISE		LC	**B**				
Webster's Salamander	*Plethodon websteri*	ISE		LC	**B**				
Wehrle's Salamander	*Plethodon wehrlei*	ISE		LC	**B**	C			
Weller's Salamander	*Plethodon welleri*	ISE		EN	**B**				
Rana Pata Amarilla (Spanish)	*Rana boylii*	ISE		NT	**B**				
Cascades Frog	*Rana cascadae*	ISE		NT	**B**				

Program Status and Data Summary Tables of Current SSP Programs

Table 5: Program Status Table of Priority I Taxa/SSP species

Program	Date Program Initiated	Current Program Leader	Date Leadership Assumed	Date of Last Studbook Update	Studbook Keeper	Date of last Master Plan Publication
Puerto Rican Crested Toad SSP	1984	Diane Barber	Jan 2005	Feb 2014	Dustin Smith	Oct 2011
Wyoming Toad SSP	Dec 1996	Val Hornyak	Sept. 2009	Feb. 2014	Sarah Armstrong	Jun 2013
Panamanian Golden Frog SSP	Mar 2008	Vicky Poole	Mar 2008	Jan 2013	Kevin Barrett	Aug 2013
Harlequin Golden Frog SSP	Mar 2008	Vicky Poole	Mar 2008	Jan 2014	Kevin Barrett	May 2014
Dusky Gopher Frog SSP	Mar 2008	Steve Reichling	Mar 2008	Oct 2011	Deanna Lance	Jul 2012
Houston Toad SSP	Mar 2007	Tyler Parker	Nov 2013	May 2014	Tyler Parker	Oct. 2013

Table 6: Animal Program Summary Data of All Current SSP programs

Common Name *Scientific Name*	Date of Last Breeding & Transfer Plan	Current Population Size (N)	Current Number of Participating Institutions	Sustainability Score (retained %GD at 100 years or 10 generation)	Animal Program Designation	Target Population Size (N)	Target Sustainability Scores, if known	Top Three Program Goals & Objectives
Puerto Rican Crested Toad *Peltophryne lemur*	Oct 2011	832 (northern and southern)	28	93	Green SSP	700 (northern and southern)	>90	Reintroduction, Assurance & Increase Capacity
Wyoming Toad *Anaxyrus baxteri*	June 2013	562	10	78.0 for 10 generations	Yellow SSP	600	N/A	Reintroduction, Assurance & Increase Capacity
Panamanian Golden Frog *Atelopus zeteki*	Aug 2013	1400 (Sora 933 & Ahogado 467)	18	Sora 70 & Ahogado 61.5 for 10 generations	Yellow SSP	1500 (Sora 900 & Ahogado 600)	N/A	Repatriation to Panama, Assurance, & Exhibit Needs
Harlequin Golden Frog *Atelopus varius*	May 2014	162	5	67.5 for 10 generations	Yellow SSP	400	N/A	Repatriation to Panama, Assurance, & Exhibit Needs
Dusky Gopher Frog *Lithobates sevosus*	Jul 2012	554	16	68.02 for 10 generations	Yellow SSP	1000	N/A	Reintroduction, Assurance & Increase Capacity
Houston Toad *Anaxyrus houstonensis*	Oct 2013	656	3	91.8 for 10 generations	Green SSP	1000	>90	Reintroduction, Assurance & Increase Capacity

GREEN SSP Population

Puerto Rican Crested Toad

Peltophryne lemur

Species Summary: The Critically Endangered Puerto Rican Crested Toad (PRCT) has been the focal species of one of the most significant AZA conservation programs. It is the only native toad to the island of Puerto Rico and has gone through population declines because of the introduction of the marine toad (*Rhinella marina*), habitat loss, and habitat degradation. Since it was first described, the PRCT has been very difficult to observe in the wild, with less than 30 sightings from its description in 1868 to the 1930s. It was then thought to be extinct until the 1960s when a population was rediscovered in the northern portion of the island. A little over a decade later, a large population was found in the southern portion of the island, which is now the only living, natural population. In the 1990s, the northern populations of PRCTs had completely disappeared.

Program Goals & Objectives: The PRCT SSP is focusing its efforts on maintaining a genetically diverse assurance colony, continuing to expand the reintroduction and sites available for reintroductions in the wild, and increase capacity within AZA facilities. There are currently 30 facilities housing crested toads, but less than half are participating in the breeding/reintroduction program. To expand the productivity of the program, facilities are needed to create space to house a breeding population of the PRCTs and maintain a portion of their offspring. Once offspring have been released, post-release monitoring is conducted to determine efficacy of the program. An MOU is in place with partners in Puerto Rico to ensure the success of the program and the long-term survival of the species. PRCT member facilities are encouraged to participate in the breeding and the release efforts through annual trips for *in-situ* capacity building and reintroductions. As of fall 2013, there have been more than 200,000 tadpoles released in Puerto Rico, due to the efforts of the SSP program.

Exhibit Qualities: This species exhibits well, as long as furnishings are placed properly within the exhibit. They are primarily nocturnal and prefer to hide in rock crevices or under props. They can be displayed in groups, and exhibit should feature limestone-type rocks or mud banks with shallow holes for the species to hide, but yet still visible to guests; exhibit can be in a vertical orientation.

Educational Qualities: PRCTs are a good species for topics regarding island species, amphibian declines, conservation/reintroduction, habitat loss, and breeding phenology. PRCTs are not recommended for outreach use. Their conservation, reintroduction, toxicity, phenology/breeding biology, and non-native species impacts can be focal points for graphics

Interpretive Messages:

- Global amphibian declines
- Captive Breeding & reintroduction
- Invasive *vs.* endemic species
- Egg-laying, larval development, and metamorphosis
- Habitat Restoration

Care & Facilities:
This is a very hardy species that can be housed in a variety of enclosure types. Most of the crested toads in AZA facilities are housed off-display in medium size aquariums (20-40 gallons) and can house between 6-10 adult specimens. When off-display, they are usually kept on rubber matting or another easily removable substrate for frequent cleaning. If kept in glass aquaria, lid should allow for adequate air flow and UV light penetration. A wide variety of props can be used in these enclosures, from natural to manmade items. Exhibits can be naturalistic, but must be designed to minimized hiding areas. Water should be dechlorinated and pre-filtered, prior to use. Ambient temperature should be in the range of 78-86°F. Toads are fed a diet typical to that of most insectivorous reptiles and amphibians and this should be as diverse as possible, with adequate vitamin and calcium supplementation. Quarantine/Breeding facilities for this species are very basic and require the typical off-display housing and husbandry listed within, but must not be kept in an open area with other reptiles and amphibians within the general collection. Puerto Rican Crested Toad SSP website has additional info and downloadable husbandry manual:
http://www.crestedtoadssp.org

Other Notes:
PRCTs must remain within AZA facilities and are owned by the Government of Puerto Rico, including all offspring produced. All transfers and breeding attempts must be approved by the SSP coordinator and all institutions holding PRCTs must be listed on the USFWS permit (managed by the SSP coordinator).
The population is managed with multiple populations. All specimens are managed by population (i.e., Northern or Southern), and the program is transitioning to include more crosses to expand genetic diversity. Specimens are also designated as either *exhibit* or *non-exhibit* animals. Exhibit animals are not part of the breeding program; non-exhibit animals only may be used in the breeding program. Multiple breeding events are scheduled at the beginning of each year based on each population to be released. Institutions wishing to breed PRCTs must be able to provide biosecure facilities (i.e. isolated from the rest of the reptile/amphibian collection) and maintain quarantine practices. These facilities will breed toads on an annual basis for reintroduction, but **less than half of the institutions holding crested toads are breeding facilities, so additional breeding facilities are desperately needed.**

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YELLOW SSP Population

Wyoming Toad

Anaxyrus baxteri

Species Summary: The Wyoming toad is a Federally Endangered Species that currently exists in the wild at only two known locations within its small range in the Laramie Basin of Wyoming. Both of these populations were created by the reintroduction of captive produced toads and tadpoles after the species was thought to be extinct, making this the first amphibian conservation program to re-establish a species within historic range through captive breeding efforts. Causes of its decline are uncertain but include habitat change/usage, aerial insecticides, predation, and as with so many other species, the amphibian chytrid fungus. Both populations have recently experienced serious declines and are once again being augmented by releases using progeny from the captive breeding program. Genetic diversity in the captive population will never increase unless new wild populations are discovered and collected as all currently known *wild* populations were re-established through reintroductions.

Program Goals & Objectives: The role of the SSP in the USFWS Recovery effort is to maintain a physically healthy and genetically diverse captive assurance population for this species and to produce numbers of offspring for release back into the wild. The SSP also assists the USFWS in Wyoming with field work and research. Recovery partners agree to work together in monitoring the reintroduced populations and conducting studies of behavior and habitat use in order to gain a better understanding of wild behavior to work out the most effective captive husbandry practices for this toad. Summer field surveys are conducted by the USFWS and volunteers to monitor and assess the wild populations. The annual SSP Master Plan and Husbandry meeting is held in Wyoming, and Wyoming Toad IRs and zoo staff assist with the July surveys; participation in these volunteer surveys is a great opportunity for Zoos that wish to make a contribution to an important amphibian conservation effort but do not hold the species in their collections.

Exhibit & Educational Qualities: Due to the small captive population size this program does not have exhibit or research populations at this time. Because all toads are potential breeders and must be maintained within biosecure holding, it is not possible to utilize toads for outreach programs or display toads to the public unless biosecure rooms are designed with a display window.

Interpretive Messages:

- Global and regional amphibian declines
- Amphibian Diseases
- Endangered Species Act protection and coverage
- Egg-laying, larval development, and metamorphosis
- Zoo and native range conservation

Captive husbandry: Prior experience breeding and raising similar Bufonids, such as American toads, is highly-recommended for facilities wishing to work with Wyoming toads. Within the biosecure room, adult toads may be maintained in aquariums or similar enclosures that are approximately 3:1 land area/water. Flow through or circulating systems may be used, with a carbon filter recommended. A 20 long tank can house 5 adult toads. Breeding tanks, tadpole rearing, and metamorph set-ups are similar to those for other Bufonids. Lights for basking and UV must be provided. A dedicated refrigeration unit for hibernation within the biosecure holding room is necessary for cycling toads recommended for reproduction. Scheduled breeding is done during a specified window of time, using hormone injections. Offspring are shipped to Wyoming for release or held back for the captive population. Nutritional needs for this species is still being determined; commonly available feeder insects such as crickets, earthworms, wax worms and others are offered but do not seem to replicate wild diet adequately; extra-supplementation is necessary, especially with Vitamin A.

Other Notes: All toads are the property of the USFWS. More zoos and aquariums with amphibian management and breeding experience are needed to expand the Wyoming toad captive assurance population. Per the Recovery Plan, production will need to be increased in the future as USFWS creates more sites for reintroduction, with criteria for participation are as follows: 1.) DEDICATED BIOSECURE HOUSING AND QUARANTINE AREAS - Isolation from all other amphibians in both quarantine and permanent holding is required in this captive breeding- for- release program; 2.) SPACE COMMITMENT - Participants must be able to hold at least four separate cohort groups (20 – 40 toads) and be able to breed several pairs of toads annually and provide space for breeding transfers and tadpole holding prior to release; 3.) USFWS ENDANGERED SPECIES PERMIT is required to hold the federally endangered Wyoming Toad and permits are only issued to breeding facilities; and 4.) PARTICIPATION in conference calls/listserv discussions and IR representation at annual Masterplan and Husbandry sessions is important to make informed pairings and group decisions. This is a very interactive program that requires involvement at the keeper level due to ongoing husbandry issues. Participants must follow guidelines and protocols of the USFWS and the SSP that have been and are being developed for this program, answer requests for information, and supply updates to Studbook Keeper, Species Coordinator, SSP Pathologist and USFWS in a timely way.

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YELLOW SSP Population

Panamanian Golden Frogs

Atelopus zeteki and *Atelopus varius*

Species Summary: These brilliantly-colored harlequin toads are striking exhibit specimens, serving as a flagship species for global amphibian declines due to the impact on Panamanian golden frog (PGF) populations from amphibian chytridiomycosis (*Batrachochytrium dendrobatidis; Bd*). PGFs live within tropical montane cloud forests, with breeding and larval development taking place in forest streams. True Panamanian golden frog, *Atelopus zeteki*, was recognized as a distinct species from the very similar-looking golden harlequin frog, *Atelopus varius*, based on a unique skin toxin, zetekitoxin, and bioacoustical differences. In addition to vocalizing, PGFs communicate by semaphoring, a limb-waving phenomenon that is hypothesized to have arisen so that the frogs could locate mates for breeding near the deafening sounds of waterfalls, where their gentle vocalizations are inaudible.

Program Goals & Objectives: *A. zeteki*, and *A. varius*, are both listed as Critically Endangered (CR) by IUCN, CITES Appendix I, and FWS Endangered since the mid-1970s. Unfortunately, *A. zeteki* has not been observed since 2009 and is most likely Extinct in the Wild (EW), while *A. varius* still persists in small isolated populations. The captive population collected in advance of the *Bd* front in the early 2000's and brought to AZA institutions were intended to serve as assurance colonies and flagship exhibit species, and continue to do so today. Now with the construction of facilities within Panama to serve as in-country breeding centers for potential release and a PHVA meeting held in late 2013, there are plans to repatriate some diverse SSP bloodlines of PGFs back to Panama to serve as founder stock. Research on disease impacts and mitigation, suitable habitat, and general health of PGFs were also identified as key needs during the PHVA. Continuing to change perceptions and raise awareness of the culturally significant, yet highly coveted PGFs within Panama to ensure their survival post-release will also be necessary.

Exhibit Qualities: These diurnal species are highly attractive, although will hide among available micro-habitats created by live plants, small boulders, and perching so a group of specimens are recommended for exhibit to increase opportunities for visitor visibility. PGFs will utilize the entire available exhibit space. Compatible species include other Panamanian dart frog, tree frog, and toad species.

Educational Qualities: PGFs will *not* tolerate handling to make them suitable for outreach programs unless only temporarily displayed within small terrariums. This is a good species to illustrate warning coloration, skin toxins, and semaphoring behaviors. PGFs also fit well into programs about tropical rain/cloud forests, biodiversity, amphibian declines, and deforestation/habitat loss.

Interpretive Messages:

- Global amphibian declines
- Extinction
- Skin toxins & Semaphoring
- Egg-laying, larval development, and metamorphosis
- Zoo and range-country conservation

Care & Facilities: This is a delicate species and husbandry requirements are well within the capabilities of AZA institutions. They do well maintained within naturalistic exhibits modeled after rocky streambeds of the frogs' native habitat. Minimum space allotted for a pair of adult *Atelopus* should be no less than a 15-gallon aquarium to provide sufficient micro-habitats, although up to a total of 6 non-breeding adult frogs could be housed in a 15-gallon tank. Mature males may need to be separated due to territorial behaviors during breeding seasons, and off-exhibit housing should be available should the need arise to separate out exhibit animals. Ambient air temperatures should be kept cool, varying between 68-75°F on a daily basis; water temperature should be between 69-72°F. Provide full-spectrum lighting (UV A & UV B) on a 12:12 lighting cycle year round, and offer a full-spectrum or plain incandescent basking spot light (60-100W) as PGFs bask naturally. Humidity levels of up 85-100% can be easily maintained with automated misting and/or fogger systems, which also helps to stimulate breeding activity. PGFs require very good water quality, so institutions may have to consider filtration of source and/or enclosure water. Good drainage and ventilation are essential to prevent stagnant air and minimize mold growth. These frogs are insectivores, readily consuming flightless fruit flies, gut-loaded 2-week crickets, flour beetles, termites, and springtails 3-7x per week based on age. Every feeding should be dusted with a vitamin-mineral supplement. A detailed husbandry manual is available for downloading from the *Project Golden Frog/Proyecto Rana Dorada* website: http://www.ranadorada.org/PDF/HusbandryManual.pdf; additionally, a PowerPoint slideshow of example exhibits is available from the Program Leader.

Other Notes: PGFs within AZA facilities are owned by the *Maryland Zoo in Baltimore* (MZB), and arrangements for transfers must go through the Population Manager at MZB. The captive population of *A. zeteki* within AZA institutions represents two distinct localities (Sora & Ahogado). Along with the single golden *A. varius* population, all three populations of PGFs are managed uniquely (i.e. not housed, nor cross bred); the SSP is seeking facilities willing to maintain these species in biosecure facilities to maintain clean bloodlines for repatriation to facilities within Panama. Institutions new to the SSP are given a single bloodline initially to become acquainted with the husbandry of Atelopus before breeding recommendations are considered. Humane euthanasia at all life stages is a necessary and approved method of population management, cleared by the USFWS for this endangered species.

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YELLOW SSP Population

Dusky Gopher Frog

Lithobates sevosus


Dusky Gopher Frog SSP

Species Summary: As the only endemic anuran of the longleaf pine ecosystem, the dusky gopher frog (DGF), *Lithobates (Rana) sevosus,* is uniquely capable of advocating for this vanishing and strikingly unique American landscape. As such, it is a species that should not be absent from any southeastern zoo. As the most critically endangered anuran in the eastern U.S., AZA facilities that seek to conserve amphibians should consider SSP participation.

Program Purposes: 100-200 DGFs exist in the wild. Their remaining, highly-degraded, habitat is threatened by a surge in residential development, and the relict *in situ* population has been infected with a new and poorly understood disease, (*Dermomycoides*) for which there is no cure. First and foremost, the purpose of the SSP is to maintain an assurance colony as a guarantee against complete extinction; long-term survival of the single wild population is quite uncertain. Second, the Dusky Gopher Frog SSP is a formal partner with the US Fish and Wildlife Service, with representatives serving on the Recovery Group. The Recovery Plan for DGFs includes the reintroduction of captive-bred frogs into the historical range. Additionally, captive specimens are used to raise public awareness of the status of this species and the plight of the longleaf piney woods.

Exhibit Qualities: Successful exhibits are those that provide for the species' fossorial nature while exploiting its propensity to bask. Captives will spend most of the daylight hours outside but near the entrance to their burrow, or just inside the entrance where they can be readily seen. Their burrow fidelity provides an advantage in that the location of the frogs can be reliably predicted and the exhibit designed around these areas. Ultraviolet basking spots are essential, as is careful monitoring of substrate moisture, keeping it neither too moist nor too dry. For those amphibian specialists who are ready for a species that requires more than a beginner level terrarium environment – one that responds to the work of an advanced keeper – *L. sevosus* is an ideal subject.

Educational Qualities: The species is especially valuable to southeastern zoos within the historic footprint of the longleaf pine belt, serving as an alarming example of forest ecosystem mismanagement.

Interpretive Messages:

- Ecology of the longleaf piney woods
- Management of longleaf pine ecosystems (prescribed burning, eco-friendly silviculture)
- Amphibian diseases
- Meta-population dynamics and its role in amphibian conservation

Care & Facilities: A variety of enclosures can be used; key elements are size, substrate, drainage, ventilation, and furnishings. Roughly 2 X 2.5 feet floor space for 4-8 adults and 1 X 1 foot area for up to a dozen newly-metamorphed froglets provides general species' space requirements. Mosses and soils is recommended as substrate to a depth greater than 6 cm to afford the opportunity to bury; gravel and sand should be avoided due to potential health risks from ingestion. Substrate concerns can be avoided by using rubber mats, with clumps of damp sphagnum provided. Cage floors should be perforated to allow for thorough drainage of substrate. To provide good ventilation, enclosure top should be screened to permit the daily drying of substrate as these frogs live in relatively open and generally xeric habitat.

Gopher frogs need shelters of some sort; artificial burrows can be created out of cork bark or broken clay pots. Since these frogs naturally bask just outside their burrows, UV light is beneficial. Standard temperate-zone photoperiod seasonal adjustments keep gopher frogs in normal reproductive cycles. Temperatures of 80-85F are ideal, though frogs remaining active and feed as low as the mid-60Fs. They have been artificially hibernated successfully at temperatures ranging from 50-60F. Enclosures should be sprayed with water once daily to saturate the substrate and allowed to surface-dry, inhibiting bacteria and mimicking the natural xeric microenvironment of this species. A shallow water dish should always be available. Frogs do well on a diet of crickets, however they will take wax worms, mealworms, chopped earthworms, and wild-caught insects; frogs at all sizes are fed 2-3 times per week. Nutritional supplementation is critical; crickets should be gut-loaded with and all prey items should be dusted with vitamins just prior to being offered.


Dusky Gopher Frog SSP

Other Notes: The situation for *L. sevosus* in the wild is critical, with a high probability of extinction with one event such as a wildfire, hurricane, reproductive hiatus due to drought, or a recurrence of widespread disease due to the *Dermomycoides* organism. AZA facilities must steward SSP holdings as a demographically and genetically robust population, and this can only be accomplished with enthusiastic support from many institutions.

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GREEN SSP Population

Houston Toad

Anaxyrus houstonensis

Species Summary: This small brownish, fossorial toad species may seem unremarkable as a display animal for many zoos, yet this toad is a flagship species for U.S. amphibian conservation due to climactic and anthropogenic causes. The Houston toad is geographically restricted to eight counties in Texas, and is further restricted by habitat type, favoring deep sandy soils with prevalent canopy cover. Breeding occurs from mid-February to late May with eggs hatching within 2 to 3 days and tadpole metamorphosis at roughly 6 to 7 weeks. The Houston toad was the first amphibian listed as an Endangered Species by the USFWS in 1970. The main threats to extinction are habitat modification by humans and severe climactic events such as the periodic droughts and wildfire.

Program Goals & Objectives: The Houston toad, which is labeled as Endangered (EN) by both the IUCN and the U.S. Fish and Wildlife Service, has experienced significant range reduction due to extreme droughts and devastating wildfires that swept through the largest contiguous area of toad habitat, greatly reducing it in 2011. Since these events, Houston toad recovery and management efforts have been refocused and reorganized. Houston toads are no longer managed as three distinct geographic sub populations, but as one range-wide population. Recovery and reintroduction efforts are no longer focused on head starting but on egg production and release. Furthermore, a renewed effort in field surveys (presence or absence) have resulted in the confirmation of toad populations in previously under surveyed areas such as Robertson County and Austin County while confirming that toads are still present in previously well surveyed and managed areas such as Bastrop County. Captive husbandry management is also paramount, as over double the wild population is held between three AZA institutions and one non-profit research institution. Within these captive populations a myriad of medical and disease issues have emerged. Most recently, a bacterial infection of Chlamydophila has confounded wild egg release due to its virulence, unreliable screening methods, and unknown origin and transmission.


Photo: Rachel Rommel

In all, four program goals and objectives have been established for this species: 1) Continued research into *Chlamydophila* infections occurring in captive populations, including the transmissibility and etiology of this pathogen, sampling of wild amphibian populations for this pathogen, and developing highly confident screening methods for captive populations; 2) Fostering and expanding current AZA and non-AZA Houston toad captive holdings for this program; 3) Maintaining a robust and reliable survey system for identify and monitoring wild populations of the Houston toad; and 4) Further developing, managing and maintaining captive assurance colonies for supplementing the wild population of *A. houstonensis* each year through egg releases.

Exhibit Qualities: Due to the fossorial and cryptic nature of the Houston toad, this species unfortunately makes a poor display animal since it spends most of its time buried and out of sight. Yet it is a great outreach and educational animal due to its ability to be mildly handled or displayed in a temporary terrarium.

Educational Qualities: Tolerate mild, moderate handling which makes them suitable for outreach programs, though only with the use of small terrariums. This is a good species to illustrate cryptic coloration and camouflage, fossorial adaptation, and a conservation message which focuses on anthropogenic issues associated with population declines.


Photo: Paul Crump

Interpretive Messages:

- Global and regional amphibian declines
- Extinction
- Endangered Species Act protection and coverage
- Egg-laying, larval development, and metamorphosis
- Zoo and native range conservation

Care & Facilities: *A. houstonensis* can be a temperamental species to keep in captivity, yet husbandry requirements are well within the capabilities of most AZA institutions. They do well when housed within either a naturalistic exhibit kept on a sand or sandy/loamy soil mix, or within a holding/breeder maintenance enclosure with a false bottom that allows for substrate to be added to one end and water to be held and utilized at the other. Native range substrates and plants can also be used. Animals should be housed in no less than a 10 gallon tank per 1 adult individual toad and no more than 2 to 3 similar sized adult individuals per 20 gallon long tank. Toads should be given access to water every day or sufficiently misted to mitigate dehydration. Temperatures for toads housed indoors should be kept between mid 60's to upper 70's. Lighting should consist of full spectrum fluorescent light bulbs along with a UVA and UVB halogen lighting bulbs. Reconstituted reverse osmosis water should be utilized. Houston toads will readily take crickets, along with mealworm and flour beetles, wax worms, and isopods dusted with a vitamin-mineral supplement.


Photo: Paul Crump

Other Notes: All Houston toads in captivity are owned by the U.S. Fish and Wildlife Service. All transfers and releases are required to be approved by USFWS and the Houston Toad SSP Coordinator at least one week prior. All captive *A. houstonensis* are to be managed as one single population, though breeding crosses from strands from different geolocalities are allowed with prior approval from the USFWS, SSP Coordinator, and PMC. Humane euthanasia at all life stages is an approved method of population management, with prior approval by the USFWS.

Program Leader Contact:
Tyler W. Parker, SSP Coordinator, Houston Zoo
tparker@houstonzoo.org
713-533-6870

Recommendation Update Table

The Recommendations Update Table is included to provide an overview of ATAG progress from the previous RCP in 2008.

Table 7: Changes from the Last RCP listed in order of former ranking[5]

Common Name	Scientific Name	Former Category	New Category	Species Contact	Reason for change from last RCP
Texas Blind Salamander	*Eurycea rathbuni*	RED SB	DERP-*No Isolation*	Nick Hanna	Insufficient number of specimens to sustain captive population long-term; other *Eurycea* sp. are prioritized for conservation; Threats for this species are reversible.
Oregon Spotted Frog	*Rana pretiosa*	DERP	ISE	Karen Goodrowe	Threats are being mitigated; over 50% of population is within protected habitat and appears stable; not prioritized as Ark/Rescue Role; *In situ* research priority.
Dwarf Coqui	*Eleutherodactylus unicolor*	PIP	NC	Jen Stabile	Used as model species, other *Eleutherodactylus* sp. prioritized for conservation over this species.
California Red-Legged Frog	*Rana draytonii*	PIP	DERP-*No Isolation*	Jessie Bushell	Used as a flagship species for conservation education; still abundant throughout historic range.
Narrow-Striped Dwarf Siren	*Pseudobranchus axanthus*	DERP	NC	Jen Stabile	Common within suitable habitat .
Dwarf Siren	*Pseudobranchus striatus*	DERP	DERP-*No Isolation*	Scott Pfaff	Common within suitable habitat; can be used as a flagship for conservation education: two-limbed amphibian.
Olympic Torrent Salamander	*Rhyacotriton olympicus*	TMAP	NC		*Ex situ* research role for husbandry only; over 50% of population is within protected/managed habitat.
Desert Slender salamander	*Batrachoseps aridus*	TMAP	NC	Andy Snider	100% of populations on protected/managed habitat.
California Giant Salamander	*Dicamptodon ensatus*	TMAP	NC		Threats are being mitigated in the wild.
Cascade Torrent Salamander	*Rhyacotriton cascadae*	TMAP	NC		Threats are being mitigated in the wild; over 50% of population is within protected/managed habitat.
Columbia Torrent Salamander	*Rhyacotriton kezeri*	TMAP	NC		Threats are being mitigated in the wild.
Coastal Tailed Frog	*Ascaphus truei*	TMAP	NC	Nate Nelson	Education potential since unique: only tailed frog; over 50% of population is within protected/managed habitat.
Idaho Giant Salamander	*Dicamptodon aterrimus*	TMAP	NC		Common within suitable habitat.
Cope's Giant Salamander	*Dicamptodon copei*	TMAP	NC		Common within suitable habitat; threats are being mitigated in wild.
West Virginia Spring Salamander	*Gyrinophilus subterraneus*	TMAP	NC		Over 50% of population is within protected/managed habitat.

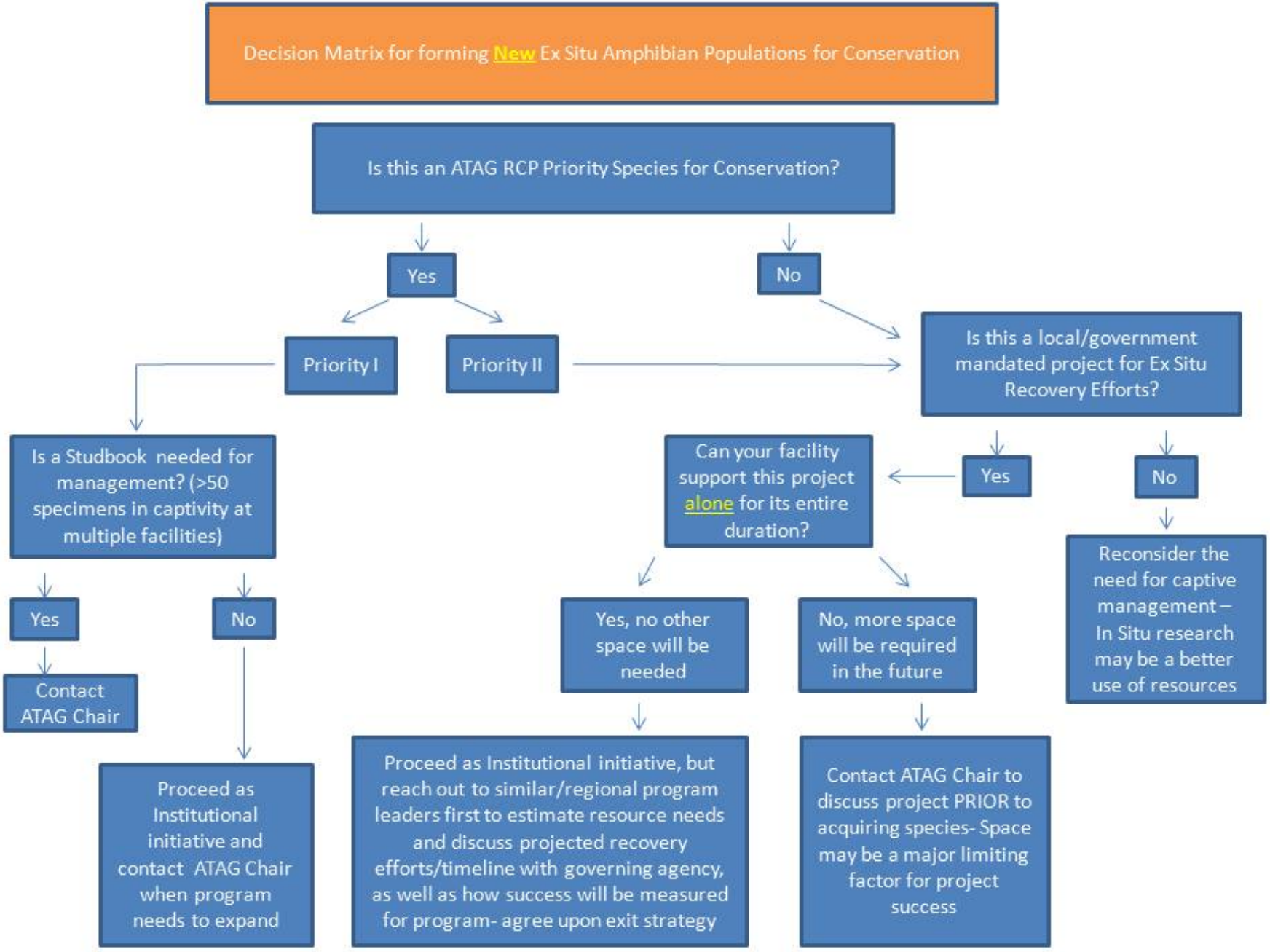
[5] For additional information regarding specific species assessments referenced herein, please see the SUMMARY TABLES listed in Appendix I.

Siskiyou Mountains Salamander	*Plethodon stormi*	TMAP	NC		Threats are being mitigated in the wild; over 50% of population is within protected/managed habitat.
Sonora tiger salamander	*Ambystoma tigrinum stebbin*	TMAP	NC		Education potential to discuss bait/disease risk (*A. tigrinum*).
Hell Hollow Slender Salamander	*Batrachoseps diabolicus*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
San Gabriel Slender Salamander	*Batrachoseps gabrieli*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
San Simeon Slender Salamander	*Batrachoseps incognitus*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
Sequoia Slender Salamander	*Batrachoseps kawia*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
Lesser Slender Salamander	*Batrachoseps minor*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
Relictual Slender Salamander	*Batrachoseps relictus*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
Chamberlain's Dwarf Salamander	*Eurycea chamberlaini*	TMAP	NC		*In situ* research role/phylogenetic studies; data deficient.
Tellico Salamander	*Plethodon aureolus*	TMAP	NC	Robert Hill	Data deficient/no evidence to suggest population declines.
Shenandoah Salamander	*Plethodon shenandoah*	TMAP	NC		100% of populations on protected/managed habitat; education potential for climate change.
Amargosa Toad	*Anaxyrus nelsoni*	TMAP	NC		over 50% of population is within protected/managed habitat; may be subsumed into *A. exsul*.
Inyo Mountains Salamander	*Batrachoseps campi*	TMAP	NC		*In situ* research role/phylogenetic studies; over 50% of population is within protected/managed habitat.
Santa Cruz Long-Toed Salamander	*Ambystoma macrodactylum*	TMAP	NC		Education potential for subspecies; local and regional declines, but no over-all declines.
Dwarf Black-Bellied Salamander	*Desmognathus folkertsi*	TMAP	NC	Robert Hill	Used as bait; not declining in areas where previously collected
Columbia Spotted Frog	*Rana luteiventris*	TMAP	NC		Over 50% of population is within protected/managed habitat; threats are being mitigated.
Cheat Mountain Salamander	*Plethodon nettingi*	TMAP	NC		Over 50% of population is within protected/managed habitat; threats are being mitigated.

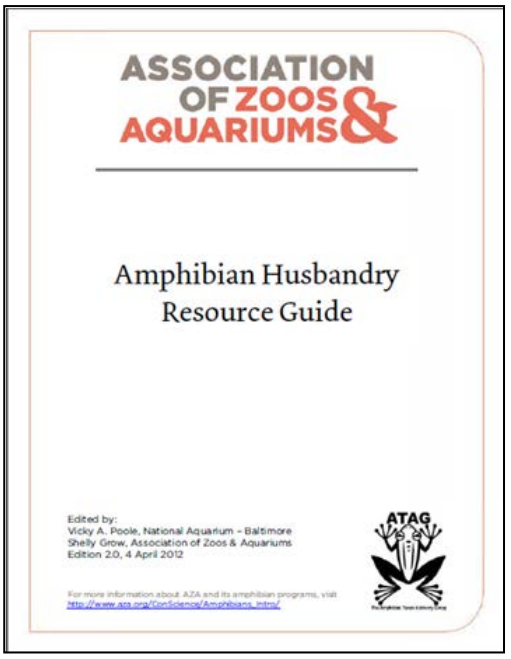
Considerations for New Studbooks and Managed *Ex situ* Programs

Studbooks are an important tool used to track populations of amphibians for genetic and management purposes. Before starting a studbook, it is recommended to contact the ATAG Chair. The Chair can discuss options and make appropriate suggestions for next steps.

Before collecting new species from the wild for captive management, or joining local/regional non-AZA initiatives for *ex situ* programs, discuss resources required, level of commitment needed and short and long-term goals with partners. Space is extremely limited for long-term collaborative programs and discussions with the ATAG Steering Committee are highly recommended before proceeding. A decision matrix is included on the following page and may be helpful when making considerations for new amphibian program management.

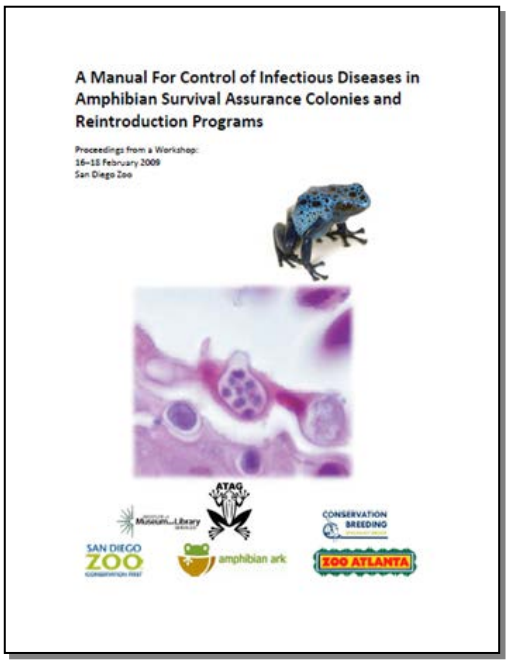

Decision Matrix for forming New Ex Situ Amphibian Populations for Conservation
Is this an ATAG RCP Priority Species for Conservation?
Yes
No
Priority I
Priority II
Is this a local/government mandated project for Ex Situ Recovery Efforts?
Yes
No
Reconsider the need for captive management – In Situ research may be a better use of resources
Can your facility support this project alone for its entire duration?
Yes, no other space will be needed
No, more space will be required in the future
Proceed as Institutional initiative, but reach out to similar/regional program leaders first to estimate resource needs and discuss projected recovery efforts/timeline with governing agency, as well as how success will be measured for program- agree upon exit strategy
Contact ATAG Chair to discuss project PRIOR to acquiring species- Space may be a major limiting factor for project success
Is a Studbook needed for management? (>50 specimens in captivity at multiple facilities)
Yes
No
Contact ATAG Chair
Proceed as Institutional initiative and contact ATAG Chair when program needs to expand

Amphibian Husbandry



Zoo amphibian collections have evolved from mere filler-specimens within the exhibits of larger reptile houses to dedicated facilities and conservation collections, and the skills and tools to maintain these animals have also expanded dramatically. As basic husbandry of amphibians vary widely based on taxa, natural history, life-stage, and habitat, in 2012, the ATAG produced the second edition of the *Amphibian Husbandry Resource Guide* (Poole and Grow, 2012) to offer basic recommendations and resources for the captive management of amphibians for purposes including conservation programs, exhibitry, education/outreach, and the field. Information on basic but critically important aspects to keeping amphibians in captivity is offered, including enclosures, water (sources and quality), environmental parameters (light, temperature, and humidity), food, natural history and behavior, and veterinary care (Pramuk and Gagliardo, 2012). Where possible, materials and suggested suppliers are listed, and in some cases, alternatives are offered for items that may not be available in all areas. Due to the limited available information on successful reproduction of majority of amphibian taxa, communication with others who have worked with that species (or closely related species or genera) in captivity is strongly encouraged, and new methods/experiences should be shared with colleagues, preferably in peer-reviewed literature. With the expansion of amphibian conservation programs primarily for release into the wild, the extensive chapter on Assisted Reproduction Technologizes (ART) explains in great detail the theories and practicalities of utilizing hormones to stimulate ovulation and spermiation in amphibians, natural *vs.* in vitro breeding, and offers resources and contacts to improve overall production of specimens for programs (Kouba, et al., 2012).

Amphibian Disease Management in Captivity

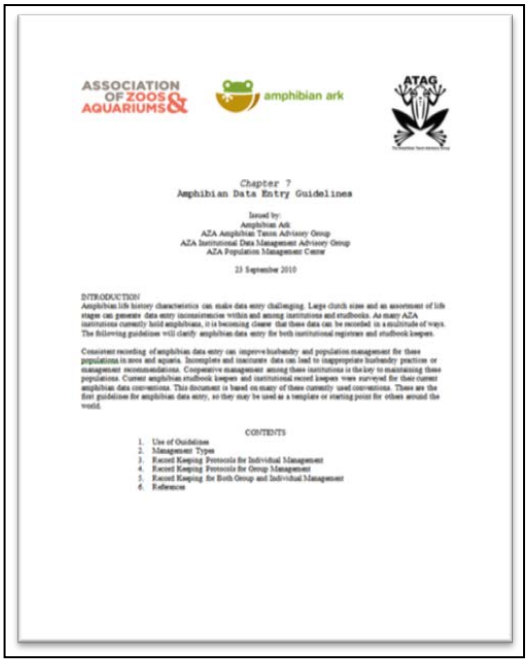


The need for disease management of amphibians in field and captive settings began with the onset of local declines and malformations described in the 1990s, and sanitary techniques evolved as new diseases and syndromes were described at a regional level. At present, research efforts into amphibian diseases are global and timely, with standardized field, husbandry, and collection management practices that address prevalent diseases, such as the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*; B.d.) and *ranavirus*, have become common place by zoo/aquarium personnel worldwide. In a zoo situation with display animals from different geographic locations (i.e., a cosmopolitan collection), biosecurity is applied to prevent pathogens from coming into the collection, transferring among amphibians in the collection, or moving outside the zoo into the native amphibian populations. For reintroduction programs, this concept similarly embraces all directions of disease transfer where pathogens should not move into, among, or out of assurance colonies. Biosecurity levels for each *ex situ* species or species assemblage is dependent on the ultimate goal of the program and the risk that wild-collected animals pose to the existing collection and native wildlife. It is possible to achieve a realistic level of biosecurity in *ex situ*

amphibian populations by following some simple and inexpensive protocols, including considerations for housing (e.g., permanent isolation for animals intended for reintroduction), equipment, water treatment, and staff procedures. While caring for amphibians, use of proper equipment is just as important as employing proper housing types when it comes to hygiene and disease management. Equipment such as tools, gloves, footwear, and clothing should be designated for use on a room-by-room or tank-by-tank basis depending on the desired level of biosecurity.

Infectious disease management guidelines evaluated by animal health and the scientific community are available and the ATAG recommends the standards established and outlined by Pessier and Mendelson (2010), especially for captive specimens designed for release programs. Additional information on amphibian disease management in the field and zoological facilities is available in the *Amphibian Husbandry Resource Guide* (Poole and Grow, 2012).

Amphibian Population Management & Data Entry Guidelines



ASSOCIATION OF ZOOS & AQUARIUMS

amphibian ark

ATAG

Chapter 7
Amphibian Data Entry Guidelines

Issued by:
Amphibian Ark
AZA Amphibian Taxon Advisory Group
AZA Institutional Data Management Advisory Group
AZA Population Management Center

23 September 2010

INTRODUCTION

Amphibian life history characteristics can make data entry challenging. Large clutch sizes and an assortment of life stages can generate data entry inconsistencies within and among institutions and studbooks. As many AZA institutions currently hold amphibians, it is becoming clearer that these data can be recorded in a multitude of ways. The following guidelines will clarify amphibian data entry for both institutional registrars and studbook keepers.

Consistent recording of amphibian data entry can improve husbandry and population management for these populations in zoos and aquaria. Incomplete and inaccurate data can lead to inappropriate husbandry practices or management recommendations. Cooperative management among these institutions is the key to maintaining these populations. Current amphibian studbook keepers and institutional record keepers were surveyed for their current amphibian data conventions. This document is based on many of these currently used conventions. These are the first guidelines for amphibian data entry, so they may be used as a template or starting point for others around the world.

CONTENTS

1. Use of Guidelines
2. Management Types
3. Record Keeping Protocols for Individual Management
4. Record Keeping Protocols for Group Management
5. Record Keeping for Both Group and Individual Management
6. References

With the global AArk efforts, standards were established with the support of the Population Management Center for amphibian population management, along with data entry guidelines to minimize conflicts between programs (Schad, 2008; Schad, 2010). ATAG follows/supports these recommendations.

Suggested Taxa for Exhibit

ATAG recognizes there is a need to exhibit amphibians from all regions of the globe for various reasons specific to each institution. Due to the quarantine requirements of assurance colonies of amphibians, the ATAG views exhibit space outside of the periphery of usable space for captive programs with reintroduction potential, therefore is not concerned about the species exhibited in institutions aside from their educational value. Species that are surplus to Species Survival Plan (SSP) programs should be exhibited with informative graphics about the recovery efforts for the species. Obviously, out of over 7,000 species of amphibians, there are a wide variety of animals that can be recommended for exhibit. Included below is a modest list of species that are broad examples of taxa commonly used for exhibit and that are relatively easy to acquire reasonably (i.e., from fellow AZA facilities or through reputable breeders) and/or maintain. For further assistance in choosing species for exhibit to reflect individual institution messaging needs, contact steering committee members directly, or use the amphibian tag or amphibian discussion listservs to inquire which species would be suitable for exhibit under specified requirements.

Table 8: Suggested Taxa for Exhibit

Common Name	Scientific Name	Category	Definition
Mandarin newt	*Tylototriton shanjing*	DERP	Display/Education
Blue dart frog	*Dendrobates (azureus) tinctorious*	DERP	Display/Education
Mantella	*Mantella spp.*	DERP	Display/Education
Central American caecilian	*Dermophis mexicanus*	DERP	Display/Education
Aquatic caecilian	*Typhlonectes spp.*	DERP	Display/Education
Mexican Axolotl	*Ambystoma mexicanum*	DERP	Display/Education
Eastern Hellbender	*Cryptobranchus alleganiensis*	DERP	Display/Education
Mudpuppy	*Necturus spp.*	DERP	Display/Education
Dwarf siren	*Pseudobranchus spp.*	DERP	Display/Education
Red-eyed tree frog	*Agalychnis callidryas*	DERP	Display/Education
North American tree frog	*Hyla spp.*	DERP	Display/Education
Waxy tree frog	*Phyllomedusa sauvagii*	DERP	Display/Education
Surinam horned frog	*Ceratophrys cornuta*	DERP	Display/Education
Ornate horned frog	*Ceratophrys ornata*	DERP	Display/Education
Coqui	*Eleutherodactylus coqui*	DERP	Display/Education
Mountain chicken	*Leptodactylus fallax*	DERP	Display/Education
Tomato frog	*Dyscophus spp.*	DERP	Display/Education
Malayan leaf frog	*Megophrys montana*	DERP	Display/Education
Surinam toad	*Pipa pipa*	DERP	Display/Education
Solomon Island leaf frog	*Ceratobatrachus guentheri*	DERP	Display/Education
Bullfrog	*Lithobates (Rana) catesbeiana*	DERP	Display/Education
Northern leopard frog	*Lithobates (Rana) pipiens*	DERP	Display/Education
Texas blind salamander	*Eurycea rathbuni*	DERP	Display/Education
Slimy salamander	*Plethodon glutinosus*	DERP	Display/Education
Giant Mexican leaf frog	*Pachymedusa dacnicolor*	DERP	Display/Education
Lemur leaf frog	*Hylomantis lemur*	DERP	Display/Education
Amazon Milk Frog	*Trachycephalus resinifictrix*	DERP	Display/Education
Vietnamese Mossy Frog	*Theloderma corticale*	DERP	Display/Education

Exhibit Species Examples

A few examples of easy to care for exhibit amphibians follow, including options for mixed species exhibits.

Solomon Island Leaf Frog
Ceratobatrachus guentheri

Species Summary: This medium-sized frog's snout and crests give it superior camouflage on the leaf-littered forest floor. Individuals vary in color from light yellows to burnt oranges and browns. This unique amphibian breeds by direct develop, skipping the aquatic tadpole stage, and hatching from the egg as a tiny froglet. When housed in mixed sex groups, they will readily reproduce on exhibit making rearing of froglets visible to zoo guests. These frogs have been successfully displayed with the Solomon Island prehensile-tailed skink (*Corucia zebrata)*. They have a loud call that sounds like a bark.

Interpretive Messages:

- Direct development
- Leaf-mimicry and camouflage
- Island endemism
- Responsible pet ownership
- Conservation


Photo: Penny Felski

Care and Facilities: Provided enough space (approximately 4' high x 4'wide x 4' deep) to set up territories, multiple breeding pairs can be kept together. Smaller spaces should only house pairs together as individuals will become stressed with overcrowding. They will burrow in substrate, hide under plant material, or sometimes sit out in the open. Provide large diameter diagonal and horizontal perches with cover. These tropical forest frogs thrive in high humidity (50-70%) and warm ambient temperatures (70-85F). In these conditions females will lay several clutches of 10-30 pea sized eggs per year. Eggs are laid in substrate depressions (sphagnum moss or sandy soil) and then buried. They will hatch 6-8 weeks later as tiny froglets. Start froglets on a varied diet of spring tails, pinhead crickets and fruit flies dusted with multivitamins and calcium. They are not adequate swimmers; if water is available make sure there is a gradient to help them out. (*Submitted by* ***Penny Felski,*** Buffalo Zoo)

Lemur Leaf Frog
Hylomantis lemur


Photo: Penny Felski

Species Summary: While not especially large, this nocturnal species has striking bright-white eyes when viewed awake during daylight hours but change color to a dark brown or maroon in the evening. This species faces a number of threats in the rainforests of Central America including habitat loss and population declines due to *Batrachochytrium dendrobatidis*. The species does well in mixed species settings with similar-sized and smaller tropical anurans (other hylids, dendrobatids, *Atelopus,* etc.). Specimens often sleep on exhibit glass and with the use of a reverse cycle lighting system, animals can be observed while active and in the nocturnal colors during the day. Their eggs are laid on leaves overhanging water and can be left in the exhibit to develop.

Interpretive Messages:

- Tropical rainforest biodiversity
- Camouflage
- Deforestation
- Eggs laid above water, not in it

Care and Facilities:
While needing somewhat specialized care, these frogs are fairly hardy, easy to reproduce, and very easy to rear under captive conditions. Plan to exhibit two pairs or one male and three females in an enclosure approximately 2' high x 18" wide x 18" deep. Optional off-display housing should be available to separate sexes reducing breeding stress. Ambient temperatures of 68 – 80F are ideal. Frequent misting (manual or timed misting system) helps maintain humidity and stimulates animal activity. Good drainage and ventilation are essential to prevent stagnant air and mold growth. Live, broad-leaved plants should be provided along with small branches (1/2 – 2"diameter) as pathways and perching opportunities. Lemur leaf frogs are insectivores and will eat a wide variety of insect prey supplemented with multivitamins and calcium. The necessity of UVB light has not been well documented in this species but limited exposure is likely beneficial. Larvae are easily reared in aquaria with filtration and/or regular water changes. A diet of powdered flake fish food works well for tadpoles. Larvae metamorphose after 45-60 days.

Other Notes: There is some evidence that the two populations occurring in US collections at this time (Costa Rica and central Panama) may be genetically distinct. As such, it is important that institutions wishing to work with this species know the pedigree of their specimens and work to keep the Costa Rica and Panama lines as separate populations. (*Submitted by* ***Robert Hill,*** ZooAtlanta)

Bumblebee Poison Dart Frog

Dendrobates leucomelas

Species Summary: Brilliantly-colored poison dart frogs (PDFs) make for great exhibit taxa. Native to South America, the small bumblebee PDFs occurs at elevations between 50-800 meters in low-land forest habitat. This bold diurnal species is very active for visitors to see, and is a good representative dart frog (Dendrobatidae) which boast some truly beautiful color variations and patterns. In addition to habitat loss/alteration and the amphibian chytrid fungus, dart frogs of all species are under threat from collection for the international pet trade; captive bumblebee and other PDF species can be obtained legally thorough zoo/aquarium and responsible hobbyists.


Photo: Penny Felski

Interpretive Messages:

- Skin toxins, warning coloration, & mimicry
- Use by native persons for hunting
- Amphibian chytrid fungus
- Rainforest deforestation

Care and Facilities: If utilizing a 2'L x 2'W x 3'H enclosure with good ventilation, two to three pairs of this semi-arboreal species may be housed together thus creating large community groups encouraging unique social dynamics and behaviors. Some institutions have successfully exhibited this species with groups of other dendrobatids. Being that *Dendrobates leucomelas* lives in moist tropical forests and requires

warm temperatures and periods of high relative humidity. Off-display housing should be available for lees-dominant individuals. Ambient temperatures for tropical PDFs should be around 78-85F with a night time low of 68-70F. Regular misting (manual or timed misting system) helps maintain humidity and stimulates activity. Although recirculating waterfalls to a pool and/or drip walls work well in PDF exhibits, good drainage is necessary so the substrate does not become saturated. Naturalistic branches, broad-leaf plants, and bromeliads should be provided as perching sites used as refugia or by territorial males. These frogs are insectivorous and require a varied diet of springtails, fruit flies, pinhead crickets, and termites supplemented with multivitamins and calcium. Seasonal light and dry/wet season cycles should be provided and should mimic that found in the tropics. (*Submitted by* ***Dan Madigan,*** Indianapolis Zoo)

Mixed-species exhibits

Species Summary: Historically in zoos/aquariums, amphibians were utilized primarily as *filler* species for snake or lizard exhibits within reptile houses, but now there are entire collections and displays of amphibians exclusively, elevating their care and conservation to new levels. Mixed- species exhibits remain a popular way to generate a niche, ecosystem approach to displays which provides another interpretation to species' natural history. Many amphibian taxa can be displayed with many other reptiles and amphibians, but work best when enclosures can provide containment & adequate humidity.

Interpretive Messages:

- Ecosystems
- Habitats/microhabitats
- Zoogeographic regions
- Natural History

Eurycea cirrigera, Eurycea longicauda, Eurycea lucifuga, Desmognathus welteri, Hemidactylium scutatum, Plethodon glutinosus, and *Pseudotriton r. ruber* Toledo Zoo

Dendrobates azureus and *Corallus caninus*
Clyde Peeling's Reptiland

Atelopus zeteki, *Dendrobates auratus,* and *Pipa parva*
Elmwood Park Zoo

Suggested Taxa for Outreach

ATAG appreciates the value in using amphibians in educational outreach programs. This list of species would be appropriate for community outreach. It is not the intent of the ATAG to produce an all-inclusive or restrictive list of species to be used in outreach. Rather, the list is intended for use as a resource and includes some of the more common species that have been safely used in outreach programs.

Table 9: Suggested Taxa for Outreach

Common Name	Scientific Name	Husbandry Level	Experience Level
Central American caecilian	*Dermophis mexicanus*	Moderate	Moderate
Two toed amphiuma	*Amphiuma means*	Moderate	Moderate
California newt	*Taricha torosa*	Moderate	Moderate
Eastern newt	*Notophthalmus viridescens*	Moderate	Moderate
European fire salamander	*Salamandra salamandra*	Hardy	Novice
Tiger salamander	*Ambystoma tigrinum*	Hardy	Novice
African bullfrog	*Pyxicephalus adspersus*	Hardy	Novice
Bullfrog	*Lithobates (Rana) catesbeiana*	Hardy	Novice
Cuban tree frog	*Osteopilus septentrionalis*	Moderate	Moderate
Horned frogs	*Ceratophrys spp.*	Hardy	Novice
Mexican burrowing tree frog	*Smilisca dentata*	Moderate	Moderate
North American tree frog	*Hyla spp.*	Moderate	Moderate
Poison dart frog	*Dendrobates spp.*	Moderate	Moderate
Red-eyed tree frog	*Agalychnis callidryas*	Moderate	Moderate
Tomato frog	*Dyscophus spp.*	Moderate	Moderate
White's tree frog	*Litoria caerulea*	Moderate	Novice
Wood frog	*Lithobates (Rana) sylvaticus*	Moderate	Moderate
Fire-bellied toad	*Bombina orientalis*	Hardy	Novice
Marine toad	*Rhinella (Bufo) marinus*	Hardy	Novice
North American toad species	*Anaxyrus (Bufo) spp. and Ollotis (Bufo) spp. and Incilius spp.*	Hardy	Moderate
Red-legged walking frog	*Kassina maculata*	Moderate	Moderate
Spadefoot toad species	*Scaphiopus spp. and Spea multiplicata*	Hardy	Moderate

Husbandry Level Definitions:

Hardy - basic diet, lighting and housing needs, easy to handle
Moderate - could require more space, more cleaning, specialized diet, complex environment, will tolerate handling in brief intervals.
Difficult - requires large space or complex environment, UV lighting imperative, intense heating, specialized feeding strategies will tolerate handling in brief intervals, could potentially be difficult to handle, unpredictable or deliver a potentially dangerous bite.

Animal Caregiver/Handler Experience Level Needed:

Novice - very little animal husbandry and handling experience.
Moderate - some reptile experience for at least one year.
Experienced - diverse reptile experience for more than two years.

ATAG Recommendations

Responsible Population Management: Humane Euthanasia

The Amphibian TAG recognizes that humane euthanasia is a management tool that may be practiced to ensure that the population remains genetically and demographically healthy for the long-term. Zoos and aquariums are encouraged to contact the Program Leader before euthanizing an SSP Program animal for management purposes, in order to optimize animal welfare. The decision to utilize humane euthanasia as a management tool is at the discretion of the individual institution, and should follow the institution's acquisition, transfer and transition policy as outlined in the AZA Policy on Responsible Population Management: Acquisitions, Transfers and Transitions by Zoos and Aquariums ("AZA ATT Policy").

Amphibians and Outreach

Live amphibians in demonstrations can be powerful ambassadors for conservation messaging. They are loved by many and are seen as harmless creatures by most. Audiences gain a lasting memory of events when they are able to experience animals up close. Using amphibians in outreach is an important tool to create bonds between humans and animals that cannot be created through media and images in books. When choosing amphibians for outreach, important considerations such as staff expertise, husbandry requirements, medical and nutritional requirements, length and types of programs, environmental needs, restraint and transportation methods, species temperament, safety issues, and educational messaging should all factor into sound collection planning. Native species are all too often overlooked in zoo programs. Through the use of locally occurring species in outreach, audiences can learn about conservation in their own backyard. Using amphibians for outreach is also a good opportunity to teach audiences about: state protected species, cohabitation, the affects of urban sprawl, pollution, global warming, biomedical applications, amphibians as bioindicators, and of course, the global amphibian crisis. A suggested outreach species list and handling and transportation guidelines are included in the ATAG RCP (Table 9).

Amphibians in Classroom Settings

Live amphibians in classrooms can stimulate students' interest in wildlife and promote respect for animals and their ecosystems. However, it is important that teachers plan for disposition of classroom pets prior to obtaining them. Obviously, it is ideal for teachers to keep the amphibians from semester to semester until their natural death. However, as this is not always possible, it is imperative that teachers seek alternatives to releasing unwanted amphibians into the wild. Releasing larval (e.g. tadpoles and newts) forms and metamorphosed (juvenile and adult) amphibians can have serious impacts on local species and their ecosystems. Released amphibians can introduce harmful pathogens and parasites into the wild. They can also out-compete native species for food and shelter, or act as predators, eating indigenous amphibians. Teachers should act responsibly and plan to keep the pet for its lifetime. If the amphibian can no longer be housed and a suitable home cannot be found, euthanasia is a better alternative than releasing it to the wild.

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Links to Amphibian Resources


Rana pretiosa Photo: Andy O'Connor

Amphibian Conservation and Husbandry
https://www.aza.org/amphibian-conservation
https://www.aza.org/AMS.aspx
https://www.aza.org/conservation-funding-sources/
http://www.saveamphibians.org/Documents/AmphibianHusbandryResourceGuide2012.pdf

Conservation Funding Sources
https://www.aza.org/conservation-funding-sources/

FrogWatch USA
https://www.aza.org/frogwatch

Amphibian Medicine Tutorials
http://www.youtube.com/channel/UCaOhxmTP7asO5zyZQwYzh-A/videos

Amphibian Ark
http://www.amphibianark.org

Amphibiaweb
http://amphibiaweb.org

IUCN
http://www.iucnredlist.org/initiatives/amphibians
https://www.iucn.org/about/union/secretariat/offices/asia/regional_activities/asian_amphibian_crisis/taking_action/amphibian_conservation_action_plan

CITES
http://www.cites.org/eng

Partners in Reptile and Amphibian Conservation
http://www.parcplace.org

Amphibian Conservation and Rescue Project
http://amphibianrescue.org

ARKive
http://www.arkive.org/amphibian-conservation

Amphibian Species of the World
http://research.amnh.org/vz/herpetology/amphibia/

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www.**edge**ofexistence.org/**species**

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Download at: www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf

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Schad, K., (ed.). 2010. Amphibian Data Entry Guidelines. Population Management Center, Lincoln Park Zoo. Chicago, IL, USA. 7 p.

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Appendix I: AArk Amphibian Species Prioritization Ranking Process and Results

SUMMARY RESULTS for each species taxon referenced under this RCP are accessible through links from the following table (AArk, 2012):

Country/ region	Date	Ark (A)	Rescue (A)	*In situ* conserv-ation (B)	*In situ* research (C)	*Ex situ* research (D)	Conserv-ation education (E)	Bio-banking (F)	None	All species
North America	Mar 12	1	6	58	59	43	89	7	125	285
Puerto Rico	Mar 11		7	6	1	8	22	7	3	25
Panama[6]	Aug 08		51	59	116	10	30	51	72	204

The AArk prioritization methodology utilized globally is process is delineated on the following pages.

References: (Summaries can be downloaded from here if hyperlinks are inaccessible.)

AArk Prioritization: http://www.amphibianark.org/resources/assessment-results/
[Date last accessed: 3 May 2014]

[6] Prioritization information for the country of Panama is only included in reference to *Atelopus zeteki* and *A. varius* since this is an existing AZA SSP program; the conservation programs for all other Panamanian species is to be addressed within the country of Panama in accordance to the AArk global plan.

AArk Amphibian Conservation Needs Assessment process

Based upon draft prepared by: Taxon selection and prioritization working group – CBSG/WAZA Amphibian *Ex situ* Conservation Planning Workshop, El Valle de Anton, Panama, February 2006.

April 2012

Rationale

Conservation resources are limited, more so for amphibians than many other taxa, and with over 2000 threatened species in need of help the process outlined below seeks to objectively and consistently identify priority species and their immediate conservation needs.

The mission of the AARK is "facilitating partnerships that ensure the global survival of amphibians, focusing on those that cannot currently be safeguarded in nature".

Ex situ conservation of a threatened amphibian species should be considered a necessity when the imperative of *in situ* 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. However, if the perceived urgency of the situation requires it, *ex situ* programs will be set up outside of range State wherever expertise and other resources are forthcoming.
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.

Ideally an *ex situ* initiative should be temporary in nature and 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 Taxon Management 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 in order to achieve the end goal of having the species safely back in nature.

The conservation needs assessment tool has been structured in two sections:

The first section concerns Assessing species for conservation actions both *in situ* and *ex situ* - i.e. with limited resources (space, staff, money etc.) which species should have *ex situ* programs established ahead of others, which species urgently need field research or protection, etc. It takes the form of a series of questions with weighted scores. The total score for a species is derived via a number of relevant questions with weighted answers. 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 questions ensuring that there is Authorization for any proposed *ex situ* conservation program, and that founder animals are available.

The information provided in sections one and two is then used to categorize each species into one or more Conservation Roles. These roles are then used to generate a series of prioritized lists which can then be used to determine the next steps required for the conservation of each species.

When considering Implementation of an *ex situ* program, each facility should work through AArk's Program Implementation tool, which considers the practical feasibility of initiating and maintaining a program – a sort of check list of essential elements prior to initiation.

While a number of very successful amphibian conservation programs have begun, and are currently underway without following all of these steps, the Amphibian Ark recommends that where possible, these steps are all followed, to ensure the best possible outcome for the population being managed.

It cannot be emphasized enough how important it is to ensure that adequate resources, including skilled staff, live food, funding, veterinary services etc. can be provided for the expected life of the *ex situ* program. Many programs run for five, ten, or even more years, and sufficient resources to support the program for the whole of this time must be available if the program is to be successful. Establishing facilities and collecting rescue populations is only the first, albeit perhaps the single greatest expense. However, it is insufficient to support only those first-year expenses without operational support for the long term, which as stated above, may amount to years or even decades. In addition to financial planning, *ex situ* programs should establish at the onset a plan for working with partners to mitigate threats in the wild and, where necessary, getting animals back into the wild, as well as how to distribute and properly manage the progeny of captive animals in the interim.

If hope remains that a species can be saved as the result of *ex situ* breeding, any number of founder animals is better than none, however, Amphibian Ark strongly recommends that at least twenty pairs of animals (or groups of individuals) are collected as founder animals. Ideally these would be unrelated and will successfully reproduce, but of course that cannot be guaranteed. Realize that many more than this number may have to be captured to ensure that twenty pairs actually survive and successfully reproduce. Searches for the sufficient number of founders should be thorough and complete, and if exhaustive searches do not result in a minimum of twenty pairs of founders, searching should continue after the program has been initiated.

Collection of founders should be targeted towards obtaining as many unique lineages as possible (e.g., collect from different locations and, if possible, different sites at each location to reduce the probability of collecting related animals). This assumes that a genetic study has been done among these different populations verifying that they are in fact the same species.

Amphibian Ark has developed a tool to help calculate the number of founders that should be collected, based on the reproductive biology of the species being considered. The tool uses data from our Amphibian Population Management Guidelines.

This conservation needs assessment 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 prioritization 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 Assessment

1. Extinction risk: What is the current IUCN Red List category for the taxon? (Modified accordingly if new/additional information is available or if country-level assessments exist).

Extinct in wild
Critically Endangered
Endangered
Vulnerable
Data deficient*
Near threatened
Least concern
Extinct

(*taxon has been regionally or nationally recognized as 'at risk' despite data deficiency)

If there is a proposal to modify the Red List category by the workshop participants, a note should be added explaining the rationale for the proposed change.

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

ED value > 100
ED value 50-100
ED value 20 - 50
ED value <20

EDGE score
Using a scientific framework to identify the world's most Evolutionarily Distinct and Globally Endangered (EDGE) species, the EDGE of Existence program highlights and protects some of the weirdest and most wonderful species on the planet. EDGE species have few close relatives on the tree of life and are often extremely unusual in the way they look, live and behave, as well as in their genetic make-up. They represent a unique and irreplaceable part of the world's natural heritage, yet, an alarmingly large proportion is currently sliding silently towards extinction, unnoticed.

Every species in a particular taxonomic group (e.g. amphibians) is scored according to the amount of unique evolutionary history it represents (Evolutionary Distinctiveness, or ED), and its conservation status (Global Endangerment, or GE). You can download the EDGE scientific paper to find out more about how EDGE scores are calculated:
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0000296

Additional information about the EDGE scoring process can be found at
http://www.edgeofexistence.org/about/edge_science.php

3. Protected habitat: Is a population of at least 50% of the individuals of the taxon included within a reliably protected area or areas?

Yes
No
Unknown

Protected habitat is defined as a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

The status of protected habitat is used to calculate Conservation Roles, and is not scored. Initial data were extracted from IUCN 2008. IUCN Red List of Threatened Species. www.iucnredlist.org And Alliance for Zero Extinction (2010). 2010 AZE Update. www.zeroextinction.org

4. Habitat for reintroduction: Does enough suitable habitat exist, either within or outside of currently protected areas that is suitable for reintroduction or translocation?

Yes
No

If the answer is Yes, a note should be added to provide details of the suitable areas.

This question provides information on particular areas of existing habitat that are suitable for reintroduction of captive-bred animals. When prioritizing species for possible *ex situ* conservation and reintroduction programs, priority should be given to those species that are known to have suitable release habitat available.

5. Previous reintroductions: Have reintroduction or translocation attempts been made in the past for this species?

Yes, successfully
Yes, but unsuccessfully
Yes, but outcome is unknown
No

If the answer is Yes, a note should be added to provide details.

This question does not affect the conservation role(s) assigned to the species, and nor does it affect the scoring. It is included purely to help guide, and to indicate the potential for demonstrable success with future reintroduction or translocation attempts.

6. Threat mitigation: Are the threats facing the taxon, including any new and emerging threats not considered in the IUCN Red List, potentially reversible?

Species does not require conservation action at this time
Species is effectively protected
Threats are being managed – conservation dependent
Threats are potentially reversible in time frame that will prevent further decline/extinction
Threats cannot/will not be reversed in time to prevent likely species extinction
Threats unknown

Species does not require conservation action at this time
This species is not currently facing any major threats in the wild, and no conservation action is currently required to safeguard this species in the wild.

Species is effectively protected
All, or the majority of the population of the species in the wild is sufficiently protected to prevent further decline in numbers (e.g. the bulk of the population occurs in protected areas).

Threats are being managed - conservation dependent
Without the current management of the threat, the species would disappear in the wild. Examples of this sort of management include actions such as filling temporary ponds each year for breeding, diverting a dam to create a torrent, or harvesting predatory species.

Threats are potentially reversible in time frame that will prevent further decline/extinction
The threats to the species can, or will likely be removed or reversed, in a timeframe that will prevent further decline of the species in the wild.
Threats cannot/will not be reversed in time to prevent likely species extinction
The species will very likely go extinct in the wild before anything can or will be done to save it, but in principle the threats to the species could be reversed and the animals in *ex situ* colonies could be used to re-stock the wild if/when the threats are reversed.
Threats unknown
Either no knowledge about the threats to this species exists, or there is so little information known about the distribution of the species in the wild, that the threats cannot be determined.

7. Population recovery: Is the known population of this species in the wild large enough to recover naturally, without *ex situ* intervention if threats are mitigated?

Yes
No
Unknown

The size of the population in the wild is used to calculate Conservation Roles, and is not scored.

8. Biological distinctiveness: Does the taxon exhibit, for example, a distinctive reproductive mode, behavior, aspect of morphology or physiology, within the Class Amphibia?

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

If the species is identified as being biologically distinct, a note should be included to explain this.

9. 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
No

Socio-economic – are the benefits from the economic activity likely to influence the conservation of the species?

If the species is identified as being of cultural or socio-economic importance, a note should be included to explain this.

10. Scientific importance: Is the species vital to current or planned research other than species-specific ecology/biology/conservation? (e.g. human medicine, climate change, environmental pollutants and conservation science), within the Class Amphibia.

Research dependent upon species
Research dependent upon <6 species (incl. this taxon)
No research dependent on this species

If the species is identified as being of scientific importance, a note should be included to explain this.

11. Over-collection from the wild: Is the taxon suffering from unsustainable collection within its

natural range, either for food, for the pet trade or for any other reason, which threatens the species' continued persistence in the wild?

Yes
No
Unknown

Information about collection from the wild is used to calculate Conservation Roles, and is not scored.

12. *Ex situ* research: Does conserving this species (or closely related species) *in situ* depend upon research that can be most easily carried out *ex situ*?

Yes
No

Information about *ex situ* research is used to calculate Conservation Roles, and is not scored.

13. Husbandry analog: Do the biological and ecological attributes of this species make it suitable for developing husbandry regimes for more threatened related species? i.e. could this species be used in captivity to help to develop husbandry and breeding protocols which could be used for a similar, but more endangered species at a later stage?

Yes
No

Resources for *ex situ* programs are scarce, and analog species should only be specified for target species that are threatened, and have not previously been successfully kept in captivity. A note should be included which lists the target species for this analog. Information about husbandry analogs is used to calculate Conservation Roles, and is not scored.

14. Captive breeding: Has this species been successfully maintained and bred in captivity?

Yes, bred to F2
Yes, bred to F1
Maintained but no successful breeding
Not held in captivity to date

Information about captive breeding is used to calculate Conservation Roles, and is not scored.

15. Educational potential: Is the species especially diurnal/active/colorful and therefore suited to be an educational ambassador for amphibian conservation?

Yes
No

Information about education potential is used to calculate Conservation Roles, and is not scored.

Section Two – *Ex situ* Program Authorization/Availability of animals

16. Mandate: Is there an existing conservation mandate recommending the *ex situ* conservation of this taxon? A recommendation for an *ex situ* population of a threatened amphibian species can come from a number of recognized national or international sources (see Appendix 2).

Yes
No

If the answer is No, there is insufficient authorization for an *ex situ* initiative at this time.
SEEK MANDATE FROM ASG/AARK OR OTHER AUTHORITY

17. Range State approval: Would a proposed *ex situ* initiative for this species be supported (and approved) by the range State (either within the range State or out-of-country *ex situ*)?

Yes
No

If the answer is No. there is insufficient authorization for an *ex situ* initiative at this time. SEEK APPROVAL FROM RANGE COUNTRY (WITH HELP FROM AARK/ASG AS REQUIRED) BEFORE PROCEEDING

18. Founder specimens: Are sufficient animals of the taxon available or potentially available (from wild or captive sources) to initiate the specified *ex situ* program? AArk recommends that a minimum of twenty pairs of animals be collected as founder animals.

Yes
No
Unknown

If the answer is No, there are insufficient potential founder specimens to initiate the *ex situ* program.
EVALUATE OPTIONS FOR ALTERNATIVE CONSERVATION STRATEGY INCLUDING GAMETE BIOBANKING

19. Phylogenetic study: Has a complete phylogenetic analysis of the species in the wild been carried out, to understand what the functional unit you wish to conserve is (i.e. have species limits been determined)?

Yes *
No

Typically this unit is a species; however, because species are continuously changing units evolving through time, there are often distinct but not yet unique subunits (evolutionary significant unit or ESU) in the process of divergence within the species and which might warrant independent consideration.

If the answer is No, there is insufficient knowledge of the species, and a phylogenetic study should be undertaken before considering an *ex situ* program for the species.
UNDERTAKE APPROPRIATE RESEARCH IN CONJUNCTION WITH LOCAL FIELD BIOLOGISTS (WITH HELP FROM AARK/ASG AS REQUIRED) IN ORDER TO CONFIRM THAT THE SPECIFIC PROGRAM ENCOMPASSES ONLY ONE EVOLUTIONARY DISTINCT UNIT (ESU) BEFORE PROCEEDING

AppendixOne–ConservationRoles

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

Eight Conservation Roles have been defined, and these are calculated for each species, based on the data provided during the prioritization workshop.

Ark
A species that is extinct in the wild (locally or globally) and which would become completely extinct without *ex situ* management.

Triggers for Ark species are:

- IUCN Red List category = Extinct in the Wild (EW)

Rescue
A species that is in imminent danger of extinction (locally or globally) and requires *ex situ* management, as part of an integrated program, to ensure its survival.

Triggers for Rescue species are:

- IUCN Red List category is not Extinct in the Wild (EW) and
- Threat Mitigation = Threats cannot/will not be reversed in time to prevent likely species extinction.

Note: Threats that constitute imminent danger of extinction include:

- Threats for which we currently have no remedy:
  - Bd, including any species known or suspected to be susceptible
  - Climate change, including any species documented to be drastically contracting its range, e.g., mountaintop salamanders in Central America (per Wake et al.) and mountaintop frogs in Madagascar (per Raxworthy et al.)
- Threats for which we have a remedy but not the resources or will to intervene
  - Imminent destruction of more than 50% of habitat, e.g., dam construction, mining/pollution
  - Species collected to brink of extinction
- All other threats are considered to be “reversible in time frame”.

In situ Conservation
A species for which mitigation of threats in the wild may still bring about its’ successful conservation.

Triggers for *In situ* Conservation species are:

- Threat Mitigation = Threats are reversible in time frame that will prevent further decline/extinction or
- Threat Mitigation = Threats cannot/will not be reversed in time to prevent likely species extinction (species is in Rescue role) and Protected Habitat = No (species will need a secure place to go back to).

In situ Research
A species that for one or more reasons requires further *in situ* research to be carried out as part of the conservation action for the species. One or more critical pieces of information is not known at this time.

Triggers for *In situ* Research species are:

- IUCN Red List category = Data Deficient (DD) or
- Threat Mitigation = Unknown or

- Protected Habitat = Unknown or
- Population Recovery = Unknown or
- Over-collection status = Unknown or
- Conservation role = Rescue.

Ex situ Research

A species currently undergoing, or proposed for specific applied research that directly contributes to the conservation of that species, or a related species, in the wild (this includes clearly defined 'model' or 'surrogate' species).

Triggers for *Ex situ* Research species are:

- The species has been identified as a husbandry analogue for a more threatened species or
- IUCN Red List category = Critically Endangered (CR) or Endangered (EN) or Vulnerable (VU) or Near Threatened (NT) or Data Deficient, and conserving this species depends on *ex situ* research and Threat Mitigation = Threats unknown or Threats are reversible in time frame or
- IUCN Red List category = Extinct in the Wild (EW) or Critically Endangered (CR) or Endangered (EN) or Vulnerable (VU) or Near Threatened (NT) or Data Deficient, and the species has not been successfully maintained and bred in captivity and the species is biologically or evolutionarily distinct.

Mass production in captivity

A species threatened through wild collection (e.g. as a food resource), which could be or is currently being bred in captivity – normally in-country, *ex situ* - to replace a demand for specimens collected from the wild. 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.

Triggers for Mass Production in Captivity species are:

- IUCN Red List category = Critically Endangered (CR) or Endangered (EN) or Vulnerable (VU) and
- Species is suffering from over-collection from the wild.

Conservation Education

A species that is specifically selected for management – primarily in zoos and aquariums - to inspire and increase knowledge in visitors, in order to promote positive behavioral 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).

Triggers for Conservation Education species are:

- The species has a high Evolutionary Distinctiveness score or
- The species is biologically, culturally, or scientifically significant or
- The species is suited to be an educational ambassador for amphibian conservation.

Supplementation

A species for which *ex situ* management benefits the wild population through breeding for release as part of the recommended conservation action.

Triggers for Supplementation species are:

- Threat Mitigation = Threats are being managed or Threats are reversible in time frame that will prevent further decline/extinction or Species is effectively protected and
- The (sub)population of the species in the wild is too small to recovery naturally and
- There is suitable habitat available for reintroduction.

Biobanking
A species for which the long-term storage of sperm or cells to perpetuate their genetic variation is urgently recommended, due the serious threat of extinction of the species.

Triggers for Biobanking species are:

- Recommended conservation role is Ark or Rescue

None
Species that do not require any conservation action at this point in time. This list may also contain species that were not evaluated during the workshop due to lack of data being available.

Triggers for these species are:

- Species does not match the criteria for any of the previous roles or
- Insufficient data available during the workshop to properly evaluate the species.

AppendixTwo–*Ex situ* Mandate

Mandate for *Ex situ* Conservation
The decision about which species should be protected in *ex situ* conservation programs should not be made by the AARK community alone because such programs 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* programs 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 recognized sources, such as:

- The IUCN/SSC Amphibian Specialist Group (ASG).
- 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 II: Creating Isolation Spaces for Amphibian Programs

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Creating Isolation Spaces for Amphibian Programs

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INTRODUCTION

Establishments have been keeping amphibians in captivity for more than a century for research and exhibit purposes. Over this time period, understanding of amphibians and their husbandry requirements has increased substantially, as has the focus on amphibian conservation. In 1984, the first Association of Zoo and Aquarium's (AZA) Species Survival Program® (SSP) was formed for the Puerto Rican crested toad (*Peltophryne lemur*) and in 1993 collaborative breeding efforts began for the Wyoming toad (*Anaxyrus (=Bufo) baxteri*). Both of these long-running reintroduction programs have served as models for intensive captive management of amphibians, and contributed to the premise of modern assurance colonies within AZA facilities.

The scope of amphibian assurance colony programs quickly expanded from regional to international following the International Union for the Conservation of Nature's (IUCN) *Amphibian Conservation Summit* (ACS) in 2005. This gathering was held in response to global amphibian declines that were documented through the 1980's and 1990's and the overall lack of action being taken to stop this rapid loss. The *Amphibian Conservation Action Plan* (ACAP) (Gascon et al., 2007) produced during that summit provided direction for the global community to address the amphibian extinction crisis. Over 500 threatened species were identified as candidates for immediate *ex situ* conservation action, and the zoological community was asked to begin creating biologically secure isolation spaces for assurance populations of these species. In 2006, the IUCN Conservation Breeding Specialist Group (CBSG) and the World Association of Zoos and Aquariums (WAZA) held the *Ex situ Conservation Planning Workshop* in El Valle, Panama. From this workshop, guidelines were developed for biosecure containment of amphibian assurance colonies (Zippel et al., 2006). These guidelines, along with the first edition of the *Amphibian Husbandry Resource Manual* (Poole and Grow, 2008) and the *Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs* (Pessier and Mendelson, 2010) have laid the foundation for responsible management of amphibian assurance colonies, and are informing the way species are managed for reintroduction.

Throughout this initial push to take action, many organizations became confused about how to create appropriate amphibian isolation spaces and discouraged by the lofty goals that were identified in these various documents. A misunderstanding and an overwhelming sense of burden has developed among some within the zoological community due to the large number of species in need and the resources perceived necessary to meet the suggested level of research and biosecurity for recovery efforts. While some have found it difficult to locate existing space for amphibians within their facilities, many more have found it challenging to identify the resources and support needed to build new structures. Despite this, many AZA-accredited institutions have found the means to respond to the call of action.

This chapter includes numerous examples of isolation areas that have been created for amphibians (descriptions and photos for each example are located at the end of this chapter). The individuals that have contributed to this chapter have encountered challenges that may be unique to their own situations, but have also found solutions through creative ingenuity that may be applicable to others. It is hoped that these examples, ranging from modified existing space to the creation of new facilities, can be used as tools for creating more places for amphibians world-wide.

BIOSECURITY (BIOSAFETY) – WHAT DOES IT MEAN?

While the term "biosecurity" may conjure up images of people in hazmat suits breathing through respirators in sterile white rooms, it actually refers to "biosafety," which is defined as *safety from exposure to infection agents*. Although intimidating to some, everyone should remain diligent about following protocols to reduce the spread of infectious agents.

It is now widely understood that costly, sterile environments for amphibians are not necessary, however questions still arise regarding the appropriate level of biosafety. The answer is that it depends upon the situation. It is recommended that assurance or reintroduction populations remain in permanent isolation (i.e., species separated into a room within a building with species from other regions, or housed in an entirely separate building). When working with local or regional species, biosafety measures may be less extensive than with species from outside the region. Important considerations for designing amphibian isolation spaces include acceptable levels of biosafety/quarantine needed, and disposal of waste material and wastewater (for more information, see Chapters 3 and 4).

TYPES OF FACILITIES

When starting a new program that requires dedicated amphibian space, review what areas and resources may already be available at the facility; these may range from new construction to modification of existing spaces. For some species, it may be preferable to create outdoor housing options, either in place of or in addition to, indoor housing to meet their needs. Most often these spaces can be found on the grounds of our existing facilities, but these same principles may be applied internationally, as needed. The following sections offer current examples of different amphibian isolation facilities, with the goal of serving as models and inspiration for new programs that may be developed.

Outdoor Space

Perhaps the simplest and least costly type of facility is one that is created for a local species that can be housed outdoors. Working with local species that are exposed to the same local environments and pathogens are the most ideal, as biosafety measures are minimal and species can be housed outdoors within secure enclosures or areas. The Riverbanks Zoo (Example 1) is working with local dwarf sirens (*Psuedobranchus sp.)* which are native to their area and are housed in large, plastic stock tanks outdoors, and the Saint Louis Zoo (Example 2) in Missouri has created a large, fast-running stream on zoo property for a population of Ozark hellbenders (*Cryptobranchus alleganiensis alleganiensis*). These hellbenders are used as a study population to learn more about their natural history and potentially to augment local populations. Both of these semi-natural enclosures require little maintenance and provide moderate protection from predators. They also expose the animals to the same elements and light cycles they would experience in their natural habitat, which helps maintain animal health and stimulate reproduction with little manipulation by caregivers. This type of situation is a LOW biosecurity risk (as described in Chapter 4), although dedicated equipment should still be used and proper hygiene techniques followed (see Chapter 3).

Detached Spaces

When referring to detached spaces in this document, the author is implying construction of a new or modified facility that is detached from existing buildings and may include shipping containers and sheds. These may be

created in range country or on zoological grounds, and are an inexpensive alternative to construction/modification of an entire building. Careful planning is warranted, as hidden costs can often drive budgets higher than anticipated.

A small, prefabricated storage shed that can be located near a building with accessible power and water is easily assembled by novice staff and is less expensive than acquiring a refurbished and outfitted shipping container/freight trailer (i.e., pod). The Fort Worth Zoo created a shed for Puerto Rican crested toads (*Peltophryne lemur*) (Example 3), and the Toronto Zoo acquired a small prefabricated building and turned it into their *Amphibian Rescue Center* to expand the amount of isolation space available for species in need (Example 4).

Shipping containers can hold many amphibians, can be outfitted in one location and transported fully-assembled to another, and may be ready for use more quickly than a building that is newly constructed or modified. However, freight costs and the installation of power, water, and possibly sewer/septic system to a container can cause costly delays and logistical nightmares. To avoid headaches in the long-run, it is imperative to conduct thorough research (e.g., identify utility sources), determine the legal classifications (i.e., temporary or permanent) of the structures, and identify permitting requirements. Planning meetings with local officials prior to installation are important and may help resolve these issues. Memoranda of Understanding (MOU) or other contractual agreements should be considered when placing mobile units in remote regions to clearly define areas of responsibility for partners prior, during, and post- installation. Atlanta Botanical Garden purchased a fully-outfitted shipping container, the *FrogPOD*, which was placed on grounds for assurance colonies of frogs from Panama (Example 5) and Central Florida Zoo obtained an empty freight trailer which they dubbed the *Coqui Pad* and transformed it into an isolation space for endangered Eleuthrodactylid frogs from Puerto Rico (Example 6).

Modified Spaces

One of the easiest ways to create space for amphibian assurance populations with limited funds is to modify existing rooms or buildings because amphibians generally require less space compared to other vertebrates and most can be housed at ambient air temperatures. Vacant 8 x 8 ft office spaces or facilities built for other species could be transformed into amphibian holding areas. Although floor drains are nice, they are not required since many options are available for pumping or moving wastewater.

A number of facilities have repurposed spaces to increase their amphibian conservation capacity. Omaha's Henry Doorly Zoo transformed empty, drain-less hallways into twelve *Isolated Amphibian Rooms*, using greenhouse material for walls and plastic storage vats for water (Example 7). Northwest Trek Wildlife Park enclosed a free-standing garage to create a rearing room for local Oregon spotted frog (*Rana pretiosa*) tadpoles and an outdoor area for staging juvenile and adult frogs prior to release (Example 8). Jacksonville Zoo and Gardens modified a building that once held koalas into a *Save the Frogs* exhibit, featuring numerous interpretive graphics and behind-the-scenes viewing of isolation rooms (Example 9). Even historical buildings can be resourcefully altered at moderate cost while still maintaining their integrity; Toledo Zoo renovated the interior of a Depression-era museum into *Amazing Amphibians*, which includes a large exhibit area for visitors and quarantined isolation space for four species assemblages (Example 10). Abandoned buildings *in situ* may be modified relatively quickly and at low cost if the overall structure is sound, providing an alternative to an outfitted shipping container; a vacated forest station in Madagascar provided the framework and foundation for a community-run amphibian rearing facility for local species (Example 11).

New Spaces

New construction dedicated exclusively to amphibians is rare. New amphibian spaces can be added to construction plans for an education building, animal hospital, primate facility, etc.; the options are limitless both in range and out of range country. Although exhibit space may help engage visitors, it is not crucial that amphibian assurance colonies are placed within public view.

The Detroit Zoo opened the first large-scale facility built entirely for amphibians in 2000, and the *National Amphibian Conservation Center* remains a popular exhibit for visitors today. The Atlanta Botanical Garden collaborated with the National Zoo in Chile to create breeding space for Darwin's frog (*Rhinoderma darwinii*) within a new building that also houses terrestrial invertebrates and flamingos (Example 12). The Fort Worth Zoo added four permanent isolation rooms for amphibians in an off-exhibit area within their newly constructed herpetarium, *Museum of Living Art* (Example 13), and the Phoenix Zoo created a conservation center for rearing and breeding rare Arizona species, which includes a large room for native amphibians (Example 14).

Additional Resources

Garnering support and obtaining resources for small creatures such as amphibians can be difficult, but it is not impossible. Amphibian programs need leaders to champion their species and conservation efforts within their own facility in order to garner resources comparable to those dedicated to other taxa. It is essential to share information and engage directors, boards, city officials, and/or state agencies regarding the need for action. Public outreach can expand a program's exposure, which may lead to unexpected external resources. Presentations and one-on-one conversations about amphibian declines have led to the development and completion of many of the amphibian facilities and programs presented in this manual.

Additional information on initiating amphibian conservation projects and identifying opportunities for grant support are available (Grow and Poole, 2008).

CONCLUSION

A mass extinction event is occurring and space and resources for amphibians needs to be committed immediately. Although space and resources are at a premium, these obstacles can be overcome if allocated to prioritize amphibian conservation; the longer we procrastinate, or wait for others to take action, the more species will disappear. All that is needed to bolster conservation efforts for amphibians is foresight and creative planning with key personnel. Through examples and discussions, this chapter has provided a foundation for people to create new functional space for amphibians. Grab a hammer and start building today!

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Example 1.
RIVERBANKS ZOO AND GARDEN NATIVE AMPHIBIAN HOLDING AREA
Information and photos submitted by Scott Pfaff, Riverbanks Zoo and Garden

Introduction
Little is known about the status of dwarf sirens (*Pseudobranchus sp.*) in the wild and few are held in zoos. Although they have a wide range, habitat requirements may be narrow. In South Carolina, habitat preferences of *Pseudobranchus s. striatus* are limited to vernal ponds and pocosins occurring in pine flat woods and long-leaf pine forest. These habitats are currently undergoing significant alteration due to forestry practices and coastal development. *P. s. striatus* is listed by the South Carolina Department of Natural Resources as a state threatened species. By maintaining colonies in outdoor enclosures (Figures 1 and 2), the Zoo has learned more about their reproductive strategies and husbandry requirements, and is prepared to offer assistance should there be a need to bolster wild populations or to help other species of dwarf sirens in the future.

Type of Construction and/or Modification
Modification of an existing outdoor service area for Riverbanks' *Aquarium Reptile Complex*

Estimated Total Square Footage
Approximately 1,500 sq. ft.

Initial Set-up Costs for Facility
About $2,000

Major Challenges
Exclusion of native predators including mink, raccoons, and natracine snakes.

Useful Additions and Features
The facility has close proximity to a water system that provides water directly from the Saluda River. The Saluda is classified as a *State Scenic River* and is relatively-free from contaminants. Access to the river water system allows the facility to use open water systems in the outdoors amphibian enclosures. Native amphibians are exposed to natural changes in photoperiod and temperature, and feed on the many invertebrates that colonize the tanks.

Areas for Improvement (i.e., planned differently or improved)
There is a need to secure all of the outdoor amphibian enclosures within a screen barrier to exclude small predators, yet allow entry of insects, natural light, rain, etc.

Figure 1. Stock tank enclosure with wire mesh lid removed.

Figure 2. Rubbermaid tub with wire mesh lid removed.

Example 2.
THE RON GOELLNER CENTER FOR HELLBENDER CONSERVATION AT THE SAINT LOUIS ZOO'S WILDCARE INSTITUTE
Information and photos submitted by Mark Wanner, Saint Louis Zoo

Introduction
The Saint Louis Zoo's WildCare Institute, *Ron Goellner Center for Hellbender Conservation*, has recently completed two outdoor streams in partnership with the Missouri Department of Conservation, U.S. Fish and Wildlife Service, and private donors. Each stream is run on a unique aquatic system and will house two different river populations of Ozark hellbenders (*Cryptobranchus alleganiensis bishopi*) (Figure 1). Hopefully, this new addition to the Zoo's hellbender facility will build upon earlier successes with head starting, husbandry, and propagation programs.

Type of Construction and/or Modification
New construction completed in September 2011

Estimated Total Square Footage
Each stream is about 40 ft. in length. A new 400 sq. ft. building was constructed to house the life support equipment.

Initial Set-up Costs for Facility
Approximate costs for the construction of streams, life support building (Figure 2), and life support equipment were $200,000.

Major Challenges
Since the stream construction was just finished, no hellbenders had been introduced at the time of this writing.

Useful Additions and Features
The hellbenders will be exposed to natural seasonal changes in photoperiod and temperature, as compared to those housed in the indoor facilities. The streams are deep enough for staff to snorkel to monitor the hellbenders, and are outfitted with chillers, boilers, UV sterilizers, carbon towers, bag filters, and outdoor bio-towers. Wastewater is treated using chlorine infusion. Stainless steel hydraulic lids were added after the initial construction was completed, are lifted manually, and will contain hellbenders while excluding predators (Figure 3).

Figure 1. Hellbender ready for transport

Figure 2. Interior view of life support building lid Figure 1 Hydraulic lid

Figure 3. Hydraulic lids

Example 3.
FORT WORTH ZOO TOAD SHED
Information and photos submitted by Diane Barber, Fort Worth Zoo

Introduction
This outdoor tool shed is a relatively inexpensive way to isolate a group of amphibians and can be placed next to a building for easy access to electricity and water (Figure 1). Similar units can be purchased at any major hardware store or on-line, and have the flexibility to be shipped or transported as an unassembled kit if needed in range-country.

Type of Construction and/or Modification
This kit was purchased in 2004 from a local hardware store, and was constructed on site by staff. Built to house Pecos pupfish, it is now used for a group of Puerto Rican crested toads (*Peltophyne lemur*). The shed's interior surfaces were easily disinfected using a large steam cleaner prior to moving in the toads. Custom wooden shelves were constructed along the walls to accommodate glass aquariums and lighting. The shed is equipped with a sink and water filtration/storage area (Figure 2), and is cooled/heated by small portable units.

Estimated Total Square Footage
This is a single room that is about 96 sq. ft. (Figure 3)

Initial Set-up Costs for Facility
Estimates for a similar set-up today would be approximately $2,220, not including labor for construction, or electrical and plumbing installation. Expenses are estimated as follows:

Metal Racks	$400
Roof shingles	$150
Flooring material	$200
Lighting/timers	$400
Tanks/lids	$280
Sink and fixtures	$60
Water storage tubs	$60
Water filtration	$120
Window air conditioner	$250
Small Heater	$300

Major Challenges

The shed lacks a central floor drain, so tank drains are routed to the sink and the linoleum covered floor is mopped. If the air conditioner or heater malfunctions, room temperatures fluctuate quickly, and so staff must be diligent about monitoring the building.

Useful Additions and Features

These easy-to-assemble units are available with windows/skylights, which would provide natural light cycles.

Areas for Improvement (i.e., planned differently or improved)

As space for a growing population may be a limiting factor, the size of the unit selected should reflect program needs. A hoseable floor surface with a central drain would be an improvement for keeper staff. An added screened vestibule or covered entryway would also be beneficial.

Figure 1. Window air conditioner powered by nearby building.

Figure 2. Water filtration and storage area.

Figure 3. Interior view of shed.

Example 4.
TORONTO ZOO AMPHIBIAN RESCUE CENTER (ARC)
Information and photos submitted by Bob Johnson, Toronto Zoo

Introduction
This building was purchased to expand isolated space for amphibians at our facility.

Type of Construction and/or Modification
This is a prefabricated building that was purchased new (Figure 1).

Estimated Total Square Footage
The *Amphibian Rescue Center* has a total of 280 sq. ft., containing two isolation rooms (Figure 2) that are 90 sq. ft. each and a vestibule (Figure 3).

Initial Set-up Costs for Facility
The building costs were approximately $84,000 (USD), shelving and tanks were about $1,500, and roughly $3,000 was spent to run the water lines and power to the facility.

Useful Additions and Features
If needed, the HVAC system allows for manipulation of temperatures in order to hibernate amphibians.

Areas for Improvement (i.e., planned differently or improved)
Several issues arise when temperatures are lowered to hibernate adult amphibians. First, the room becomes too cold for the juvenile amphibians, which has been overcome by staging the hibernation in the following manner: the room temperature is lowered by 10-15 F, which is still comfortable for the juveniles; once stabilized, the adults are moved to separate aquatic chiller systems where they are further cooled, while the room is returned to a normal temperature range for the growing juveniles. Second, high humidity within the rooms at low temperatures is also problematic as moisture condenses on the walls.

As space has become a limiting factor, the rooms should have been made about three feet larger so that three more tanks or a water reservoir could have been added.

Figure 1. Moving the Amphibian Rescue Center onto the concrete pad

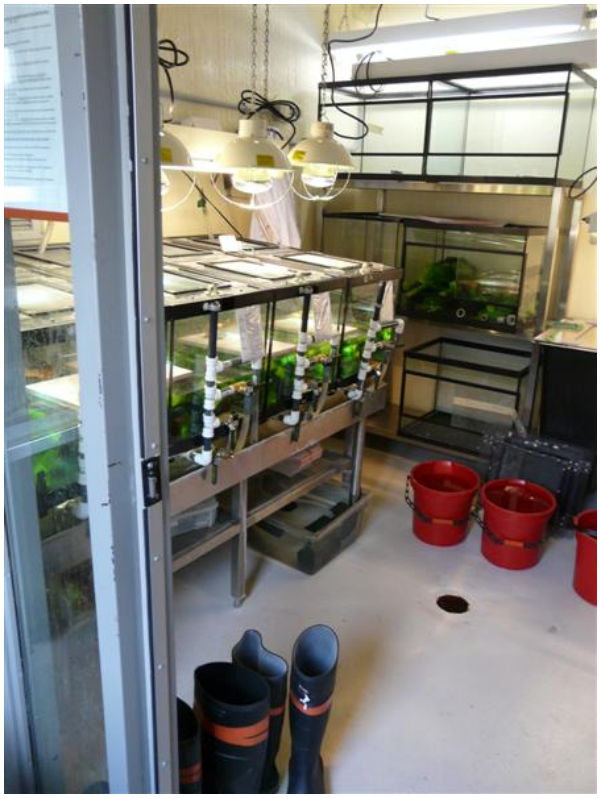

Figure 2. Interior amphibian room

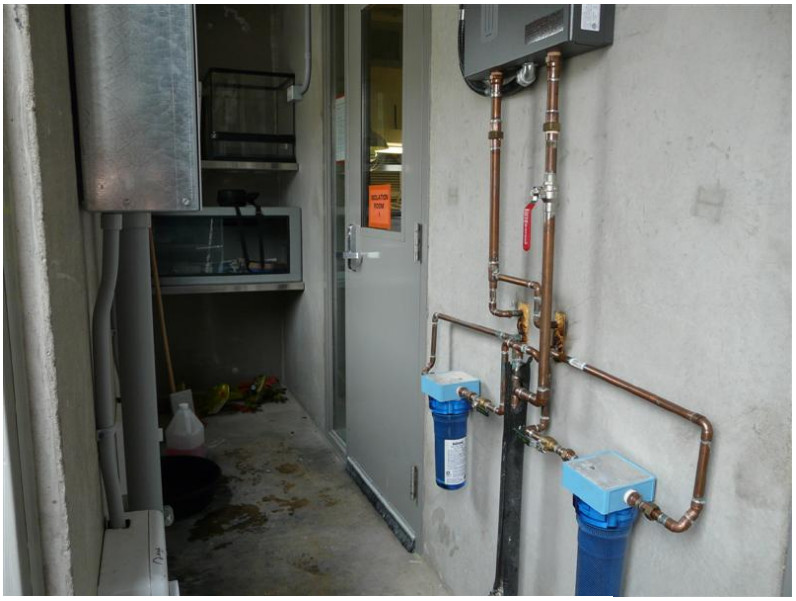

Figure 3. Interior vestibule

Example 5.
ATLANTA BOTANICAL GARDEN'S FROGPOD
Information and photos submitted by Robert L. Hill, Atlanta Botanical Garden

Introduction
The *FrogPOD* was purchased in order to house an assemblage of amphibians that were collected in Panama as an assurance population. This off-exhibit facility currently houses approximately 200 juvenile to adult animals, but could potentially house many more if needed.

Type of Construction and/or Modification
In 2008, the shipping container was purchased new as a complete, fully equipped/outfitted unit. Doors, windows, floor drain, and electrical outlets were installed by the company offering the unit, while plumbing, enclosures, and additional "after market" accessories were installed on-site.

Estimated Total Square Footage
Approximately 3,200 sq. ft.

Number of Isolation Rooms
The pod includes two rooms: an 800 sq. ft. entry room used for general storage and changing footwear, and a single 2,400 sq. ft. amphibian room (Figure 1).

Initial Set-up Costs for Facility
$53,000

Major Challenges
Inadequate heating and cooling systems were initially installed and the grated flooring/drain system has been problematic.

Useful Additions and Features
The heating and cooling problems have been remedied by upgrading to a more powerful split-unit heat pump, and installing back-up window air-conditioning units and small space heaters, to be utilized as necessary. The box shape of the unit makes design and layout of enclosures quite simple, as the pod lacks the odd columns or strangely placed corners often found in many herp buildings.

Areas for Improvement (i.e., planned differently or improved)

Modification of the grated floor would be nice, as drainage has been a constant problem due to the lack of solid-surface floor material. The initial purchase of a split-unit heat pump would have solved many of the heating and cooling issues from the start. In areas that may reach warm seasonal temperatures for extended periods of time (i.e., the southeastern USA), inexpensive window a/c units may prove to be inadequate.

Figure 1. Amphibian holding room

Example 6.
CENTRAL FLORIDA ZOO'S COQUI PAD
Information and photos submitted by Jen Stabile, Albuquerque BioPark

Introduction
The Central Florida Zoo has partnered with the University of Puerto Rico - Rio Piedras to conserve several species of Eleuthrodactylid frogs that are on the verge of extinction. The *Coqui PAD* units were installed at the Central Florida Zoo to house assurance colonies of coqui as part of *The Coqui Initiative*.

Type of Construction and/or Modification
A refrigerated semi-truck trailer was purchased from a salvage company and the interior was remodeled in-house. Construction is in progress at the time of this writing (Figures 1 and 2).

Estimated Total Square Footage
384 sq. ft.

Number of Isolation Rooms
There are three rooms within the unit: the entrance room which serves as a keeper changing and storage area (64 sq. ft.); a quarantine room (64 sq. ft.); and the main frog room (240 sq. ft.)

Initial Set-up Costs for Facility
Initial costs for facility, prior to permitting inspections, were approximately $16,125. Actual costs for retrofitting the entire unit in order to comply with permit requirements (see Major Challenges) brought the final total to $29,770 (including labor). Initial costs are detailed below:

Basic Structure		
Insulated trailer (48x8x8 ft.)	$2,200	
Hurricane straps	$250	
Foundation - cement/block	$1,500	
Sealant for roof	$150	
Wall construction	$200	
PVC wall covering (48x8 ft.) 32 pcs	$3,376	
Screws, rubber washers, and silicone seal	$200	
Metal exterior doors w/deadbolt, 3 pcs	$600	
Electrical/Plumbing		
Power upgrade	$1,800	
GFI breakers	$150	
HVAC unit (512 cubic ft.)	$3,000	donation
Window unit for QT	$400	
Lighting – interior, exterior, and emergency	$350	
Outlets, 25 total	$125	
Instant hot water heater	$215	
Filtration	$100	
Misc. plumbing, check valves, and lighting	$500	
Hose, 3 pcs	$60	
Wet/Dry shop-vacuum	$82	
Utility Sinks, 3 pcs	$180	
Furnishings		
Naturalistic Terrarium (12x12x12 in.), 10 pcs	$420	
Naturalistic Terrarium (18x18x18 in.), 13 pcs	$1,010	
Naturalistic Terrarium (18x18x24 in.), 5 pcs	$460	
18” hood lights (2) bulbs, 3 pcs	$420	
Racks (36x14 in.), 6 pcs	$360	
Racks (48x24 in.) ,6 pcs	$420	
Cabinets, 4 pcs	$400	
Desk	$100	
Anti-fatigue rubber mats (36x36 in.), 32pc	$640	
Footbath	$100	

Major Challenges

When the trailer unit was originally placed on site, the wheels were removed, placed on blocks, and hurricane-strapped to the concrete foundation pad. By doing this, a “permanent” structure was inadvertently created, which was then held to different permitting standards, including compliance with Americans with Disabilities Act (ADA) guidelines and required electrical upgrades. Since retrofitting the unit to be ADA compliant was not feasible, a decision was made to reattach wheels to the trailer, reclassifying the structure as “temporary” per the city’s definition. These unexpected permit requirements created costly delays and expensive upgrades.

Useful Additions and Features

Although this is an off-exhibit facility, one side of the trailer was placed in line with the public fence with the intent to paint it with a giant mural describing *The Coqui Initiative* (Figure 3).

Areas for Improvement (i.e., planned differently or improved)

It would have been nice to have installed some skylights. It is also recommended to double check permitting regulations prior to building installation, even when dealing with structures intended to be "temporary."

Figure 1. Inside of trailer during construction

Figure 2. Inside of trailer during construction

Figure 3. Side of trailer from public side, to be painted with a mural

Example 7.
OMAHA'S HENRY DOORLY ZOO'S ISOLATED AMPHIBIAN ROOMS
Information and photos submitted by Jessi Krebs, Omaha's Henry Doorly Zoo

Introduction
Following the 2006 *Amphibian Ex situ Conservation Planning Workshop* in El Valle, Panama, Omaha's Henry Doorly Zoo responded to the call-to-action and immediately established dedicated amphibian rooms within existing buildings on zoo grounds. The *Isolated Amphibian Rooms* (IARs) have become a working model for the application of the recommended standards in a zoo or aquarium setting. Each of the IARs holds one species or an assemblage of species from the same geographical area.

Type of Construction and/or Modification
IARs are versatile rooms constructed out of commercially available greenhouse materials with all construction completed by zookeepers. They have been set-up within the hallways of an unused, existing building on the Henry Doorly Zoo grounds.

Estimated Total Square Footage
Total square footage is over 4,200 sq. ft.

Number of Isolation Rooms
Currently there are 12 rooms that vary in size from 44 sq. ft. to 160 sq. ft. with the potential to add three more rooms.

Initial Set-up Costs for Facility
Current 2011 prices are approximately $8,000 to set up an 8x8 ft. unit. For estimating purposes, the rough expenses are as follows:

Room materials	$1,200	
Shelving	$300	
Heater/AC	$850	
Frog tanks	$150	each x 18 = $2,700
Lighting	$220	each x 9 = $1,980
Plumbing	$500	
Electrical/duct work	$250	
TOTAL for one room	$7,780	

Major Challenges
Biggest challenge has been to staff the area and get outside help to complete projects.

Useful Additions and Features
IARs at the zoo range from 8x4x8 ft. (2.4x1.5x2.4 m) in size to 10x16x8 ft. (3x4.9x2.4 m). The walls are made of 1.5x1.5 in. (3.8x3.8 cm) hollow-aluminum tubing overlaid with two-ply Lexan® sheeting (Figure 1 and 2). Individual walls are joined together with 1 in. (2 cm) aluminum angle pieces (Figure 3). Commercially purchased storm doors are used to access each room. All joints and cracks are sealed with 100% silicone to prevent water from leaking into common areas or into other isolation rooms. Seals are pressure-tested before installation of equipment and animals and visual inspections are ongoing to maintain biosecure levels. The storm door is placed at the lowest point and the one-inch threshold allows each room to hold at least 175 gallons (796 L) before overflowing into a common hallway with a drain. List of items used for the construction of an 8x8 ft. room:

Cap[7]	18 @ 8 ft. (2.4 m)
Splice[2]	3 @ 8 ft. (2.4 m)
Lexan®[2]	6 @ 6x8 ft. sheets (1.8x2.4 m)
Aluminum Tubing[8]	18 @ 8 ft. [1.5x1.5 in. (3.8x3.8 cm); 1/8 in. (0.3 cm) thick]
Storm door	
Hardware, screws, washers	

Portable heating/air condition units are used to control the ambient temperature in each room (Figure 4). Units can be purchased with different BTU ratings for different size rooms: 8x8x8 ft. (2.4x2.4x2.4 m) rooms use 10,000 BTU units; the 10x16x8 ft. (3x4.9x2.4 m) use 12,000 BTU units[9]. Also visible in Figure 4 is the designated footwear for within this room. Footwear that is easy to disinfect is changed as the keeper crosses the room threshold.
Once the shelving[10] is installed, tubs and lids[11] used for amphibian enclosures are fabricated from food-grade polycarbonate material to prevent the leaching of toxins sometimes found in plastic materials (Figure 5). Though glass fish-tanks may be a less expensive, the polycarbonate tubs are far more durable and versatile, making them suitable for housing terrestrial or aquatic species. Drilling each tub does not require a specialized drill bit nor do they crack or break as easily as glass. The volume of the tanks used ranges from 5-16 gallons.

The drain for each enclosure runs into a common piping system located under every shelf. Drain system lines are 2 in. (3 cm) diameter to allow for large volumes of water to pass through them without backing up into adjacent enclosures (Figure 6). The drain systems pipes all run into the wastewater collection tub (Figure 7).

Lighting on every rack system is made available in two forms: compact florescent or MR16 track lights[12] above each shelf to provide ultraviolet light, and small heat lamps on each enclosure to offer basking sites for species requiring higher temperatures (Figure 8).

Areas for Improvement (i.e., planned differently or improved)
At the time of design of the IARs, wastewater treatment was highly recommended for all amphibian isolation facilities, however current practices only require wastewater treatment for those facilities which do not directly flow into a municipal sewage system. The information on the IAR wastewater treatment plan that follows is offered for facilities desiring such an example.

A sink combination is used to collect all wastewater from each isolation room and is created by stacking two inexpensive utility sinks together (Figure 7). The bottom tub (without legs) is set directly on the floor un-drilled. The second sink (with legs) is set within the tub below, and plumbed to drain into the lower tub without splashing. A sump pump[13] with an automatic on/off switch is set within the lower tub to pump wastewater to the *Central Treatment Station* (Figure 9). The upper tub can be plumbed for use as a working sink if desired, or else dedicated hose-lines can be run into each room and provide filtered source-water.

[7] **www.stuppy.com**
[8] **www.statesteel.com/omaha.htm**
[9] **www.sunpentown.com**
[10] **www.samsclub.com** or from materials acquired at local hardware stores
[11] **www.rubbermaidcommercial.com/rcp/products/detail.jsp?rcpNum=3328**
[12] 50 watt MR-16 style Eiko® bulb
[13] **www.flotecpump.com**

All water is treated coming into and out of the IAR facility at the *Central Treatment Station*. A large water container is used to hold reconstituted reverse-osmosis (RO) water that can be pumped to each room as needed (right side of Figure 9; See Chapter 1 for additional information on reconstituted RO water). Two barrels are used to collect all wastewater (center of Figure 9), which is then treated with household bleach for 12 hours before being released into the city sewer system (see Chapters 3 and 4 for more information on wastewater treatment). List of basic items used for influent and effluent water treatment within the room shown in Figure 9:

RO water storage vessel	300 gallons (1135 L)
RO filter system	
RO reconstitution feeder	
Wastewater treatment barrel	2 @ 55 gallon (208 L)
Bleach feeder system	

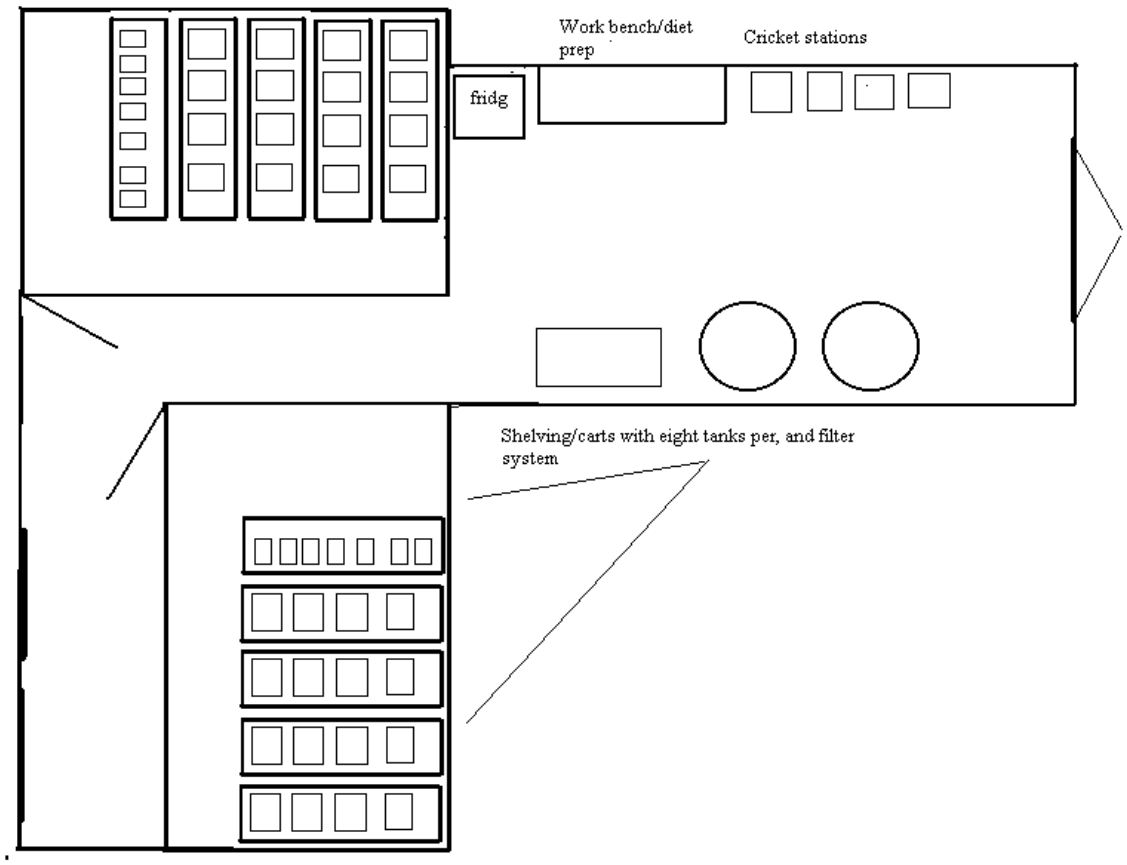

Figure 1. Floor plan of one Isolation Amphibian Room (IAR) with dedicated food preparation area.

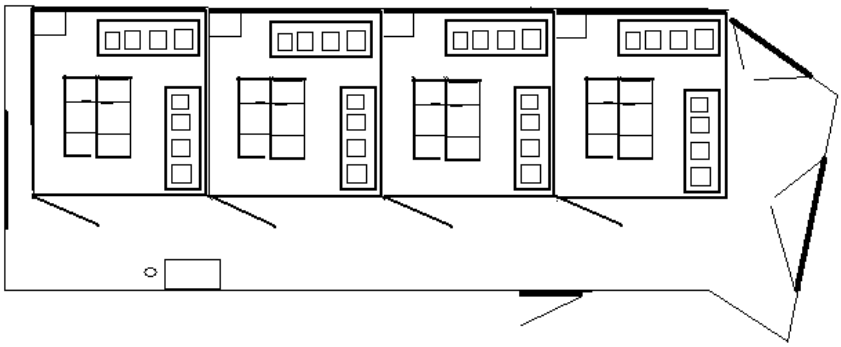

Figure 2. Floor plan of additional IARs.

Figure 3. Close-up of the 1 in. (2 cm) aluminum angle pieces holding the 1.5x1.5 in. (3.8x3.8 cm) aluminum tubing and storm door.

Figure 4. The portable heating/air condition unit and dedicated footwear placed in each room.

Figure 5. Shelving with amphibian enclosures

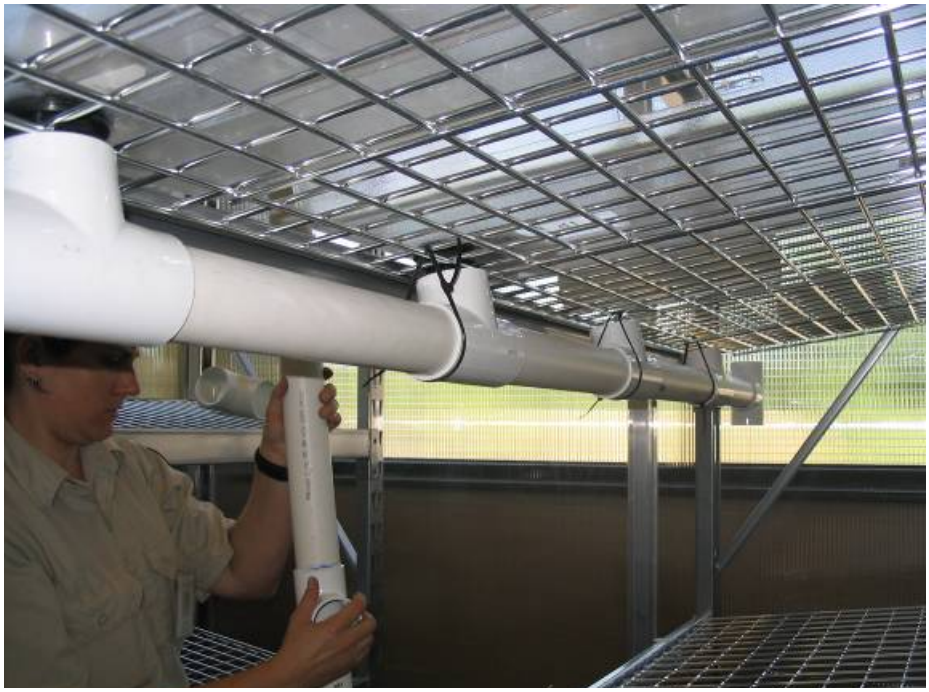

Figure 6. The over-sized drain system under each shelf being installed in the IAR.

Figure 7. IAR wastewater collection tub with sump pump below

Figure 8. Lighting accommodated into the racks

Figure 9. The building's water storage and *Central Treatment Station*

Example 8.
NORTHWEST TREK WILDLIFE PARK'S OREGON SPOTTED FROG REARING FACILITY
Information and photos submitted by Allison Abrahamse, Northwest Trek Wildlife Park

Introduction
The Northwest Trek Wildlife Park participates in the recovery efforts for the Oregon spotted frog (*Rana pretiosa*) with several other zoos and agencies. Since this is a regional species, they can be housed in outdoor enclosures. Although not every facility maintains Oregon spotted frogs in the same type of setting, this is one example of how facilities can accommodate local species.

Type of Construction and/or Modification
NTWP remodeled a free-standing garage into a workspace complete with sink, refrigerator, stove, and space necessary for diet preparation and storage of materials. The insulated garage is temperature controlled and utilizes a specialized filter to eliminate excess iron from local well water. In addition, a chain link kennel was constructed outside of the garage to house adult frogs (Figure 1). The frogs are reared in 300 gallon holding tanks[14] within the kennel, with each tank able to hold approximately 100 animals. Separate 300 gallon reservoir tanks with de-chlorinated water are adjacent to each respective holding tank, along with a dedicated pump used for water changes (Figure 2). The size of kennel needed is relative to the number of tanks used for rearing. To prevent predation from above, the kennel is covered with nylon netting, and hot wire runs around the top edge to deter climbing predators (e.g., raccoons).

Estimated Total Square Footage
A total of 1,400 sq. ft. is used for the NTWP Oregon spotted frogs. The converted garage is approximately 600 sq. ft., the enclosed kennel is approximately 400 sq. ft., and the space with the reservoir tanks is about 400 sq. ft.

Initial Set-Up Costs for Facility
The total cost to create this facility with four holding tanks and four reservoir tanks was approximately $7,745, which does not include costs for the "kitchen/storage" area remodel, labor, or installation. Cost approximations are detailed as follows:

Fencing	$1200
Netting	$150
Hot wire	$150

[14] Rubbermaid® stock tanks

300 gallon stock tanks	$375 per tank
800W titanium aquarium heaters	$45 per tank
Temperature controller	$28
Timers	$25
Thermometers	$20
Air pump	$210
Air stones/tubing	$35 per tank
Water pump	$200 each
Hoses	$20
Lids (tight construction mesh w/bungee ring suspended over PVP pipe diameter support rod)	$100 each
Cleaning equipment (buckets, nets, turkey basters, etc.)	$30 per tank
Net-pens (pool noodles and aquarium nets; houses approx. 20 eggs each)	$12 each
Water quality testing kits	$50 each

Major Challenges

One challenge faced was a lack of amphibian expertise on staff, leading to a significant amount of time invested in reading related literature and talking to more experienced colleagues. Other beginners should not be surprised to do the same, and it is recommended to have one or more mentors from outside the institution if in-house experience is lacking. Even with more experience under one's belt, collaboration with other facilities is still one of the best resources.

The next challenge faced was an unexpected amendment to the rearing protocols that now incorporated the use of supplemental heat to accelerate the development of tadpoles and frogs. Adding heat precipitated the need to start improvising and acquiring items that had not been budgeted. Staff time dedicated to addressing this issue immediately ballooned, and the ultimate demands for electricity required significant investment in electrical infrastructure among other features.

Another challenge faced was related to water quality. The facility is located in a rural area and uses well water which requires extensive water quality testing; this would normally be conducted by a municipal water department in suburban or urban areas. Because the well water has high iron content and is not processed by a municipal water treatment plant, an iron filter was installed to produce an acceptable influent to the Oregon spotted frog facility.

Useful Additions and Features

The literature was mixed with respect to the need for full-spectrum lighting however, NWTP was conservative and invested in full-spectrum lighting for rearing eggs and young tadpoles indoors (Figure 3). Floating net-pens (Figure 4) in outside holding tanks negate the need for artificial full-spectrum lighting.

A good quality water test kit with freshly stocked reagents is recommended.

In the author's opinion, institutional commitment for all departments and at all levels is the single most important *feature* needed to succeed.

Areas for Improvement (i.e., planned differently or improved)

Have seasoned amphibian experts on staff prior to beginning a project, ideally with experience working with the same or a closely related, species. Shy of that, employ committed seasoned generalists, who are willing to learn, hustle, adapt, communicate, and persevere.

Figure 1. Outdoor Kennel that houses adult frogs.

Figure 2. Each holding tank for live individuals (inside the fencing) has its own separate reservoir tank (outside the fencing) that holds de-chlorinated filtered water.

Figure 3. Tadpole rearing enclosures inside of remodeled garage.

Figure 4. Net-pens currently used for tadpole rearing outdoors.

Example 9.
JACKSONVILLE ZOO'S SAVE THE FROGS EXHIBIT
Information and photos submitted by Dino Ferri, Jacksonville Zoo and Gardens

Introduction
The Jacksonville Zoo decided to retrofit an old koala exhibit and dedicate the space to amphibian conservation.

Type of Construction and/or Modification
Retrofit that was completed in 2008 for *Year of the Frog*, which included biosecure rooms with dedicated water treatment systems (Figure 1).

Estimated Total Square Footage
About 1,500 sq. ft.

Number of Isolation Rooms
Currently there are two isolation rooms (120 sq. ft. each; Figure 2), one exhibit room (80 sq. ft.; Figure 3), and a potential future fourth space (100 sq. ft.) that is currently used by the bird department as an egg incubation room.

Initial Set-up Costs for Facility
$30,000 to retrofit the entire building and set up the amphibian areas: $20,000 for building modifications and $10,000 for educational graphics, including a $2,500 mural (Figure 4).

Major Challenges
Securing the species for display in time for exhibit grand opening.

Useful Additions and Features
The public is able to view the amphibians in quarantine while in a comfortably air-conditioned building. The isolation rooms have skylights, which not only help illuminate the space, but provide more natural photoperiods for the amphibians.

Areas for Improvement (i.e., planned differently or improved)
More space would be nice in order to work with additional species.

Figure 1. Sink and water treatment area for each room

Figure 2. Isolation room

Figure 3. Exhibit room

Figure 4. Graphic wall

Example 10.
TOLEDO ZOO'S AMAZING AMPHIBIANS
Information and photos submitted by R. Andrew Odum, Toledo Zoo

Introduction
In May 2008, the Toledo Zoo opened its permanent dedicated *Amazing Amphibians* (AA) facility in the Depression-era Museum of Science building constructed in 1937. The area of AA is roughly divided into thirds, with one-third each dedicated to biosecure amphibian populations, keeper service, and public education. The first goal of this facility is to provide a conservation education experience for the Zoo visitor focused on both local amphibian species and the worldwide diversity of the Amphibia. The second goal is to provide four isolated and discrete biosecure amphibian facilities to serve as areas for *ex situ* conservation efforts. Three of these isolation areas are currently dedicated to ongoing reintroduction programs.

Type of Construction and/or Modification
New space within an existing building.

Estimated Total Square Footage
Total square footage of AA is 2,000 sq. ft.

Number of Isolation Rooms
There are four biosecure isolation rooms that vary in size from 100-170 sq. ft.

Initial Set-up Costs for Facility
The total project budget was approximately $750,000. This amount included the structure; caging; display; interpretive graphics; environmental control systems; plumbing; new electrical service and electrical installations; keeper service areas; and biosecure facilities.

Major Challenges
Available funds did not cover the labor for equipping and fitting the reserve areas, life support systems, and biosecure facilities; these were completed by keeper staff. Fabrication of the elevated floors and curbs in AA required a more expensive alternative as the existing floors of the old Museum building were inadequate support the weight of concrete.

Useful Additions and Features

AA features four separate isolation rooms connected to a common pre-isolation hallway (Figure 1). The hallway has a unique access point from the public area with no direct connection to other animal areas. This hallway is used for staff preparation prior to entering isolation areas and doubles as a dedicated invertebrate culture area and storage. It includes a curtained area for privacy, where keepers wash and change into scrubs prior to entering any isolation rooms.

Elevated floors with curbs in all service areas allow for drains and prevent water on the floor from flowing between service areas. A structure of wood framing, plywood, and composite-layered epoxy-flooring forms service area floors with drain troughs, and continues up each wall for approximately one foot, creating a waterproof barrier. Each isolation room entrance has an 8 in. sill to prevent water from entering or exiting the room at the doorway (Figure 2).

The walls were made of 6 in. metal framing, 5/8 in. plywood sheathing, and covered with a fiberglass reinforced panel (FRP) system with molding. This creates a waterproof seal which facilitates cleaning. All walls were insulated with fiberglass, and a clear plastic vapor barrier was installed inside the plywood on both sides.

Each independent isolation room has its own air handling system, using commercially-available refrigeration equipment. There is no fresh air provided in the design of the isolation rooms. Instead, air exchanges are provided by opening the door during servicing to exchange air with the hallway. A constant unidirectional flow exhausts air that is exchanged between the hallway and isolation rooms, preventing cross-contamination between rooms as only one isolation room door is opened at a time. Direct-wired time-clocks and thermostats provide a day/night temperature change.

Hot and cold domestic water supplies, carbon-filtered water (for dechlorination)[15], and reverse osmotic (RO) water are available in AA. All wastewater from enclosures, keeper areas, and biosecure rooms is routed to a single common drain system in the floor trough, allowing disinfection if necessary; however, currently the wastewater is routed to the municipal water treatment plant and no further treatment is considered warranted (Pessier and Mendelson, 2010).

A new electrical service was installed for the entire facility. All room circuits were protected with ground fault circuit interrupt breakers (GFCI) installed within the panels. The electrical outlets are installed in the raceway system at a height of about six feet and separate circuits were provided for timers and continuous power.

Shelves were created out of composite decking 2x4 in. lumber and stainless steel fasteners. The shelf tops are made of half-inch high-density polypropylene purchased from a local plastic suppler. Cage lighting was provided by track light systems and 50W Eiko® EXT/SU 12V halogen bulbs with the lens removed (Browne et al., 2007).

All the glass tanks[16] were drilled and fitted with ¾ in. PVC bulkhead fittings. A false floor was installed and the drains were piped to external standpipes to prevent cage flooding (Figure 3). A quick-drain method was provided by the PVC ball valves installed below the level of the tank bottom. These drains are piped into a common drain with an air-gap to prevent siphoning of water between cages. The common drain empties into a floor trough drain piped to the building's wastewater system. Rain systems were later installed using the carbon filter water supply.

Staff maintain biosecure isolation for each of the rooms by donning dedicated footwear, head coverings, and clean scrubs; disinfecting hands before and after animal exposure; and utilizing latex gloves between each cage (Figure 4).

Areas for Improvement (i.e., planned differently or improved)

One issue that was not anticipated was the amount of dew produced each morning when the temperatures changed from nighttime lows to daytime highs; addressed by using off-the-shelf domestic dehumidifiers to help dry the air during temperature transitions.

[15] 3M backwashing filter from Grainger® - Part # 3P971
[16] Zoo Med® terraria typical

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Pessier, A. and J. Mendelson, Eds. 2010. A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs. Apple Valley, MN, IUCN/SSC Conservation Breeding Specialist Group.

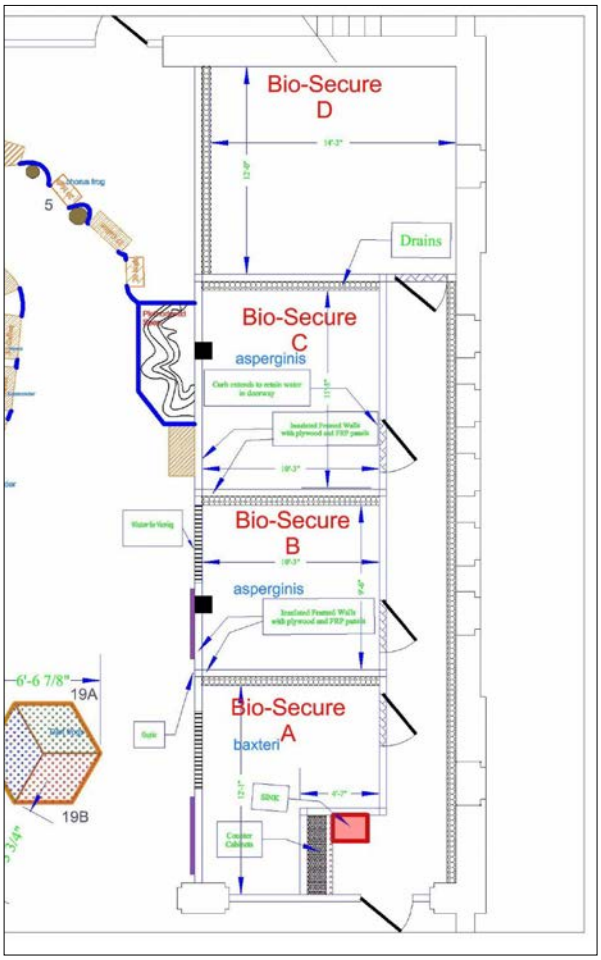

Figure 1. The isolation area hallway is used to access the four individual biosecure rooms in AA.

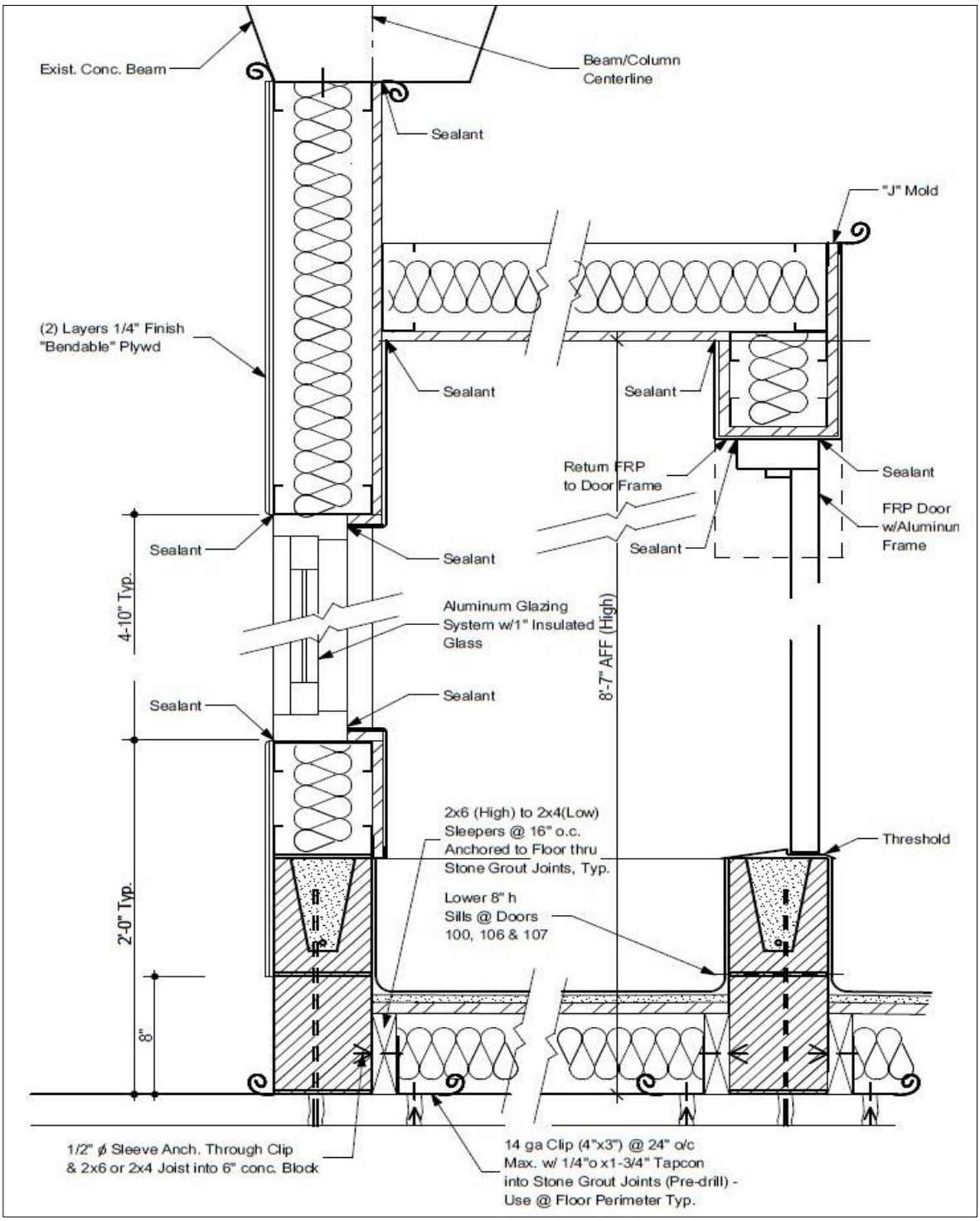

Figure 2. Detail for the floor, wall, and door structures. Note the elevated door threshold to prevent water from exiting and entering the room under the entrance door.

Figure 3. Each tank has its own standpipe overflow created out of "T" and flexible PVC, serviced by a quick-drain valve. All these drains flow into a two- inch common drain pipe created by drilling a hole in the pipe and loosely fitting the ¾-inch drain into the pipe. This prevents siphoning between cages.

Figure 4. Elevated door threshold into an isolation room from common hallway. Note the dedicated footwear for hallway and each room.

Example 11.
MADAGASCAR AMPHIBIAN CONSERVATION PROJECT
Information submitted by Jennifer Pramuk, Woodland Park Zoo; Photos by Devin Edmonds

Introduction

Slightly more than one quarter of Madagascar's amphibian species are threatened with extinction. Habitat destruction and over-harvesting are the greatest factors contributing to this dramatic decline. The impending threat of amphibian chytrid fungus (*Batrachochytrium dendrobatidis; Bd*), which is responsible for many of the world's recent amphibian population declines and extinctions, is also of great concern. With the generous financial assistance of multiple organizations, the community-run Malagasy organization Association Mitsinjo has constructed a captive breeding facility in the Mitsinjo-managed Analamazaotra Forest, two km outside of Andasibe village in east-central Madagascar. This is the first in-country captive breeding and amphibian conservation project of its kind in Madagascar, and the facility will house captive populations of threatened amphibians to safeguard against current threats as well as the future introduction of *Bd*. The goal is for the facility to become a center for training and education in a bio-region of Madagascar which contains tremendous amphibian diversity and endemism. This project also has begun to develop additional value-added components, including collaborative efforts with the Amphibian Specialist Group (ASG) to perform local and country-wide *Bd* testing as a first line of detection for the disease in Madagascar. So far, four frog species have been selected for this project through discussions with colleagues that developed *A Conservation Strategy for the Amphibians of Madagascar* (ACSAM) and the ASG of Madagascar: *Blommersia blommersae*, *Boophis pyrrhus*, *Heterixalus betsileo*, and *Mantidactylus betsileanus*. These species are absent from zoological collections and little or nothing is known of their husbandry. They were selected based on their varied life histories and presumed correlated differences in captive care parameters to provide technicians with a diverse set of husbandry experience during training. Technicians from Andasibe have been trained in proper quarantine, biosecurity, and acclimation protocols, in addition to animal health procedures that ensure the health of each frog before it is transferred to permanent housing. The project's second phase will involve development of educational materials and graphics to accompany an exhibit that will display some of the frogs to the public. Tourists will be charged a nominal fee to view the exhibit and these admission funds will augment the livelihoods of Malagasy technicians running the facility.

Type of Construction and/or Modification

This project was almost completely new construction, but was built upon the foundation of an old, abandoned forest station in the Analamazaotra Forest Reserve. The foundation included a partial concrete pad and walls. The facility is solidly constructed of bricks, mortar, wood, plaster, concrete, and a zinc sheet metal roof. Basic construction of the facility was completed in late winter of 2011.

Estimated Total Square Footage
The total square footage of the facility is 185 sq. m (Figure 1).

Number of Isolation Rooms
The facility includes three primary biosecure rooms for culturing live foods (Figure 2), maintaining captive populations of frogs (Figure 3), conducting husbandry research, and for quarantine (Figure 4).

Initial Set-up Costs for Facility
Initial set up costs were approximately $45,000 which included facility construction, on-going maintenance, tanks, shelving, electrical wiring, amphibian husbandry materials, and equipment for the production of live food. Early and significant funding was received from the AZA Conservation Endowment Fund and more recent support was awarded by Conservation International, Wildlife Conservation Society, Woodland Park Zoo, Cleveland Metroparks Zoo Africa Seed Grant, Durrell Ivoloina Training Course Small Grant, Tree Walkers International Amphibian Conservation Partnership, and the Amphibian Ark Seed Grant.

Major Challenges
Construction of municipal water and electrical lines to the facility has been the greatest challenge to the project. Politics have delayed the delivery and installation of a water line in the facility for almost seven months. Electricity is an even greater financial obstacle as the electric company wants to charge a substantial amount for installing power lines to the facility. Alternative energy, such as from solar panels, are being investigated to power the facility. Fortunately, a recent grant from Conservation International will allow the purchase and installation of large rain barrels that will be used for the primary water supply.

Additional challenges include sourcing materials in-country (e.g., plastic boxes, aluminum framing, glass, and silicone). Materials such as prefabricated aquariums, which are taken for granted in the United States, are nearly impossible to obtain in Madagascar.

Useful Additions and Features
A rainwater collection system is being developed so that the technicians do not have to hand-carry water to the facility. Solar panels are being sought to use as a reliable power source.

It was necessary to construct an exclusion fence for zebu and other large animals to prevent damage to the facility itself.

Areas for Improvement (i.e., planned differently or improved)
Improved communication with other international organizations prior to project initiation would have been tremendously beneficial. Relationships that were damaged due to poor communications early on are now being repaired; this could have been prevented if plans were more thoroughly vetted with other stakeholders from the start.

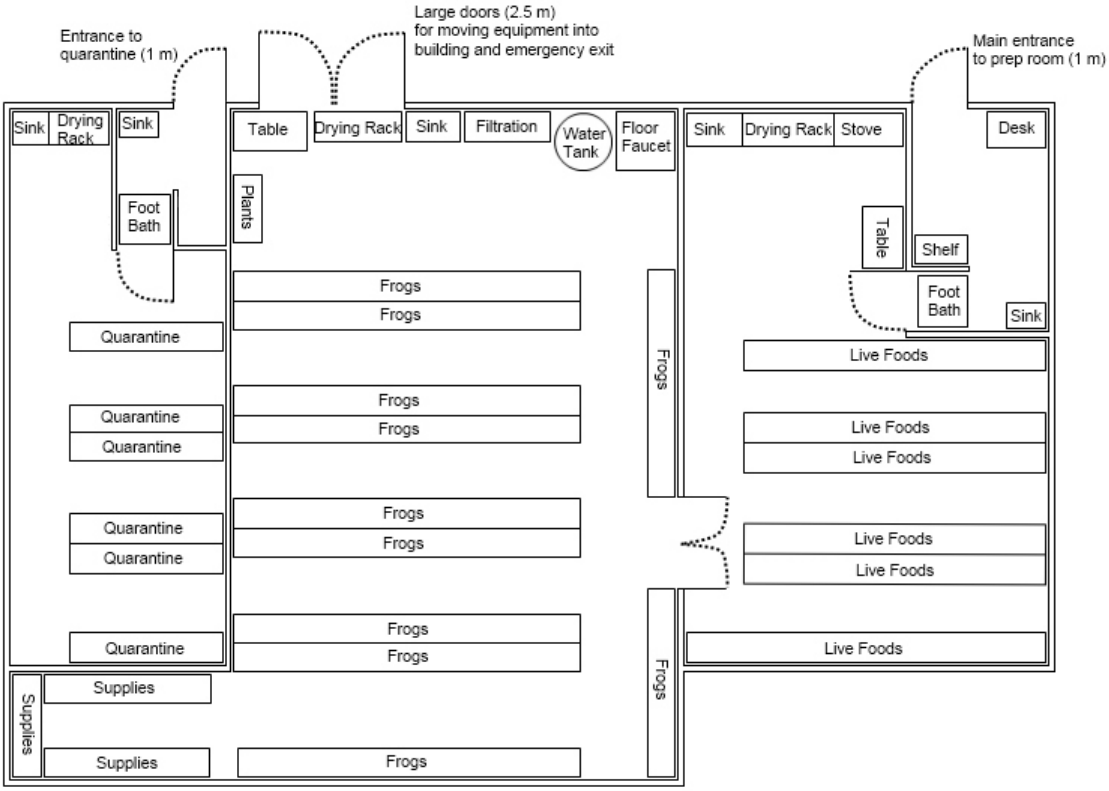

Figure 1. Floor plan

Figure 2. Insect Room

Figure 3. Anteroom to quarantine

Figure 4. Quarantine Room

Example 12.
DARWIN'S FROG BREEDING FACILITY AT THE NATIONAL ZOO OF CHILE
Information and photos submitted by Danté Fenolio, Atlanta Botanical Garden

Introduction
The Atlanta Botanical Garden helped the National Zoo of Chile (Santiago Zoo) complete a breeding facility for Darwin's frogs (*Rhinoderma darwinii*). This facility also includes two other areas dedicated to rearing Chilean flamingoes and feeder insects.

Type of Construction and/or Modification
A newly constructed building completed in 2009

Estimated Total Square Footage
The amphibian level is approximately 14 sq. m.

Number of Isolation Rooms
Two amphibian rooms, approximately 7 sq. m each. There is an additional insect culture room on the first level of the building that is also about 7 sq. m.

Initial Set-up Costs for Facility
The actual construction cost for all three levels of the building was approximately $360,000 (USD). The cost to equip (e.g., shelving, lighting, aquariums, etc.) the inside of the amphibian isolation rooms cost approximately $15,000 (Figure 1).

Major Challenges
One of the major challenges with setting up this facility was the development of preventative measures in the event of an earthquake. This resulted in the installation of a self-starting generator (Figure 2), a gravity-fed water storage system (Figure 3), and securing aquarium racks to walls. These additions were proven effective after a large earthquake impacted the area shortly after building construction, and left the zoo without electricity and water for a short period of time.

The amphibian isolation rooms are visible to the public through a large glass window (Figure 4). Initially, the window received a lot of sunlight in the mornings and overheated the rooms. Therefore, a large 4x1 m banner was

installed above the upper portion of the windows, providing adequate shade from the sun and also serving as a graphic panel that describes the Darwin's frog project to visitors in both English and Spanish.

Useful Additions and Features

A large statue of a Darwin's frog was placed outside of the amphibian exhibit to attract children to the area and entice parents to read and interpret the graphics to them (Figure 5).

Areas for Improvement (i.e., planned differently or improved)

More space for juvenile frogs will probably be needed in the future. Two additional units are planned to accommodate at least six other critically endangered Chilean amphibians.

Figure 1. Lab service area

Figure 2. Generator

Figure 3. Water storage tank

Figure 4. Exhibit view

Figure 5. Frog sculpture

Example 13.
FORT WORTH ZOO AMPHIBIAN QUARANTINE ROOMS
Information and photos submitted by Diane Barber, Fort Worth Zoo

Introduction
The Fort Worth Zoo's herpetarium features four amphibian isolation rooms. Each room houses a different species that is part of a reintroduction program (Figure 1), or serves as an assurance population with the potential for reintroduction in the future. A limited number of staff has access to these rooms, and biosecurity procedures are followed when servicing each area (Figure 2). This type of single-room approach can be applied to retrofit spaces within existing buildings (e.g., hospitals, bird or mammal areas, office spaces, etc.) at minimal costs.

Type of Construction and/or Modification
The amphibian quarantine rooms are within the newly constructed *Museum of Living Art* (MOLA), which opened in 2010.

Estimated Total Square Footage
760 sq. ft.

Number of Isolation Rooms
Three rooms are approximately 10x12 ft., and the forth room is 10x20 ft. The amphibian room corridor is about 203 sq. ft., and the remaining 560 sq. ft. is dedicated quarantine space (Figure 3) divided into four rooms.

Initial Set-up Costs for Facility
The rooms were part of a multi-million dollar construction project. Costs for equipment to initially outfit all four rooms [reverse-osmosis (RO) unit, water storage, sink, racks, tanks, lights, etc.] were approximately $8,225.

Major Challenges
Originally poured concrete curbs were requested to prevent water moving from the corridor under the doors, but due to Americans with Disabilities Act (ADA) regulations, it was not possible to add that feature. Instead, floor sweeps were added to the bottom of all doors and thresholds were installed on the interior floors to prevent water transfer. Daily cleaning and quarantine procedures overcome any minor water breeches that may occur.

Useful Additions and Features
Ultra-violet (UV) penetrating skylights were installed in each of the rooms. Each room has its own sink, hose, water filtration/storage area, and floor drain (Figure 4). A multitude of timed and untimed outlets are on each of the walls.

Although the amphibian room's air conditioning system is shared with the adjacent kitchen area, the ducts that supply air to each of the rooms is equipped with a High-Efficiency Particulate Air (HEPA) filter.

Areas for Improvement (i.e., planned differently or improved)
It would have been ideal to have separate heating and cooling systems for each of the rooms, but it was too costly; instead, the four rooms are on a single thermostat. Bigger spaces, or additional rooms, are preferred where possible.

Figure 1. Rooms are permanently marked to identify occupants and remind staff to follow protocols.

Figure 2. Dedicated footwear, gloves, and lab coat are worn by staff.

Figure 3. This large quarantine room with skylight houses larval hellbenders on the shelves, and includes a 12 ft. long enclosure to accommodate adults.

Figure 4. Service area within each quarantine room includes a cabinet, sink, hose, and water filtration/storage vat.

Example 14.
THE ARTHUR L. AND ELAINE V. JOHNSON FOUNDATION CONSERVATION CENTER AT THE PHOENIX ZOO
Information and photos submitted by Tara Sprankle, Phoenix Zoo

Introduction
This facility was built for head starting and captive breeding/rearing of Arizona native species.

Type of Construction and/or Modification
This conservation center is a new facility completed in the summer of 2007.

Estimated Total Square Footage
The building is 3,000 sq. ft. There are four separate labs used for Arizona species, one of which is a 1,250 sq. ft. room dedicated to amphibians (Figure 1).

Initial Set-up Costs for Facility
The total cost for construction of the building was approximately $750,000. The initial cost to outfit the amphibian room was about $5,150, detailed below:

Shelving	1,400
Rubbermaid food storage tubs	1,000
Filters	750
Misc. supply	2,000

Major Challenges
The facility has insufficient storage space.

Useful Additions and Features
The amphibian room is equipped with a deep sink (bathtub), which is ideal for disinfecting tanks and cleaning filters. The lab is visible to visitors so they can see the work being done with the amphibians, including rearing tadpoles (Figure 2). Solar panels on roof help power the facility (Figure 3).

Areas for Improvement (i.e., planned differently or improved)
More storage space and additional electrical outlets would be useful.

Figure 1. Interior view of the amphibian lab

Figure 2. Tadpole rearing tanks

Figure 3. Exterior of the facility exhibiting solar panels