amphibian ark

Keeping threatened amphibian species afloat

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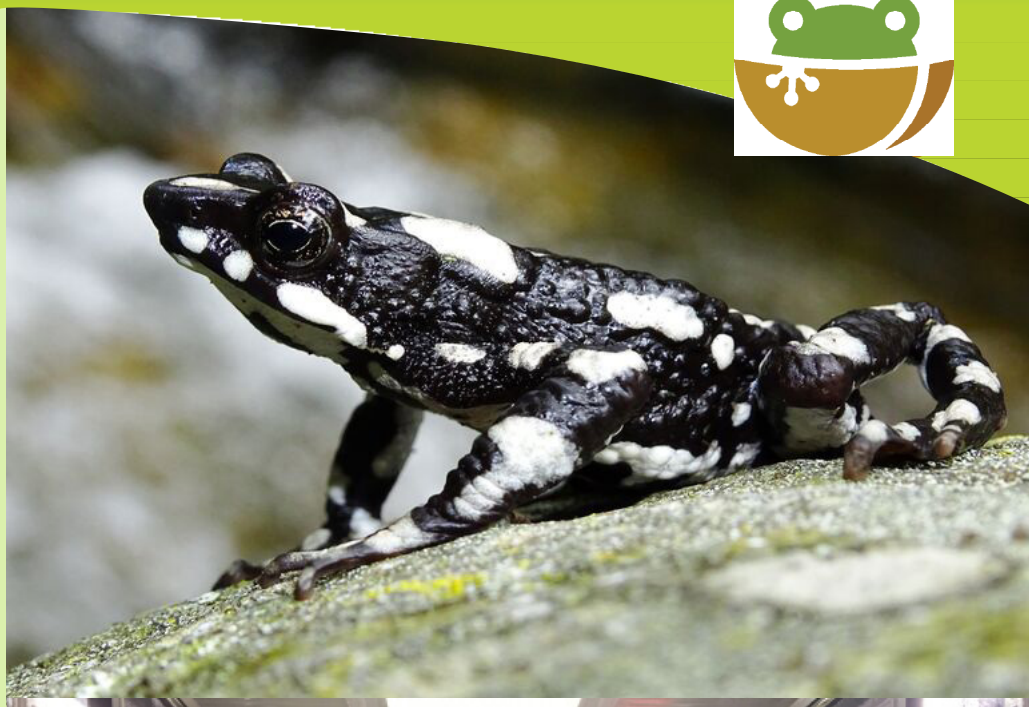

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Atelopus conservation workshop / *Atelopus* Survival Initiative

Luis Carrillo, Training Officer, Amphibian Ark

Atelopus is a large genus of toads that occurs from Costa Rica to Bolivia including Surinam and Guayana. *Atelopus* species are small, generally brightly colored, and diurnal. This genus has been greatly affected by habitat loss, pollution, and introduced species, but the primary cause of these declines appears to be the amphibian fungus, *Batrachochytrium dendrobatidis*. Many species of *Atelopus* are now considered endangered, while others already are extinct.

Global Wildlife Conservation organized a workshop at Parque Explora in Medellín, Colombia from November 4-7. Experts from Costa Rica, Panama, Venezuela, Colombia, Ecuador, Peru, Brazil, and Bolivia developed an action plan to help conserve *Atelopus*. The Atelopus Survival Initiative was launched to implement this action plan in range countries.

The thirty-four participants developed a common vision to save *Atelopus* from extinction. Goals, strategies, responsibilities and a time-line were developed. The action plan will guide conservation actions within range countries and will be reviewed every five years.

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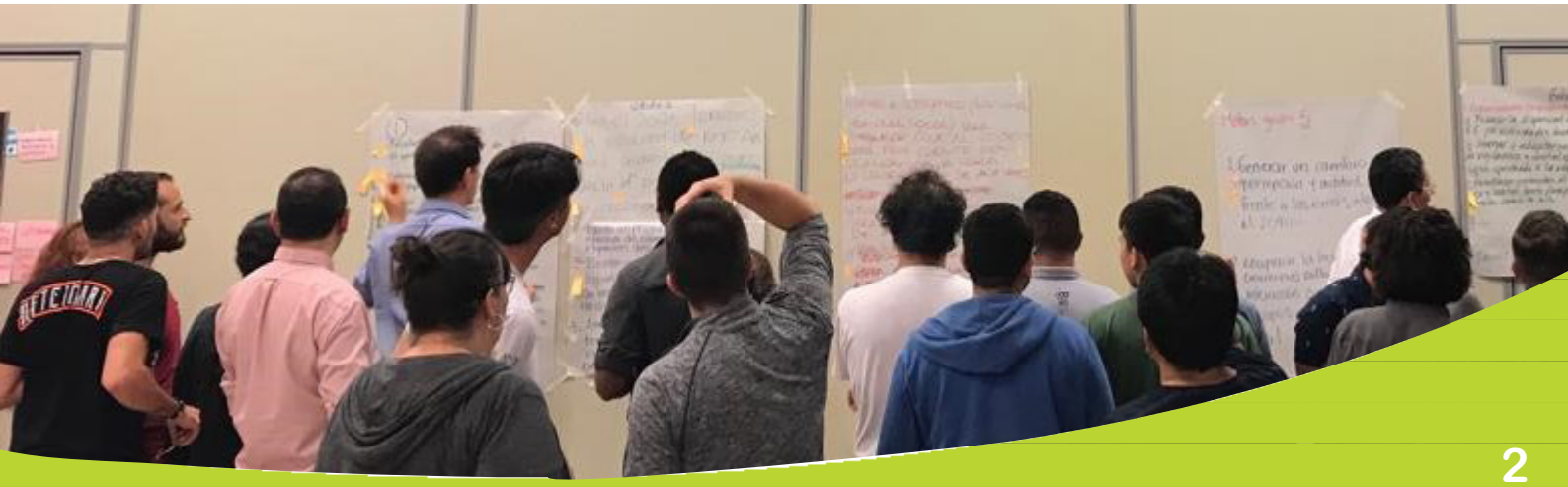
Atelopus Survival Initiative workshop, held in Colombia with representatives from range countries of *Atelopus*. Photo: Luis Carrillo.

Creating a common vision for *Atelopus*. Photo: Luis Carrillo.



Reintroduction trials of Harlequin frogs bred in captivity at the Panama Amphibian Rescue and Conservation Project

Blake Klocke

Smithsonian Conservation Biology Institute's Center for Conservation Genomics.

Many species of Harlequin frogs (Genus: *Atelopus*) have experienced catastrophic declines since the arrival of the amphibian chytrid fungus in Latin America. The Panama Amphibian Rescue and Conservation Project has secured populations of five Atelopus species in captivity. A sixth Panamanian species, the Chiriqui Harlequin frog (*Atelopus chiriquiensis*), has not been seen since 1996 and may be extinct. There is currently no method to remove the amphibian chytrid fungus from the environment for the long-term. The rainforests of Panama host a high diversity of amphibian species, and many persist in the presence of chytrid and act as disease reservoirs. At our field sites we find that 20-25% of the amphibians in the community are infected with chytrid – sometimes this number is as high as 45%, which may be due to seasonal variation in temperature and rainfall. Meanwhile habitat destruction continues to reduce viable habitat for some of the Panamanian *Atelopus* species and it's likely that climate change will further alter potential suitable habitat and chytrid dynamics.

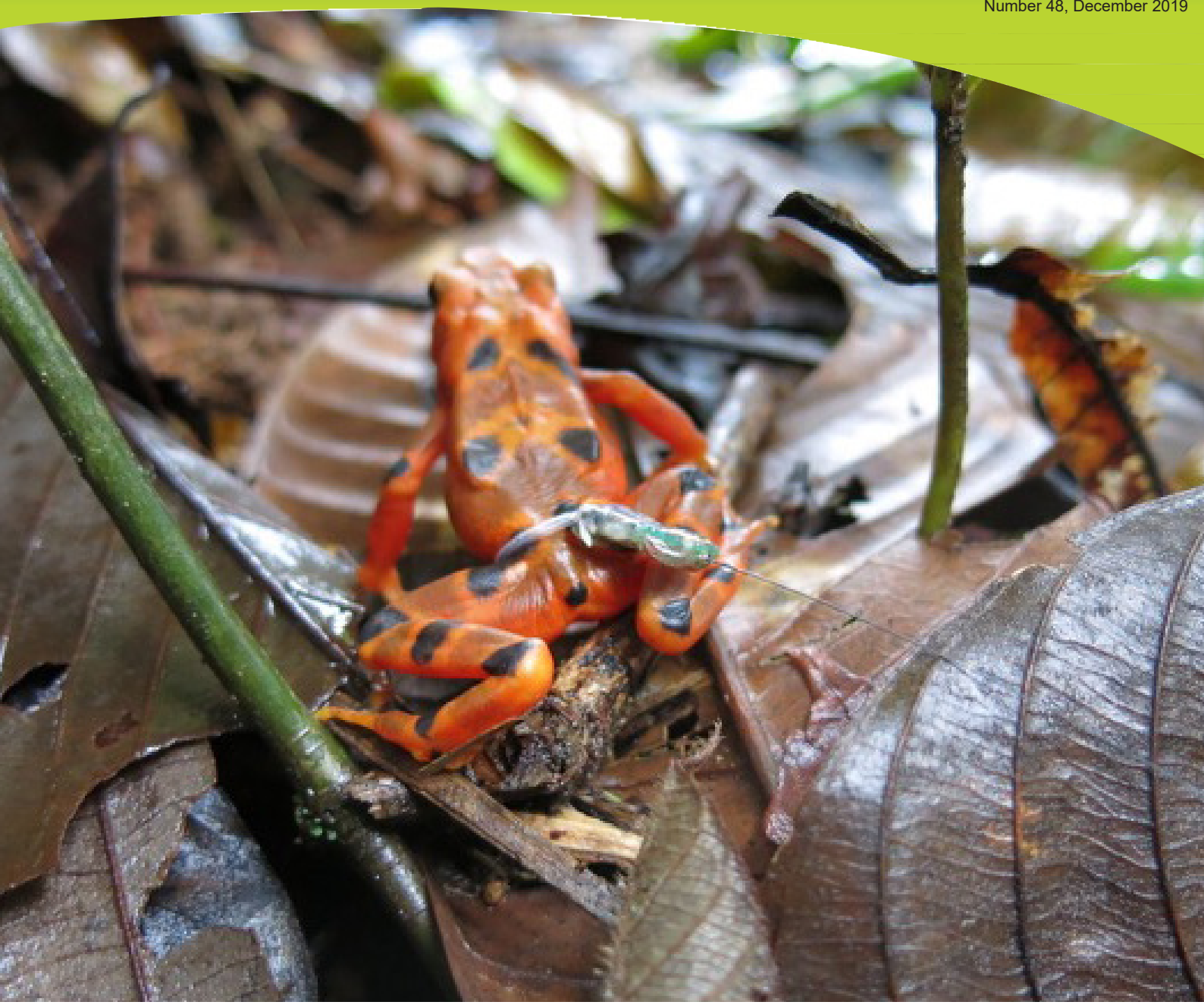
The prospects of reintroducing species highly susceptible to chytrid seem grim at best. Generally, threats that lead to the initial decline of a species are mitigated before reintroductions take place. However, there is reason to be optimistic: it was recently found that several species that initially declined when chytrid arrived in Panama have populations that may be recovering and increasing in resistance, including the Variable Harlequin Frog (*Atelopus varius*). The Limosa Harlequin frog (*Atelopus limosus*) also persists at some sites, but at populations much smaller than the pre-chytrid era. I think there is hope that one day we can produce frogs with some level of resistance to chytrid, or methods to mitigate chytrid will be developed.

With many surplus captive bred *Atelopus* at the Panama Amphibian Rescue and Conservation Project, we decided that it was time to start learning how to reintroduce *Atelopus* back into the rainforests of Panama. If we do not take these opportunities to learn, we risk being stuck in conservation paralysis with captive colonies of amphibians threatened by extinction. There is a lot to learn during reintroductions, and realistic goals need to be set to answer specific questions and improve methodology for the future, increasing chances of success. I will say this right now: a lot of unpredictable things can happen during a reintroduction and we have learned a lot during these trials.

Limos Harlequin frog (*Atelopus limosus*) with radio transmitter.
Photo by Blake Klocke

We have completed three reintroduction trials so far, two with the Limosa Harlequin Frog and one with the Variable Harlequin Frog. Our primary goals during these trials was to learn about the fate of these released frogs and how they are affected by chytrid post-release. We also collected data on the existing native amphibian community and environmental data. The primary methods we used were radiotracking, 'soft release' mesocosms, and mark-recapture surveys.

During all three trials we used small radio transmitters (Holohil LB-2X) to track the *Atelopus* post-release. Figuring out the best way to make a frog belt and get the right fit to attach the transmitter is a bit challenging, but important. We did not know how well the radio transmitters would work, but it turned about to be an incredibly useful method. We were able to follow individuals for up to fifty-two days in the rainforest post release – monitoring their distance moved, weight, chytrid status, and overall condition. Our average search time was about six minutes for 371 recaptures during the first release, and without the radio transmitters I am doubtful we would have found many of these individuals again. The number of predation events we observed during radio tracking was surprising; arachnids and snakes were responsible for these predation events. Predation related mortalities occurred before many individuals even became infected with chytrid or succumbed to it; this was one of the most unexpected lessons learned during these releases. For many individuals, they did not disperse far from the release location, which was



Variable Harlequin frog (*Atelopus varius*) with radio transmitter. Photo by Blake Klocke

very interesting. Sometimes heavy rainfall events would cause the frogs to move towards higher elevations. Overall, radio telemetry seems to be a very data rich method in amphibian reintroductions.

Mesocosms were used for 'soft' versus 'hard' release comparisons. A 'soft' release means that the animals have time to acclimate in an enclosure in the environment before being fully released, whereas a 'hard' release involves no acclimation time.

'Soft' release enclosures did have some benefits: they were easier to locate and monitor individuals in an enclosure, however they do have disadvantages too.

The 'soft' release period allowed for more time to be exposed to chytrid – our enclosures had holes small enough that adult *Atelopus* could not escape but small amphibians in the community could and did pass through. We did not expect to find native amphibians in these enclosures, but small Truando Toads (*Rhaebo haematiticus*) – many tested positive for chytrid - and Dendrobatids would make their way through. Additionally, we had a few snakes break into the enclosures and consume the *Atelopus* or ants would swarm the enclosure. We do think there are advantages in using these enclosures. The acclimation period may reduce stress, which may reduce the risk of the individual rapidly dispersing or being predated upon post-release. The enclosures are certainly a very cost-effective method. We are currently thinking of ways we can improve these mesocosms for the future.

The last method I want to talk about is mark-recapture surveys. We used mark-recapture during the first two reintroduction trials, and it was very ineffective for monitoring individuals. Recapturing enough animals after release was very challenging: trying to find a frog weighing four grams in the rainforest is equivalent to trying to find a needle in a haystack. After disappointing mark-recapture results during the first reintroduction trial, we heavily modified our methods to improve our results, but our luck didn't improve.

The reintroduction trials with these two *Atelopus* species provided a lot of information that will be important for future reintroductions. We want to investigate reintroducing different life stages in the future, as all these trials included adults or late juveniles. We are also exploring ways to return the skin toxins to these Harlequin frogs before releasing them, as this may reduce predation. We have learned a lot during these trials and although there is no solution to chytrid yet, there are many questions we can explore to ready ourselves (and the frogs!).

Thanks to Brian Gratwicke, Roberto Ibañez, Jorge Guerrel, Orlando Ariel Garćes, Elliot Lassiter, Heidi Ross, Mirjana Mataya, Jeff Baughman, Angie Estrada, and Daniel Medina for their help and collaboration.

Reintroducing Green Toads to historical sites; a collaborative effort between Nordens Ark and the County Administrative Board of Kalmar, Sweden

Kristofer Försäter, Nordens Ark Foundation, Sweden and Susanne Forslund, County Administrative Board of Kalmar, Sweden

The species

There is some debate as to whether the Green Toads in Sweden are *Bufotes viridis*, Dufresnes et al. (2019) or if they should be considered *Bufotes variabilis*, Stöck et al. (2006). However these two species have similarities as both are considered continental species that require warm summers and cold winters, with slight differences depending on local climate. They can be found in most of Europe with the south of Sweden being its northernmost range. In Sweden, toads are found on shoreline meadows and with shallow ponds in areas with high solar radiation that heat up early in spring as prime oviposition sites. They can also be found in areas with ponds in rocky cliffs surrounded by sandy grass and shrub-dominated areas. Historically, the species could be found in more than 100 sites in southern Sweden but it is now restricted to a handful of small and fragmented sites and considered to be the most threatened amphibian in Sweden. The main threat to the species is the continuing loss of suitable land habitat and spawning water where overgrowth, drainage and lowering of groundwater levels are amongst the most significant problems. Predation, disease and road construction also pose significant threats. Habitat restoration and reintroduction to historical sites are a highly priority and officially recommended in the Species Action Plan overseen by the Swedish Environmental Protection Agency.

Collaborative efforts

Once considered the most common species of amphibian on Öland, an island situated in the Baltic sea on the Swedish east coast, numbers drastically declined during the 20th century and was considered locally extinct on the island in the early part of this century. Nordens Ark and the County Administrative Board of Kalmar started work in 2003 by restoring habitat and releasing toads. This site was however declared unsuitable for further release in 2007 due to the number of predators that had colonized the area. The project relaunched again in 2009 and since then Nordens Ark and the County Administrative Board of Kalmar are working together to bring back the Green Toad to Öland.

Pair of green toads in amplexus in Limhamn limestone quarry. Photo: K. Försäter.

Habitats have been restored along the eastern shoreline with suitable ponds and land areas managed. These habitats also have positive effects on other animal groups such as wading birds and insects.

In total more than 14,000 toads and tadpoles reared at Nordens Ark have been reintroduced to three sites ranging from the southern tip of the island to the north eastern region. The aim is to establish a metapopulation and connecting the sites on the southern tip of the island with sites in the north. Even though the project has been running for 10 years the real success (besides the odd number of male toads calling each year) is yet to come. Only in the last three years have larger number of toads have been released and the hope is that this will ensure that more toads survive to breeding age.

Kristofer Försäter releasing tadpoles in to holding cages for the first few days in Högby hamn Natura 2000. Photo: Sandra Josefsson.

Captive breeding and rearing

Since Nordens Ark first got involved with the Green Toad project in 1995 the role has been to give a head start to small numbers (5 000-10 000) of eggs and larvae collected from stable wild populations. The main site used is a limestone quarry in Limhamn, Scania. Concerns have risen as to how well suited these animals are for release to the type of environment found on Öland and at what level these animals are inbred as there are no other sites in close proximity for gene dispersal.

One option is to use material from the other sites but since *Batrachochytrium dendrobatidis* (*Bd*) now is widespread within all the Green Toad populations in Sweden, except the one in the limestone quarry, that poses a large risk collecting eggs and larvae.

However, the other option would be to collect adult toads from different sites and bring them in to captivity and treating them for *Bd*, after which they could be used as a captive breeding group. Nordens Ark during the last two years developed a technique to breed Green Toads in captivity. This not only means we no longer have to collect material from the wild but also means we get even more eggs than before as each female can produce between 8,000 – 18,000 eggs.

Habitat restorations, managing and releases

As part of the EU Life funded "BaltCoast"-project, the County Administrative Board of Kalmar restored coastal habitats on the eastern shoreline. In late 2009 the first release of toads, reared at Nordens Ark, was carried out and 400 toads were released at Ottenby Natura 2000 on the southern tip of Öland. These toads, a mix of juveniles and adults, were released in October and males could be heard calling in May 2010. In the summer of 2010 newly metamorphed toads was found, proving that captive reared toads can reproduce and that the aquatic habitat is suitable for eggs and tadpoles. Since then an additional 6,000 toads have been released at this site. In 2012 the first toads were also released in the northeastern part of Öland, Högby hamn Natura 2000. This site was the last known place in which Green Toads lived before going locally extinct. And in May 2019 the first captive bred tadpoles, as part of a first trial, was released here. Newly metamorphed toads resulting from this release were observed in close proximity to one of the release ponds in late June the same year.

Over the coming years the county administrative board of Kalmar county is further expanding the range for green toads on Öland and restoring more habitats along the eastern shoreline by creating more shallow ponds and adding suitable winter brumation sites.

Future plans

There are uncertainties as to how related Green Toads in the different sites in Sweden are to one another, therefore a genetic study is a highly priority. Such a study will hopefully increase our knowledge of what are the most important sites in Sweden and possibly also neighbouring countries.

With the predicted low genetic diversity we get from the material of the one site used, there is discussion about the possibility of bringing in adult toads from other parts of Sweden. These toads, once declared free from *Bd*, should then form a more genetically diverse breeding colony at Nordens Ark and can then be used to produce offspring to be used for future releases.

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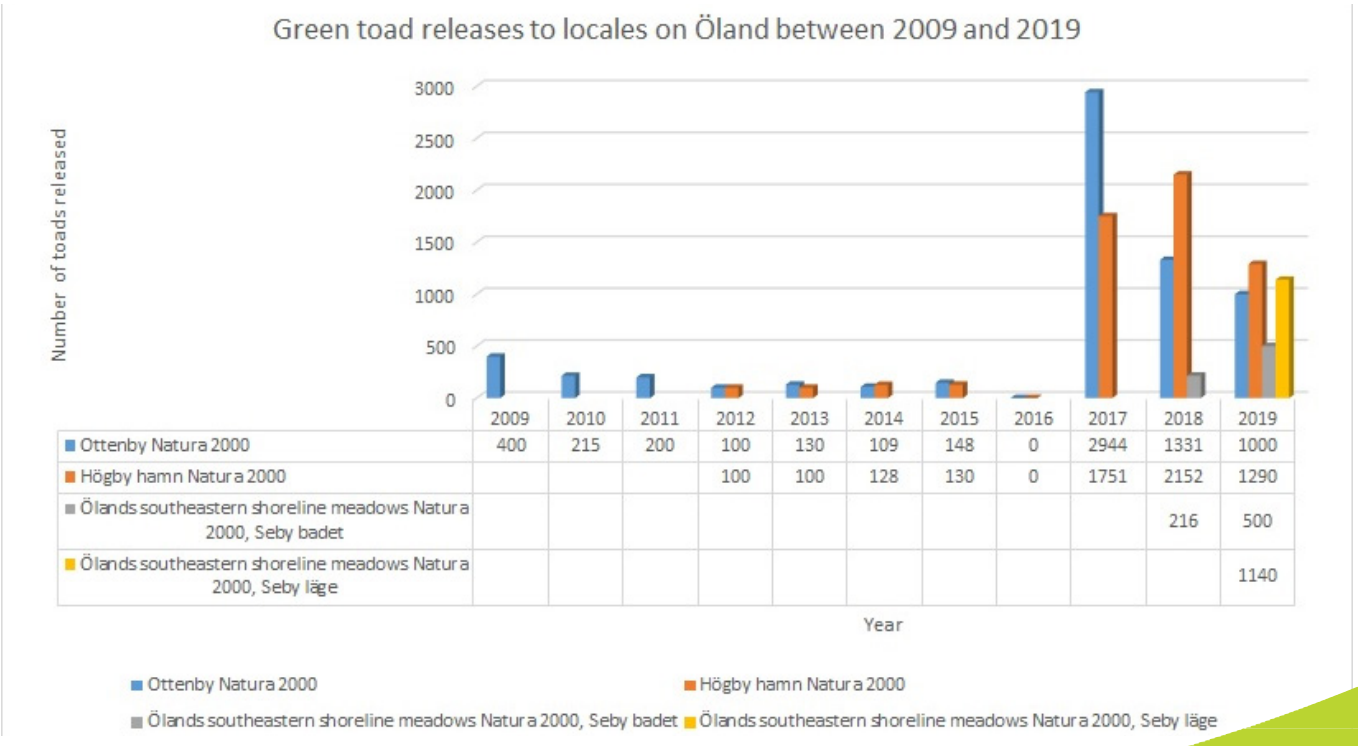
New pond in Högby hamn Natura 2000. Photo S. Forslund



Rediscovery of La Culata's Frog (*Aromobates duranti*), a critically endangered species

Enrique La Marca, Luis A. Saavedra C., and Gabriel Sánchez, Centro de Conservación REVA (Rescate de Especies Venezolanas de Anfibios amenazados), Mérida, Venezuela

History

La Culata's Frog (*Aromobates duranti*) was described in 1985 and a few additional specimens were deposited in museums until the end of that same decade. Subsequently it seems to have disappeared, judging by the absence of visual records or collections after 1990. We do not know what caused the decline or extinction of their populations, even though it is very likely that a set of factors acting in synergy are responsible for this debacle.

In the late 1980s the El Niño phenomenon created unusually dry periods in the Venezuelan Andes. These prolonged and successive droughts may have affected the reproduction and survival of amphibian species in the region. Climate change, reflected in rising temperatures, may have also contributed to the spread of an epidemic caused by the pathogenic fungus *Batrachochytrium dendrobatidis*, detected in several specimens of frogs from the Merida Andes captured at the end of the 1980s.

The range of La Culata´s Frog has also been greatly affected by the deforestation that wiped out virtually all the forests at the bottom of the Mucujún river valley, leaving remnants only towards the foothills of the surrounding mountains. The deforested areas were destined for rural use, livestock, agricultural and touristic activities. Crops have been a source of contaminants in the form of agro-toxic compounds that have affected the quality of the waters in the region. Irrational tourism activity and the mismanagement of solid waste in some sectors contribute to the degree of pollution in locations where populations of this amphibian were previously found.

Probable distribution area (yellow polygon) of La Culata's Frog in the Mucujun river basin, northeast of Merida, Andes of Venezuela.
Base image taken from Google Earth®

Rediscovery

Following a conservation program at the REVA (Rescue of threatened Venezuelan Amphibian Species) Center that received support from Amphibian Ark, we rediscovered La Culata's Frog in a small forested remnant with an extension of about 1,000m^2 in the sector called La Culata, in the Libertador District of the State of Merida, Andes of Venezuela. Searches in additional locations have not yielded positive results. It has been almost thirty years since the last time this frog was reported, which makes this finding an important discovery.

Adult female La Culata's Frog. Specimens of this endemic and threatened species can reach up to 32mm in total length.
Photo: Enrica La Marca.

There are still a few relatively pristine forest remnants where populations of the species may survive. In this sense, we believe that efforts must be concentrated in potential sites of the El Escorial mountain range, which have not yet been studied because of their relative inaccessibility. Towards the Sierra de La Culata the forests with suitable habitat for this amphibian have been almost completely destroyed. Surveys among local people revealed that in the recent past populations of this species were found in other places from which they have already disappeared. The available information indicates that the species has a distribution area of approximately 20km^2 in the Mucujún river valley, between the towns of La Culata and La Caña, framed between the Sierra de La Culata and the El Escorial mountains ranges. Towards the mountainous foothills, the upper limit of distribution is given by páramo environments. The lower limit is not well determined, especially because of the absence of records and the high degree of anthropogenic intervention in the area.

The population we located in the course of this project confirms that La Culata's frog survives in very disturbed remnants of cloud forest near the paramo limit. The recently discovered population lives in a freshwater spring under the shade of small trees and shrubs, with some introduced pines, with abundance of "curuba" (*Passiflora mollisima*), ferns and mosses; as well as common duckweed (*Lemna* sp.), invasive watercress *(Nasturtium officinale*) and sedges (*Cyperaceae*) that predominate in the aquatic environment. In the surroundings of the town, livestock, horticulture and tourism activities are developed, which have had a major impact on deforestation and pollution, the latter particularly with toxic agrochemicals.

Conservation status

Based on this finding and the new data collected, there is a need to re-evaluate the conservation status of the species, following the threat categories and criteria established by the IUCN. La Culata's frog is currently considered Endangered (EN) under category B1ab (iii) + 2ab (iii). In the Red List of Venezuela, it is listed as Insufficient Data (DD). The species has regional protection under the regulations of the Mucujún River Protective Basin, even if it is not under any strict protected area figure, such as a national park.

For this species we determined a geographical range with an extension of presence in continuous decrease and less than 100 km^2, severely fragmented, with an observed decrease in habitat quality and number of known locations (only three, two of them without current populations). Under these data, we suggest the following new category of threat to the species: Critically Endangered (CR) B1ab (i, iii, iv) + 2ab (i, iii, iv). More simply, it means that this species faces an extremely high risk of extinction in wildlife. It is an endangered animal that must be subject to studies and immediate conservation actions.

Virtually nothing is known regarding the natural history of La Culata's Frog. Our observations reveal that the species prefers humid and very shady places, under the shelter of vegetation and rocks associated with bodies of moving or relatively stagnant waters. In the field we have registered maximum temperatures of 18.3 ºC and minima as low as 10.1 ºC, with relative humidity between 81% and 58%. The data analysis based on a local weather station indicates that for the region of the Mucujún river valley framed between the towns of La Culata and La Caña, the mean annual temperature is 10.8 °C (with a minimum average of 6.7 °C and maximum average of 13.0 °C). Similarly, the rainfall record indicates an annual average of 1,430mm (range between 1,110mm and 1,742mm).

Ex situ program

We started an *ex situ* breeding project with a dozen specimens that we managed to catch. A few evaded capture. The species seems to be uncommon. In captivity we maintain three specimens for each glass terrarium with dimensions of 42 cm long, 30 cm wide and 34 cm high, with a simulated cloud forest environment. We try to keep one breeding pair for each terrarium. The determination of sex by visual examination is difficult. However, adult females have a bulkier belly and are larger than males; and the latter, when they reach reproductive maturity, develop a dark throat as opposed to the females that have them pale colored. Juveniles have a uniform yellowish or cream color.

The terrariums are kept in a cold room specially designed for the ex situ breeding colony, with air conditioning regulated at 16 ºC; The average water temperature

Humid montane forests in the Mucujun river basin, where *Aromobates duranti* lives.
Photo: Enrica La Marca.

in small internal ponds in the terrariums reaches to about 13 ° C. We provide artificial lighting with LED bulbs connected with a timer that simulates the natural photoperiod, and a 100W incandescent bulb that only lights during the hours close to noon. The relative humidity in the terrariums remains close to 80% average. The reproduction of the specimens in captivity has not yet been achieved; although on several occasions we have heard and recorded songs that males usually emit when conditions are darker as lights are turned off.

Some tadpoles caught in the field are developing well, feeding on fish food and prepared food that we have developed in REVA and that we have reported on previous occasions. As a complement to the feeding of the larvae and to provide shelter we have placed aquatic plants (*Elodea* sp. and *Vallisneria* sp.) previously treated for elimination of possible disease vectors. To generate the pH conditions closest to their natural habitat, where a certain amount of plant organic matter such as leaves and logs can be found in the water, we add leaves and cones of alder seeds (*Alnus* sp.) that tends to slightly acidify the water (which is beneficial in several respects, as aquarists know). Tadpoles do not survive at temperatures higher than 14 °C.

Some tadpoles have already metamorphosed and since then they demonstrate a voracious appetite and non-evasive behavior. They feed on fruit flies (*Drosophila melanogaster*) supplemented with calcium and minerals. Adults have secretive habits and maintain a varied diet consisting of fruit flies, flour larvae (*Tenebrio molitor*), juvenile little cockroaches (*Blatella germanica*), as well as larvae and adults of various species of beetles (*Tribolium castaneun*, *Stegobium paniceum*, *Sitophilus oryzae*, and an unidentified *Chrysomelidae* probably of the genus *Bruchus*). Occasionally they are given ants (not identified). In their natural habitat we have registered the following groups of invertebrates: harvestmen spiders, terrestrial and aquatic shelled snails (bivalves, gastropods), slugs, aphids, dipterans, moisture mealy bugs, prawns (little river shrimps), copepods, mayflies, caddisflies, cockroaches, ringed worms and planarians. The wild diet for the species has not been determined.

Future

We are carrying out some priority actions *in situ* in favor of the species, taking measures to prevent the degradation of the places where it currently lives and implementing habitat restoration actions. The first major effort in this regard was the cleaning of solid wastes that were present in the new site where we found the founder stock for the *ex situ* colony. An urgent measure would be the implementation of a habitat restoration and recovery plan, as well as reforestation with native species. These actions must be accompanied by an environmental education campaign with local people, which we have already started, that helps to raise awareness about the problems associated with this species.

As with other members of the genus, the main threat to La Culata's Frog is habitat loss. Possible remaining populations would be highly susceptible to specific stochastic threats (such as landslides, extreme drought events, deforestation, contamination by solid and liquid wastes, etc.), which can become a vicious circle of population decline that can lead to eventual extinction. In this sense, the *ex situ* breeding plan that we have implemented in REVA is one of the best immediate strategies that we conceive to address the conservation problem of this frog. The *ex situ* colony will serve for captive breeding purposes with the subsequent objective of serving as a source of frogs for introductions or reintroductions, and it is vital to ensure the future of the species.

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Baw Baw Bunker 2.0: conservation breeding program update

Deon Gilbert, Threatened Species Biologist, Zoos Victoria, and Damian Goodall, Amphibian Specialist, Melbourne Zoo, Australia

It's difficult to believe that this is the fifth Amphibian Ark Newsletter update on the Baw Baw Frog (*Philoria frosti*). Following previous achievements of the conservation breeding program (see newsletters 18, 26, 30 and 37) it seems fitting that this update highlights the establishment of a second captive facility. The wild population of the Baw Baw Frog continues to decline, largely driven by chytrid fungus. Importantly, the captive population is demographically stable with recovery objectives well on target. To facilitate increased reproductive output and mitigate genetic loss from an unexpected catastrophic event, a second facility was fabricated off-site and delivered to Melbourne Zoo (Australia) earlier this year where it was assembled. We have named this new facility the Baw Baw Bunker 2.0. It is now fully operational and functions independently of the original facility, with its own backup power and life support systems. Importantly, independent temperature and photoperiod schedules will allow us to experiment with optimising growth and development of the frogs, as well as reproductive output to meet conservation objectives.

Rearing habitat.
Photo: Damian Goodall.

The new facility addresses learnings made from the first facility with a redesign of rearing and breeding habitats to allow better filtration and more appropriate space for nest construction and egg laying. Both facilities are largely automated with open filtration systems and bioactive substrate and require very little husbandry maintenance apart from monitoring life support systems. In total both facilities house around 300 individuals of all age groups from one-year old juveniles up to breeding adults. There is plenty of room for the population to increase. In addition to the intensive indoor management we will be experimenting with outdoor habitats. Baw Baw Frogs naturally occur at sub-alpine elevations so providing those condition outside of their geographic range on-site at Melbourne Zoo, in a coastal city, has been challenging. The current outdoor habitats utilise deep thermal buffered substrate, shaded aviaries and chilled water pipes set below the substrate surface. This allows refuge sites to maintain temperatures cooler than 20 °C during extended Melbourne summer temperatures, which is below the critical thermal limit for the species.

Baw Baw Frog outdoor aviary - chilled water pipes.
Photo: Damian Goodall.

These outdoor habitats may provide a more efficient way of rearing optimal wild fit individuals for release and will be described in a future Amphibian Ark Newsletter.

At time of writing it is almost spring (in Australia), males will be establishing call sites in the coming weeks in preparation for breeding and we expect choruses in both fa-

cilities. Unfortunately such choruses are now rarely heard in their natural habitat. Female Baw Baw Frogs develop follicles pre-winter and typically lay during the October and November. Last year most of the gravid females deposited eggs in specially designed breeding tanks replicating natural seep lines, however fertility and egg survivorship was low and has given us yet another challenge to look forward to this season.

During the coming field season activities will concentrate on monitoring population transects, collection of unrepresented wild genetics and experimental reintroduction. Baw Baw Frogs have a unique life history where almost everything occurs underground: mating, egg laying, egg and larval development and metamorphosis, all in the absence of light. Then to make matters more complex eggs and larvae rely on an intimate relationship with undergrounded hydrology to complete development.

In 2018 we were able to create artificial oviposition sites and begin experimental reintroduction of captive laid eggs. The methodology appears sound with eggs able to complete development to metamorphosis, however the sample size was very small and needs to be more rigorously tested and will be a major component of this year's field work.

Despite chytrid still being a problem in some parts of the Baw Baw Frog historical range we are confident there may be large areas of environmental refuge limiting disease transmission and will focus our reintroduction strategies at these sites.

Captive laid Baw Baw Frog eggs.
Photo: Damian Goodall.

Of course, there is still a long way to go in the recovery journey of the Baw Baw Frog, but it's important to highlight the small wins along the way and stay positive when we are focused on such long-term biological time frames. It's my hope that it won't be me writing the update when we announce that the population has been recovered, but rather, I'll be sitting back toasting a glass of red wine reflecting on the hard work of the many that goes into threatened species recovery.

Baw Baw Frog outdoor aviary.
Photo Damian Goodall

Sharing people skills to develop amphibian husbandry in Papua New Guinea

Chris Banks, Zoos Victoria, Australia

Background

In AArk Newsletter 42 in March 2018, AArk readers were introduced to the long-term plan to future-proof frogs in Papua New Guinea against the likely impacts of the amphibian chytrid fungus. The article outlined a range of processes and activities that were underway or planned as part of the multi-faceted strategy, and arising from a meeting of all stakeholders at the Port Moresby Nature Park in PNG in December 2017. Many of the initiatives cited are progressing and the issue has since been taken to the wider conservation community through the publication of "Island of opportunity: can New Guinea protect amphibian from a globally emerging pathogen?" (Bower et al. 2019, in Frontiers of Ecology and Environment).

Developing husbandry capacity for PNG frogs

One of the important objectives recognised at the 2017 meeting was development of captive husbandry capability for PNG frogs at the Nature Park. Taking a proactive approach is critical, rather than trying to respond when chytrid reaches PNG and impacts native frogs. Establishing captive colonies is one response to declines in wild populations, to mitigate against species loss, but such *ex situ* capability has to in place.

The December 2017 meeting allowed identification of three priorities to initiate the first phase of *ex situ* support for PNG frogs:

- Develop staff expertise.
- Infrastructure that allows for growth in response to changing needs.
- Sustainable live food production.

The Sister Zoo partnership between Zoos Victoria and the Port Moresby Nature Park provides the framework for attending to the three priorities.

Significant strengthening of the Park's live food production has occurred over 2018/19, with a visit by Melbourne Zoo's invertebrate specialist, Kate Pearce. In addition to regular production of crickets (*Grylodes* sp.), mealworms, Giant African Land Snails *(Achatina fulica*), cockroaches (*Pycnoscelus surinamensis*), and an unidentified species of slater; some initial problems with raising grasshoppers/locusts have been overcome. The latter comprise Migratory Locust (*Locusta migratoria*) and two unidentified species of New Guinea grasshoppers.

In September 2019, Melbourne Zoo's frog husbandry specialist, Damian Goodall, spent a week sharing his expertise with the Park's frog and reptile keepers, Ryan Reuma and Dagie Solomon. The Park's first frog exhibit, and likely the first for PNG, was established in the Park's new reptile display, ie. two 12 m converted shipping containers with extensive interpretive panels.

A 1 m x 0.6 m x 0.6 m glass aquarium was fitted-out with filtration and irrigation systems, lighting to support live plants and meet the frogs' UV requirements, and natural landscaping to highlight the frogs to Park visitors. A major focus was ease of maintenance and recording climatic parameters, e.g. temperature and humidity. The exhibit's first inhabitants, White-lipped Tree Frogs *(Litoria infrafenata*) and Green Tree Frogs (*Litoria caerulea*) have settled in well. Further displays for Cane Toads (*Rhinella marina*) and Water Frogs (*Rana daemeli*) as additional display aquariums become available in 2019/20. These four species were chosen for their availability (they all occur on the Park grounds), and their general adaptability to captivity. They also allow the Park's keepers to develop their skills with species that exhibit different behavioural and ecological characteristics.

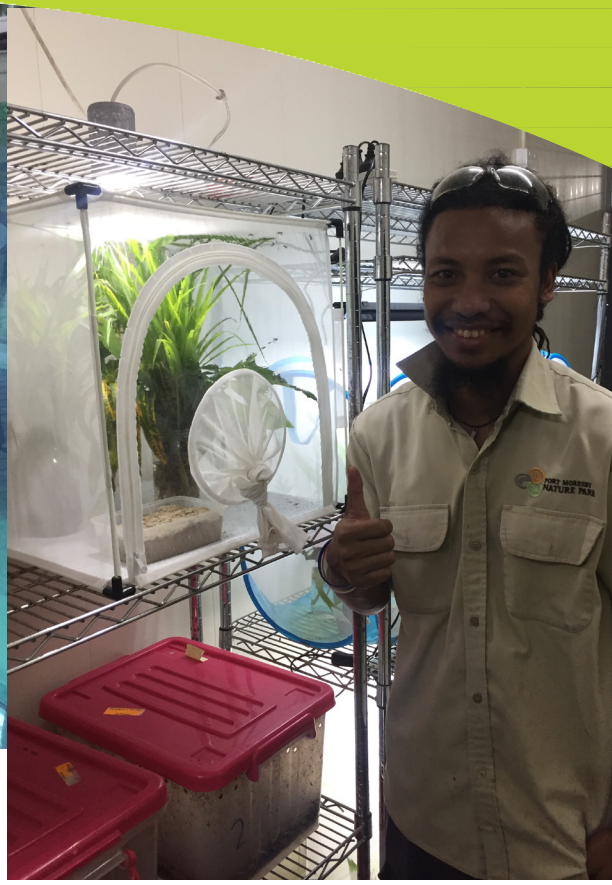
Establishing the display was underpinned by two workshops on frog husbandry and facility maintenance for the Park's Life Science staff, and complemented by installation of off-exhibit tanks for tadpoles and metamorphs. Damian also worked with the Park's keepers to review invertebrate husbandry and implement improvements.

Much of PNG's frog fauna comprises small species with poorly known captive needs, ie. the large number of microhylids. Initiating husbandry capacity for these species is the next phase of the *ex situ* program and will be considered once husbandry skills at the Park are suitably developed. Detailed assessment of which species should be considered for this phase was undertaken at an AArk Conservation Needs Assessment at the Nature Park in July 2019. The outcomes of the CNA workshop will be presented once analysis of the results is completed.

Ongoing sharing of staff expertise and passion is at the core of the ZV-PMNP sister zoo partnership, which has facilitated visits by almost forty staff across the gamut of operations at the two zoos. Most recently, the Park's Ryan Reuma was able to spend a week with Melbourne Zoo's Ectotherm Department. This came at an ideal time to allow Ryan to

Ryan Reuma-Dougie Solomon-Damian Goodall at Nature Park frog exhibit. Photo: Damien Goodsall.

Dougie and Ryan preparing the frog exhibit.
Photo: Damien Goodsall.



Ryan: success with raising grasshoppers.
Photo: Damien Goodsall.

further his training and see firsthand the operations of Melbourne Zoo's amphibian conservation recovery facility, gain a solid understanding of high quality welfare practises, and reinforce learnings to benefit live food production at the Nature Park.

As captive husbandry develops at the Nature Park, it will also support other research and advocacy aspects of the over-arching program to ensure a future for PNG's frogs.

Port Moresby Nature Park exhibit for Green Tree Frogs and White-lipped Tree Frogs.
Photo: Damien Goodsall.

Amphibian Translocation for Conservation Symposium

Luis Carrillo, Training Officer, Amphibian Ark

Many amphibian populations have been decimated in the wild and many others are fragmented. This means that colonizing suitable habitat is almost impossible, due to the inability of many amphibian species to move long distances.

Translocation is a primary tool in the conservation toolbox, and often requires the help of captive breeding programs as a source of animals. Reintroduction in conjunction with threat mitigation and habitat protection should be one of the major goals of almost any comprehensive amphibian conservation program. To be successful, program managers should properly plan their programs.

Reintroduction and supplementation have become more relevant to amphibians due to the continued population declines for many species. However, we still need to better understand the different factors that affect the success or failures of amphibian reintroduction programs.

This online symposium was designed to allow speakers and participants to learn from each other's successes and failures, receive new and unpublished information and learn from the experiences of other projects so it could help to better design their own reintroduction protocols; avoid unsuccessful practices or strategies; and connect with amphibian management experts and other program managers from different regions of the world.

The symposium was divided into four blocks:

Theoretical framework

Habitat management / restoration

Reintroduction program examples

Post-release monitoring.

Thirty-three speakers representing zoos, aquariums, government, and universities from Europe, Australia, USA, Africa and Latin-America composed the faculty.

A total of 80 participants registered for this online symposium. The following tables summarize participant's information. There were attendees from:

USA	LATIN AMERICA	CANADA	EUROPE	ASIA
31	24	4	3	1

Attendees were from these organisations:

ZOOS	UNIVERSITIES	MUSEUMS	NGOs	GOVERNMENT
20	6	2	8	4

An assessment was sent after each block, and a final assessment was complete at the close of the whole symposium.

The following information summarizes the general symposium assessment:

- 89% of participants felt overall satisfied to very satisfied

- 85% of participants felt the symposium was useful to very useful professionally to them

- 89% of participants said they gained new skills/understanding with the information presented during the symposium

- 82% of participants said the symposium helped broaden their mind about *ex situ* amphibian conservation planning

- 93% of participants said the symposium encouraged them to try new approaches toward amphibian conservation work

- 86% of participants said program and symposium content were suitable to their needs

- 93% of participants said they would recommend this symposium to a colleague

Some of the participants provided some feedback about the symposium:

> "The course was extremely relevant to my field of work, created many new ideas to apply, and answered questions I had regarding other programs."
>
> "I liked this symposium because there were many specialists who have worked in reintroduction and have a lot of experience and shared valuable information from many places in the world and all in just one click away."
>
> "A great symposium with excellent speakers on a topic that is increasingly becoming more important for conservation biologists."
>
> "I really like the course. To me it was modern and new way to win experience. I saw people of different countries that they work with amphibians with many effort."
>
> "I hadn't known much about AARK before I attended the Amphibian Translocation Symposium, and I could not be more impressed. I gained so much new and relevant information that I can use in my recovery plans."
>
> "I found the symposium very useful and I am looking forward to sharing the information I gained with my colleagues at the zoo and on the recovery team."

Videos of the symposium will be available online early in 2020.

Establishing connections between people and nature, dissemination and environmental education actions to assist the Water Frog of Lake Titicaca

Jhazel Quispe, Verónica Choquehuanca, Gariz Riveros and América Machaca, "Association for Environmental Science and Development, Natural Way", Peru.

'Science and Education for a Sustainable Tomorrow!' is the motto of the Association for Environmental Science and Development, Natural Way. We are a nonprofit organization that has worked in the Puno Region in southern Peru since 2017 seeking to guarantee the continuity of nature in this region.

One of the three areas in which we work we call impact education. Our objective is to change minds through experiences held outside the classroom. We also carry out environmental education works, to influence people and encourage their involvement in the conservation of the environment. Our work is based on the premise: 'you don't want what you don't know, and you don't take care of what you don't want'. We organize and participate in events where we raise awareness of environmental problems such as loss of biodiversity. We focus on species such as the Critically Endangered Titicaca Water Frog (*Telmatobius culeus*). Despite it being endemic and fulfilling an important role for the Lake Titicaca ecosystem this species is very poorly known in the Puno region of Peru. This article describes our work in 2019.

Painting activities (Lake Titicaca, Rana and Zambullidor), at the Real Plaza Shopping Center. Photo: Gluberth Ramos.

At our first event at the beginning of March, we organized a Scientific-Cultural Conference called: Frog, the Protective Giant of Lake Titicaca. This was held in the city of Puno. During the conference, we presented our research and conservation results from 2018. We were seeking to bring about behavioural change in the lives of the North Perka community, so that the Titicaca Water Frog and local biodiversity might be protected and enhanced. We are supported by organizations such as Denver Zoo, Hatun Ñakaj, Municipality of Puno and The Red Ford Center. Jeff Reichert and Farihah Zaman, environmental filmmakers from the Red Ford Centre, conducted a video conference from New York - USA, to talk about their film "Nobody Loves Me" in which the main character is the Titicaca Water Frog. This film was first shown

publicly in the city of Puno. More than sixty audience members spoke with Jeff and Farihah. One of the discussion points was that people provide protection for animals that are considered the most adorable, but are people as likely to provide protection for those species that are considered less attractive? Should only the cute survive?

This was our second consecutive year organizing “Earth Hour” in the city of Puno. We were supported by WWF-Peru and the Municipality of Puno. The event was held in the busiest park in the city: Parque Manuel del Pino. Other organizations involved included WCS-Peru, CLIP, Titikaka Kuntur, and the Environmental University Network of the San Carlos University and Universidad Nacional del Altiplano - UNA Puno. The event featured the Titicaca Water Frog and the Keñola Diver (*Rollandia microptera*). Both species are currently threatened, and they were key to the call for the reconnection of nature and people. The event included music, photography and videos.

In May we were invited by the Municipality of Capachica to conduct training in Ecotourism and Sustainable Development for the community of Yapura. All families participating learned about the environmental and socio-economic benefits involved in the conservation of the Lake Titicaca ecosystem. There was a specific focus on the protection of endangered species. We shared positive global and local stories, including that of the Titicaca Water Frog, and how as a focus species it helps achieve great opportunities for sustainable development.

Recently, we have been involved in a seminar: Conservation of Andean amphibians. There was a focus on perspectives of environmental and scientific education, and approach to forest wildlife legislation. The event was organized by SERFOR (Peruvian National Forest and Wildlife Service) and supported by institutions such as Denver Zoo and RANA Group. We presented several papers including ‘Conservation and Sustainable Development: Hand in hand with the Titicaca Water Frog. There were more than sixty attendees.

We celebrated the World Environment Day (June 5) with a workshop: Life in Titicaca. We collaborated with Real Plaza, and the event took place in the food court of the busiest shopping center in the city of Juliaca. Children from ages 3 to 11 years, and their parents, carried out activities including painting the Lake Titicaca ecosystem. There was a focus on both Titicaca Water Frog and the Keñola Diver. The children made a toy frog of recyclable material and learned about Lake Titicaca and its two endangered species.

In our final event in the first half of the year, we again joined SERFOR which had organized a photographic exhibition called Knowing the Titicaca Giant Frog: the story of an amphibian in danger of extinction. More than twenty photographs were presented, each one showing a different aspect of the species. The focus was mainly on its threats and the different conservation advances that are being made. We also conducted guided tours explaining in greater depth each of the photographs. This made the event more dynamic and participatory for the more than 130 people who attended the event.

The sum of these activities over six months is something that had not been seen before in the Puno Region. As we focused upon the Titicaca Water Frog, we are sure that we encouraged more people to get involved in the conservation of the Titicaca Water Frog specifically, and Lake Titicaca in general. If you want to know more about our work please follow us on Facebook: NaturalWay – PERÚ. If you want more information, please write to nwa.peru@gmail.com.

Knowing the Titicaca Water Frog, the Story of an Amphibian in Danger of Extinction. Photo: Jhazel Quispe.

Amphibian Ark donors, November 2019

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