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FrogLog

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Promoting Conservation, Research and Education for the World's Amphibians

Love at First Squeak

Protecting a "Sky Island" of Cloud Forest for Threatened Amphibians

Raising the Next Generation of Amphibian Aficionados

... and so much more!

Gravid female Arthroleptis troglodytes. Photo: Francois Becker.

FrogLog

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Editorial

Dear FrogLoggers,

I joined the Amphibian Survival Alliance (ASA) in July of last year, and have since been very fortunate to learn about many new and remarkable initiatives conserving amphibians all over the world. During this time, I have met a great many passionate people, and have been hugely enthused by the strength and commitment of the ASA partnership, and our fantastic colleagues in the IUCN SCC Amphibian Specialist Group (ASG) and Amphibian Ark. Amphibians have been a considerable preoccupation of mine for a long time. Following years of admiring them from afar (and often up close as well), I started working on global amphibian conservation efforts over 10 years ago. I began by coordinating the Zoological Society of London's EDGE Amphibians programme, which works to conserve some of the world's most evolutionarily distinct and threatened species, including the mighty Chinese giant salamander and secretive Sagalla Caecilian. I followed this with a Ph.D. that focussed on improving the impact of amphibian conservation through developing the use of scientific evidence to guide management interventions. During this time, I also worked as a Programme Officer for the ASG. I therefore thought I had a reasonable knowledge of amphibian conservation efforts, but it has been wonderful to learn every week about new projects and organisations that are devoted to developing a better future for amphibians.

Following a year of events that have rocked the world several times over, it is perhaps a comfort to know that some things remain unchanged. Amphibians are still amazing. More specifically, frogs are still *fantastic*, salamanders are still *splendid*, and caecilians are still, well, limbless…and ex-*ceptional*. Although these incredible species continue to need our help more than ever, it is also comforting to know how many people out there want to ensure that amphibians thrive in our shared world. This bumper double issue of *FrogLog* explores the important issue of captive breeding for conservation purposes, and also (fittingly enough for Valentine's Day) examines many fascinating approaches to sharing love and appreciation for amphibians.

As we unite to implement the Amphibian Conservation Action Plan globally, we must continue to tackle key threats and management issues that help improve our ability to effectively conserve amphibians. Furthermore, there is much we can learn from one another. So many threats are linked, and so many management actions demand a thorough understanding of multiple stressors to the survival of amphibians.

We hope that you will learn a lot from this issue, and feel assured of the great passion and skill driving action across the amphibian conservation community. Wishing you a very happy Valentine's Day full of love for amphibians everywhere!

Helen Meredith
Executive Director

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Great Smokey Mountain National Park. Photo: Daveallenphoto | Dreamstime.com.

A Unique Partnership to Protect the Salamanders of the Great Smoky Mountains

By Kate Williams & Julie Thorner

An interview by Kate Williams, CEO of 1% for the Planet with Julie Thorner, President and Founder of Liquid Spark, Inc., a member of 1% for the Planet since 2014 and Amphibian Survival Alliance Partner and Corporate Sponsor.

Photo: Julie Thorner.

TELL US A LITTLE ABOUT YOU AND ABOUT LIQUID SPARK.

I am a multi-lingual citizen earth guardian, marketing entrepreneur and adventure parent with a past that includes being a river guide, whitewater kayaking instructor and bike tour guide. I've worked extensively within corporate America and even on Wall Street, and definitely prefer the outdoor recreation and adventure travel and tourism industries. I founded Liquid Spark to help inspire the general public to enjoy outdoor adventures through providing marketing services to adventure companies. Running my own agency gave me the critical flexibility to parent my kids and choose who I wanted to work with – our tribe of fellow outdoor enthusiasts. Liquid Spark's mission is to create practical marketing that inspires adventure, action, and stewardship of people, place, and planet. I am also a marketing educator with the Adventure Travel Trade Association (ATTA) and do volunteer marketing consulting to Tibetan responsible tourism entrepreneurs.

WHAT CHANGE DO YOU WANT TO MAKE IN THE WORLD?

I really want to help encourage a shift in mindset that spurs tangible action. If we all choose to step up and be part of solutions – instead of just complaining about or giving up on – problems, we can make a real difference. Dare I say, we can change the world. Taking baby steps is an overstated cliché, but it is wickedly understandable and it works. My 1% involvement is my shift in citizen mindset to guardian action.

WHAT ENVIRONMENTAL ISSUES ARE YOU MOST CONCERNED ABOUT?

Watershed protection and clean water for the entire ecosystem. Liquid Spark's name draws from the importance of water (liquid) as both the spark of life and the spark of inspiring fun (paddling, skiing, etc.). I am inspired by work that can be cogently linked to direct human benefits and tangible progress because that is how we sell our fellow humans on the importance of participating in this work. Without participation at the individual and organization level, we can't succeed. I fear too many people can't relate to an individual species issue, like a rare salamander going extinct, but they can relate to a well-drawn comparison that connects salamander extinction to clean water to human survival, for example. Hearing about riparian stream bank protection isn't nearly as helpful as learning that the riparian eco-zone is the key to supporting animals with food and shelter across the food chain.

WHAT BRINGS YOU THE GREATEST HOPE?

The fact that we already have the technology and understanding of how to power the planet on 100% renewable energy sources, and that action is coming from individuals and smaller organizations who are demanding change through taking action themselves.

WHY DID YOU JOIN 1% FOR THE PLANET? HOW DOES 1% FOR THE PLANET HELP YOU ADDRESS YOUR CONCERNS AND HOPES?

My agency became a 1% for the planet member because I wanted to "walk my talk" to my kids. I was constantly telling my sons how important it is to contribute to the environmental solution and not just wail about problems. I felt that my efforts at recycling, using only eco-friendly cleaners and buying organic products were a good start, but still surface solutions. Contributing my small agency's hard earned income off the top line to an organization that could double my impact or more, was the hardest thing I could think of to do, so I did it. Money talks, and I wanted my money to support my beliefs.

HOW AND WHY IS YOUR 1% FOR THE PLANET MEMBERSHIP VALUABLE TO YOUR BUSINESS?

I believe that business can and should be a reciprocal force for good for people, place and planet. For me, my agency's 1% membership is the glue that binds my belief and makes it real. Liquid Spark's annual donation to our partner the Amphibian Survival Alliance (ASA) was used to start a seed grant to do the first ever ASA-amphibian protection project here in the Great Smoky Mountains. ASA had projects all over the world, but none in the USA or the Great Smoky Mountains, which is an International Biosphere Reserve. It was really important to me to try to use our 1% donation to impact local projects, if at all possible. Reaching out and working with then director of operations James Lewis at ASA, we were able to come up with a way for the Liquid Spark donation to fund a seed grant for work in the Smokies to study Bsal, a newly described fungal pathogen that is causing declines of some European salamanders and species and has the potential to significantly impact North American salamander populations. James really understood and valued that I wanted to put my agency's dollars to work locally – and he and his team created this new project with local on the ground partners to meet my goals, while meeting ASA's goals. I was absolutely thrilled.

I believe that as adventure companies we have an additional responsibility to protect the environment because we use it to generate our income – through outdoor adventures. I want to help encourage other adventure companies to continue to step up as participating solution seekers and not be ruled by fear of financial scarcity. Does my 1% membership contribute to my business success? I ask a different question: how can my 1% membership inspire my adventure clients to join in and be active stewards beyond the sustainability basics? That's reciprocal business success.

ANYTHING ELSE YOU'D LIKE US TO KNOW?

I wanted to share our 1%er story with you, in the hopes that it will motivate and inspire other small companies to step up with their non-profit environmental partners to create a truly reciprocal relationship through the 1% for the Planet program. Every dollar counts! Our donation was able to provide seed money for a much larger, first ever ASA conservation effort in the Smokies. So I really want to encourage other small companies that you can make a difference, and asking the questions for how can this work impact your "backyard" is a perfect example of the power of grassroots 1% activism. I like to now say I am a proud 1%er, not the elite 1% income group kind, but the inclusive, citizen activist businessperson kind!

ABOUT 1% FOR THE PLANET

1% for the Planet is a global organization, leading a network of businesses, nonprofits, and individuals working together for a healthy planet. Launched in 2002 by Yvon Chouinard, founder of Patagonia, and Craig Mathews, former owner of Blue Ribbon Flies, our network consists of more than 1,100 member companies and thousands of approved nonprofit partners in more than 40 countries. Brands whose products and services feature the 1% for the Planet logo give 1% of sales annually to nonprofit organizations dedicated to a healthy planet. Our members have given more than $150 million back to the planet since 2002. Look for our logo and visit www.onepercentfortheplanet.org to learn more.

Public Outreach Campaign to Promote Awareness of the Illegal Trade and Consumption of the Lake Titicaca Frog, *Telmatobius culeus*

By Roberto Elias, James Garcia & Matt Herbert

Since the end of last year, Denver Zoo, with the support of other institutions (Reserva Nacional del Titicaca, Gobierno Regional de Puno and the IUCN SSC Amphibian Specialist Group), is collaborating with the Municipality of Lima and the Technical Forest and Wildlife Management of Puno (Administración Técnica Forestal y de Fauna Silvestre de Puno, or ATFFS-Puno) in a campaign to promote awareness about the illegal use of the Lake Titicaca Frog (*Telmatobius culeus*) in medicinal extracts. The campaign in Lima has begun with the development of banners (Fig. 1) that are displayed in the waiting area where people apply for their public health license to be able to work in the food business (Fig. 2), and in some events organized by the municipality, such as health campaigns. The campaign highlights the possible public health issues that could be caused by the consumption of this species (in a research study three species of bacteria of the genus *Vibrio* were isolated from *T. culeus*), without detracting from the fact that it is Critically Endangered in both national legislation and in The IUCN Red List of Threatened Species and its use is illegal. In addition, in Puno, posters have been printed (Fig. 3) and are being distributed by ATFFS-Puno in different bus terminals in the Puno region, where potential traffickers use them to transport these amphibians. Furthermore, Denver Zoo will be placing these posters in high schools, centers of study, hotels, etc., around the city of Puno.

Fig. 1: Banner with a public health warning advising against frog extract consumption due to the presence of harmful bacteria.

Fig. 2: Waiting area. Photo: Hector Bezada - Municipalidad de Lima.

Fig. 3: Poster appealing to the Peruvian pride for the species: "Help us to conserve our natural heritage. NO to the traffic and trade of our Titicaca Frog!"

Adult male of the threatened toad *Melanophryniscus montevidensis* from southern Uruguay. Photo: M. Beheregaray & R. Maneyro.

New Red List of Uruguayan Amphibian Species

By Raúl Maneyro[1], Santiago Carreira[1,2] & Luis Fernando Marin da Fonte[3]

The amphibian diversity of Uruguay includes 48 species (*1*), distributed in two orders (Anura and Gymnophiona) and 8 families. In addition, at least four populations of the exotic invasive species American Bullfrog (*Lithobates catesbeianus*) have been recorded in the country (*2*, *3*). The conservation status of the Uruguayan amphibians has been previously assessed in several opportunities. One of the first works (*4*) used an index (*5*) based on natural history features and on the geographic range of the species.

Although some following popular publications about the Uruguayan fauna (*6*) have also assigned conservation status to the taxa, using the categories proposed by IUCN (*7*), at that time the authors based the assessments on the subjective "expert criteria." Since 2000, however, the Sociedad Zoológica del Uruguay, along with the Uruguayan Committee of IUCN, leads a process to provide the herpetologists with the tools to conduct evaluations using the standardized criteria of IUCN.

The first workshop gathering experts took place between 2000 and 2002, but the results were published just several years later (*8*). Therefore, when the list was finally issued, many amphibian assessments were already out-of-date: taxonomic changes (such as synonymizations) have been made, new taxa have been described and many species were registered for additional localities in the country, expanding their geographic range. For all these reasons, and taking into account that the application of the IUCN Red List criteria at the regional level has changed in the last years, a new evaluation of the conservation status of the Uruguayan amphibians species should be done.

The new assessment process started in 2013 and followed entirely the IUCN guidelines, categories and criteria (*7*). All native amphibian species known for Uruguay to date were evaluated. Based on bibliographic sources and distributional data gotten from scientific collections (such as of Facultad de Ciencias de la Universidad de la República and Museo Nacional de Historia Natural de Montevideo), preliminary categories were assigned to each taxon. After, when necessary, specific adjustments were made based on personal observations.

After this preliminary evaluation, 65 herpetologists with expertise in Uruguayan species were invited to take part in the process (which was carried out along with the reptiles assessment); half

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Melanophryniscus devincenzii **(considered as Endangered national and global level) exhibiting aposematic coloration. Photo: M. Beheregaray & R. Maneyro.**

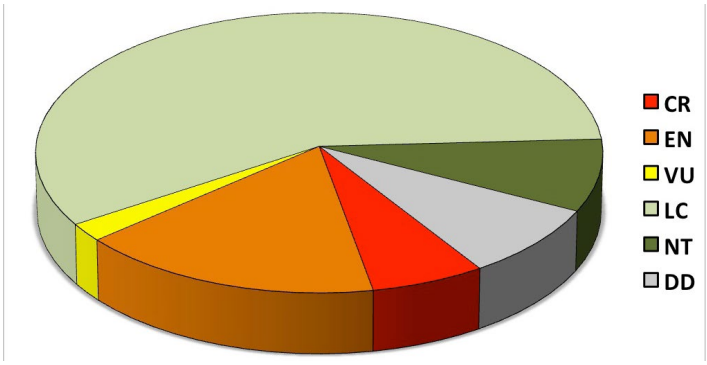
of them were herpetologists living in Uruguay, and the rest were specialists working in academic institutions in neighboring countries (mainly Brazil, Argentina, and Paraguay). Each invited expert received instructions about the evaluation process and access to a web page with the preliminary assessment, thus being able to make comments, additions and corrections.

The authors of the preliminary list received and incorporated the suggestions, and then prepared a final version of the Red List. This version was again shared with all contributors, and after was sent to three external reviewers (herpetologists with expertise in conservation assessments using the IUCN criteria and the Program's Senior Officer of IUCN South America Office). After corrections, the document was submitted to the Uruguayan national authority (the Dirección Nacional de Medio Ambiente, an office of the Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente), which approved it without modifications. Later on, the Red List of Amphibians and Reptiles of Uruguay was distributed, both as a printed book (given priority to NGOs, academic institutions, and national or regional authorities) and as an electronic publication (*9*).

Of the 48 native amphibian species of Uruguay, 28 species were categorized, at the national level, as "Least Concern" (LC = 57.0%), four as "Near Threatened" (NT = 8.2%), one as "Vulnerable" (VU = 2.0%), eight as "Endangered" (EN = 16.3%) and three as "Critically Endangered" (CR = 6.1%), totaling 12 taxa (25%) assigned to any threat category (Fig. 01). Four taxa were considered "Data Deficient" (DD = 8.2%) and the American Bullfrog (*Lithobates catesbeianus*) was not evaluated ("not applicable"), since it is an exotic species in Uruguay (*9*).

The 28 species assigned to the category LC at national level are in the same category at global level (*10*). On the other hand, six other species that were globally assigned to the LC category were considered to be threatened in Uruguay (mainly because they have a very narrow extent of occurrence and/or just historical records in the country). Five of these species were considered EN (*Dendropsophus minutus*, *Dendropsophus nanus*, *Lysapsus limellum*, *Scinax nasicus* and *Physalaemus fernandezae*), and one CR (*Leptodactylus furnarius*). Finally, three species assigned to the LC category at global level were considered DD at national level (*Hypsiboas albopunctatus*, *Leptodactylus podicipinus* and *Physalaemus cuvieri*).

Among the threatened or near threatened species at global scale, only two taxa retained the same category at national level: *Melanophryniscus langonei* (CR) and *Melanophryniscus devincenzii* (EN). The rest showed some differences: *Melanophryniscus montevidensis* (global = VU, national = CR), *Melanophryniscus pachyrhynus* and



Percentage of species that inhabit Uruguay in each of the IUCN categories (*Lithobates catesbeianus* not included). References: CR - Critically Endangered, EN – Endangered, VU – Vulnerable, LC - Least concern, NT - Near Threatened, DD - Data Deficient.

Scinax aromothyella (global = DD, national = EN), *Ceratophrys ornata* (global = NT, national = VU) and *Argenteohyla siemersi* (global = EN, national = DD). Among the NT species at national level, two were also considered NT at global level (*Melanophryniscus sanmartini* and *Pleurodema bibroni*), one LC (*Rhinella achavali*) and the other (*Odontophrynus maisuma*) was not yet evaluated at global scale.

Of the 12 threatened amphibian species of Uruguay, three taxa deserve special attention. One of them is *Melanophryniscus langonei*, a little toad endemic from Uruguay that was recently described (*11*) and it is known only from less than five localities. Its extent of occurrence is smaller than 15 km^2 and all the known sites that it inhabits are natural fields that were artificially forested with *Pinus*. Additionally, climatic models predict a future loss of about 10% for the suitable habitats for this species, with the major part of such loss in Uruguay (*12*). This taxon is listed as CR not only al regional level, but also globally (*13*).

Another species of particular concern for conservation is the "Escuerzo" (*Ceratophrys ornata*), a big and very conspicuous toad, which occurs from southern Brazil to Argentina. In Uruguay, there are historical records of its presence in the sand shores of Rio de la Plata and the Atlantic Ocean (*1*). Despite being a very noticeable animal, its last record in the country was more than 30 years ago (in 1982), in a sand beach in the Rocha Department. Although it might be considered an extinct species in the country, it is difficult to assert, since there were no significant specific efforts to search for it. Therefore, this species is considered as VU in Uruguay (globally NT) and there is still a little hope that may exist some relictual populations in remote locations.

Finally, it is worthwhile to make a brief mention about *Melanophryniscus montevidensis*. Historically, this species was distributed across the southern Uruguay region, from Montevideo and San José to Rocha Departments, and there were some recent records in the southern Brazilian Rio Grande do Sul State. Since it is a habitat specialist species, instead of the "Extent of Occurrence" (EOO) criteria, it was possible to use the "Area of Occupancy" (AOO) criteria. For its assessment, we used historical records deposited in scientific collections and evaluations of the suitable habitats for the species. As a consequence, the AOO was found to be lower than 10 km^2. According to recent studies (*12*, *14*), this will be one of the species most impacted by climate change, with predictions that the suitable habitats for its occurrence in Uruguay can disappear in only few decades. Moreover, other anthropic actions, such as habitat fragmentation and depletion, appear to negatively affect the populations of this amphibian.

The elaboration of the Red List of the Uruguayan Amphibian Species allows us to draw some conclusions, and thus help policy makers to promote the conservation of the herpetofauna in the country. One of these conclusions is that the fragmentation of natural habitats appears to be one of the major threats for both amphibians and reptiles. Since they are animals with reduced ability to move (low vagility), they have difficulties to modify their home range or, in the case of amphibians, to change their reproductive sites when unexpected events occur.

Urbanization, especially on the coasts, causes significant habitat alterations that prejudice the normal dynamics of amphibian and reptiles populations. These disturbances include modifications in the natural characteristics of the environment, the loss of suitable habitats for foraging, reproduction or refuge and the decrease in water quality, among others.

Even so, some measures can be adopted to mitigate such negative impacts. First of all, the assessments of the conservation status of Uruguayan wild species should be regularly updated. This must be an essential part of the national conservation policy. Furthermore, efforts must be made to develop a National Action Plan for Uruguayan amphibians and reptiles, in order to set priorities and to allow the establishment of concrete conservation actions for species and populations. Along with this Plan, and having in mind that many of the data used in the evaluations came from scientific collections (and hence do not necessarily reflect the current situation), it is necessary to keep doing fieldwork, in order to increase the knowledge about the biodiversity and its current situation in Uruguay.

Finally, environmental education actions are very important to raise awareness among local people. It is essential that people understand the importance of these vertebrates, if we expect them to join the efforts for conservation. In this sense, a documentary about the natural history of amphibians and reptiles from Uruguay was recently released (*15*). This kind and other complementary initiatives, such as the publication of books with popular language about Uruguayan amphibians and reptiles (*1*, *6*, *16*), will help interested citizens to have a first approach to these fascinating creatures.

Acknowledgements:

We are grateful for all the people that contributed to the original publication Lista Roja de los Anfibios y Reptiles del Uruguay: scientists, collaborators, reviewers and various authorities. We are also in debt to all the people who share unpublished information and personal observations.

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Amphibians in the November 2016 update of The IUCN Red List of Threatened Species

By Kelsey Neam[1,2]

The mission of the Amphibian Red List Authority (ARLA) is to provide accurate and up-to-date information on the extinction risk of all amphibian species known to science. Following the November 2016 IUCN Red List update, 2,012 amphibian species have up-to-date IUCN Red List assessments, constituting over twenty-six percent (26.5%) of the 7,586 amphibian species currently recognized by Frost (*1*). A summary of the 121 assessments published in the November 2016 IUCN Red List update is described below.

GEOGRAPHIC EXTENT

Amphibian species published on the IUCN Red List (version 2016-3) have been submitted by nine ARLA Working Groups or regional Amphibian Specialist Group (ASG) members: East Africa, Madagascar, Mainland Southeast Asia, Mesoamerica, Mexico, Southern Africa, Sri Lanka, West and Central Africa, and West and Central Asia (Fig. 1).

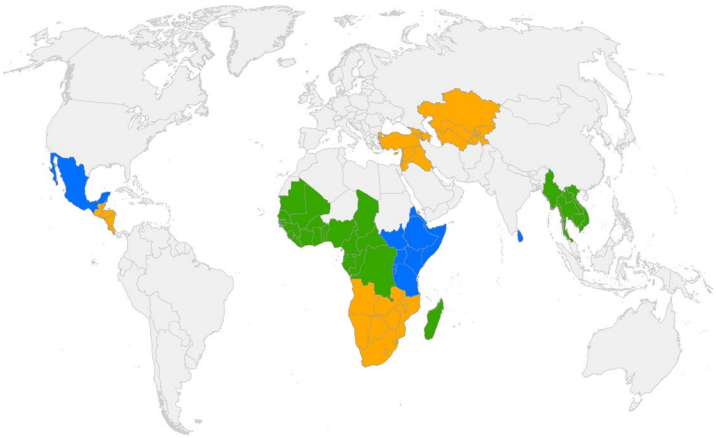

Fig. 1: Geographic scope of the ARLA Working Groups and regional ASG members that have published assessments in the November 2016 IUCN Red List update.

Additional assessments from these and many other ARLA Working Groups and regional ASG groups are in the process of being updated. Assessments that passed review following the August 2016 submission deadline will be published in the June 2017 update, so be on the lookout for further news!

LEVEL OF THREAT

The IUCN Red List is a global standard for assessing the conservation status of species. The main purpose of the IUCN Red List is to document, catalogue and highlight the species facing the highest risk of global extinction, specifically those in the three threatened categories: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU).

Species classified as Least Concern (LC) comprise the greatest proportion of the assessments published in the November 2016 update (50.4% or 61 species). Also considerable is the proportion of species in a threatened category (39.6% or 48 species), including three species tagged as 'Possibly Extinct' (CR(PE)) (Fig. 2). These figures are significantly higher than those of amphibian species globally, in both LC (38% or 2,485 species) and threatened (31.7% or 2,068 species) categories, at the end of 2016 (*2*).

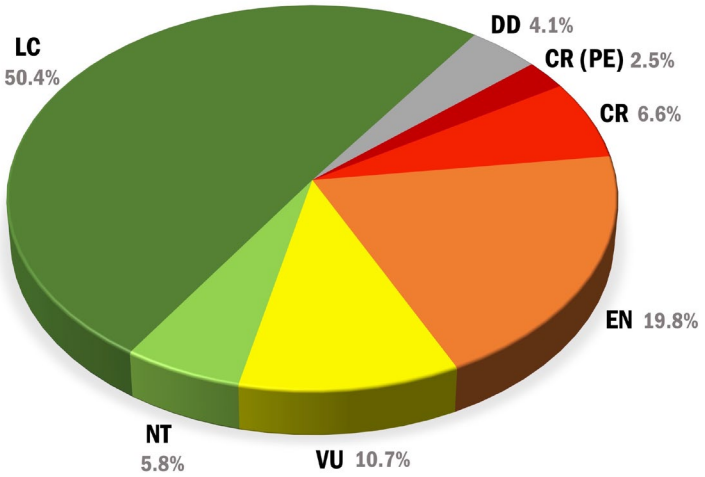

Fig. 2. Proportion of the 121 species assessments published in November 2016 IUCN Red List update in each category. Three species were assessed as CR(PE), however no species were assessed as Extinct (EX) or Extinct in the Wild (EW).

Most notably are the criteria triggering the threatened assessments. All 48 species assessed as threatened met the quantitative thresholds for Criteria B, either in the form of B1 and/or B2, as well as the Subcriteria b(iii). Thus, continuing decline in the area, extent and/or quality of species' habitat was a universal theme of the November update.

CATEGORY CHANGES

Of the 121 assessments published in November 2016, 13.2% (16 species) were first-time assessments. The remaining 86.8% (105 species) were re-assessments from previous years, including many that had not been re-assessed since the comprehensive amphibian assessment (Global Amphibian Assessment) completed in 2004 (*3*). Among these were 11 species (9.1%) that were uplisted (*i.e.*, moved to a higher category of threat), 24 species (19.8%) that were downlisted (*i.e.*, moved to a lower category of threat), 15 species (12.4%) that were deemed to now have sufficient information and were removed from the category Data Deficient (DD), and 55 species (45.5%) that remained the same category as their previous assessment (Fig. 3). Where change occurred, more species have moved to lower threat categories than to higher categories, however all category changes are because of non-genuine reasons (*i.e.*, new information, taxonomic revision, improved knowledge of the criteria, or incorrect data used previously) rather than genuine changes in extinction risk. A list of all the category changes for all species on the IUCN Red List is made available after each update on the Summary Statistics page of the website (*4*).

We continue to make progress towards our goal of updating all amphibians on the IUCN Red List. The ARLA relies on valuable research from around the world to provide new and improved information for amphibian species. The accomplishments thus far are largely because of the dedication and efforts of the ASG members

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who volunteer their time, including the ARLA national and regional coordinators, assessors, contributors, and interns, as well as the support of the ARLA partners. Our sincere gratitude is extended to all who have been and continue to be involved!

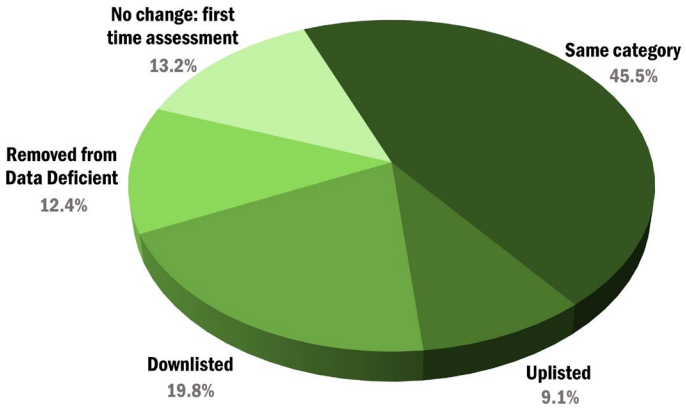

Fig. 3. Changes in IUCN Red List category for assessments published in the November 2016 IUCN Red List update.

We welcome any questions about the results, assessments or our strategy. If you have data or knowledge to contribute to an assessment, we would appreciate your input!

Discover additional information on the species highlighted in this article among thousands of others at: www.iucnredlist.org.

Mark Scherz of Zoologische Staatssammlung München catches us up on the 20 Madagascar amphibians included in the November 2016 IUCN Red List update, while Dr. John Measey, Alex Rebelo and Dr. Jeanne Tarrant of the South African Frog Re-assessment Group (SA-FRoG) fill us in on the conservation status of the 21 amphibian species from southern Africa.

SPOTLIGHT ON MADAGASCAR

Mark D. Scherz

Almost all 313 of Madagascar's currently described frog species have now been re-assessed or assessed for the first time since the ACSAM2 (A Conservation Strategy for the Amphibians of Madagascar) meeting in Madagascar in 2014. Most recently, twenty species, including two species described in 2016, were re-assessed. The majority of these are LC, because prioritization led to the least threatened species being re-assessed last. Among these LC species are twelve *Mantidactylus* species, a genus of mostly nocturnal frogs that tend to be found in the vicinity of flowing water. These frogs typically having rather wide distributions that preclude their listing in higher threat categories, and may also be tolerant to quite significant deforestation, though not in all cases.

Fig. 4: The Savaka Diamond Frog (*Rhombophryne savaka*), described in June 2016, was recently assessed as EN because of its restricted range and ongoing habitat loss. Photo: Mark D. Scherz.

Of great interest to international stakeholders will be the new statuses of two *Mantella* species, Madagascar's poison dart frogs. *Mantella laevigata* was downlisted from Near Threatened (NT) to LC, while *M. haraldmeieri* was uplisted from VU to EN. Both of these changes have more to do with the way that the IUCN Red List Categories and Criteria are applied than changes to our knowledge of the species, which has been a distinct trend throughout the re-assessments of Madagascar's frogs. Two new species of *Rhombophryne* described in 2016 from Madagascar's north east were published in the November 2016 update as well, both of which are assessed as Endangered due to their small distributions inside forest that is disappearing rapidly.

SPOTLIGHT ON SOUTHERN AFRICA

By Alex Rebelo, John Measey and Jeanne Tarrant

The Southern African Frog Re-assessment Group (SA-FRoG) met in November 2015 with 16 representatives from Angola, Malawi, South Africa, and Zimbabwe, whose combined expertise on amphibians is considered to cover the entire region. During the workshop, 70 southern African species were assessed, and 21 of these have been officially updated in November. Of these, 13 did not change their status, six were downlisted and two uplisted. None of these represented genuine changes, but rather changes in data availability.

For example, Pickersgill's Reed Frog, *Hyperolius pickersgilli*, has been downlisted from CR to EN based on an increase in survey and research effort since 2008. This has extended the previous range to the north and south of known sites, reaching a new total of 25 sites for the species. However, most of these sites are in unprotected areas. Furthermore, the development of a Biodiversity Management Plan (BMP-S) for *H. pickersgilli* has resulted in active management at several unprotected sites and at least one site has been acquired for long-term protection and several others have plans for future habitat protection action. In addition, monitoring protocols have been developed and employed at several sites to provide sub-population estimates and monitor impact of conservation interventions, such as removal of alien vegetation.

Uplisted from EN to CR was the Northern Moss Frog, *Arthroleptella subvoce*, for which 10 years of monitoring data show extreme fluctuations in abundance estimates that demonstrate the vulnerability of sub-populations to fire. Of concern is the increasing frequency of fires in the region coupled with the slow ability of this species to recover. Lastly, the Cave Squeaker, *Arthroleptis troglodytes**, was last seen in 1962 from high elevations of the western Chimanimani Mountains in eastern Zimbabwe. This species remains listed as CR(PE), as recent survey efforts have failed to find this species at its only known locality. Availability of locality data for South Africa enables increasingly accurate assessments for most of its 125 species, but assessments for species occurring in other countries continue to be hamstrung by data deficiency.

Fig. 5: Pickersgill's Reed Frog *(Hyperolius pickersgilli)* has been downlisted from CR to EN as a result of an increase in research efforts. Photo: Nick Evans

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**Arthroleptis troglodytes* has since been rediscovered in Zimbabwe (see page 15).

Twenty-five Percent of Known Amphibian Species are up-to-date on The IUCN Red List of Threatened Species

By Jennifer Luedtke

As of 30 June 2016—the date of the Spring 2016 IUCN Red List update—1,891 amphibian species will have up-to-date assessments on The IUCN Red List of Threatened Species (IUCN Red List), up from 1,386 in June 2015.

In other words, of the 7,520 species recognized by Frost (1) a little over twenty-five per cent (25.15%) of amphibians have an IUCN Red List assessment that has been published between 2010 and 2016. Of course, this percentage is constantly shifting as new species are described every week and will also change when the Autumn IUCN Red List update is published in November this year.

This achievement is in no small part due to the tireless efforts of the Amphibian Specialist Group members who volunteer their time —the Amphibian Red List Authority (ARLA) regional and national coordinators, assessors, contributors, and interns—and the support of the ARLA partners. A big heartfelt thank you to everyone who has been and continues to be involved!

Another factor pushing up the number of assessments published is an increase in the ARLA's capacity in the form of dedicated Program Officers. Thanks to the generosity of new partners, Trento Museum of Science, Global Wildlife Conservation and Texas A&M University, three full-time Program Officers now work alongside the ARLA Coordinator, Jennifer Luedtke

Photo: The ARLA Program Officers: Louise Hobin (Bath, UK), Elena Garollo (Trento, Italy) and Kelsey Neam (Austin, USA).

Below is a summary of the assessments published in the November 2015 and June 2016 bi-annual IUCN Red List updates.

REGIONAL SPREAD

Species published on the IUCN Red List over the last twelve months have been submitted by fourteen ARLA Working Groups or regional ASG members: Amazonian Basin, Argentina, Chile, East Africa, Ecuador, Japan, Madagascar, Mainland Southeast Asia, Mexico, New Zealand, North America, Panama, Southern Africa, West and Central Africa.

Many more assessments from these and other Working Groups are in various stages of being updated. Assessments that have passed review between the March and August submission deadlines will appear in the November 2016 update, so stay tuned for more news!

LEVEL OF THREAT

The main purpose of the IUCN Red List is to document and highlight the species facing the highest risk of global extinction, i.e. those in the three threatened categories: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU).

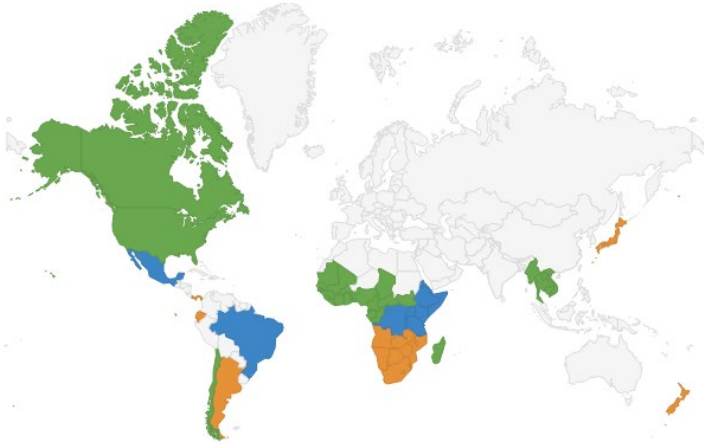

Figure 1: Map of ARLA National and Regional Working Groups and ASG groups that have published assessments in the November 2015 and January 2016 IUCN Red List updates.

The greatest proportion of the 505 species risk assessments published in the November 2015 and June 2016 updates are Least Concern (237 species or 46.9%). However, the percentage of species in a threatened category is far from insignificant, coming in at 42.4% (214 species) (Graph 1). These figures are both higher than the global ones for amphibian species in the LC (2,427 species or 37.6%) and threatened (1,994 species or 30.9%) categories at the end of 2015 (2), both good and bad news.

In addition, not visible on Graph 1 are the four Critically Endangered species that have now been marked with the flag "Possibly Extinct" (PE):

- *Rhinoderma rufum* and *Telmatobius pefauri*, endemic to Chile,
- *Arthroleptides dutoiti*, an endemic of Mount Elgon on the border between Kenya and Uganda, and
- *Pseudoeurycea aquatica*, endemic to Mexico.

This flag has been developed to identify Critically Endangered species that are likely to already be Extinct (or Extinct in the Wild), but for which confirmation is required. While it is currently not possible to search for these species on the IUCN Red List, a list of all PE species is available on the website (3).

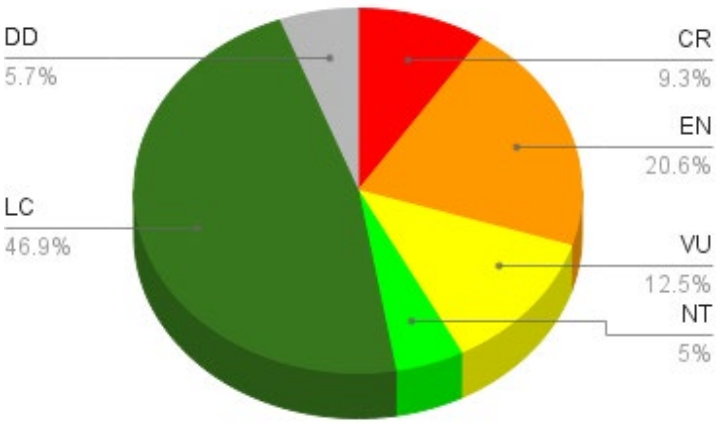

Figure 2: Percentage of the 505 species assessments submitted for the Autumn 2015 and Spring 2016 IUCN Red List updates in each category (no species were assessed as Extinct (EX) or Extinct in the Wild (EW).

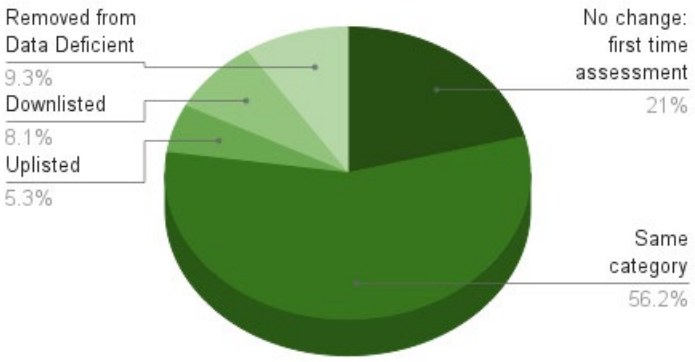

Figure 3: Changes in the IUCN Red List category for the assessments published in the November 2015 and June 2016 IUCN Red List updates.

REASONS FOR CHANGE	
Genuine - population increase	1
Genuine - increase in severity of threats	1
Nongenuine - range extension	16
Nongenuine - range contraction	1
Nongenuine - EOO/AOO recalculation	36
Nongenuine - taxonomic change	9
Nongenuine - incorrect calculation of AOO	1
Nongenuine - incorrect prediction in population decline	1
Nongenuine - incorrect assessment of threats	3
Nongenuine - incorrect use of criterion D2	2

Figure 4: Reasons for change for the 68 species that changed IUCN Red List category when reassessed in 2015 and 2016. N.B. Of the 68 species that changed IUCN Red List category, 65 have one reason for change and three species have two non-genuine reasons for change.

Photo: *Leiopelma hamiltoni*. Paddy Ryan.

REASONS FOR CHANGE

Of the assessments published since June 2015, 21% (106 species) were first-time assessments for recently described species.

However, the remaining 399 were re-assessments from previous years. Among these are 68 with a changed Red List category, 47 that were deemed to now have sufficient information and were removed from the category Data Deficient (DD) and 284 that remained the same category as their previous assessment (Graph 2). A list of all the category changes for all species on the IUCN Red List is made available after each update on the Summary Statistics page of the website (4).

The IUCN Red List database, the Species Information Service (SIS), allows assessors to record the reason a species changes category. The Guidelines supporting the IUCN Red List provide three valid reasons for a change in category; these are:

- Genuine change: a genuine improvement or deterioration in the species' status.
- Non-genuine change (i.e., status changes due to new information, improved knowledge of the criteria, incorrect data used previously, taxonomic revision, etc.).
- Error: the previous listing was an Error.

Of the species addressed in this article, only two species changed category for a genuine reason and the remainder changed category for non-genuine reasons.

Of note are the two species that changed category because of a genuine change in their circumstances. Hamilton's Frog, *Leiopelma hamiltoni*, in New Zealand was "downlisted"—or moved to a lower category of threat—from Endangered D1 to Vulnerable D1+2. This is due to an increase in the species' population thanks to targeted conservation actions, including a successful translocation of the species from Stephens Island to Nukuwaiata Island.

Unfortunately, *Rhinella atacamensis* from Chile was "uplisted" from Least Concern to Vulnerable A2ac. The threats of extensive droughts and water pollution, abstraction of surface water (both for human consumption and for agricultural use), mining, agriculture, livestock farming and timber plantations have increased in severity such that local extinctions have been recorded.

Find out further details on these two species and the others addressed in this article at www.iucnredlist.org.

Please feel free to get in touch should you have any questions about the results, assessments or our strategy. If you have data or knowledge to contribute, we would love to hear from you.

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3. http://cmsdocs.s3.amazonaws.com/summarystats/2015-4_Summary_Stats_Page_Documents/2015_4_RL_Stats_Table_9.pdf
4. http://www.iucnredlist.org/about/summary-statistics

AMPHIBIAN RED LIST AUTHORITY

Sinkhole Squeaker (*Arthroleptis troglodytes*). Photo: Francois Becker.

Love at First Squeak: Scientists Re-Discover Tiny Lost Frog Species in Zimbabwe

By Lindsay Renick Mayer

For herpetologist and self-proclaimed "frog guy" Francois Becker, laying eyes on a frog lost to science for five decades was a moment of pure joy, not so unlike the jolt of adrenaline that comes with being hit by Cupid's arrow.

"Of the big moments in my life, this one is pretty close to the top," Becker says. "This is probably one of the biggest African frog-finds in the past few decades. A lot of people have been looking for this species for a long time. Many people thought it was extinct."

THE SEARCH FOR THE SQUEAKER IS ON

It took Becker and his team a full year to plan the December 2016 expedition to Zimbabwe's Chimanimani Mountains, funded by the Mohamed bin Zayed Species Conservation Fund. The trip was meant to be a last-ditch effort to look for the Sinkhole Squeaker (*Arthroleptis troglodytes*), which was last seen in 1962—the year it was discovered in sinkholes on the eastern side of the mountain range. Becker, who is a master's student at the University of Cape Town, says he anticipated that they would return empty-handed like the many previous expeditions.

It wasn't until after the first grueling day of digging through sinkholes and clambering through deep caves in search of the small frog, which is no bigger than a bottle cap, that hope arrived in the form of a distant and peculiar whistling call. Becker was out on a moonlit walk while the rest of the team cooked dinner at camp when he heard the first call and suspected right away that the squeaky call belonged to a frog species in the *Arthroleptis* genus. It took him 45 minutes to track the source, but when he finally got eyes on the individual, Becker says he knew immediately that he had done what many expeditions before him had failed to do: re-discover the elusive Sinkhole Squeaker.

It was love at first squeak.

"The closer I got to the call, the more I was convinced that this had to be it," Becker says. "When I finally narrowed my search down to a small patch and saw the frog hopping, there was no doubt. I had seen the museum specimens and knew what it looked like. When I grabbed the frog, my hands were shaking so badly from excitement that it got away and jumped into a deep crevice."

Becker persevered and was able to track down another individual shortly before midnight. "I couldn't return to camp empty-handed," Becker says. He ran back to camp, frog in hand, triumphantly shouting to his team—Zimbabwean entomologist Scott Herbst and two Outward Bound guides, Fungai Marema and Tor Simonson. He didn't sleep much that night, he says, and immediately called his supervisor, his wife Tessa, and colleague Robert Hopkins, an associate researcher with the Natural History Museum in Bulawayo, who had launched several expeditions since 1999 to look for this frog.

Finding the species was especially significant for Hopkins, who was a close friend of Don Broadley, the herpetologist who discovered the species in the 1960s. Broadley died just months before this rediscovery. Broadley was "the greatest herpetologist in the world," Hopkins told the Zimbabwean.

TAKING THE SQUEAKER ROAD LESS TRAVELLED When Becker and his colleagues planned the expedition, they intentionally planned to be in the field during the rainy season when the frogs would be active and likely calling.

And according to Becker, the chorus of calls indicated a healthy population of tens or hundreds of squeakers, clearly breeding successfully. Unlike many other frog species, frogs in the *Arthroleptis* genus experience direct development, skipping the tadpole stage and hatching as mini adults.

Becker and his team focused on mapping the species' distribution, collecting data about its habitat and describing the frog's unique call. They also collected four individuals, three males and one female, which they transferred to Hopkins' lab at the Natural History Museum to become part of a breeding program. According to Hopkins, the frogs are doing well so far, feeding well and living in a terrarium that mimics their natural habitat as closely as possible.

The breeding program, which aims to someday be the source of additional wild populations placed in suitable habitat, is only one important step in the conservation of the species, which the IUCN Red List has most recently classified as Critically Endangered (Possibly Extinct). Even though the population Becker re-discovered is in a protected area in a national park, it is limited to a small area, four or five acres at the most, making the species particularly vulnerable to any sort of habitat change or destruction as the result of extensive fires, climate change, illegal mining or increased forestry in the area.

As such, Becker recommends that the IUCN Red List continue to list the species as Critically Endangered, and Hopkins is working with Zimbabwe's National Parks Authority to help ensure the habitat remains intact and to prevent any illegal collections by private individuals. Hopkins is aiming to establish a research and monitoring program for the wild populations in the future.

SQUEAKER AMORE

Not long after Becker snapped photos of the three Sinkhole Squeakers the team brought into captivity, Becker's wife Tessa pointed out the two heart-shaped markings on the back of the tiny female frog. It seemed an appropriate emblem for a re-discovery that can only be described as an extraordinary labor of herpetological love.

And if it is love and passion and hope that drives scientists to search for the seemingly impossible, then Becker seems to be brimming with the sense of possibility as he shares his tale of re-discovery. Ultimately, he says he is now confident that the Sinkhole Squeaker has a bright future.

"This species has been there all this time, without human intervention, and it has been fine," Becker says. "As long as we can help keep its habitat intact, I'm hopeful the Sinkhole Squeaker will never be lost again."

Female Sinkhole Squeaker (*Arthroleptis troglodytes*) Frog with two heart-shaped markings on her back. Photo: Francois Becker.

Chucantí Salamander. Photo: Abel Batista.

Land Purchase in Panama Helps Protect a "Sky Island" of Cloud Forest for Threatened Amphibians

By Guido Berguido, Lauren Colegrove, Carlos R. Garcia & James P. Lewis

Cerro Chucantí Nature Reserve in Panama has been expanded by 260 acres and safeguards critical habitats for newly discovered species, thanks to Asociación Adopta el Bosque Panamá (ADOPTA), Rainforest Trust (an Amphibian Survival Alliance Partner) and the International Conservation Fund of Canada (ICFC) and other supporters.

Three land properties were purchased to establish an important buffer zone that will act as a barrier to prevent squatters from moving into extensive public wilderness areas and to discourage poachers from hunting in the vicinity.

"This initiative that first started with the purchase of 100 acres of rainforest has grown to almost 1,500 acres of rainforest that we're protecting now," said Guido Berguido, Executive Director of ADOPTA. "With the help of Rainforest Trust and the International Conservation Fund of Canada, we have increased its conservation value."

Cerro Chucantí, an isolated massif or "sky island" in eastern Panama, rises from sea level to 4,721 feet in elevation and sustains a diverse cloud forest and other adjacent tropical forest ecosystems. The closest peaks with similar elevation and vegetation are found at least 90 miles away. The geographic isolation of the Cerro Chucantí mountaintop has allowed its flora and fauna to differentiate considerably, such that it contains a number of locally endemic rainforest species found nowhere else on Earth.

Cerro Chucantí is home to many species new to science, and there is a high potential for many more to be discovered. In 2008, the dark brown Chucantí Salamander (*Bolitoglossa chucantiensis*) was discovered in this area. In addition, a new frog species called Maje Dink Frog (*Diasporus majeensis* sp. nov.) and a new snake species called the Chucantí Centipede Snake (*Tantilla berguidoi* sp. nov.), were also found there and formally described in 2016. The Maje Dink Frog, a chestnut-colored frog with red markings, received its name from the genus' characteristic 'dink' call, though this specific species' sound is more reminiscent of a whistle. The Chucantí Centipede Snake received its scientific name in honour of ADOPTA's Executive Director, Guido Berguido.

"This site of Cerro Chucantí has turned out to be far more exceptional than we ever dreamed," said Berguido. "More than 20 new species of plants and animals have been found at this location that are found nowhere else on Earth."

There are still two species of snakes, at least three frogs, one salamander and over a dozen species of ants awaiting formal description. Cerro Chucantí is also home to a number of species recognized as being at high-risk for extinction, including the Great Green Macaw, Baird's Tapir, Giant Anteater and the Black-headed Spider Monkey.

Despite their incredible biodiversity, the rainforests in Cerro Chucantí are under significant threat from slash-and-burn activities, logging and cattle ranching. During this year's long dry season, forest destruction and conversion to pasture land continued near Cerro Chucantí Nature Reserve. The new strategic expansion of the reserve secures a new section of the forest and prevents further clearing, especially as colonists are encroaching on thousands of acres of unclaimed land. As a gateway to over 60,000 acres of public lands, Cerro Chucantí Nature Reserve is laying the foundation for the designation of government protected areas, an effort ADOPTA is working hard to achieve with the support of Rainforest Trust and ICFC.

This project joins a growing number of amphibian focused conservation efforts supported by Rainforest Trust. For almost 30 years, Rainforest Trust has been working with local conservation organizations to help protect the most important sites for threatened species. With this focus, they have made significant progress on establishing key sites for the protection of amphibians – the network of protected areas Rainforest Trust has helped create is home to some 1,600 species of amphibians, including over 360 that are listed as threatened on the IUCN Red List of Threatened Species*TM*.

Cerro Chucantí Nature Reserve. Photo: Anand Varma.

Amphibians are also a prime focus of several of the International Conservation Fund of Canada's projects (see *FrogLog*, 114: 32-34). As does Rainforest Trust, ICFC partners with capable in-country conservation organizations, who best understand the sociopolitical and biological environment. ICFC and Rainforest Trust have partnered with Fundación para el Ecodesarrollo y la Conservación (FUNDAECO) in Guatemala to acquire lands to create the 1,900-hectare Sierra Caral Amphibian Conservation Reserve and a 845-hectare property in the Sierra de los Cuchumatanes Mountain range in northwestern Guatemala, to protect Threatened amphibians (*e.g.*, the Finca Chiblac Salamander, Long-limbed Salamander, Jackson's Climbing Salamander, and the Critically Endangered Morelet's Black-eyed Treefrog). Amphibians also benefit from ICFC's work in protecting landscape-scale reserves such as the Kayapo Indigenous Territories in Brazil (which span 11 million hectares), and Peru's Los Amigos Conservation Concession, which spans 146,000 hectares of old growth Amazonian forest.

"Both the 2005 and 2016 versions of the Global Amphibian Conservation Action Plan have identified habitat protection as one of the most important priorities—if not the most important—or the amphibian conservation community," explained James Lewis, Amphibian and Reptile Conservation Officer for Rainforest Trust. "Now we have a major opportunity to turn those priority actions into real, long-term, conservation solutions on the ground."

Last year, Rainforest Trust launched the SAVES Challenge, a commitment to raise $50 million as a challenge match that will direct a total of $100 million to establish new protected areas to save the world's most threatened species.

"Amphibians are a key component of this effort, and we want to see a significant increase in the number of protected areas created to safeguard threatened amphibians in the wild," said Lewis. "It is up to us as a community to come together, identify these key sites and implement effective conservation strategies. Rainforest Trust is ready to help."

To learn more about ADOPTA and their conservation work to save the sky islands of Panama, please visit http://adoptapanama-rainforest.org/. To find out how to join Rainforest Trust and ICFC in their efforts to protect the most important sites for amphibians around the world, see https://www.rainforesttrust.org/saves-conservation/, and http://icfcanada.org/.

Maje Dink Frog. Photo: Abel Batista.

The Whitley Awards

By Alison Rosser

Every year the Whitley Fund for Nature (WFN) gives the Whitley Awards to recognise some of the world's most effective and inspiring local conservation leaders in developing countries. WFN is a UK registered charity and the Whitley Awards are both an international profile prize and a form of project funding worth £35,000 over one year. Calls for proposals open around mid-year and close in late October. Proposals are assessed and finalists notified around March/April, with the Awards ceremony taking place around April/May. For more information on the Whitley Awards please visit https://whitleyaward.org/.

We will be posting new information on the 2018 Awards soon. Stay tuned for updates on this year's call for proposals in upcoming editions of *FrogLog* and in amphibians.org!

Photo: Whitley Fund for Nature.

Froglife Names new Head of Conservation

By Jenny Tse-Leon

Wildlife conservation charity, Froglife, announces the appointment of Dr Laurence Jarvis as its new Head of Conservation. Laurence will lead Froglife's practical conservation activities to create and restore habitats across the UK, scientific research on the conservation of UK amphibians and reptiles and coordinate the Toads on Roads project which helps move tens of thousands of toads to safety across the UKs road network every year.

Laurence joins from FERA where, as Field Wildlife Ecotoxicologist, he acted as Study Director and Project Manager for ecotoxicology fieldwork. Prior to FERA Laurence worked at the Field Studies Council, TCV and completed a Ph.D. on habitat preferences of the Great Crested Newt.

Laurence joins Froglife as the charity builds on the momentum of its recent research into common toad declines which made national headlines at the end of 2016. Laurence will be expanding on this work to find out more about the causes of these declines and what can be done to address them including the use of road mitigation tunnels. He will also work closely with Froglife's partners on the Garden Wildlife Health Project to further investigate amphibian and reptile disease.

Kathryn Wormald, Froglife Chief Executive Officer says "Froglife are delighted to welcome Laurence to the team. Laurence's combination of scientific and practical experience makes him well placed to make a big impact in this diverse role at an exciting time for our conservation work."

Since 1989 Froglife has been at the heart of efforts to conserve native amphibians and reptiles. Throughout this time Froglife have initiated a number of national and regional projects, and remained a central voice for public advice on issues surrounding reptile and amphibian conservation. Over the last 5 years Froglife has focussed on developing its scientific research capabilities and is now a well-respected authority on amphibian and reptile conservation in the UK. The new Head of Conservation will continue to expand on this over the coming years, with support from Esmée Fairbairn who help fund this position.

Laurence's appointment is effective immediately and you can keep up-to-date with Froglife's latest work at www.froglife.org.

Back to the Future with Frog Hero Gina Della Togna

By Lindsay Renick Mayer

Not only is the Panama Amphibian Rescue and Conservation Project giving the country's most-imperiled frog species a safe haven, thanks to Smithsonian researcher Gina Della Togna, the rescue project is developing the innovative tools necessary to do the seemingly impossible: send the animals (or at least their genes) through time.

The time machine? A technique called cryopreservation, which allows scientists to take sperm or eggs from an animal, freeze the cells now, and then thaw them—even many years into the future—to use to infuse species with the kind of genetic diversity necessary for optimal population health.

Della Togna has become the first ever to develop protocols to successfully extract and freeze sperm from some of Panama's most endangered frog species.

Their future depends, in large part, on her continued success.

THE PAST

Della Togna has the distinction of being the first Panamanian to earn her Ph.D. studying the Panamanian Golden Frog (*Atelopus zeteki*), an animal with cultural significance. Although she wasn't always a self-professed frog lover, she says even her earliest memories involve a prevailing passion for animals. Born and raised in Panama City, Della Togna and her family frequently camped, went boating on Gatun Lake, spent time in the countryside, and summered in nature-rich Costa Rica, her mother's home country.

"I was often surrounded by nature," Della Togna says, adding that she inherited her passion for science from her mother, a microbiologist. "And when I wasn't, I went out looking for it."

And so she sought a career that would conserve the natural world she had come to love. She studied biology with a focus on zoology as an undergraduate student at the University of Panama. Her thesis looked at the prevalence of both Chagas disease and leishmaniasis disease in communities in Panama, specifically at how domestic dogs carried the leishmaniasis parasite and transferred it to humans. Then she took a detour into clinical research, working with an NGO on trials for two GlaxoSmithKline vaccines.

This led her to clinical research in a reproduction lab at the Institute for Scientific Research and High Technology Services (INDICASAT) in Panama. It was here that she met a group of visiting researchers from the Smithsonian Conservation Biology Institute. Della Togna was so inspired by their work, that, right there and then she asked one of them—SCBI reproductive physiologist Budhan Pukazhenthi—to be her advisor on her master's thesis in molecular biology. Pukazhenthi agreed, and together the two worked on collecting sperm from and characterizing the male reproductive system of tapir. It wasn't until she began her Ph.D. work with a scholarship from the Panamanian government (the equivalent of the Fulbright scholarship in the States) that Della Togna turned to frogs.

Panamanian Golden Frogs (***Atelopus zeteki***). Photo: Pei-Chih Lee, Smithsonian Conservation Biology Institute.

Della Togna with a Panamanian Golden Frog in the lab. Photo: Pei-Chih Lee, Smithsonian Conservation Biology Institute.

THE PRESENT

"Gina is very passionate about doing science and very committed to her work," says one of Della Tonga's mentors, Oris Sanjur, associate director for Science Administration at the Smithsonian Tropical Research Institute in Panama. "Not only does she enjoy doing science, but she shines when she talks about her projects. Ever since I have known her, she has shown so much energy and love for what she does. She is compassionate and very true to her values. She has a wonderful heart."

Just a few days after defending her master's thesis, Della Togna came to the United States to begin her Ph.D. work at the University of Maryland with advisor Pierre Comizzoli, a reproductive physiologist at SCBI. It was then that she connected with Brian Gratwicke, SCBI amphibian conservation biologist and international coordinator of the Panama Amphibian Rescue and Conservation Project.

"I always thought I was going to work on mammals," Della Togna says. "But when Brian emphasized that it's essential to have someone doing reproductive work on frogs, not just mammals, I was like, 'yes, absolutely, of course. Let's do this.' Now I'm completely a frog person. Completely. I'm in love with them."

Getting started, however, wasn't easy. Researchers had successfully collected sperm samples from Mississippi Gopher Frogs and Leopard Frogs, but nobody had done this work with Panamanian Golden Frogs, which are extinct in the wild. The Panamanian Golden Frog Species Survival Plan, run by the Maryland Zoo in Baltimore, provided Della Togna 30 male golden frogs, which she worked with for long hours at the Smithsonian's National Zoo in Washington, D.C.

First she had to figure out which hormone treatment to use and at what concentration to yield the highest concentration of sperm. Then she had to figure out how to keep the sperm alive long enough to freeze it, a challenge unique to amphibians. And finally she had to work out the best protocol to use to freeze the sperm in a way that would allow the highest recovery of sperm once it thawed.

"We didn't know anything about anything when we started," Della Togna says. "It took a year and a half of trial and error, of literally running from frog to frog every hour after giving hormone injections. But I love a good challenge."

THE FUTURE

In December 2015, Della Togna earned her Ph.D. with her Panamanian Golden Frog research. Today she continues to perfect the protocol for golden frogs, even as she has started work establishing cryopreservation protocols in Panama for other species the rescue project is protecting, including four other *Atelopus* species: Mountain Harlequin Frog (*A. certus*), Pirre Harlequin Frog (*A. glyphus*), the Variable Harlequin Frog (*A. varius)* and the Limosa Harlequin Frog (*A. limosus*). Most recently, Della Togna has begun work on the first non-*Atelopus* species, the Rusty Robber Frog (*Strabomantis bufoniformis*).

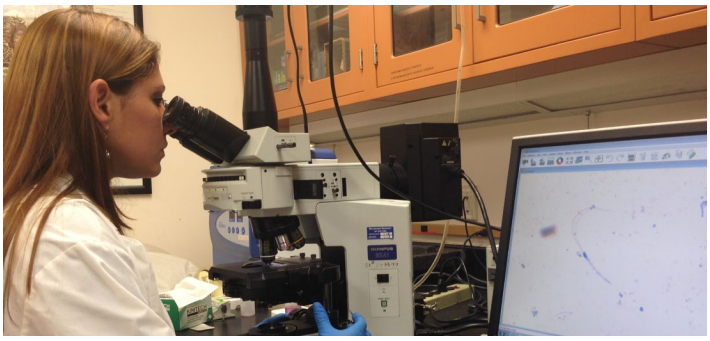
"Breeding frogs is absolutely fundamental to the future of these species," Gratwicke says. "Thanks to Gina's work, we'll be able to produce frogs from cryopreserved sperm from a male frog even if he dies and we haven't been able to successfully breed him. Gina's work is of huge applied value."

Della Togna is also hoping soon to work with female Panamanian Golden Frogs to develop a protocol to collect eggs for artificial insemination, using fresh and frozen sperm. She also aims to get out into the field to do similar work with frogs in the wild to capture their genetic lineages. And at the end of April, Della Togna applied a hormone treatment to a total of six pairs of the Limosa Harlequin Frog and the Pirre Harlequin Frog that hadn't laid eggs before—and now the team has tadpoles from the valuable founding population.

"Gina is a really dedicated scientist who has a contagious passion for amphibian conservation," Comizzoli said. "She is also highly knowledgeable about the value of golden frogs in the Panamanian culture, which creates a wonderful bridge between science and humanities."

Panamanian Golden Frogs vanished before Della Togna had a chance to see one herself in its natural habitat. But she responds to a question about hope for their future—and the future of other frog species—emphatically.

"I am 100 percent positive we can make a difference," Della Togna says. "Frogs have their space, their niche in the ecosystem. They need to be there. They belong there. We're responsible for getting them back to where they were. I hope my legacy is helping to recover the populations in the wild through the work in captivity."



Della Togna's work will help ensure genetic diversity of Panama's most imperiled amphibians. Photo: Pei-Chih Lee, Smithsonian Conservation Biology Institute.

A Giant Bullfrog in Walkerville, just outside Johannesburg. Gauteng is traditionally the stronghold of this species' distributional range in South Africa. Photo: Charmain Hart.

Why did the Bullfrog Cross the Road?

By Wendy Collinson and Jeanne Tarrant

Would you cross a busy road, knowing that you might not make it safely across? Unlikely, so why do hundreds of Giant Bullfrogs do it each year?

The Giant Bullfrog (*Pyxicephalus adspersus)* is the second largest species of frog in the world, and an iconic species in the Gauteng Province, which is the stronghold of their distributional range in South Africa. Loss of grassland and pan habitat within this rapidly urbanizing area is threatening the species' survival. This includes both the direct impacts of roads, such as being killed by vehicles, and the indirect impacts, such as being prevented from reaching breeding sites from over-wintering sites. The species is an explosive breeder – emerging from underground burrows where they spend most of the year for only a few weeks in summer. With the recent heavy rains in Gauteng, the Endangered Wildlife Trust (EWT) has received unprecedented reports of Giant Bullfrog sightings, including many of roadkill occurring at several sites.

The EWT is working to gather records and help prevent roadkill of this iconic species by informing members of the public when and where the bullfrogs are likely to be active. A request for sightings from the public was issued by the EWT in January including road collisions and local developments that threaten the species' habitat. Numerous reports have come in and these are being collated to assist us in identifying breeding sites and areas that require potential conservation action to reduce the roadkill. Other plans to protect these animals include modification of under-road culverts and encouraging the bullfrogs to make use of these passages as crossing routes to their breeding sites. Reducing incidences of roadkill of this species will contribute to alleviating the threats facing these animals, and given their high visibility and short breeding season, is a project that could have high impact for their ongoing survival. The records will also be used to identify and oppose developments affecting the species as well as sites at which population census can be undertaken, hopefully with the help of a public monitoring project.

Together, we can make a difference on our country's roads – will you help? If you find a bullfrog on the road, dead or alive, please send us a photograph, the location (preferably GPS coordinates) and road name, as well as the number of bullfrogs seen, to roads@ewt.org.za. If you find an injured bullfrog, it can still be saved by taking it to your local veterinarian.

The EWT's Wildlife and Roads Project is supported by Bridgestone SA, N3 Toll Concession, Bakwena Platinum Corridor Concession and TRAC N4.

ENDANGERED WILDLIFE TRUST

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Creating Protected Areas for Threatened Amphibians and Reptiles

By James P. Lewis[1]

In 2004, the Global Amphibian Assessment identified habitat loss as one of the major causes of amphibian declines throughout the world. This should have sparked a major global effort to protect as many key sites for amphibians as possible. After all, many highly threatened amphibians are range-restricted – therefore it is very possible to protect a significant percentage of a global species population by safeguarding an individual site. Despite this opportunity, however, relatively few Protected Areas have been created specifically for amphibians.

The unfortunate reality for many threatened species is that if they are not large and charismatic, they are often not the focus of high priority conservation action. Of course there is a very sound argument that when an extensive landscape is protected, the habitats of many species that use that area are safeguarded. However, there are times when this broad landscape approach misses some of the most important sites for range-restricted species, specifically amphibians and reptiles.

That is why Rainforest Trust always considers the biodiversity value of sites, no matter how large, small or seemingly "dull" the key species might be. Throughout our history, we have focused on helping protect key sites for amphibians and reptiles. Rainforest Trust has helped support a range of herpetofauna related projects, including the protection of Ankaratra Massif and Mangabe in Madagascar, securing of key habitat for the Geometric Tortoise in South Africa, and protection of many sites in Colombia and Ecuador that are home to a range of threatened species. In early 2016 I joined the Rainforest Trust conservation team as their Amphibian and Reptile Conservation Officer to help scale up our efforts to protect the most important sites for amphibians and reptiles in the tropics.

RAINFOREST TRUST SAVES CHALLENGE: SAFEGUARDING AREAS VITAL TO ENDANGERED SPECIES

At last year's IUCN World Conservation Congress in Hawaii this September, we launched the SAVES Challenge with the purpose of Safeguarding Areas Vital to Endangered Species. Through our SAVES Challenge, Rainforest Trust has committed to raise $50 million as a challenge match that will direct a total of $100 million to establish new Protected Areas to save the world's most endangered species. Ensuring the full integration of amphibians and reptiles into this SAVES Challenge is of utmost importance to us. We are eager to connect with and hear from all individuals and teams working in the tropics with threatened amphibians and reptiles that might benefit from a new Protected Area.

Rainforest Trust initiatives are true conservation partnerships. This means that if you are a researcher who knows of an important area but you don't have the capacity to move forward with the development of a Protected Area, then we can help connect you with one of our partners on the ground. If you are a conservation NGO that would like to engage more in amphibian and reptile conservation issues, then we can help you build connections with the research community. We recognize that strong and committed partnerships are critical in supporting Rainforest Trust's mission of helping protect the most important sites for threatened species throughout the World's tropics.

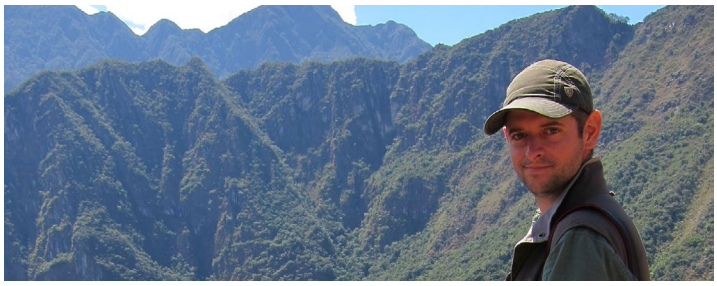
The Rainforest Trust conservation team is constantly looking for new opportunities to help local partners create new Protected Areas in the tropics. Through the SAVES Challenge, we will support a range of approaches to create new Protected Areas, including but not limited to: government designation as a Protected Area; conversion of logging concessions to reserves; community protection; the expansion of existing Protected Areas; and land purchase. Identification of priority areas is based around the occurrence of species categorized as Endangered or Critically Endangered on the IUCN Red List of Threatened Species. It is important that the proposed sites do not currently receive any level of formal protection based on the IUCN Protected Areas categories one through six. Partnership applications should be submitted by a local NGO that has the capacity to implement the proposed project, with evidence of support from both local communities and the government of the country where the project will be located.

RAPID PROTECTED-AREA FEASIBILITY AWARDS

The conservation partnership application for the SAVES Challenge assumes that much of the fundamental information needed to develop a Protected Area is already available. As we know, especially with amphibians and reptiles, this is often not the case. Therefore, Rainforest Trust has developed Rapid Protected-Area Feasibility Awards to help researchers and NGOs obtain the answers they need in order to ascertain the viability of creating a Protected Area. These awards can be used for a range of activities, from rapid biological surveys to evaluating land ownership and assessment of community interest in the establishment of a Protected Area.

This is an exciting time for those interested in creating Protected Areas for threatened amphibians and reptiles in the tropics. With significant habitat loss occurring each and every day, we need to actively protect as many key sites as possible to ensure we don't lose these amazing species. If you know of a threatened amphibian or reptile that will benefit from the creation of a new Protected Area, please reach out to me directly at james@rainforesttrust.org to discuss partnership opportunities.

We look forward to you joining the SAVES Challenge.



Amphibian and Reptile Conservation Officer James Lewis. Photo: James Lewis.

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Borneo Rainbow Toad (*Ansonia latidisca*). Photo: Robin Moore.

Race for the Rainbow Toad

By Robin Moore

The first time I heard about the International Bornean Frog Race, I had visions of crowds cheering on Freddie and Frida as they hopped down a frog-track in a bid to beat their amphibious competitor. It was with great relief and excitement that I learned that it is not, in fact, a race among frogs, but among people armed with cameras on a mission to capture beautiful images of frogs. Far from degrading frogs, the Frog Race celebrates them.

And so it was a great honor to be invited as the international speaker at the 5th Bornean Frog Race at the end of April. I was excited to be Borneo-bound, and didn't miss a beat in asking organizer Dr. Indraneil Das if we could go in search of the iconic Bornean Rainbow Toad (*Ansonia latidisca*). The rainbow toad was one of the top ten "most wanted" amphibians during the Search for Lost Frogs, and was rediscovered in 2011 after 87 years without trace. Dr. Das promised that we could try, but could not promise that we would find it. I was happy to take my chances.

It was a mere 40-hour hop from my home to Lambir Hills National Park in Sarawak, the site of the frog race. I arrived the day prior to the event and began my own race against jet lag. Like the frogs, I was waking up as the sun sank behind the forest. On the morning of the race, artists, scientists, school children and photographers gathered in the Park headquarters to paint, learn, and document a day dedicated to frogs. The day transitioned into an evening of amphibian-related talks, and I had an opportunity to present to the gathered crowd on photography and storytelling as tools for conservation. It is always a pleasure to speak to an engaged audience, and this crowd was as passionate as they come.

As darkness fell, the 100-plus photographers that had signed up for the race began clicking and flashing in anticipation as they checked memory cards, snapped on lenses, and shaped homemade diffusers. After listening intently to the rules of the race, they scurried into the forest, where they had two hours to find and photograph frogs. As the race drew to a close they gathered like moths around a line of students illuminated behind laptops to download

Borneo Eared Frog (*Polypedates otilophus*). Photo: Robin Moore.

Wallace's Flying Frog (*Rhacaphorus nigropalmatus)*. Photo: Robin Moore.

their images for judging. The best photo, rarest species, most species, and best photo taken with a phone were selected and projected onto a big screen following a live auction of frog paraphernalia, and the photographers responsible for each awarded generous cash prizes.

It was an inspiring and fun evening, and a creative way to connect people with amphibians. I couldn't help but wonder how we could inspire similar initiatives in other parts of the world. The concept was the brainchild of a student of Dr. Das from Universiti Malaysia Sarawak named Pui Yong Min and, as impressive as his vision for the race has been, Pui also has another claim to fame. He was the first person to set eyes on the Borneo Rainbow Toad in 87 years. And now that the frog race was over I could think of little else as I headed to the Borneo Highlands with a team that included both Pui and Dr. Das in search of the elusive amphibian.

We drove up steep windy roads to arrive at the jungle cabins that would be our base for three nights of toad hunting. It rained heavily for much of our first afternoon, which bode well for finding the toad and for being devoured by leeches. The rain subsided with the afternoon light, and we donned our headlamps to embark on the steep, muddy climb through beautiful forest. As we climbed past large dipterocarp trees draped in lush foliage with oversized leaves, it felt truly tropical. It wasn't long before we were finding frogs resting on leaves by the side of the trail, including a relative of the rainbow toad and another Bornean endemic, *Ansonia minuta*. As I studied the small toad's form I was struck by how much they reminded me of the Latin American harlequin frogs, genus Atelopus, with their long, slender limbs and upright gait.

As we climbed higher, and closer to where Pui had rediscovered the rainbow toad, he recounted how it felt to find the toad after eight months of searching. "We were originally looking lower down the mountain, as the toad was known only from that elevation," he explained, "but when we couldn't find any sign of it, we decided to search streams higher up. I found the first individual while I was taking a water break, and my eyes scanned this large tree trunk in front of me. The spot where we found it is a couple hundred feet higher than it was originally known from." It must have felt pretty good, I said, and his broad smile said it all. He told me how he was surprised to find the toad high on the trunks of large trees, as closely related species are found on lower vegetation. Looking for a tiny toad up tall trees in a vast forest sounded a little like looking for a needle in a haystack, but Pui seemed confident he could lead us to one in the coming days, and I felt confidence in him.

And we didn't even need that long. As I was fussing around trying to get a photo of *Ansonia minuta* on a leaf (those guys can jump!), I heard a call from above me "he found one!" There are few more exciting phrases. I grabbed my camera bag and light stand and raced up the muddy slope, stumbling over snaking roots. "Can you see it?" Pui asked as I approached and, like a magnet, the beam of my headlamp was drawn straight to the tiny toad resting at eye level on a leaf beside a large tree. I dropped my gear and enjoyed the moment. In front of me was a tiny celebrity—a pocket-sized Leonardo DiCaprio. Like any dedicated photographer, there was only so long that I could enjoy the moment before wanting to capture it, and so I grabbed my camera.

We found a total of two Borneo Rainbow Toads that night. I was thrilled to get shots of the animal at night and during the day in its habitat. With the toad under the belt we had two more days to explore the forests—the diversity of amphibians, reptiles and insects was astounding. Highlights included the iconic Wallace's Flying Frog (*Rhacaphorus nigropalmatus*), a young Borneo Eared Frog (*Polypedates otilophus*) that looked like it hard been carved out of wood and katydids the size of mice. Lowlights included leeches and large night wasps that were attracted to our headlamps and threatened to sting if we didn't turn them off upon hearing or seeing their approach. "Those things could kill you!" Dr. Das kept assuring us, with a reminder that during their last expedition a team member was hospitalized after a sting to the face.

The forest that these species, including the rainbow toad, call home are owned by a private landowner who has built a resort. We hope that by highlighting the unique value of these forests we can convince the owner to create a rainbow toad reserve. Despite a wasp sneaking into our car on the last night and appearing out the air vent to circle us, we avoided stings.

My visit to Borneo was short but amazing, and I am left feeling inspired by the Frog Race and the team of dedicated individuals behind it. I am excited to see it grow and, hopefully, spread.

Is the Demand for Amphibians as Pets Threatening Their Survival in the Wild?

By Jodi J. L. Rowley, Chris R. Shepherd, Bryan L. Stuart, Truong Q. Nguyen, Huy D. Hoang, Timothy P. Cutajar, Guinevere O.U. Wogan & Sompouthone Phimmachak

While most people are aware that the global trade in wildlife threatens big, charismatic species, such as elephants, rhinos and tigers, the trade in smaller wildlife, such as frogs and other amphibians, and reptiles, goes largely unnoticed. We investigated the trade in Southeast Asian newts, a group of amphibians that are threatened in the wild and in high demand as pets. We found large numbers of Southeast Asian newts being harvested from the wild and sold as pets around the world, but official records capture only a fraction of this. We strongly recommend that all Southeast Asian newts be listed on CITES so that trade can be better monitored and regulated at an international level, thus helping to safeguard wild populations of these vulnerable species.

Amphibians are the most threatened group of animals on the planet, and are traded in large numbers globally for food, pets and for use in traditional medicine. While many species, especially frogs, may be suffering from over-collection for use as food, the demand for amphibians as pets is also a concern for rare and/or particularly attractive species.

One group of amphibians in high demand as pets are newts, and Southeast Asian newts are among the most highly sought after. Many of these species are known from small areas and are likely to be under great threat in the wild. The Lao Newt (*Laotriton laoensis*), for example, is now considered globally Endangered primarily as a result of over-collection for the pet trade.

To better understand the nature and scale of the Southeast Asian newt trade, we examined available import records, internet trade, and local retail shops. We found that thousands of newts from this region were recorded as being imported into Europe and the US over the last decade, with the vast majority recorded as being wild-caught. We also found these newts advertised for sale on the internet throughout Europe, Asia and the Americas, often for high prices. The local trade in Southeast Asian newts, however, appeared much smaller in scale.

Because the trade in Southeast Asian newts is largely unregulated and unrecorded, we were only able to gain a glimpse of the true scale. Local reports indicate that the overall harvest of Southeast Asian newts is far greater than the limited number of trade statistics suggest. For example, local residents in Laos report selling hundreds of Lao Newts to visiting collectors. Internet advertisements also revealed species of newts for sale that didn't show up in official records.

The lack of data on the nature and scale of the trade in Southeast Asian newts is largely because it's not a requirement in many countries to keep records of all the wildlife that is imported. So many countries don't- making it impossible to monitor and accurately assess the threat of the trade.

Given that the international trade is likely a major threat, we highly recommend that all Southeast Asian newts be listed in CITES so that their trade can be monitored, and the data can be used to inform conservation decisions and safeguard these species from over-harvesting.

It is also important for range countries to ensure laws protecting these species, and/or regulating trade, are in place and effectively enforced. Such actions may be a key step towards ensuring that these amazing amphibians are not pushed further along the path towards extinction.

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Tam Dao Newt. Photo: Jodi Rowley, Australian Museum.

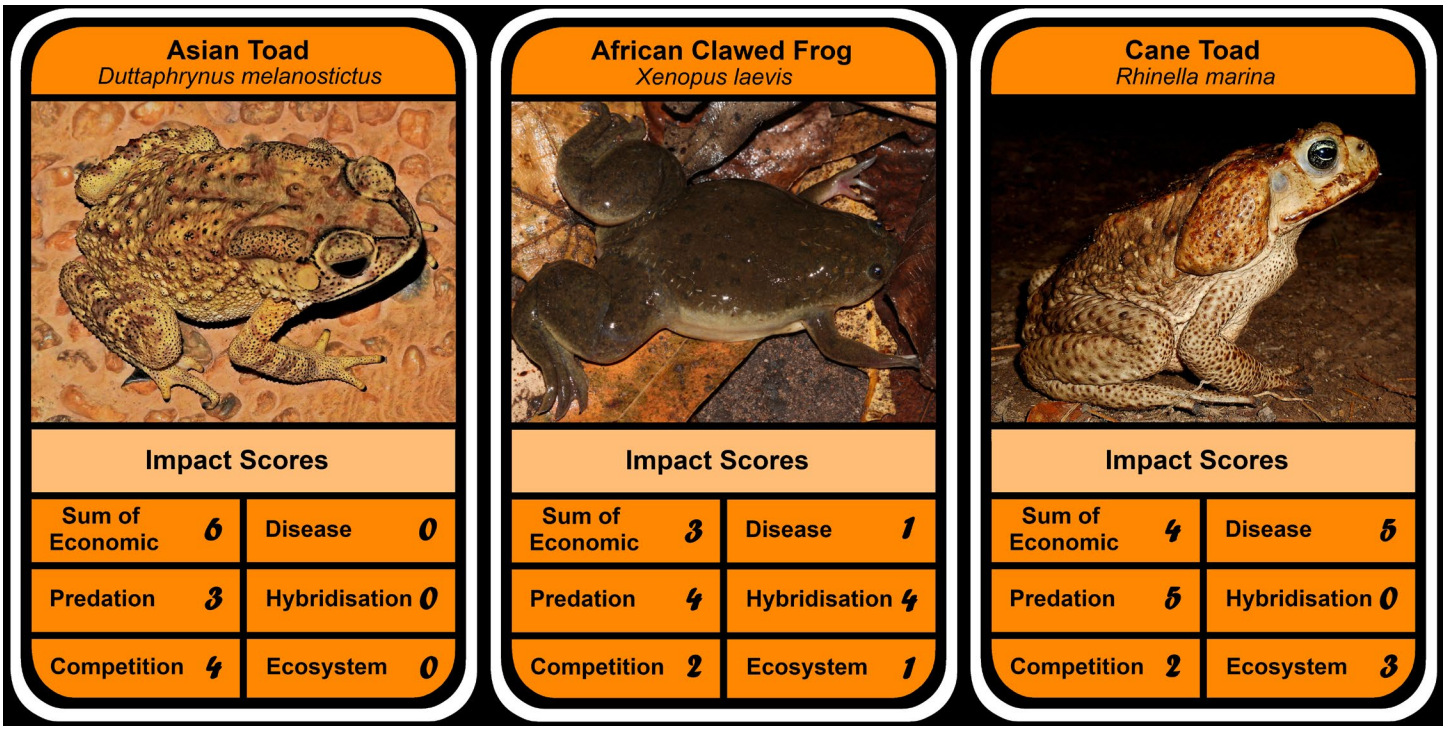

Fig. 1: The three invasive species with greatest impacts displaying some of the results of the Generic Impact Scoring System (GISS). Photographs (from left to right) by Brian Fisher, Alex Rebelo and Jose Martinez.

Assessing the Impacts of Invasive Amphibians

By Alexander Rebelo[1] & John Measey[2]

The world has entered an era of globalization, with a greater volume of goods being traded and at further distances than ever before. This has dramatically increased the chances of introducing and spreading exotic species with cargo, causing a rising number of documented alien invasions (*1*). The major concern with invasive species is their negative impact on the natural environment and human activities. If the impact is expected to be extremely detrimental, an eradication program can exterminate the invasive population. But eradication is very costly, especially when trying to avoid collateral damage to the surrounding environment. Therefore, it is easy to see the value of being able to predict impacts of invasive species before prioritizing action.

The problem is that, although impacts for invasive amphibians are known, there is currently no way to compare them between species, or for that matter between a potentially invasive frog and a mammal or bird. But we need to make informed decisions as soon as possible, preferably before the aliens become well established. For example, if an alien toad is introduced to an area, should we use all our resources to exterminate it, or should we spread our resources to other invasive species already established or that might easily be introduced? Presumably this decision should depend on their relative impacts. This is becoming even more relevant as the number of introduced species increases. We decided to start tackling this problem with a review of all published literature on invasive amphibian impacts, and to assess them using an impact scoring system (*2*).

We used the generic impact scoring system (GISS) framework, essentially a score-sheet that lets one categorize an impact and its severity. This is a standardized method that has already been used on other invasive animals in Europe (*3*), and allows a comparison across other groups, not only amphibians. We used Kraus's book of global amphibian introductions (*4*) to identify which species have been introduced outside of their native ranges. With this information about species and places of introduction we could systematically search with Google Scholar for literature investigating invasive impacts. Each relevant paper was scanned to determine whether it reported any kind of environmental or socio-economic impact.

GISS splits environmental impacts into competition, predation, spread of disease, herbivory and hybridization. Socio-economic impacts (those that affect humans) include damage to farming, impacts on infrastructure and even influences on human health or social life. Severity of the impact was scored between 0 (no impact) and 5 (highest possible impact), using pre-determined severity criteria for each impact category. This was quite a task to complete for 104 species even with dividing the work between a team of seven.

Reviewing published literature can be a long and tedious process, but it can also be highly rewarding. During this process we discovered some of the interesting impacts that amphibians could have on people. One particularly shocking discovery was the resting locations of the Cuban Tree Frog (*Osteopilus septentrionalis*) in Florida. This species prefers to hide in sheltered areas, including man-made objects, with the occasional result of transformer destruction followed by power-cuts (*5*). In another case, an invasion of toxic Asian Toads (*Duttaphrynus melanostictus*) in Indonesia, caused poisoning of unsuspecting villagers and the death of at least one child (*6*). In Hawaii, the invasive Coqui Frog (*Eleutherodactylus coqui*) call so loudly at night that residents are unable to sleep, causing property prices to drop in invaded areas (*7*).

Centre for Invasion Biology, Department of Botany & Zoology, Stellenbosch University, South Africa. [1]alexrebelo@sun.ac.za; [2]john@measey.com.

While these socio-economic impacts were certainly interesting, they were few and far between. The majority of documented impacts were on the natural environment. The impacts with the highest severity were hybridization, followed by predation, disease, competition and herbivory. While by far the most common documented impact of invasive amphibian species was predation, including frogs eating frogs (*8*). In comparison with other vertebrate groups, we found that invasive amphibians had impacts comparable to fish and birds, but lower than that of mammals. Proportionately however, far fewer amphibian species have impacts than in other groups. This suggests that studies investigating amphibian impacts are lacking, possibly because they are overlooked as a serious threat. We show that this is not true and that they deserve more attention in future.

So which invasive amphibians are the "biggest and baddest"? Previously, several amphibians were included amongst the a list of the "100 worst invaders" (*9*), but now using the GISS system, we were able to compare all amphibian species. In third place is the Asian Toad (*Duttaphrynus melanostictus*), which has a lower environmental impact than some other candidates, but has significant socio-economic impacts (Fig. 1). In second place is the African Clawed Frog (*Xenopus laevis*), which has an impressive introduced range (almost everywhere) and a ferocious appetite so that it literally eats its way through many aquatic ecosystems. In first place, hands down, is the Cane Toad (*Rhinella marina*), which has invasive populations best studied in Australia, but present in at least another 38 countries (*4*). This large toad is reputed to eat anything that fits within its mouth, while also possessing a toxin not natural to native Australian predators. As a result, it causes tremendous impacts both above and below its food chain, affecting biodiversity as well as a number of economic activities.

Amphibian invaders can be major players in the ecosystem, and with increasing rates of introductions and dwindling natural areas we need to be on our guard. Keep a look out for invasive amphibians and report any impacts or suspicious individuals to your local authorities. Try joining a citizen scientist initiative in your area (such as iSpot or iNaturalist) where you can share your findings as well as contribute valuable information about native amphibians.

Acknowledgements:

We would like to thank our co-authors: Corey Thorp, Sarah Davies, Giovanni Vimercati, André De Villiers, Mohlamatsane Mokhatla, Sabrina Kumschick, the many researchers who published on amphibian impacts, and those who commented on this MS.

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The outcome of a predation attempt by an Australian goanna on the invasive Cane Toad *(Rhinella marina*). The bufotoxins secreted by Cane Toads are unfamiliar to Australian predators and many succumb to poisoning, causing major impacts on predator populations. Photo: Thomas Madsen.

Fire Salamander (Salamandra salamandra). Photo: Tariq Stark.

An Update on Crowdfunding for Chytrid 2.0

By Steven Allain, Tariq Stark & Sara Viernum

Some of you may be aware of the recent crowdfunding campaign that we initiated and coordinated as members of The Wandering Herpetologist (also in FrogLog: 116:20). This campaign ran on the crowdfunding website WorthWild and was titled 'Studying the Eater of Salamanders in Belgium!". The aim was to raise $5,000 for the analysis of samples for the presence of *Batrachochytrium salamandrivorans* (*Bsal*) in Belgium Fire Salamanders (*Salamandra salamandra*). This fungus causes lethal chytridiomycosis in Urodelans. The samples were collected by swabbing Fire Salamanders from areas where the disease was suspect or examining individuals that had died under suspicious circumstances. The research group that firest identified and described the pathogen and disease at Ghent Univeristy, Belgium analysed all samples. Fire Salamanders have been most affected by the disease in Europe, but if sick or dead newts/salamanders of other species were found, we did aim to sample/analyse these too.

To kick off our crowdfunding campaign we put together an initial video outlining the threat that *Bsal* poses and what donor's money would be spent on. This video was hosted by AmphibiaWeb on their YouTube channel, of which we are very grateful. The video was well received and shortly afterward was followed by a shorter video with news of *Bsal* being discovered in Dinant, in the Belgian region of Wallonia. This video was also hosted by AmphibiaWeb. Both videos were constructed of footage from a number of volunteers, all of whom we would like to thank. We'd also like to thank our The Wandering Herpetologist team member Mark Goodman, for narrating the videos. There was also a lengthy social media campaign to try to help raise awareness of the campaign, which too was successful.

In the end we managed to raise $645, which is unfortunately less than our $5,000 target. However, this is still enough to test 20 or so samples for the presence of *Bsal*. Neither of us had been involved in such an ambitious project before and we're happy with where we've ended up. The whole team has learned some valuable lessons that will definitely help us with structuring crowdfunding campaigns in the future.

As this disease slowly marches on in Western Europe, we would like to highlight that this is a problem of ongoing concern. Please consider donating your time, energy and, if possible, money to research and citizen science initiatives on amphibian infectious diseases. We can all make a difference!

If you would like to know more about the current situation of *Bsal* in Europe, please visit www.sossalamander.nl (by RAVON: Reptile, Amphibian and Fish Conservation the Netherlands). For more on the situation in the Americas please visit the *Bsal Task Force* at http://www.salamanderfungus.org/.

Lastly, we would like to thank our partners: Ghent University, RAVON, Natagora, AmphibiaWeb, the Amphibian Survival Alliance and Liége University.

Carpathian Newt Collection in Sarisske Museum Bardejov, Slovakia—the Largest in the World?

By Veronika Baranová[1] & Mikołaj Kaczmarski[2]

Sarisske Museum Bardejov (SMB) is located in north-eastern Slovakia in the western Carpathians, in the Europe temperate zone (49°17′42″N 21°16′33″E). For many it is famous for an important natural history collection holding about 400,000 specimens of both invertebrates and vertebrates, fossil and extant collected personally or under leadership of Mr. Tibor Weisz (1928–1983), a Slovak zoologist and collector. He collected intensively amphibians during his career however, there is no list of the batrachological collection available. The largest portion of the SMB collection comprises of four newt species and the Fire Salamander (Caudata – tailed amphibians), living in the Bardejov region. We surveyed all specimens and noted data contained on labels (Fig 1. A). Whole newts collected consist of approximately 1,781 individuals gathered during a 22 year period. The most numerous species are the Carpathian Newt *Lissotriton montandon*i (Boulenger, 1860) –47% (840 individuals) (Fig 1. B) and the Smooth Newt *Lissotriton vulgaris vulgaris* (Linnaeus, 1758)–32% (571 individuals). Next in number is the Alpine Newt *Mesotriton alpestris alpestris* (Laurenti, 1768)–32% (315 individuals) and the Great Crested Newt *Triturus cristatus* (Laurenti, 1768) which is only 3% of the amphibian collection (54 individuals). Unfortunately, above 50% of the collection lost labels which contained information regarding place and time collected, only the broad locality is known (such as Bardejov region). Despite problems with labels, the collection of Carpathian newts, including 840 properly labelled individuals, represents a tremendous resource and probably the largest known in the world.

All four discussed newt species above are categorized in the category of Least Concern by The IUCN Red List of Threatened Species. The Great Crested Newt is one of the most rapidly declining amphibian taxon in Europe, including also the Alpine and Carpathian Newts (Fig 2.) having current population trends specified as decreasing (IUCN). A total number of 1,781 specimens is really large by today's collecting standard ethics and collecting and killing amphibians for most reasons should be unacceptable at present both for ethical and conservation reasons. However, for biological and ecological studies, collecting specimens was necessary in the past and were often practiced. These resources are now a valuable world resource. In earlier years, there was no other way how to obtain convincing occurrence records—only properly labelled specimens were considered to be valid and confirm occurrence of a particular species. Today, there is growing importance of long-term fauna collections as a comparative material in scientific research of biodiversity and its conversation. Also collections of amphibians seem to be useful for many investigations. Nowadays any large museum collection of amphibians may be helpful in the study of diseases or the novel pathogens like *Batrachochytrium dendrobatidis* or *B. salamandrivorans*, which currently constitutes the greatest threat for the whole family Salamandridae. Currently, our team has developed the first results of research carried out with this important collection (2). However, we are still working and looking for new hypotheses that can be tested on a collection such as at the SMB.

SMB provides a unique information about occurrence of newts in the region between 1958 to 1980. Knowledge about distribution and morphological data of amphibians (especially newts) in north-eastern Slovakia are very scarce. We believe that amphibians sampled in SMB allow individuals to carry out more detailed comparative studies between historical and present amphibian populations, which is especially important for conservation studies.

Acknowledgments:

We are very thankful to Martin Hromada (University of Presov in Presov) as an incentive of the SMB´s newt collection study and Tomáš Jászay (SMB) for access to the collection.

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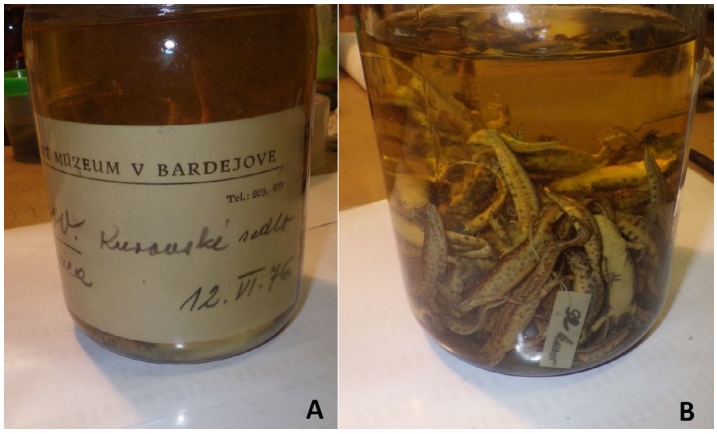

Fig. 1: Jar with newts in alcohol from collections Sarisske Museum Bardejov. A) The museum label from 1976, B) Carpathian Newts sample. Photo: Mikolaj Kaczmarski.

Fig. 2: Male Carpathian Newt *Lissotriton montandoni* Boulenger, 1860. Drawing: Veronika Baranová, 2016.

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Within the Public Water Column: *Eurycea waterlooensis*

By Matt Charnock

Cool morning water continued to travel down my back with each passing undulation. Stroke after each stroke: one, two, three. Head-up. Inhalation followed by exhalation. Head-down: three, two, one. Lost in my own thoughts amongst the spring's veiled mist.

"God, this is a great swim!" So I swam.

"Ah, what's that?" I questioned, pulling my head above water and rubbing my irritated eyes.

"I must've gotten something caught in my eyes. Silt, yea, that's it. For sure."

But my eyes still hurt, however, and now I was blinded both to the aquatic and terrestrial worlds around me.

"How can any one thing live a life in this way?" I wondered.

But it's those cloaking clouds of silt where some of the world's most unique species are trying to live, including cave salamanders. Cave salamanders, in general, are ecological canaries in the mines—they mirror back the health of their environmental niches. Silt is a malignancy. It suffocates permeable aquatic plants, dirties once pristine structures with slick sheets, cocoons not-yet-broken larval envelopments, and cloaks entire food webs in a sort of cancer.

Aside from the ubiquitous salamander of Barton Springs *(Eurycea sosorum)*, the water system's also home to another endemic and endangered amphibian, the equally enigmatic Austin Blind Salamander (*Eurycea waterlooensis)*.

The Austin Blind Salamander is roughly the same size, the same shade of off-white-pink-salmon, occupying the same public accessible spring. These amphibious blind mice are found within the water system's cavernous areas where there's very little—if any—natural sunlight. But they're not entirely blind and visually alienated from the world around them, despite what their common names might suggest.

Austin Blind Salamanders have two small skin-covered eyes, more or less for the sole purpose of telling which way is up and for picking up small refractions of light. And, like a fair amount of other cave-dwelling aquafauna, Austin Blind Salamanders (along with most studied and understood fully aquatic salamanders) are dotted with a lateral line system, helping them detect the displacements in the water column caused by the movements of soon-to-be prey or run-away predators. In addition, the salamanders' lack of well-developed optical cones and rods, coupled with the eye's overlay of dermal tissue, has likely made them more codependent on their lateral line system than those with superior eyesight (*1*).

What we've come to collectively know about the hydrology of the Edwards Aquifer has, in part, been fueled by the solidification and upholding of the Endangered Species Act (ESA). Barton Springs has been under relentless commercial subsidization since around the early '90s due to land ownership arguments, environmental and non-environmental tourism, the housing markets pushed by flocking populations of soon-to-be Austinites, etc. (*2*).

Our relationship with these key habitats is often an afterthought, if a thought at all. It's the sign that reads "You're now entering an important recharge point" that you hastily read down I-35. At sixty

Texas Blind Salamanders (*Eurycea rathbuni*), close cousins of the Austin Blind Salamander (*Eurcecea waterlooensis*), occupy nearly identical niches in their endemic habitats. Photo: Brian Gratwicke.

Both Texas Blind Salamanders (*Eurycea rathbuni*) and Austin Blind Salamanders (*Eurcecea waterlooensis*) posses a pair of skin enveloped eyes, merely used to determine the intensity and presence of light. Photo: John Perry.

miles an hour. On an overcast day. At night. As a result, eroded and polluted landscapes continue to bleed into those silent waterways with each revolution of a lawn mower's blade, flinging topsoil and fertilizer.

And up from the limestone matrix, it'll rise—suffocating silt. And at all four discharge points within Barton Springs, to boot. Fertilizer run-off creates nitrogen acidification; much in the same way fallen rain in smog-blanketed cities decreases the pH of surrounding water bodies. It also may introduce unwelcomed fungi, such as *Batrachochytrium dendrobatidis*, the fungus causing the global declines of already vulnerable amphibian populations. Chytridiomycosis has afflicted other endemic salamander species found within the aquifer (*4*, *5*, *6*). All of this creates unnecessary and unwarranted pressure on extinction's shoulder—a reality that dawn swimmers can't avoid.

But there's another proverbial iron in the fire that may push Austin blind salamanders toward extinction: the introduction and over propagation of both native and non-native (introduced) aquatic predators. While there's little in the way of captive studies done on Austin Blind Salamanders, there is plenty of data about the adaptive predator evasion related to their sister species, the Barton Springs Salamander. What this entails and, therefore leads to, are reclusive tendencies which may mitigate otherwise healthy behaviors such as seeking out a mate or looking for a meal (*7*).

We are, right at this very second, in a pivotal point in time; we're on the eleventh-hour hand of mass extinction's midnight gala. And, at twelve, the vigil will be cheered with champagne glasses held high. The sanctuaries closed, the rivers dry, the forests from roars to whimpers. Whistles of strong winds in between empty and dead and still biospheres. This is a cataclysm at it's most malignant iteration. But time is still to be had; the hand's of time have yet to meet. We can still act in true and honest and radical ways to ensure such an overlap remains alien to us. We can do better, as a group, community, the collective whole of humanity. What a thought—a notion amongst many others during an early morning swim.

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Amphibian Reintroduction Guidelines are Coming!

By Gemma Harding, Luke Linhoff & Richard Griffiths

A working group involving a variety of partners and experts has been established to produce amphibian reintroduction guidelines. These guidelines will encompass a variety of information and guidance, and a draft will be available for open comment via the ASG website later this year.

The International Union for the Conservation of Nature (IUCN) Reintroduction Specialist Group (RSG) has developed non-taxon specific, best practice guidelines for reintroductions and other conservation translocations. The most recent guidelines published in 2013 was a major collaboration between dozens of reintroduction specialists. Various working groups have also developed reintroduction guidelines for specific taxon groups, such as elephants and non-human primates (all guidelines are available for download at http://www.iucnsscrsg.org/index.php). Currently, a new guidelines document specifically for amphibian reintroductions and other conservation translocations is being developed in a major new collaboration.

Recent research has shown that since the publication of the ACAP in 2007, the number of amphibian programs involving captive breeding and reintroduction has increased by over 50% (*1*). Supporting translocations and reintroductions to ensure they are carried out with the best available evidence is integral to the ACAP's goals for amphibian conservation. The production of a set of amphibian reintroduction guidelines has been a priority action of the ACAP reintroduction group for some time and has been driven to fruition by a variety of stakeholders. The advantages of such a document are that it will provide amphibian-specific guidance on such issues as planning, risk assessment, threat mitigation and monitoring. This will provide vital information not covered in the general guidelines for practitioners either currently carrying out or planning reintroductions.

We are aware there are limitations in the development and application of amphibian specific reintroduction guidelines. It is very difficult to make generalizations for such a diverse group of organisms that encompasses a vast range of ecology, physiology, behaviours, and natural history. Equally, many species that may be a high priority for reintroductions have poorly understood—or even unknown—natural histories (2). We therefore aim to embrace commonalities, case studies, and best practices and provide guidance and links to resources developed elsewhere that are useful for practitioners involved in reintroductions. The document will be organized in sections that cover each of the main stages of the reintroduction process from pre-release planning, implementation, and post-release monitoring, providing examples and useful links along the way. We hope that after the first guidelines are produced, they can be regularly updated and improved to maintain relevance and new developments in this rapidly changing field of amphibian conservation.

We are using similar processes utilized to develop other reintroduction guidelines. Initial planning and development started in earnest in February 2015. A core group 11 specialists based in six different countries were enlisted in the fall of 2015 to develop the initial draft text. The guidelines are currently in a draft form, and are still being developed by the core team. However, in late-summer or fall 2016 we will be soliciting comments and feedback on a complete first-draft version. We aim to be inclusive, and with the draft publically hosted online will invite feedback from all stakeholder groups, such as ACAP, ASG and RSG members; as well as ASA partner organizations and other SSC working groups such as the Wildlife Health Specialist Group. Indeed, we welcome feedback from both conservation professionals and citizen scientists. Following the consultation, comments and feedback will be integrated, and the guidelines will be put forward for formal adoption by the IUCN. The aim of the guidelines is to help in informing and improving reintroduction and translocation programs. Comments and feedback at the draft stages will be therefore critical to developing high-quality and useful guidelines.

We want feedback from YOU! So stay tuned for more information on this important document that you will have a chance to be a part of!

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Reintroduction in action: Releasing Chiricahua Leopard Frogs. Photo: Arizona Game and Fish Department.

The ASG Captive Breeding Working Group

By Kevin Johnson[1] & Ben Tapley[2]

In 2013 the Amphibian Specialist Group (ASG) and the Amphibian Survival Alliance (ASA) jointly established twelve amphibian conservation working groups, based on each of the chapters in the Amphibian Conservation Action Plan (ACAP, www.amphibians.org/publications/amphibian-conservation-action-plan/). The goal of each of the working groups is to review progress of the actions outlined in the ACAP, identify and address challenges, develop and prioritize further actions, and support the implementation of those actions. The first revision of the ACAP is complete, and each of the working groups has identified short, medium and long-term goals and actions. The working groups are listed on the ASG web site, www.amphibians.org/asg/working-groups/, with links to the visions, goals, challenges and priority actions for each group. Amphibian conservation involves a wide range of actions and expertise, and the joint efforts of these groups will hopefully result in a decrease in amphibian declines and will see amphibian populations once again safe in the wild.

One of these groups, the Captive Breeding Working Group (CBWG) is co-facilitated by Kevin Johnson, Taxon Officer at Amphibian Ark and Ben Tapley, Team leader, Herpetology Section at ZSL London Zoo. Membership of the group is made up of over forty amphibian husbandry experts from twenty-six different countries.

The first task of this group was to develop a vision for the group, which is: "*All amphibian species assessed by AArk Conservation Needs Assessments or other nationally-recognized organizations that are recommended as priorities for conservation breeding, are established in genetically and demographically viable and financially stable ex situ programs. Where possible, programs should be within the indigenous range, with program outlines which identify short, medium and long term goals and an exit strategy.*"

A series of goals has been further broken down into a range of short-term (1–3 years) and long-term (3–10 years) actions, with priorities and responsible organizations assigned to each. The goals of the group are:

SPECIES SELECTION AND RESPONDING TO NEW THREATS

- Identify species that are both priorities for *ex situ* conservation action and are appropriate candidates for such action.
- A community that can respond to new demands and challenges as they emerge.
- Implement *ex situ* conservation action in accordance with the national and international legislations and agreements.

CAPACITY BUILDING, TRAINING AND MENTORS

- Provide high quality training/capacity building and long term support in regions where captive breeding programs are required but there is not currently sufficient expertise.
- Advise organizations on transparent, efficient and responsible use of resources.
- An Amphibian Ark staff member in every amphibian-rich country of the world, reviewing and updating the conservation needs assessments, organising and delivering training, lobbying for habitat protection, raising funds and managing and supervising species programs.

PROGRAM IMPLEMENTATION

- Leverage the resources required to ensure that when high priority species are brought into captivity, they are held in effectively managed facilities.
- Ensure that effective program planning, including methods of evaluating the success or failure of the program and its goals, and an exit strategy is developed for each new conservation program, before the program is actually implemented.
- Ensure that all necessary import and export permits are obtained for all interstate and international movements of animals, and when collecting animals from the wild.

CAPTIVE HUSBANDRY

- The effective management of disease in captive populations.
- Maintain genetically and demographically viable populations in captivity while threats are either better understood or mitigated in the wild.
- Provide fit, healthy animals for release that are capable of establishing self-sustaining populations in the wild once threats have been correctly identified and removed or sufficiently reduced (released animals should not provide a disease risk to other individuals/species at the release site).
- All breeding programs will endeavour to the best of their ability to comply with all national and international requirements on activities involving specimens in captive breeding colonies.
- Provide best practice recommendations to the community for screening animals prior to release in order to mitigate unintentional transfer of disease or disease strains.

EFFECTIVE PARTNERSHIPS

- Foster/contribute to partnerships and collaborations that facilitate positive conservation outcomes, funding and political support.
- Foster scientific research on captive colonies to generate information relevant for amphibian conservation.
- Engage national agencies to pledge resources and support *ex situ* conservation action.
- Implement actions of ACAP through nodal agencies/persons identified in different regions.

COMMUNICATION

- Captive amphibians on public display are used to effectively convey conservation messages to the visiting public, in order to develop a feeling of responsibility for conservation.
- Share and communicate results and network with the amphibian conservation community.

A number of restraints to achieving all of the actions relating to *ex situ* conservation were also identified. Some of the more significant ones are:

- Insufficient funding and/or resources.
- Insufficient technical expertise and a lack of species champions.
- Lack of stronger connection between *ex* and *in situ* programs and methodologies.
- New threats and limited capacity.
- Risk of novel pathogens in *ex situ* facilities.

[1]Amphibian Ark; [2]Zoological Society of London.

The ASG Captive Breeding Working Group recommends that *ex situ* programs be established for species assessed as requiring urgent captive rescue, and that those programs be established within the range country and managed by local amphibian conservationists. The Golden Mantella (*Mantella aurantiaca*) program run by Association Mitsinjo in Madagascar is a great example of this type of program. Photo: Devin Edmonds.

Members of the group, along with others in the wider *ex situ* amphibian conservation community continue to work hard to meet these challenges, within their own conservation programs and on a national and international level. As is the case with so many conservation projects, insufficient funding and resources is definitely the largest challenge. We must come up with new and creative ideas for ensuring that sufficient resources can be found to ensure the success of all *ex situ* conservation initiatives.

A summarized version of the Captive Working Group Action Plan is available on the ASG web site at www.amphibians.org/asg/workinggroups/captive-breeding/ and the complete plan can be found on the Amphibian Ark's web site, www.amphibianark.org/?wpfb_dl=187.

If you are currently working with captive amphibians and would like to assist with any of the actions, please contact Ben Tapley (Ben.Tapley@zsl.org) or Kevin Johnson (kevinj@amphibianark.org). We all have a responsibility to help care for amphibians, and our collective efforts will benefit all amphibians around the world.

European Treefrog. Photo: Sergey Cicagov.

Developing IUCN Amphibian Conservation Translocations and Reintroduction Guidelines

By Pritpal S. Soorae

Reintroductions and other conservation translocations are common tools utilized by conservation practitioners for an increasing number of threatened species of flora and fauna. Amphibians are currently experiencing an unprecedented conservation crisis with nearly 2,000 species threatened with extinction following The IUCN Red List of Threatened Species. Linked to the rapidity of this deterioration, the number of amphibian *ex situ* conservation programs and amphibian translocations have risen dramatically in the last two decades. However, translocation methods are often difficult, interdisciplinary and highly variable across taxa. The International Union for the Conservation of Nature (IUCN) has published generalized best-practice guidelines for conservation reintroductions and other translocations that are applicable to a wide variety of organisms. However, successful conservation translocations may require largely different and specialized methodology dependent on the type of organism being re-introduced to the wild.

We are developing a new set of amphibian-focused translocation guidelines through a major international collaboration of reintroduction practitioners with the guidance of the IUCN SSC Reintroductions Specialist Group and Amphibian Specialist Group. These guidelines will directly address one of the Amphibian Conservation Action Plan's (ACAP) Reintroduction priorities, namely to "Produce reintroduction guidelines for amphibians to complement current IUCN SSC guidelines" (http://www.amphibians.org/asg/workinggroups/reintroductions/).

We hope these guidelines will offer amphibian re-introduction practitioners a one-stop document that will provide guidance and links to various resources when planning amphibian translocations. It is aimed for these guidelines to be finalized by the end of 2016.

ASG
IUCN SSC
Amphibian
Specialist Group

RSG

Amphibian Captive Breeding Programs for Madagascar: Where We Are Now and the Road Ahead

By Tsanta Fiderana Rakotonanahary[1], Jeff Dawson[2], Franco Andreone[1,3], Justin Claude Rakotoarisoa [4] & Devin Edmonds[4]

Madagascar supports nearly unparalleled frog species richness and endemism. More than 300 frog species have been described from the island and recent DNA barcoding has revealed that Madagascar likely supports more than 500 (*1*). All but two species of exotic and recently introduced amphibians are endemic (2). Alarmingly, more than a quarter of the described frog species are considered threatened with extinction by the IUCN Red List, with the main threat habitat loss due to slash-and-burn agriculture, charcoal production and fuel wood harvest, logging and timber extraction, and both artisanal and larger industrial mining activities. Climate change, invasive species, and infectious diseases, including amphibian chytrid which has recently been detected in Madagascar, are also a major concern.

Despite the many threats facing Madagascar's exceptional amphibian fauna, infrastructure and technical capacity to enact conservation breeding programs has only recently been developed in-country. Following the 2006 ACSAM initiative and resulting Sahonagasy Action Plan (*3, 4*), the country's first biosecure captive breeding facility specifically for amphibians was developed in Andasibe east-central Madagascar. Training courses and exchanges have also been held to support the development of additional facilities at other locations. Still, in spite of this encouraging progress the survival of Madagascar's most threatened frog species remains uncertain, and the ability to rapidly enact captive breeding initiatives for species in decline as well as properly design and implement associated reintroduction and population supplementation programs is lacking.

Herein we outline both the progress that has been made and discuss the future direction of *ex situ* conservation for Madagascar's amphibians, highlighting especially the continued need for support from the international zoo and *ex situ* conservation community.

WHERE WE ARE NOW

The frogs of Madagascar have been kept by zoological institutions for decades, though only a handful of particularly charismatic and colorful species are well represented. A review of ISIS and ZIMS databases found barely two dozen of the more than 300 frog species known from Madagascar kept in captivity (*5, 6*). Nearly all of these were frogs from four genera: *Dyscophus*, *Heterixalus*, *Mantella*, and *Scaphiophryne*. Even though the species kept at zoos abroad represent just a small portion of Madagascar's amphibian diversity, important conservation research has been carried out with them. For instance, Bristol Zoo, Chester Zoo, Paignton Zoo and the Paris Zoo have partnered with the Technical University of Braunschweig and the Emergency Chytrid Cell of Madagascar to develop effective probiotic treatment to address the threat of amphibian chytrid (*7*). More often zoological institutions maintain public exhibits of these species to raise awareness of the plight of amphibians as a whole and, in some cases, to draw attention to conservation issues in Madagascar.

[1]Amphibian Specialist Group – Madagascar, c/o Durrell Wildlife Conservation Trust; [2]Durrell Wildlife Conservation Trust; [3]Museo Regionale di Scienze Naturali, Via G. Giolitti, 36, I-10123 Torino; [4]Association Mitsinjo, Lot 104 A Andasibe Gare, Andasibe 514, Madagascar.

In-country the main captive breeding centre for amphibians is located near the town of Andasibe in east-central Madagascar. This part of the country supports an exceptional diversity of frog species, with more than 100 known from the area (*8*). The Andasibe captive breeding facility is run by the community group Mitsinjo and was opened in early 2011 through a contract of collaboration with the Direction Générale des Forêts (DGF) and the Amphibian Specialist Group of Madagascar (ASG) (*9, 10*). The DGF help to align the breeding center's objectives with national priorities while members of ASG serve as scientific advisors to the project.

The Mitsinjo captive breeding facility works towards protecting local amphibian species from extinction but is not currently equipped to serve as a national centre for the entire country. The project's Malagasy staff maintain a survival assurance colony of the Critically Endangered Golden Mantella (*Mantella aurantiaca*) that was rescued from the footprint of the nearby Ambatovy nickel and cobalt mine. Offspring produced are intended for release at created habitat to attempt to mitigate the mine's environmental impact. The breeding centre also works with an additional eleven local frog species to gain experience maintaining those never kept in captivity before, and to conduct hypothesis-driven husbandry studies to learn about best management practices.

Further east near the coast at Parc Ivoloina, another captive breeding facility for Madagascar's amphibians is under development. The centre is located on a private zoo and botanical gardens managed by the Madagascar Fauna and Flora Group. Zoo staff have been trained in amphibian conservation husbandry at a work-

Local species maintained at Mitsinjo's captive breeding facility in Andasibe. Photo: Devin Edmonds.

shop held in Andasibe, as well as through more recent exchanges between Parc Ivoloina and Mitsinjo and abroad with Durrell Wildlife Conservation Trust at Jersey Zoo. Currently the Parc Ivoloina breeding facility supports live food colonies rather than frogs. Keepers at the zoo are continuing to gain the skill set needed to maintain captive amphibians while infrastructure at the breeding centre is improved.

To prioritize the species in Madagascar most in need of *ex situ* conservation initiatives, the Amphibian Ark Conservation Needs Assessment tool (www.conservationneeds.org) has been used to evaluate more than 200 frog species from the country. This effort is being conducted by an international team of herpetologists to build upon an initial but outdated assessment from 2007. While still incomplete for all species, preliminary results have provided direction for captive breeding action in Andasibe and have already helped to select several new frog species which have recently been acclimated to captivity there (*11*).

THE ROAD AHEAD

While much progress has been made, there is still a seemingly overwhelming gap between the conservation breeding programs that can be immediately enacted and the need. There is also very little capacity developed in-country to facilitate the release and monitoring of captive-bred stock to assist declining wild populations or reintroduce species to areas they are now extirpated from. This leaves a long way to go before captive breeding programs for the frogs of Madagascar can effectively address the many threats they face. Indeed, in many situations captive breeding programs are not appropriate or may not be the wisest use of resources to protect species (*12, 13, 14*). Still, we see a role for continued development of *ex situ* conservation measures, namely in the steps outlined below from within the most recent update of the Sahonagasy Action Plan.

- Selection of priority species for captive breeding programs. Already started using the Amphibian Ark Conservation Needs Assessment tool, this action will identify the frog species most in need and direct resources to them effectively. Once completed, it will be crucial to present the results from the assessment to national and regional government and to actively search for support to launch new breeding programs for target species.
- Collection and integration of field data to captive programs. While much can be learned by keeping species in captivity and experimenting with different captive conditions, it is essential to have at least some understanding of the species' biology before doing so. The frogs of Madagascar as a whole are poorly known and increasing field studies that directly improve or contribute to captive programs should be top priority.
- Continued training and capacity building in Madagascar. The country's first captive breeding facility for amphibians has been established in Andasibe, but in all other regions of the country there is no capacity to enact conservation breeding initiatives. It will be important in coming years to continue training new staff and organizations in these techniques, and also to identify whether to focus on adding additional capabilities to the existing ones in Andasibe and Ivoloina or to es-

***Mantella aurantiaca*. Photo: Devin Edmonds.**

tablish new local centers in other locations. Likely the easiest and most practical route to go is to expand existing captive facilities.

- Reinforce wild populations. Maintaining a genetically-viable captive assurance colony of a highly threatened species can prevent its extinction, but as important is the proper design and implementation of releasing stock back to the wild. In Madagascar, there is some existing reintroduction expertise with taxa such as lemurs and tortoises but none so far for frogs. Bringing in skilled reintroduction specialists with expertise in designing programs specifically for amphibians is the next step.

An overview of the main room for housing frogs at the breeding facility in Andasibe. Photo: Devin Edmonds.

Mitsinjo technicians caring for a captive survival assurance population of the Critically Endangered frog *Mantella aurantiaca*. Photo: Devin Edmonds.

Staff at Parc Ivoloina learning how to prepare fruit fly media. Photo: Devin Edmonds.

To accomplish the above actions requires not only financial support from abroad, but also willing and motivated international amphibian experts. We see a role for international zoological institutions to partner with existing breeding centers in Andasibe and Ivoloina, and especially for those zoos and aquariums that already keep Malagasy species overseas to make an effort to direct resources to *ex situ* conservation breeding programs in Madagascar. Additionally, there is an opportunity for zoos to help design and conduct studies that help inform decisions on the ground in Madagascar and we would like to see more institutions involved in this way.

There is also a possible role for individuals outside the zoo community, namely prospective students, volunteers and researchers. Much of the need that remains involves finding answers to questions about poorly known frog species. Not only is there little understood about the captive husbandry requirements for most of Madagascar's frogs, but also nearly nothing is known about their natural history and ecology. This type of information is valuable not just to inform captive breeding programs but also is crucial when designing methodologies for releasing captive stock to help declining wild population or reintroducing species to areas where they have already been lost.

Lastly, it is vital that governing bodies in Madagascar continue to be actively involved in amphibian conservation breeding programs. The DGF has been supportive of the captive breeding facility in Andasibe and is one of the project's main partners, but to facilitate future programs will require keeping government involved at each step along the way.

Though the tasks that lay ahead may seem daunting, there is too much at stake not to act. The frogs of Madagascar represent a relatively large portion of the world's amphibian diversity. With habitat destruction continuing at an alarming pace and with the recent detection of infectious amphibian diseases in-country, now more than ever the international *ex situ* conservation community needs to take steps to ensure a future for Madagascar's exceptional amphibian fauna.

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The Amphibian Ark - 10 Years on

By Kevin Johnson, Luis Carrillo & Anne Baker

September 2016 marked the tenth year since members of the World Association of Zoos and Aquariums (WAZA) passed a resolution calling for the international zoo and aquarium community to respond immediately to the amphibian extinction crisis. This was, and still is, considered to be one of the greatest conservation challenges for the conservation community, since without an integrated and world-wide response, much of an entire vertebrate class could be lost. Over the past ten years the *ex situ* amphibian conservation community has responded to the call for action, with nearly 180 *ex situ* rescue and husbandry research programs for threatened species currently being managed around the world (*1*).

WHO WE ARE

As a result of this resolution the Amphibian Ark (AArk, www.amphibianark.org) was formed in 2006, with its overall goal to implement the *ex situ* components of the Amphibian Conservation Action Plan (ACAP) (*2*). In addition to zoos and aquariums, the *ex situ* conservation community includes museums, universities, botanic gardens and private conservationists. The AArk acts as an umbrella organization to help coordinate their collective conservation programs.

The AArk is a joint effort of three principal partners: WAZA, the IUCN SSC Conservation Breeding Specialist Group (CBSG), and the IUCN SSC Amphibian Specialist Group (ASG). AArk is also a partner in the Amphibian Survival Alliance (ASA). Strategic guidance is provided by Executive Co-Chairs representing each of the three principal partners along with key advisors from the academic and conservation communities. A Steering Committee includes 21 representatives from zoo and aquarium associations, museums, botanic gardens and the private sector and serves as a communication link to these sectors.

Our vision is ***the world's amphibians safe in nature***, and our mission is ***ensuring the survival and diversity of amphibian species focusing on those that cannot currently be safe-guarded in their natural environments***. Our emphasis is on conservation programs within the range countries of each species, and on programs which include close integration between captive conservation measures and efforts to protect or restore species in their natural habitats. We see the end goal of every captive conservation program being a self-sustaining wild population of the species, ultimately negating the need for a captive component.

ACTIVITIES OF THE AARK

With a focus on well-managed, range-country *ex situ* conservation programs, our primary activities centre around assessing the conservation needs of amphibian species, training and capacity-building where it is most needed, providing seed grants to help establish *ex situ* facilities, identifying partners for *ex situ* range-country programs, and raising awareness about amphibian declines and the steps being taken to reduce those declines. We have developed a range of tools to help assess and prioritize species for conservation actions, and to help with planning prior to implementing new amphibian conservation programs. The AArk web site acts as a central information hub for information relating to captive conservation programs for threatened amphibians, as well as providing a wide-range of documents of particular use to those involved with managing *ex situ* amphibian programs. All of these activities help conservation managers maximize the impact of their limited conservation resources by ensuring well-planned programs which are managed to best-practice standards.

Ideal *ex situ* amphibian conservation programs, such as the one for Titicaca Water Frogs (*Telmatobius culeus*), managed by the Bolivian Amphibian Initiative at the Museo de Historia Natural Alcide d'Orbigny in Cochabamba, Bolivia, include a successful captive breeding component (above), integrated with efforts to determine and mitigate the threats facing those species in the wild (below). Photos: Arturo Muñoz Saravia.

AMPHIBIAN CONSERVATION NEEDS ASSESSMENTS

In 2006, during an Amphibian *Ex Situ* Conservation Planning workshop in El Valle de Antón, Panama, a taxon selection and prioritization working group developed a series of questions to select and prioritize which taxa are most in need of *ex situ* assistance. The decision tree was subsequently further reviewed and refined to include a broader array of conservation actions, and evolved into the Amphibian Conservation Needs Assessment process. The assessment process has proven to be a logical, transparent, and repeatable procedure for guiding amphibian conservation activities within a country or region. The Conservation Needs Assessment process evaluates and prioritizes species, with a range of both *in situ* and *ex situ* conservation actions subsequently being recommended for each species.

The lists of prioritized conservation actions can then be used by amphibian conservationists as a guide for their future conservation work. Mitigating threats in the wild is of course the over-riding action required to secure all species. It is also generally the most expensive, the most time-consuming and in many cases, the most difficult action to achieve. The assessment process identifies species for which some aspects of their wild populations are unknown, and these species are identified as needing additional *in situ* research. These species are ideal candidates for further research work by students, so that eventually the data that are currently missing from the assessments can be included, and more accurate recommendations can be generated.

An initial step for *ex situ* conservation programs involves evaluating species on a national basis, to help conservation managers identify which amphibian species are most in need of particular types of conservation action. *Ex situ* conservation of a threatened amphibian species is considered a necessity when the imperative of *in situ* conservation cannot by itself ensure the survival of a species and its ecosystem. For those threatened species whose basic biology might not be well-known, it is important that more common surrogate or analog species be identified, and then used as a model to develop husbandry protocols and guidelines, which can subsequently be used to manage the more threatened species.

To date the current version of the AArk Conservation Needs Assessment process has been used to generate over 2,600 assessments for more than 2,200 unique species (29% of the 7,530 currently-known species), in 27 different countries or regions. Several more country-wide assessments are presently underway. Prior to 2016, assessments were completed during a workshop process which gathered a region's amphibian experts together for several days. Although the process worked well, it was expensive, and funding became increasingly hard to find. In 2016 an online version of the AArk Conservation Needs Assessment became available and the online process is being used for current assessments.

CAPACITY BUILDING

Adequate resources, in predictable and steady supply, are crucial to the success of all *ex situ* programs. Resources include proper facilities, live food, funding, and very importantly, skilled husbandry staff and veterinary services.

Amphibians brought into captivity must have a purpose and must receive the highest standards of care. The mission for our husbandry training programs is ***to provide range-country personnel with the tools and expertise to offer the best care to amphibians under their stewardship and to enable the planning and implementation of successful captive conservation programs that, where appropriate, end with amphibians back in nature.***

AArk has a long history and experience in organizing and delivering capacity building training courses in countries with high amphibian diversity but little experience in amphibian husbandry or development of *ex situ* amphibian conservation programs. We help to develop husbandry manuals and guidelines for the care of amphibians, along with species management plans.

The two main objectives of AArk capacity building courses are to provide the technical skills necessary for long-term management of *ex situ* populations of amphibians, from species selection to reintroductions with focus on husbandry, health, biosecurity and population management; and to build networking capacity for practitioners in range countries or regions so they can better work together in taking charge of the conservation of their local species. The courses also provide guidance on developing regional conservation plans and strategies for closer collaboration with local *in situ* and municipal partners. Ultimately, we hope to provide the most useful set of skills and resources to motivate course participants to

In April 2016, Taronga Zoo and Zoos Victoria in Australia marked the tenth year of its very successful captive conservation program for the endangered Southern Corroboree Frog (*Pseudophryne corroboree*). Over 2,000 eggs have been released back into the wild to supplement the wild population which is facing the threat of extinction due to chytrid fungus. Photo: Kevin Johnson.

plan future workshops within their regions, so they can stimulate further interest in amphibian conservation and find resources for designing, funding and implementing conservation programs in their region.

The team of Amphibian Ark husbandry instructors includes experienced professionals from the zoo, academic and private communities. All instructors make their services available at no cost to Amphibian Ark or course participants.

To date AArk and its partners have led and delivered 61 training courses on anuran husbandry and conservation, veterinary medicine for amphibians, *ex situ* amphibian population management, and salamander husbandry and conservation. These courses have been held in 33 different countries around the world and have included nearly 2,045 students.

RAISING AWARENESS

In 2008 AArk worked with the zoo and aquarium community to launch *The Year of the Frog* campaign. This campaign was successful in raising international awareness of the amphibian crisis as well as generating funding for new amphibian conservation programs. An AArk Newsletter in both English and Spanish editions is distributed quarterly to more than 5,500 subscribers and highlights current amphibian conservation activities, important publications on amphibian disease and other articles of interest. The AArk website, www.amphibianark.org, provides current information on Conservation Needs Assessment results, on-going *ex situ* conservation programs, and over 200 documents relating to amphibian husbandry and veterinary care. While most of these husbandry documents are in English, we are currently adding additional documents in Spanish to help support amphibian programs in Latin America.

AMPHIBIAN ARK SEED GRANTS

In 2009, AArk initiated a yearly seed grant program to encourage and support small rescue projects for species whose threats cannot be mitigated in the wild in time to prevent their extinction and which therefore require *ex situ* intervention to persist. To be eligible for one of these $5,000 grants, projects must be based within the range country of the target species; involve range-country biologists; follow recommended biosecurity standards; should include strong linkages with *in situ* conservation measures; and involve partnerships to maximize the likelihood of the program's long-term sustainability and success.

Over the past seven years, eighteen grants totalling $88,160 have been provided to organizations and individuals in thirteen countries. Many of the programs that were initiated by these grants have subsequently attracted additional funding, and evolved into well-managed and highly successful programs. While the majority of seed grants have gone to organizations in Latin American countries, seeds grants have also helped develop captive-breeding facilities in Madagascar and in New Zealand. Three excellent examples of programs that have received an AArk seed grant are the program to rescue *Scinax alcatraz*, at the São Paulo Zoo in Brazil; the Bolivian Amphibian Initiative, established at the Museo de Historia Natural Alcide d'Orbigny in Bolivia; and the establishment of a captive breeding facility for Malagasy amphibians at Association Mitsinjo in Madagascar.

MONITORING OUR PROGRESS

Since 2007 we have monitored and documented the great progress of *ex situ* amphibian rescue and husbandry research programs around the world. The progress of these programs includes a series of key steps in the progression of successful amphibian conservation programs, and regular updates for each program show how each is progressing, and which programs might be in need of additional resources. The updates allow us to show significant achievements by the *ex situ* amphibian conservation community towards reducing declining amphibian populations, and maintaining stable assurance populations while threats in the wild are mitigated. By documenting this progress we are showing that zoos, aquariums and other *ex situ* facilities are making a vital conservation contribution towards reducing the loss of amphibian species, and for our community to be acknowledged as a credible conservation partner.

The progress of over 180 programs that we are currently monitoring can be seen on our web site at www.amphibianark.org/progress-of-programs/.

PLANS FOR THE FUTURE

AArk will continue to focus on those aspects of the ACAP that directly address captive breeding, at the same time increasing our efforts to ensure that captive programs have direct links to efforts in the field. In addition to further refinements to the Conservation Needs Assessment process we will be exploring a closer linkage of the Conservation Needs Assessment results to the IUCN Red List. More recent Conservation Needs Assessments have been developed in collaboration with governmental environmental agencies within the country and we are encouraging the development of a National Amphibian Action Plan for each country or region once the assessments for that country are complete.

We hope to expand our capacity building efforts to include a series of on-line training videos that can be used to support and complement in-country training courses. In addition, we are exploring the potential for an internship program that can further develop skills taught in our husbandry training courses.

Recognizing that amphibian diseases, both currently known and yet to be discovered, will remain a concern into the future we are exploring the potential for utilizing stable *ex situ* populations to contribute to reintroduction research designed to examine how well species can adapt to emerging disease.

Finally, we look forward to developing closer ties with the ASA and the ASG to ensure that our efforts to secure "amphibians safe in nature" are well-coordinated and resource efficient.

More information about the Amphibian Ark and all of our activities can be found on our web site, www.amphibianark.org.

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Developing Baw Baw Frog Husbandry at Melbourne Zoo

Adult male Baw Baw Frog. Photo: D. Goodall.

By Chris Banks[1] & Deon Gilbert[2]

The Baw Baw Frog (*Philoria frosti*) is one of six species in the genus *Philoria* - small, terrestrial or sub-surface dwelling frogs from coastal eastern Australia (*1*). All have very restricted distributions and most, if not all are considered rare. With the exception of *P. frosti*, each is confined to a handful of known sites in montane forests near the border of New South Wales and Queensland.

The Baw Baw Frog occurs much further south, where the wild population is restricted mainly to three small locations within approx. 135 km², at 900–1,560m elevation on the Baw Baw Plateau, about 120 km east of Melbourne in the state of Victoria (*2*). The area is covered with snow during the winter and frogs spend the majority of their lives underground throughout the year, amongst a damp tangle of rocks, logs, mud and seepage lines. Eggs are deposited in underground foam nests in November-December and tadpoles develop at oviposition sites with very little water (*3*). The egg masses can be as much as 1m below the surface and locating them requires careful searching by hand in sites identified from pin-pointing calling males.

Concerns over its status in the late 1980s led to a Ph.D. on its ecology and conservation, and subsequent publication of a Recovery Plan in 1997 (*4* & *5*). The species is now listed as Critically Endangered by the IUCN (*6*).

Although the bulk of the frog's habitat is now protected, the amphibian chytrid fungus has caused more than a 98% decline since the late 1980s, including almost complete disappearance from sub-alpine elevations. The most recent analysis of male calling data (to 2011) estimated the wild population at about 2,500 frogs (*7*). The decline has continued since then.

Zoos Victoria is a statutory authority with management responsibility for three public zoos in Victoria, including Melbourne Zoo. In 2010 we committed to supporting the conservation of this frog as part of our Fighting Extinction campaign (*8*). The species had only been kept in captivity three times previously and only raised to adults once, although none survived past three years of age (*9*). Captive breeding had never been achieved and information on captive management was virtually non-existent.

Searching for an egg mass. Photo: D. Goodall.

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Baw Baw Frog field conditions. Photo: C. Banks.

With the support of the Baw Baw Frog Recovery Team, Victorian Department of Environment & Primary Industries (since renamed as Department of Environment, Water, Land & Planning-DELWP), Baw Baw Shire and the Mt. Baw Baw Alpine Resort Management Board, ZV collected an egg mass in late 2011 as the first step in developing husbandry techniques in the event that the species continued to decline in the wild and *ex situ* intervention was needed. Extremely high outside temperatures that coincided with air-conditioning failure mid-way during development, compromised the egg mass, causing it to rupture early. An additional factor may have been inadequate oxygen flow around the eggs due to mud from the site packed around them during transport; this was rectified, but the eggs had already been impacted. Although 15 tadpoles developed and eight metamorphosed, all dying within 90 days, our understanding of captive requirements benefited significantly (*10*). A 6m custom-designed refrigerated shipping container was installed the following year and no further technical problems have been encountered.

No egg masses were located in 2012 due to unfavourable weather, but two masses were collected in November 2013 about 20-30cm below ground in small cavities. They were immediately transferred to Melbourne Zoo and maintained under strict quarantine (*11*). Nine further egg masses have since been collected and captive rearing is continually being refined.

Captive development from collection to metamorphosis is approximately 16 weeks. Eggs were initially incubated in total darkness and at a cautiously low 7–8^{o}C due to limited knowledge of development of this species in captivity. They have since been raised in lit conditions at 9–12 ^{o}C. Jelly masses start to break down after 4–5 weeks, with embryos and tadpoles visible throughout develop-

Retrieving an egg mass in the field. Photo: D. Goodall.

Baw Baw Frog tadpoles. Photo: D. Goodall.

ment. Developing tadpoles feed on trophic eggs and dead siblings, and silt on the tank floors. Tadpole hatching has been 40–100% per egg mass, with metamorphosis commencing 83–85 days later.

Emerging frogs are 5–7mm long and immediately active, including climbing up the insides of tank walls over the first 2–3 days - an intriguing behaviour never before observed and possibly related to moving up and away from flowing underground water in the wild after completing metamorphosis. The young frogs also feed readily, including when keepers are present. Tracking development of sub-sets of frogs from the early egg masses showed weight increases from 0.06–0.07g at metamorphosis to 1.2–3.0g after 12 months and average of 4.1g at 2 years of age.

Metamorphs feed predominately on collembolans until about 4 weeks of age, when they are then offered size-appropriate woodlice and pill bugs. Prey size is increased as the frogs grow and is offered *ad lib* every 7–10 days. Analysis of the woodlice and pill bugs has shown them to have far higher calcium levels than commercially grown insects, even allowing for gut-loading the latter. Analysis of this in ongoing.

HUSBANDRY CHALLENGES

Managing these frogs in captivity has been and continues to be a learning experience, with numerous challenges encountered and addressed along the way. Two in particular are worth noting.

Early in our journey, some tadpoles from one of the early egg masses exhibited swollen abdomens and appeared to have retained fluid late in development—all were subsequently treated with Amphibian Ringer Solution and while most recovered fully, some died and 32 metamorphosed.

A little later, symptoms suggesting Metabolic Bone Disease were observed in one of the early group of frogs at 3 months of age. These were successfully treated with calcium gluconate baths, topical applications and injections. Treatment of this condition spurred assessment of the calcium-phosphorus ratio in the food animals (crickets, etc.) and calcium, ammonia and phosphorus levels in the substrate (sphagnum moss, etc. as it broke down over time).

Use of dead commercially-purchased sphagnum as the substrate has since ceased due to the continually elevating ammonia and phosphate levels. It has been replaced with live plants (moss and baby tears *Soleirolia soleirolii*) grown on top of granite or coco

Baw Baw Frog exhibit at Melbourne Zoo. Photo: D. Goodall.

palm peat. Rinse water testing from these environments indicate no harmful levels of ammonia or phosphate. This environment is able to be thoroughly sprayed, creating natural break-down and filtration of metabolic and organic waste.

No further husbandry problems have arisen and we are now comfortable with raising and maintaining these frogs, some of which are 27 months old at the time of writing. Captive breeding is the next challenge and appropriately-landscaped enclosures have been set-up in readiness.

In late 2014 the Recovery Team agreed that the frog was on an extinction trajectory in the wild and elevated development of a sustainable captive insurance population to the highest priority for the species. The Team also endorsed a major increase in collection of egg masses and frogs. An approved plan is in place to support this for the next three years and 14 frogs have been collected to date. With the exception of two juveniles, all are males.

A major focus for the 2016 field season will be securing adult female frogs. Females are very rarely encountered and without them, breeding at the Zoo will be reliant on females maturing from the groups of young captive-raised frogs, which is expected to be in 2019.

The most recent milestone was unveiling the Baw Baw Frog to Zoo visitors in February 2016, the first occasion on which this little frog has ever gone on public display. Four 18-month old frogs were initially placed in the naturally-landscaped 0.25m³ exhibit. All frogs can be seen moving around in the exhibit and feeding readily. Despite their small size, some individuals are always visible. The display is complemented by an adjacent video of the Zoo's work in the field.

Zoos Victoria is very excited with the progress achieved to date with this little frog. Our commitment is for the long-term and working with partners to eventually have a secure population in the wild.

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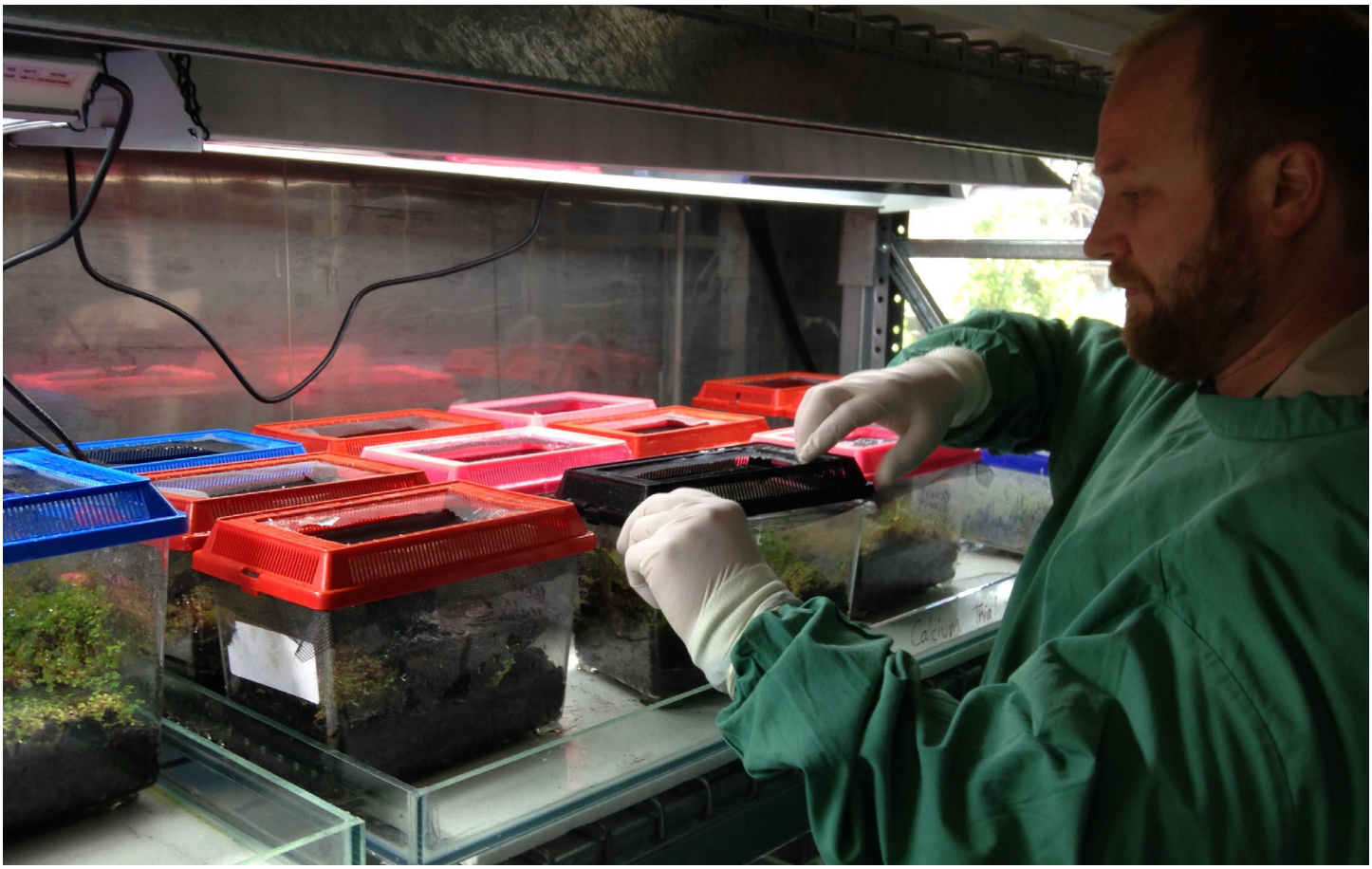

Servicing frog tanks at Melbourne Zoo. Photo: C. Banks.

Female *Xenopus longipes*. Photo: Benjamin Tapley / ZSL.

The Importance of Incorporating Field Data into Captive Breeding Programs, and Vice Versa: Breeding the Critically Endangered Lake Oku Frog (*Xenopus longipes*) at ZSL London Zoo

By Benjamin Tapley[1], Christopher J. Michaels[1], Luke Harding[1], Iri Gill[1], Oscar Nyingchia[1] & Thomas Doherty-Bone[2]

Zoos are in a unique position to undertake research that may underpin conservation efforts (*1*). Key areas of research include the development of husbandry techniques, which are frequently subtle, complex and highly specific (*2,3*) and elucidation of species biology, which is often difficult, and sometimes impossible, to observe in the field.

The Lake Oku Clawed Frog *Xenopus longipes* is an aquatic frog found only in Lake Oku, a high elevation crater lake in Cameroon. *X. longipes* is a Critically Endangered, (Evolutionarily Distinct & Globally Endangered) and AZE (Alliance for Zero Extinction) priority species (*4,5*) due to its evolutionary history, restricted range and vulnerability to stochastic factors. There are recurring, enigmatic *X. longipes* mortalities, but the overall impact of these events on wild populations is unknown (*6*). A captive-breeding and research program was considered vital in order to develop husbandry protocols that could be used in Cameroon in the case of a catastrophic collapse of the population due to the potential introduction of fish to the lake, habitat degradation and disease threats (*7*).

When this program was initiated, the tadpole of *X. longipes* was undescribed and the reproductive biology of the species unknown. We aimed to breed the species in captivity, document reproductive biology, describe the tadpole and disseminate our findings to conservation biologists. Such information is of importance for developing *in situ* conservation management strategies.

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In 2008 a group of *X. longipes* were collected from Cameroon after permits were acquired and local communities consulted. The collected animals were received by three institutions including ZSL, London Zoo for conservation and research purposes with the aim of documenting the reproductive biology of the species, which was unknown. At the same time, a monitoring project for the environmental parameters of Lake Oku was initiated to understand its ecology and thus aid captive management of this species.

Repeated attempts to breed the species in captivity failed. In 2012 the husbandry of *X. longipes* was reviewed at ZSL London Zoo. Captive management should be informed by field data (*8,2*)

Spawning *Xenopus longipes*. Photo: Benjamin Tapley / ZSL.

Tadpole of *Xenopus longipes*. Note the reduced barbel. Photo: Benjamin Tapley / ZSL.

and after consultation of the seasonal environmental data that had accumulated over the past four years, it was clear that the temperature regime and water parameters in captivity did not reflect field conditions. In 2012, founders were sexed and there was a heavily biased female sex ratio. CRAAC organized the collection and export of additional male *X. longipes* from Cameroon. After completing their quarantine period these were assimilated into the existing *X. longipes* colony. A schedule was established so keepers could adjust water parameters to replicate natural seasonal fluctuations in the captive environment. In June 2013, mixed sex groups were transferred to a custom-made system and a more diverse array of food items were offered to compensate for potential dietary deficiencies as knowledge regarding the nutritional requirements of amphibians is lacking (*9*). All environmental manipulations, husbandry changes, reproductive behaviour and larval development data were recorded on Zoological Information Management System (ZIMS).

In March 2014 several natural spawning events occurred, a world first. Initial spawning events occurred after a planned temperature and pH adjustment to replicate seasonal changes in Lake Oku. Eggs developed and hatched in 2–4 days. A variety of combinations of conditions were used in attempts to rear the tadpoles (*10*). We only had success by maintaining tadpoles in water with a very low total dissolved solid (TDS) of around 20 mg/L and without any live plants or accumulation of humic detritus (*10*). The tadpoles of *X. longipes* are mid-water filter feeders and occupy a lentic habitat, making them sensitive to water currents. It was crucial for tadpole development that food was always in suspension and available to the developing tadpoles whilst simultaneously managing water quality to prevent the build-up of toxic nitrogenous waste products. This was further complicated as water movement caused by aquatic life support systems had to be minimized as it would interfere with feeding.

The husbandry of adult *X. longipes* is similar to other *Xenopus* species; adult frogs are able to survive a range of water parameters. However, the tadpoles were more sensitive. The dietary requirements of tadpoles were similar to other *Xenopus* species, but tadpoles appeared more sensitive to the mineral/solute content of water. Tadpoles maintained in water with a TDS higher than 80 ppm died rapidly and tadpoles developed well with a TDS of around 20 ppm. We formally described the tadpole and deposited voucher

Tadpole of *Xenopus longipes*. Note the reduced barbel. Photo: Benjamin Tapley / ZSL.

Female *Xenopus longipes*. Photo: Benjamin Tapley / ZSL.

specimens at the Natural History Museum, London (*11*). Tadpole development was slower in *X. longipes* than congeners. The relative size of the tadpole when compared to the adult frog is greater in *X. longipes* than in other congeners for which there is a tadpole description and there are several other important morphological diagnostic features, including a reduced barbel. We suspect that the long larval development, large relative tadpole size and reduced barbels all represent adaptations to a transparent lake habitat that undergoes little seasonal environmental change.

These observations provided the first insight into the behaviour, development, and captive requirements of *X. longipes*. This was notable as prior to the start of this project the tadpoles of this species had never been observed alive or intact in the field and nothing was known of their habits in Lake Oku. In particular, the high sensitivity to mineral content and smaller clutch size of this species may make *X. longipes* more susceptible to aquatic pollution and less able to recover quickly from declines. Moreover, this characteristic highlights the limitations of the "analogue species" concept (*12*), whereby common relatives of a threatened species are used as models to develop husbandry strategies before working with target, usually Critically Endangered, species.

Our findings will hopefully improve success with this species in other institutions, and contribute to the long-term viability of captive colonies. In January 2016 the F1 frogs laid viable eggs and some tadpoles from this clutch have now (May 2016) metamorphosed, indicating that larval period may be more flexible than originally thought. Although existing captive populations of *X. longipes* are not managed under strict enough biosecurity controls to be suitable for reintroduction efforts (*13*), laboratory techniques for other *Xenopus* exist to generate "clean" animals by treating ova (*14*). There is therefore potential to use these techniques to create biosecure cohorts that could safely be used for reintroduction should it be required.

Husbandry protocols have been distributed to other zoos and aquariums working with the species and, more importantly, to Cameroonian specialists so that conservation breeding facilities can be developed in country if necessary; this option is often preferable due to reduced risk of disease transmission and reduced cost. More work is required to fully understand and control the reproduction of this species in captivity as well as the field. A studbook should be developed to ensure that a viable population of this species is maintained in captivity long-term, both for conservation breeding and for research purposes.

These findings are also enabling planning for targeted surveys in Lake Oku, as well as contextualising of existing survey data for this species. Next, we shall work to input both field data and captive life history data for PVA analysis.

Clearly defined goals, a network of specialists, extensive literature review, an annual plan for seasonal environmental fluctuations, thorough record keeping and strict water testing regimes enabled us to develop and disseminate rearing protocols, including successes and failures, for species that was not established in captivity, and also to elucidate important aspects of its reproductive biology. Our captive breeding efforts reached 19 million members of the public globally, indicating an impact beyond the academic. We hope that this case study demonstrates some of the contributions that institutions maintaining captive populations of amphibians can make to the conservation of a species, without necessarily breeding animals for release into the wild.

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Isla Luna *Telmatobius culeus*. Photo: Dan Lay.

Developing Captive Breeding Capacity to Save an Iconic Bolivian Species: Ten Years of Collaboration

By Dan Lay

In February 2016 Dan Lay, Deputy Head of Herpetology at Durrell Wildlife Conservation Trust, travelled to Bolivia to assist the Bolivian Amphibian Initiative in setting up a captive breeding facility for the Critically Endangered Lake Titicaca Water Frog *Telmatobius culeus*. This collaboration is the result of a ten year relationship built upon Durrell's ethos of training conservationists from around the world.

Durrell, headquartered in the British Channel Island of Jersey, is a conservation organization with the mission of saving species from extinction. We pursue our goal of restoring species and ecosystems using a multifaceted approach incorporating the following components:

- The wildlife park in Jersey, which supports conservation through captive breeding projects, practical training for conservationists and education of the public.
- Field programmes around the world.
- Conservation academies in Jersey and Mauritius that provide training courses for endangered species conservation management and techniques.
- Scientific research to identify priorities and guide our conservation work.

The Bolivian Amphibian Initiative (BAI) is a project of the Alcide d'Orbigny Museum of Natural History aiming to conserve endangered amphibian species in Bolivia with a focus on species in the high Andean region. To achieve this, BAI undertake research into local amphibian diversity, ecology and natural history; education


Dan Lay and Patricia Mendoza. Photo: Dirk Ercken.

BAI new facilities. Photo: Dirk Ercken.

and training of local people, their threats and research methods and developing the first captive breeding strategy for the threatened species in Bolivia.

The relationship between Durrell and BAI began in 2006 when Arturo Muñoz Saravia, founder of BAI, attended the Amphibian Biodiversity Conservation course at Durrell's Conservation Academy in Jersey. "My first contact with Durrell was in 2006. Since then I have been in contact with Durrell staff and created a relationship and friendship" says Arturo. Three years later Arturo was back in Jersey attending Durrell's Facilitation and Communication course, before BAI and Durrell worked together to deliver an Amphibian Conservation Course at Lake Titicaca, Bolivia. According to Arturo, the training he received at Durrell provided him with the skills and passion to work in conservation, allowing him to "introduce more people from my country to amphibian conservation."

In 2011 Arturo returned to Jersey to complete a four month conservation internship in the Herpetology and Veterinary departments, after which Arturo said, "Now after a four month internship at Durrell I come back to Bolivia with a lot of knowledge, energy and with a special feeling that back in Durrell I have a family that is supporting my work." Later that year BAI and Durrell collaborated once again, alongside Amphibian Ark to run an Amphibian Husbandry Course in Argentina.

Since then two further BAI staff have visited Jersey to undertake training courses at Durrell. In 2012 Andrea Fuentes completed a 12 day Amphibian Conservation Husbandry course and last year Patricia Mendoza, BAI's current captive breeding coordinator com-

Arturo Muñoz Saravia during his internship. Photo: Gerardo Garcia.

pleted Durrell's flagship training course, the Durrell Endangered Species Management Graduate Certificate (DESMAN). This 12 week course is designed to equip conservation professionals with a complete range of skills to maximise their effectiveness at managing or participating in conservation projects. Patricia said "To go to Durrell Wildlife Conservation Trust was a dream come true. It was the best experience that I have had. You have to take up the knowledge that they have and share. Then you should apply in your country. The threatened biodiversity needs us."

It is through training such as this that Durrell seeks to help empower and give skills to local conservationists to develop projects and programs to save species from extinction. Now through Durrell's Saving Amphibians From Extinction - SAFE Programme, this relationship with BAI is being developed further to support conservation efforts for threatened Bolivian amphibians.

During my visit to Bolivia I travelled with BAI to the two major basins of Lake Titicaca - Lago Menor (Guaqui) and Lago Mayor (Isla de la Luna) - to assist with surveys for *Telmatobius culeus*. At Isla de la Luna, a current stronghold for the species, we found a number of dead *T. culeus* specimens. These were collected for *Batrachochytrium dendrobatidis* (*Bd*) analysis by the international team of Timothy James (University of Michigan), Ignacio de la Riva (Spanish National Research Council) and Patricia Burrowes (University of Puerto Rico). Under the microscope, it was immediately evident that the collected specimens had high yields of *Bd*.

Unfortunately, en-route to Isla de la Luna we saw evidence of another major threat facing the species with several restaurants offering *T. culeus* for sale on the menu. Later this year a Durrell co-ordinated MSc study is planned to survey the perceptions and usage of frogs in communities surrounding Lake Titicaca. This information will be crucial in developing effective conservation interventions to address this threat.

At Guaqui, and some other areas of the lake, an additional threat occurs from pollution events; a major occurrence of this in 2015 resulted in huge mortality of individuals, with 100% of frogs found dead in some areas. With all of these very evident threats, it was obvious that a captive breeding facility is required to ensure the continued survival of this threatened species. Until the threats in the wild are better understood and can be mitigated accordingly, it is essential to refine captive breeding practices in order to maintain viable insurance populations and prevent the extinction of Telmatobius culeus. I was thrilled to be able to travel to Bolivia and work with the BAI in setting it up the facility. It was remarkable to see what the passion and dedication of the BAI staff and volunteers, which combined with Durrell training since 2006, is achieving for the conservation of threatened amphibian species in Bolivia. Arturo and BAI staff and volunteers should be very proud of their progress and success, which Durrell is delighted to support, and will no doubt continue long into the future.

Dan Lay and Arturo Muñoz planning the waste water fittings for new facilities. Photo: Dirk Ercken.

Seventy Titicaca Water Frogs were collected from two different sites in Lake Titicaca to establish a new captive assurance population in Bolivia. Photo: Dirk Ercken.

Saving the Lake Titicaca Water Frog in Bolivia

By Arturo Muñoz Saravia[1] & Kevin Johnson[2]

The Bolivian Amphibian Initiative (BAI) works in four main areas of amphibian conservation: monitoring, training, education and captive breeding, focusing its efforts on species from the High Andes, and most recently with threatened species from the genus *Telmatobius*. Along with the Museo de Historia Natural Alcide d'Orbigny (Museum of Natural History) in Cochabamba, Bolivia, the BAI has been working for several years with the Titicaca Water Frog (*Telmatobius culeus*) both *in situ* to evaluate the status of this species and to better understand the natural history and some aspects of this unique frog; and *ex situ* to develop the skills for maintaining and breeding the species in captivity. After trialing various husbandry conditions, we have now successfully produced offspring on multiple occasions.

The Titicaca Water Frog is the world's biggest fully aquatic frog and is endemic to the cold waters of the high elevation Lake Titicaca on the border of Bolivia and Peru. It is listed as Critically Endangered by the IUCN and can grow up to 145mm long and 379g in weight. This species is facing extinction due to pollution; unsustainable harvesting; the introduction of exotic species such as trout and king fish; diseases such as chytrid fungus; and it is known to suffer from extreme die-offs due to spikes in water pollution in the lake.

The threats faced by the species must be mitigated to ensure the long-term survival of the species in the wild, but in the meantime an assurance population has been established in a secure captive breeding facility at the Museum of Natural History, where the frogs are thriving and reproducing.

As well as managing the captive assurance population of the Titicaca Water Frogs, the team from BAI is also heavily involved with *in situ* research at Lake Titicaca, monitoring populations of the frogs and documenting any die-offs, and seeing how the frogs evolve and react to the constant change of conditions in the lake. We have been gathering information about the natural history of the species, using new methods such as scuba diving, which allows us to get information such as reproduction strategies, behaviour and habitat use; and information about water quality, temperature, UV radiation and other parameters have also been obtained. Specific research about population densities of the species in different areas of the lake was carried out and we are now starting social research in the area. All of this information will allow us to contribute to the conservation of the species in a better way.

Building capacity is another important part of the BAI's role, including training young local biologists, and students, and working with local communities and park guards around the lake to teach them about amphibian monitoring methods. We have delivered a number of training courses relating to amphibian research and conservation, providing students with tools that can be used for their future work with amphibians. These courses have not just been at the Bolivian level but have included participants from other South American countries, and this has subsequently resulted in some wonderful opportunities for working together. We have worked

[1]Museo de Historia Natural Alcide d'Orbigny; [2]Amphibian Ark

closely with some university students on our project and some of the students have now also had the chance to develop their own projects. The BAI has also collaborated on training courses about amphibian conservation and husbandry in Peru and Argentina over the past five years.

In June 2014, in conjunction with the AArk, the BAI ran an amphibian conservation husbandry training course to build capacity within Bolivia for the *ex situ* conservation of threatened Bolivian amphibians. Eighteen biologists, amphibian conservationists and researchers from Bolivia and one from Argentina attended the training course, including biologists from both captive facilities and field programs within Bolivia and national institutions such as natural history museums, zoos and government organizations. In addition to trainers from Mexico and Ecuador, the team from the BAI shared their expertise and past experiences during the four-day course, which included classroom presentations and a range of practical, hands-on workshops. This was a great opportunity for people within Bolivia to learn the skills required for best-practice husbandry techniques for captive amphibian programs, and hopefully, these skills will be put to good use in future captive conservation programs in Bolivia.

Education is also an important aspect of the project, so we can raise awareness about Lake Titicaca and the species that depend on it. The BAI has developed different educational activities, such as workshops, exhibitions in local communities, schools within the main cities, as well as different activities in the Museum of Natural History in Cochabamba. We also are developing educational materials such as calendars, books, postcards, coloring books and games related to amphibians. The BAI has also been providing information about Bolivian amphibians and their situations as well as the work we are we doing to conserve them, to various media such as newspapers, TV and radio programs, and we have been collaborating on some documentaries focused on Lake Titicaca and the Titicaca Water Frog.

After identifying the Titicaca Water Frog as a priority for *ex situ* conservation action, and with the support of the IUCN Save Our Species (SOS) fund, Amphibian Ark, Stiftung Artenschutz Rufford foundation and other institutions, we decided to start a captive breeding program of the species to maintain genetically and demographically viable populations in captivity while threats in the wild become better understood and mitigated. Two founder populations were collected, one from Lago Mayor (the larger portion of the lake) where the frogs and the habitat seem to be in relatively good condition, and another population from Lago Menor (the smaller section of the lake) where the frogs and the habitat are in worse condition, and where in some areas the species has already disappeared. Due to some of the differences working with a captive breeding program in a developing country we have adapted some of the husbandry protocols for the conditions in Bolivia, while still reaching the desired standards to keep a captive population for reintroduction purposes. We are developing husbandry guidelines, protocols for live food production, water management and population management of this species that will allow other institutions in Bolivia or other countries to replicate the work we are doing.

In April and May of 2015 a massive die-off of the species was recorded in the Lago Menor region of the Bolivian side of Lake

Team members from the Bolivian Amphibian Initiative working in the new Titicaca Water Frog facility. Photo: Dirk Ercken.

Titicaca and this underscored the critical importance of the captive population. Although an annual pollution spike has caused small die-offs in the previous years, this unprecedented pollution event caused massive frog mortality, higher than we had seen in the past. The BAI started a project to understand the scale of the problem and to identify the cause of these massive mortalities. We began monitoring the situation in the lake and the findings were alarming. We found hundreds of dead frogs in very small areas in the shallow shores of the lake. After diving in deeper waters we confirmed that 100% of the frogs in the area were dead.

After several months of monitoring the species we have a better idea of the situation in the lake. We already knew that water pollution and sedimentation is the main factor that causes the massive die-offs of the frogs in the lake, but we also found other aspects, such the presence of Chytrid in the area, overharvesting of the species for local and international market (mainly Peru), and fishing activities that are playing a role in the decline of the species.

We found an area of about 300 square kilometres in the Lago Menor where there are no more frogs - areas where previously the species was relatively common. There are also other areas where adult frogs are absent, and it seems that only juveniles or small adults are present. In these areas we also found that the number of frogs is less than we found in previous years. In a small area of Lago Menor we can still find adult frogs and even breeding activity, but unfortunately the water quality and the densities are not as good as the areas of Lago Mayor where the frogs are in much better conditions and we do not know if the eggs in those areas will survive because of the water quality. This is an important issue that we need to study and monitor.

Efforts by scientists and local officials are underway to identify and dramatically reduce the sources of pollution in Lake Titicaca, but these will take time and political will to accomplish. In the meantime, the frogs at the Museum of Natural History maybe the Lake Titicaca Water Frog's best hope for the future. All of this work has been in coordination with Bolivian government departments such as the Ministerio de Medio Ambiente y Aguas (Ministry of Environment and Water) and the Dirección General de Biodiversidad (General Directorate of Biodiversity) and other national and international institutions.

To ensure the maximum health of the captive frogs, especially if we are to eventually release captive-bred animals back to the lake, we realized that we needed to work under higher levels of biosecurity. We decided to set up a new container that will be used only for the Titicaca Water Frog, and where we will be able to manage, monitor and breed the species in a way that will allow reintroduction of the species in a relatively short time. Thanks to funding from the IUCN Save Our Species (SOS) fund, and an additional grant from the Amphibian Ark and Stiftung Artenschutz, we purchased a second-hand shipping container and transported it to the Museum of Natural History.

In January 2016, thanks to generous cooperation with staff from Kansas City Zoo and Atlanta Zoo in the US, and Durrell Wildlife Conservation Trust in Jersey, the team from the BAI and other volunteers we were able to set up the second shipping container in around three weeks, including the installation of a new cooling system, two large water storage tanks and forty aquariums, with all the electrical equipment and plumbing to allow easy management of the species.

The amazing team at the BAI, including Patricia Mendoza, Gabriel Callapa, Sophia Barron, Adriana Aguilar, Lupe Mamani, Saúl Zuna and Mateo Muñoz, worked closely with an international group of experts, including Tim Steinmetz (Kansas City Zoo, USA), Dr. Robert Hill (Zoo Atlanta), Dan Lay (Durrell Wildlife Conservation Trust, Jersey) Ineke Plaetinck, Dirk Ercken and Lizbet Colson (Belgium) for the conservation of this species. This part of the project was also supported by several international organizations, including the Kansas City Zoo, Zoo Atlanta, Jacksonville Zoo, the Museum of Natural History, Amphibian Ark, IUCN, Durrell Wildlife Conservation Trust and Denver Zoo.

After the new container was fitted out, and ready to house animals, the team went on a field trip to Lake Titicaca to collect a new founder population. We collected a total of 70 individuals from two sites: 35 from Lago Mayor and 35 from Lago Menor, with the support of the Bolivian government (DGB). The new founders were carefully transported back to Cochabamba, and as soon as they arrived at the new facilities we began the quarantine period, and treatment for Chytrid, which we know is already present in the lake. After the frogs finish this quarantine period, the new group of Titicaca Water Frogs will be established in the new facilities, and hopefully they will breed in the near future.

This experience of working with a range of different organizations and experts gave us a great opportunity to join efforts for the conservation of one species; it also created a collaborative network among different institutions that will help us with the goal that we have of working for the conservation of threatened Bolivian amphibians. We are truly thankful for the support of all of these organizations and individuals.

Although we have been working with this species for a while now, we know that there is much more to do and this is just the starting point. Over the coming months we plan to establish a network of all the institutions working or interested to work for the conservation of this species and its habitat and to develop a strategy that will allow us to better tackle the situation faced by this species. In the short term we are continuing the monitoring program of the species, and we plan to see how the species responds to the pollution problem in the lake. New studies with our captive population will be started so we can hopefully achieve the best results. As is the case with many new conservation programs, we need as much support as possible, not just economically but also from people with knowledge, contacts and tools that can help us to conserve this iconic species and its habitat.

With support from Amphibian Ark we launched a GoFundMe project earlier this year, with the hopes of raising US$6,000 so we can replace the ageing air conditioning unity in our original amphibian container. To date we have raised just over $800 so we still have a little way to go. Thanks to everyone who has supported our project so far, and if you would like to help save the Lake Titicaca Water Frog, we'd very much appreciate it. Donations can be made at www.gofundme.com/WaterFrog.

For more information about the Bolivian Amphibian Initiative or the Titicaca Water Frog program, please visit www.bolivianamphibianinitiative.org, www.bolivianamphibianinitiative.blogspot.com or contact us via email at: hyla_art@yahoo.com.

Golden Mantellas in the center at Andasibe. Photo: N. Wöhl/Durrell

From Jersey to Madagascar: A Keeper's Visit to Support the Development of In-Country *ex situ* Facilities

By Nadine Wöhl[1]

In May 2015, an amphibian technician from Association Mitsinjo's Amphibian Survival Assurance Center in Andasibe, Madagascar spent one month at Durrell's Herpetology section in Jersey, UK. While there, Mampi (Jeanne Soamiarampionona) trained with the team on amphibian husbandry, culturing live-food and quarantine /bio-security procedures and protocols.

In January 2016, Nadine Wöhl a Senior Herpetology Keeper at Durrell Wildlife Conservation Trust, travelled to Madagascar on an internal travel award to reciprocate the visit and complete the exchange. The plan was to spend three weeks in Madagascar - two weeks in Andasibe with Association Mitsinjo and one week in Tamatave, visiting Parc Ivoloina, a small zoological collections run by Madagascar Fauna and Flora Group (MFG) who are in the process of setting up a small captive breeding facility for amphibian. Here is Nadine's account.

"Leaving behind a cold, wet January in Jersey I arrived in Andasibe exchanging the British winter for Madagascar's tropical rainy season. From the three (hibernating) amphibian species of Jersey for Madagascar's 300 plus species - Andasibe itself has over 100 species of frogs recorded there. Long before nightfall on that first wet afternoon the noise of the frogs calling was something incredible and that night Mampi and I were out with our torches looking for frogs. What I hadn't quite grasped before I arrived was just how many frogs there would be and how small most of them are! *Boophis pyrrhus* were everywhere, the small males only around 4cm in length. Many of the other species were no bigger and many were even smaller!

The next day, with the entry permits in place, I went to see the bio-secure Amphibian Survival Assurance Center where I was shown around by the Devin Edmonds, the Amphibians Conservation Director at Mitsinjo who introduced me to the team. As we entered it was shoes off, wellies on, hands washed and popping on lab coats to enter the facility. The main part of the building has two rooms, a large insect breeding room and an even larger amphibian room. The majority of the frog room is used for the assurance population of Critically Endangered Golden Mantella (*Mantella aurantiaca*); their founders are maintained as two separate populations from two different ponds plus their respective offspring. A corner

[1]Senior Keeper Herpetology, Durrell Wildlife Conservation Trust, Jersey.

of the room is dedicated to a few small groups of local and locally abundant amphibian species that have never been kept, bred or reared in captivity before. While I was there, Mitsinjo staff were preparing the quarantine area to receive some new species. Working in the facility actually wasn't too different to working with the amphibians in our own collection and the system of husbandry being very similar - including service order system, the breeding of food invertebrates, record keeping, the feeding regime as well as maintaining a high level of cleanliness and using clear disinfection procedures.

One of the aims of my visit was to assess the impact of Mampi's training at Durrell and I arrived armed with a questionnaire for Mampi, her colleagues and Devin; the results will help us to identify key areas of further training and prepare for the next member of staff from Mitsinjo visiting Jersey. Some of the ideas Mampi introduced after returning to Madagascar which had quite a big impact included changes to the husbandry of their invertebrate food colonies – even simple things like *e.g.*, moving springtails from small clear boxes to large blacked out containers made a massive difference to their breeding output. Seeing the invertebrate species we breed gave her more ideas: while walking through the local food market she noticed ean weevils on some loose dried beans so Mampi bought some of the beans and now they have an additional local food source for the frogs.

After spending time at Mitsinjo I travelled to visit MFG's Parc Ivoloina, just outside Tamatave. Once again I met a familiar face in Bernard Iambana Richardson, Parc Ivoloina's 'Chef du Parc', who had spent some time at Durrell in 2015 in both, our mammal and herpetology sections. MFG are setting up their own amphibian captive breeding centre and Durrell has supported the project with a seed grant and also provided help by facilitating training exchanges with Mitsinjo. While MFG are in the long process of setting up the centre, there are currently no amphibians kept, but staff are concentrating on sustainable live food culturing and that all the necessary infrastructure is in place. My visit to Ivolonia was more in an advisory role and helping to take a few more steps towards the center being up and running. Since my visit, MFG have recruited a voluntary amphibian husbandry assistant to help get the centre up and running, which will be a huge help to the team. One of the highlights of my time at Ivoloina was seeing the environmental education; it is a great example of how to implement important components of conservation. The education center and the on-site facilities are impressive. Parc Ivolonia supports local schools groups of all ages and run a Saturday school.

Overall, it was an amazing trip and an invaluable opportunity to put names to faces and working with so many passionate "amphibian people." It was great to offer all the help and support I could and believe it can only strengthen the links between our organizations and help develop Madagascar's *ex situ* capacity. We look forward to the next member of staff from Mitsinjo arriving for another internship and continuing developing these important links between us."

The team at Association Mitsinjo (left to right), Devin, Blasé, Edipsi, Justin-Claude, Samilia and Mampi. Photo: N. Wöhl/Durrell.

Nadine at the the Amphiabian Survival Assurance Center at Association Mitsinjo. Photo: N. Wöhl/Durrell.

Amphibian Ark Seed Grant Program

By Kevin Johnson[1], Devin Edmonds[2], Cybele Lisboa[3], Arturo Muñoz Saravia[4] & Jonathan Kolby[5]

Since 2009 the Amphibian Ark (AArk) has awarded seed grants to fund start-up rescue projects for amphibian species that cannot currently be saved in the wild. Over the past seven years, eighteen grants have been awarded to projects in thirteen countries, totaling US $88,160 (see Table 1). We would like to acknowledge the generous support of the Andrew Sabin Family Foundation, Chester Zoo, the European Association of Zoos and Aquariums, George Rabb, Josie Lowman, Naples Zoo in Florida, Ronna Erickson, the Wildlife Conservation Society, Woodland Park Zoo, and the other AArk supporters who helped establish and support these grants over the past seven years.

Successful proposals reflect AArk values and must include the following requirements:

- **An *ex situ* component**. While we highly value *in situ* conservation, research, assessment, and education, our funds are extremely limited and we require that all proposals include an *ex situ* component. *In situ* conservation, research, assessment, and education can be included as valuable components of any good proposal that otherwise focuses on rescuing species *ex situ*. Ideally, our support of *ex situ* components helps the projects to secure funds for these other components as we do not fund components such as workshops or educational exhibits, for which other funding could be found.
- **Working with species that need to be rescued.** Proposals must relate to rescuing species whose threats cannot be mitigated in nature in time to prevent their extinction and which therefore require urgent *ex situ* intervention to persist. This status should be determined by relevant field experts, *e.g.*, the IUCN SSC Amphibian Specialist Group field experts through AArk Conservation Needs Assessments (www.Conservation-Needs.org) or similar national processes. While we appreciate efforts to keep locally or regionally threatened but globally stable species, our limited funds are restricted to projects involving species that need help at a global level.
- **Working with species within their native range country.** Unless capacity absolutely cannot be built in the range country in time to prevent imminent extinction, we do not fund projects that remove animals from their range country. In addition, every effort should be made to enable national biologists to lead the program.
- **Adhering to recommended biosecurity standards.** Regardless of where the rescue populations are held, measures must be taken to isolate them from allopatric (non-overlapping) species that might be in the collection as well as from the original threats (*e.g.*, chytrid), except where a valid scientific argument can be made to the contrary. AArk has developed recommended biosecurity standards (www.AmphibianArk.org/pdf/Biosecurity_standards_for_amphibians.pdf) which should be followed by all projects which receive a grant.
- **Newly launched programs.** The concept of a 'seed' grant is to fund projects at the very beginning of their life in order to help them attract larger and/or long-term funding for the duration of the program. We do not favor projects that are already well established or have significant funding, although we are happy to see some funding in place for complementary components (like fieldwork or education).

Many of the conservation projects that have been funded by AArk seed grants have evolved into very successful programs. Four excellent examples are described below by the project coordinators, along with a brief update.

HONDURAS AMPHIBIAN RESCUE AND CONSERVATION CENTER (2012)

Jonathan Kolby, Honduras Amphibian Rescue and Conservation Center, Honduras

The protection of amphibian biodiversity in Honduras is challenged by numerous obstacles. Illegal deforestation continues at an alarming rate in many areas of the country, and its detrimental effects are confounded by the presence of amphibian disease. After detecting amphibian chytrid fungus in endangered and critically endangered amphibians in 2007, it became apparent that the country's cloud forest species are in jeopardy. In 2012 a seed grant from the AArk helped establish the Honduras Amphibian Rescue and Conservation Center (HARCC). The Center has been able to build upon this beginning to attract funding from other organizations.

The core project activities of the Honduran Amphibian Rescue and Conservation Center are:

- Establishment and maintenance of long-term captive assurance populations to buffer against the risk of extinction in the wild.
- Annual population supplementation via head-starting to increase the number of animals that may survive to adulthood and reproduce in the wild.
- Long-term amphibian disease monitoring in Cusuco National Park to identify increased risks of extinction.

Local capacity-building and public outreach are integral principles in this project, and the project will be based at Lancetilla Botanical Garden and Research Institute, a location with a high volume of school group visitation.

In May 2015, with help from the Omaha Zoo Foundation and Slobodnik Construction Group, Inc., two used insulted shipping containers were purchased and shipped to Omaha's Henry Doorly Zoo & Aquarium in the United States, to be developed as amphibian breeding facilities. Over the following months, zoo interns, zoo staff, and local businesses graciously volunteered their time and expertise to assist with construction activities. Both shipping containers were retrofitted with sanitization vestibules, additional plumbing, and improved electrical infrastructure. The containers were then transported to Honduras via ocean cargo ship and installed onsite at Lancetilla.

After several years of fundraising and planning, HARCC is now preparing to establish the country's first captive amphibian populations, made possible by funding from the AArk Seed Grant, Amphibian Survival Alliance Seed Grant, the Chicago Zoological Society-Chicago Board of Trade Endangered Species Fund, Rufford Small Grants for Nature Conservation, Omaha's Henry Doorly Zoo & Aquarium, and a generous donation from the Omaha Zoo Foundation.

[1]Amphibian Ark; [2]Association Mitsinjo; [3]São Paulo Zoo; [4]Bolivian Amphibian Initiative; [5]Honduras Amphibian Rescue and Conservation Center.

"I believe amphibian conservation is a global health priority and I'm excited to be able to help prevent the extinction of amphibians in Honduras through my rescue project made possible with the support of an Amphibian Ark Seed Grant." Jonathan Kolby.

CONSERVATION OF THE ALCATRAZ SNOUTED TREE FROG, *SCINAX ALCATRAZ* (2011)

Cybele Lisboa, São Paulo Zoo, Brazil

The Alcatraz Snouted Tree Frog, *Scinax alcatraz* is a tree frog, endemic to the small Ilha dos Alcatrazes (Alcatrazes Island) near São Paulo in Brazil. Due to its occurrence in a restricted area (135 ha) and the threats to its habitat, this species is listed as Critically Endangered in the IUCN Red List.

The island belongs to the Brazilian Navy, and until 2013, it was used for target practice by navy ships. These practices often used to cause spot fires on the island and consequently destroyed bromeliads, the habitat of this tree frog. For this reason the establishment of an *ex situ* breeding program, as well as maintaining a viable population in captivity, was deemed necessary and urgent. Founder animals were collected in 2011 and were housed in a biosecure room developed at São Paulo Zoo to house the Alcatraz Snouted Tree Frogs. In that year, the Amphibian Ark seed grant allowed us to purchase an air conditioner, water filtering and misting system, aquariums and lighting equipment for the amphibian room.

The Alcatraz Snouted Tree Frog had never been maintained in captivity, so before working directly with the species, the Zoo conducted a pilot study using a closely related surrogate species, *Scinax perpusillus* in 2009. After two years working with the surrogate species, learning and developing management and reproductive techniques, it was time to apply our experience to the Alcatraz Snouted Tree Frog. The husbandry and reproduction of *S. perpusillus* proved to be successful in the pilot study and the skills acquired during this process were then applied to the threatened Alcatraz Snouted Tree Frog. Using the same protocols developed and after just three months in captivity, offspring were produced. Currently there is a population of about 150 adult captive-born *S. alcatraz* maintained at São Paulo Zoo, as well as the founder animals. The breeding protocol has been established since 2012 and in case of immediate need, we are able to increase the number of individuals produced under these conditions.

The Brazilian Navy stopped the target practice at the island due an agreement made with the governmental institution "Instituto Chico Mendes" (ICMBio) to protect the endemic island species. Even with the end of this practice, is still necessary for us to maintain a backup population of *S. alcatraz* due to its restricted range of occurrence. Now, we are developing different researches with this population to test its viability for reintroduction, providing subsidies for *ex situ* conservation. The most recent study is testing the locomotor performance of the individuals born in captivity - the locomotor function of organisms is the key to catching prey and escaping from predators, among other activities that determine its survival.

"This program has been extremely important, not only to the species, but also to Brazilian amphibian conservation in general. Due to the good results, this pioneer ex situ program is now being included in conservation actions in Brazil. Also, this program is calling the attention for the situation of amphibians in Brazil and serving as an example for others zoos and institutions, encouraging them to initiate programs like this with others amphibian species." Cybele Lisboa.

In 2010 a seed grant from the Amphibian Ark helped the Bolivian Amphibian Initiative to obtain aquariums with filtering systems and other related equipment to maintain water quality for different *Telmatobius* species. Photo: Arturo Muñoz Saravia.

BOLIVIAN AMPHIBIAN INITIATIVE (2010)

Arturo Muñoz Saravia, Museo de Historia Natural Alcide d'Orbigny, Bolivia

The Bolivian Amphibian Initiative has been working for a number of years with Bolivian amphibians, and is now focusing efforts on the high Andean species of the aquatic frogs of the genus *Telmatobius*.

This project encompasses four main areas:

- **Field research.** Obtaining information about populations, habitat, threats and requirements
- **Capacity building.** Training young biologists, students, local communities and park guards in amphibian monitoring methods
- **Raising awareness**. Developing different educational activities, in local communities, schools and in the Museum of Natural History
- **Captive breeding.** Working with *Telmatobius hintoni*, *T. yuracare*, *T. simonsi*, *T. gigas*, Titicaca Water Frog, *T. culeus* and other species that are probably new to science.

In 2010 a seed grant from the Amphibian Ark helped us to obtain aquariums with filtering systems and other related equipment to maintain water quality for the different *Telmatobius* species. An event in 2015 underscored the critical importance of the captive population. Although an annual pollution spike has caused small die-offs in the past, an unprecedented pollution event at Lago Menor in Lake Titicaca in the spring of 2015 caused massive frog mortality. Efforts by scientists and local officials are underway to identify and dramatically reduce the sources of pollution in Lake Titicaca, but these will take time and political will to accomplish. In the meantime, the frogs at the Museo de Historia maybe the Lake Titicaca Water Frog's best hope for the future.

In early 2016, thanks to a grant from IUCN Save Our Species (SOS) fund, an additional shipping container was purchased and set up as a new breeding facility for the Titicaca Water Frogs. A group of amphibian experts from a range of organizations including the Durrell Wildlife Conservation Trust, Kansas City Zoo and Atlanta Zoo volunteered to go to Bolivia and work with the team from the Bolivian Amphibian Initiative to set up the new container to house Titicaca Water Frogs, collect new founder animals from Lake Titicaca, and establish them in the new facilities. This fantastic cooperation brought together a wealth of expertise and experience and resulted in a new network of individuals and organizations from around the world committed to working together to support the Titicaca Water Frog.

In addition to the AArk seed grant, the work of the Bolivian Amphibian Initiative has been supported by a range of institutions including the Amphibian Specialist Group, Rufford Small Grants, Durrell Wildlife Conservation Trust, European Association of Zoos and Aquaria, Denver Zoo, Fresno Chaffee Zoo, Museo de Historia Natural Alcide d'Orbigny, Idea Wild, Stiftung Artenschutz, Jacksonville Zoo, Kansas City Zoo and Atlanta Zoo.

"This seed grant provided vital support in the goals that I have as a conservationist and researcher." Arturo Muñoz Saravia.

ESTABLISHING A CAPTIVE BREEDING FACILITY FOR MALAGASY AMPHIBIANS (2009)

Devin Edmonds, Association Mitsinjo, Madagascar

Slightly more than one quarter of Madagascar's amphibian species are threatened with extinction. Habitat destruction and overharvesting are the greatest factors contributing to this biodiversity crisis, but the impending threat of amphibian chytrid fungus *Batrachochytrium denrobatidis* (*Bd*) is also of huge concern.

Association Mitsinjo, a community-run organization founded by villagers in Andasibe, began construction of Madagascar's first amphibian captive breeding facility in 2010, and it was opened in 2011. This facility maintains captive amphibian populations to help ensure the continued survival of species at the greatest risk of extinction. In 2009 the funds from the AArk seed grant were used to purchase supplies for live food production and equipment for field work. The real benefit from financially supporting this proj-

The Golden Mantella Frog, *Mantella aurantiaca*, is one of Madagascar's most threatened amphibian species. To safeguard against extinction a captive assurance population was established at the Mitsinjo breeding facility in Madagascar in February 2012. Photo: Devin Edmonds.

ect however, was the ability to demonstrate solid backing from the AArk on applications to leverage additional funding from a range of other organizations.

Two common frog species, *Boophis pyrrhus* and *Mantidactylus betsileanus* were originally bred at the facility. The resulting tadpoles were used to study the optimal husbandry requirements for the larvae of these species, which are being applied to maintaining threatened frog species of similar ecological guilds. Additionally, technicians gained tremendously valuable experience raising tadpoles and frogs in captivity, and have developed a unique set of skills to aid current and future *ex situ* conservation action in Madagascar.

The Golden Mantella Frog, *Mantella aurantiaca*, is one of Madagascar's most threatened amphibian species. To safeguard against extinction and help mitigate the loss of the mantella frog breeding sites found on the footprint of the Ambatovy Nickel and Cobalt Mine, a captive assurance population of the Golden Mantella was established at the Mitsinjo breeding facility in February 2012. The frogs are maintained by a team of eight Mitsinjo technicians, and successful breeding has taken place on a regular basis.

At the end of 2015 preliminary results from the Conservation Needs Assessments were used to help select new species for Mitsinjo's captive breeding program - *Anodonthyla pollicaris*, *Boophis bottae*, *Gephyromantis boulengeri*, *Platypelis barbouri*, and *Plethodonthyla notosticta*. Also contributing to species selection was input from national collaborators and an evaluation of the feasibility of establishing survival assurance colonies for associated priority species if and when needed. In February 2016 small numbers of these five new species were collected from the forest surrounding the breeding station. Maintaining more common and often abundant species in eastern Madagascar will provide better understanding of the captive requirements of their more threatened relatives.

Association Mitsinjo is extremely grateful to the AArk for helping us launch this project, and to the additional organizations which have supported the continued development of the facility since receiving the AArk Seed Grant: Woodland Park Zoo, Understory Enterprises, Ambatovy Minerals S.A., Cleveland Metroparks Zoo, Cleveland Zoological Society, Conservation International, Biopat, DGHT, SACAS, Toronto Zoo, the Wildlife Conservation Society, American Frog Day, Dendrobatidae Nederland, Colchester Zoo, Chester Zoo, Niabi Zoo, Tree Walkers International and Durrell Wildlife Conservation Trust.

"*This project was a dream of Mitsinjo's for years and now we finally have the infrastructure and specialized knowledge in place to conserve Andasibe's amphibians through ex situ means.*" Devin Edmonds.

Table 1. Amphibian Ark Seed Grant recipients, 2009-2015.

Project	Organization	Country	Amount
2015			
Rescuing the endangered Merida's Collared Frog	University of Los Andes at Merida	Venezuela	$5,000
Establishing a breeding laboratory specializing in *Pristimantis* species	Fundación Zoológico Santacruz	Colombia	$5,000
Saving endangered frogs from Cordillera del Condor	Amphibian Conservation Center - Zoo Amaru	Ecuador	$4,998
2014			
Developing a captive breeding facility at Parc Ivoloina	Parc Ivoloina	Madagascar	$5,000
Construction of a breeding room at Centre Valbio for endangered frogs from Ranomafana National Park in south-east Madagascar	Centre Valbio	Madagascar	$4,988
The first amphibian rescue center in Argentina: An *ex situ* conservation program for *Telmatobius pisanoi* and *T. stephani*	La Plata University	Argentina	$5,000
2013			
Ex situ conservation program for the Ecuadorian Tiger Frog	Gustavo Orcés Herpetological Foundation	Ecuador	$5,000
Ex situ methodology building for Neotropical caudates	Costa Rican Amphibian Research Center	Costa Rica	$4,700
Ex situ management of *Centrolene buckleyi* in Ecuador	Centro Jambatu	Ecuador	$5,000
Ex situ reproduction and *in situ* conservation of *Alsodes vanzolinii*	Universidad de Concepción	Chile	$5,000
2012			
Honduras Amphibian Rescue and Conservation Center	Honduras Amphibian Rescue and Conservation Center	Honduras	$5,000
Conservation Plan for *Eleutherodactylus portoricensis*	University of Puerto Rico at Humacao	Puerto Rico	$4,939
2011			
Conservation of *Scinax alcatraz*	São Paulo Zoo	Brazil	$5,000
2010			
Conservation of the Cuban Long-nosed Toad	Museo Nacional de Historia Natural de Cuba	Cuba	$5,000
Frogs and toads from south-eastern Colombia	Jonh Jairo Mueses-Cisneros	Colombia	$5,000
Bolivian Amphibian Initiative	Museo de Historia Natural Alcide d'Orbigny	Bolivia	$5,000
Maude Island Frog Habitat	Orana Wildlife Park	New Zealand	$3,563
2009			
Establishing a captive breeding facility for Malagasy amphibians	Association Mitsinjo	Madagascar	$4,972

Students Secure the Safe Migration of Amphibians in Leeuwarden

By David Brouwer[1], Remco Ploeg[1], Tariq Stark[2] & Koen van Lieshout[1]

The Potmarge is a small river meandering through the city of Leeuwarden, in the North of the Netherlands. A large proportion of this river is guided by small streaks of fairly natural riverbanks on both sides. Unfortunately, there is also a busy bicycle road, situated alongside the river, causing fragmentation of amphibian habitats. As a consequence, a large number of amphibians are killed while crossing the road during their migration from hibernation sites to breeding waters.

However, as detrimental as this situation to the amphibian community is, it also provides a remarkable opportunity. The bicycle road is right in front of Van Hall Larenstein, University of Applied Sciences. Passionate students are given the opportunity to get involved in a road mitigation project (initiated by Carlijn Laurijssens and Tariq Stark) as a volunteer or member of the coordination team to learn essential research- and natural history skills, get experience with project management and help employ outreach programs for the local community. Five years down the road the project still exists and expands with each consecutive year, all thanks to the dedication of students, the municipality of Leeuwarden and VHL University of Applied Sciences.

HELPING THE AMPHIBIANS CROSS THE ROAD

Every year in spring, when the amphibians are migrating to their breeding waters, the cycle road is fenced at both sides, preventing amphibians from crossing it by themselves (Fig. 1, 2). Subsequently, the amphibians are trapped in pitfalls that are emptied by students twice a day. This resulted in a safe passage for more than 3,000 amphibians in the past five years. The majority consists of Smooth Newts (*Lissotriton vulgaris*) but also decent numbers of Common Toads (*Bufo bufo*) are present. Just a small proportion consists of Grass Frogs (*Rana temporaria*), Marsh Frogs (*Pelophylax ridibundus*) and Edible Frogs (*Pelophylax* kl. *esculentus*) (Fig. 3). The Edible Frog is a hybrid between the Marsh- and Pool Frog (*Pelophylax lessonae*). The low numbers of Marsh- and Edible Frogs can probably be linked to their late period of activity. More importantly, they hibernate at the bottom of breeding sites and rarely need to cross roads or migrate great distances.

In 2016, David Broek, David Brouwer and Remco Ploeg coordinated a team (with the support from Van Hall Larenstein lecturer Koen van Lieshout) of more than 20 enthusiastic students, all contributing to the success of this project. Thanks to them, 558 amphibians safely reached the other side of the road. Figure 3 depicts the numbers per species from 2012 to 2016. We observed a small early peak of activity in the last week of February 2016 due to some warm days. This only lasted for a few days however, because the temperatures dropped again in the first half of March. The vast majority of amphibians migrated in the second half of March and the first half of April when the temperatures were suitable again.

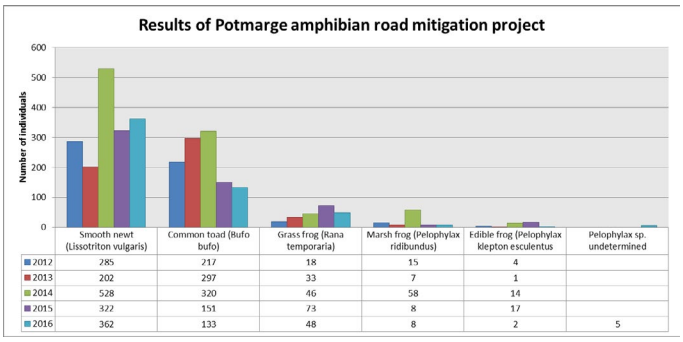
Helping hundreds of amphibians to safely cross the road each year is of course a good thing on its own merits. However, the educational value of the whole project may be even more important. In 2016, we a reached the wider public with our message about why amphibians and other animals are so important.

THE FINGERPRINT OF A NEWT

The students that were directly involved in the project learned a lot about amphibian ecology, behaviour and, of course, how to protect them. In addition, this year we started to explore certain scientific methods regarding capture-mark-recapture techniques. Identification of individuals was based on photographs of the unique belly patterns in individual Smooth Newts, providing us with a non-invasive method.

Fig. 1: Volunteers and the municipality of Leeuwarden set up the fencing. Photo: David Broek.

Fig. 2: From left to right: The Potmarge river, the fencing and the bicycle road. Photo: David Broek.



	Smooth newt (Lissotriton vulgaris)	Common toad (Bufo bufo)	Grass frog (Rana temporaria)	Marsh frog (Pelophylax ridibundus)	Edible frog (Pelophylax klepton esculentus	Pelophylax sp. undetermined
2012	285	217	18	15	4	
2013	202	297	33	7	1	
2014	528	320	46	58	14	
2015	322	151	73	8	17	
2016	362	133	48	8	2	5

Fig. 3: The number of transferred amphibians per species during five years of the Potmarge amphibian road mitigation project.

[1]Van Hall Larenstein, University of Applied Science; [2]RAVON, Reptile, Amphibian and Fish Conservation in the Netherlands.

Fig. 4: Male Smooth Newt with distinct belly pattern placed in a CD cover for photo-identification. Photo: Niek Oldenburg.

Students collected observations with photographs using a custom-made digital standardized field form (developed by Koen van Lieshout) within the ArcGIS Collector application. The application allowed students to collect the data off-line in the field using a smartphone. The collected data was easily uploaded to one joint online database (ArcGIS Online) as soon as access to internet was available again. This method was a major success as it gives a clear and easy structure for data collection and storing, which is necessary as more than 20 volunteers were collecting photos, all with different devices.

We used photo identification software to analyse the photographs for a quicker comparison (as described in Mettouris *et al.*, 2016 *(4)*). In this instance, we used the computer program I3S Classic (Interactive Individual Identification System). It creates a database of "fingerprints" as a result of manually annotating the centre of the spots on the belly pattern of each individual newt. Subsequently, I3S compares the fingerprints in the databases to find matches. Perhaps additional photo-identification software e.g. WildID could also be used for this purpose. Results of I3S as well as WildID could be compared in the future.

It was not always easy to make quality photographs due to often low-light conditions and the use of smartphones to take pictures. This resulted in the fact that we were only able to identify male smooth newts as they have a much more distinct belly pattern compared to females. One of the challenges was to fixate the amphibians, as one of the conditions for the use of photo identification software is to photographs newts in a straight position. To fixate the newts we gently placed them between the two sides of a CD cover (Fig. 4, 5). Volunteers were also provided with a small measurement tape that they could place next to the newt. In this way it is possible to do measurements on the newts without long handling time, thus reducing stress. As a result, we collected a lot of valuable data rather easily. In 2017 we aim to continue this study and build a larger dataset in order to more accurately assess the population size, structure and temporal- and spatial use of newts. We will keep you updated!

Fig. 5: Female Smooth Newt with exceptionally distinct belly pattern placed in a CD cover for photo-identification. Photo: Niek Oldenburg.

TRANSFORMING PERCEPTIONS

Other than students from VHL University of Applied Sciences, we also did an outreach project for students of nearby secondary school C.S.G Comenius. In cooperation with teachers, we gave practical lectures on field ecology to six classes. The focus of those lectures was to show students the variety of life in the water and how the different animals interact with each other (*e.g.*, food web). Amphibians and our mitigation project were included in this story. It was nice to see how fear of supposedly creepy, slimy animals quickly changed into admiration.

We also organised an excursion day to make the residents of Leeuwarden enthusiastic about wildlife in the Potmarge and about our project. Armed with dipping nets, we visited several promising ditches and ponds to show the wide variety of animals that lived there. It was a great success and not only primary school children, but also their parents were astonished about the diversity of life in their city (Fig. 6).

All these activities were invaluable of course, but the highlight of this year was without doubt the visit from the Dutch radio and television show 'Vroege Vogels' (Early Birds) about flora and fauna in the Netherlands. They were interested in the project because it is completely run by students and because of the photo-identification project of smooth newts. The radio broadcast can be found at the website of the Dutch public service television (5).

This year, new students will help amphibians cross the road again. We plan to continue the photo-identification research with improved methods and database. Moreover, we hope to get many local people and students involved in the project again so they will admire and respect our urban wildlife. This is essential to get support for the project, guaranteeing its future and the future of the amphibians living in the Potmarge area.

Acknowledgements:

We would like to thank the municipality of Leeuwarden, especially Gilberto Squizzato and his team. We are also grateful for the cooperation with Comenius teacher Lies le Clercq and other teachers that helped during the guest lectures. Finally we would like to thank all volunteers of the project, because their effort was essential for the success of the whole project.

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Fig. 6: An excited boy with an aquarium of Smooth Newts (*Lissotriton vulgaris*), a Common Toad tadpole (*Bufo bufo*), Ninespine Sticklebacks (*Pungitius pungitius*), a Spined Loach (*Cobitis taenia*) and a Common Roach (*Rutilus rutilus*), all found during the excursion day. Photo: Remco Ploeg.

Karaavali Skittering Frog, a new frog species discovered from the western coastal regions of India. Photo: Seshadri KS.

Discovery by a Citizen Scientist: A new Species of Frog that calls like a Kingfisher

By Gururaja KV[1]

Can you please tell me what species is this?" asked CR Naik while playing a call record from his mobile phone. "White throated Kingfisher" was the unanimous and quick response from all of us, who were sitting in Naik's house after a brief survey of frogs in Sanikatta village in June 2015. I went a step further to cut a joke saying, "What is this Naik? Even after 8 years of bird watching, you still do not know one of the most common bird." The response from Naik made me fall flat on my face. He said "Ho Sir, this is not from a Kingfisher, but from a frog. Now please tell me what species is this?" still being very enthusiastic about knowing the species. I did not know what the species was, and neither did my team. We had just released our CD on Acoustic Guide to Frogs and Toads of the Western Ghats, and compared this call with the database, but none of them matched with what Naik had recorded. The conversation ended up as a serious discussion and search for the frog species. We ask Naik to make a small video of the unknown species.

My journey with CR Naik started in 2006-2007, when I visited Dandeli Anshi Tiger Reserve (DATR) to carry-out a research project on Anuran diversity and distribution in Dandeli Anshi Tiger Reserve. We met in a very strange way though. Naik was then a guard at the Tiger Reserve and was accompanying me as an official from forest department. The very first question he asked me was "What is this species?" pointing at a frog in the dark that was making a bird like call. I could tell that it was a Castlerock Night Frog, but not before having a lengthy conversation on how to identify a frog, what to observe and how to record it. I had similar interactions with Naik for next couple of years throughout my frog survey visits and every time Naik was curious to know more about frogs. He has been very active in searching frogs and now knows more than 30 species of amphibians from the DATR. Naik is enthusiastic and passionate about not only frogs but also other species. He has made several natural history observations like the feeding behaviour of pied hornbills, understanding the phenology of trees in the Tiger Reserve, identifying spiders, butterflies and so on. In the last few years, Naik has been actively involved in education programs and gives free talks at schools and colleges to create awareness and spread messages about conservation. For his nature education activities, he received prestigious Jumbo Award in 2012.

In July 2015, Naik sent me a few pictures and mobile video clips of the frog species, and I was convinced that this could be new species. In the 3rd week of July, Naik and Seshadri KS, who is a Ph.D. student at the National University of Singapore, searched the paddy fields of Sanikatta and got a few individuals of the frog species that we were looking for. After the search Seshadri said, "Indeed the frog call resembled that of a white-throated kingfisher. It was through this clue we located the frogs in inundated paddy fields and were surprised to see that the sound was indeed coming from frogs and not from the kingfisher bird."

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Citizen scientist, CR Naik in the field. Photo: Gururaja KV.

The next step was to see whether it was indeed a new species or not. I sent the tissue samples to Ms. Priti H, a PhD Student at Ashoka Trust for Research in Ecology and the Environment (ATREE). "It was not easy to distinguish the new species even with molecular phylogenetic analysis. There was some confusion. An earlier work of 2009, placed one of the sequences of the new species to an earlier described species of *Euphlyctis hexadactylus*. I had to check for voucher specimens collected at the localities of all described species to ascertain if what we were looking at was indeed new," says Priti.

During the same time, the species was recorded by Ramit Singal, a freelancer and a citizen scientist, who was working on "My Laterite: My Habitat," an outreach and education initiative at coastal town Manipal in Karnataka state. By the end of August, the new frog species was known from seven localities along the coast, and the majority of them were explored by CR Naik.

Seshadri and myself performed bioacoustic analysis of the call which proved the frog species to be new to science. One of the video clips sent CR Naik is available here. The frog belongs to a group known as "skittering frogs", because of their habit of floating on water and skittering away when disturbed. With consensus from the team, the frog was named as Euphlyctis karaavali after Karaavali, the coastal region of Karnataka. The Karaavali Skittering Frog is considered to be Endangered due to its restricted geographic area and threat from expanding developmental activities like expansion of highways and conversion of land to non-agricultural purposes. Currently there are only seven known species in this genus and are found as far west as the Southwestern Arabian Peninsula through South East Asia to the east.

The new species of frog was published in the Asian Herpetological Research journal (DOI: 10.16373/j.cnki.ahr.160020) on 25th December 2016. The team comprised of Priti H, Naik CR, Seshadri KS, Ramit Singal, Vidisha MK, Ravikanth G and and Gururaja KV.

After the publication, I spoke to Mr. CR Naik. He said, "I am so happy that a new frog is discovered from my native place and I am delighted to be part of this discovery. I am thankful for the entire team who trusted me. This discovery has motivated me and I will continue making natural history observations. Only such observations can help in creating awareness among citizens about nature." Mr. Naik is currently the Deputy Range Forest Officer at Dandeli Anshi Tiger Reserve (Kali Tiger Reserve).

The discovery of a new frog species involving citizen scientists like Mr. Naik and Mr. Ramit Singal was a wonderful journey to me. This helped me personally to no longer be complacent about natural history observations. I sincerely hope that this discovery inspires and motivates many more people to get involved in frog research and conservation. I hope more observations will be posted on Frog Watch India portal in days to come. Only by such efforts of both scientists and citizens, can we have successful amphibian conservation programs, not only India, but across the globe.

Habitat of Karaavali Skittering Frog at Sanikatta, Kumta, Karnataka. Photo: Gururaja KV.

Nurturing Citizen Scientists Through Wetland Rehabilitation

By Cherise Acker-Cooper

Durban, on the east coast of South Africa, has an assortment of wetlands, from big to small, temporary to permanent, grassy to reedy. Many people pass these precious ecosystems without realizing how important these natural water filters are to our survival. They clean our water and store valuable water resources as ground water but they are also a home for many creatures both great and small.

Durban wetlands are a haven for approximately 35 different frog species. These frogs often go undetected until the spring rains arrive, bringing a chorus of croaks, whistles, squeaks and chirps, announcing their return from their long wintery slumber. Urbanites then tuck their heads under their pillows to endure the public frog courting process. Unfortunately, frogs do not know how to WHISPER sweet nothings to each other!

But these calls signal something far more important than the start of the mating season, it conveys to us that our wetlands are doing well. Frogs are sensitive to pollution on both land and in water. A decline in croaking calls should signal something alarming to us and the night time silence that you wish for should rather keep you up with worry.

The Endangered Wildlife Trust's Threatened Amphibian Programme (TAP) is working tirelessly to rehabilitate protect several precious Durban wetlands that are home to the Endangered Pickersgill's Reed Frog (*Hyperolius pickersgilli*), which serves as a flagship for many other frog and wetland residents. Through the Department of Environmental Affairs and in partnership with eThekwini Municipality, TAP employs 65 people to clear alien invasive plants and rehabilitate four priority wetlands in the greater eThekwini municipal area, namely: Mt Moreland, Isipingo, Adams Mission and Widenham.

The Adam's Mission wetland in particular is rich in biodiversity and in addition to Pickersgill's Reed Frog, also comprises patches of swamp forest that host the Endangered Kloof Frog. Through their protection TAP, is promoting water security, the conservation of other wetland residents and initiating positive social change within the surrounding communities.

TAP realizes that because our clearing teams are in field most days they have an opportunity to positively contribute to the scientific community through Citizen Science.

To facilitate this process, TAP developed a field ecology handbook to assist teams with animal identification, including frogs, birds, butterflies and plants. We also turned to social media through WhatsApp as a platform for our field staff to share their discoveries. In TAP's most recent intervention, we have created iSpot accounts for all contributors to post their observations.

Through these interventions we have seen a marked increase in our field staff contributions with a growth of 79% since the iSpot intervention. This is opening a whole new group of people who are able to contribute as Citizen Scientists and we are excited and proud to be a part of this!

Maybe next time you hear the call of the frog, jump out of bed, grab your torch, put on your gumboots, take a photo and join all types of Durbanites in conserving our precious frogs. You may even find the Endangered Pickersgill's Reed Frog!

Red Toad (*Schismaderma carens*). Photo: Sizwe Shozi.

Greater Leaf Folding Frog (*Afrixalus fornasinii*). Photo: Joseph Kweyama.

#NotJustFrogs – A Citizen Science Initiative in a Stunning University Town of India

By Madhushri Mudke[1]

Scientific studies can make a huge difference with the help of citizen scientists. In the stunning town of Manipal within the Western Ghats of India, we started a campaign to increase awareness of frogs. The town is situated on a laterite plateau, and is well-known for a top-tier private educational institution, the Manipal University. Over 25,000 students from across 60 countries study here, making it one of the most cosmopolitan towns in India. Within a fast growing economy, Manipal, thankfully, still has many untouched natural spaces which several endemic amphibians, birds and mammals call home.

The government classifies laterite plateaus as "wastelands" and therefore the town that supports a brilliant biodiversity is facing threats from all sides. And yet again, amphibians will be the first to bear the brunt. In India, frogs are often ignored by citizens in spite of them being a very important bio-indicator species. We started the #NotJustFrogs movement with help from researchers at Gubbi Labs to not only draw attention to the tiny croakers, but to also scientifically document them. Manipal supports a brilliant population of frogs. More than 22 species have already been reported. In monsoons, ephemeral pools are formed on the plateau which serve as breeding grounds for a variety of endemic frogs. In the year 2016, *Microhyla laterite*, a new species of narrow-mouthed frogs was discovered here. Several other species are just waiting to be found as well!

#NotJustFrogs campaign was launched in October 2016. In a span of three months -

- We've delivered lectures on the importance of frogs in different educational institutes which are a part of Manipal University. We've also expanded the awareness drive to educate students on school trips to nearby biodiversity hotspots, reaching a total number of 256 children in the age group of 14 to 17 years. The transformation in their attitude towards frogs is indeed heart-warming.
- Students, locals and faculty members came together and gave rise to our very own Frogs of Manipal (FoM) club.
- Our regular frogging activities include at least two guided frog-walks for students which encourages their gradual transformation into citizen scientists! More than 20 frog walks have been conducted. The maximum number of students on a frog-walk has increased to 18. The moderators maintain high ethical standards and regular data sheets.
- With the involvement of citizens we have documented about 5 road-kills in the dry season. We also recorded an eyeless Endangered frog - *Uperodon mormorata* and Nematode infection in an aquatic frog.
- To bridge the gap between the scientific literature and concerned citizens, we started a weekly blog under the hashtag #FridayFrogFact. The blogs speak about different frogs and are published on www.girlgonebirdzz.com. Approximately 9 frog blogs have been written so far, reaching international platforms like The Society for the Study of Amphibians and Reptiles (SSAR).

Our club has grown to more than 130 members on Facebook. In the future, we aim to make a larger community and organise fun activities like Frog Movie Nights. We also plan to approach the university to set up Batrachariums - natural reserved habitats for frogs and continue scientific documentation of endemic frogs, their abundance and record any abnormalities while finding links to climate change.

Acknowledgments:

My heartfelt thanks to each participant of the FoM community. I must mention Dr. Gururaja for motivating me, Mr Rahul SN for organizing talks, Archit Kejriwal for technical support and to all the scientists from Gubbi Labs.

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Curious kids take a look at a frog while a Frog-Watching session. Photo: Sudha Iyer.

Nematode infection in an aquatic frog. Photo: Madhushri Mudke.

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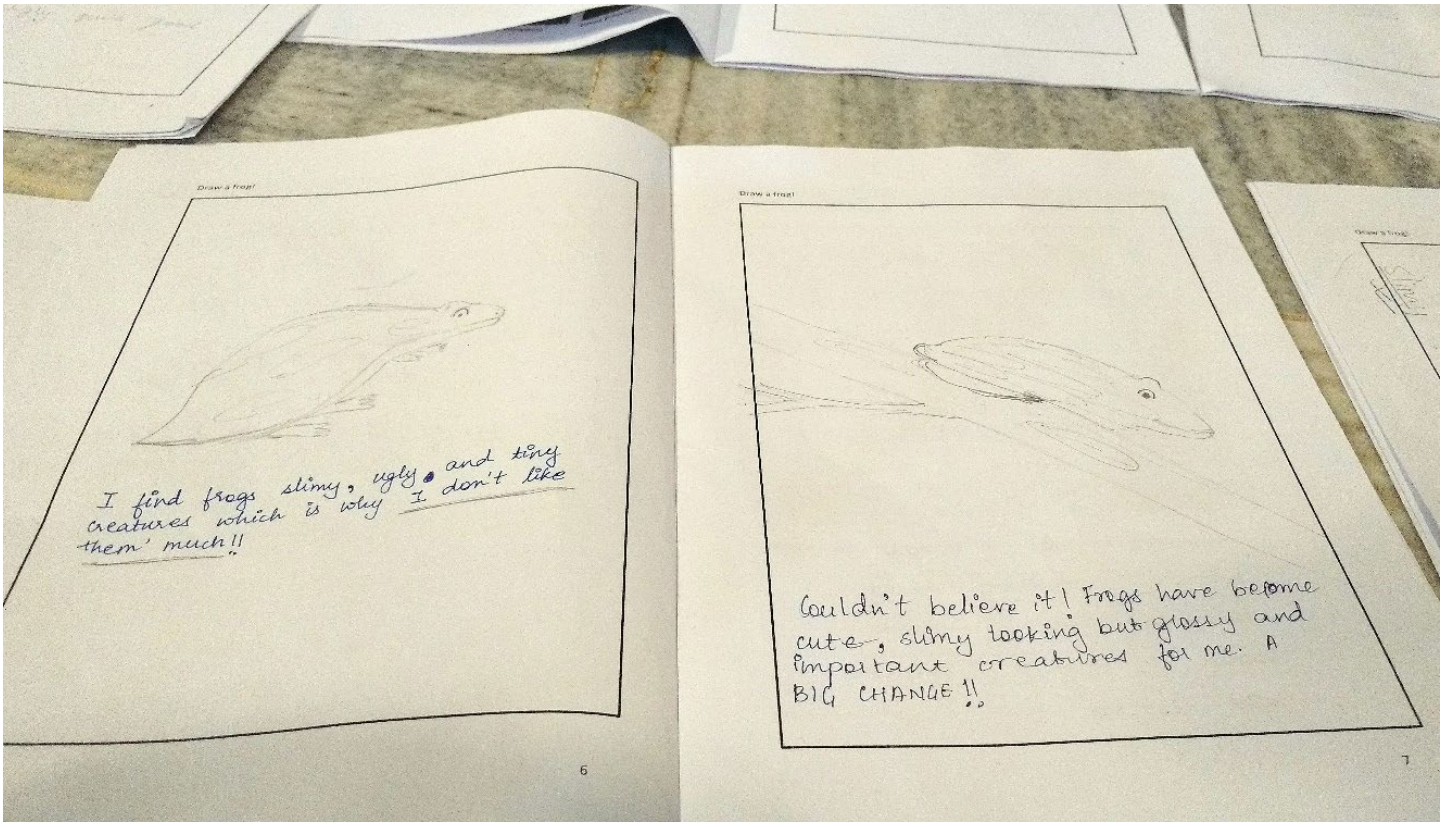
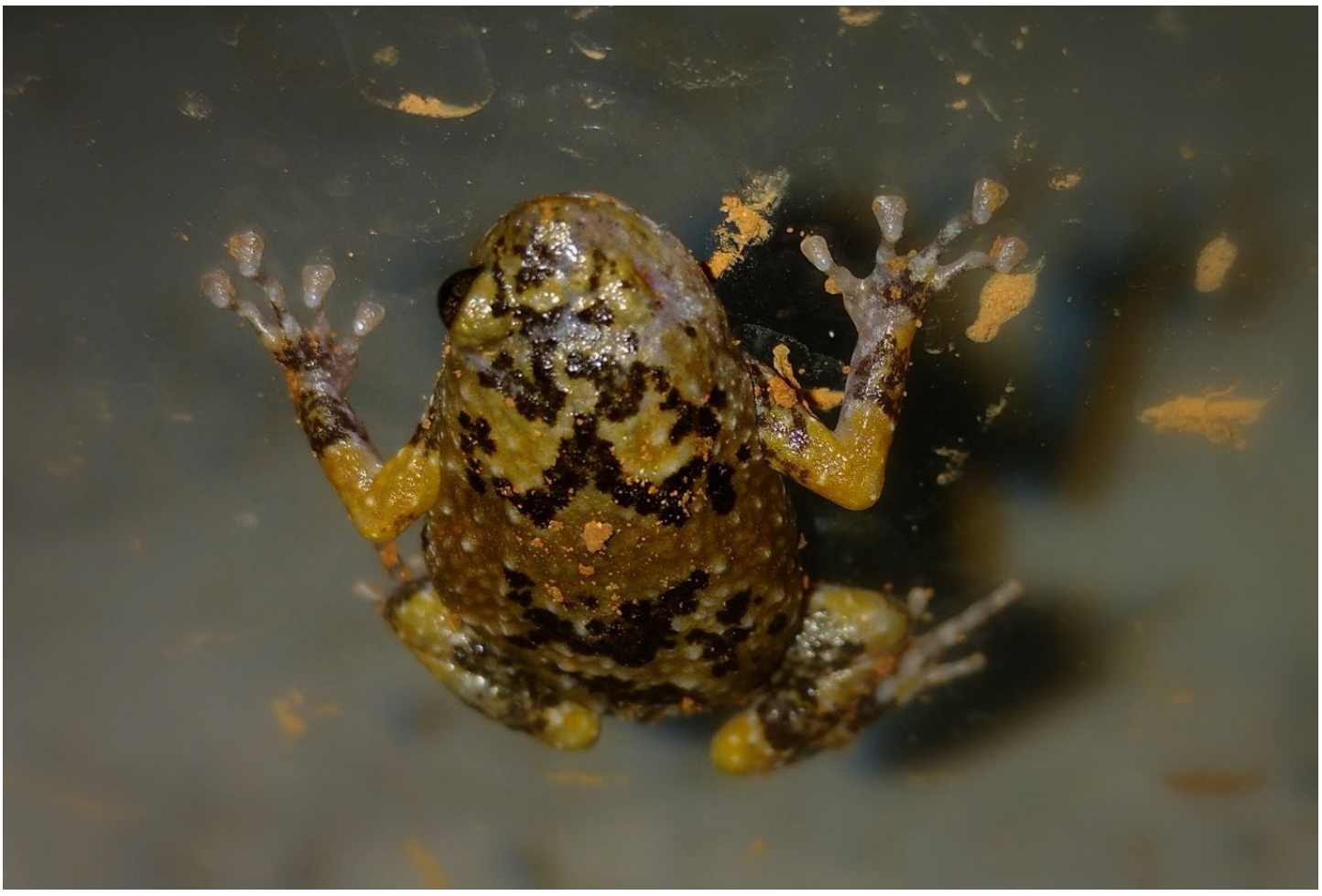


A 9th grade student pens down his/her thoughts after a frog talk. Photo: Madhushri Mudke.



An eyeless *Uperodon mormorata*. Photo: Madhushri Mudke.

A naturalist guides a group of preschool students in a search for tadpoles at the Harris Center's educational "frog pond." Photo: Harris Center for Conservation Education (New Hampshire).

Raising the Next Generation of Amphibian Aficionados

By Dave Huth

One of the most widely applied principles of conservation is summarized in Senegalese conservationist Baba Dioum's declaration to the IUCN's 1968 General Assembly: "In the end we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught."

In the spirit of this often-quoted ideal, many conservationists labor to bring together knowledge and action through a bridge of love. A frequent focus of energy for that labor is teaching and empowering children.

This 5 year old has been taught to carefully and safely find and identify salamanders in the forests of Allegany County, New York (USA). Photo: Dave Huth.

Journalist Richard Louv's best-selling *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder* (Algonquin Books of Chapel Hill, 2005) presents a virtual manifesto for the improvement of human life by raising children with experiences of the natural world. Not as frequently cited is the corollary of Louv's argument: teaching children to know and value nature will also provide the foundation of nature's conservation well into the future.

Conserving amphibians is a notoriously multi-fronted battle. Habitat destruction, the spread of pathogens and invasive species, changing climate, and other threats can all be described through their most obvious common characteristic—values-motivated collective decisions made by human beings.

USING WONDER TO SHAPE YOUNG MINDS

How can human values be shaped to encourage decisions that protect and preserve the habitats and disease-free environments amphibians need to survive and thrive?

Jeff Beane, Herpetology Collections Manager at the North Carolina State Museum of Natural Sciences, believes children are especially open to internalizing the values of conservation.

"Children can have more of a sense of wonder than adults," Beane says of his work educating the public, "and early experiences that make a positive impression on them can be things that they carry

for the rest of their lives… If they are taught to be conservationists early in life, chances are they always will be."

Rachel Rommel-Crump, a conservation practitioner and ASG's Communications & Education Working Group facilitator, agrees. "For a future conservation outcome, I find it important that young people learn to think critically and understand the importance and interrelatedness of the world around them, how they impact the natural world, and how that, in turn, can impact themselves and others."

But Rommel-Crump also believes these efforts don't necessarily need a long wait to produce results: "Not only are young people the future stewards of our natural resources, they can also have an impact on conservation efforts today." She says she's encouraged by ways that young people worldwide often surprise their elders by self-mobilizing for environmental issues that they care about.

"Youth campaigns have been responsible for many of the designations of state amphibians across the United States, and have also been involved in speaking out to local policymakers," she says.

THE NEXT GENERATION OF AMPHIBIAN AMBASSADORS

For many conservationists, developing approaches to encourage children and young adults for a life of support and action on behalf of amphibians is an ongoing process of experimentation and adaptation. Many find it important to think strategically, to educate young people as ambassadors to peer groups, or even parents, beyond the reach of any particular program or organization.

Melanie Smith, an environmental educator and director of communications for the Roger Tory Peterson Institute (RTPI) in Jamestown, New York, says she is enthusiastic about kids' propensity for networking and sharing their ideas.

"Fortunately, younger people often have the advantage of sharing the same perspective as their peers, and they are often better received when they relay information or experiences with their families and communities," Smith says.

Opportunities for children to express curiosity about the living world can develop a tendency to support conservation values as adults. Photo: Dave Huth.

Elyse Henshaw, who collaborates with Smith at RTPI as a conservation technician and self-described "lover and cuddler of salamanders and frogs," notes that parents tend to catch a child's excitement in public outreach programs. She described the institute's springtime "Salamander Saturday" event, which included a woodland walk to a vernal pool for entire families, not just kids.

"Although the kids were more likely to get their hands in the

A curious boy explores a creek for Northern Dusky Salamanders (*Desmognathus fuscus*), Fridley Gap in the George Washington National Forest of Virginia (USA), Photo: Steven David Johnson.

mud and flip logs looking for salamanders, parents and grandparents became just as fascinated by what the children wanted to show them, saying 'I didn't know those things live here!' and asking questions" Henshaw says. The word she uses to describe the most common reaction to encountering amphibians in the field is "joy," which, she says "is infectious."

GETTING KIDS' HANDS DIRTY

These direct encounters with living animals make some of the most effective and lasting impressions on young people. Jennifer Pramuk, animal curator at Woodland Park Zoo in Seattle, stresses that a public educator's job need not be more complicated than facilitating an interaction.

"If you have those moments," she says of the opportunities for children to hold an amphibian, or to get a close look at one of its predators of other associated species, "The animals themselves make all the magic. They're the stars, the ones that do all the work."

Jeff Beane agrees that children seem naturally drawn to living animals, and presented with one safely by a knowledgeable adult who's passionate about its value "will capture nearly any kid's interest, and usually hold it for about as long as anything else you could show them."

Often these encounters overcome what seem to be internalized fears or revulsions many children may feel. Kids may be isolated from experiences in natural spaces like forests, streamsides or even public parks. Elyse Henshaw worries that parents and teachers, who themselves often don't know much about amphibians and their habitats, instill unnecessary hesitancy or misconceptions in children.

On an educational outing with a teacher trained in biology, two girls prepare to wade into a stream in Erie County, NY (USA) to satisfy their in-born curiosity about the natural world. Photo: Peace of the City Ministries.

Involving kids in citizen science projects can make a lasting impact, such as this boy assisting biologists in the field during a spring migration of ***Ambystoma maculatum***. Photo: Brett Amy Thelen.

Henshaw's experience with young children has been that they are ready and eager to touch a smooth moist frog, pick up a wriggly salamander, gently prod a toad to hop. But by the time they reach adolescence, many students who show up to educational events will hold back, and even resist connecting emotionally with small animals. Henshaw blames a general lack of time spent outdoors, which creates an uncertainty and discomfort for kids wishing to integrate confidently with peer groups.

Without opportunities for new positive associations, this continues into young adulthood, a situation Henshaw, who is 25, says is especially frustrating.

"People my age are always distracted," she says. "It's not always cool to show interest in something a little unusual or scary."

CONSERVATIONISTS FOR LIFE

Jennifer Pramuk notes research that suggests the younger age children are exposed to positive experiences with natural environments and animals, the more likely they'll be to form lifelong attachments leading to supportive actions in conservation.

She tells a captivating story about her own introduction to American Toads (*Anaxyrus americanus*) growing up in Ohio, chasing and catching them, staring into their eyes, cradling them in her hand while drawing pictures of them. She describes these encounters as finally leading to a "revelation," after which she confidently informed her mother: "I have a life calling. I'm going to do this for the rest of my life." She was about 6 years old.

"I've seen that same switch turn on in the eyes of many children," Pramuk says, adding it's deeply satisfying to observe. But the older a person is, the harder it can be to turn that switch. "It's like learning a language. It can be done when you're older. But it's easier and more natural when you're young," she says.

Pramuk says she believes amphibians can be ideal introductions to the wider planet of organisms and ecosystems, because they are small enough for a child's hand, easy to locate if you're small, they don't bite or scratch like a rodent, they don't fly away like a bird.

Along similar lines, Rachel Rommel-Crump calls amphibians a "gateway" to conservation advocacy and action, which she promotes as a way to engage even fearful, resistant teenagers who haven't previously had opportunities for contact and understanding of nature.

"My experience is that when a program appeals to a child's sense of empowerment, you can really get them connected," she says.

YOUNG CITIZEN SCIENTISTS

Rommel-Crump advocates for citizen science projects in which kids collect data, and participate directly in work that is benefitting native animals. "I have conducted hands-on science programs with amphibians that have started with a lot of apprehension at the prospect of touching a toad." She goes on to describe how, working alongside biologists in the field, young people who collect GPS and environmental data, search for toads, and take measurements, "forgot about any fear they may have had."

Rommel-Crump relies on child development concepts that appear when children start to reason and solve problems. Involving young people directly in solving problems, which adults haven't yet mastered, can engage their interest with a feeling of meaningful contribution.

"Once you can tap into this by empowering them as the citizen scientist or the species hero or the educator, how they can make a difference, I think you make them braver and more passionate about saving amphibians," she says.

Elyse Henshaw takes an expansive view of the value of inspiring children and young adults to take amphibian conservation seriously. "Getting younger people involved in conservation brings opportunity not just to teach," she says, "but also to learn— ourselves—as conservation professionals.

Henshaw says that it's one thing for her to conduct research and publish her findings for other professionals. But when she takes the step to explain what she knows to young people, she's forced to frame her work with a sense of meaning or purpose that may not have been immediately apparent before.

"Having knowledge is transformed by drawing kids in, and then spreading that knowledge," Henshaw says. Often this takes on new significance with the most common response a child has when a question they have about amphibians is answered—they ask a new question.

Melanie Smith has a similar experience working with children—even her own 7-year-old son. "While the state of conservation efforts today (or the environment at large) may sometimes seem very doom-and-gloom, signs of hope can present themselves in unexpected places." Smith herself has a renewed sense of hope when her son teaches her something she didn't know about a local organism.

Exploring wetlands and other natural habitats is educational for children by allowing them to explore using their natural sense of play. Photo: Dave Huth.

Exploring wetlands and other natural habitats is educational for children by allowing them to explore using their natural sense of play. Photo: Dave Huth.

Henshaw elaborates on this unexpected dynamic. "Time spent with kids is time for them to come up with really good questions, or look at a subject with a new perspective," she says. "In our jobs we take questions seriously, and expect to be taken seriously ourselves." When a child raises a question of their own, Henshaw says, "We then have to take their questions seriously…which can give a whole new way of looking at what we're doing."

Henshaw views engagement with youth to be keeping an important conversation going through time. "If we spark interest in young people, that interest can carry through a lifetime. Not only the lifetime of the kids, but the lifetime of … the whole conservation effort of this generation… It's kids that make that happen."

High school students, participating in Seattle's Woodland Park Zoo Amphibian Monitoring Program, pose with educational staff in 2014. Some of the course participants are pursuing careers in conservation, biology or related careers. Photo: Jennifer Pramuk.

Making the Leap Toward Sustainable Change

By Cherise Acker

The Endangered Wildlife Trust's Threatened Amphibian Programme (TAP) envisions pristine wetlands filled with leaping frogs as a result of effective habitat- and species conservation efforts. Saving wetlands involves working with wetland neighbours, which includes not just frogs and plants, but also humans--who can talk back and often even fight back! This threatens our precious vision of a picturesque wetland with a full chorus of chirping Pickersgill's Reed Frogs surrounded by urban settlements. So, can people and nature live in harmony?

Societies themselves are like living systems. They are dynamic, changing to the beat of the political, economic and environmental tones that dictate their survival. TAP realises that understanding how society interacts with its environment is central to the success of urban wetland conservation.

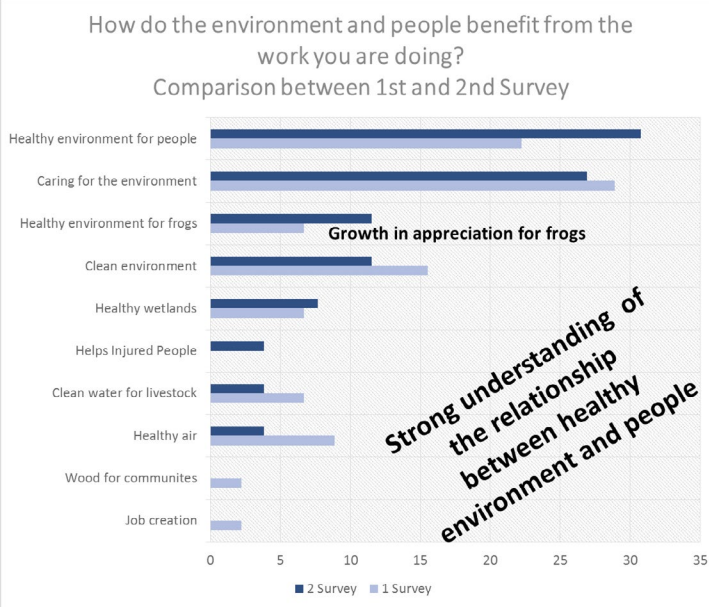


Fig. 1: Programme benefits.

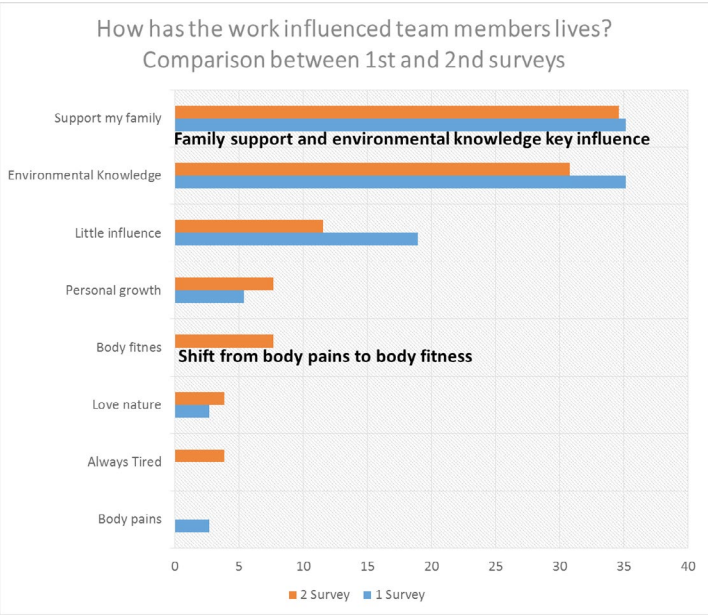


Fig. 2: Programme influence.

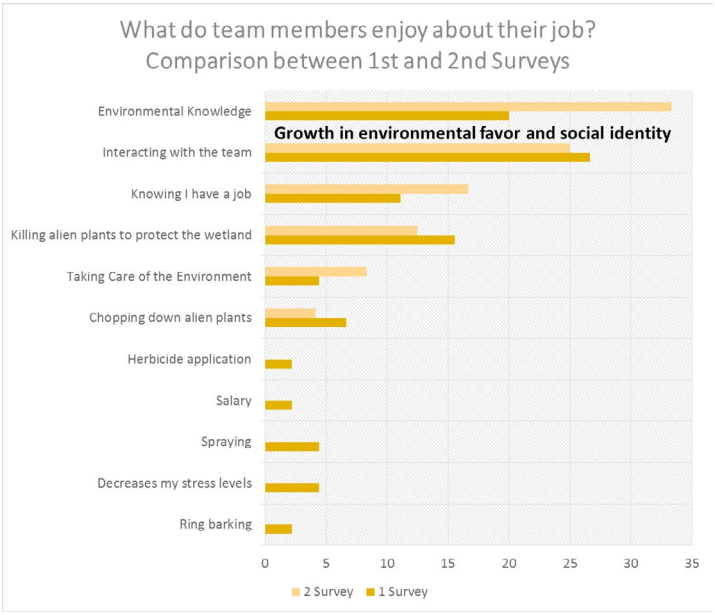


Fig. 3: Job enjoyment/ satisfaction.

TAP adopts employment strategies through its Natural Resource Management Project (NRM) funded through a Department of Environmental Affairs grant, to create green economies through alien plant clearing programmes and green skills capacity development within the greater Durban area, along the east coast of South Africa. Through this, bridges (both figurative and literal) are gradually being built between frogs, their habitats and their human neighbours, highlighting the benefits of urban conservation. To appreciate the strength of this economic and environmental relationship, TAP has initiated a socio-economic study and attitude-to-biodiversity assessment study to understand how green economies contribute to social change within a community. Although these studies are ongoing, our preliminary results have revealed some interesting findings.

Of great importance to the programme is the question of whether people develop an environmental understanding and appreciation through the work they are doing within environmental programmes?

The survey has revealed that people involved in the programme have indeed developed a strong understanding of the relationship between people and their environment (Fig. 1). In addition, there is a growth in the understanding of the importance of the work they are doing and how this contributes to frog conservation. This is significant for TAP, which is endeavouring to conserve threatened frogs and their habitats within an urban setting.

When asked how the work has influenced their lives, support of family and environmental knowledge are ranked the highest (Fig. 2). When asked what they like or dislike about their work, the team members ranked knowledge appreciation the highest and social identity as the second highest (Fig. 3).

These results are significant because they indicate key drivers in social change within environmental programmes, namely:

- Environmental knowledge acquisition, and
- Establishing environmental orientated social identities.

The results from the social-economic survey show incremental directional changes.

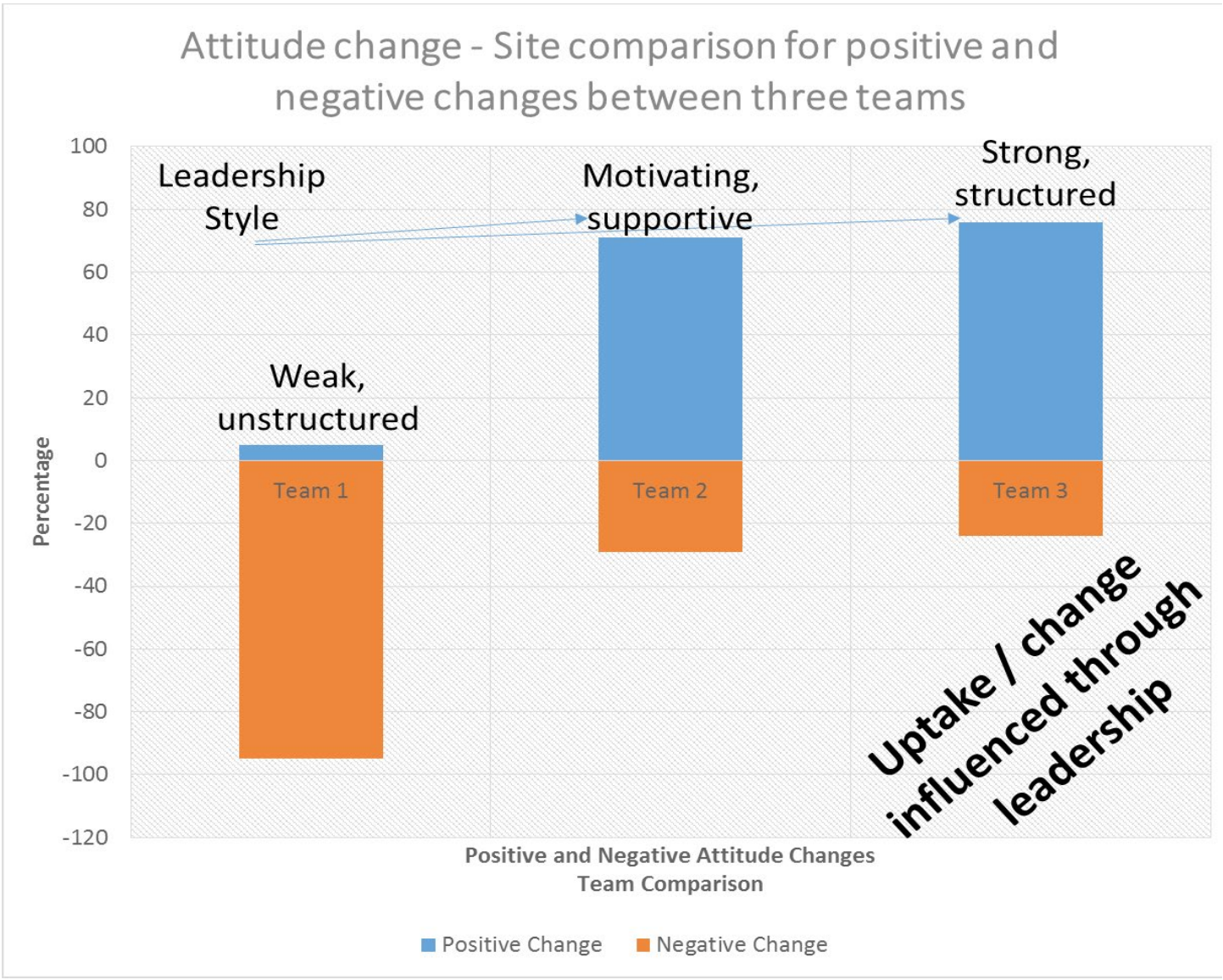


Fig. 4: Attitude survey results.

In contrast, the results of the attitude survey demonstrate more than a 70 percent shift toward positive change. Surprisingly, the attitude change is directly linked to leadership, which greatly influences the attitude direction (Fig.4). This is extremely important—it clearly demonstrates the importance of selecting the 'right person for the job' if successful positive social change is to occur.However, social change is also influenced by outside forces. The conditions required to instil permanent positive social change depend on economic and political stability that is conducive toward sustainable change. TAP's NRM Project is facing many challenges on this front, from budget limitations to wetland loss/degradation by land invasions fuelled by political agendas.

It is for this reason that we are working with various local and national government structures, including eThekwini Municipality and the Department of Environmental Affairs, as well as traditional community stakeholders to build strong partnerships based on healthy and mutually beneficial relationships to affect sustainable change. Some of these relationships include working with community gardeners toward sustainable livelihoods that do not promote habitat loss, and we hope to initiate community recycling systems in the near future.

Lastly, we are working with the teams on alternative livelihoods (firewood, wood chipping and recycling initiatives) to ensure that once the TAP's NRM Project comes to an end, the green economy is entrenched within the community. Through these strategies, we hope that these wetland neighbours overlook picturesque and functional wetlands and look forward to hearing the chirp of the Pickersgill's Reed Frogs as the evening sets.

We would like to take the opportunity to thank the Department of Environmental Affairs, eThekwini Municipality, Rand Merchant Bank and the Disney Foundation for their support.

Amphibian Conservation Action in the Atlantic Forest in Bahia, Brazil: Research, Monitoring, Environmental Education and Outreach

By Moacir S. Tinoco, Bruno Cardoso Dantas, Francisco P. Branco Bahiense & Marcileida dos Santos

There are few regions in the world exhibiting high indices of amphibian diversity (*1*), and the Atlantic forest of the North Coast of Bahia–Brazil, known as NCB, is one of them. The diversity in this area falls between the 16 out of the 21 important global amphibian hotspots in the world (*1*). One of the greatest assets to the vast diversity of neotropical amphibians is their distinct reproductive and adaptability modes to various habitats, particularly those considered harsh (*2–5*), as this is the case of white sand dune ecosystems on Brazilian coastline. In the Atlantic Forest, these ecosystems, known as restinga, are distributed along the seaside, and consist of white sand dunes and coastal strands that allow different types of vegetation habitats (*6–8*). The state of Bahia–Brazil is composed by the largest extant of this ecosystem (220 km) throughout the northern coast. In addition to extensive savannas and caatinga, as well as mangrove, swamps and flooded plains, Atlantic forest remain preserved in small patches between <50 ha and >500 ha. The entire coastline is home to over 90 amphibian species (at least 87 anurans and 3 caecilians) in less than 25,000 km², which denotes its importance for the biome (*5, 9*). However, only a small fraction of the protected network of protected areas is designated to protect the actual amphibian diversity, which adds further pressure to the already threaten amphibian taxa (Figs. 1 and 2).

Fig. 1: Cururu Toad (*Rhinella jimi*). Photo: S.Piña.

Fig. 2: Golden-eyed Tree Frog (*Trachycephalus mesophaeus*) on a tank bromeliad. Photo: R. Marques.

Fig. 3: Target sites for amphibians at Fazenda Milagres. Photo: M. Tinôco.

MAJOR THREATS TO AMPHIBIANS WITHIN THE REGION

Salvador is the capital of Bahia, located on the southern tip of the coast. It is the third largest city in Brazil and the 7th largest metropolitan area, with a population of more than 4 million people (*10*). Its main developmental vector flows toward the north, where the main remaining restinga systems are located, as well as eight important river basins within the region, attracting great attention for tourism and real estate development (*4, 5*). The entire region is considered one of the important tourist destination in Brazil *(10)*. The population size rises from four to six million people during the summer peak (*10*). Other dominant economic activities in the area are: agriculture, eucalyptus plantation, and cattle (*10*). Other factors such as, illegal sand extraction, illegal wildlife trade, road kills, burning and illegal clearing of vegetation on land and wetlands, chytrid fungus disease, sand beach pollution, and the introduction of exotic species including the North American Bullfrog (*Lithobates catesbeianus*), the Corn Snake (*Pantherophis guttatus*), the African Gecko (*Hemidactylus mabouia*), the American Slider Turtle (*Trachemys scripta*), represent the greatest threats to the amphibian biodiversity in the region (*11*). The area houses nearly 10% of all Brazilian anuran diversity (*4, 12, 13*) and over 30% of the Bahia State amphibian fauna. Given the importance of the biome, this area should be considered as priority for global amphibian conservation. Additionally, *in situ* conservation within protected areas is considered the most appropriate and economically viable way to protect amphibians in developing countries (*15, 16*).

Fig. 4: Targeted area for herpetofauna conservation at Fazenda Milagres. Photo: M. Tinôco.

Fig. 5: Air view of Fazenda Milagres. Photo: M. Tinôco.

STRATEGIES FOR CONSERVATION

The Herpetofauna of the North Coast of Bahia project, or simply HLNB, was established in 2007 at the ECOA group (Ecology and Conservation of Animals) at the Universidade Católica do Salvador (UCSAL)(*14*), with the aim of understanding patterns in Atlantic Forest diversity, and identifying priorities for conservation *(17)*. Protecting this area is crucial particularly due to the vast number of rare species, many of which are yet to be discovered and others that we have little information about. The project built partnerships with both local and international institutions, such as DICE - Durrell Institute for Conservation and Ecology at the University of Kent in Canterbury, more recently the Universitat des les Isles Balears - UIB - Spain, the University of Otago in New Zealand. Support was also given by other organizations or initiatives such as the Amphibian Ark, Operation Wallacea and Herpetofauna Foundation. One of the major collaborators is the Fazenda Milagres, located in the village of Barra do Itariri in the municipality of Conde (Fig. 3 and 4). This private property, mostly made of preserved restinga habitat and located within the Environmental Protection Area (APA) of the NCB, has been the target of studies by the aforementioned institutions. The area comprises of four well-defined restinga habitats: beach vegetation, wetlands, shrubs, and restinga forest. The long term aim of the project is to model the study of the fauna and flora *in situ*, particularly the conservation of amphibians and reptiles in restinga environments, and apply the knowledge acquired on a long-term program for the entire region (Fig. 12). The project provides the necessary support for capacity building at the local community level by raising awareness, promoting environmental education measures and formal training, as well as making recommendations for public policy change with the intent of protecting the biodiversity. The latest amphibian inventory (~30 ha), revealed 28 species of amphibians (Fig. 13). To date, the project investigates: the use of microhabitat associated to endemic species, the identification of species through vocalization using bioacoustic patterns, the genetic structure of populations, occupancy and detection modelling and survival rates for amphibian species. More recently, amphibian species were included in a photoID project, conducted in partnership with the UIB/Spain (Fig. 6c). Fazenda Milagres was the first private property supporting the conservation and research of the herpetofauna (Fig. 4-5), and the aim is to extend this initiative to other private properties. We are currently seeking to expand the project by creating other areas

Fig. 6: (a) Tissue sampling, (b) VIE marking and (c) PhotoId sampling. Photo: HLNB archive.

Figure 7 a–f: Lectures and workshops at various events. Leida dos Santos (a) (U.of Otago) and Vera Luz (b) (RAN/ICMBio) and research teams from UCSAL and DICE/UKC(c–f). Photo: HLNB archive.

such as the UCSAL Ecological Park, and the dunes of Condomínio Busca-Vida in Camaçari. HLNB currently works in partnership with Garcia D'Ávila Foundation – Projeto Floresta Sustentável, as well as Parque das Dunas in Salvador, where the pilot studies were carried out.

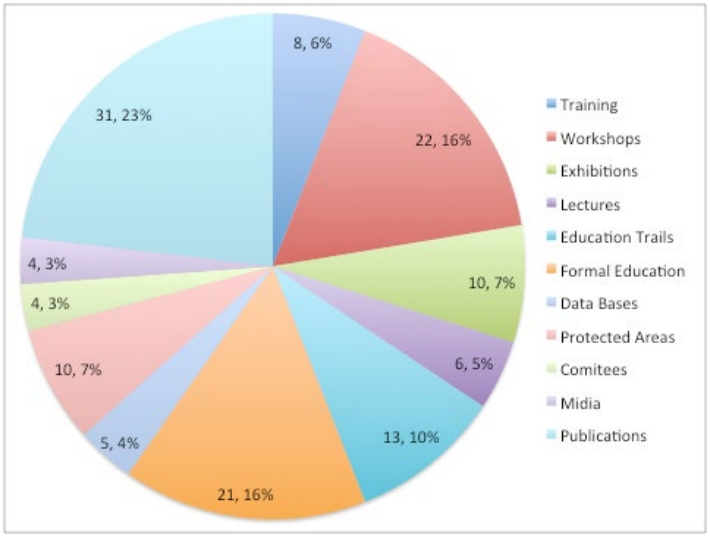


Fig. 8: Amphibians occasions' percentage of conservation action raking place at NCB by HLNB. Publications shows highest score and midia and commitees the least number of occasions.

Fig. 9: Thematic exhibition, where undergrad Raissa Nunes interacts with public (Photo: HLNB archive).

Fig. 10: Round table on endangered species assessment (a)Cristina Vieira(SEMA), Vera Luz(RAN), Moacir Tinôco(HLNB), Carolina Lins(ICMBIO), Geraldo Moura(UFRPE), (Photo: HLNB archive).

Support and partnership with federal government agencies is crucial for the project`s development. HLNB is part of the Technical Advisory Group for the National Action Plan of the Conservation of Herpetofauna of the Northeastern Atlantic Forest at ICMBio (the Chico Mendes Institute for Biodiversity Conservation) under the governance of RAN - National Centre for Conservation of Herpetofauna. Additionally, we are involved with the creation of two RPPN (Private Natural Heritage Reserves), which will protect >20 ha of natural amphibian habitats, and the second in the municipality of Camaçari.

The National Action Plan focuses on several species, and special attention is given to the following species: the Rocket Frog (*Allobates alagoanus*), the Leaflitter Frog (*Chiasmocleis sapiranga*), both recorded by the HLNB in the NCB-APA, as well as Caecilian species such as the ones under the *Chthonerpeton* genus. More recently, the HLNB become a member UNESCO Atlantic Forest Biosphere Reserve (AFBR) national council. It recognized ECOA from the UCSAL with the title of Advanced Post for the AFBR/ UNESCO in 2015.

CONSERVATION ACTION ACHIEVEMENTS

Since it was proposed, HLNB has continuously monitored the region. Most of the activities are related to education and communication (C&E) action plan, but also involve providing advice for public policy making and conservation research. These actions aim to achieve at least ten goals that are in line with ACAP C&E short and long term priority actions (see Table 1 and Figs. 5–12).

Table 1: Resumes project's achievements over ten years.

GOAL	ACHIEVEMENTS					
	AIM	PUBLIC	PERIOD	MUNICIPALITIES/ LOCATIONS	Nº PEOPLE / INSTITUTIONS	OUTCOMES
(1) Workshops	Training and capacity building	Professionals and public agents	2010-2016	Salvador, Camaçari, Mata de S. João, Entre Rios e Esplanada	>200 people / Environmental Police; City Guard; State agencies and volunteers	30 sessions/workshops and 8 training courses
(2) Exhibitions	Thematic on amphibians and reptiles	General Public	2007-2016	Salvador	>1,000 people / various institutions	Thematic permanente exhibit
(3) Lectures	Addressing herpetofauna conservation	Academics and General Public	2008-2016	Salvador	>500 people / various local and regional institutions	Lecturers from DICE, UID, Uni.Otago, RAN, UFRPE
(4) Ecological trails	*In situ* environmental education	Academics and General Public	2015-2016	Itapuã, Patamares, Nova Brasília, RMS and Sapiranga.	>400 people / diferente undergraduation courses	Partnership with AFBR/UNESCO and part of National Council and parto f the CIEA council
(5) Formal education	Assist undergraduate and graduate projects	Academics	2008-2016	Salvador and Metropolitan Area	>10 undergrad projects/>Master's/2 PhD's	Partnership with UCSAL, DICE: and other international institutions
(6) Regional database	Building database on populations, tissues samples, photoid, and biocoustics	Academics and public agents	2007-2016	NCB and Metropolitan Areas	>100 researchers/ HLNB/ECOA; DICE; UID	>4,000 specimens records; >60,000 wild records >240 recorded herpetofauna species confirmed by 04 National Collections. Part of GAT/PAN
(7) Protected Areas for Herpetofauna (RPPN)	Proposition of new areas and strengthening formal partnerships with existing ones;	Public and private owners	2007-2016	NCB and Metropolitan Area	>100 researchers involved/ ECOA/UCSAL; IBAMA; ICMBio; UNIDUNAS	Proposition of two National Parks, two Private Preserves and assistence on other 4 units.
(8) Traditional and digital media	Use of for the dissemination of conservation actions	Academics and General Public	2007-2016	Global reach	>10,000 hits/ Social media and sites	Five social media under @herpetofaunabahia and @herpetofaunainb
(10) Herpetofauna knowledge production	Increasement of regional background information	Academics and General Public	2008-2016	Global reach	>100 researchers/ HLNB/ECOA/UCSAL ; DICE	>30 published papers and prize from the Brazilian Society of Herpetology for inovation with the introduction of VIE Teenique in Brazil

We are proud of the goals achieved over the last ten years, and we believe that the HLNB/ECOA/UCSAL project is a growing tool for the conservation of Atlantic Forest amphibian diversity in Bahia, and may serve as role model to engage wider communities, such as stakeholders, NGO's & business contributing to minimize global amphibian declines.

Acknowledgements

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Fig. 11: Professor Richard Griffiths(DICE/UK) lecture on global amphibian declines(Photo: HLNB archive).

Fig. 12: Samuel Piña(UIB/Spain) workshop on PhotoId (Photo:HLNB archive).

Fig. 13: Researcher(Claudia Araujo) at community and citzen based science (Photo:HLNB archive).

Fig. 14: Species at the Fazenda Milagres site (Photos: M.Tinoco).

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Changing Attitudes about Amphibians: Experiential Learning with Lynford School, Ixopo

By Jeanne Tarrant & Cherise Acker-Cooper

Amphibians are currently the most threatened class of vertebrate on Earth, with 42% of species experiencing population declines. The Endangered Wildlife Trust's (EWT) Threatened Amphibian Programme (TAP) aims to implement specific conservation actions to address direct threats and protect critical amphibian habitat; support relevant research projects focused on critical knowledge gaps in amphibian conservation; and raise awareness about the importance of amphibians in a South African context.

In an effort to help protect critical amphibian habitat and improve the understanding of endangered amphibians, TAP is working in the Ixopo area, which is home to the Mistbelt Chirping Frog (*Anhydrophryne ngongoniensis*). This Endangered frog is restricted to an area smaller than 10km², which is under severe pressure from commercial afforestation.

Part of TAP's strategy is educating the local community about the MCF. One of the schools situated in the heart of the chirping frog's habitat is Lynford Primary School near Ixopo, KwaZulu-Natal. TAP implemented an education programme with the school during August 2016.

TAPS'S INTERVENTION STRATEGY

We worked with grade 4 and 5 learners during a month-long awareness intervention to gauge changes in attitudes toward frogs through experiential learning, based on four key interventions:

Pre-attitude surveys

The pre-attitude surveys formed the baseline of the intervention to measure positive or negative change from the intervention strategies. Two types of surveys were used:

1. Questionnaires: the fifth grade students answered a questionnaire based on 29 questions.

2. Picture surveys: the fourth grade students drew a picture of a wetland.

Classroom activity – A Froggy Friend

Learners could 'meet a frog' through a sensory activity. They could touch, smell, see and hear a frog that was brought into the classroom.

Wetland Study

In this activity, learners visited a local wetland to learn more about wetlands as frog habitats.

Post-Attitude survey

The post-attitude surveys (the questionnaire and pictures for the respective grades) measured the change in the learners.

INTERVENTION RESULTS

The students in grades 4 and 5 participated in the same interventions but we used different methods of measuring changes in attitudes to frogs. The fifth grade students completed questionnaires before and after the experiential interventions and the fourth grade students drew posters of wetlands before and after the interventions.

Results from the fifth grade students show an overall shift of 67 percent (Figure 1) toward a positive attitude about frogs after the intervention strategy.

The positive changes were further broken down into categories of

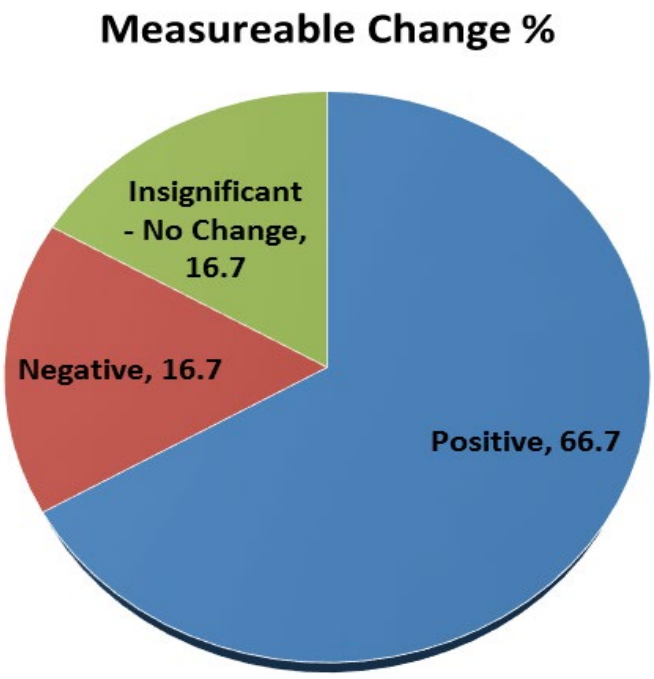

Fig. 1: Percentage change in attitudes to frogs before and after experiential learning by the fifth graders as assessed by questionnaire surveys.

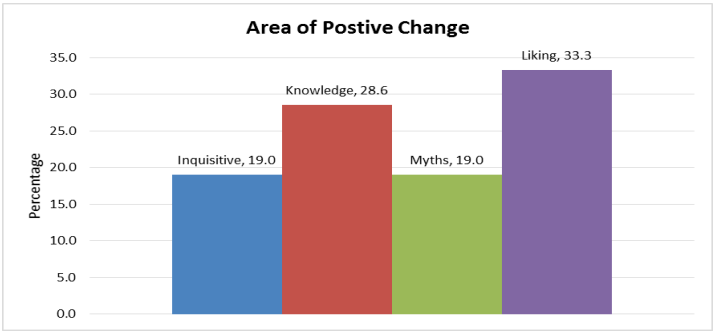

Fig. 2: Factors that influenced positive change in Grade 5 learners – Interest, Knowledge, Myths or Liking.

change. In Figure 2, it can be noted that the learners seemed to start liking frogs more because of the interventions, and their knowledge base improved. They were more inquisitive and a lot of the myths around frogs were debunked through the education program.

The method of assessing the pictures drawn by the fourth grade students was not as detailed as the questionnaires. The positive changes that we recorded were based on recording any living organisms that were added into the follow-up pictures that they drew (Figure 3) and improved detail of water clarity. The negative influences are mainly on effort put into the second drawing in terms of colour (Figure 4). Lastly, we recorded no change for drawings that remained the same or very similar (Figure 5). According to these criteria, there was a significant positive change of 76 percent in the learner's knowledge of a wetland (Figure 6), while the negative 14 percent was based only on the lack of colour added to their pictures on the second poster. Seven percent of the changes were registered as no change and the learners' drawings remained the same.

A student from grade 4, Zama Hadebe, was selected to follow her

Figure 3: Example of positive change in attitude around the understanding of amphibian habitat through the addition of detail such as fish, plants and people in the second image. (Left) Before intervention. (Right) After intervention.

Fig. 4: Example of negative change demonstrated by less colour and effort – fewer elements and no living organism additions.

Fig. 5: Example of pre-and-post drawings demonstrating little change.

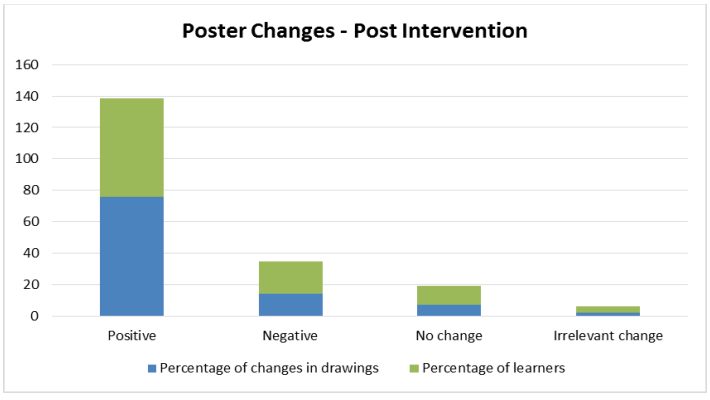

Figure 6: Overall responses from the Grade 4 learners through the drawing assessments.

educational journey with photographs. From the photographs, she showed significant enjoyment with the learning programme but little change with her drawings. This may show that the picture surveys' ability to measure change is relatively low and should be used with another method of assessment for example photo journey or through stories of change.

RECOMMENDATIONS AND CONCLUSIONS

The interventions were very well received by the students. Both teachers from the grade 4 and 5 classes reported that between the lessons the students enthusiastically spoke of frogs and the TAP programme activities. This in itself is a good measure of the success of the intervention. However, it is clear that the questionnaire

method of assessing a change in attitude adds far more value to the understanding of the impacts of the TAP's intervention strategies. It should be noted that the picture surveys are far more suited for younger grades, but should be used in conjunction with a photo journey or a story of change.

Fig. 7: Educational Photo Journey follows Zama through the various stage. Pre-and post- picture surveys show no change in animal life but there is a change with the plant life. Reeds instead of trees can be found in her wetland. Her wetland also takes a lot more space in the follow-up drawing.

Frog Monitoring in New Zealand: Increased Effort Involving Local Communities

By Javiera Cisternas[1,2], Jennifer M. Germano[3], Nancy Longnecker[2] & Phillip J. Bishop[1]

All species of native frogs in New Zealand (*Leiopelma* spp.) are currently threatened (*1-2*) and ranked in the top 60 Evolutionarily Distinct and Globally Endangered (EDGE) amphibians (*3*). Specifically, *Leiopelma archeyi* Turbott 1942 (Fig. 1) is categorized as Critically Endangered and is the number one EDGE amphibian. A major population decline of 88% was reported in the stronghold Coromandel population for this species between 1996 and 2001 (*4*). When chytrid was discovered in the only other population of Archey's frogs at Whareorino Forest, an emergency conservation translocation (assisted colonization *sensu* IUCN 2013) was planned in order to protect that population's genetic diversity in case of another crash. In 2006, 70 *L. archeyi* were collected in the Whareorino Forest, and released 70 km away in the Pukeokahu Forest in the Waikato region of New Zealand (called hereafter the study area, Fig. 2).

Frogs were released in a 10m x 10m grid, inside an herbivore-resistant fence, installed to encourage vegetation restoration (Fig. 3). An annual capture-recapture monitoring plan was started in April 2007 over an area of approximately 175m^2. The original search area includes the original grid, a 2m buffer around the original grid and a 2m buffer area around the outside perimeter of the herbivore-resistant fence (hereafter referred to as original search area, Fig. 4A). As with other *Leiopelma* monitoring (*5*), low detectability and small number of captures per session, have compromised the quality of data collected in Pukeokahu and raised doubts about the effectiveness of the monitoring process. Moreover, in the 2014 monitoring period, several individuals were found in a previously unsearched area, over 10m from the original search area. As Leiopelmatid frogs are known to have small home ranges of only a few m^2 (*6-8*), it was not expected that individuals would disperse widely.

Based on the evidence of frogs outside of the original search area, the monitoring design was reassessed. In 2015, the aim was to determine the current distribution of frogs in the study area. For this purpose, it was necessary to search a wider area. A large number of participants was needed to simultaneously search the bigger area (Fig.4B). The frog monitoring described below represents an example where a management problem (*i.e.*, insufficient monitoring data) was tackled with the inclusion of a wide variety of participants. This accomplished two goals: first, increasing the search effort and secondly and perhaps even more importantly, empowering a local community to engage with amphibian conservation.

The Department of Conservation of New Zealand (DOC), together with the University of Otago, developed a monitoring plan for 2015 and 2016. Two other organisations, Rereahu iwi (local indigenous **Māori** tribe) and Auckland Zoo, supported the initiative and participated in the monitoring sessions. In addition, volunteers without specific affiliations took part in the monitoring, contributing to the diversity of participants (Fig. 5 and 7).

All participants attended a training session where the objectives of the sampling were explained and the sampling techniques were practiced (Fig. 7). Specifically, for those participants with less experience searching for *Leiopelma* spp., a series of visual exercises was run to improve observation skills. Emphasis was placed on training participants to walk carefully in the search area to minimize direct impact on the frogs, as well as reinforcing biosecurity procedures, especially those related to footwear hygiene and compulsory glove use.

In 2015, the search area was extended from 175m^2 to 2500 m^2 (Fig 4B). During four consecutive days in November, 34 participants found 32 frogs, 22 (63%) of which were found outside the original search area. Based on these results, the herbivore-resistant fence was enlarged. A release of another 60 individuals was planned for 2016 as part of a reinforcement project developed by DOC and Auckland Zoo. In 2016, the monitoring priority was to look for newly released individuals within this extended fenced area of approximately 1600 m^2 (Fig. 4C). Between November 28th and December 1st, 2016, 21 participants found 82 frogs, of which 59 (72%) were found outside the original search area.

To validate the data collected and minimise errors caused by differences in the experience of the participants, two elements were take into consideration. Firstly, the lanes / transects were assigned to participants with different levels of experience between contiguous lanes, and each participant searched different lanes on consecutive days. Secondly, the effectiveness of the participants was checked by grouping together the participants from both years into two lev-

Fig. 1: *Leiopelma archeyi* from Pukeokahu Forest. Photo: Jennifer M. Germano.

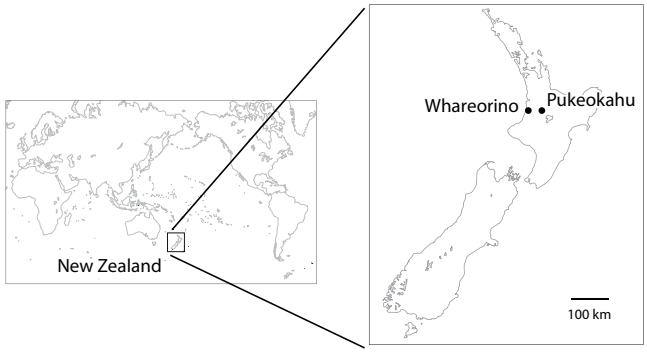

Fig. 2: Map of the donor (Whareorino Forest) and translocation (Pukeokahu Forest) localities.

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Fig. 3: Herbivore-resistant fence installed in 2006 in the study area (Pukeokahu Forest). Photo: Javiera Cisternas.

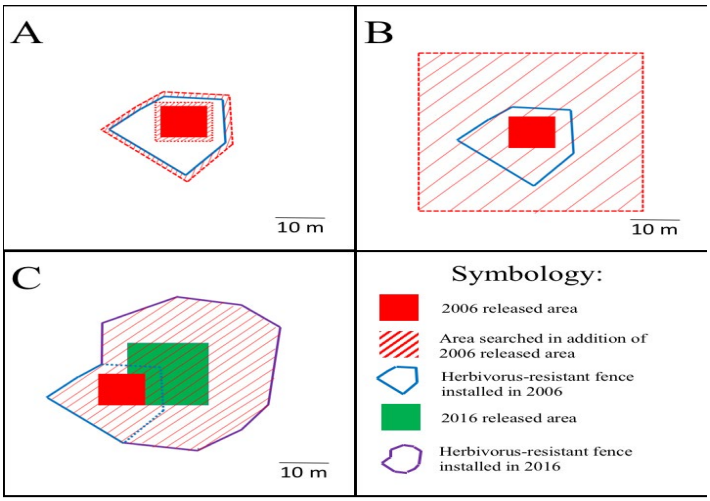

Fig. 4: Diagram of the study and search areas. A) The original search area used from 2007 to 2014. B) The search area used on 2015. C) The search area used in 2016.

els of experience (without previous experience if the participant had less experience than a total of five days searching for *Leiopelma* spp. in the wild, and with previous experience if the participant had more than five days of experience). Then, the number of frogs found between these two levels of experience was compared, and no differences were found (Table 1). Moreover, in 2015 the person that found the most frogs was a volunteer with no previous experience searching for frogs, and in 2016 for the first time, two frog breeding sites with eggs were identified and both were found by participants in the less experienced group (Fig. 8).

This initiative not only improved the management of an endangered species, but also facilitated community engagement and commitment. Before this initiative, it was unclear whether the translocated individuals were alive, or if they had just moved away from the monitoring area. The results of the monitoring revealed a patchy aggregation of individuals for this population, similar to what has been observed in other *Leiopelma* species' populations (*8-10*). Furthermore, a wide range of volunteers and institutions have become involved and felt motivated with the monitoring work. In particular, it was important to involve, for the first time, the local indigenous community (Rereahu iwi) who have kaitiakitanga (traditional guardianship) over this species.

It is hoped that the results obtained will inform selection of a second grid to add to the long term monitoring plan established for this translocation. It is unclear whether or not subsequent monitoring will include as large a number of participants as in 2015-16. Even though the social outcomes produced with this initiative are numerous, the final number of participants to be involved in each monitoring will be primarily decided in terms of the monitoring data requirements, availability of potential participants and resources available for recruitment, training and organisation of volunteers.

This initiative embraces all the five working goals in the Communications and Education Working Group of the Amphibian Conservation Action Plan (ACAP) (*11*) (Table 2).

We recommend that the benefits of community involvement be considered when decisions are made about future resource allocations and methodologies.

Special thank to all the participants involved in this initiative, part of whom agreed to be identified (Richard Gibson, Greta Horne, Cullum Parker, Karina Radley, Su Sinclair, Leigh van Wyk). JC acknowledges CONICYT-BECAS CHILE for her doctoral scholarship. Thanks to Micheal Heads for providing Figure 2. This study has been approved by the Otago Human Ethics Committee, University of Otago, New Zealand.

Fig. 5: Group of participants on the first day of the 2015 monitoring sessions. Photo: Luke J. Easton.

Fig. 6: Group of participants getting ready for the monitoring work in 2016. Photo: Javiera Cisternas..

Table 1: Number of frogs found by level of participant experience.

Monitoring dates	Frogs found	
	With previous experience	Without previous experience
23-Nov-15	1	0
24-Nov-15	1	7
25-Nov-15	4	0
26-Nov-15	14	8
28-Nov-16	2	3
29-Nov-16	12	20
30-Nov-16	8	9
1-Dec-16	20	8
Total	62	55
Average	7.75	6.875

Table 2: ACAP Education and Communication working goals and the evidence of achievement, or partial achievement, of these goals for this project.

ACAP working goal	Evidence of (partial) achievement
Increase collaboration across disciplines, professions, and stakeholder groups to find sustainable solutions to amphibian declines	Wide variety of institutions and volunteers participating for two consecutive years
Build capacity and provide resources to plan, implement, and evaluate effective public engagement programs	DOC has lead the planning and implementation of 2015-16 massive monitoring sessions. However, no public engagement evaluations have been conducted yet
Identify, engage, and empower target audiences to take action to monitor and protect amphibians and habitats	All the participant institutions are related with *L. archeyi* conservation projects
Using amphibians as ambassadors, increase experiential learning opportunities in communities across the globe to inspire deeper connections with nature	Not formally evaluated, but the comment of one volunteer about its experience in the monitoring work: "For me the most memorable & fantastic thing was finding my first frog - awesome! I learnt so much also, was amazing" - Volunteer 4
Continue to raise awareness and knowledge of the ecological, cultural, and intrinsic value of amphibians and their habitats	This species is taonga (a treasure) for the indigenous community (Rereahu iwi) involved in the monitoring

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Fig. 7: 2015 training session. Photo: Luke J. Easton.

Fig. 8: Breeding site of *Leiopelma archeyi* inside ponga observed in Pukeokahu Forest. Photo: Karina Radley.

Using Educational Interventions as Sustainable Solutions to Prevent Further Amphibian Declines

By Marcileida M. Dos Santos

In recent years, many researchers have shown that humanity is not living within our natural limits. In fact, humans are consuming the Earth's resources at an increasingly unsustainable rate (*1*). As a result, there has been an increase in the incidence of habitat destruction, pollution, and emerging disease, phenomena that are affecting amphibians worldwide. This is known as the "Amphibian Extinction Crisis" (*2–4*). The future for amphibian populations is perceived as being bleak by some; populations are being lost from meta-populations at an average rate of 3.79% per year, and most of these are affected on a regional scale (*5*). Given the current global amphibian extinction crisis, it is almost impossible to predict the future for amphibians. Engaging local communities on amphibian issues have a positive correlation to people's biophilia towards amphibians and a negative correlation towards the reactions of fear and disgust (*6*). Many strategic action plans have emerged since amphibians were first reported as being in trouble across the globe in 1989, at the First World Congress of Herpetology in the UK (*8*). These take the form of the IUCN Global Amphibian Assessment (GAA) (*9*) and the IUCN SSC Amphibian Action Plan (ACAP) (*10*) which are both strategies that address only one concern - the decline of amphibian populations worldwide (*9,10*). Since the publication of the ACAP, the IUCN SSC Amphibian Specialist group (ASG), has evolved to create a multidisciplinary support network of working groups to tackle the global amphibian declines. The Communication and Education (C&E) Working Group was created in 2014, with the vision to "Secure the world's endangered amphibians and their habitats through empowered communities that are motivated to act on behalf of biodiversity conservation" (*11*). One of the C&E Working Group's major constraints is the lack of an interdisciplinary communication channel to inform not only researchers but a wider community about the global amphibian declines, particularly the young people that have increasingly disconnected from nature (*11*). With the Communication and Education ACAP chapter in mind, my current research focuses on narrowing the knowledge gap between different communities and stakeholders, including educational institutions, on non-formal, informal and formal education levels. This will be achieved by primarily evaluating the existing public knowledge of amphibian conservation, identifying different strategies to teach and engage students, using different interventions to raise awareness, and encouraging positive attitudes to everyday actions. I will evaluate effectiveness by conducting pre-tests, post-tests and retention tests. The project aims to promote amphibian biophilia to minimize further amphibian declines, as well as identify ways to increase engagement with stakeholders, scientists and the community on amphibian related matters. The final step will be to make recommendations to improve amphibian-related education programs, that when used as a tool, will support efforts to halt the global amphibian declines. This work will then be contributing to the implementation of the mid-term priorities, from C&E ACAP, regarding "societal level change seed planting."

Fig 1 A and B . 1A M. Dos Santos , frog dissection session, Department of Zoology, University of Otago, 1B. Javier Cisternas and M. Dos Santos. Close animal encounter – Students had the opportunity to see closely an introduced frog of New Zealand.

Fig.2 Luke Easton - Close animal encounter – Students had the opportunity to see closely a native frog of New Zealand

Department of Zoology, University of Otago, PO Box 56, Dunedin, 9054, New Zealand.

FORMAL EDUCATION LEVEL "SEED PLANTING"

Two environmental education outreach programs focused on amphibians were designed targeting students from 11–14 and 15–18 years old, at three schools of different socio-economic backgrounds in New Zealand. The program duration depended upon school availability and lasted from one to two weeks. Using amphibians as ambassadors to encourage a positive attitude towards them is one of C&E ultimate goals (ACAP). This project was developed for New Zealand as a model, and can be adapted for other regions around the world. It has been developed in partnership with organizations such as NGOs and businesses, which is one of the C&E ACAP mid-term priorities, and will greatly benefit both community and conservation research. To engage stakeholders, amphibian experts and NGOs, this project involved several institutions and experts: The Department of Zoology at the University of Otago, the Orokonui Ecosanctuary (Fig.3–5), Computer Science Department from the University of Otago, AD Instrumental New Zealand, and three schools of different socio-economic backgrounds (decile rating) in New Zealand. Over one thousand surveys were carried out to evaluate different interventions (n=2), *i.e.*, out-of-class and eLearning online platform. Students have had the opportunity to have a close encountered with native and exotic species of frogs in New Zealand (Fig. 1, 2) and experience the life of a herpetologist/biologist/zoologist (Fig. 3–5), collect samples in the field and bring them to the classroom (Fig. 6.) and learn about native and exotic species of amphibians of New Zealand and their relevance in the ecosystem. Students had hands-on experience with up-to-date technology used by scientists in the field. Following involvement with the program, students showed a significant improvement in their knowledge on different dimensions. Further analysis is being carried out for future publication of these results. This work could not have been possible without the support of the Department of Zoology at University of Otago and the support of the schools and institutions involved

Fig. 3 A & B. Orokonui Eco-sanctuary. Students had the chance to collect data in the field, look-ing at the suitability of the environment for future reintroduction of New Zealand native frog at the Eco sanctuary

Fig.4. Tahu McKenzie, the environmental education officer of Orokonui Ecosanctuary, giving a talk on the importance of the center for New Zealand the native species.

INFORMAL AND NON-FORMAL EDUCATION – SEED PLANTING

One of the ACAP C&E mid-term priorities highlights that one of the major constraints to effective conservation is to "Identify & communicate with priority target audiences (audiences who have an impact on the success/failure of desired conservation outcomes) more strategically at global, regional, and local levels" (9). However, to enhance conservation efforts of a target audience, an evaluation of the current knowledge is fundamental and then it will be possible to develop effective tools that will make a difference (*12*). Zoos already make a great contribution to the *in situ* and *ex situ* amphibian conservation programs (*13*). According to the World Association of Zoos and Aquariums (WAZA) there are over 700 million visitors annually attending the 280 zoos and aquaria members of WAZA around the World (*14*). Zoos are the

Fig. 5 C and 5 D. Orokonui eco-sanctuary. 5C. Mr McMilllian and the school team and Mrs Dodd and school team. Students were engaged and thoroughly enjoyed the day.

perfect setting for the formal, non-formal and informal educational outreach, making their visitors an important target to enhance conservation communication, one of the main educational goals of many Zoo accredited organizations (*15*). Additionally, people visiting zoos and aquaria are already engaged in some animal affairs (*16*). An evaluation of the current knowledge on the global amphibian declines and amphibian conservation of the visitors to zoos and aquaria, is essential to support the efforts already in place and engage the public effectively on amphibian conservation. This research involved three countries (Brazil, New Zealand and the United Kingdom), fifteen organizations, and focused on what the public know about amphibian declines and amphibians in general.

Fig.6. Students engaged. Students was actively engaged , working as a team they processed the data collected Orokonui and at the Zoology department they prepare a presentation to the whole school, which was presented in an assembly.

Additional to evaluating the public knowledge, an evaluation of the use of amphibians in the outreach programs from the different institutions visited was carried out. The results will help zoos and aquaria improve their outreach programs related to global amphibian declines.

In addition, we also worked with local organizations, such as universities, zoos and schools, presenting talks, roundtable discussions, and nocturnal tours, to engage the public on an interdisciplinary matter, "the global amphibian declines" (Fig. 7–11).

Additionally, I am working in partnership with Professor Bishop on the production of an iBook, to be used by all schools, zoos and herpetological communities, focusing on the global amphibian declines with special reference to the amphibians of New Zealand. The final step in my research will be to make recommendations for the improvement of amphibian conservation education within global conservation initiatives and policy making. The qualitative and quantitative methods proposed focus on most areas where we can raise awareness of amphibian declining events, consequently it is a great model for future outreach programme species conservation focussed.

Acknowledgments

I am thankful for the many institutions which have supported my project: Zoology Department, University of Otago, Orokonui Ecosanctuary – particularly to Tahu Mackenzie and team, Dunedin, New Zealand, Futureintech, New Zealand, NZ Frog Group, ADInstrumental - New Zealand, British Herpetological Society, Mohamed bin Zayed Species Conservation Fund, Nick Meek from Computer Science University of Otago, New Zealand, Tim Jowett Mathematics Department, University of Otago, to all the zoo/aquaria/museums that took part on my research in New Zealand - Auckland zoo, Hamilton zoo, Napier National Aquarium, Orana , in the United Kingdom - Wildlife Park, Manchester Museum - The Vivarium, Paington zoo, London Zoo (Zoological Society of London),Wildwood Education Center, Durrell Wildlife Park (Jersey Zoo) and in Brazil - São Paulo Zoo, Parque Zoobotânico Getúlio Vargas (Salvador Zoo), Fundação Zoo-Botânica de Belo Horizonte (BH Zoo), Parque Zoologico Municipal Quinzinho de barros (Zoo de Sorocaba), Zoopark Itatiba and Jardim Zoologico do Rio de Janeiro (Rio Zoo). To all the schools and HoDs that allowed my project to take place; Mrs Allison Dodd, Dr Simon McMillan, Mrs Dunn, all the Zoos/Aquaria and Institutions that kindly allowed me to carry out this project in Brazil, New Zealand and the United Kingdom. To all colleagues that have been supportive on my journey, particularly Luke Easton, Scott Jarvier, Dr. Moacir Tinoco from the Catholica University of Brazil. My family and friends and foremost to Professor R. A. Griffiths and Professor P. J. Bishop for insightful advice, encouragement and support.

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Fig.7. M. Dos Santos presenting a talk on the current research involving Batrachochytrium den-drobatidis (BD) and the current amphibian decline crisis. (Auckland Zoo, New Zealand).

Fig. 8. M. Dos Santos in Brazil, Salvador Zoo, presenting a talk for zoo keeper & staff - The role of Zoos in conservation and global, and the global amphibian declines.

Fig.9. M. Dos Santos in Brazil. Minas Gerais, raising awareness of global amphibian declines at a secondary school.

Fig.10. M. Dos Santos in Brazil: UCSAL (University Catholic of Salvador Bahia), giving a talk about global amphibian conservation and amphibian global declines. The audience involved professors, researchers, master students and undergraduate students.

Fig.11. M. Dos Santos in Brazil, Salvador. Time to find some frogs. Field work part of the Her-petofauna do Litoral Norte da bahia (HLNB).

IN THE WILD

Wet meadow monitoring site near Red Rock Mountain in the Klamath Mountains of Northern California, typical of high-elevation wet meadows in the region. Photo: Charles Adelsheim.

Hydroperiod and cattle use associated with lower recruitment in an r-selected amphibian with a declining population trend in the Klamath Mountains, California

Esther M. Cole, Rosemary Hartman & Malcolm P. North

Recent population declines in amphibians associated with mortality in early life stages highlight the need for a better understanding of the environmental factors related to successful survival to metamorphosis. Cascades Frog (*Rana cascadae*) is an informative focal species for studies on reproductive success because it is an r-selected amphibian experiencing population decline associated with juvenile mortality. *Rana cascadae* breeds in lakes and wet meadows. Each female produces an egg mass annually that contains between 300 and 800 ova and embryos complete their development from egg to metamorphosis over the course of a single summer (May–November). In our study, we closely examine the relative importance of environmental factors to three stages of recruitment for Cascade Frogs (*Rana cascadae*), a declining amphibian, in high-elevation wet meadows. Wet meadows provide unique aquatic habitats in high elevation areas because they are not actively stocked with non-native trout but also tend to be focal sites of grazing by cattle on public lands.

Our results show that local dynamics, more than landscape level variables, are strongly associated with breeding site selection, the number of egg masses, and the number of individuals that survive to metamorphosis per egg mass. *Rana cascadae* does not tend to breed in wet meadows where nonnative trout are present. Survival to metamorphosis per egg mass is lower when hydroperiod of pools is shorter, cattle use is higher and native insect predators are present. Future increases in temperature and decreases in precipitation may cause reductions in pool hydroperiod that fail to meet the minimum hydroperiod length required for successful metamorphosis and high fitness in wet meadows. Earlier studies have shown that cattle impact was not strongly associated with adult abundance of *R. cascadae* in wet meadows (Cole and North 2014), suggesting that earlier, less mobile life stages may be more sensitive to cattle impact than adults. Our results suggest that future management efforts to conserve *R. cascadae* should strive to protect and restore wet meadows free from nonnative trout, containing many pools with longer hydroperiods, and subjected to minimal cattle use during sensitive development periods.

E. M. Cole, R. Hartman, M. P. North, *Journal of Herpetology* **50**, 37–43 (2016).

A juvenile Anamalai Gliding Frog *Rhacophorus pseudomalabaricus*. Photo: Lilly M. Eluvathingal.

Note on range extension, local knowledge and conservation status of the Critically Endangered Anamalai Gliding Frog *Rhacophorus pseudomalabaricus* in the Cardamom Hills of Western Ghats, India

Monica Harpalani, Sethu Parvathy, Arun Kanagavel, Lilly M. Eluvathingal & Benjamin Tapley

Rhacophorus pseudomalabaricus is a Critically Endangered, range-restricted frog found in the southern Western Ghats of India. We report new distribution records outside the protected area network in the Cardamom Hills of Kerala State through direct sightings and local ecological knowledge. These records increase the distribution by 12 km to the south-east of its currently known range and increase the altitudinal range of the species to 1,600 m asl. We present a preliminary call analysis of the species that is distinct from the call of its nearest congener R. malabaricus. Foam nests, tadpoles and metamorphs were sighted in agricultural land suggesting the importance of these landscapes for breeding. Breeding continues into the month of November extending the known length of its breeding season. Breeding occurred in highly disturbed areas and oviposition sites varied according to the vegetation around breeding sites and included the use of non-native plants. This suggests the need to exercise caution while conducting habitat restoration programs that involve a standard removal of non-native plants. The IUCN Red List status for this species could be revised from 'Critically Endangered' to 'Endangered' in light of our findings. Local ecological knowledge on amphibians could provide supplementary information on distinct species with local names and those that have short periods of activity, which may not be frequently encountered during field surveys.

M. Harpalani, S. Parvathy, A. Kanagavel, L. M. Eluvathingal & B. Tapley, *Herpetological Bulletin* **133**: 1–6 (2015).

New county distribution records for amphibians and reptiles in Wisconsin

Gary S. Casper

Twenty-seven new amphibian and 35 new reptile county records for Wisconsin are provided, along with one correction.

G. S. Casper, *Herpetological Review* **46(4)**, 582–586 (2015).

Nimba Toad (*Nimbaphrynoides occidentalis*) males are very small with a snout-vent length of < 20 mm. Photo: L. Sandberger-Loua.

Conserving the unique to save the diverse: Identifying key environmental determinants for the persistence of the viviparous Nimba Toad in a West African World Heritage Site

Laura Sandberger-Loua, Joseph Doumbia & Mark-Oliver Rödel

Funds for conservation efforts are limited and thus need to be prioritized to profit species and areas of particular need. The Nimba Toad (*Nimbaphrynoides occidentalis*) is the only known truly viviparous (matrotrophic and pueriparous) anuran on Earth and the flagship species of the World Heritage Site Nimba Mountains in West Africa. To ascertain the persistence of this unique toad and other Nimba Mountain

endemic species, increased conservation efforts are necessary. To set the baseline for conservation efforts we focused on the relationship between environmental parameters and the Nimba Toad's distribution. With linear, generalized linear, generalized additive and zero-inflation models we analysed the toads' distribution and range limits. In the past Nimba Toads were never recorded on elevations below 1,200 m asl and our results indicate the importance of weather conditions for this lower elevation boundary. Generally, it is assumed that lower elevation boundaries are determined by competition with closely related species. In contrast, for two salamander species it was hypothesized that it is the high elevation species which limits through competition the more widely distributed lowland species. We hypothesized that this was as well the case for Nimba Toads and that weather condition was the determining variable for the lower elevation boundary. Nimba Toads spend the dry season in dormancy sites underground and can only be found above ground and active during the rainy season. Water impermeable geologic layers seem to be inevitable for adequate dry season dormancy sites, thus being the main factor predicting the patchy above ground wet season distribution. From our models Nimba Toad occurrences were predicted in two areas with present Nimba Toad absences. Within the larger of these areas Nimba Toads were recorded over 60 years ago and since then human presence was highest there, a possible reason for present day toad absences in this area. Hence, these results emphasize the importance to include in distribution estimates for conservation planning two aspects: non-breeding, temporally used habitats, as in this case dry season dormancy sites, and second to incorporate recent historic changes and their influence on the distribution of the focal species.

L. Sandberger-Loua, J. Doumbia, M. -O Rödel, *Biological Conservation*, **198**, 15–21 (2016) doi:10.1016/j.biocon.2016.03.033, http://www.sciencedirect.com/science/article/pii/S0006320716301215

Species interactions in constructed wetlands result in population sinks for Wood Frogs (*Lithobates sylvaticus*) while benefitting Eastern Newts (*Notophthalmus viridescens*)

Chelsea S. Kross & Stephen C. Richter

Wetland construction has been used as a tool to mitigate wetland loss, but constructed wetlands might not provide the same functions as natural wetlands. Hundreds of long-hydroperiod wetlands have been constructed within the Daniel Boone National Forest, Kentucky, in a ridge-top ecosystem where natural wetlands dry annually (*i.e.*, have short hydroperiods). The constructed wetlands have been colonized by several amphibian species not historically associated with this ecosystem and that could have negative impacts on native amphibian species. We compared Wood Frog (*Lithobates sylvaticus*) reproductive success at constructed and natural wetlands and benefits of wood frog presence in constructed wetlands to Eastern Newts (*Notophthalmus viridescens*). Wood Frog reproductive success was zero when eggs were laid in constructed wetlands: 7–70 % of eggs were consumed and no wood frog larvae were found. Eastern Newts, present at all constructed wetlands, benefited from wood frog presence, *i.e.*, newts in constructed wetlands with Wood Frog eggs had higher body condition than newts in natural wetlands. Wetland construction techniques should be altered so their hydrology mimics that of natural wetlands to support historically occurring species. Understanding the influence of species interactions, as habitat loss and modification increase, will continue to be critical for amphibian conservation.

C. S. Kross, S. C. Richter, *Wetlands* **36**, 385 (2016).

The lateral spot patterns of Alpine Newts (*Ichthyosaura alpestris*; right) and the ventral spot patterns of Smooth Newts (*Lissotriton vulgaris*; left) can be utilized to distinguish individuals from other conspecifics in natural populations. Photo: Onoufrios Mettouris.

A newt does not change its spots: Using pattern mapping for the identification of individuals in large populations of newt species

Onoufrios Mettouris, George Megremis & Sinos Giokas

Capture-mark-recapture (CMR) methods are widely used in ecological studies to collect data on the demography, migration and life cycle of animals and estimate population parameters (*e.g.* abundance, survival rates). The correct identification of individuals, which is a basic requirement of CMR methods, is most commonly achieved by applying artificial marks or by mutilation of study-animals. An alternative, non-invasive method to identify individuals is to utilize their natural body markings, such as stripes, spots or blotches; these natural patterns are photographed and then used to distinguish between individuals. Although most amphibians exhibit some form of natural patterns, the use of pattern mapping in amphibian CMR studies is not yet widespread, mainly because it is considered time consuming, particularly in large populations or long-term CMR studies. Using the freely available, open-source software Wild-ID, we explore the use of pattern mapping for the identification of adult individuals in the Alpine (*Ichthyosaura alpestris*) and the Smooth (*Lissotriton vulgaris*) Newt. We constructed photographic datasets that included nearly 4,000 captured animals' images, taken during three years of sampling. We show that the spot patterns of individual newts do not change over time and are sufficiently varied to allow their individual identification, even in datasets comprising hundreds of animals. The pattern-recognition algorithm of Wild-ID is very efficient in identifying individual newts in both species. Pattern mapping can thus be successfully employed for individual identification in large populations of a broad range of animals that exhibit natural markings, including many amphibians. We argue that pattern mapping has the potential to become a powerful tool in CMR studies, particularly in species of conservation interest, such as many amphibians facing population declines, where long-term information on their demography and population dynamics is required.

O. Mettouris, G. Megremis, S. Giokas, *Ecol. Res*. **31**, 483 (2016).

Adult male of *Pleurodeles poireti*. Photo: D. Escoriza.

Factors determining the occurrence of *Pleurodeles poireti* (Caudata: Salamandridae) on Edough Peninsula, northeastern Algeria

Ben Hassine, Daniel Escoriza & Badis Bakhouche

The Edough Ribbed Newt *Pleurodeles poireti* is one of the lesser-known

amphibians in the Mediterranean basin. This newt is confined to the Edough Peninsula in northeastern Algeria. Here we assessed the factors that could influence on the presence of *P. poireti*, by affecting its selection of both aquatic and terrestrial habitats. Aquatic habitats were characterized according to their size and the water parameters. We also examined the topographical, substrate and landscape features and climatic conditions at the occurrence sites. Our surveys showed that, contrary to previous reports, *P. poireti* is widely-distributed on the Edough Peninsula. *Pleurodeles poireti* predominantly breeds in moderate to large water bodies densely covered with Water Crow-foot (*Ranunculus*). The physical and chemical parameters of water are less influential in its occurrence, except dissolved oxygen and turbidity, which are usually high at the occupied sites. At the broad spatial scale, *P. poireti* is positively associated with lowlands in agro-steppes. However, the species has a relatively broad niche in the region, and also occurs in broadleaved forests of *Quercus suber*. The species tolerates some level of human disturbance, but some populations close to villages could disappear caused by the combined effects of the habitat degradation and the recent introduction of an alien fish, the Eastern Mosquitofish *Gambusia holbrooki*.

J. Ben Hassine, D. Escoriza, B. Bakhouche, *Afr. J. Herpetol.* **65**, 55–67 (2016).

Movement and survival of an amphibian in relation to sediment and culvert design

R. Ken Honeycutt, Winsor H. Lowe & Blake R. Hossack

Habitat disturbance from stream culverts can affect aquatic organisms by increasing sedimentation or forming barriers to movement. Currently, land managers are replacing many culverts to reduce these negative effects, primarily for stream fishes. However, these management actions likely have broad implications for many organisms, including amphibians in small streams. To assess the effects of culverts on movement and survival of the Idaho Giant Salamander (*Dicamptodon aterrimus*), we used capture-mark-recapture surveys and measured sediment in streams with two culvert types (*i.e.*, unimproved culverts, improved culverts) and in streams without culverts (*i.e.*, reference streams). We predicted that culverts would increase stream sediment levels, limit movement and reduce survival of Idaho giant salamanders. We also determined the effect of sediment levels on survival of salamanders because although sediment is often associated with distribution and abundance of stream amphibians, links with vital rates are unclear. To estimate survival, we used a spatial Cormack-Jolly-Seber (CJS) model that explicitly incorporates information on movement, eliminating bias in apparent survival estimated from traditional (*i.e.*, non-spatial) CJS models caused by permanent emigration beyond the study area. To demonstrate the importance of using spatial data in studies of wildlife populations, we compared estimates from the spatial CJS to estimates of apparent survival from a traditional CJS model. Although high levels of sediment reduced survival of salamanders, culvert type was unrelated to sediment levels or true survival of salamanders. Across all streams, we observed only 15 movement events between study reaches. All movements were downstream, and they occurred disproportionately in one stream, which precluded measuring the effect of culvert design on movement. Although movement was low overall, the variance among streams was high enough to bias estimates of apparent survival compared to true survival. Our results suggest that where sedimentation occurs from roads and culverts, survival of the Idaho Giant Salamander could be reduced. Though culverts clearly do not completely block downstream movements of Idaho Giant Salamanders, the degree to which culvert improvements affect movements under roads in comparison to unimproved culverts remains unclear, especially for rare, but potentially important, upstream movements.

R. K. Honeycutt, W. H. Lowe & B. R. Hossack, *J. Wildl. Manag.* **80**(4), 761–770 (2016).

Female Pool Frog (*Pelophylax lessonae*) at a breeding locality in Sweden. Photo: Germán Orizaola.

Developmental plasticity increases at the northern range margin in a warm-dependent amphibian

Germán Orizaola & Anssi Laurila

Accurate predictions regarding how climate change affects species and populations are crucial for the development of effective conservation measures. However, models forecasting the impact of climate change on natural environments do not often consider the geographic variation of an organism's life history. We examined variation in developmental plasticity to changing temperature in the Pool Frog (*Pelophylax lessonae*) across its distribution by studying populations from central areas (Poland), edge populations (Latvia) and northern marginal populations (Sweden). Relative to central and edge populations, northern populations experience lower and less variable temperature and fewer episodes of warm weather during larval development. Plasticity in larval life-history traits was highest at the northern range margin: larvae from marginal populations shortened larval period and increased growth rate more than larvae from central and edge populations when reared at high temperature. Maintaining high growth and development under the scarce spells of warm weather is likely adaptive for high-latitude populations. The detection of high levels of developmental plasticity in isolated, marginal populations suggests that they may be better able to respond to the temperature regimes expected under climate change than often predicted, reflecting the need to incorporate geographic variation in life-history traits into models forecasting responses to environmental change.

G. Orizaola, A. Laurila, *Evol. App.* **9**, 471-478 (2016).

Juvenile Bullfrog *Lithobates catesbeianus*. Photo: Robin Greene.

Functional distance to recipient communities may favor invasiveness: Insights from two invasive frogs

Daniel Escoriza & Albert Ruhí

Invasive species present negative impacts on native biodiversity at a global scale. A key goal of community ecology is to identify what drives invasiveness, but hypotheses relying on biotic mechanisms remain largely untested for many groups. Here we asked whether source and recipient communities of two highly-successful invasive anurans (the Bullfrog *Lithobates catesbeianus* and the Cane Toad *Rhinellla marina*) differ consistently from a taxonomic and/or functional standpoint. If affirmative, this pattern could suggest that taxonomic and/or functional distances between an invasive species and a potentially-recipient community might influence the alien's invasive potential.

Based on co-occurrence data of 1,061 amphibian species, we compared 30 source to 30 recipient world-wide communities of Bullfrogs and Cane Toads by means of biotic metrics that summarize taxonomic and functional diversity and the relative position of the invasive species within the community. We also included environmental drivers that reportedly influence invasibility (climate, resource availability, spatial heterogeneity and propagule pressure). Both invasive species were functionally-distant to their respective recipient communities; in contrast, community diversity did not explain much variation between source and recipient communities. Climate matching possibly influenced Cane Toad's but not Bullfrog's invasiveness, and landscape factors had little relevance overall. This study advances the notion that the relative position of a recently-introduced species within the native functional space may help predicting its invasive potential.

D. Escoriza, A. Ruhí, *Divers. Distrib.* (in press).

***Imantodes cenchoa*. Photo: Nicolas Urbina-Cardona.**

Abundance signals of amphibians and reptiles indicate strong edge effects in Neotropical fragmented forest landscapes

Laure Schneider-Maunoury, Veronique Lefebvre, Robert M. Ewers, Guido. F. Medina-Rangel, Carlos A. Peres, Eduardo Somarriba, Nicolás Urbina-Cardona & Marion Pfeifer

Breaking up tropical forests into increasingly smaller "forest islands" means more species are being forced to live on or near the forest edge, prompting a decline in the abundance of species sensitive to changes in light, moisture and temperature. Studying 104 species of reptiles and amphibians living in nine fragmented forested landscapes in Central and South America, this study found that over 90 % of all species increased or decreased in abundance in response to the forest edge. Furthermore, the negative impact of the forest edge on the abundance of forest-dependent species, which represented the majority of species present in the studied landscapes, can extend up to 2 km into the forest interior. Sampling in areas where the forests had been divided to make way for farming or roads, the research team showed that the average "edge effect" extended more than 250 m into the forest. This means a forest island with a diameter of less than 500 m would contain no viable "core" area for many forest-dependent species. For such species, this edge effect will further reduce the habitat suitability of already diminishing forest area.

Dr Marion Pfeifer, who coordinated the study, explains, "The rapid decline in the world's rainforests is having a devastating effect on species numbers and diversity but until now there has been inconsistent information about the additional impact of forest fragmentation. We clearly show that, while many species may decline, some others may actually benefit, and in particular species that are less sensitive to temperature, light and moisture variability. Some species are more sensitive than others to microclimatic changes happening at the edge zone, which significantly impacts their ability to survive. We show that large forest patches will need to be conserved to protect forest-dependent species and to avoid diminishing the loss of biodiversity, those function in ecosystem processes is still little explored in tropical landscapes."

The team is currently looking at the impact of the ''edge effect" on other species, from insects to birds and mammals in fragmented forested landscapes (for details see the global BIOFRAG project, led by Pfeifer: https://biofrag.wordpress.com/).

L. Schneider-Maunory *et al.*, *Biol. Conserv.* **200**, 207 (2016).

***Pristimantis calcaratus*. Photo: E.W. Basham.**

Quantifying carbon and amphibian co-benefits from secondary forest regeneration in the Tropical Andes

Edmund W. Basham, Pamela González del Pliego, Andres R. Acosta-Galvis, Paul Woodcock, Claudia A. Medina Uribe, Torbjørn Haugaasen, James J. Gilroy & David P. Edwards

Tropical land-use change is a key driver of global declines in biodiversity and a major source of anthropogenic carbon emissions, yet there is a substantial shortfall in the funding available to tackle these issues. We urgently need mechanisms that can simultaneously tackle both biodiversity and carbon losses, with carbon-based payments for ecosystem services (e.g. REDD+) of particular interest. A critical question is whether such payments offer strong carbon–biodiversity co-benefits via the regrowth of forests on abandoned farmlands (carbon enhancements) for amphibians, which are the most threatened vertebrate group and reach the greatest richness of threatened and small-ranged species in the montane tropics (>1000 m a.s.l.). Here, we study changes in amphibian communities across a typical Andean habitat transition from cattle pasture through secondary forests (8–35 years) to primary forest. As secondary forests mature, they recovered the abundance, species richness, species composition and Red-listed (near threatened and threatened) species typically found in primary forest. By contrast, cattle pasture contained much lower richness of Red-listed species and a different species composition compared to forest. We then reveal positive relationships between carbon stocks and amphibian species richness and abundance, Red-listed species richness and abundance and the similarity of communities to primary forests, confirming significant carbon–biodiversity co-benefits. Our results underscore the high conservation value of secondary forests and the strong potential for carbon and biodiversity recovery. Using carbon-based funding initiatives to support the regrowth of forests on marginal agricultural land is therefore likely to conserve threatened biodiversity in the Tropical Andes.

E. W. Basham *et al.*, *Anim Conserv*, **19**, 548–560. doi:10.1111/acv.12276 (2016).

IN CAPTIVITY

Chiricahua Leopard Frog (*Lithobates chiricahuensis)* from Buenos Aires National Wildlife Refuge, Arizona. Photo: B. Sigafus, USGS.

Modeling habitat connectivity to inform reintroductions: A case study with the Chiricahua Leopard Frog

Christopher J. Jarchow, Blake R. Hossack, Brent H. Sigafus, Cecil R. Schwalbe & Erin Muths

Managing species with intensive tools such as reintroduction may focus on single sites or entire landscapes. For vagile species, long-term persistence will require colonization and establishment

in neighboring habitats. Therefore, both suitable colonization sites and suitable dispersal corridors between sites are required. Assessment of landscapes for both requirements can contribute to ranking and selection of reintroduction areas, thereby improving management success. Following eradication of invasive American Bullfrogs (*Lithobates catesbeianus*) from most of Buenos Aires National Wildlife Refuge (BANWR; Arizona, United States), larval Chiricahua Leopard Frogs (*Lithobates chiricahuensis*) from a private pond were reintroduced into three stock ponds. Populations became established at all three reintroduction sites followed by colonization of neighboring ponds in subsequent years. Our aim was to better understand colonization patterns by the federally threatened *L. chiricahuensis* which could help inform other reintroduction efforts. We assessed the influence of four landscape features on colonization. Using surveys from 2007 and information about the landscape, we developed a habitat connectivity model, based on electrical circuit theory, that identified potential dispersal corridors after explicitly accounting for imperfect detection of frogs. Landscape features provided little insight into why some sites were colonized and others were not, results that are likely because of the uniformity of the BANWR landscape. While corridor modeling may be effective in more complex landscapes, our results suggest focusing on local habitat will be more useful at BANWR. We also illustrate that existing data, even when limited in spatial or temporal resolution, can provide information useful in formulating management actions.

C. J. Jarchow *et al., J. Herpetol*. **50**, 63–69 (2016).

ONE GREEN HEALTH

Plethodon cinereus (Eastern Red-backed Salamander) not affected by long-term exposure to soil liming

Alexander C. Cameron, Cari-Ann M. Hickerson & Carl D. Anthony

The recovery of ecosystems affected by anthropogenic acidification is often a slow process, and one that is not always achievable through natural means. Application of carbonate materials to forest soils is being used more frequently to aid in the recovery of acidified ecosystems. However, few studies have addressed how the application of carbonate materials affects amphibians. We sampled field sites undergoing long-term application of high-calcium lime to investigate the effects of increases in soil pH on body condition and population demography of *Plethodon cinereus* (Eastern Red-backed Salamander). We found no effect of soil liming on body condition, population demographics, or density of surface- active Eastern Red-backed Salamanders. Our results are consistent with previous studies regarding the response of this species to soil liming, but unique in that they arise from an investigation of the long-term effects of liming exposure on density and demography in a wild population of Eastern Red-backed Salamanders.

A. C. Cameron, C. M. Hickerson, C. D. Anthony, *Northeast. Nat.* **23**, 1 (2016). http://www.eaglehill.us/nena

The Italian Crested Newt (*Triturus carnifex*). Photo: B. Trapp.

Histological changes, apoptosis and metallothionein levels in *Triturus carnifex* (Amphibia, Urodela) exposed to environmental cadmium concentrations

Anna Capaldo, Flaminia Gay, Rosaria Scudiero, Francesca Trinchella, Ivana Caputo,Marilena Lepretti, Anna Marabotti, Carla Esposito & Vincenza Laforgia

Aquatic pollutants are considered a contributing factor in the global decline of amphibians, especially urodeles, spending a great part of their life in the aquatic environment and provided with a naked, highly permeable skin. One of the most toxic environmental and industrial pollutants is cadmium, a metal well-known to be teratogen, carcinogen and a possible mutagen. Since it is not biodegradable, it accumulates in freshwater organisms, damaging the physiological processes also at very low concentrations. Therefore, freshwater safety values were established from the European community for cadmium of 44.5 nM/L in drinking water and 178 nM/L in sewage waters. However, a chronic exposure during three and nine months to these low cadmium concentrations induced endocrine disruption in the newt *Triturus carnifex*, an urodele amphibian highly sensitive to waterborne chemicals. Therefore, in this study we evaluated if the same chronic exposure to cadmium (44.5 nM/L and 178 nM/L, corresponding to the freshwater safety values established in drinking water and sewage waters, respectively), during three- and nine-months, induced in *T. carnifex* cadmium accumulation, histological alterations and apoptosis in the kidney, the liver and the skin, and changes in the amount of metallothioneins, involved in metal detoxication, and metallothionein mRNA. Our results showed that only the newts exposed to cadmium during nine months accumulated cadmium in their tissues, whereas all the newts exposed to cadmium showed alterations in the kidney, the liver and the skin, irrespective of the dose or the time of exposure. Only the kidney showed apoptosis, whereas metallothioneins and metallothionein mRNA did not increase. Our results show that also at very low concentrations, cadmium is able to induce accumulation of this metal, alterations in the tissues of *T. carnifex* and apoptosis, even if only in the kidney. Considering the physiological role of the tissues examined, the non-biodegradability of cadmium and the endocrine disruption, previously shown in this species as a consequence of the chronic exposure to the same cadmium concentrations, our results indicate that the current freshwater safety values established for cadmium appears not protective of amphibian health.

A. Capaldo *et al*., *Aquat. Toxicol*. **173**, 63 (2016).

Striped Marsh Frog (*Limnodynastes peronii)* tadpole. Photo: C. Lanctôt.

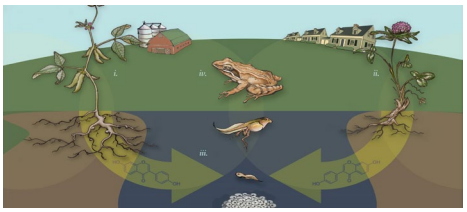
Behavior, development and metal accumulation in Striped Marsh Frog tadpoles (*Limnodynastes peronii*) exposed to coal mine wastewater

Chantal M. Lanctôt, William Bennett, Scott P. Wilson, Larelle Fabbro, Frederic D. L. Leusch & Steven D. Melvin

Coal mining generates large quantities of complex effluent, and this often contains high levels of dissolved solids, suspended solids, metals, hydrocarbons, salts and other compounds. Substantial volumes of mine wastewater are periodically discharged into the environment, through both planned and accidental releases, and this raises concerns about the potential for adverse impacts on aquatic wildlife. There have been few attempts to explore sub-lethal effects of coal mine wastewater on amphibians compared to other organisms, and this is particularly true for Australian species. To address existing knowledge gaps, we exposed Striped Marsh Frog (*Limnodynastes peronii*) tadpoles to 25, 50 and 100% coal mine wastewater collected from two holding dams (CMW1 and CMW2) located at an open cut mine in Central Queensland, Australia. The exposure lasted for four weeks, after which survival, growth and development, swimming behavior and concentrations of metals and metalloids in tail and liver tissues were assessed. Physico-chemical

parameters varied considerably between sites, with higher turbidity, nutrients, total and dissolved organic carbon, alkalinity and arsenic (As) concentrations at CMW1, and higher conductivity, salinity, dissolved solids, hardness and sulfate levels at CMW2. There was no mortality in controls and less than 5% mortality in CMW1 treatments, whereas survival was significantly decreased in tadpoles exposed to CMW2 with 40 and 55% mortality in the 50 and 100% treatments, respectively. Development was significantly delayed in 100% CMW1 wastewater, but tadpole size (growth) was not influenced by the exposure. Hepatosomatic indices were significantly increased in tadpoles exposed to 25 and 50% CMW1 but not the 100% treatment group. Exposed tadpoles (predominantly those exposed to CMW1) exhibited increased activity after very short-term exposure (24 h), but this did not persist as animals approached metamorphic climax. At the end of the experiment, tadpoles exposed to both wastewaters had elevated levels of selenium (Se), cobalt (Co) and As in tail and liver tissue compared to controls. Manganese (Mn) levels were also elevated in livers and tails of CMW2 exposed tadpoles. Hepatic tissue accumulated 8–9 times higher concentrations of Co, Mn and Se compared to tail tissue, irrespective of treatments. Future research is warranted to explore possible relationships between metal bioaccumulation,morpho-physiological effects during development, and subsequent higher-level outcomes related to individual performance and population fitness.

C. Lanctôt, W. Bennett, S. P. Wilson, L. Fabbro, F. D. L. Leusch, S. D. Melvin, *Aquat. Toxicol.* **173**, 218–227 (2016).



Conceptual diagram illustrating parallel impacts from plants like (i) agricultural soy or (ii) clover in suburban yards on developing (iii) and adult (iv) amphibians from root exudates. These exudates are hormonally active and hypothetically transit through the soil into aquatic ecosystems, impacting amphibian development. Illustration: Monte Kawahara.

Clover root exudate produces male-biased sex ratios and accelerates male metamorphic timing in Wood Frogs

Max R. Lambert

In amphibians, abnormal metamorph sex ratios and sexual development have almost exclusively been considered in response to synthetic compounds like pesticides or pharmaceuticals. However, endocrine-active plant chemicals (*i.e.*, phytoestrogens) are commonly found in agricultural and urban waterways hosting frog populations with deviant sexual development. Yet the effects of these compounds on amphibian development remain predominantly unexplored.Legumes, like clover, are common in agricultural fields and urban yards and exude phytoestrogen mixtures from their roots. These root exudates serve important ecological functions and may also be a source of phytoestrogens in waterways. I show that clover root exudate produces male-biased sex ratios and accelerates male metamorphosis relative to females in low and intermediate doses of root exudate. My results indicate that root exudates are a potential source of contaminants impacting vertebrate development and that humans may be cultivating sexual abnormalities in wildlife by actively managing certain plant species.

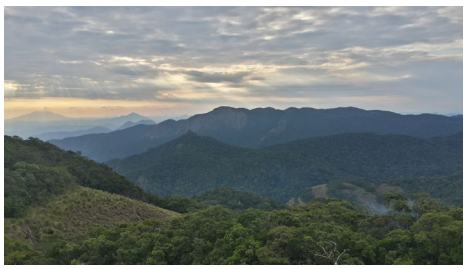
M. R. Lambert, *R. Soc. Open. Sci.* **2**, 150433 (2015).

Amphibian-killing chytrid in Brazil comprises both locally endemic and globally expanding populations

Thomas S. Jenkinson, Clarisse M. Betancourt Román, Carolina Lambertini, Anyelet Valencia-Aguilar, David Rodriguez, Carlos H. L. Nunes-de-Almeida, Joice Ruggeri, Anat M. Belasen, Domingos da Silva Leite, Kelly R. Zamudio, Joyce E. Longcore, L. Felipe Toledo & Timothy Y. James

Chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis* (*Bd*), is the new disease responsible for recent population declines and extinctions of amphibian species worldwide. *Bd* isolates from regions of amphibian decline have all belonged to a single, hypervirulent clonal strain (*Bd*-GPL). However, prior studies in the Atlantic Forest of southeastern Brazil detected a novel, putatively endemic lineage (*Bd*-Brazil), and hybrid strains between *Bd*-GPL and *Bd*-Brazil. In this study, we describe the spatial distribution and population history of these strains in the Brazilian Atlantic Forest. To investigate the genetic structure of *Bd* in this region, we collected and sequenced DNA from *Bd* strains along a 2,400 km stretch of the Atlantic Forest. *Bd*-Brazil genotypes were confined to a narrow zone in the southern Atlantic Forest, while *Bd*-GPL strains were widespread and geographically unstructured. *Bd* population genetics in this region support the hypothesis that the recently discovered Brazilian lineage is endemic in the Atlantic Forest of Brazil, and that *Bd*-GPL is likely a more recently expanded invasive. We collected additional hybrid isolates that demonstrate the recurrence of hybridization between *Bd*-GPL and *Bd*-Brazil strains, confirming the existence of a hybrid zone in the Serra da Graciosa mountain range of Paraná State. Our observations suggest that *Bd*-GPL may be more infective toward native Brazilian amphibians, and potentially more effective at dispersing across a fragmented landscape. We also provide further evidence of pathogen translocations mediated by the Brazilian Bullfrog farming industry with implications for regulations and policies on global amphibian trade.

T. S. Jenkinson, C. M. Betancourt Román, C. Lambertini, A. Valencia-Aguilar, D. Rodriguez, *et al.*, *Mol. Ecol.* **25**, In Press (2016).



'Sky Islands' forest of Mount Mabu, northern Mozambique. Photo: Werner Conradie.

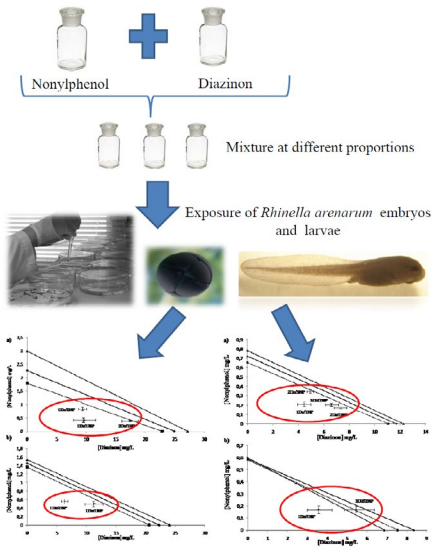
Batrachochytrium dendrobatidis survey of amphibians in the northern Mozambique "Sky Islands" and low-lying areas

Werner Conradie, Gabriela B. Bittencourt-Silva, Simon P. Loader, Michele Menegon, Cristovão Nanvonamuquitxo, Antoinette Kotzé, Desiré L. Dalton, Hanlie M. Engelbrecht & Krystal A. Tolley

Over the last few decades the amphibian chytrid fungus, *Batrachochytrium dendrobatidis* (*Bd*) has been cited as a possible cause for widespread mortalities and population declines in anuran species, however its status as a pathogen implicated in amphibian losses in Africa remains uncertain. In Africa, although most studies have mainly focused on reporting *Bd* presence, some studies have reported on the absence of *Bd* in localities. The mapping of the presence and absence of *Bd* has allowed us to determine areas of high prevalence of the pathogen and therefore potentially areas of greater conservation concern in terms of possible population declines. The high altitude inselbergs in northern Mozambique have been predicted as hotspots for *Bd*. Until now, no *Bd* surveys have been undertaken for Mozambique and we report on the first results of the presence and absence of *Bd* in the northern part of the country. Samples from Mount Mabu, Mount Namuli and Mount Ribáuè showed no infection, except for the one low-lying record. The almost complete absence of chytrid as outlined here, if correct, is surprising as areas in northern Mozambique are geographically close to areas where high prevalence has

been recorded. For now, it appears that the amphibians of northern Mozambique are not yet negatively impacted by *Bd* and prevalence is low. However, additional surveys are needed with larger sample sizes and species over a greater geographical coverage, to fully understand of the prevalence and consequence of the fungus in Mozambique.

W. Conradie *et al.*, *Herp. Review*. **47**, 42–46 (2016).



Credit: Aronzon Carolina.

Synergy between Diazinon and Nonylphenol in toxicity during the early development of the *Rhinella arenarum* toad

Carolina M. Aronzon, Gabriela V. Svartz & Cristina S. Pérez Coll

On May 2016, we published a paper in *Water, Air and Soil Pollution Journal*. The aim of the study was to assess the single and joint toxicity of the extensively applied organophosphate pesticide, diazinon and nonylphenol one of the major degradation products of nonylphenol polyethoxylates which is commonly used as surfactant in pesticide formulations. Both pollutants are widely distributed and often coexist in agroecosystems, where they might cause toxic effects to wild biota. Toxicity was assessed by means of a standardized test, AMPHITOX, on the early development of *Rhinella arenarum*. Joint toxicity of diazinon/nonylphenol mixtures were assessed in embryos and larvae exposed to three different proportions at different exposure times. Embryo and larval toxicity was time-dependent, and larvae were significantly more sensitive than embryos to both compounds with LC50s values of 0.59 mg nonylphenol/L and 8.34 mg diazinon/L at 168 h. For both embryos and larvae, nonylphenol was between 11 and 18 times more toxic than diazinon. It is noteworthy that the use of alkylphenol ethoxylates is still completely unrestricted in Latin American countries and nonylphenol is an emerging pollutant, not currently covered by water quality regulations, and it is thought to be a potential threat to ecosystems and human health. These results are particularly relevant for Argentina and other developing countries where large agricultural areas are treated with pesticides containing non-ionic surfactants. Despite that some active ingredients of pesticides are reported of low toxicity, added surfactants may be a health risk to aquatic biota as shown in this study. Joint toxicity of chemicals showed a tendency to be significantly higher than the predicted by additivity effects. These synergistic toxic effects provide evidence of the possible higher toxicity of commercial formulations. The synergistic interactions observed highlight the threat that diazinon/nonylphenol mixtures represent for *Rhinella arenarum* populations.

C. M. Aronzon, G. Svartz, C. Pérez Coll, *Water, Air and Soil Pollution Journal* **227**(5), 139 (2016).

Combined endosulfan and cypermethrin-induced toxicity to embryo–larval development of *Rhinella arenarum*

Gabriela V. Svartz, Carolina M. Aronzon & Cristina S. Pérez Coll

On February 2016, we published a paper in the *Journal of Toxicology and Environmental Health*. The combined effects of two widely used pesticides, endosulfan and cypermethrin, on survival of embryo–larval development of the South American Toad (*Rhinella arenarum*) were examined. The toxicity bioassays were performed according to the AMPHITOX test. Embryos and larvae were exposed to mixtures of these pesticides at equitoxic ratios from acute or chronic exposure to evaluate interaction effects. The results were analyzed using both Marking's additive index and combination index (CI)–isobologram methods. Acute (96-h) and intermediate (168-h) toxicity of endosulfan–cypermethrin mixtures remained almost constant for larvae and embryos, but when exposure duration was increased, there was a significant elevation in toxicity, obtaining chronic (240-h) no-observed-effect concentrations (NOEC) values of 0.045 and 0.16 mg/L for embryos and larvae, respectively. These are environmentally relevant concentrations that reflect a realistic risk of this pesticide mixture to this native amphibian species. The toxicity increment with the exposure duration was coincident with the central nervous system development on embryos reaching the larval period, the main target organ of these pesticides. The interactions of the pesticide mixtures at acute and chronic exposure were antagonistic for embryo development (CI > 1), and additive (CI = 1) for larvae, while chronic exposure interactions were synergistic (CI < 1) for both developmental periods. Data indicated that endosulfan–cypermethrin mixtures resulted in different interaction types depending on duration and developmental stage exposed. As a general pattern and considering conditions of overall developmental period and chronic exposure, this pesticide mixture usually applied in Argentine crop fields is synergistic with respect to toxicity for this native amphibian species.

G. Svartz, C. Aronzon, C. Pérez Coll, *J. Toxicol. Environ. Health A*. **79**(5), 197–209 (2016).

Japanese Tree Frogs (*Hyla japonica*) infected by chytrid fungus call more to attract mates. Photo: Jungbae Park.

Enhanced call effort in Japanese Tree Frogs infected by amphibian chytrid fungus

Deuknam An & Bruce Waldman

Some amphibians have evolved resistance to the devastating disease chytridiomycosis, associated with global population declines, but immune defenses can be costly. We recorded advertisement calls of male Japanese Tree Frogs (*Hyla japonica*) in the field. We then assessed whether individuals were infected by *Batrachochytrium dendrobatidis* (*Bd*), the causal agent of the disease. This allowed us to analyze call properties of males as a function of their infection status. Infected males called more rapidly and produced longer calls than uninfected males. This enhanced call effort may reflect pathogen manipulation of host behavior to foster disease transmission. Alternatively, increased calling may have resulted from selection on infected males to reproduce earlier because of their shortened expected lifespan. Our results raise the possibility that sublethal effects of *Bd* alter amphibian life histories, which contributes to long-term population declines.

D. An, B. Waldman, *Biol. Lett.* **12**, 2016.0018 (2016).

Sex reversal assessments reveal different vulnerability to endocrine disruption between deeply diverged anuran lineages

Stephanie Tamschick, Beata Rozenblut-Kościsty, Maria Ogielska, Andreas Lehmann, Petros Lymberakis, Frauke Hoffmann, Ilka Lutz, Werner Kloas & Matthias Stöck

Multiple anthropogenic stressors cause worldwide amphibian declines. Among several poorly investigated causes are global pollution of aquatic ecosystems with endocrine disrupting compounds (EDCs). These substances interfere with the endocrine system and can affect the sexual development of vertebrates including amphibians. We test the susceptibility to an environmentally relevant contraceptive, the artificial estrogen 17α-ethinylestradiol (EE2), simultaneously in three deeply divergent systematic anuran families, a model-species, *Xenopus laevis* (Pipidae), and two non-models, *Hyla arborea* (Hylidae) and *Bufo viridis* (Bufonidae). Our new approach combines synchronized tadpole exposure to three EE2-concentrations (50, 500, 5,000 ng/L) in a flow-through-system and pioneers genetic and histological sexing of metamorphs in non-model anurans for EDC-studies. This novel methodology reveals striking quantitative differences in genetic-male-to-phenotypic-female sex reversal in non-model vs. model species. Our findings qualify molecular sexing in EDC-analyses as requirement to identify sex reversals and state-of-the-art approaches as mandatory to detect species-specific vulnerabilities to EDCs in amphibians.

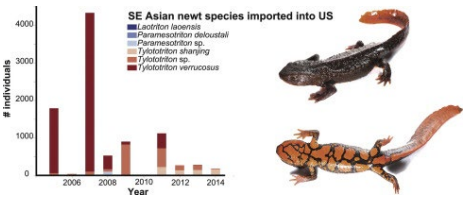
Stephanie Tamschick *et al.*, *Scientific Reports* **6**, Article number: 23825 (2016). doi:10.1038/srep23825

A model to inform management actions as a response to chytridiomycosis-associated decline

S. J. Converse, L. L. Bailey, B. A. Mosher, W. C. Funk, B. D. Gerber, & E. Muths

Decision-analytic models provide forecasts of how systems of interest will respond to management. These models can be parameterized using empirical data, but sometimes require information elicited from experts. When evaluating the effects of disease in species translocation programs, expert judgment is likely to play a role because complete empirical information will rarely be available. We illustrate development of a decision-analytic model built to inform decision-making regarding translocations and other management actions for the Boreal Toad (*Anaxyrus boreas boreas*), a species with declines linked to chytridiomycosis caused by *Batrachochytrium dendrobatidis* (*Bd*). Using the model, we explored the management implications of major uncertainties in this system, including whether there is a genetic basis for resistance to pathogenic infection by *Bd*, how translocation can best be implemented, and the effectiveness of efforts to reduce the spread of *Bd*. Our modeling exercise suggested that while selection for resistance to pathogenic infection by *Bd* could increase numbers of sites occupied by toads, and translocations could increase the rate of toad recovery, efforts to reduce the spread of *Bd* may have little effect. We emphasize the need to continue developing and parameterizing models necessary to assess management actions for combating chytridiomycosis-associated declines

S. J. Converse *et al*, *EcoHealth*, 1–12 (2016). DOI: 10.1007/s10393-016-1117-9



Number of individuals of Southeast Asian (Laos, Myanmar, Thailand and Vietnam) newts, (or newts potentially from Southeast Asia (*Paramesotriton* sp. and *Tylototriton* sp.), imported into the US during 2005–2014 (LEMIS) by species. Newt is *Paramesotriton deloustali*. (from paper).

Estimating the global trade in Southeast Asian newts

Jodi J. L. Rowley, Chris R. Shepherd, Bryan L. Stuart, Truong Q. Nguyen, Huy D. Hoang, Timothy P. Cutajar, Guinevere O.U. Wogan & Sompouthone Phimmachak.

The global trade in amphibians is widespread, involves hundreds of species, and has been implicated in amphibian population declines. The pet trade is the primary driver for population declines in one Southeast Asian newt species (*Laotriton laoensis*), and is a known threat to most of the 13 other known species from the region. Despite this, there has been little attempt to assess the impact of collection for the pet trade on Southeast Asian newts. We examined available import data from the US, Europe and Hong Kong, assessed current online trade and surveyed local pet traders within Southeast Asia. Large numbers of Southeast Asian newts are harvested from the wild to meet the demands of the international pet trade, with more than 7,500 individual newts imported into the US alone during 2005–2014. Internet trade surveys revealed the global extent of the trade, with Southeast Asian newts for sale as pets in 15 countries throughout Europe, Asia and North America, at between ~ USD30–260 each. The trade in newts within Southeast Asia appears negligible in comparison. Urgent measures are required in order to conserve Southeast Asian newts but the lack of data on the species and number of individuals impacted by the pet trade makes it difficult to monitor and accurately assess its threat. We strongly recommend that all Southeast Asian newts be listed on CITES. This measure should improve monitoring of trade and provides importing countries opportunity to curb trade in species that were illegally harvested, thus helping to safeguard wild populations.

J. J. L Rowley *et al.*, *Biol. Conserv.* **199**, 96–100 (2016).

Bullfrog (*Lithobates catesbeianus)* tadpoles. Photo: Ana M. Vasconcelos.

Acute and chronic sensitivity, avoidance behavior and sensitive life stages of Bullfrog tadpoles exposed to the biopesticide abamectin

Ana M. Vasconcelos, Michiel A. Daam, Liliana R. A. dos Santos, Ana L. M. Sanches, Cristiano V. M. Araújo & Evaldo L. G. Espíndola

As compared to other aquatic organism groups, relatively few studies have been conducted so far evaluating the toxicity of pesticides to amphibians. This may at least partly be due to the fact that regulations for registering pesticides usually do not require testing amphibians. The sensitivity of amphibians is generally considered to be covered by that based on toxicity tests with other aquatic organisms (*e.g.*, fish) although the impact of a pesticide on amphibians may be very different. In the present study, acute and chronic laboratory tests were conducted to evaluate the acute and chronic toxicity of abamectin (as Vertimec 18EC) to Bullfrog (*Lithobates catesbeianus*) tadpoles. Acute tests were conducted at two tadpole stages (Gosner stage 21G and 25G) and avoidance tests were also conducted with stage Gosner stage 21G tadpoles. Calculated acute toxicity values were greater than those reported for standard fish test species, hence supporting the use of fish toxicity data as surrogates for amphibians in acute risk assessments. Given the limited number and extent of available amphibian toxicity studies, however, research needs to increase our understanding of pesticide toxicity to amphibians are discussed.

A. M. Vasconcelos, M. A. Daam, L. R. A. dos Santos, A. L. M. Sanches, C. V. M. Araújo, E. L. G. Espíndola, *Ecotoxicology* **25**, 500–509 (2016).

Long term effects of carbaryl exposure on antiviral immune responses in *Xenopus laevis*

Francisco De Jesús Andino, B. Paige Lawrence & Jacques Robert

There is growing awareness that exposure to environmental contaminants is an overlooked but important contributor to the burden of infectious diseases. This is particularly significant for emerging infectious diseases implicated in the dramatic worldwide amphibian declines that are of major concern for the maintenance of biodiversity. Notably, water pollutants associated with agriculture may contribute to the increased prevalence of infectious diseases caused by ranaviruses. We have established the amphibian *Xenopus laevis* and the ranavirus Frog Virus 3 (FV3) as an important model system for evaluating the effects of common waterborne pollutants, such as the insecticide carbaryl. Exposure to for 3 weeks 10 ppb carbaryl induced marked mortality and accelerated development of *X. laevis* tadpoles. Furthermore, exposure to lower concentrations, albeit not overtly toxic of carbaryl (0.1 and 1.0 ppb), impaired tadpole innate antiviral immune responses, as indicated by significantly decreased expression of immune genes such as TNF-α, IL-1β, IFN-I, and IFN-III. Notably, the defect in IFN-I and IL-1β gene expression levels persisted after metamorphosis in froglets, whereas only IFN-I gene expression in response to FV3 was attenuated when carbaryl exposure was performed at the adult stage. These data suggest that the agriculture-associated carabaryl exposure at low but ecologically–relevant concentrations has the potential to induce long lasting alterations in host-pathogen interactions and antiviral immunity.

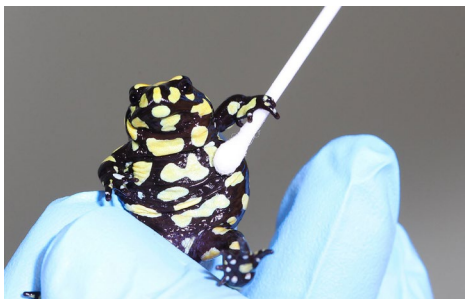
F. De Jesús-Andino, B. P. Lawrence, J. Robert, *Chemosphere* **170**,169 (2017)...

Recombinant ranaviruses for studying evolution of host–pathogen interactions in ectothermic vertebrates

Jacques Robert & James K. Jancovich

Ranaviruses of the family Iridoviridae are large double standed DNA viruses that are causing emerging infectious diseases at an alarming rate in both wild and captive cold blood vertebrate species worldwide. The general biology of these viruses that presents some similarities with poxvirus has been characterized to some extent. However, many aspects of their replication cycles, host cell interactions and evolution still remain poorly known, especially in vivo. In recent years, strategies to generate site-specific ranavirus recombinant, either expressing fluorescent reporter genes or deficient for particular viral genes, have been developed. The authors of this article review these strategies, the main ranavirus recombinants characterized and their usefulness for in vitro and in vivo studies.

J. Robert, J. K. Jancovich, *Viruses*, pii: E187. doi: 10.3390/v8070187 **(**2016).



A Southern Corroboree Frog (*Pseudophryne corroboree*) getting tested for infection with *Batrachochytrium dendrobatidis* (Bd). Photo: Doughty.

Characterization of MHC class IA in the endangered Southern Corroboree fFog

Tiffany A. Kosch, John A. Eimes, Chelsea Didinger, Laura A. Brannelly, Bruce Waldman, Lee Berger & Lee F. Skerratt

Southern corroboree frogs (*Pseudophryne corroboree*) have declined to near extinction in the wild after the emergence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* (*Bd*) in southeastern Australia in the 1980s. A major captive breeding and reintroduction program is underway to preserve this iconic species, but improving resistance to *Bd* would help the wild population to be self-sustaining. Using 3′ and 5′ rapid amplification of complementary DNA ends (RACE), we characterized the major histocompatibility complex (MHC) class IA locus in this species. We then used sequences generated from RACE to design primers to amplify the peptide-binding region (PBR) of this functional genetic marker. Finally, we analyzed the diversity, phylogeny, and selection patterns of PBR sequences from four *P. corroboree* populations and compared this with other amphibian species. We found moderately high MHC class IA genetic diversity in this species and evidence of strong positive and purifying selection at sites that are associated with putative PBR pockets in other species, indicating that this gene region may be under selection for resistance to *Bd*. Future studies should focus on identifying alleles associated with *Bd* resistance in *P. corroboree* by performing a *Bd* laboratory challenge study to confirm the functional importance of our genetic findings and explore their use in artificial selection or genetic engineering to increase resistance to chytridiomycosis.

T. A. Kosch, J. A. Eimes, C. Didinger, L. A. Brannelly, B. Waldman, L. Berger, L. F. Skerratt, *Immunogenetics* (2016). doi:10.1007/s00251-016-0965-3

COMMUNICATION & EDUCATION

Houston Toad, *Anaxyrus houstonensis*. Photo: Rachel E Rommel

Leaping from awareness to action: Impacts of an amphibian educator workshop

Rachel E. Rommel, Paul S. Crump & Jane M. Packard

Where endangered species occur, recommendations call for conservation education programs that engage local educators; however, few studies have measured the effectiveness of implemented programs. We conducted a multipartner educator workshop for the endangered Houston Toad, *Anaxyrus houstonensis*, as one local example illustrating the broader issue of globally declining amphibians. We measured the effect of the workshop on participants' (n = 50) awareness/knowledge, values, beliefs, emotions and intent to take action. We observed significant increases in awareness/knowledge and values regarding general amphibian declines and the focal species. The workshop significantly increased participants' belief that they had necessary resources to teach about the Houston Toad. Ninety-nine percent of participants agreed that they cared more about wild toads after meeting live ambassador toads. Postworkshop, we observed a 33% increase in use of amphibians or Houston Toads in participant learning settings. We recommend that educator workshops include biologist–educator teams, identify and address incentives and barriers to action, develop ecological knowledge and incorporate experiential programming focused on native species and habitats.

R. E. Rommel, P. S. Crump, J. M. Packard, *J. Herpetol.* **50**, 1 (2016).

Instructions to Authors

Background

FrogLog has been one of the leading amphibian conservation community newsletters since the early 1990's. Over the years it has been affiliated with different groups but has always strived to help inform the community. In 2005 *FrogLog* became the official newsletter of the IUCN SSC Amphibian Specialist Group and is produced on a quarterly basis.

FrogLog invites contributions of research, reviews on current management and conservation issues, methods or techniques papers and, editorials. We also actively encourage submissions describing the current activities relating to projects and academic institutions in order to help inform the community as to the general state of current research and conservation activities.

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Manuscripts can only be received as electronic files. Text should be submitted in MS Word format and may contain tables, but figures should be sent as a separate attachment where possible. All documents should be sent to froglog@amphibians.org. Each file should be labeled in a style that illustrates clear association, i.e., authors_name_ms and authors_name _figure1.

Guidelines for Authors

All manuscripts must be written in Standard US English. For example, "colour" should be spelled "color."

Title

Titles should ideally be no more than 15 words.

Authors

Authors names should be written in full as follows: By James P. Lewis & Robin D. Moore

Main body of text

Use Georgia 11-point font. Genus and species names should be in italics as should the abbreviation for *Batrachochytrium dendrobatidis*, *Bd*. Suggested headings include Acknowledgements, Author Details and References and Notes.

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Figures should be numbered and include brief, concise legends. Where photographs or illustrations are used please state whom the image should be credited to, e.g., Photo: James P. Lewis. Graphics should preferably be submitted in tiff or jpeg format in the highest possible quality. Resolution should be at least 300 dpi at the final size.

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Citation of literature

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Journals/Periodicals

1. E. Recuero, J. Cruzado-Cortés, G. Parra-Olea, K. R. Zamundio, *Ann. Zool. Fenn.* **47**, 223 (2010).

Books

2. J. Gupta, N. van der Grijp, Eds., Mainstreaming Climate Change in Development Cooperation (Cambrdige Univ. Press, Cambridge, UK, 2010).

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3. G.B. Shaw, Practical uses of litmus paper in Möbius strips (Tech. Rep. CUCS-29-82, Columbia Univ., New York, 1982).

Paper presented at a meeting

4. M. Konishi, paper presented at the 14th Annual Meeting of the Society for Neuroscience, Anaheim, CA, 10 October 1984.

Published Online Only

5. N. H. Sleep, Geochem. *Geophys. Geosyst.*, 10, Q11010 (2009): DOI:10.1029/2009GC002702.

Web site

6. National Oceanic and Atmospheric Administration, Beaufort Wind Scale, http://www.spc.noaa.gov/faq/tornado/beaufort.html (2012).

SPECIAL NOTE: Use only one space after all punctuation marks (this includes only one space after "periods" at the end of sentences).

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American toad (*Anaxyrus americanus*). Photo: Dave Huth.