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# FrogLog

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



## UPDATING THE AMPHIBIAN CONSERVATION ACTION PLAN: “IN THE WILD” EDITION

Increasing Habitat Protection

Considering the Impacts of Climate Change

A Global Approach to Surveys & Monitoring

Developing Species Conservation Strategies

# FrogLog

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# Editorial

**H**ello to an all new *FrogLog*! In celebration of the recently updated Amphibian Conservation Action Plan—ACAP (yes, after eight years since the production of the original ACAP, it has now been reviewed and updated and is now a living document that can be found [here](#)), we are moving the focus of *FrogLog* away from the regional approach to one that focuses on the global and local strategies that are underway to address the ACAP priority actions.

Each edition of *FrogLog* will now focus on one of the four core Amphibian Survival Alliance (ASA) “Challenges” (as outlined on [amphibians.org](#)): In the Wild (March), In Captivity (June), One Green Health (September) and Communication and Education (December). Each of these Challenges encapsulates several ACAP themes (found [here](#)).

As both the Amphibian Specialist Group (ASG) and ASA have been growing and developing, so has our individual and joint impacts. *FrogLog* is now providing us with an opportunity to showcase some of these efforts in a format that addresses global priorities. However, soon after we started working on this edition of *FrogLog* it became clear that the new approach posed new challenges. First and foremost, we wanted to report on the global response to address the new ACAP priority actions, not merely the actions taken by the ASA and ASG. Although we have tried to reach out to many different groups, we have been unable to present a comprehensive summary of all the actions taken. Therefore, please consider this as the bare minimum of what has been achieved during the last year. We know that there are likely more actions, from the local to the global level, that are not reported here (please [contact us](#) if you would like us to feature your response to the priority actions). In the coming years we hope to improve this situation, helping to communicate the amazing amount of ongoing work around the world to help save amphibians.

We had three key considerations in updating ACAP. Firstly, ACAP needed to be a framework for any individual, group, policy maker or organization to be able to easily engage in amphibian conservation. Secondly, it needed to provide discrete, measurable and achievable targets that could be easily evaluated and thirdly, we needed a model that could be regularly and cost-effectively updated. In short, the new ACAP needed to be achievable, accessible and accountable. The output was a broad overview of current challenges in 12 thematic areas which identified very specific priorities for the short, medium and long terms.

The new ACAP provides a list of major constraints to each conservation issue, and then a list of mid- and short-term priority targets. Most thematic working groups (WGs) divided these into Science, Policy and Conservation actions to help focus on the individual issues. With around 450 actions, this is no small list of priorities. The twelve ASG WGs were made up of members from around the globe, with well over 100 experts providing input into the process.

From the perspective of the ASA, this was exactly what was needed to give the Alliance direction and continue its growth. From the outset, the ASG has acted as the Scientific Advisory Board to the Alliance. Under the helm of Ariadne Angulo and myself the ASG has made major progress in establishing itself as an effective coordinating group for amphibian conservation around the world. During the last year members of the ASG have provided input on the value of projects, policy issues and opinions. This effective and operational resource is allowing the Alliance to move forward on projects based on the scientific advice and guidance of over 500 of the world’s leading amphibian conservationists, researchers and educators.

With the ACAP updated, the ASA and ASG have started to coordinate its implementation. As the Alliance is still a relatively young entity, it is in the early stages of determining how to effectively coordinate global actions. We are striving to get to a point where there is a clear set of priority actions, that a coordinated community is working on accomplishing and effectively reporting on its progress. The new ACAP is helping us move in this direction but we need more input, more partners and improved communications across the board before we get there. Until then, we will continue to work to improve all of these aspects—advice, assistance, and of course funding—are very much appreciated and needed.

*Phil Bishop*

Co-Chair, IUCN SSC Amphibian Specialist Group  
Chief Scientist, Amphibian Survival Alliance

# FrogLog

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# AMPHIBIAN CONSERVATION ACTION PLAN

## Updating the Amphibian Conservation Action Plan

In mid-2013 the IUCN SSC Amphibian Specialist Group (ASG), in partnership with the Amphibian Survival Alliance (ASA), established twelve thematic working groups comprising ASG members with interest and expertise on specific topics relevant to global amphibian conservation. The objective of the working groups has been to review efforts since the publication of the original Amphibian Conservation Action Plan (ACAP) in 2007, and develop a clear strategy to address amphibian conservation challenges worldwide, as well as support its implementation.

The immediate aim for each working group has been to develop priorities for conservation action, building on the relevant section of ACAP. The first revision to ACAP has now been completed and published online, with each group having identified short- and medium-term actions designed to address specific challenges in their field.

Implementation of the priority actions is currently ongoing. The ASA is working on these priorities through its partners, and the ASG thematic working groups (WGs) are further developing those identified priorities where ASG WGs are best placed to spearhead the process. However, ACAP is designed as a tool to be used by any person, group or organization with an interest in and commitment to amphibian conservation, so we encourage the greater conservation community to use ACAP as an implementable framework for amphibian conservation.

It is important to note that the new concept for ACAP is that it becomes a living document, with ongoing updates and revisions undertaken as conservation action is implemented and new challenges present themselves across the different thematic areas. To this end, we have strived to make this version of ACAP more easily implementable.

*FrogLog* has been refocused to help highlight the new ACAP priority actions, as well as to help get reports on actions underway and/or completed by the community at large. The *In The Wild* section features updates from projects that are addressing priority actions from the following ACAP sections:

- [Habitat protection](#)
- [Climate change](#)
- [Surveys and monitoring](#)
- [Species conservation strategies](#)

If your project or organization is currently addressing any ACAP priorities and you would like us to highlight your work, help you network with similar projects or link you up with potential funders, please [contact the Editor-in-Chief](#).

**WHAT IS THE ASG?**  
The Amphibian Specialist Group (ASG) provides the scientific foundation to inform effective amphibian conservation action around the world.

### IUCN SSC Amphibian Specialist Group

Amphibian Conservation Action Plan  
April 2015

**WHAT IS THE IUCN?**  
The International Union for the Conservation of Nature (IUCN) is the world's largest and oldest environmental organization.

**WHAT IS THE ACAP?**  
The current Amphibian Conservation Action Plan (ACAP) is a living document. Reviews are planned on a regular basis to ensure that ACAP remains updated.

**WHAT DOES IT DO?**  
ACAP covers 12 themes and identifies short and mid-term priority actions for each theme.

**WHAT IS THE SSC?**  
The Species Survival Commission (SSC) is the largest of IUCN's six commissions. ASG is part of the SSC.

**WHAT IS THE ASA?**  
The Amphibian Survival Alliance (ASA) is a partnership of institutions, groups and organizations joining forces to implement conservation action. It uses ACAP to guide its actions.



Edited by Sally Wren, Ariadne Angulo, Helen Meredith, Jos Kielgast, Marcileida Dos Santos & Phil Bishop



## Where Next in the Fight Against the Invasive Toad in Madagascar?

By James P. Lewis

As many of you will have heard already, the arrival of the Asian Toad (*Duttaphrynus melanostictus*) in the biodiversity hotspot of Madagascar is nothing but bad news! The toad poisons predators, has the potential to impact human health and disrupts nutrient pools and parasite dynamics. Unfortunately, much like its distant relative, the Cane Toad, the Asian Toad is highly fecund, producing up to 40,000 eggs per clutch giving it the potential to spread rapidly.

The presence of the toad came to the attention of the Amphibian Survival Alliance in 2014 and we immediately began working with eradication experts and with our partners to better understand the threat and decide on next steps.

When the teams got to the field to undertake an eradication feasibility study what they found wasn't good. [The report](#) published in early 2016 tells the story of how the Asian toad has been spreading unchecked through the eastern part of Madagascar with the potential to have a direct threat not only to the country's biodiversity, but to human health and the economy.

Based on all available information it appears the toad arrived in Madagascar from Southeast Asia between 2007–10, but it was not properly identified until 2014. The population is now estimated at around four million toads, covering an area of some 100 sq km, and expanding at a rate of two km per year. The site of incursion is ad-

acent to the port city of Toamasina, but interestingly they have not been detected at the port itself. What this tells us is the port was not the point where the toad first escaped.

Although there are still a lot of questions that need to be answered, it seems pretty apparent that if the toads are not eradicated they will continue to spread over the majority of Madagascar causing havoc to the fragile biodiversity of the country.

"The Asian Toad can spread across most habitats with no obvious barriers. However, it is currently restricted to about 110 sq km, which gives us hope that we can contain it, but only if we act now," said James Reardon, an eradication expert with New Zealand's Department of Conservation, and co-author of the report.

"If the toads become established in the Pangalanes canal system—one of the longest manmade canals in the world—eradication will no longer be an option, and they will likely cause ecological damage similar to that of the cane toad in Australia."

So what are the next steps? Well, a team of experts launched a series of eradication trials in January 2016 to find out what might be the best way to remove the toads from the wild. A number of options appear to be working, including manual removal, trapping with drift fences, tadpole trapping and most promisingly spraying them with citric acid, which has resulted in a 100% mortality rate.



The Asian Toad (*Duttaphrynus melanostictus*) in Madagascar. Photo: James Reardon.



Experts fear ecological impacts similar or worse to those wrought by the Cane Toad in Australia. Toamasina, Madagascar. Photo: James Reardon.

With this knowledge we stand a chance of being able to remove these toads and prevent them spreading throughout Madagascar. However, this isn't going to be cheap. The eradication feasibility report put the cost of the eradication program at \$2M–\$10M, and this price tag will keep going up.

One question we still haven't answered completely is how did the toad get to Madagascar in the first place, or perhaps another way of putting it: Who is responsible for making sure this invasive species is removed from the country?

Many people see the arrival of the toad being directly linked to the development of Ambatovy processing plant that is south of the port city and pretty much in the center of the incursion site.

We are continuing to look for other potential routes of entry that could have lead to the toad arriving in Madagascar but have found no other substantial leads as yet. When you look at the area most likely the center of the incursion area there appears to only be a couple of significant business in the area between 2004–2011 and as far as we can tell only one that was importing materials from outside of Madagascar: Ambatovy. A *Mongabay* article further supports this with evidence provided by an independent source stating "the only ships coming from Southeast Asia during that period, when the toads arrived, was that of the mining company."

If the arrival of the toad was a direct result of the development of the Ambatovy processing plant then we sincerely hope that the Ambatovy management, and all the investors in the project, take immediate action to address this situation.

To date we have unfortunately seen no real attempt to address the situation in any significant way therefore allowing the incursion area to expand and the potential threat to biodiversity in Madagascar increase.

Unfortunately, we are quickly running out of funding to support this effort. To date, the feasibility study and current trials have been funded almost exclusively by the conservation community and our options for securing further funding to support eradication are almost at an end.

Chris Raxworthy, herpetologist and co-author of the feasibility study summed up the situation pretty well "Considering the broad range of biological and economic negative impacts that are expected from this toxic toad, future generations will be furious, should we not make an eradication effort now, while there is still a chance of success, we do not want to look back 20 years from now and wonder what Madagascar would be like if we had addressed this issue properly."

The Alliance is now working with partners to try and secure the necessary funding to continue these vital ongoing efforts.



# Dr. Ariadne Angulo Receives IUCN Award of Excellence

By Phil Bishop

The IUCN Species Survival Commission awarded the SSC Chair's Citation of Excellence Award to Amphibian Specialist Group Co-Chair Dr. Ariadne Angulo on Sept. 18, 2015. The award recognizes Ariadne's tireless, conscientious and dedicated leadership of amphibian conservation in the SSC, including through the Amphibian Specialist Group (ASG) and Amphibian Red List Authority. The certificate was presented during the final session at the 3rd IUCN SSC Leaders Meeting at the Ritz-Carlton Abu Dhabi, United Arab Emirates, in front of a large, enthusiastic crowd.

"This has been a tremendously humbling experience for me," Ariadne said after the meeting, which was sponsored by the Environment Agency – Abu Dhabi. "I have the honor of working with amazingly driven, inspiring and dedicated people every day, who are committed to conservation in general and amphibian conservation in particular. Amphibian conservation endeavors are team efforts, and they come to fruition because of dedicated and supportive teams. Because of this, I feel that this award is a team award, and I wish to wholeheartedly dedicate it to all of my colleagues in ASG, Amphibian RLA and Amphibian Survival Alliance who are making a difference for amphibians and nature every day."

The IUCN Species Survival Commission Chair's Citation of Excellence was created in 2004 and is awarded in recognition of outstanding contributions to the Species Survival Commission.



Photo: Debbie Bishop.



Photo: Debbie Bishop.





Photo: Ian Telfer.

## Prince Charles Gets up Close and Personal with Native New Zealand Frogs (*Leiopelma* spp.)

By Phil Bishop

As part of their Royal down-under tour His Royal Highness Prince Charles and Her Royal Highness Camilla Duchess of Cornwall visited Orokonui Ecosanctuary (<http://orokonui.nz>). This was the perfect time for me to wangle an official invitation to be part of the royal event. After being thoroughly investigated by the Special Security Forces, I was allowed 60 seconds with the Royals. I was armed with a box of rare *Leiopelma* frogs (*L. hochstetteri* and *L. pakeka*, part of the captive colony at the University of Otago) and was given the instructions.

“On being introduced simply shake hands in the usual way (ideally wait for the Royal to offer their hand—which they will). Regarding forms of address, the first time you address the Royals it’s ‘Your Royal Highness,’ and thereafter: ‘Sir’ or ‘Ma’am’ (rhymes with jam!)”

As soon as His Royal Highness approached, I forgot the protocols and enthusiastically grabbed his hand, shook it and planted the bean bag Archey’s Frog (*Leiopelma archeyi*) in it and asked the Prince to hold onto Archey! I then launched into my 60 second speech (which lasted a good five minutes) and managed to convince the Prince and the Duchess how important frogs (and their kin) are, and how dire the situation is for them in regard to global habitat destruction and global climate change. The Prince was very much in agreement and seemed concerned about the plight of amphibians. However, he kept his distance from the live frogs keeping a firm grip on

Archey with one hand, while the other was neatly tucked into his jacket pocket. They were both concerned whether or not the frogs had enough oxygen and food in the plastic bags. The Duchess was very interested in the live frogs and held a *Leiopelma pakeka*, peering at it rather intensely (maybe she is short-sighted), so perhaps its time to name a new species of frog after Camilla?



*Leiopelma hochstetteri*. Photo: Phil Bishop.



Photo: Dennis Van De Water.

## New IUCN SSC Amphibian Specialist Group Members

By Ariadne Angulo and Phil Bishop

**I**n 2015 the ASG welcomed the following new members to the ASG family:

- Celsa Señaris (ASG Regional Co-Chair for Venezuela)
- Gemma Harding (ASG Reintroductions Working Group Co-Facilitator)
- Helen Diaz Paez (ASG Member - Chile)
- Iberê Farina Machado (ASG Program Officer for Brazil)
- John Lamoreux (ASG Member)
- Kristiina Ovaska (ASG Regional Co-Chair for Canada)
- Marcileida Maria Dos Santos (ASG Program Officer)
- Margarita Lampo (ASG Regional Co-Chair for Venezuela)
- Michelle Boone (ASG Ecotoxicology Working Group Co-Facilitator)
- Neil Cox (ASG Member)
- Pritpal "Micky" Soorae ((ASG Regional Co-Chair for West Asia)
- Rick Relyea (ASG Ecotoxicology Working Group Co-Facilitator)
- Sara Ashpole (ASG Regional Co-Chair for Canada)
- Sathyabhama Das Biju (ASG Member - India)

Each of these new members brings invaluable expertise, knowledge and drive to ASG, and we are very excited and honored to have these new members on the global team. Please join us in welcoming our newest members to ASG!



**ASG**  
IUCN SSC  
Amphibian  
Specialist Group



Students encounter a Trinidad Leaf Frog during an evening field survey. Photo: María Matilde Aristeguieta.

## Joint ASA/ASG Seed Grant Project: Strengthening Capacity to Conserve Venezuelan Amphibians

By J. Celsa Señaris, Haidy Rojas and Jon Paul Rodríguez

Venezuela is recognized as a megadiverse country. With 363 species of amphibians—about five percent of the global total—it is among the top 10 continental territories with the greatest species richness in this group of vertebrates. Researchers know very little about this richness of amphibians, especially the natural history, ecology and distribution of endemic species. It is important that conservationists study these species, assess their extinction risk and implement efficient conservation strategies. According to The IUCN Red List of Threatened Species, 73 of these species are threatened and one is extinct, representing 20 percent of the amphibian fauna of the country.

One of the biggest challenges that we face in Venezuela is the lack of technical human resources for amphibian research and conservation. To address this, a multidisciplinary team of seven professionals from academia, civil society and governmental agencies, joined their expertise to organize the first theoretical-practical course in the country entitled “Herpetology I: taxonomy, ecology and biogeography of Amphibians.” The course took place between Oct. 15 and 22, 2015. This eight-day intensive training course spanned a wide range of topics: origin and evolution, general characteristics (osteological, morphological and ecological traits, including vocalizations), diversity and distribution, field techniques, global and national threats and conservation. Additionally, the course examined the process for obtaining national research permits, and discussed the development of funding proposals. During a three-day field trip to the Ecological Reserve La Guáquira (<http://www.guaquira.net/>) in the central portion of Venezuela’s northern

coastal range, students also acquired practical skills on amphibian identification, data collection, GPS use and basic inventory and monitoring techniques. Fifteen of 54 applicants were admitted to this first course. Students came from research centers and national universities, some were independent investigators, and others from



Photo: Trinidad Leaf Frog *Phyllomedusa trinitatis*. Photo: Haidy Rojas.

environmental and national parks government agencies. We expect that the information and skills they obtained will impact their future work, especially the lessons about the threats and pressures on Venezuelan amphibians, and the urgent need to join efforts for amphibian conservation. We hope the participants will help get the word out.

The course offered formal academic credits from the Center of Advance Studies at the Venezuelan Institution for Scientific Investigation (IVIC), and received support from IVIC, Guáquira Foundation, Universidad Central de Venezuela (UCV), La Salle Foundation (Museo de Historia Natural La Salle) and the Venezuelan Ministry for Ecosocialism and Water. Funds were provided by a joint Amphibian Specialist Group (ASG)–Amphibian Survival Alliance (ASA) seed grant to the project “Amphibian Capacity Building in Venezuela: Taxonomy, Biology, Distribution and Ecology,” with generous financing from Global Wildlife Conservation.

Five students were awarded modest fellowships to continue with a three-month training in amphibian red-listing. During the first month, they will be asked to take the [on-line course](#) on IUCN Red List Categories and Criteria, and pass the final exam with a score of 90 percent or more. Those that succeed will move on to the second phase where they will update the assessments of Venezuelan endemics in the IUCN Red List of Threatened Species. Their task will be to review the recent literature and assure that species accounts reflect current knowledge. They will also make sure that distribution maps and Red List categories are accurate and up to date.

Given the success of the first edition of the course, and the need to increase capacity, we plan to offer it periodically. Risk assessment of Venezuela’s diverse amphibian fauna, and the implementation of efficient strategies for their conservation, need many more human and financial resources than are currently available. Little by little, we aim to reduce this gap.



Demerara Falls Treefrog *Hypsiboas cinerascens*. Photo: J. Celsa Señaris.



Looking for tadpoles. Photo: Haidy Rojas.



The group at the Ecological Reserve La Guáquira. Photo: Delvis Romero.

# Disappearing Frogs Project Leaps into Action in the Triangle and Sandhills in 2016

By Pam Hopkins

The Disappearing Frogs Project (DFP), in partnership with the Amphibian Survival Alliance (ASA), is bringing environmental awareness events to the Triangle and Sandhills region of North Carolina (NC) beginning in February 2016. DFP—a grassroots environmental art project—invites professional and emerging artists to create and submit artworks to support the mission of raising awareness of the global decline of frogs and other amphibians.

In its 3rd annual art exhibition, the DFP expands its reach with nine unique art venues spanning 90 days in six different N.C. counties.

Frogs are a visible and audible link to the well-being of our environment, and North Carolina's amphibian diversity is among the highest in the world. They also play a critical role in the health of the global ecosystem. From February through mid-May 2016, DFP will use art as a vehicle to communicate to the public this important message: *Amphibians are critical to the health of our planet and ultimately to the health of humankind.*

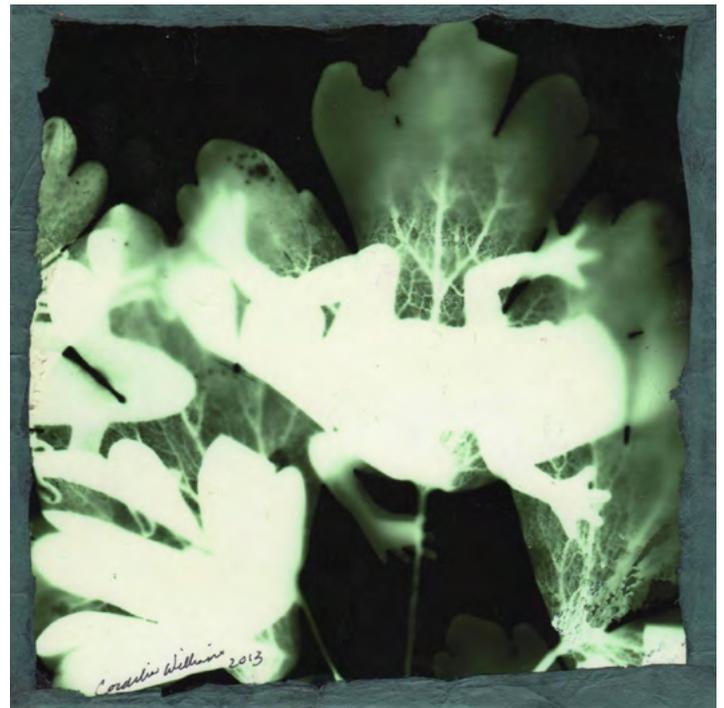
"This project gives artists an opportunity to support grassroots amphibian conservation, education and research by taking personal action to visually communicate this extinction threat," says founder and artist Terry Thirion. "Then we take it one step further and invite scientists to give public presentations about frogs, amphibians and environmental issues relevant to their research."

DFP has put out a call for artists who would like to participate in this important awareness effort. For more information, go to: <http://www.amphibians.org/disappearingfrogsproject/call-for-artists-2016/>.

Local and regional artwork will fill the exhibition spaces with distinctive pieces displayed from around the country and Canada. Mediums can include works on paper, photography, clay, jewelry, and more. Brady Beck, NC. wildlife biologist and nature photographer is one of many who has already donated his artwork to the exhibit. Beck's work includes a unique video capturing wildlife portraits and behaviors found in our North Carolina Longleaf pine forests. The performance arts also on the rise for 2016 as authors, poets and musicians participate at various venues.

The DFP has a full schedule of activities in the Research Triangle area and the Sandhills beginning Feb. 1 – May 14, 2016 including a special Earth Day celebration on April 22. Science presentations, films and several children-specific events round out the roster. Most events are free.

For schedule of activities and more information about the DFP go to: <http://www.amphibians.org/disappearingfrogsproject/>



Art: Cordelia Williams.



Art: Terry Thirion.



## New Website for Deadly Salamander Fungus

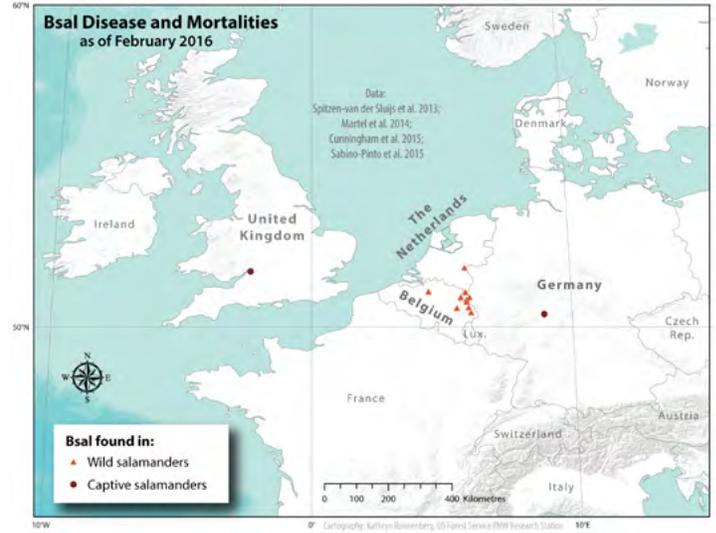
By Louise Rollins-Smith

A new, central source for information about a devastating salamander skin fungus is now available: [salamanderfungus.org](http://salamanderfungus.org). Known as “*Bsal*,” this fungus has affected salamanders in Asia and Europe and poses a threat to North American salamanders if it were to spread to wild populations. North America is a “hot spot” of salamander diversity, and importation and spread of the new fungus would be potentially devastating to North American salamander populations.

The website provides information on *Bsal*:

- Biology and epidemiology
- Task Force efforts and contacts
- Lacey Act interim rule
- Biosecurity
- Diagnostic labs
- Guidance for the general public (pets, actions)
- Publications and factsheets

This website represents the communication portal for the “*Bsal* Task Force,” a group of scientists and representatives from North America and Europe, including US and Canadian federal agencies, US states, the Amphibian Survival Alliance (ASA), the Pet Industry Joint Advisory Council (PIJAC), non-governmental organizations and a number of Colleges, Universities and Zoos. A *Bsal* data management portal is under construction by AmphibiaWeb (UC Berkeley amphibian information site), see: <http://updates.amphibiandisease.org/>



Contact person for European data: An Martel ([An.Martel@ugent.be](mailto:An.Martel@ugent.be)).

## Switzerland Bans the Importation of all Salamander Species Because of the Salamander Chytrid

By Benedikt Schmidt

Emerging diseases are a major threat to amphibians. The team of An Martel, Frank Pasmans and collaborators recently described a novel chytrid fungus *Batrachochytrium salamandrivorans* (*Bsal*) that caused mass mortality and the near-extirpation of the Fire Salamander (*Salamandra salamandra*) in the Netherlands (2,5). Most European and many North American salamander and newt species are highly susceptible to *Bsal*, whereas many Asian species are comparatively tolerant or resistant. *Bsal* is native to Asia and was most likely brought to Europe via the amphibian pet trade (3). In the meantime, *Bsal* was discovered in captive salamanders in the United Kingdom and Germany (1,4). Because *Bsal* has not yet been detected in the US, Yap *et al.* (6) called for an immediate ban on live salamander imports until effective prevention and management protocols are in place. Switzerland appears to be the only country where a ban on live salamander imports is in place. After the publication of the paper by Martel *et al.* (3), KARCH (the Swiss Amphibian and Reptile Conservation Program) alerted the Swiss Federal Office of the Environment that there was a novel threat to salamanders. As a result, the Swiss Federal Food Safety and Veterinary Office established a ban on the importation of all salamander

species into Switzerland in mid-2015. KARCH supports this decision.

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AN INTERNATIONAL DAY TO RAISE AWARENESS ABOUT  
SALAMANDERS AND THEIR  
HABITAT

**SALAMANDER  
SATURDAY**

**7 MAY  
2016**

**HELP FCSAL CELEBRATE SALAMANDERS!  
Create a Salamander Saturday event at a local  
nature center, zoo library or small business  
near you.  
The possibilities are endless!**

Photo by Matt Neff



INITIATIVE OF THE FOUNDATION FOR THE  
CONSERVATION OF SALAMANDERS (FCSAL)

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Staff at Mequon Nature Preserve hold salamanders that are part of the preserve's translocation project. Photo courtesy of Mequon Nature Preserve.

## Translocation Project Gives Wisconsin's Salamanders a Helping Hand

By Lindsay Renick Mayer

Seven years after staff at the [Mequon Nature Preserve](#) (MNP) in southeastern Wisconsin began a project to re-establish the hardwood forests that once dominated the landscape, they noticed that while snakes, frogs and birds had returned in abundance, one important resident family of species was still missing: salamanders. Farmland development, parking lot construction and other urban sprawl projects around the preserve had essentially closed it off, making it difficult for salamanders to find their own way to the perfect new habitat.

So MNP decided to give them a lift with an ambitious strategy.

MNP has translocated two species—the Blue-Spotted Salamander and the Eastern Tiger Salamander—from nearby healthy salamander populations to the preserve in the hopes that the salamanders would re-establish breeding populations. For the first time since the project started four years ago, researchers found a few large masses of Tiger Salamander eggs, likely from adults that were translocated as eggs in 2013, indicating a naturally reproducing population.

"Salamanders often cannot voluntarily recolonize fragmented habitats," said Dr. Gary Casper, a herpetologist with the University of Wisconsin-Milwaukee. Casper drew on his years of expertise to help MNP determine how to set this project up and where to pull the eggs. "Much sweat and treasure has been invested in restoring these habitats, and if the salamanders succeed, we will know we got it right."

The salamander crew worked with local partners and pulled eggs from five distinct ephemeral pools, ensuring genetic diversity. They took eggs only from populations that wouldn't be harmed by the action. The biggest challenge? Figuring out the best time to go out to pull salamander eggs from each location, says Jason Nickels, MNP's director of education and land restoration.

"Every single one of these ponds seems to be on a little bit of a different time table for when it warms up and when the rain comes," Nickels says. "It's much more difficult to try to go out there and find the translucent eggs when they're under six inches of water that's murky from the rain. We have about a three-week window to get to the right spot at the right time to find the eggs."

Although the team hasn't yet found Blue-Spotted Salamander eggs, Nickels says it stands to reason that if the Tiger Salamanders have survived, the more elusive Blue-Spotted Salamanders are likely reproducing, too. The team will continue monitoring every year, which includes visual searches for egg masses and funnel trapping for larvae.

"We've put them in the right place, we've given them the right habitat, we've taken care of everything around them," Nickels says. "Nature will do its thing."

For other organizations looking to do a similar project, Nickels recommends talking to as many experts as are available and working with local partners that can help determine the right time to col-

lect eggs and the best populations to pull from. Ultimately, though, he says that preservation—rather than translocation—is always ideal, even when the species aren't threatened or endangered.

"Preservation is so much less work," Nickels says. "You don't want to wait until it's too late and you're just saving the last few individuals. Now we have to go through all this extra work to make sure that something that should be common doesn't disappear."

The most surprising part of the project has had nothing to do with the salamanders themselves, Nickels says, but with the response from visitors to the preserve.

"I never thought this project would be a big deal, but it has turned out to be a great way to educate visitors," Nickels says. "They're not just learning about salamanders, but about why we had to do this in the first place, what humans have done to the salamanders' homes. You've got to have an emotional hook to convince people to protect natural habitat and using cute little salamanders has been really effective."

MNP's salamander translocation project was funded in part through the [Natural Resources Foundation of Wisconsin's C.D. Besadny Conservation Grant Program](#). Wetland restoration and/or wildlife monitoring at MNP has been funded by the Antonia Foundation, Greater Milwaukee Foundation, Brookby Foundation, Patricia Smith Wilmeth Fund, Fund for Lake Michigan and James E. Dutton Foundation.

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Dr. Gary Casper holds up salamander eggs as part of a salamander translocation project in Wisconsin. Photo: Lindsay Renick Mayer.



Dr. Gary Casper and Emily Biagi search for Blue-spotted and Tiger Salamanders at the Kettle Moraine State Forest in Wisconsin. Photo: Lindsay Renick Mayer.

# The Salamander's Smile: Photography's Powerful Role in Conservation



Spotted Salamander (*Ambystoma maculatum*). Photo: Dave Huth.

By Dave Huth

Conservation has always been a collaborative enterprise. Rachel Carson's description of ecological interconnectedness seems also true of human efforts to protect and repair nature: "In nature nothing exists alone." The Amphibian Survival Alliance's 2015–16 Strategic Plan lines up with this theme, listing "collaboration" as one of four core values.

Image-makers have long played a distinctive role in these collaborations. The work of conservation frequently includes visual communicators, alongside field researchers, natural historians, experimental scientists and conservationists (not to mention the contributions of activists, politicians and concerned citizens).



Natural history has always included beautiful and precise images providing visual depictions of biological subjects. Image from *The Tailless Batrachians of Europe W.2* (1897-98). c) Courtesy Biodiversity Heritage Library.

It seems to have always been so. In *The Invention of Nature*, historian Andrea Wulf explains the modern character of the fields of conservation, ecology, field research and science communication. She does this by chronicling the influential legacy of early 19th century Prussian naturalist Alexander Von Humboldt.

Humboldt appears remarkably contemporary in how his scientific observations and cautions about climate change (yes, even then) always integrated elements of visual communication. Wulf writes that Humboldt was driven to the brink of financial ruin by insisting on costly scientific diagrams and nature illustration to visually enrich his publications.

Biological sciences have since relied on visual imagery: from the exquisitely drawn visualizations of Ernst Haeckel (whose lasting contributions and greatest controversies are remembered in terms of pictures), to the finely detailed depictions of seemingly alien life seen through Van Leeuwenhoek's microscope, to Darwin's tree of life illustration in *Origin*, which established a familiar visual form that science writer Carl Zimmer calls "a visual hypothesis."

Today, pictures serve to illustrate, clarify and otherwise support field notes, data display, scientific argument, political discourse, commercial investment and appeals for social change. Conservation undertakes to align these activities, so perhaps it should be expected that photography can play a key role.

"Science communication" is a widely discussed subject across many disciplinary specialties of both science and communication. The National Academy of Sciences made this discussion a priority in a series of 2012–2013 colloquia on *The Science of Science Communication*. Presenters described science communication as a crucially

important two-way conversation conducted between scientists and the public.

This important conversation is also challenging. “Not only are scientists just one of many stakeholders vying for access to the public agenda,” wrote the colloquium co-organizers in a press statement, “but the political debates ... may sometimes confront scientists with unfamiliar and uncomfortable discussions involving religious values, partisan interests and even the trustworthiness of science.”

These challenges are familiar to Gabby Salazar, a science educator who regularly incorporates photography in her conservation practice. “If we want public audiences to make informed decisions about issues like climate change or environmental health,” Salazar says, “we have to help people understand the scientific process and how the results of scientific research may be relevant to their daily lives.”

During her term as president of the North American Nature Photography Association, a group with a history of uniting scientists and photographers, Salazar promoted photography as serving a common cause between disparate fields. Connecting ecologists and photographers with common interests, Salazar says, “we can act as a bridge between many different disciplines.”

Many conservation projects build these bridges through photography’s ability to evoke emotions. “Sometimes, photography tells stories more effectively than words,” says Brett Amy Thelen, science director at the Harris Center for Conservation Education, a local land trust and conservation education organization in New Hampshire.

Much of Thelen’s work coordinates citizen science efforts, such as a “Salamander Crossing Brigade” program, which enlists local residents to protect migrating amphibians from automobile traffic. At public presentations about the program, audiences at first “nod politely,” comprehending but not emotionally connected. Then, once Thelen projects photos of the amphibians, “the polite nods turn into awwwwwws and gasps. People are instantly drawn in, instantly interested, in a way they weren’t before seeing the photo.”

Sometimes, biological research and photography are accomplished by the same person. JP Lawrence, a Ph.D. candidate at the University of Mississippi, does field work related to anuran speciation in French Guiana, Panama and Australia. Perhaps because a large portion of his work relates to frogs’ color patterns, photography is a useful tool for practicing science in addition to communicating about it.

“Photography gives us a way to remember particular conditions for a particular situation,” Lawrence says of his research. Photography can also assist in taking measurements under controlled conditions.

“I’ve used photos to take length measurements on small frogs... I can use photos to assess degree of [visual] conspicuousness in their natural environment. I can even use photos to assess how frogs look to different animals that perceive color in different ways,” Lawrence says.

Others in a new generation of Ph.D. candidates studying amphibians, such as Andrew Snyder, also at the University of Mississippi, and Todd Pierson at the University of Tennessee, agree that photography is increasingly becoming a powerful tool for scientists.



A skilled photographer will carefully choose lenses and compositions that depict important ecological relationships, such as linking this Giant River Toad (*Bufo asper*) with its habitat by a stream in the Indonesian rainforest. Photo: Gabby Salazar.



Experimenting with photographic techniques such as “wide angle macro,” an ecologically-minded photographer will often capture details of an organism’s appearance along with many surrounding environmental details. Photo: Andrew Snyder.



Composite images can clearly and aesthetically summarize aspects of research findings, such as this documentation of color morph variety of *Oophaga pumilio* from Bocas del Toro, Panama. Photo: JP Lawrence.



Underwater field photography provides more opportunities to make otherwise difficult observations of aquatic species and their behaviors without setting up the artificial conditions of tanks and other enclosures. Pacific Chorus Frog (*Pseudacris regilla*). Photo: Steven Johnson.

Pierson names specialized photographic technologies for expanding into new research methods, “from landscape-scale satellite imagery to citizen science-powered bioinventory projects like HerpMapper,” which incorporates important photographic metadata routinely included in GPS-enabled cameras, like those in mobile phones.

Snyder explores ways that photography can be of particular support to work with amphibians. He encourages scientists who collect specimens for scientific research to capture dorsal and ventral images of each individual.

“Many colors in preservation disappear over time,” Snyder cautions, “making the ability to discern subtle pattern differences very difficult, if not impossible.” Recording documentary photos of an amphibian’s life coloration, associated with the voucher specimen, can be valuable for future research.

Many of those working in scientific, conservation and photographic partnerships see photography as specially suited to communicating about amphibians.

For Clay Bolt, a natural history and conservation photographer employed as communications lead for World Wildlife Fund’s Northern Great Plains Program, the cryptic lives of most amphibian species calls for special efforts of visual communication.

“Amphibians are often small, nocturnal, or living in places that are generally inaccessible to most of us,” says Bolt. He echoes a

common challenge of many conservation communicators: “When it comes to conservation, the old adage ‘out of sight, out of mind’ rings true.”

Bolt sees photography as a method for making visible the invisible. “The more often we can put intriguing imagery of unseen species in front of the public, the better the opportunity for inspiring others to take up the flag of conservation.”



Photographers can be valuable members of survey teams for important conservation projects. This *Phyllomedusa bicolor* was documented as part of a biodiversity assessment of the Berbice, Guyana forests that fall within an area owned by a logging concession. Photo: Andrew Snyder.



Field photography can often capture contextual information difficult or impossible to document in laboratory or highly controlled situations, such as this adult Ring-necked Snake (*Diadophis punctatus*) eating a Cumberland Dusky Salamander (*Desmognathus abditus*) on Tennessee's Cumberland Plateau, or a nest of Black-bellied Salamander eggs (*Desmognathus quadramaculatus*) near hatching in southwest Virginia. Photos: Todd Pierson.

Andrew Snyder agrees with the importance of documenting the unseen. He thinks people respond to visual expressions of how many species of frogs there are, the unique ecological niches they fill and the special adaptations they have evolved. "Without images, people are far less likely to notice subtle differences that make frogs so appealing to amphibian researchers." This can lead to understanding a species' specialness, and thus contribute to its



A photographic approach for small subjects like amphibians is the increasingly popular Meet Your Neighbours Field Studio technique (<http://meetyourneighbours.net/>) showing close details under clear lighting on a white background. Photo: Dave Huth.



Conservation photographer Clay Bolt hauls his photographic equipment deep into the field on a herpetology survey along the Rupununi River, Guyana. Photo: Andrew Snyder.

conservation.

There can be practical complications to incorporating photography into fieldwork. One is an increase in the amount (and carrying weight) of technical gear. Engineering advances in miniaturizing digital tools can help lighten the load, but it remains a tech-heavy practice.

"I typically will hike for many miles every day, with lots of weight on my shoulders in my backpack," Snyder says of his tropical field research, adding that it depends on whether he'll be photographing frogs, collecting scientific data, or both.

"As much as I want to just pass out in my hammock [at the end of a long day], I need to make sure all of my gear is safely put away, and raised off of the ground, in the event of a massive rain event."

JP Lawrence also sometimes double-packs for the field. "Often the scientific research I do is observational, so I can get away with doing science while having all of my photography equipment on my back."

However, Lawrence frequently works alone, so double-packing can be impractical. "There are times where I have to separate the two. I will do my scientific experiments and leave my photography equipment, [or] vice versa."

This compromise can frustrate Lawrence's photographic goals, because wildlife photo-ops are typically spontaneous. "There have been plenty of opportunities where I missed the chance... because I was otherwise occupied doing scientific observations," Lawrence says.

Perhaps because of these challenges, partnerships with photography specialists are common.

Steven Johnson, a professional conservation photographer and chair of the department of Visual and Communication Arts at Eastern Mennonite University in Virginia's Shenandoah Valley, teaches photography coursework to prepare students for these partnerships.

Johnson begins by getting students out of the classroom to experience the environments that ecologists study and for which conservationists advocate. "When you are immersed in a chilly mountain stream tracking an elusive salamander," he reports, "it is about as far from the culture of standardized tests as possible."

Once Johnson's students become attuned to the natural world, he connects them with work that is enriched by their photographic expertise. "We work with partner organizations on important real-world projects," Johnson says.



Prof. Steve Johnson (left) guides a group of conservation photography students in documenting stream habitats in Virginia's Shenandoah Valley. Photo: Caleb Schlabach.

Johnson's students have partnered with science faculty on a grant-funded project studying best practices for stream restoration. Another group partnered with the Virginia Wilderness Committee documenting at-risk ecosystems in the path of the proposed Atlantic Coast Pipeline.

"After the pipeline company dismissed scientific surveys of the salamander habitat as being outdated, one of our partners pulled out images my students had just made," Johnson says. "This completely changed the tone of the conservation."

The claim that conservation faces problems of overwhelming scale, complexity, longevity and interconnectedness feels like an



Fast visual documentation in the field was successfully tested for individual spot pattern ID during a Spotted Salamander (*Ambystoma maculatum*) migration event in New Hampshire (USA). Photo: Brett Amy Thelen/Harris Center for Conservation Education.

understatement to many who work with these problems. A particular challenge is how quickly the scale of these issues renders them abstract and difficult to grasp for non-specialists.

Gabby Salazar says she thinks communicating well about anything with this level of complexity requires all methods available.

She says she believes photography's special character—to focus on details with documentary clarity, while simultaneously drawing audiences to a larger picture through artistic appeal—makes it especially well suited for conservation. "Compelling conservation photographs can move people to care about abstract environmental issues that may be far removed from their daily lives," she says.

Brett Amy Thelen values the documentary information inherent in a photograph for quality control when volunteer surveyors of vernal pools identify egg masses by species. A volunteer's photograph contains the precision and clarity for trained scientists to later verify correct IDs. This improves the quality of collected data, and increases confidence in citizen science initiatives.

When speaking of photography's additional capabilities, Thelen refers to the emotional evocations of "the grandeur of a protected landscape, the look of concentrated joy on a child's face when she's discovered a really cool frog, the irrepressible charm of a Spotted Salamander's smile." This range of communication capacity can be vital for conservation work in need of just such range.

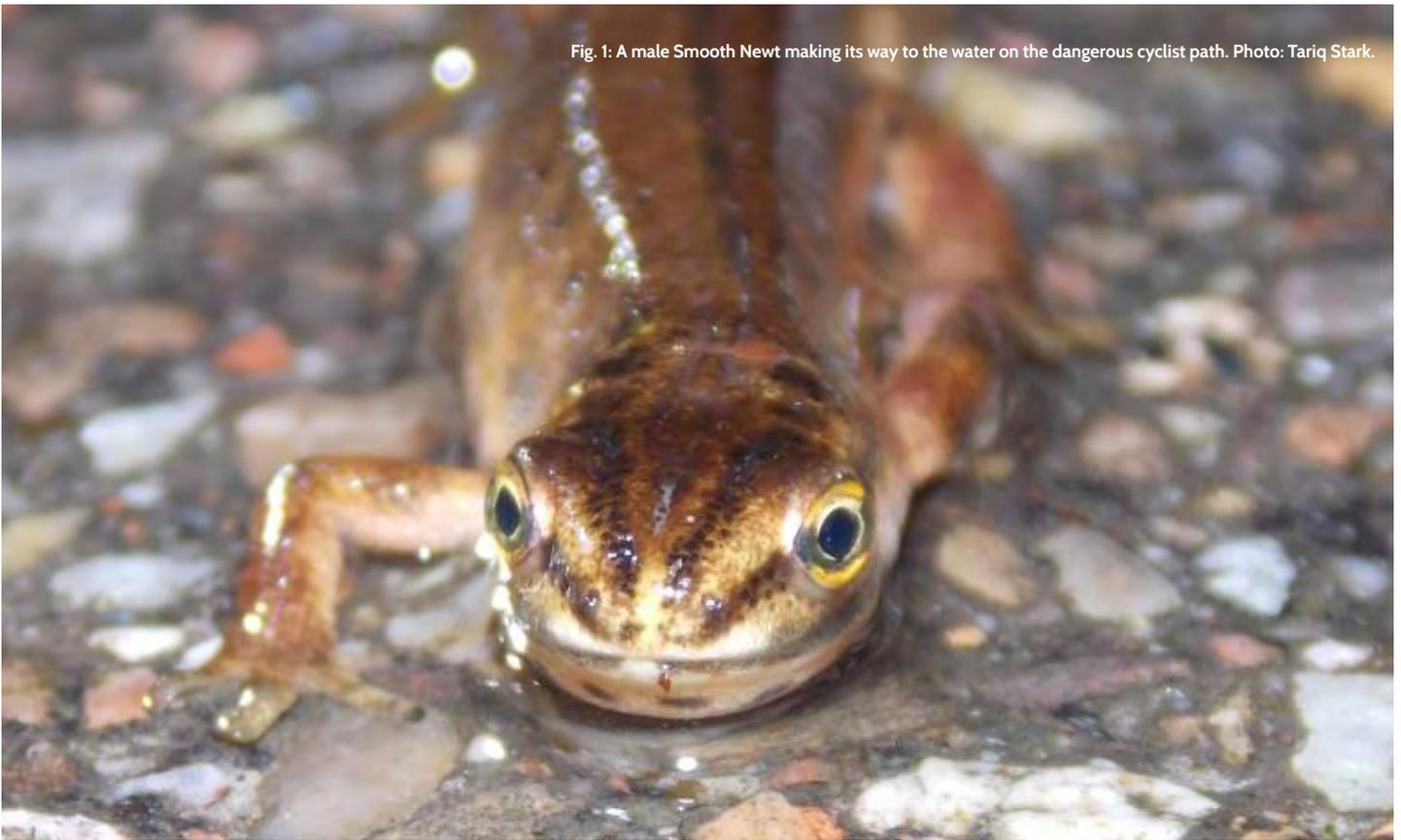
The story of conservation communication is long, with many chapters. When photographers are among the collaborators telling that story, they contribute a reach and depth that are difficult to obtain in other ways.

Todd Pierson is enthusiastic about what photography can offer. "Photography is a great tool for demonstrating the beauty and uniqueness of amphibians to those who don't otherwise see them," Pierson says. "The conservation of amphibians is important for a host of utilitarian reasons, but we should also care about the aesthetic value that they provide."

Clay Bolt agrees, and thinks photography can go even further. "Conservation is also about more abstract realities, such as ecosystems, climate patterns, social trends. The ultimate goal is to move people to care enough to take action and stand up for species and ecosystems in peril."

Bolt says he finds the most value in keeping this end goal in mind. "Sometimes this can be done very effectively through beautiful images, and sometimes it comes when a portfolio of destruction has been revealed," he says. "The best strategy is to tell the story of a species or place as honestly as possible. If you follow that thread and give the story time, the right elements will find their way into the final story."

Fig. 1: A male Smooth Newt making its way to the water on the dangerous cyclist path. Photo: Tariq Stark.



## Urban Amphibians: Results of the Fourth Year of a Road Mortality Mitigation Project in Leeuwarden, the Netherlands

By René Broek, Albertjan ter Heide, Michael Meijer, Tariq Stark and Koen van Lieshout

Just outside the historical center of Leeuwarden, the capital of Dutch province Friesland in the north of the country, a small area alongside the river Potmarge is home to a community of five amphibian species. Unfortunately, this previous, relatively quiet piece of urban nature has become increasingly urbanized over the decades putting pressure on many animal species in the area, including amphibians. Since 2011 Carlijn Laurijssens and Tariq Stark have seen lots of dead Smooth Newts (*Lissotriton vulgaris*) on the cycle path that stretches alongside the river, separating hibernation sites from breeding waters. Alarmed by the number of road mortalities in this species they decided to start a project to help the amphibians cross the cycle path during their yearly spring migration. The results of the project were presented in *Froglog* 107 (1), *Froglog* 111 (2) as well as in the newsletter of *Year of the Salamander 2014* and several local news papers. The project is an official partner of the Amphibian Survival Alliance and actively promotes urban ecology projects run by students. During the first year 539 animals were safely transferred to their breeding waters. The second and third year represented 540 and 966 animals assisted across the road during spring migration by the team. This short update will report on the results of the fourth season of the project, provide notes on this and previous seasons with educational efforts and lastly, the preparation of season five for 2016.

The area is home to five amphibian species. This community consists of Smooth Newts (*Lissotriton vulgaris* – Fig. 1, 2), Common

Toads (*Bufo bufo*), Common Frogs (*Rana temporaria*), Edible Frogs (*Pelophylax klepton esculentus*) and Marsh Frogs (*Pelophylax ridibundus*). Hereafter all species are referred to by their generic names, including images and figures. At the onset of spring these species will awaken from hibernation and migrate to their breeding waters. To reach these breeding waters the animals need to cross a cycle path used by students and other people. To prevent the amphibians from being run over by cyclist, mopeds and scooters a group of students of the Van Hall University of Applied Sciences (who run the project) and the municipality of Leeuwarden (led by Gilberto



Fig. 2: Snacking on the path, a Smooth Newt makes quick work of an earthworm. Photo: René Broek.

Squizzato) place drift fences and pitfalls next to the cycle path just prior to the spring migration (Fig. 3). When migrating the amphibians try to get around the drift fences and are guided into the pitfalls effectively stopping them from crossing the dangerous cyclist path. The pitfalls are emptied twice a day (morning and evening) by students. In the last *Froglog* (2) article it was mentioned that the future of this project was entirely in the hands of ambitious and enthusiastic (future) students, the municipality of Leeuwarden and the Van Hall Larenstein University of Applied Sciences. This year the project is led by three ambitious students and conservationists: René Broek (project manager), Albertjan ter Heide (data manager) and Michael Meijer (communication and education). With the help of Koen van Lieshout (supervisor Van Hall-Larenstein University), the municipality of Leeuwarden, no less than 20 volunteers, project initiators Tariq Stark and Carlijn Laurijsens and the Amphibian Survival Alliance the continuity of the project is guaranteed!



Fig. 3: Part of the project area with one of the most important breeding waters in the background. The drift fences are decorated with images of salamanders to let the public know what their function is. Photo: René Broek.

During this season a total of 571 amphibians were safely helped in crossing the bicycle path. Figure 4 depicts the numbers of individuals per species and the number of individuals per species in the previous three years. The bulk of the numbers this year consisted of Smooth Newts (322 individuals/ 56.39 %) and Common Toads (151 individuals/ 26.44 %) as they were in previous years. More on the numbers of this year and comparison with previous years will be presented in the notes and this and previous seasons.

To assess if this community of amphibians is doing well is quite hard. People living in the area for decades have stated the habitat and the number of amphibians seen have degraded and declined; especially the Common Frog seems to have declined considerably. In the spring many breeding individuals could be observed in the past, now only a hand full are seen which our data and observation corroborates. Alas, we do not have baseline population data for this community of amphibians but only our own and anecdotal data. The two species most encountered in the pitfall traps are Smooth Newts and Common Toads. Numbers of individuals in both species captured have fluctuated throughout the years but it is too early in the project to establish if there is either a negative or positive trend. Noteworthy is the number of Common Toads this year was roughly half of that in 2014: 151 in comparison with 320. Smooth Newt numbers have also dropped: 528 individuals in 2014

and 322 in 2015. Common Frog numbers seem to be steadily rising with a maximum number of 73 individuals this year in comparison with 18 individuals in 2012. Amphibian populations can fluctuate greatly from year-to-year (3) so we are careful to draw any conclusions from our data. Water Frog numbers in the pitfall traps have always been low due to the means of hibernation in these species. Marsh Frogs mostly hibernate in the muddy bottom of the water body it lives in (4). Edible frogs seem to hibernate on both land and water (5). Their spring migration is often vertical (they resurface in spring) and the pitfall traps are thus avoided. In total a number of 2,616 amphibians were safely transferred to their breeding waters during the four years of the project.

Reproduction success of the species involved lies somewhat outside of the scope, for the moment, of the project. However, after the breeding season some students and project initiators, have sampled all breeding waters during four consecutive years (2011–2014). Especially Newt larvae are present in the core breeding waters in good numbers as are larvae of the Common Toad. Larvae of Common Frogs and later in the season metamorphs of this species are less common. Water Frog larvae are encountered often during summer and many subadults can be observed throughout the season. It would be interesting to incorporate reproductive success into the project and link it to for example educational excursions or ecology lessons at the University and make this aspect of the project quantifiable.

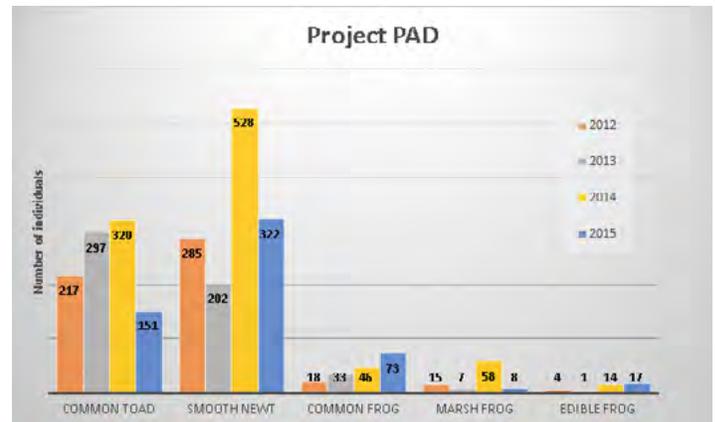


Fig. 4: The results of all four seasons for each species.



Fig. 5: A map of the project area depicting hibernation- and terrestrial sites, breeding waters and the bicycle path. Map: Koen van Lieshout.



Fig. 6: A beautiful female Smooth Newt caught by children on the educational day. Photo: René Broek.

Outside of the project area many road mortalities, especially in Smooth Newts, are still observed. Within the project area they have dropped considerably. This area seems to be a core area with both quality breeding waters and hibernation sites in place. However, other areas remain unprotected and it would be advisable that permanent amphibian crossings be implemented for these areas also outside our project. The habitat is improved by the Municipality of Leeuwarden under the guidance and supervision of Gilberto Squizzato and his team by actively seeding native plants, creating a floral diversity that promotes a more abundant and diverse arthropod community, which in turn is positive for the amphibians (5).

This year the municipality of Leeuwarden generously provided us with new drift fences, especially made for amphibians. These drift fences have replaced the old ones. The project area marked in yellow in the image below (Fig. 5) remained the same as in previous years. The yellow lines depict the location of the drift fences and a pitfall trap was placed every 10 meters from one another. Unfortunately, we had a lot of problems with vandalism this year. Vandalism on the project wasn't something new but much higher this year than in previous years. Usually the vandalism consisted of damaging the drift fence and throwing away the buckets that were placed in the pitfalls. Luckily, damages could be easily detected and quickly repaired.

Every year the students of this project organize an educational day for local residents and give guest lectures at a local school (Comenius Middle School). These efforts are to show how special it is to have these amphibians in the middle of the city and how many different insect (macro fauna) species live in the water (Fig. 6,7) all in their own backyard! At Comenius Middle School a practical biology lesson was given, about our project, to their second year students (13/14 years old.) In addition an educational day was organized for local children and their parents.

On both occasions the educational day and the lesson at Comenius a lecture about the Road Mitigation Mortality Project was



Fig. 7: One of the insect species caught, a wonderful and big aquatic bug called *Ranatra linearis* from the Nepidae family. They are typically five centimeters long and are real sit-and-wait-predators. Sometimes they feed on amphibian larvae but mostly on other invertebrates. Photo: René Broek.



Fig. 8: Hands on education! René Broek making the participants familiar with all the wonderful creatures living in this Dutch pond! Photo: Michael Meijer.

presented. After the lecture we went to the amphibian breeding water areas and let the students and children use dipping nets to catch all these wonderful and special animals. With our assistance, the teachers, students and parents and their children determined which species they had caught (Fig. 8). This all gives participants an idea how many different species live in the water and how they are all connected—a basic aquatic ecology lesson in a most engaging manner.

We've had a lot of positive responses from the teachers and parents this year despite the rain—Conservation by Education!

Like last season, the future of the project will be in the hands of new volunteer students, the municipality of Leeuwarden and the Van Hall-Larenstein University. But we are happy to announce that some students already notified that they want to coordinate next season's project. This project also provides an excellent case for Wildlife/Ecology students at the Van Hall University of Applied Sciences, which is just adjacent to the project area, to practice ecological methods like "capture-mark-recapture" and many other base line methods that can be applied in their field of study later on. We are looking forward to report on our project in *FrogLog* in 2016!

#### Acknowledgements:

We would like to thank for their help at the project: Gilberto Squizzato and his amazing team from the Municipality of Leeuwarden as well as the Municipality of Leeuwarden itself, Koen van Lieshout from Van Hall Larenstein University, Tjalling Huisman from Van Hall Larenstein, Eelco Dekkers from Comenius College and of course a big thank to all our volunteers!

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Fig. 9: Michael Meijer helping the participants out with determining what cool critters they have caught! Photo: René Broek.



## The Wisconsin Frog and Toad Survey: A Great Amphibian Adventure

By Lindsay Renick Mayer

**I**t is a late night in June in Wisconsin's beautiful Kickapoo Valley and I am straining to hear the calls of frogs around me. It's not that they're faint, it's that there are too many of them, coming from the woods in all directions. I try to remember what a seasoned birder once told me—that picking one species out of the cacophony is a lot like training yourself to hear just the violin section of an orchestra. Do I hear Leopard Frogs? Maybe. Treefrogs? Sure, but is it the Gray or the Cope's Gray? Chorus Frogs? I think so. I cup my hands around my ears and listen again.

And then, through the din, comes a call I can't miss. It sounds like what I imagine is a spaceship landing somewhere nearby and I know I've got it: the American Toad. Suddenly they're everywhere, surrounding me, like space amphibians coming to our planet to tell us Earthlings their stories. I am relieved to finally have gotten one call right and try to commit it to memory.

I'm out this evening on a frog blitz field trip with the [Natural Resources Foundation of Wisconsin](#), learning about how to participate in the [Wisconsin Frog and Toad Survey](#), America's longest-running frog and toad calling survey. The project officially began in 1984, after conservationists had noticed a steep decline in a number of Wisconsin's frog species: the Northern Leopard Frog, the American Bullfrog and the Blanchard's Cricket Frog. Today more than 132 volunteers run more than 130 survey routes throughout the state, helping the Wisconsin Department of Natural Resources track trends in population size and location.

"Calling surveys are an extremely efficient and effective way to monitor populations statewide," says Andrew Badje, a DNR conservation biologist and Wisconsin Frog and Toad Survey coordinator. "Volunteers can cover much more ground than any single DNR team could in a year, and at a much reduced cost. The DNR is receiving a comprehensive statewide inventory of frog distribution, relative abundance, and long-term trends. In addition, data collected aids the DNR in determining where localized projects can best conserve populations of rare frogs. These volunteers are out doing something fun that also really makes a difference."

The best part of having volunteers, or citizen scientists, Badje says, is that they become more invested in amphibian conservation and look forward to seeing data and trends that they themselves have helped collect.

"Besides having a lifelong interest in frogs and toads, I realize the need for dependable volunteer observers to contribute to important scientific studies, so I enjoy being a citizen scientist," says Arthur Stevenson, who has participated in the Wisconsin Frog and Toad Survey since the early 1990s and is a senior lecturer at the University of Wisconsin-Stevens Point. Stevenson currently has two survey routes and does two extra runs at Sandhill Wildlife Area to listen specifically for the elusive Blanchard's Cricket Frog. "Monitoring the health and population trends of frogs and toads is important as an environmental factor. I am glad to have been involved all this time."

Each volunteer takes a survey route with 10 sites, which they monitor three times every spring and summer to ensure they hear both the early breeding species and the later breeding species. They record where they are, the weather conditions, the species they hear and whether they hear a few individuals or a din of calls all at once. They then report this information to Badje, who synthesizes all of the data at the end of the year. The program has become so popular in Wisconsin that some volunteers wait on a waiting list for 10 years before getting a route in their preferred county, especially those that are more populated like Dane County, home to the state's capital city of Madison.

"I've learned how important it is to engage our community in these types of programs—they really enjoy it, appreciate the connection to the state and our natural resources," says Licia Johnson, who began as a volunteer in 2015 after waiting for a route and is a naturalist at [North Lakeland Discovery Center](#). "It is so important to take time to be out in the natural world, quiet and dark, to recharge yourself and center your mind. This survey is the perfect excuse to do that."

Wisconsin has 12 frog species, one of which is endangered (the Blanchard's Cricket Frog), while the Wisconsin DNR lists four species (the American Bullfrog, Mink Frog, Northern Leopard Frog and Pickerel Frog) as species of "special concern."

In 2014—the most recent year for which the survey has comprehensive data—survey sites with American Bullfrog, Boreal Chorus Frog, Cope's Gray Treefrog, Gray Treefrog, Green Frog, Northern Cricket Frog, Spring Peeper and Wood Frog were above their long-term averages. Of the 12 Wisconsin frog species, seven showed an increase in percent occurrence in 2014 compared to 2013. The Northern Leopard frog was below 2013's occurrence level.

"In 2014 we had a later spring. It wasn't as harsh, we didn't have a drought, so we could see that the populations have re-bounded a bit from previous years," Badje says. "But in general we're seeing the same things—certain species are going up, certain species are going down."

While they're out collecting data, volunteers aren't just helping DNR, but they're taking part in a fun adventure, Badje says.

"To observe the stars and planets, while hearing a beaver splash in a lake or muskrats munching vegetation against a chorus of calling frogs, and breathing in the earthiness of clean country air, is an



Members of the Natural Resources Foundation of Wisconsin learn about how to participate in the Wisconsin Frog and Toad Survey during a Foundation field trip. Photo: Jamie Corey.

experience unlike any other," says volunteer Heidi Conde, who did her first survey in 2010 and has two routes. "I have seen bats flying over water in the moonlight, heard the mating and juvenile calls of owls, watched meteors streak across dark skies, and enjoyed the wonder of fireflies winking their greetings. I would recommend the experience to anyone."

For organizations and individuals interested in establishing frog and toad surveys in their state/region/country, Badje has a few recommendations:

If you're in North America, try to use the standardization protocol that the [North American Amphibian Monitoring Program](#) has established, with tweaks as necessary. This will help with national/global assessments, ensuring that the data will be used both at a local scale and on a broader scale.

Find a stable organization or agency that will provide indefinite funding for the project. In order to be effective, the data needs to be collected over time and secure funding will help ensure that happens.

Make sure that the project isn't too labor intensive for volunteers, or you risk a waning of enthusiasm over the years and limited retention. Provide your volunteers with findings/summaries on an annual basis if possible, and demonstrate that volunteers and data managers are truly making a difference. Make the program as transparent as possible.

For more information, contact Andrew Badje at: [andrew.badje@wisconsin.gov](mailto:andrew.badje@wisconsin.gov).



DNR conservation biologist Andrew Badje coordinates the Wisconsin Frog and Toad Survey, the longest-running frog and toad calling survey in the United States. Photo: Lindsay Renick Mayer).



# Special Amphibian Issue of Conservation Evidence Now Available

By Nancy Ockendon

The online journal Conservation Evidence has published a special issue that focuses on interventions for the conservation of amphibians. The articles, plus an editorial (1) providing an overview of amphibian conservation and the use of evidence, are freely available from the Conservation Evidence website: <http://conservationevidence.com/collection/39>.

The special issue includes articles on approaches for enhancing or establishing breeding populations, with a methodology for captive-rearing Crawfish Frogs (*Lithobates areolatus*) in Indiana in the United States of America, an assessment of the effectiveness of different designs of artificial breeding sites in encouraging native amphibians and an analysis of the effectiveness of excluding non-native crayfish and fish in Italy. Reducing the impact of competitor species was also investigated in a study looking at the effect of controlling the African-clawed Frog (*Xenopus laevis*) on the local population of endangered Cape Platanna (*Xenopus gilli*). Another article on translocation compared the survival of Puerto Rican Cave-dwelling Frogs (*Eleutherodactylus cooki*) that were released into natural and artificial habitats. The final paper assessed the effectiveness of legal protection on the persistence of Fire-bellied Toads (*Bombina bombina*) in Danish ponds. The editorial that prefaces the issue provides a useful, well-referenced summary of the current status and importance of amphibians globally, the threats that they face and the conservation responses to these threats, and the use of evidence in amphibian conservation.

The publication of these five new papers testing conservation interventions for amphibians has doubled the number of amphibian articles in Conservation Evidence (see the Amphibian Management virtual collection <http://conservationevidence.com/collection/28>), and demonstrated the range of approaches that researchers and conservationists can test. As the graph below shows, overall the amount of evidence relating to the conservation of amphibians has (at last!) increased over the past two decades, although the number of studies still tends to be low compared to other taxa. For example, of the 271 articles in Conservation Evidence up to the end of 2015, just 2 percent were on amphibians compared to 29 percent on birds, 29 percent on plants, 13 percent on invertebrates and 7 percent on mammals.

So we need your help! Can you help add to the available evidence? If you have tested an intervention for the conservation of amphibians, and monitored the effects, you could share your results by publishing them in Conservation Evidence. It could be anything from protecting, restoring or creating habitat to translocating species or educating the public. We are particularly keen to learn more about interventions for which we found no available evidence when compiling the synopsis Amphibian Conservation: Global Evidence for the Effects of Interventions (2; <http://conservationevidence.com/synopsis/index>).

Studies should test a single intervention, and must contain a control or comparison for the intervention (either comparing before-and-after an

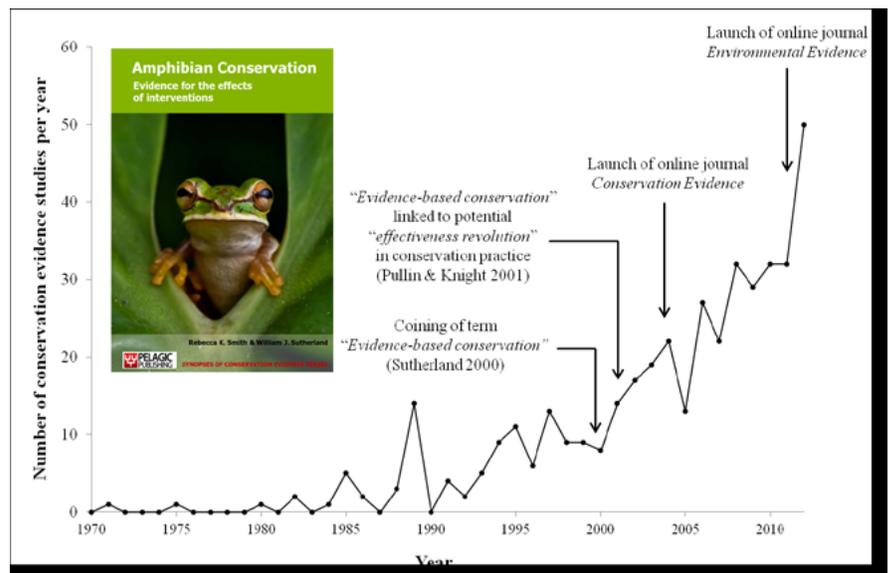
intervention, a control site with a treatment site, or the effectiveness of two different methodologies for an intervention). We strongly encourage publications describing both successful and unsuccessful measures—it is just as important to collect and share data on things that don't work as things that do. By working together, sharing experiences, learning from successes and failures and embracing a culture of evidence-based practice, we can help amphibian conservation flourish in the future.

The journal is aimed at a practitioner audience, and most authors of papers published in *Conservation Evidence* were practitioners. We aim to make preparation of manuscripts as simple as possible, and just require a straightforward description of the action that was taken and its impact, compared with a control situation. Producing an article for submission should not require a large time investment: our "Short Communications" are just a page long and standard articles are normally 3–4 pages long. We welcome pre-submission enquiries as to the suitability of a study for consideration in *Conservation Evidence*.

We hope that the release of the amphibian special issue will increase interest in the use of evidence-based conservation for these species, and inspire the production of significantly more conservation evidence for amphibians. We urge you to share your experiences through research that tests the effectiveness of interventions in diverse contexts, including actions related to threat mitigation, species management and human behavior change through education and engagement. We hope that you will look for opportunities to carry out evidence gathering and publication, and welcome contributions or feedback.

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Annual rate of production of conservation evidence studies for amphibians collated in the Amphibian Synopsis: "Amphibian Conservation: global evidence for the effects of interventions" (Smith & Sutherland 2014). Figure from Meredith et al. (2016).

# Research, Environmental Education and Ethnobiology: Integrated Actions and Strategies for Amphibian Conservation in Brazilian Agricultural Landscapes

By Lucas Ferrante

Developing countries face the challenge of reconciling development and biodiversity conservation (1). According to the Food and Agriculture Organization of the United Nations (FAO), the exploration of natural resources for land use for agriculture is the base of the economy in developing countries in South America, including Brazil (2). To achieve food security, the FAO's goals do not ignore the preservation of natural resources of land, water and the genetic heritage (animal and plant) for future sustainability (3). Agriculture and aquaculture are the two biggest threats to amphibians (4), which are the most threatened wildlife group among vertebrates (5). There have been multiple population declines in amphibian species all over the world (6), including Brazil (7,8,9). Habitat loss is the main cause of those declines in South and Central America, where land is cleared for crops and livestock (Fig. 1); pollution, diseases, invasive species, fire and human disturbance also are threats to amphibians (10).



Fig. 1: Fragmented landscape of Atlantic forest by crops of coffee, sugar cane and livestock. South of Minas Gerais, Brazil. Photo: Lucas Ferrante.

Amphibians are undergoing the largest extinction event since the dinosaurs. Reversing this trend will require multiple innovative conservation actions (11). The Amphibian Conservation Action Plan (ACAP) recommend communication and education as the key to sustain support for biodiversity conservation, emphasizing the importance of collaboration and performance of multiple sectors of society and integration of professionals of the biological and social sciences (12). The title in the *Alytes* journal about the Brazilian Amphibian Conservation Action Plan (BACAP) is "A leap further: the Brazilian Amphibian Conservation Action Plan" (13). This publication covered research gaps and protocols for the conservation of Brazilian amphibians, but did not include activities that communicated the results to other sectors of society. Scientists often communicate their work only within the scientific community, failing

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National Institute for Research in the Amazon - (INPA), Ecology Graduate Program, 69060-001 - Manaus, AM - Brazil. Instituto Boitatá Etnobiologia e Conservação da Fauna, 74265-310 - Goiânia, GO - Brazil. E-mail: [lucasferrante@hotmail.com](mailto:lucasferrante@hotmail.com)

to communicate with decision-makers and policymakers, causing a gap in conservation action (14). Scientific papers are read infrequently even within the academic community, and reaching the general public is even less likely (15). Making the general public aware of the amphibian crisis is urgent (4).

To maximize the efficiency of amphibian conservation in landscapes that have been strongly fragmented by agriculture and cattle farming in southern Minas Gerais, Brazil, we have utilized research and outreach strategies. Those actions involved researchers, NGOs, universities, companies and urban and rural populations of multiple age groups. The integrated actions aimed to create partnerships that could mutually benefit the actors involved. The actions started with studies that would influence three different sectors: 1) policy making for conservation; 2) dissemination of science based on the results obtained; and 3) engagement of residents as conservation and research agents.

So far we have implemented our actions only in the Atlantic Forest biome. The Atlantic Forest is home of 7.7 percent of all amphibians in the world, and many species are endemic to this biome (16) (Fig. 2). This is the most devastated biome in Brazil, at less than seven percent of its original length and contains the bulk of the country's population, industries and agricultural crops (16,17).

One of our partners in the implementation of the actions is Cia. Agropecuária Monte Alegre, a farming company that deals with coffee and sugarcane plantations and cattle farming (<http://www.montealegrecoffees.com>). The farm is Rainforest Alliance Certified and UTZ Certified, and has to comply with several socio-environmental requirements. Due to the requirements for environmental certification and its interest in environmental initiatives, the company established a mutual-benefit deal with our research group. The farm granted access to researchers to visit plantations and forest fragments within its property, and also collaborated with our group on environmental education activities focused on forest fragmentation and herpetology (Fig. 3a). In this process, we carried out ethnobiological studies (Fig. 3b), which turned rural workers into conservation agents. For example, they helped us conduct an inventory about myth and traditional beliefs concerning herpetofauna and did an inventory on species.

We developed scientific studies in the region to understand how agriculture and cattle farming affect the structure of forest remnants and the amphibian assemblages in those fragments (18). We also tested whether small fragments could support a species assemblage as rich as those found on large fragments (19). Based on these studies, we produced the first free-access amphibian guide for the region (20), which can be accessed [here](#). This way anyone can learn about the amphibian species of the region. We were able to share the results of the studies with rural workers through environmental education activities (Fig. 3c). The people with the species identification knowledge can become conservation agents. There are a number of ways for those rural workers to engage in conservation, including long-term species monitoring, which can prevent future population declines of many species. Rural workers can also help gather natural history and behavior data, as they have more direct

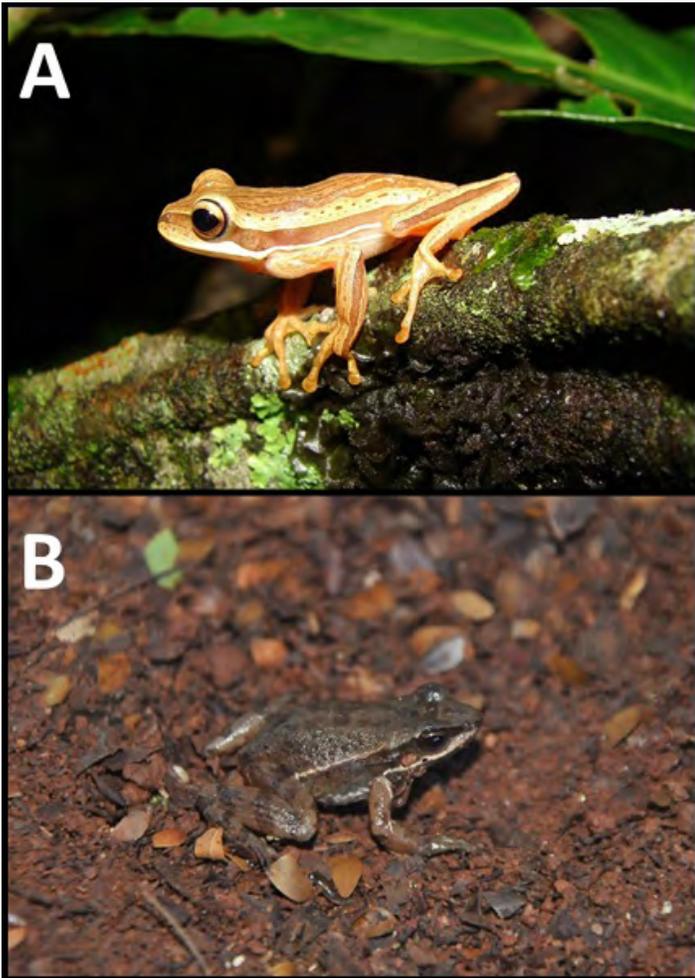


Fig. 2: A) Tree frog of the *Polytaenia* group in South of Minas Gerais. We have identified three different cryptic species for this group. B) *Hylodes szaimai* which occurs only in streams. Their habitat is threatened by mining and deforestation in the states of São Paulo and Minas Gerais, Brazil. Photos: Lucas Ferrante.



Fig. 3: A) Part of the ethnobiology team on amphibians in southern Minas Gerais. From left to right: Lucas Ferrante (Coordinator), Nathalia Klann Torres, Marina Mohallen and Armando Mendes Nogueira. B) Interview in the Taquaruçu farm, Municipality of Areado, South of Minas Gerais (Photo: Lucas Ferrante). C) Environmental education lecture for rural workers in a coffee granary, Bem-te-vi farm, Municipality of Alfenas, Minas Gerais state, Brazil. Photo: Armando Mendes Nogueira.

contact with the local fauna than the researchers and therefore a better chance of sampling rare species.

The rural workers made an interesting observation in this process: they spotted a number of individual *Phyllomedusa burmeisteri* tree frogs (Fig. 4) on the coffee trees in the plantation. This demonstrates the potential of this agricultural matrix as a corridor and habitat for this species. By comparing these ethnobiological observations with data from the literature, we can better understand the

potential of this amphibian species for pest suppression. The diet of *P. burmeisteri* includes groups such as Acariformes, Coleoptera, Diptera, Hemiptera, Lepidoptera and Nematoda (21), all common pests of coffee plantations (22,23). Other rural workers reported terrestrial species with a predation potential to control pests in plantations of coffee and sugar cane. Bufonidae species *Rhinella icterica* and *Rhinella schneideri* (Fig. 5) have a diet of ants and beetles (24,25), contributing to natural control of pests in the coffee and sugar cane crops.



Fig. 4: *Phyllomedusa burmeisteri*, a species of tree frog which has all the colors of Brazil's flag (green, blue, yellow and white). Photo: Lucas Ferrante.

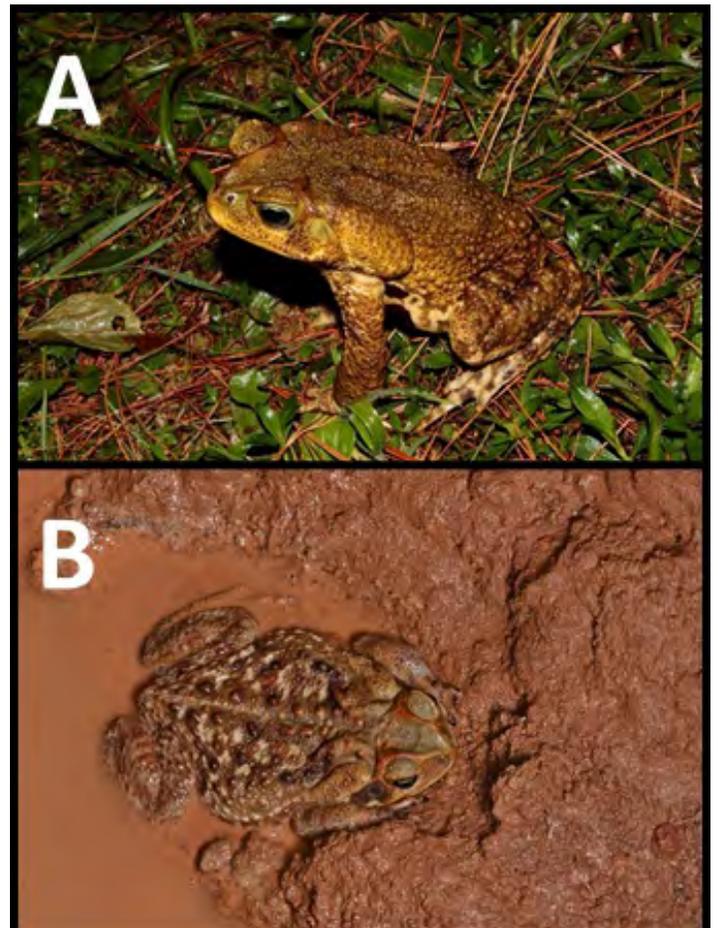


Fig. 5: A) *Rhinella icterica*; B) *Rhinella schneideri*. Both species are prey and habitat generalists and occur in the edge of forest fragments, open areas and agricultural crops. Photos: A) Rafael Menegucci / B) Renato Gaiga.

The occurrences of frog species reported by rural workers in agricultural crops were corroborated by our team through a sampling in 21 different landscapes. The frogs are present both on the ground and on top of plants in agricultural crops; pesticides such as Blitz or Lorsban®480 BR (Dow AgroSciences) act only on the soil. More than 20 different pesticide types are used in those crops, according to our inventory on the farm. Because species that could potentially suppress pests have been found in these crops, it is possible that some agrochemicals used for pest control, such as Abamectin, Aftacor, AzaMax, Blitz, Durivo, Lorsban 480 BR, Klorplan, K-Othrine 2P, Premier Plus, Warrant 700 WG and VERDADERO WG, may not be necessary, although this requires targeted study. This type of information benefits rural workers, who can avoid using pesticides that harm human health and the environment. Currently, there is no evidence that the volumes of potential pests ingested by frogs would be sufficient to control the pest problem. Due to this, should be encouraged studies that involving interaction of amphibians and pest in agricultural crops, providing greater light to this issue. Using amphibians that live naturally in crops may improve integrated pest management (IPM), a form of pest control that aims at using chemical, biological and behavioral methods (22).

Our guide from the municipality of Conceição dos Ouros in the Chapada Farm provided another interesting ethnobiological report. We were checking which type of agricultural matrix around forest fragments most impacted the amphibian community inside the fragment, when our guide, Agnaldo Rosa, said: “The cattle wander through that forest path, so the vegetation is thin due to animal trampling; you will not find frogs there.” This report was corroborated later when we concluded our investigations. This kind of report is important to help generate new ecological hypotheses that advance our understanding of declines in amphibian populations.

Through the NGO Instituto Boitatá Etnobiologia e Conservação da Fauna (<http://institutoboitata.org/>), ethnobiological activities became more frequent. We taught the first regional course on Biology and Conservation of Amphibians and Reptiles (Fig. 6 and 7), which taught the whole integrated conservation plan implemented in the region. This theoretical and practical course involved undergraduate biology and veterinary students, as well as herpetologists that work in environmental consulting. The course covered taxonomy, animal behavior, biogeography, biodiversity, bioacoustics, landscape ecology and conservation. The methodology of The IUCN Red List Categories and Criteria was also part of the course,

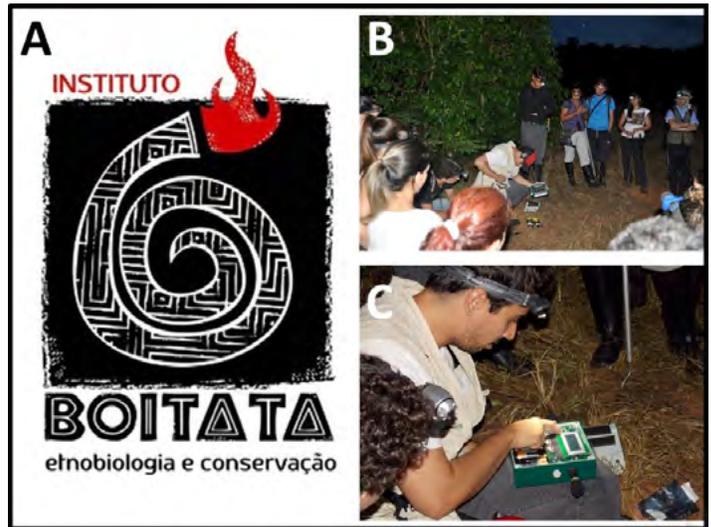


Fig. 7: A) Instituto Boitatá Etnobiologia e Conservação da Fauna logo. B and C) Practical class of acoustic monitoring of amphibians in the first course of Biology and Conservation of Amphibians by Instituto Boitatá. Photo: Iberê Machado.

with the goal of ensuring that more researchers are aware of the method and will apply it to the assessment of threatened species or collaborate with Red List assessments in Brazil.

We also carried out environmental education activities at schools in the rural and urban areas of the cities where the studies were developed (Fig. 8). Our objective was to show the importance of amphibians and reptiles for the ecosystem, inspiring empathy in children toward those animals. We also intended to awaken the scientific curiosity of students through our work with herpetology and conservation. In all those lectures, we covered topics such as the ecological importance and conservation of amphibians, their life cycle, main threats, and simple initiatives through which any citizen can contribute to environmental conservation. We also assessed the importance of environmental education relating to amphibians with high school students. An undergraduate student of biology, Carina Veiga, developed those activities through a partnership between the Instituto Boitatá NGO and her university, Unifeob, in São João da Boa Vista, state of São Paulo, Brazil (Fig. 9). The objective of the study was to assess how much students in their second and third high school years knew about amphibians both before and after lectures on the biology and conservation of amphibians.

Through all of these activities, we can affirm that the integration of several components of society, such as the private sector, rural sector, universities, researchers and general public, is essential. This integration can turn scientific production and the implementation of conservation initiatives into a cycle (Fig. 10). Another important aspect is to allow for increased visibility of environmental education and ethnobiological research in conservation and herpetology journals. Universities play a key role through research and outreach. Public notices for conservation projects by national or international organizations, such as CNPq, CAPES and WCS, can benefit from this type of initiative that integrates research and outreach—they are more likely to play a role in these projects and interact with all parts of society, which can increase the direct impact of their results. This integrated action plan can be applied to other taxonomic groups, and is already being implemented for reptiles and mammals by our team. By virtue of the size and megadiversity of Brazil, the Instituto Boitatá, the National Institute for Research in the Amazon (INPA), National Center for Research and



Fig. 6: Field class of the first course of Biology and Conservation of Amphibians and Reptiles by Instituto Boitatá. 04 February 2015, Alfenas municipality, Minas Gerais State, Brazil. Photo: Iberê Machado.



Fig. 8: From left to right: Biology teacher Ana Cristina Gória, Instituto Boitatá members Rafael Menegucci, Lucas Ferrante and Nathalia Torres, elementary school director Nivea Carvalho and Lucinéia Machado; below, the students of the elementary school José Olímpio da Silva in Conceição dos Ouros municipality, Minas Gerais state, Brazil. Photo: Unknown.



Fig. 9: Interview conducted by undergraduate student in biology Carina Veiga to high school students, municipality of São João da Boa Vista, São Paulo state, Brazil. Photo: Unknown.

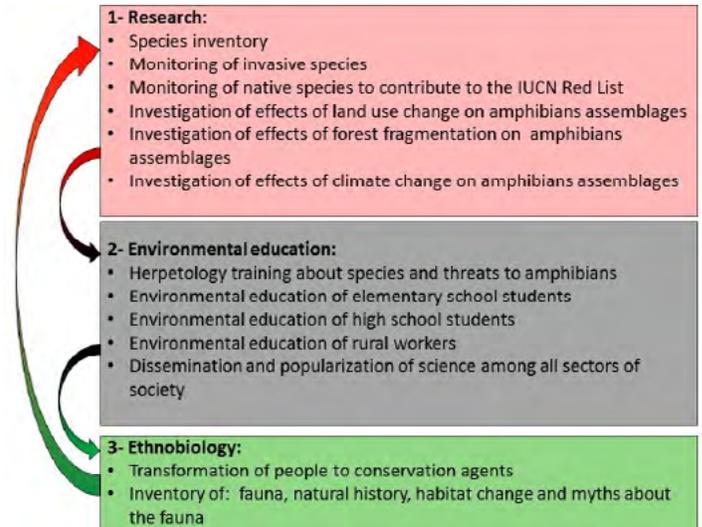


Fig. 10: Cycle of actions for conservation.



Fig. 11: From left to right: Vívian Uhlig - National Center for Research and Conservation of Reptiles and Amphibians (RAN), Débora Silvano - Regional Co-Chair of the IUCN SSC of Amphibian Specialist Group in Brazil, Iberê Machado - President of Instituto Boitatá and Lucas Ferrante - National Institute for Research in the Amazon (INPA) and Amazonian Coordinator of Instituto Boitatá. Photo: Unknown.

Conservation of Reptiles and Amphibians in Brazil (RAN) and the Regional Co-Chair of the IUCN SSC Amphibian Specialist Group in Brazil, joined efforts to study future threats of amphibians in the Atlantic Forest and Amazonian Forest in Brazil (Fig. 11).

The implementation of those activities could result in more conservation benefits if extended into environmental certification and environmental laws. The Brazilian forest code is inefficient and controversial (26), proving a lack of awareness and environmental education among Brazilian policymakers. Brazilian aquatic biodiversity is also being managed by public policies that are not in line with the viewpoint of scientists because those policies often ignore the conservation needs of many species (27). Agents of environmental damage are always advocating for their impacts (15), but these “reasons” have to be questioned by experts. Amphibians depend on both terrestrial and aquatic environments (28), demanding that public policy ensures the preservation of the dynamics of both environments. Conservation initiatives that involve several parts of the society are easier to implement because they result in a higher awareness of ecological relationships and public policy that involves society. In this process, the implementation of conservation can be easier in private or public hearings aimed at policy-making. Conservation actions such as those discussed here can be the way to build a society with higher environmental awareness, which is also more active in conservation and establishment of laws that protect natural environments and the fauna. Maybe it is also the way to save amphibians from their current environmental crisis.



Fig 12. Juvenile *Bokermannohyla luctuosa*, forest dependent species in Atlantic Forest fragments. Photo: Lucas Ferrante.

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## Protecting Africa's Most Endangered Frogs

By Jesse Lewis

In the past year, Amphibian Survival Alliance's long-standing collaborator Rainforest Trust worked with local partners in Ghana and Madagascar to ensure a future for some of Africa's most endangered frogs through the establishment of two new protected areas.

In Ghana, Rainforest Trust teamed up with local partner Ghana Wildlife Society to transform the poorly protected Atewa Forest Reserve into a well-managed 63,840-acre national park.

Ghana's Atewa Range contains one of the last intact areas of the Upper Guinean Forest, which encompasses three quarters of all remaining upland rainforest in the West African nation. As the headwater for three major rivers, the range is also a vital water source for many Ghanaians, including more than half of the inhabitants of Accra, Ghana's capital city. However, destructive human activities place ever-mounting pressures on the ecosystem and cast doubt on its future health.

Rainforests in the Atewa Range provide shelter for a host of endangered wildlife, including what may be the last viable population of the Critically Endangered Togo Slippery Frog. In addition, the range provides refuge for two other endangered frog species, the Bobiri Reed Frog (*Hyperolius bobirensis*) and *Phrynobatrachus ghanens*.

The new national park designation provides the first-ever protection for these species and others, while helping ensure the water supply for thousands local people.

Rainforest Trust has conservation efforts underway to save threatened frogs in Madagascar as well. Of the planet's major biodiversity hotspots, few compare to Madagascar. More than 80 percent of the island's flora and fauna are found nowhere else, but rapid deforestation and habitat loss threaten many of the unique species with extinction.

In Madagascar's Moramanga District these threats pose a dire risk to endemic wildlife, including the Critically Endangered Golden Mantella Frog, one of Madagascar's most threatened and elusive species. To protect these lush forests and the threatened amphibians that inhabit them, Rainforest Trust collaborated with local partner Madagasikara Voakajy to create a network of seven protected areas totaling 74,816 acres. The largest of these, the proposed Mangabe protected area, will act as a last stronghold for the Golden Mantella Frog, protecting more than 60 percent of the remaining population within the Mangabe reserve.

"Both of these projects have great conservation merit for being located in African biodiversity hotspots and for containing Critically Endangered frog species not found in any protected areas," said Dr. Bert Harris, chief biodiversity officer at Rainforest Trust. "We're proud to have the opportunity to protect these amazing habitats for wildlife."



Bobiri Reed Frog. Photo: Daniel Portik.



Golden Mantella. Photo: Frank Vassen.



Madagascar. Photo: Robin Moore.



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Photo: Carlos Vasquez.

## The Sleeping Child Reserve in the Western Guatemalan Highlands

By <sup>1</sup>Carlos Vásquez Almazán

In the heart of the Western Guatemalan Highlands, several indigenous communities refer to salamanders as the “sleeping child” in their local language. It is here, in the Northern Region of Huehuetenango, that local conservationists from the Foundation for Eco Development and Conservation (FUNDAECO) joined together with academics and conservationists from around the world to establish “Yal Unin Yul Witz” (or “Sleeping Child Between Mountains” in the Mayan language Q’anjob’al), an ecological reserve aimed at protecting some of the most biologically diverse ecosystems in all of Guatemala—and the wildlife species that call this area home.

And many species do. The region is a biodiversity hotspot and serves as refuge for dozens of threatened endemic animal and plant species, such as the Endangered Guatemalan Fir (*Abies guatemalensis*), the Endangered Horned Guan (*Oreophasis derbianus*), the Vulnerable Highland Guan (*Penelopina nigra*) and the Near Threatened Resplendant Quetzal (*Pharomachrus mocinno*).

Monitoring in the reserve has identified relatively healthy populations and reproductive activities of many frog species. Currently, 10 species of Vulnerable, Endangered or Critically Endangered amphibians are found in the Yal Unin Yul Witz Ecological Reserve:

- Morelet’s Treefrog (*Agalychnis moreletii*)
- Xucaneb Robber Frog (*Craugastor xucanebi*)
- Guatemala Treefrog (*Ecnomihyla minera*)
- Perkins’ Treefrog (*Exerodonta perkinsi*)
- Ikil Spikethumb Frog (*Plectrohyla ixil*)
- Hartweg’s Spikethumb Frog (*Plectrohyla hartwegi*)
- Copan Stream Frog (*Ptychohyla hypomykter*)
- Bromeliad Treefrog (*Bromeliophyla bromeliacia*)

The Vulnerable Salamander Müller’s Mushroomtongue Salamander (*Bolitoglossa mulleri*) and the Large-Crested Toad (*Incilius macrocristatus*) can also both be found within the reserve. Endemic plants, insects and reptiles are present, including the beautiful and Vulnerable Palm-Pitviper (*Bothriechis aurifer*). The first bird survey in the area revealed eight Nearctic/Neotropical migratory bird species and nine endemic resident species.

<sup>1</sup>Museo de Historia Natural/USAC and The Foundation for Eco Development and Conservation (FUNDAECO).

In the early 1970s, scientists from the University of California at Berkeley conducted amphibian and reptile surveys in the area, finding an exuberant forest with few and scattered coffee farms at the time. During that survey, the scientists discovered two new genera of salamanders; several endemic species, including the Critically Endangered salamander *Bradytriton silus* and the Endangered *Nyctanolis pernix*; and the Data Deficient *Bolitoglossa jacksoni*, a salamander that has been lost to science since the original discovery.

### THE PERFECT HOME FOR WILDLIFE

This spectacular ecological reserve was the ideal location to establish a preserve to protect unique amphibian species and their habitat in perpetuity. Huehuetenango contains the greatest coverage of coniferous forests in the country, in addition to broadleaf and mixed forests. It is an area that contains a great diversity of ecosystems, from riparian wetlands and dry forests, to wet tropical forests, karst sinkholes, montane forest and subalpine moorland. These varying types of ecosystems surround the Yal Unin Yul Witz Ecological Reserve. Elevations here range from 1,000 meters to 1,770 meters above sea level. The Yal Witz (or Between “Cerros” River) intersects the reserve and helps provide the magnificent natural conditions that support the various habitat types. With two local offices, FUNDAECO has been working in Huehuetenango since 2006 on issues related to the sustainable use and legal conservation of protected land in Guatemala.

The reserve itself is located in the Alliance for Zero Extinction (AZE) site of Mountain Los Angeles, close to the town of Santa Cruz Barillas, north of Huehuetenango. It is part of the Caribbean



Photo: Carlos Vasquez.

slope of the Sierra de los Cuchumatanes, adjoining a few kilometers at the border with Mexico and the Lacandona forest. It is one of Guatemala’s wettest regions (around 5,000 mm of precipitation annually), creating unique moisture conditions for many species that, as a result, are especially sensitive to changes in their ecosystems. The Mountain of Los Angeles is also the site of a joint project, “Debt-for-Nature Swap,” between the governments of Guatemala and the United States and two NGOs, Conservation International and The Nature Conservancy.

### FEET ON THE GROUND

With less than one year since the reserve’s formal establishment, studies and research on the ground are just starting. Currently, FUNDAECO is taking the lead on two critical strategies to comple-



*Bradytriton silus*. Photo: Hussain Aga Khan Hussain Aga Khan.

ment regional efforts for the reserve. First, the local organization aims to expand the conservation property to the nearby flooded mountain area, a magnificent and rare open area that is paradise for amphibians and both resident and migratory birds. The second strategy is to expand the area of the Reserve to the highest elevation in the adjacent north-east Mountain El Quetzal, to protect the Yul Witz River basin that runs through the Reserve.



*Nyctanolis pernix*. Photo: Carlos Vasquez.

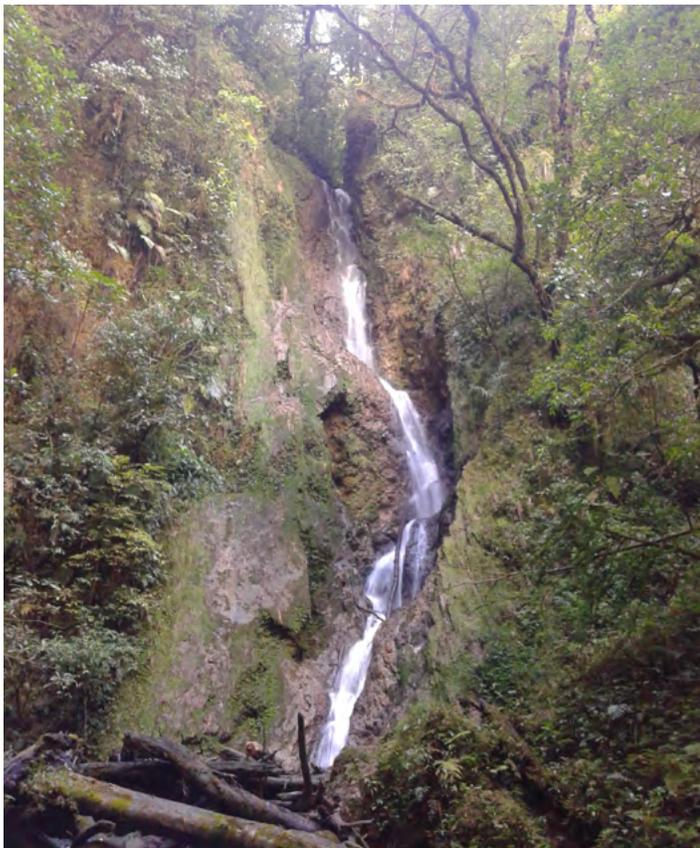


Photo: Carlos Vasquez.



Photo: Carlos Vasquez.



*Plectrohyla ixil*. Photo: Carlos Vasquez.

FUNDAECO is implementing initial management activities and the construction of a Mountain Refuge will serve as the first phase to support general management, and both biological and surveillance activities. The organization recently recruited a reserve manager to focus on community outreach with local leaders and private owners to ensure their support and participation in the implementation of sustainable strategies for habitat protection and sustainable community development. Communication (vision, management principles and administration of the natural resources produced within the reserve) is among the top priorities so that the implementation of sustainable strategies is done in partnership with the local community.

FUNDAECO will continue to implement these ambitious and highly critical conservation initiatives to protect the Yal Unin Yul Witz Ecological Preserve and the species that live there, with the goal of broadening these conservation efforts in an area that is critical to amphibian biodiversity.

#### Acknowledgements:

Funding for fieldwork was provided by the Fondo para la Conservación de los Bosques Tropicales (FCA), the Mohamed Bin Zayed Species Conservation Fund and the Museo de Historia Natural (MUSHNAT). Support for the establishment of the Reserve was provided by: Amphibian Survival Alliance, Global Wildlife Conservation, Andrew Sabin and the Andrew Sabin Family Foundation, Rainforest Trust, International Conservation Fund of Canada and the World Land Trust-UK. Special thanks to Paul Elias and Prince Hussain Aga Khan, who visited the Reserve in 2014. For more information contact: [www.fundaeco.org.gt](http://www.fundaeco.org.gt); [fundaecoinfo@fundaeco.org.gt](mailto:fundaecoinfo@fundaeco.org.gt)



*Plectrohyla hartwegi*. Photo: Carlos Vasquez.



*Bradytriton silus*. Photo: Carlos Vasquez.

# Priority Amphibian and Reptile Areas (PARCAs) Aim to Jumpstart Conservation for North America's Rich Amphibian and Reptile Diversity

By J. J. Apodaca and Alex Navarro

As our biodiversity faces persistent and emerging threats at an alarming rate, it is imperative that we quickly evolve to meet these challenges through new and innovative forms of conservation. The increasing complexity of threats (climate change, diseases, etc.) coupled with limited conservation resources requires us to make difficult decisions on where to focus the majority of our conservation efforts and resources. This is especially true for amphibians and reptiles, which tend to be declining faster and are overall more threatened than other vertebrate groups. Additionally, they have historically received far less conservation focus and energy. It is clearly time to develop and implement new strategies and tools to enhance the conservation of amphibians and reptiles worldwide.

There are no simple solutions for the plight of amphibians and reptiles, but it is evident that we as a conservation community need to both prioritize and grow current resources. The foundation of effective and lasting conservation efforts is a robust network of protected areas. Recently, Partners in Amphibian and Reptile Conservation (PARC) created a framework to help emphasize the conservation of North America's amphibians and reptiles through the development of model criteria for identifying and ranking Priority Amphibian and Reptile Conservation Areas (PARCAs). Modeled in part on the successful Important Bird Areas concept, this effort aims to promote voluntary conservation actions through the identification of the most significant geographic areas for herpetofauna. It is our hope that PARCAs will guide the limited resources available to conservation efforts towards areas that are disproportionately



important to the long-term survival of our diverse amphibians and reptiles. Concurrently, PARCAs are intended to raise awareness of globally important areas of conservation, thus growing the pot of resources dedicated to their conservation.

PARCA model selection criteria are a valuable conservation tool, especially when combined with the expert knowledge available through the PARC network. It would be difficult to overstate the need for such a tool in the United States, one of the global centers for salamander biodiversity (including several endemic genera) and overall an amphibian diversity hotspot. The urgency for PARCAs became clear when several of PARC's regional working groups (southeast, northeast and southwest) began discussing similar concepts at the same time. Given this broad interest, a national task team was formed in 2008 to develop criteria and an implementation plan, completed in 2012.

PARCAs, while identified and coordinated at the national scale, will be implemented at state or regional levels. PARCAs carry no regulatory authority; however, the goal is to encourage and incentivize habitat management, restoration or acquisition actions to benefit amphibian and reptile populations.

In 2015, the PARC Joint National Steering Committee agreed to make the implementation of PARCAs a national priority for the next three to five years. Currently, there are efforts underway to complete the identification in the Southeast, Northeast and New Mexico. In 2016, we hope to continue identifying PARCAs across the country. Plans are also in place to make PARCA shapefiles available for download via the PARC website.

In a world of rapid population declines and species extinction, our hope is that PARCAs will expedite conservation action for amphibians and reptiles by leveraging research and management activities within them.



Fig. 1: Current draft PARCAs in the Southeastern United States and New Mexico. Cross hatching indicates a PARCA identification process is underway.

# Establishing a Global Acoustic Monitoring Network

By <sup>1,2</sup>T. Mitchell Aide

**A** critical component of the Amphibian Conservation Action Plan (2) is to improve surveys and monitoring activities. Here, I describe a road map for establishing a global acoustic monitoring network. The general vision is to make acoustic biodiversity monitoring stations as common as weather stations, and make the information available in real-time for all users around the world. The technology exist; what we need are the funds and the will to do it.

## PROBLEM

The scientific community does a very good job of monitoring land use and land cover change from the local to the global scale. For years, we have been monitoring patterns of deforestation, and new sensors are providing information on forest structure in three dimensions and even identifying individual tree species in high diversity tropical forests. Unfortunately, our ability to monitor the fauna is not nearly as advanced. It is much easier to determine the presence or absence of a forest, than identify the presence or absence of the fauna within the forest, but we urgently need to address this challenge.

## SOLUTION

To help contribute to a solution, we have developed the Automated Remote Biodiversity Monitoring Network (ARBIMON) (1). ARBIMON is a novel combination of hardware and software for automating data acquisition, data management and species identification based on audio recordings. The data acquisition component of ARBIMON includes permanent recording stations and portable recorders. In addition, we have developed a free Android app (ARBIMON Touch) that will turn any Android smartphone into a recording device. Solar powered permanent monitoring stations (Fig. 1) along with the ARBIMON II bioacoustics analysis platform (Fig. 2) will be the core of a global network (Fig. 3). The monitoring stations are programmed to record 1-minute of audio every 10 minutes, and then they send the recordings through a cellular network or Wi-Fi in real-time to the ARBIMON servers in the “cloud.” The recordings can then be accessed and analyzed in the ARBIMON II bioacoustics analysis platform (Fig. 2). Automating acoustic data acquisition is not new, but three aspects of this bioacoustics analysis platform are novel:

**Data management/browsing/visualization:** ARBIMON II is the first web-based platform for managing the millions of recordings collected each year. Most researchers and technicians store their recordings on external hard drives, which are easily misplaced, but even worst, most of the recordings are never viewed or processed. ARBIMON II provides tools for creating multiple projects, uploading recordings, browsing recordings, viewing and listening to the spectrograms. This approach makes it easy for the users to securely store their data in the cloud and easily share results with colleagues around the world.

**Automating data analyses:** In the past, most researchers have only analyzed a small percent of the recordings they have collected. This is because most people analyze the data by hand, and this is very time consuming. There are software programs for data analysis of acoustic recordings, but none link the database with the ana-

lytical tools on a cloud-computing platform. ARBIMON II provides tools so that the user can create their own species-specific identification algorithm, including model training and validation. The major advantages of these tools are that they allow the user to analyze all of their data.

**Real-time acoustic monitoring:** Moving data from the field to the web in real-time is a major advance, particularly when the raw data can be analyzed on the fly, so that processed results are displayed immediately.

## ESTABLISHING A GLOBAL ACOUSTIC MONITORING NETWORK

No one questions the importance of the global network of weather stations, now it is time to establish a global network of biodiversity stations (Fig. 3). While the global decline of amphibians is the major motivation for this global network, the acoustic monitoring



Fig. 1: ARBIMON biodiversity monitoring stations will be the core of a global network. The solar powered stations include an ARBIMON recording device (Android smartphone) with a cellular data plan, which is used to upload recordings in real-time to the ARBIMON II bioacoustics analysis platform. In addition, a companion app uploads status reports on the state of the battery, cellular connectivity and recording collection and upload. Photo: Sieve Analytics.

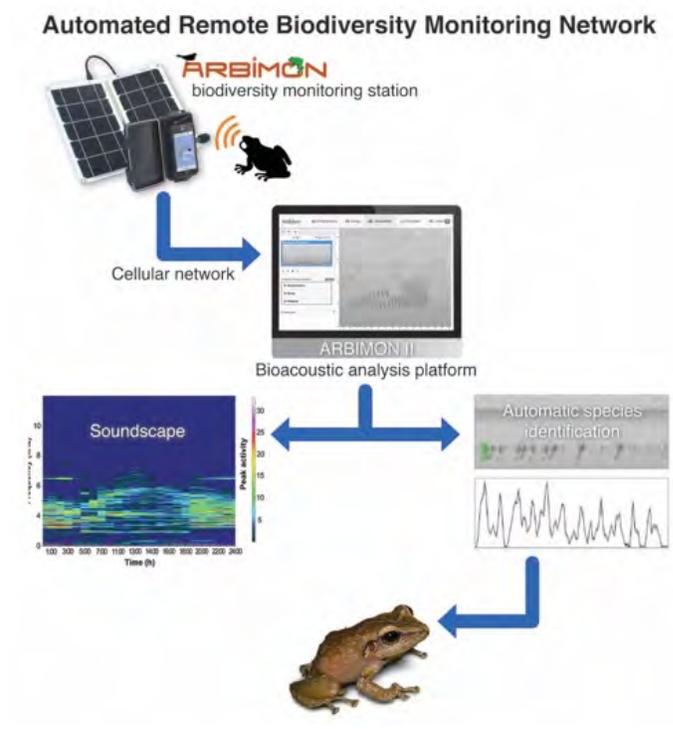


Fig. 2: Data acquisition, transfer, storage and analysis from the ARBIMON biodiversity monitoring station to the ARBIMON II bioacoustics analysis platform.

<sup>1</sup>University of Puerto Rico – Rio Piedras. <sup>2</sup>Sieve Analytics Inc. [mitch@sieve-analytics.com](mailto:mitch@sieve-analytics.com)

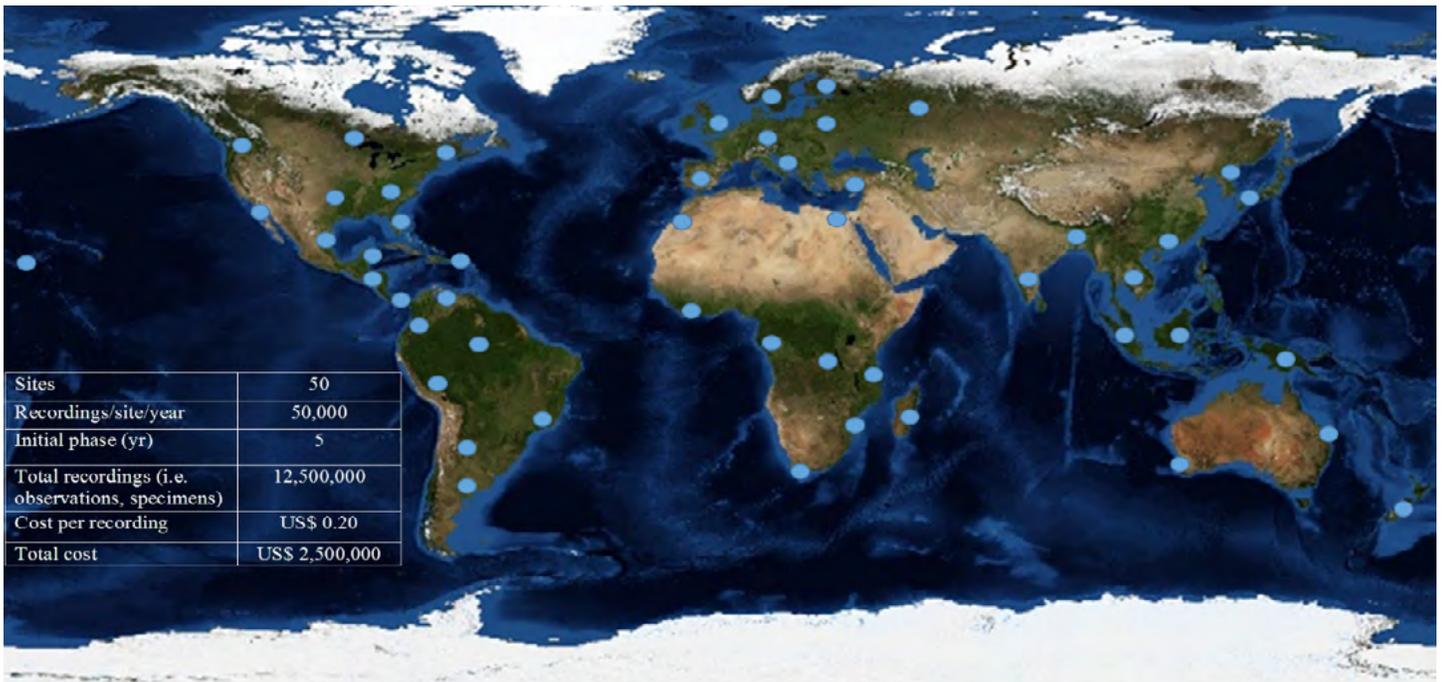


Fig. 3: The initial goal of this long-term project is to establish 50 ARBIMON biodiversity monitoring sites around the globe during the first five years. These stations will collect ~12,500,000 1-minute recordings, creating the most extensive bioacoustics “museum” at a cost of only US\$2.5 million. Image courtesy of the NASA’s Earth Observatory.

stations will also provide data on birds, insects, mammals and the environment in general. To make this a reality we need to:

**Identify partner organizations:** The major partners in this effort will be universities, biological research stations, protected areas, conservation NGOs, zoos, natural history museums and ecolodges around the world. All of these groups have a strong interest or responsibility to know the status of the fauna in the areas that they manage or where they work. Ideally, these partners will form a steering committee or establish a NGO to run the network.

**Funding:** The cost of establishing 50 monitoring stations and running them for five years is estimated to be ~US\$2.5 million. This effort will result in ~12,500,000 1-minute recordings from around the world, and given that each recording is the equivalent of a museum specimen, we will soon have an impressive collection that will serve scientist, managers and conservationists today, but also in the future.

**Site selection:** Partner organizations and funding sources will play an important role in determining the location of the sites. In addition, sites could be associated with existing forest and fauna monitoring networks (e.g., The Center for Tropical Forest Science - Forest Global Earth Observatory (CTFS-ForestGEO), Conservation International for the Tropical Ecology Assessment and Monitoring (TEAM) Network).

**Establish monitoring stations:** A representative responsible for each monitoring station will attend a 5-day workshop to learn the details of the ARBIMON hardware and software. The workshop will focus on establishing, maintaining and troubleshooting the monitoring station. In addition, the workshop will cover the basics of data analysis. Within two weeks of the workshop, the representatives should establish the monitoring system. In addition, funds are included for the ARBIMON core staff to visit each site to provide technical support and lead a detailed data analysis workshop.

**Network symposiums and workshops:** Symposiums and workshops could be held at international scientific meetings to share results, stimulate use of the extensive database and discuss strategies for expanding the network to thousands of sites.

## CONCLUSION

Climate change, deforestation, diseases and many other threats to biodiversity are moving ahead quickly. We, as the monitors and protectors of biodiversity, need to move even faster. With a relatively small investment, we can quickly begin to build a global monitoring network that will greatly improve the information we use for our conservation and management activities.

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# Update from the ASG Species Conservation Strategies Working Group

By Sally Wren, Federico Kacoliris and Mark Stanley-Price

The ASG Species Conservation Strategies Working Group has been working to implement priority actions that were identified during the recent ACAP revision. Here is an update on two aspects where we have been focussing our attention.

## PROVIDING TECHNICAL ADVICE FOR CONSERVATION PLANNING

One of the actions that emerged from the ACAP's Species Conservation Strategies themes was the need for technical knowledge and support to be provided to those who are undergoing amphibian conservation planning. The ASG Species Conservation Strategies Working Group is working closely with the IUCN Species Conservation Planning Sub-Committee (SCPSC) in implementing this action, which we hope will both expand the number of species covered by conservation strategies, and to ensure that the strategies result in effective conservation for those species.

The IUCN Species Conservation Planning Task Force has provided written assistance for those undergoing planning projects in the form of the Strategic Planning for Species Conservation [Overview](#) and [Handbook](#) guidance documents. These provide detailed advice on a proven method for conservation planning, including information on who should be involved in the process and what methods result in a successful outcome. These documents are an excellent resource for anyone undertaking amphibian conservation planning, but we aim to go a step further, linking up experts to provide the best science for conservation management, and giving advice specific to each project.

Since mid-2015, the ASG Species Conservation Strategies Working Group has been working with the Argentinian agency CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas) and La Plata Museum (MLP) on a conservation-planning project led by Federico Kacoliris. The aim is to develop a strategy to conserve threatened species on the Somuncura Plateau in Patagonia, including two species of frog: the Valcheta Frog (*Pleurodema somuncurense*; Critically Endangered) and the Somuncura Frog (*Atelognathus reverberii*; Endangered). The threats to these species include invasive predatory fish species and farming practices that have resulted in severe habitat degradation.

To date we have provided advice on the steps necessary for undergoing species-based conservation planning, who should be invited



Photo: Federico Kacoliris.

to be involved in a planning workshop and methods to employ in the planning process. We are also working with the Amphibian Red List Authority to update the assessments of the two frog species to make sure that we are starting with the most up-to-date and accurate information. We will continue to provide support throughout the planning and implementation process, working together with CONICET and MLP to enable the best conservation outcomes for these species.

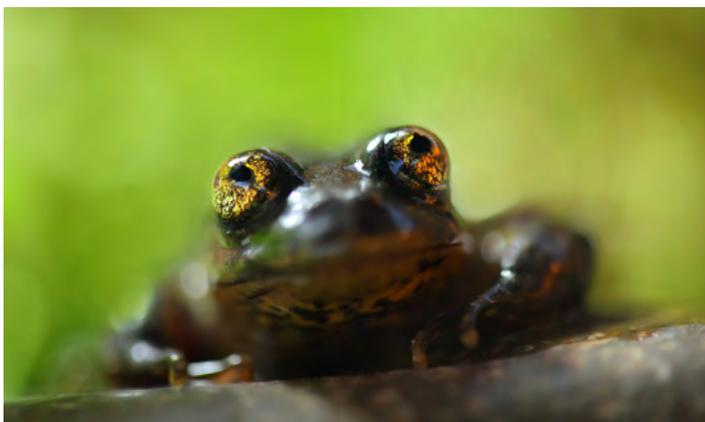
The strategy developed will include the Naked Characin (*Gymnocharacinus bergii*), an endangered fish that shares the same habitat as the Valcheta Frog and suffers from similar threats, so we have also been consulting with the Freshwater Fish Specialist Group to make use of its expertise. In the long-term all of these species will be used as flagships for the protection of the whole Somuncura plateau.

**Our aim is to provide similar support to other amphibian conservation planning projects, so please get in touch with Sally Wren ([swren@amphibians.org](mailto:swren@amphibians.org)) or Mark Stanley-Price ([mark.stanleyprice@zoo.ox.ac.uk](mailto:mark.stanleyprice@zoo.ox.ac.uk)) if you would like to find out more about what technical support we could offer to your amphibian conservation project.**

## LEARNING FROM EXISTING ACTION PLANS

Another area that was highlighted during the ACAP update was the need to be able to learn from existing Action Plans, and as such we are working to expand on the existing collection of action plans and conservation strategies on [amphibians.org](http://amphibians.org). Once we have assembled a good collection of documents we will move on to an analysis phase, assessing successes and failures from each plan, with the aim of learning lessons from past projects and improving the effectiveness of future conservation planning efforts. This will also contribute to the aims of other working groups, including the Captive Breeding and Reintroductions groups, both of which prioritized similar actions during the ACAP update process.

If you have copies of any actions plans or conservation strategies for amphibian species that are not yet included in the [amphibians.org](http://amphibians.org) collection, please forward these to Sally Wren ([swren@amphibians.org](mailto:swren@amphibians.org)) or Mark Stanley-Price ([mark.stanleyprice@zoo.ox.ac.uk](mailto:mark.stanleyprice@zoo.ox.ac.uk)).



Valcheta Frog (*Pleurodema somuncurense*). Photo: Dario Podesta.

# Update from the ASG Climate Change Working Group

By Phil Bishop

The devastating effects of climate change on tropical forests has been well documented and these forests are particularly important for amphibian biodiversity. Although other habitats may not have as many amphibian species they will also be negatively affected by climate change. The problem of climate change presents a large-scale effect and all ecosystems will need to be well managed to prevent further losses of amphibian diversity. However, the direct impacts of climate change are difficult to quantify and tangible mechanisms to mitigate these effects are few and far between. There have been a few suggestions in the literature to increase the resilience of natural systems such as irrigating potential breeding sites; increase shelters to reduce desiccation and thermal stress; manipulate ephemeral ponds to prevent early desiccation; and, provide corridors of protected habitat along elevational gradients (1,2). More research is needed to design and test new initiatives to respond to this emerging crisis.

The Climate Change Working group is facilitated by Guin Wogan and Johannes Penner and as we do not know which species are most likely to be affected by climate change, the group's main focus will be the identification of climate change vulnerabilities among the 7500 species of amphibians as the first critical step. To do this the group will survey (both online and through email) the global network of amphibian experts, including those involved with the Amphibian Red List. In addition, the Working Group will

use community-based niche modeling to determine how regional faunas will respond under proposed climate change scenarios. The group will also identify high and low risk geographical areas using GIS and conduct a comprehensive review and meta-analysis of published studies to identify commonalities and trends in life history traits, distribution characteristics, and taxonomic trends (e.g. are certain families or groups more vulnerable than others).

They anticipate that these priorities will synthesize the current state of amphibian vulnerabilities with regards to climate change, and will assist in the identification of key areas where critical information is lacking.

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Early metamorphosed juvenile African Bull Frogs (*Pyxicephalus adspersus*) start to devour tadpoles in a drying wetland. As ephemeral ponds start to dry up more rapidly in the face of climate change, species that develop the fastest will be favored. Photo: Les Minter.

## IN THE WILD



The Fire Salamander, *Salamandra salamandra*, a native species in Austria under the threat of urbanization. Photo: Christina Straub.

Population genetics of Fire Salamanders in a pre-alpine urbanized area (Salzburg, Austria)

Christina Straub, Florian Pichlmüller & Véronique Helfer

Habitat alteration has been identified as one of the major causes of amphibian decline. In particular habitat fragmentation due to increasing urbanization has been shown in various studies to be a major limiting factor of gene flow and causal agent of genetic differentiation in amphibian species.

In this study we focus on the potential effect of the progressing urbanization on the population structure of fire salamanders in a pre-alpine region. The Fire Salamander, *Salamandra salamandra*, shows strong site fidelity and has small home ranges, hence the effect of habitat fragmentation on this species is difficult to foresee.

We investigated the genetic structure of seven Fire Salamander subpopulations in the urbanized area of Salzburg (Austria) based on seven polymorphic microsatellite loci. We combined Bayesian clustering approaches (STRUCTURE, TESS) with the traditional F-statistics to evaluate the effect of potential barriers on gene flow. Both clustering approaches suggested that all sampled individuals belong to a single genetic pool ( $K = 1$ ). While no clear-cut sign of genetic differentiation could be detected, pairwise  $F_{ST}$ -values suggest that the city of Salzburg potentially has an effect, but the effect of the highway leading to it remains hypothetical. This study corroborates that habitat alteration effects might take several generations before leading to isolated genetic pools, particularly in long-lived species. Such delayed effects have to be taken into account for population genetic analyses, in particular when it comes to conservation management and planning.

C. Straub, F. Pichlmüller, V. Helfer, *Salamandra*, **51**, 245–251 (2015).



*P. auratus* observed in Cerro Humo, Península de Paria.

Photo: Mayke De Freitas.

Discovery of the Critically Endangered Golden Tree Frog, *Phytotriades auratus* (Boulenger, 1917), in Eastern Venezuela, with comments on its distribution, conservation and biogeography

Gilson A. Rivas, Mayke De Freitas S. & Tito R. Barros

A new population of the enigmatic and elusive hylid *Phytotriades auratus* has been recently discovered in Península de Paria, Northeastern Venezuela. Since its description by Boulenger in 1917, the species was thought to be an endemic of Trinidad Island, where two populations survive in Mount El Tucuche (936 m) and Cerro del Aripo (940 m). The discovery of the Golden tree frog in Cerro Humo (1,250 m), the highest peak of Paria, is hardly surprising, due to the abundant evidence that links Península de Paria and Trinidad Island, which is considered an extension of the Venezuelan coastal cordillera. Both Trinidad and Tobago Islands are reputed to have been connected with mainland during glacial maxima, when sea levels were lower, therefore the close connection between the fauna and flora of the islands and Península de Paria. The conservation status of *P. auratus*, *Critically Endangered* B1ab(iii)+2ab(iii), is not expected to improve with the addition of a new population and an enlarged habitat range, since the same conservation problems that exist for the species in Trinidad, are exacerbated in Venezuela due to institutional weaknesses and an almost inexistent presence of environmental authorities within the area, formally protected as Península de Paria National Park. Despite the possibility of finding new populations of *P. auratus* in Venezuelan mainland, several other conservation challenges must be tackled first if the species is to be preserved, such as climate change, and the dangerous proximity of Chytridiomycosis. The species has now been included in the Venezuelan Red Book of Fauna and the authors are working to verify potential localities to confirm other populations in Venezuela's mainland and Margarita Island, as well as the relationship between the population from Trinidad and Venezuela in collaboration with Michael Jowers.

G. Rivas, M. De Freitas, *Herpetol. Rev.* **46**, 153–157 (2015).

Snow cover and late fall movement influence Wood Frog survival during an unusually cold winter

Jason H. O'Connor & Tracy A. G. Rittenhouse

Understanding how organisms will respond to altered winter conditions is hampered by a paucity of information on the winter ecology for many species. Amphibians are sensitive to environmental temperature and moisture conditions and may be vulnerable to changes in winter climate. We used a combination of radio telemetry and field enclosures to monitor survival of the freeze-tolerant Wood Frog (*Lithobates sylvaticus*) during the unusually cold winter of 2013–2014. We experimentally manipulated snow cover to determine the effect of snow removal on winter survival. In addition, we placed a group of untracked frogs at locations used by tracked frogs prior to long-distance late fall movement to investigate whether late fall movement entailed survival consequences. Winter survival was highest (75.3 %) among frogs at post-movement locations that received natural snow cover. The odds of surviving the winter for frogs in the snow removal treatment was only 21.6 % that of frogs in the natural snow treatment. Likewise, paired frogs placed at pre-fall movement locations had only 35.1 % the odds of surviving as tracked frogs at post-fall movement locations. A comparison of a priori models that included microhabitat conditions measured at wood frog overwintering locations revealed that the minimum temperature experienced and the depth of the frog in the substrate explained additional variation in winter survival. Our results suggest that acute exposure to lethal temperature conditions is the most likely cause of mortality during this study, rather than energy exhaustion or desiccation. They also demonstrate the importance of snow cover to the winter survival of Wood Frogs.

J. H. O'Connor, T. A. G. Rittenhouse, *Oecologia* DOI: 10.1007/s00442-015-3450-z (2015).





A paedomorphic Palmate Newt (*Lissotriton helveticus*) from Larzac, France. Photo: Mathieu Denoël.

Using kernels and ecological niche modeling to delineate conservation areas in an endangered patch-breeding phenotype

Mathieu Denoël & Gentile Francesco Ficetola

Efficient delineation of conservation areas is a great challenge in maintaining biodiversity. Kernel density estimators (KDEs) are a powerful tool in this perspective, but they have not been applied at the population level on patch-distributed organisms. This would be particularly worthy for species that need broad habitats beyond those where they can be sampled; such as terrestrial lands for pond-breeding amphibians. The aim of this study was to compare different approaches for the identification of suitable areas for conservation: KDE, ecological niche modelling, and a combination of KDE and niche models. Paedomorphosis was chosen as a model system because this is an important form of intraspecific variation that is present in numerous taxa, but geographically localized within species and globally endangered. 277 ponds were sampled in one of the hotspots of paedomorphosis to determine the abundance and distribution of paedomorphs (i.e., individuals retaining gills at the adult stage) of the Palmate Newt (*Lissotriton helveticus*), with emphasis on the connections between the most valuable populations. KDEs gave insights into the surface areas required to balance the maintenance of certain number of connected ponds and the respective number of disjoint areas in which the whole population is divided. The inclusion of barriers in the models helped in accurately designing the limits of the areas to protect. Alone, habitat models were not able to successfully delineate the area to protect, but the integration between terrestrial suitable areas or barriers and KDE allowed an objective identification of areas required for conservation. Overall, the best performance was observed by the KDE integrating ecological barriers, and by the combination between KDE and niche modelling. In a broader perspective,

KDEs are thus a pertinent tool in providing quantitative spatial measurements to delineate conservation areas based on patch-abundance data with a specific focus to connectivity.

M. Denoël, G. F. Ficetola, *Ecol. Appl.* 27 (2015): 1922–1931.

<http://hdl.handle.net/2268/178265>

#### Evaluation of potential toxicants for removing invasive American Bullfrogs (*Rana catesbeiana*)

Gary W. Witmer, Nathan P. Snow & Rachael S. Moulton

While native to the eastern United States, American Bullfrogs (*Rana catesbeiana*) have been introduced to western North America and most other continents, as well as many islands around the world. Because of their large size and voracious appetite, they cause significant negative impacts to many native vertebrate and invertebrate species. Effective and efficient control methods are needed to manage invasive American bullfrogs and reduce those impacts. Current methods such as hand- or net-capture are labor intensive and not particularly effective. No toxicants have been identified or registered for American Bullfrogs, but we predict they could eventually allow a cost-effective control alternative. Stemming from research with chemical control for invasive Coqui frogs and cane toads, we identified and tested the efficacy of 10 potential toxicants for controlling invasive bullfrogs. Caffeine, chloroxylenol, and a mixture of rotenone with permethrin proved highly effective (100% mortality) at the concentrations tested. Additional follow-up studies on delivery systems and reducing any non-target hazards of these 3 compounds will hopefully result in effective management tools for reducing populations of invasive American Bullfrogs.

G. W. Witmer, N. P. Snow, R. S. Moulton, *SpringerPlus* 4, 497 (2015).

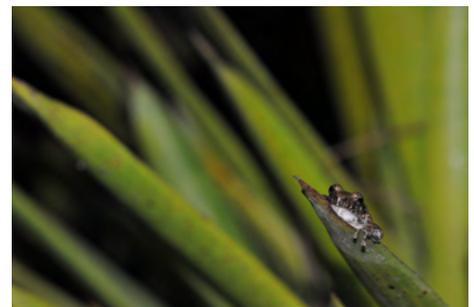
#### Hydroregime prediction models for ephemeral groundwater-driven sinkhole wetlands: A planning tool for climate change and amphibian conservation

Cathryn H. Greenberg, Scott Goodrick, James D. Austin & Bernard R. Parresol

Hydroregimes of ephemeral wetlands affect reproductive success of many amphibian species and are sensitive to altered weather patterns associated with climate change. We used 17 years of weekly temperature, precipitation, and waterdepth measurements for eight small, ephemeral, groundwater-driven sinkhole wetlands in Florida sandhills to develop a hydroregime predictive model. To illustrate

its utility for climate-change planning, we forecasted weekly wetland water-depths and hydroperiods (2012–2060) using our model and downscaled climate data from the CSIRO Mk3.5 Global Circulation Model under an A1B emissions scenario. We then examined how forecasted water depths and hydroperiods might alter reproductive success, and thereby populations, of five anuran species. Precipitation and water-depth from the prior week were significant predictors of water depth. Our model forecasted shallower depths and shortened hydroperiods for most wetlands when used with the CSIRO Mk3.5 A1B scenario. The forecasted hydroregimes would likely provide adequate reproductive opportunity for only one of the five species we examined. We demonstrate the utility of our model in examining how different climate change scenarios might affect hydroregimes and, indirectly, biological diversity. Climate change uncertainty highlights the importance of retaining multiple, hydrologically diverse wetlands on landscapes to maximize the potential for successful reproduction by species having differing hydroregime requirements.

C. H. Greenberg, S. Goodrick, J. D. Austin, B. R. Parresol, *Wetlands* 35:899–911 (2015). DOI 10.1007/s13157-015-0680-0



Deforestation-tolerant *Craugastor fitzingeri* perches atop a bromeliad near the Las Cruces Biological Station in southern Costa Rica. Photo: L. O. Frishkoff.

#### Thermal niche predicts tolerance to habitat conversion in tropical amphibians and reptiles

Luke O. Frishkoff, Elizabeth A. Hadly & Gretchen C. Daily

Habitat conversion is a major driver of the biodiversity crisis, yet why some species undergo local extinction while others thrive under novel conditions remains unclear. We suggest that focusing on species' niches, rather than traits, may provide the predictive power needed to forecast biodiversity change. We first examine two Neotropical frog congeners with drastically different affinities to deforestation, and document how thermal niche explains deforestation tolerance. The more deforestation-tolerant species

is associated with warmer macroclimates across Costa Rica, and warmer microclimates within landscapes. Further, in laboratory experiments the more deforestation-tolerant species has critical thermal limits, and a jumping performance optimum, shifted ~2 °C warmer than those of the more forest-affiliated species, corresponding to the ~3 °C difference in daytime maximum temperature that these species experience between habitats. Crucially neither species strictly specializes on either habitat—instead habitat use is governed by regional environmental temperature. Both species track temperature along an elevational gradient, and shift their habitat use from cooler forest at lower elevations, to warmer deforested pastures upslope. To generalize these conclusions, we expand our analysis to the entire mid-elevational herpetological community of southern Costa Rica. We assess the climatological affinities of 33 amphibian and reptile species, showing that across both taxonomic classes thermal niche predicts presence in deforested habitat as well as or better than many commonly used traits. These data suggest that warm-adapted species carry a significant survival advantage amidst the synergistic impacts of land-use conversion and climate change.

L. O. Frishkoff, E. A. Hadly, G. C. Daily, *Global Change Biology*, 21 3901–3916 (2015).



The most common frog species at our study site, the Fire-bellied Toad (*Bombina bombina*). Photo: Béla Mester.

Spatiotemporally variable management by grazing and burning increases marsh diversity and benefits amphibians: A field experiment

Béla Mester, Mónika Szalai, Oliver T. Méré, Miklós Puky & Szabolcs Lengyel

Amphibians are in a rapid decline due to several human-induced global threats such as the degradation and loss of their freshwater habitats. Low-intensity grazing by cattle and late-summer burning of overgrown marsh vegetation were promising methods to increase marsh diversity and to create open-water surfaces for amphibians. We implemented both of these management actions in a field quasi-experiment between 2010 and 2011 and surveyed frogs and toads in six levels of management to address the

following questions; (i) Does management reduce reed cover, influence vegetation structure and increase the diversity of habitats? (ii) Do changes in reedbed properties due to management benefit anuran amphibians? (iii) Is there a direct link between management and benefits to the amphibian community? (iv) Do grazing and burning differ in their impacts on the reed habitats and on amphibians? (v) Does management intensity influence anuran species richness and counts? Prescribed fire effectively removed old reed and increased the heterogeneity of marsh vegetation by the next spring. We found dense reedbeds in areas burnt 2 or 3 years before our study, indicating that fire can rejuvenate the reed. In contrast, grazing kept reed cover low, and created and maintained open water surfaces. Amphibian richness and abundance decreased with mean reed cover and old reed density, and increased with variability in reed cover. Correspondingly, amphibian richness and counts in the spring were greatest in areas burnt the previous summer. However, a year later, richness and counts were greatest in grazed-only areas, with large decreases in newly burnt and control areas. We conclude that low-intensity grazing and fire can create and maintain mosaic marsh structure with different patches, some of which can be suitable for frogs and toads in one year, whereas other patches may become suitable in a subsequent year due to rapid successional changes in the vegetation. To increase the number of optimal habitat patches, mosaic marsh management should repeat rotational reed burning once every 2 or 3 years, and also maintain low-intensity cattle-grazing. Our results supports spatiotemporally varied management to maintain habitat diversity and complexity in dynamic landscapes.

Mester *et al.*, *Biol. Cons.* 192, 237–246 (2015).

#### Taxonomic biases of seven methods used to survey a diverse herpetofaunal community

Donald T. McKnight, Joshua R. Harmon, Jennifer L. McKnight & Day B. Ligon

We conducted a survey of a diverse herpetological community in southeastern Oklahoma from 2012–2013, with the goals of examining its composition and comparing the results of several commonly used survey methods. We used pitfall traps and funnel traps positioned along drift fences, funnel traps placed along logs, various aquatic turtle traps (hoop nets, crawfish traps, and minnow traps), artificial cover objects, and automated recording systems. We also recorded all incidental encounters. We documented 53 reptile and amphibian species. Incidental encounters, funnel traps along drift fences,

and pitfall traps documented more species than any of the other methods. Incidental encounters, funnel traps along drift fences, and turtle traps were the only methods that captured unique species (i.e., species that were undetected using other methods), and the combination of those three methods documented representatives of every species found at the site. Funnel traps along drift fences had significantly higher capture rates than funnel traps along logs, and crawfish traps captured more species and had higher capture rates than minnow traps.

D. T. McKnight, J. R. Harmon, J. L. McKnight, & D. B. Ligon, *Herptol. Conserv. Biol.* 10, 666–678 (2015).



Eastern Spadefoot Toad (*Scaphiopus holbrookii*) captured in a pitfall trap at a forested site at Kiawah Island, South Carolina, USA. Photo: Keith M. Hanson.

Anthropogenic impacts and long-term changes in herpetofaunal diversity and community composition on a barrier island in the southeastern United States.

Keith M. Hanson & Eric J. McElroy

We determined the impacts of human development on the herpetofauna of Kiawah Island, a barrier island in South Carolina, USA. We used drift fence arrays with pit and snake traps, cover boards, and visual encounter surveys to sample herpetofauna at twelve sites along a gradient of developmental density (low, moderate, and high) in two dominant habitats (forest and sand dune). We found the highest species richness in the low development area with 16 species, while we found 14 species in the moderate area and 13 species in the high area. We also found that abundance was the highest in the low development area with 587 individuals encountered. However, we found no statistically significant differences in richness and abundance across development areas. Diversity indices and evenness were significantly higher in the moderate and high development area when we compared them to the low development area, which we attributed to the large numbers of a few amphibian species that we found in the low development area. Community composition was fundamentally different between development areas; we encountered the

largest number of families and sensitive species in the low development area. Furthermore, we found four unique species in the low development area, whereas we found one unique species in the moderate area and none in the high area. We found that species richness and abundance were significantly higher in forest habitats when compared to sand dunes, however we found two species only in the sand dunes. When we compared the results of our survey to a survey completed a few decades ago, we found that Kiawah may have lost two species but has retained 29 other herpetofaunal species and has gained two more species. We found that a variety of vegetative and environmental characteristics were important for predicting richness and abundance within each habitat. Overall, our results indicate that a mixture of various levels of development and types of habitat with certain characteristics (e.g., plant species richness, canopy cover, etc.) may have the ability to maintain the greatest herpetofaunal diversity on barrier islands. Full text available at: <http://www.herpcnbio.org>

K. M. Hanson, E. J. McElroy, *Herpetol Conserv Biol* **10**; 765–780 (2015).



Laguna Raimunda Frog, *Atelognathus reverberii*. Photo: Mauricio Akmentins.

A new threat for the endangered frog *Atelognathus reverberii* (Anura: Batrachylidae) in Argentinean Patagonia

Mauricio S. Akmentins, Melina A. Velasco, Camila A. Kass & Federico P. Kacoliris

*Atelognathus reverberii* (Ceí, 1969) is an endemic terrestrial frog that inhabits semi-permanent or temporary volcanic clay lagoons. These lagoons are scattered throughout the desertic Somuncura Plateau of Argentinean Patagonia. This frog species was listed as Endangered in the IUCN's red list. On February 2015 a possible source of mass mortality for Laguna Raimunda Frog's was registered at the locality of Laguna Azul in Somuncura Plateau, Río Negro Province, Argentina. A total of 441 individuals of *Atelognathus reverberii* were found trapped in a water pit dug in the ground about 15 m from the shore of a semi-permanent volcanic clay lagoon, and eleven of them were already dead inside the water pit. After the incident,

430 live individuals were released in the shore of the lagoon and the water pit was fenced to prevent further mortality of frogs. These water pits, named "jagüeles" are dug by local residents near the water sources to cattle consumption; they act as pitfalls for frogs. Because the frogs cannot climb out of them, they either drown or dehydrate. This human intervention should be considered as a threat to this terrestrial frog in its natural habitat. Despite the low density of people in the Somuncura Plateau, the impact of poor water management could drive the decline of the populations of *Atelognathus reverberii*. It would be useful to implement a population monitoring program for the Laguna Raimunda Frog. Concrete conservation plans should be developed to provide local residents a water-extraction/storage system for supplying water to cattle that does not contribute to anuran mortality.

M. S. Akmentins, M. A. Velasco, K. A. Kass, F. P. Kacoliris, *Phyllomedusa* **14**, 63 (2015).



The threatened Green and Golden Bell Frog, *Litoria aurea*, perched on emergent vegetation beside a pond. Photo: James I. Garnham.

The winter microhabitat selection of a threatened pond amphibian in constructed urban wetlands.

James I. Garnham, Michelle P. Stockwell, Carla J. Pollard, Evan J. Pickett, Deborah S. Bower, John Clulow & Michael J. Mahony.

Mitigating the threat of habitat loss requires actions such as restoring and creating new habitat. In order to effectively achieve this, species habitat requirements and use patterns need to be understood. While many studies have been conducted on the habitat choice of species, these generally focused on habitat use during periods of high activity and detection probability without considering seasonal shifts in habitat use. Understanding habitat selection by frogs during the winter season of low activity may be crucial since it may differ to that used during the summer and may be overlooked as important for population

success. We describe the microhabitat use of the threatened green and golden bell frog (*Litoria aurea*) using radio tracking methods during winter when detection is low and knowledge is limited. We followed 26 individuals between May and July, 2011 to determine whether they selected specific overwintering microhabitats and related this to levels of individual exposure to predators, distance from the edge of the water and temperature of microhabitats. We found that overwintering bell frogs inhabited reeds and rock gabions more frequently than expected and that females used a reduced subset of microhabitats compared to males. Additionally, microhabitats used were more likely to conceal an individual from view and the majority of overwintering sites were located within 5 m of the edge of the water which may be important for reducing the risk of predation and desiccation. Rock gabions had significantly warmer (1.0 °C – 2.3 °C) mean temperatures than the other microhabitats used. The information presented here can be used in habitat creation and reintroduction programs to provide habitat which is suitable during both the breeding and non-breeding season for the conservation of other populations.

Garnham, J. I. *et al.*, *Austral Ecology* **40**, 816–826 (2015).



Yellow-bellied Toad (*Bombina variegata*), Rhône-Alpes region, France. Photo: Yves Fol.

Slow life history and rapid extreme flood: Demographic mechanisms and their consequences on population viability in a threatened amphibian

Hugo Cayuela, Dragan Arsovski, Sylvain Boitard, Éric Bonnaire, Laurent Boualil, Claude Miaud, Pierre Joly & Aurélien Besnard

In the Northern Hemisphere, an increase in both the frequency and magnitude of violent flooding events has been reported due to climate change. According to life history theory, one might postulate that in "slow" species: (i) environmental canalization may act as a selective force that minimizes to some extent adult survival variations caused by catastrophic flood and (ii) extreme flooding events would cause important variations in recruitment and young survival. Hence, it may be hypothesized that (iii) the population growth

rate of “slow” species might be relatively insensitive to changes in the frequency of extreme climatic events if adult survival remains largely unaffected. In this study, we investigated how extreme rainfall events resulting in severe flood impact population dynamics of a long-lived endangered amphibian, the Yellow-bellied Toad (*Bombina variegata*: Bombinatoridae). To address this issue, we used capture–recapture (CR) data collected on two populations (768 and 1154 individuals identified) in southern France and developed multi-event CR models. Our results indicated that extreme flooding did not cause any variation in sub-adult or adult survival, whereas recruitment and juvenile survival were negatively impacted. Furthermore, our simulations indicated that the population growth rate was only marginally sensitive to potential changes in the frequency of extreme flooding in the future. Hence, we suggest that extreme flooding does not appear to be a proximal factor of extinction risk for this endangered amphibian species.

H. Cayuela *et al.*, *Freshwater Biol.* **60**, 2349–2361 (2015).



A male of *Hypsiboas pulchellus* calls from an irrigation canal beside a rice field in Rio Grande do Sul, Brazil. Photo: Leonardo Moreira.

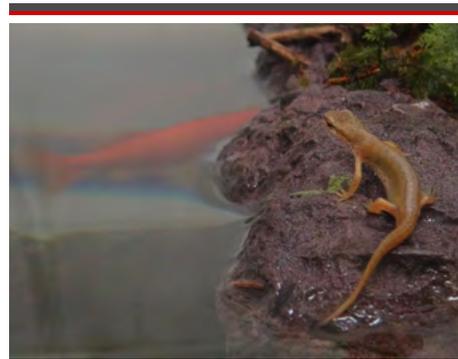
Our time will come: Is anuran community structure related to crop age?

Leonardo F. B. Moreira & Leonardo Maltchik

An ongoing controversy involves the debate about the effects of man-made land transformation on freshwater biodiversity. It has been suggested that agricultural areas provide habitats for many species of amphibians, but crop age may affect richness and community structure. In such modified landscapes, a nested structure has been commonly detected, although community structure may be season specific and guild specific. Here, we determined detectability associated with site-specific and survey-specific variables and examined nestedness patterns in anuran communities in natural areas and rice fields with different crop ages (10 and 20 years) in southern

Brazil. We studied whether nestedness was associated with time since cultivation and whether these patterns were similar across guilds in these areas. Anuran detectability was related only with time after sunset. Community composition varied between crop ages. Aquatic and arboreal species were associated with native areas and showed a nested pattern. Fossorial species did not show significant nestedness. Our results showed that factors associated with crop age may affect guilds in different ways. These effects seem to be related to individual traits of species (habitat preferences, reproductive modes, plasticity). Incorporating species traits may enhance conservation strategies in agroecosystems.

L. F. B. Moreira, L. Maltchik, *Austral Ecol.* **40**, 827–835 (2015).



A Palmate Newt that escaped water after Goldfish introduction. Photo: Laurane Winandy.

Amphibians forgo aquatic life in response to alien fish introduction

Laurane Winandy, Elodie Darnet & Mathieu Denoël

Species with complex life cycles are good models to understand trade-offs between life in hostile and favourable habitats. Newts remain in breeding wetlands for a long period and are strongly affected by fish introduction; however, mechanisms of the exclusion observed in the field are still not well known. In particular, whether newts skip breeding and leave water for land in response to fish introduction and how aquatic shelter may influence their choice remain open questions. To investigate these questions, we experimentally studied the use of aquatic and terrestrial habitats during the breeding season of Palmate Newts, *Lissotriton helveticus*, in the presence and absence of Goldfish, *Carassius auratus*. We determined the consequences of habitat choice on newt fitness by assessing sexual activity and number of eggs. There was a strong, significant avoidance of the aquatic environment in the presence of fish, particularly when no aquatic shelter was available. This escape from the water had an impact on reproduction: newts decreased their sexual activity and laid fewer eggs. The availability of shelters favoured coexistence

but did not prevent a large proportion of the newts from leaving water and skipping reproduction. This study shows how the presence of fish and the absence of aquatic shelters can lead to newts forgoing aquatic life, thus improving our understanding of the mechanisms behind the coexistence and exclusion patterns found in the wild. More broadly, these data contribute to explaining aquatic versus terrestrial life in favourable and unfavourable environments.

L. Winandy, E. Darnet, M. Denoël, *Anim. Behav.* **109**, 209–216 (2015).

<http://hdl.handle.net/2268/184506>



Measuring body parameters of a Danube Crested Newt (*Triturus dobrogicus*), one of the commonest amphibian at the Egyek-Pusztakócs marsh and grassland system. Photo: Szabolcs Lengyel.

Low frequency of amphibian morphological anomalies in a large protected wetland and grassland complex in Hungary

Béla Mester, Szabolcs Lengyel & Miklós Puky

In parallel to the global decline of amphibians, their morphological anomalies (malformations and deformities) have been in focus since the early 1990s. Morphological anomalies can result from a number of factors ranging from parasites through unsuccessful predation attempts to the pollution of aquatic habitats, all of which can negatively affect amphibians at various developmental stages. Previous studies estimated the background frequency of anomalies between 0 to 5 % for wild populations in natural habitats. Other studies found that this frequency can be exceeded even in protected areas due to abrupt changes in the local ecosystem, and suggested that the frequency of anomalies can reflect the health of the entire ecosystem. We collected anomaly data in postmetamorphic amphibians during a long-term monitoring of several conservation actions in the Egyek-Pusztakócs marsh and grassland system, Hungary. Our study site is a wetland and grassland complex that had been heavily affected by intensive agriculture until 1973 when it was protected, restored, and managed for conservation. We examined 4,953 individuals of 11 amphibian species during 2010–2013. We

did not find malformed specimens, and we found a low frequency (0.3%) of amphibian deformities in 15 individuals of four species. All observed anomalies were consistent with injuries caused by predators, but the role of existing parasites also could not be excluded. It remains uncertain whether the absence of malformations and the observed low frequency of anomalies were related to the 40 years of protection and the long-term decrease in agrochemical use or to more recent grassland restoration and marsh management actions. Nevertheless, our results provide an example that large, healthy populations of amphibians can exist in large protected wetlands managed for biodiversity.

B. Mester, S. Lengyel, M. Puky, *Herp. Cons. Biol.* **10**, 679–687 (2015).



A California Tiger Salamander (on right) and a hybrid salamander (on left). Photo: Jarrett Johnson.

Amphibian molecular ecology and how it has informed conservation

Evan McCartney-Melstad & H. Bradley Shaffer

**M**olecular ecology has become one of the key tools in the modern conservationist's kit. Here we review three areas where molecular ecology has been applied to amphibian conservation: genes on landscapes, within-population processes, and genes that matter. We summarize relevant analytical methods, recent important studies from the amphibian literature, and conservation implications for each section. Finally, we include five in-depth examples of how molecular ecology has been successfully applied to specific amphibian systems.

E. McCartney-Melstad, H. Bradley Shaffer, *Molecular Ecology* **24**, 5084–5109 (2015).

Baseline distribution records for amphibians and reptiles in the upper peninsula of Michigan

Gary S. Casper, Ryne D. Rutherford & Thomas G. Anton

**W**e examined the empirical evidence for the distributions of 18 amphibians and 20 reptiles in the fifteen counties comprising the Upper Peninsula of Michigan, U.S.A.

We applied rigorous vetting criteria and examined all known documentation for species occurrence. We corrected several historical errors that have been repeated in the literature for some time, suppress several records that do not meet scientific standards, and provide 49 new county records. We provide new distribution tables listing voucher specimens for each species and county, and encourage building upon this baseline by publishing new voucher based records as they become available.

Gary S. Casper, Ryne D. Rutherford, and Thomas G. Anton, *Herpetological Review* **46**(3): 391–406 (2015).



Invasive Cane Toads (*Rhinella marina*) in Northern Australia. Photo: Martin Mayer.

Habitat use of the introduced Cane Toad (*Rhinella marina*) and native frog species in tropical Australia

Martin Mayer, Gregory P. Brown, Barbara Zimmermann, Matthew J. Greenlees & Richard Shine

**T**he ecological impacts of introduced species can reveal mechanisms underlying habitat selection and behaviour. We investigated the habitat use of native frog species and invasive Cane Toads (*Rhinella marina*) in tropical Northern Australia to measure overlap in habitat use, and to test if the presence of the Cane Toad influences frog behavior. Native frogs and cane toads both preferred habitats close to water and unvegetated holes. However, native frogs were found further from water (on average 19.4 m) than were toads (on average 12.6 m), and preferred areas with higher vegetation (8–50 cm) than did toads, which were more abundant in vegetation lower than 8 cm. For both types of anuran, the next neighbour was more often of the same type (89% in frogs, 52% in toads) than expected by chance (observed ratio: 75% frogs vs 25% toads), reflecting these differences in habitat use. Our counts of frog abundance increased on average 14.5% in areas from which we removed cane toads temporarily. This result suggests that Cane Toads inhibit the activity of native anurans either by inducing avoidance, or by reducing activity. By modifying the behaviour and spatial distribution of native taxa, invasive Cane

Toads may curtail activities such as feeding and breeding.

M. Mayer, G. P. Brown, B. Zimmermann, M. J. Greenlees, R. Shine, *Journal of Tropical Ecology* **31**, 531–40 (2015).

## IN CAPTIVITY



Individuals from the F1 generation aged 11 and 13 months after completing metamorphosis with uniform orange-red adult colouration, shown here feeding on collembolans. Photo: Devin Edmonds.

Captive husbandry, reproduction, and fecundity of the Golden Mantella (*Mantella aurantiaca*) at the Mitsinjo breeding facility in Madagascar

Devin Edmonds, Justin Claude Rakotoarisoa, Solonirina Rasoanantenaina, Samina Sidonie Sam, Jeanne Soamiarimampionona, Edupsie Tsimialomanana, Youssouf (no last name), Rainer Dolch, Falitiana Rabemananjara, Nirhy Rabibisoa & Eric Robsomanitrdrasana

**W**e provide an account of maintaining a captive population of the Critically Endangered mantellid frog *Mantella aurantiaca* at a breeding facility near Andasibe, Madagascar, reporting novel observations on behavior, fecundity, reproduction, temperature tolerance, age at maturity, and survivorship. In April of 2012, 25 breeding groups were established from founder stock collected at three natural breeding sites located on the footprint of the Ambatovy nickel and cobalt mine. Over a two-year period, 469 breeding events were recorded. Breeding activity was highly seasonal and aligned with average monthly temperatures, with peak breeding activity observed during the austral summer months of December and January. An average of 7 egg clutches per female was recorded over the two years, with the mean clutch size being 74 eggs (193 max/24 min). Tadpoles completed metamorphosis between 53 and 139 days, with 441 individuals from 22 clutches of eggs surviving to one year of age. Males were recorded vocalizing 4 months after completing metamorphosis, and the first fertile eggs were produced at 11 months. Reproduction in the F1 generation was captured on video and we provide a detailed description of this behavior, including an observation of males “pulsating” femoral

glands on the dorsum of a female during reproduction. Based on these data and observations, we discuss the importance of record keeping for captive amphibians, potential conservation implications of creating new breeding sites for reintroducing *M. aurantiaca*, as well as the advantages of running captive breeding programs within the native range of a species.

D. Edmonds *et. al.*, *Salamandra* 51(4), 315–325 (2015).

## ONE GREEN HEALTH



Both *Bd* and ranavirus were detected in Green Salamanders from southwestern Virginia. Photo: M. Kevin Hamed.

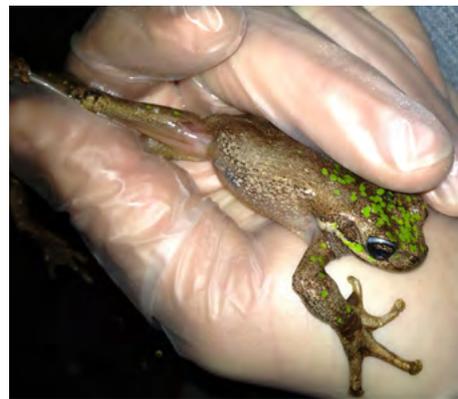
First report of ranavirus and *Batrachochytrium dendrobatidis* in Green Salamanders (*Aneides aeneus*)

Melissa Blackburn, Jack Wayland, Walter H. Smith, Joseph H. McKenna, Matthew Harry, M. Kevin Hamed, Matthew J. Gray & Debra L. Miller

The Green Salamander (*Aneides aeneus*) is distributed sporadically throughout the Southern Appalachian Mountains from Pennsylvania to Alabama, with a disjunct population in southwestern North Carolina and northwestern South Carolina. Green Salamanders are thought to be at risk of range-wide declines and extirpations due to their unique habitat requirements and have accordingly been granted some level of conservation concern throughout the species' entire range. North Carolina populations experienced local extirpations from the 1970s to 1980s, with up to a 98% reduction in population size occurring since the 1980s. A definitive cause for reductions and extirpations has not been established. Diseases caused by ranaviruses or *Batrachochytrium dendrobatidis* (*Bd*) have been responsible for numerous amphibian declines and form a possible mechanism for declines in Green Salamanders; however, little to no work has been performed to date to sample for the presence and prevalence of these pathogens in this species. We sampled 41 Green Salamanders for *Bd* and, of those, were also able to sample 38 salamanders for ranavirus. We detected *Bd* in 15% (6/41) and ranavirus in 8% (3/38) of sampled

Green Salamanders with no incidences of co-occurrence. Our survey was the first to document ranavirus infections in Green Salamanders and the first to detect *Bd* in Green Salamanders from Virginia. Only one salamander that tested positive for *Bd* displayed an external sign of infection, and this individual was emaciated. However, we did not collect tissue for histological examination to confirm the cause of emaciation. A single sampling location, Breaks Interstate Park, had individuals that tested positive for both pathogens. Our findings suggest that both ranavirus and *Bd* could impact Green Salamander populations. These results also suggest that past declines could have been influenced by pathogens and support the implementation of range-wide pathogen monitoring for Green Salamanders.

M. Blackburn *et al.*, *Herpetol. Rev.* 46: 357–61 (2015).



*Litoria burrowsae*. Photo: Scott Cashins.

Using site-occupancy models to prepare for the spread of chytridiomycosis and identify factors affecting detectability of a cryptic susceptible species, the Tasmanian tree frog

Scott D. Cashins, Annie Philips & Lee F. Skerratt

The global reduction of amphibian biodiversity as a result of the disease chytridiomycosis (caused by the fungus *Batrachochytrium dendrobatidis*; *Bd*) has highlighted the need to accurately detect local population declines in association with *Bd* presence. Although *Bd* has spread globally, some remote regions such as the Tasmanian Wilderness World Heritage Area (1.40 million ha; TWWHA) in Australia, remain largely, but not entirely, disease free. The Tasmanian Tree Frog (*Litoria burrowsae*) resides primarily within TWWHA boundaries, and is believed to be susceptible to chytridiomycosis. In the absence of historical abundance data, we used a single-season multi-state site-occupancy model to investigate the impact of *Bd* on *L. burrowsae* populations, on factors affecting species detection and to inform

ongoing surveillance and conservation. We recorded frog detection and ranked call intensity (estimation of population size) from repeated independent surveys within a season to estimate the role of covariates, such as presence of *Bd* and environmental variables, on species occupancy and detection probability. Modelling revealed large frog populations are more likely to be present at naturally formed than human formed ponds, strong winds negatively affect detection of populations, and time after sunset affects detection of large populations. Large frog populations were more likely to be *Bd*-negative; however, models including *Bd* presence were not well supported, in part a result of the small number of *Bd*-positive sites recorded. The utility of site-occupancy modelling in understanding the impact of disease on populations is little known, but has the potential to improve the accuracy and efficiency of many conservation programs.

S. D. Cashins, A. Philips, L. F. Skerratt, *Wild. Res.* 42, 405–413 (2015).

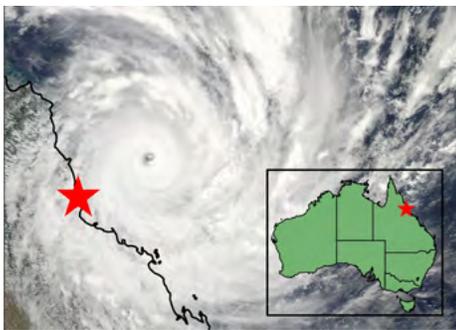
Acute toxic effects of the herbicide formulation Focus® Ultra on embryos and larvae of the Moroccan Painted Frog, *Discoglossus scovazzi*

Norman Wagner, Stefan Lötters, Michael Veith & Bruno Viertel

Effects of pesticides on amphibians are known to differ among species and their life-stages. The authors examined the acute toxic effects of a cycloxydim-based herbicide formulation on embryos and early larvae of the Moroccan Painted Frog (*Discoglossus scovazzi*). In only one previously conducted amphibian-toxicological study, the effects of a cycloxydim-based herbicide were investigated using the African Clawed Frog (*Xenopus laevis*). The higher test concentrations induced clinical signs in embryos (twitching, convulsion and narcosis) and larvae (total immobilization or irregular escape responses). Retardation (growth inhibition) could be observed in both life-stages. However, all test concentrations, including the worst-case expected environmental concentration, inhibited growth in larvae. The connection to teratogenesis remained unclear though total length reduction occurred at concentrations below 20% of the median lethal concentration of larvae. Mortality of larvae was enhanced during the first day of exposure. Surprisingly, exposure to the herbicide formulation did not significantly increase malformation rates in embryos, but in the early-stage larvae, starting at a concentration free of lethal effects. In general, embryos were significantly more tolerant than larvae, probably due to increased

activity of larvae with the consequence of higher food ingestion and incorporation of the compound. Compared to standard test organisms (Rainbow Trout and *Daphnia magna*), the herbicide formulation induced comparable lethal and immobilization effects in aquatic developmental stages of *D. scovazzi*. The apparent field safety data of the formulation is based on modelled surface water concentrations of cycloxydim, which is only a proxy for contamination with the formulation, *i.e.*, the active ingredient plus added substances (which mainly contribute to adverse effects). More data on real contamination levels in amphibian breeding ponds within cultivated landscapes is necessary. Furthermore, sufficient buffer strips between the farmland and breeding ponds must be considered to ensure field safety, but many amphibians use small water bodies like vernal pools or ditches for reproduction and such water bodies are usually not protected by no-spray buffer zones.

N. Wagner, S. Lötters, M. Veith, B. Viertel, *Arch. Environ. Contam. Toxicol.* **69**, 535–544 (2015).



A satellite image of Severe Tropical Cyclone Yasi approaching the northeastern coast of Queensland, Australia, in February 2011. A star denotes our study region, and the inset shows this location within Australia. Photo: Elizabeth A. Roznik, satellite image provided by NASA.

### Natural disturbance reduces disease risk in endangered rainforest frog populations

Elizabeth A. Roznik, Sarah J. Sapsford, David A. Pike, Lin Schwarzkopf & Ross A. Alford

Natural disturbances can drive disease dynamics in animal populations by altering the microclimates experienced by hosts and their pathogens. Many pathogens are highly sensitive to temperature and moisture, and therefore small changes in habitat structure can alter the microclimate in ways that increase or decrease infection prevalence and intensity in host populations. Here we show that a reduction of rainforest canopy cover caused by a severe tropical cyclone decreased the risk of endangered rainforest frogs (*Litoria rheocola*) becoming infected by a fungal pathogen

(*Batrachochytrium dendrobatidis*). Reductions in canopy cover increased the temperatures and rates of evaporative water loss in frog microhabitats, which reduced *B. dendrobatidis* infection risk in frogs by an average of 11–28% in cyclone-damaged areas, relative to unaffected areas. Natural disturbances to the rainforest canopy can therefore provide an immediate benefit to frogs by altering the microclimate in ways that reduce infection risk. This could increase host survival and reduce the probability of epidemic disease outbreaks. For amphibian populations under immediate threat from this pathogen, targeted manipulation of canopy cover could increase the availability of warmer, drier microclimates and therefore tip the balance from host extinction to coexistence.

E. A. Roznik, S. J. Sapsford, D. A. Pike, L. Schwarzkopf, R. A. Alford, *Sci. Rep.* **5**, 13472 (2015).

### Low concentrations of metal mixture exposures have adverse effects on selected biomarkers of *Xenopus laevis* tadpoles

Erta Yologlu & Murat Ozmen

Polluted ecosystems may contain mixtures of metals, such that the combinations of metals, even in low concentrations, may cause adverse effects. In the present study, we focused on toxic effects of mixtures of selected metals, the LC50 values, and also their safety limit in aquatic systems imposed by the European legislation using a model organism. *Xenopus laevis* tadpoles were used as test organisms. They were exposed to metals or their combinations due to 96-h LC50 values. Glutathione S-transferase (GST), glutathione reductase (GR), acetylcholinesterase (AChE), carboxylesterase (CaE), glutathione peroxidase (GPx), and catalase (CAT) levels were evaluated. Metallothionein concentrations were also determined. The LC50s for Cd, Pb, and Cu were calculated as 5.81 mg AI/L, 123.05 mg AI/L, and 0.85 mg AI/L, respectively. Low lethality ratios were observed with unary exposure of each metal in lower concentrations. Double or triple combinations of LC50 and LC50/2 concentrations caused 100% lethality with Cd + Cu and Pb + Cd + Cu mixtures, while the Pb + Cu mixture also caused high lethal ratios. The selected enzyme activities were significantly affected by metals or mixtures, and dose-related effects were determined. The metallothionein levels generally increased as related to concentration in unary metals and mixtures. Acceptable limit values of unary metals and mixtures did not significantly change metallothionein levels. The results suggest that oxidative stress-related mechanisms are involved in the toxicity induced by selected metals with

combinations of very low concentrations.

E. Yologlu, M. Ozmen, *Aquat. Toxicol.* **168**, 19 (2015).



*Batrachoseps attenuatus* and field notes. Photo: Carla Sette.

### Reconstructing historical and contemporary disease dynamics: A case study using the California slender salamander

Carla M. Sette, Vance T. Vredenburg, Andrew G. Zink

The amphibian disease chytridiomycosis, caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), has been implicated in amphibian die-offs and even extinctions throughout the world. This pathogen has caused recent mass die-offs in California, though its date of arrival in the region is unknown. We utilized large museum collections of the most abundant and widespread terrestrial amphibian species in Northern California, the California slender salamander, *Batrachoseps attenuatus*, in a retrospective study to fill in the timeline of disease emergence within its range. This species is known to be infected by *Bd*, but little is known of its disease dynamics. We examined the effect of disease history on contemporary disease dynamics by re-sampling historically positive *B. attenuatus* populations. We also correlated standard environmental variables (*e.g.*, temperature, precipitation), and ecological variables (such as host group size) with *Bd* prevalence to understand what factors are associated with *Bd* emergence. We found that *Bd* emerged in a non-linear pattern in Northern California. Warm, wet years were linked to historical *Bd* prevalence, while proximity to permanent bodies of water was linked to both historical and contemporary prevalence, suggesting that aquatic carriers of *Bd* may contribute to *Bd* prevalence in *B. attenuatus*. We also found that, within the 14 field sites sampled, populations with more recent historical infection had larger group sizes than populations that had been infected over multiple decades. This result suggests that sociality may facilitate disease spread in terrestrial hosts and that populations with longer exposure to this pathogen may evolve away from the ancestral condition of sociality.

C. M. Sette, V. T. Vredenburg, A. G. Zink, *Biological Conservation* **192**, (2015).

# GENERAL ANNOUNCEMENTS

## EVENTS

The following information can be found at: <http://www.amphibians.org/meetings>

### August 2016

15–21, 8th World Congress of Herpetology, Hangzhou, China

### September 2016

1–10, IUCN World Conservation Congress, Honolulu, Hawai'i

## INTERNSHIPS & EMPLOYMENT

### Kirtland's Snake Technical Services

Indiana Division of Fish and Wildlife (Posted to PARC 1/14/16, Closing March 7, 2016)

### Internship

Archbold Biological Station, FL (Posted to PARC 1/9/16, Open Until Filled)

### Animal Keeper II (Herpetologist)

The Dallas Zoo, Dallas, TX. (Posted to PARC 11/23/15, Open Until Filled)

### Herpetologist

Wyoming Game and Fish Department, Casper, WY. (Posted to PARC 10/01/15, Open Until Filled)

## FUNDING OPPORTUNITIES

The Amphibian Survival Alliance is pleased to announce an open call for seed grant applications. Seed grants are normally provided in amounts ranging from USD \$500–\$1,000 and are designed to help kick start projects or allow teams to try new innovative approaches to address conservation, research and education challenges. [Link](#)

The Leapfrog Conservation Fund has been created specifically to support the creation of new reserves for important amphibian habitat, or the expansion of existing reserves through local organizations. If your organization is working toward the protection of critical habitat for threatened amphibian species, we would love to hear from you. [Link](#)

The following information is kindly provided by the Terra Viva Grants Directory, for more information please visit: <http://www.terravivagrants.org/>

## April

**EC Research and Innovation (Horizon 2020) -- Marie Skłodowska-Curie Research Fellowships 2016.** The Marie Skłodowska-Curie Research Fellowships include the Research and Innovation Staff Exchange (RISE). RISE aims to develop partnerships at the international level in Europe and outside Europe (most developing countries are eligible) in academic and non-academic sectors. The organizations constituting the partnerships contribute to joint research and innovation by seconding and/or hosting eligible staff members. Program MSCA-RISE-2016. The deadline for applications is 28 April 2016. [Link](#)

**Lawrence Foundation -- Grants for Environment.** The Lawrence Foundation makes grants to U.S. nonprofit organizations for projects in environment, education, and other themes. There is no restriction on the geographical area where grant activities can be implemented. Average grant size is over US\$10 thousand. The two deadlines for applications are 30 April and 01 November of each year. [Link](#)

**New Zealand Aid Program -- New Zealand Development Scholarships 2016.** New Zealand's government provides a variety of opportunities for training and university study through the New Zealand Aid Program, Ministry of Foreign Affairs and Trade. Scholarships are available to persons from the Pacific and some countries of Asia, Africa, Latin America and the Caribbean. The priorities for scholarship support include agriculture, renewable energy, fisheries, disaster risk management and other areas related to natural resources and environment. The period for online applications is 01 February through 30 April 2016. Note: Applicants in countries eligible to submit paper applications have a deadline of 15 April. [Link](#)

**Suez Environnement -- Fonds Suez Environnement Initiatives.** The Fund makes grants and provides technical skills for projects in water, sanitation, waste water treatment and waste management in developing countries. Eligibility for grants extends to solidarity organizations and institutions in all countries. The deadlines for applications (*French, English*) are 30 April and 31 October of each year. [Link](#)

## May

**Amphibian Ark -- Seed Grants 2016.** Amphibian Ark offers the AArk Seed Grant of US\$5 thousand in support of *ex situ* conservation of globally endangered

amphibian species. The grant is intended for start-up rescue projects that need seed money in order to attract larger funding. Projects should work with species in their range countries, involve range-country biologists, conform to biosecurity standards and observe other guidelines explained on the website. The application deadline is 01 May 2016. [Link](#)

## June 2016

**Riverbanks Zoo and Garden -- Conservation Support Fund.** The Riverbanks Zoo and Garden (USA) makes grants for field conservation; habitat management; conservation education; *ex situ* captive breeding; animal health and welfare; and other themes in wildlife research and conservation. Grants generally range from US\$1 thousand to US\$5 thousand. The application deadlines are 01 June and 01 December. [Link](#)

**BBVA Foundation -- Awards in Frontiers of Knowledge, Nominations 2016.** The BBVA Foundation annually makes awards to recognize innovative and fundamental advances in science, culture, and collaboration. Thematic areas include ecology and conservation biology; climate change; and development cooperation (*among others*). In each prize category, BBVA awards €400 thousand plus a diploma and a commemorative artwork. The awards are open to individuals and organizations of any nationality. The deadline for nominations is 30 June 2016. [Link](#)

**Gadfly Project -- Grants 2016.** Gadfly provides services and training in the developing world to develop new geographical information systems (GIS), web maps and geo-management practices. Gadfly offers in-kind grants to nonprofit organizations to develop custom web or mobile software. Eligibility to apply is open to any organization focused on improving the well-being of humanity and/or the natural environment. The closing date for proposals is 30 June 2016. [Link](#)

## 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.

As the ASG's newsletter members are encouraged to contribute to *FrogLog*'s content and direction. To aid in this process each edition of *FrogLog* focuses on one of four broad categories. The publication schedule is as follows:

- March—In The Wild
- June—In Captivity
- September—One Green Health
- December—Education & Communication

*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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### PUBLICATION

*FrogLog* is published online at: [www.amphibians.org](http://www.amphibians.org) and is Open Access.

### REVIEW

*FrogLog* is not a peer-reviewed publication and the onus for submitting accurate information remains with the authors.

### PRODUCTION EDITOR

Candace M. Hansen-Hendrikk: [cmhansen@amphibians.org](mailto:cmhansen@amphibians.org)

### EDITORIAL COMMITTEE

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Additional reviewers will be requested as required.

### SUBMISSION OF MANUSCRIPTS

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](mailto: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.

### AUTHOR DETAILS

Author details may be provided, including affiliations and contact details.

### FIGURES

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.

### TABLES

Tables may be included within the text file and should be numbered and include brief, precise legends.

### CITATION OF LITERATURE

*FrogLog* uses a numbering system for references and notes. This allows explanatory or more detailed notes to be included with the references. Journal names are abbreviated using common abbreviations to save space.

#### 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* (Cambridge Univ. Press, Cambridge, UK, 2010).

#### Technical reports

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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# Coming up in *FrogLog* 118

Strengthening Captive Breeding Efforts  
Towards More Effective Reintroductions  
Raising the Importance of Taxonomy  
Grants  
Recent Publications  
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June 2016

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