

Promoting Conservation, Research And Education For The World's Amphibians

FrogLog



The new ASG Telmatobius Task Force, for the conservation of threatened high-Andean species



Telmatobius rubigo in habitat © Sebastian Bartonuevo

ASG NEWS

IUCN Status review
for 46 Malagasy EDGE
Amphibian Species

CONTRIBUTED ARTICLES

Successful conservation
actions for the agile frog
in Italy

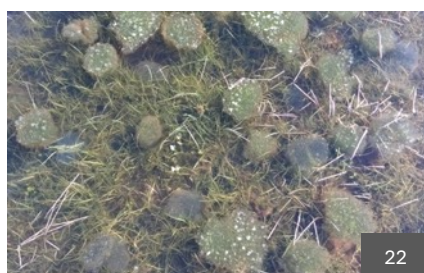
ASG WEBINAR ABSTRACTS

Developing genomic
approaches for increasing
amphibian resilience

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FrogLog is produced by the IUCN SSC Amphibian Specialist Group (ASG) to serve as the amphibian conservation community's news publication.

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Dear Readers,

Thank you for all the support that was given to our reestablishment of FrogLog at the end of last year, as a key resource where the amphibian conservation community can share their work, updates and progress. We have been thrilled to receive submissions for this issue on an array of subjects, ranging from field surveys, captive management, and education and awareness-raising - all necessary components in addressing the amphibian crisis. We have also expanded the FrogLog team, welcoming Franco Andreone to the Editorial Board as well as Sumbul Gill, Sandeep Das and Kirsty Kyle to the team. We are very happy to have a guest editorial for this issue from Claude Gascon, one of the earliest ASG Chairs, so we'll hand over to Claude for his thoughts.



Amaël Borzée, Sally Wren and Franco Andreone
FrogLog Editorial Board

Protecting amphibians: a global imperative

Amphibians are disappearing. Frogs, toads, salamanders, and caecilians—some of Earth's most ancient and fascinating creatures—are vanishing at an alarming rate. More than 40% of amphibian species are currently threatened with extinction, according to the International Union for Conservation of Nature (IUCN). From shrinking wetlands and deforestation to pollution, invasive species, and the deadly chytrid fungus, amphibians are facing a perfect storm of environmental threats. And yet, despite their peril, amphibians hold a vital place in our ecosystems—and they may also hold the key to understanding the health of the planet.

Often called the “canaries in the coal mine,” amphibians are sensitive indicators of environmental change. Their semi-permeable skin makes them particularly vulnerable to toxins, diseases, and climate shifts, meaning their declines often signal deeper problems in the ecosystems we all share. When amphibians start disappearing, it's a clear warning: something is wrong.

But here's the hopeful truth—amphibians can recover. With the right protection, conservation strategies, and scientific knowledge, populations can rebound. This is where global coordination becomes essential, and where the Amphibian Specialist Group (ASG) of the IUCN plays a central role.

The ASG is a global network of scientists, conservationists, and experts united by one mission: to conserve amphibians and their habitats. By developing species assessments, guiding national and regional conservation strategies, and providing up-to-date scientific data, the ASG ensures that amphibian conservation is strategic, science-based, and effective. Their work is foundational to our global understanding

of amphibian threats and to the implementation of actions that can halt—or even reverse—their declines.

But science alone isn't enough. What makes the ASG uniquely powerful is its emphasis on collaboration and communication. Amphibian conservation depends on the sharing of information, successes, failures, and evolving research. No single institution or country can address this crisis alone. Scientists in Costa Rica, field biologists in Madagascar, and conservationists in Australia must all be part of the same conversation. That's why building and maintaining a strong international network of amphibian experts is just as important as field surveys and lab work. Publications like FROGLOG—the ASG's official newsletter—are vital tools in this effort. More than just a journal, FROGLOG is a platform for dialogue and connection. It allows conservationists to share new discoveries, highlight urgent conservation needs, celebrate success stories, and learn from one another. Through FROGLOG, researchers and practitioners stay informed, inspired, and united.

As we confront global biodiversity loss and the accelerating impacts of climate change, the plight of amphibians must not be overlooked. Protecting them is not only a moral obligation, it's also a smart investment in the health of our ecosystems. Amphibians control insect populations, serve as food for other animals, and contribute to nutrient cycling. Their loss would ripple through entire ecological communities.

We still have time to act. Through science, cooperation, and a commitment to long-term conservation, we can change the trajectory for amphibians. We can support the work of the ASG, amplify the voices in FROGLOG, and advocate for stronger protections for amphibian habitats around the world.

Amphibians are among the oldest vertebrates on Earth, having survived mass extinctions and dramatic climate shifts for hundreds of millions of years. Their continued survival now depends on us. Let's ensure that these remarkable creatures remain part of our planet's future—not just as survivors of the past.

Claude Gascon



ASG News

Update on the Third Global Amphibian Assessment (GAA3): 2024 to April 2025

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The GAA3 is well underway, having been officially launched at the beginning of 2024. After careful consideration of past successes and challenges, there has been a shift away from the previous centralised implementation model, which was led by the Amphibian Red List Authority (ARLA) team, to a model where regional partners lead the work. The ARLA is now providing support to develop and implement regional plans for the GAA3 alongside ASG Regional Chairs and ARLA Regional coordinators. ARLA will support each region by providing training in IUCN Red List categories and criteria, GAA project management, the Species Information System

(SIS) database and GIS mapping, as well as technical assistance with maintaining species lists, fundraising and grant writing, among others.

Another key component of the new strategy is more regular GAA updates through an alternating five year assessment cycle which focuses on assessing threatened species (those categorised as Critically Endangered, Endangered and Vulnerable) during one five-year cycle, and completing assessments for all species in a region during the alternating comprehensive cycle. This will ensure that threatened species assessments remain as up to date and relevant to conservation planning as possible, while also reducing some of the workload associated with assessing non-threatened species. Most of 2024 was spent introducing this new strategy to the ARLA network and, so far, it has been embraced with enthusiasm as it gives regions much greater control over the process, and plans for most regions are now underway. As of April 2025, North America, north Asia, north Africa, the Caribbean, and a few countries in South America are yet to begin, although discussions in for many of these are planned in the near future.

To date, nine formalised regional partnerships have been established to support GAA implementation with various museums, universities and other institutions

Regional Partnerships



Southern Africa



Chile



Brazil



Seychelles



Bangladesh



Nepal



Guatemala

Figure 1: ARLA Regional Partnerships for GAA3.

from seven different countries (Figure 1), with another eight to ten pending finalisations. GAA training has already been provided for teams in East Africa, Southern Africa and Madagascar, and there are plans to run more GAA training workshops this year for Indonesia, Sri Lanka and the Philippines, as well as for regions in Mesoamerica and South America soon — either in English or in Spanish. Please reach out to the ARLA team if you are interested in participating in a GAA training course this year.

Multiple expert review workshops have also taken place in Africa. In 2024, there was a workshop on southern African amphibians held in South Africa, and another in Tanzania focusing on 27 EDGE species endemic to the Eastern Arc mountains. In January 2025, a combined Red List, Green Status and Conservation Needs Assessment workshop was held in the Seychelles to assess the status of their amphibians (and squamate reptiles) and involved many scientists, individuals from conservation

NGOs and environmental government staff. Another workshop was held in Madagascar to assess 46 endemic EDGE species, see article on page 8. Assessments from these workshops are currently being finalised and reviewed, and they will be submitted for the second IUCN Red List update later this year - representing the first completed assessments for GAA3.

With a lot of the ARLA network now in the process of planning their work for this assessment cycle, we welcome anyone interested in becoming involved in the GAA3 to reach out to the relevant ASG Regional Chairs/ARLA Regional coordinators. The current ARLA Regional coordinators are listed on the ASG website: <https://www.iucn-amphibians.org/arla-regional-partnership/>. We are also looking forward to keeping everyone updated on GAA progress via these updates in the bi-yearly issues of Froglog.

Background and mission of the ASG

The IUCN SSC Amphibian Specialist Group (ASG) is part of the International Union for Conservation of Nature's (IUCN) Species Survival Commission (SSC). ASG is a global volunteer network of dedicated experts who donate their time and expertise to create a community from where practical amphibian conservation can be advanced based on a solid foundation of science. This network currently consists of over 390 members in over 40 regions around the Earth, enabling the ASG to act on a global scale.

The Amphibian Specialist Group provides the scientific foundation to inform effective amphibian conservation action around the world, working towards our mission of “*amphibians thriving in nature*”. More specifically, the ASG stimulates, develops and conducts scientific research to inform the conservation of amphibians and their habitats around the world, supports the assessment of the conservation status of amphibian biodiversity, and communicates evidenced-based information about amphibian conservation-related issues and priorities. This is attained by supporting and mobilising a global network of members to develop capacity, improve coordination and integration to achieve shared, strategic amphibian conservation goals.

Telmatobius Task Force established, uniting forces to conserve one of the world's most unique and highly threatened genera

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Worldwide, there are currently 8,877 amphibian species (1). This group of animals makes crucial contributions to the natural environment, but approximately 41% of these species are at risk of extinction, making amphibians the most threatened vertebrate group. Nearly half of the world's amphibians are found in the Neotropics and the region concentrates 60% of the world's threatened amphibians (2). This situation requires urgent and coordinated conservation actions by the scientific community and other stakeholders.

With 60 recognised species, the *Telmatobius* genus is distributed throughout the Andean and Sub-Andean mountains from Ecuador, through Peru and Bolivia, to central Argentina and northern Chile (3; Figure 1). These fantastic high-Andean amphibians are adapted to extreme aquatic ecosystems ranging from highlands, deserts and valleys to mountain forests. Their aquatic and semi-aquatic lifestyle, behaviour and morphology make them truly unique. The only genus within the family Telmatobatiidae, these highly threatened



Figure 1: *Telmatobius* distribution map in the world. Map: Sebastián Barrionuevo.

amphibians are classified as EDGE species – those that are both Evolutionarily Distinct and at high risk of extinction (4).

Several species of the *Telmatobius* genus are considered culturally significant. The Titicaca Lake water frog (*Telmatobius culeus*) inhabits the highest navigable lake in the world (Figure 2). The Sehuenas water frog (*T. yuracare*) and the Loa water frog (*T. halli*, formerly *T. dankoi*; Figure 3) are attracting media attention. Their stories and their critical situation have mobilised conservationists around the world. Additionally, the Andes smooth frog (*Telmatobius macrostomus*), is considered the largest aquatic frog in the world (Figure 4). The high-Andean frogs have a deep cultural significance among the Andean people. They are considered by Andean culture to be fertility and abundance symbols, and a Mother Earth (Pachamama) representation.

All *Telmatobius* species are facing direct and indirect threats. Habitat loss, pollution, emerging diseases, ille-

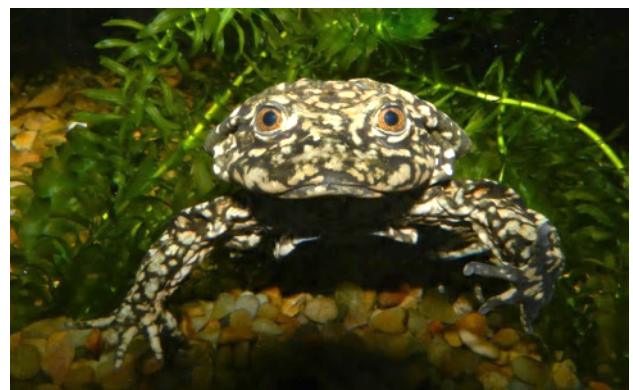


Figure 2: *Telmatobius culeus*. Endangered (EN). Adult in captive breeding. Photo: Patricia Mendoza-Miranda.



Figure 3: *Telmatobius halli*. The Loa water frog in habitat. Chile.
Photo: Gabriel Lobos.

gal wildlife trafficking, invasive species, and climate change are some of those threats. Current conservation actions are insufficient to protect all *Telmatobius* species and to slow down the rate at which species and populations are disappearing. In the second Global Amphibian Assessment published on the IUCN Red List of Threatened Species, of the 59 *Telmatobius* species assessed 51 are considered threatened (21 Critically Endangered, 21 Endangered, 9 Vulnerable), two are Near Threatened and another six have too little data to be categorised and are listed as Data Deficient. With 96% of non-Data Deficient species threatened, *Telmatobius* is the third on the global list of "Highly Threatened Genera", in the State of the World's Amphibians report (2).

To effectively address the threats facing these amphibians, a long-term, large-scale, multi-institutional collaboration is essential. Bringing together academics, non-governmental organisations, government agencies, and donors is vital to effectively manage resources and expertise and implement conservation actions. Local organisations and communities, with their unique understanding of regional dynamics, will play a crucial role identifying and implementing practical solutions on the ground.

Therefore, there is a clear need to unite ideas, skills, and forces, and above all, to encourage the development of greater conservation actions that can improve communication between countries and institutions working with *Telmatobius*. The aim of the Symposium "High-Andean Amphibians: Conservation Status of the Amphibians of the *Telmatobius* Genus and Conservation Actions" developed during the XII Latin American Congress of Herpetology in Cochabamba-Bolivia 2023 was, in the first instance, to bring together scientists,



Figure 4: *Telmatobius macrostomus*. Endangered (EN), Perú.
Photo: Roberto Elias.

naturalists and managers who work or are in some way involved in the conservation of *Telmatobius* species to form a single conservation front.

Step by step, a group was formed and worked toward that goal, until the IUCN SSC Amphibian Specialist Group *Telmatobius* Task Force was established. The objective of the *Telmatobius* Task Force is to integrate all those interested in the conservation of the genus. Together we can carry out conservation actions that allow us to understand, contribute, and minimise the threats affecting the *Telmatobius* species. At this initial stage, the group is composed of representatives from the genus range countries. As we move forward, we expect all those interested in the genus will also join the Task Force.

As a starting point we are organising our first workshop, where the Red List assessments for the genus *Telmatobius* will be reviewed and a "Conservation Action Plan for the Genus *Telmatobius*" will be developed. This workshop is the beginning of a coordinated effort, aimed at increasing conservation actions for this highly threatened genus, and safeguarding these species for generations to come.

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Figure 1: Participants at the review workshop in Andasibe, Madagascar. Photo: Miaro ny Sahona (MISA).

Review of the IUCN Status of 46 EDGE amphibian species in Madagascar

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The Regional Group for Madagascar of the IUCN SSC Amphibian Specialist (ASG-Madagascar) and the Miaro Ny Sahona Association (MISA), a non-governmental

organisation based in Madagascar that contributes to the implementation of ASG-Madagascar's activities on the ground, thanks to the support of a SSC EDGE Internal Grant, have reviewed the IUCN Red List of Threatened species' status of 46 Malagasy amphibian species listed on the EDGE (Evolutionarily Distinct and Globally Endangered) list (Figure 1).

During the Second Global Amphibian Assessment (GAA2) conducted by the Amphibian Red List Authority (ARLA; 1), a total of 311 endemic amphibian species were assessed for Madagascar. Since the end of GAA2, many new species have been formally described, and data for the distribution of several species has become available (2,3). Of the 46 EDGE species analysed in this project, 34 were recently described species that had not been assessed for the IUCN Red List of Threatened Species, while the remaining 12 species were assessed during GAA2 but needed updating.

The project had two main aims: 1) increase capacity in-country for IUCN Red Listing, and specifically knowledge of the categories and criteria and methods

of evaluation, and 2) complete the assessment and reassessment of the 46 EDGE Malagasy amphibians. The implementation of this project was carried out in two stages, via an online training on IUCN Red Listing, delivered by the Amphibian Red List Authority through a 9-hour course, and through a workshop to assess and review the IUCN status of the 46 Malagasy amphibian species included on the EDGE list (Figure 2).

The online training was delivered over three consecutive half-days, on 18-20 March 2024 and was attended by 22 participants. Among these, there were several young Malagasy students, herpetologists and some conservation professionals, as well as students and members of ASG-Madagascar from abroad, who also work in Malagasy amphibian conservation.



Figure 2: Amphibian Specialist Group Madagascar (ASG-Madagascar) Co-Chair Angelica Crottini and Miaro ny Sahona (MISA) Project Coordinator Dina Lydie Ramamonjisoa. Photo: Fandresena Rakotoarimalala.

The review workshop took place on 19-24 January 2025 in Andasibe (East Madagascar). The SSC EDGE Internal Grant supported the involvement of 14 participants. Attendance was open to everyone who had attended the online training in person, in addition to the ASG-Madagascar Co-chair Angelica Crottini who had coordinated the meeting, and one participant from abroad. This participant was selected through a lucky draw among the participants of the online training who had expressed their interest in taking part in the in-person review meeting.

Participants were distributed in four groups, and all contributed to compiling the information for the assessment/reassessment (Figure 3). During the meeting,



Figure 3: Participants working in groups. Photo: Fandresena Rakotoarimalala.

all the information needed to complete the new assessments and to update the previous assessments of the 46 species of Malagasy EDGE amphibians was compiled. As a result, all participants were able to consolidate their training in IUCN Red Listing, its categories and criteria, and methods of evaluation. The new information obtained during the workshop was then added to the SIS system, and it is currently being reviewed for publication on the IUCN website.

In total, this project resulted in 34 new assessments and 12 reassessments for the global IUCN Red List of Threatened Species. It has also strengthened the capacity of researchers and students in Madagascar to implement the Third Global Amphibian Assessment (GAA3), and consolidated links between the stakeholders involved in amphibian conservation in Madagascar.

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John Measey's life contributions to invasive species science

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John Measey was a real character as an invasion scientist, as a herpetologist, as an ecologist and as an unforgettable human being. John was a very enthusiastic and productive scientist with over 260 papers and more than 10,000 citations.

John was a core team member of the Centre for Invasion Biology (CIB) at the Department of Botany and Zoology at Stellenbosch University and huge asset to this renowned centre, bringing in insightful thought and investigations to the animal side of invasion biology in South Africa and the many countries touched by the CIB network. Recently he was based at the Institute for Biodiversity at Yunnan University in Kunming. He was also an Honorary Attaché of the Muséum national d'Histoire naturelle de Paris.

John was the global expert on invasions of the common platanna (or African clawed frog) and collaborated in many countries around the globe. It was this global view that gave him great perspective on invasive species effects on threatened species, for example the direct impact of the abundant and Least Concern common platanna on the Endangered Cape platanna. He was a keen conservationist at heart and made many valuable contributions to improving conservation science and supporting research within conservation agencies. He was a regional chair for the IUCN SSC Amphibian Specialist Group until 2020 and made major contributions to the Red Listing assessments of African



Figure 1: John Measey and Patrick Malonza during a break at the 16th Conference of the Herpetological Association of Africa in Wilderness, South Africa.

amphibians and reptiles and was one of the few caecilian experts.

Biological invasions are a challenging topic with many ecological and contextual complexities. But the indomitable John Measey tackled these complexities with vigour and delved into the underlying drivers and characteristics of invasive species and their ecosystems. Part of his sharp insight derived from his great evolutionary understanding so he could always see species in their evolved ecological contexts. And this scope extended from the macroscale of evolutionary and landscape processes to the microscale investigating the role of the gut microbiome, work which he was still actively pursuing amongst his many other valuable research interests. He was also a great, if demanding, supervisor and mentor to his many students who have written many heart-warming accounts of their interactions with him. His enquiring mind and endless willingness to take on scientific research, his off-beat humour, flamboyant shirts and reading glasses will be sorely missed.

Preserving the living legacy of Andy Charrier

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With great sadness we learned of the passing of our colleague and friend Andrés “Andy” Charrier (1971-2025). Andy was a renowned herpetologist, superb wildlife photographer, author of dozens of scientific articles and books, leader of pioneering conservation initiatives, but also a charismatic communicator and an enthusiastic creator of naturalist literature for children. A truly complete conservationist, one that is rarely seen, who not only understood the science but also acted on it with dedication, love and generosity. He was an innate source of inspiration—a spark ignited in countless local actors throughout Chile, awakening in them the courage to explore, monitor, write, and share the wonders of biodiversity. His encouragement planted seeds that continue to grow today in forests, wetlands, and the hearts of many people. Despite the difficulties he had to live with since childhood, he was a tireless explorer and nature was his home. Surprisingly, Andy was

not biologist but in his own words: “a lost anthropologist”, and luckily so; he had a different perspective for the issues facing biodiversity and tools that we biologists lack. He many times said: “we need interlocutors in society capable of building bridges between science, which is confined to universities, and the community”.

His first experience with wildlife conservation was in the mid-1980s handling birds of prey, work that led to the creation of the first raptor rehabilitation centre in Chile (CRAR) in 1991. In 2001, he started working as a field researcher and museum assistant at Pontificia Universidad Católica de Chile. Andy was an always enthusiastic and highly motivated field researcher working with wild rodents and sampling the most diverse ecosystems along Chile, but it was in 2002 while kayaking in the fjord of Cahuelmó (south Chile) when he saw his first pregnant male Darwin’s frog. He always said: “the frog found me”; that was a life-change experience. Since then, he became one of the most important amphibian conservationists in Chile and the region. In 2008 he organised the International Symposium on Global Amphibian Decline: the case of the Darwin’s frog, an initiative that provided crucial momentum for advancing both research and conservation efforts on Darwin’s frog, planting the seed for great achievements such as two ex situ breeding centres, different in situ conservation programmes, an explosive increase in scientific articles, culminating with the launch of the Bi-national Strategy for the Conservation of Darwin’s frogs (1). Since 2010, he was a founder member of the Chilean Herpetology Network, where he acted as vice-president (2015-2018). In 2013, he was among the authors of the seminal book “Amphibians of Chile, a challenge for conservation” (2). From 2014 until this day, he led the long-term monitoring of the high Andes spiny-chest frogs *Alsodes tumultuosus* and *A. montanus* (3). Also, in 2014, he was co-founder member of the Chilean Bulletin of Herpetology. In 2015 he became member of the IUCN Amphibian Specialist Group, the same year in which he with other colleagues described a new amphibian species, the Cantillana spiny-chest frog (*A. cantillanensis*) (4). Later, in 2017, he published his first illustrated book for children, “Natural history of forest animals” (5) as a prelude to a prolific career as a biodiversity communicator, including his books “Water and Land” (6) and “Croaks” (7). In 2019, he published the “Field guide for the forests and Patagonian amphibians of south-central Chile” (8). More recently, one of the things Andy will be most remembered for is his leading role of the Loa water frog (*Telmatobius dankoi*, now *T. halli*) rescue in 2019, saving this population from

imminent extinction (9, 10). For the last 4 years Andy was working along with other authors in the most complete book on Chilean amphibians, and now an important part of the book is written.

Andy's influence in raising awareness of biodiversity, especially for amphibians, is incalculable. His work will inspire new herpetologists and conservationists in Chile and elsewhere. We celebrate his life, and we are committed to continue his work as a living legacy for future generations.



Figure 1: Andy Charrier during fieldwork at Pumalín Douglas Tompkins National Park, Patagonia, Chile. This is one of his last photographs. Note the frog that forms from Andy's breath. Photo: Kurt Ruiz.

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Contributed Articles

Fundacion AMITIGRA: efforts for the conservation of amphibian in the Parque Nacional La Tigra of Honduras.

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Parque Nacional La Tigra was the first national park established in Honduras, created in 1980 through Decree No. 976-80. However, historically, the importance of the area dates to the 1920s, when its hydrological importance was recognised for supplying water to the city of Tegucigalpa and its surrounding communities. Prior to its designation as a protected area, the region was subject to intense mining activities, particularly around El Rosario, including the El Rosario mine itself, which resulted in severe deforestation. This environmental degradation prompted the government to adopt protective measures to safeguard the cloud forest and secure a stable water supply (1).

Initial steps toward conservation began in 1952, and its official status as a national park was consolidated in 1980. Since then, management of the park has been overseen by the Fundacion AMITIGRA, a non-profit organisation responsible for enforcing regulations that restrict human activity within the Core Zone and limit use within the Buffer Zone, thereby promoting biodiversity conservation. The park covers an area of 24,040 hectares and includes four primary forest formations: Premontane Dry Forest, Premontane Wet Forest, Lower Montane Wet Forest, and Lower Montane Moist Forest (2).

Over the past decade, several field visits have been conducted non-systematically, focusing primarily on the visitor centre area in the locality of Jutiapa and Las Golondrinas locality in the municipality of Valle de Ángeles. Other locations have also been visited, such as Cerro La Estrella, the highest point in the park. These efforts are aimed at documenting endemic species or identifying potentially undescribed taxa. So far, 20 amphibian species been recorded through voucher specimens: two salamanders, four bufonids, one *Craugastor* species, six hylids, three leptodactylids, one microhylid, and three ranids (3,4).

Despite these efforts, the park appears to host a seemingly depauperate herpetofauna. According to Wilson (3), no concerted attempt has yet been made to survey this taxonomic group. This is both intriguing and unusual, given the park's proximity to the Honduran capital. Nonetheless, the scarcity of amphibians known from La Tigra likely reflects the broader lack of documentation for this taxon in the Southeastern Highlands, the ecoregion in which the park is situated (3).

The need for systematic studies was noted decades ago. Carr (5) observed that, despite the lush vegetation, fauna was difficult to detect, suggesting that many species are likely present but go unnoticed without proper sampling techniques. He also indicated that the apparent low visibility of fauna may be due to insufficient



Figure 1: Emlen rain frog (*Craugastor emleni*) species evaluated as Endangered B1ab(iii) (EN) according to IUCN. Photo: José Mario Solís.

observation methods rather than true scarcity, thereby emphasizing the need for systematic biological surveys. Some species have only been observed at highly specific locations within the park. For instance, *Craugastor emleni* (Figure 1) has only been recorded at Las Golondrinas (Figure 2; 6); *Lithobates lenca* is known only from



Figure 2: View of mining remnants in the lower montane wet forest of Las Golondrinas, a locality within the municipality of Valle de Ángeles, known as a *Craugastor emleni* observation site. Photo: José Mario Solís



Figure 3: Toad: *Incilius porteri* observed in the park at Jutiapa visitor centre. The species is evaluated as Least Concern (LC) according to IUCN. Photo: Jorge Luis Murillo

Las Caballerizas; *Plectrohyla guatemalensis* has only been seen in a stream near the visitor centre, and *Incilius porteri* (Figure 3) has been observed only along the roadside leading to the Jutiapa visitor centre. These cases reflect very “restricted distributions”, highlighting the need for more extensive and focused research to determine their full range.

To address these gaps associated with historical deforestation due to mining and forestry activities, systematic methodologies are now being developed to document the amphibian diversity. These include altitudinal and transversal transects across their different forest formations. Through this effort, Fundación AMITIGRA seeks to strengthen biological monitoring, support research on key species, and implement conservation actions that preserve the ecological integrity of the cloud forest and its associated ecosystems in the Buffer Zone. Parque Nacional La Tigra not only harbours an invaluable biodiversity, but also serves as a sentinel ecosystem, indicating the broader environmental health of Honduras’s highland regions.

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Successful breeding and care of Yule Island tree frogs (*Litoria congenita*) at Port Moresby Nature Park

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Introduction

Port Moresby Nature Park in Papua New Guinea has undertaken a pioneering effort to conserve the country's unique amphibian diversity, including the elusive Yule Island tree frog (*Litoria congenita*). This initiative is a proactive response to global amphibian declines driven by threats like chytrid fungus (*Batrachochytrium dendrobatidis*), climate change, and habitat destruction. By focusing on ex situ conservation and research, the Park aims to secure populations of at-risk species and equip herpetology staff with the necessary skills to care for and breed these frogs.

Since 2013, Port Moresby Nature Park and Zoos Victoria have maintained a sister zoo partnership that fosters collaboration through knowledge exchange, capacity building, and conservation initiatives (1). One of the key projects under this partnership focuses on frog conservation, with efforts aimed at enhancing husbandry and breeding techniques for Papua New Guinea's native amphibians. Through this collaboration, Zoos Victoria has provided ongoing technical support and guidance that have significantly contributed to the improved care and breeding success of species such as the Yule Island tree frog at Port Moresby Nature Park. This article details the challenges, successes, and ongoing efforts surrounding the breeding and care of *L. congenita*, with the hope of continuing with this on-going conservation and research program and inspiring similar conservation initiatives worldwide.

Purpose of the conservation project

The primary goal of this initiative is to safeguard Papua New Guinea's amphibian species from chytrid fungus, a devastating pathogen yet to reach the nation's shores (2). Additionally, the project addresses the broader

threats of climate change and habitat degradation that imperil amphibian populations. The first phase of the program focused on husbandry and breeding of more common species, such as the common green tree frog (*Litoria caerulea*), providing invaluable knowledge for future work with endemic species like *L. congenita* and wood frog (*Papurana daemeli*), with the future aim of working with conservation dependent species of amphibian endemic to Papua New Guinea. A key milestone was achieved in 2024 with the successful breeding of an F1 generation of *L. caerulea*, underscoring the effectiveness of the Park's techniques and expertise.

The Yule Island tree frog: An overview

The Yule Island tree frog belongs to the family Pelodytidae and is native to the southern New Guinea mainland and Yule Island in Central Province, approximately 160 km northwest of Port Moresby. The species is currently listed as Least Concern on the IUCN Red List of Threatened Species (3). Its preferred habitats include moist savannah, intermittent freshwater marshes, rural gardens, and degraded forests (4). Adults cared for in captivity typically measure 30–41 mm in snout-vent length and weigh 3–5 grams. These small brown tree frogs (Figure 1) are often observed perched on vegetation, displaying a slender morphology, snout rounded-truncate, dorsum brown or, more usually with one, two or three yellowish stripes with light ventral shading, and elongated limbs adapted for climbing.

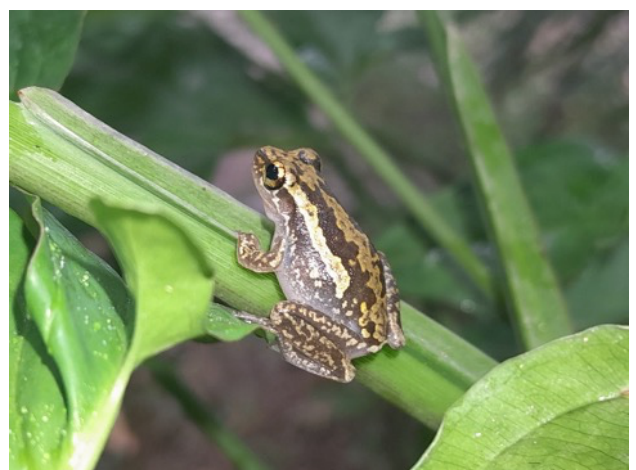


Figure 1: A *Litoria congenita* in the breeding vivarium. Photo: Francis Gundu - Port Moresby Nature Park.

Challenges in breeding *L. congenita*

Since 2021, the Nature Park has faced significant challenges in breeding *L. congenita*. Limited knowledge



Figure 2: A male *Litoria congenita* with a visible vocal sac. The image was taken during mating calls in the breeding vivarium on 24 August 2024. The vocal sac, seen as loose skin under the male's neck, is absent in females and is currently used as the primary feature for sexing this species. Photo: Francis Gundu - Port Moresby Nature Park.

about this species meant that an experimental approach was required. The Park initially acquired 38 wild individuals over 4 years, with 28 individuals surviving. Mortality was due to various stressors and the delicate nature of the species. In captivity, sexing individuals proved difficult as vocal sacs in males were not visibly distinct, complicating efforts to establish breeding pairs

(Figure 2). Additionally, maintaining an optimal habitat required fine-tuning over several years, with earlier attempts at breeding proving unsuccessful.

Innovative habitat design

Significant improvements were made to the frogs' on-display breeding vivarium in 2024 (Figure 3), which likely contributed to the success of the recent breeding event. The breeding enclosure, measuring 100 x 60 x 90 cm, includes a water filtering and misting system, eco-friendly lighting to support live plants and UV requirements, and a naturalistic landscape to mimic their wild habitat. Specific modifications included:

- *Water Features:* Reducing the overflow depth from 10 cm to 5 cm and installing a rain chamber.
- *Structural Enhancements:* Adding bamboo segments with water-retaining holes.
- *Floral Additions:* Incorporating bromeliads to replicate banana leaf sheaths, which are natural nesting sites on-site at Port Moresby Nature Park.

These changes created an environment conducive to breeding while also serving as an educational exhibit for visitors (Figure 3 A and B).

Feeding and care regimen

The frogs were provided with a diverse diet of gut-loaded or calcium-dusted insects to ensure optimal

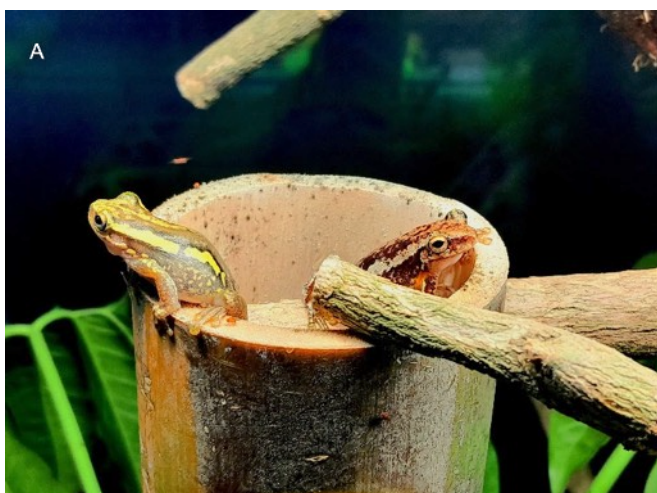


Figure 3: (A) Adult *L. congenita* using bamboo stems. (B) Breeding vivarium, back view. Photos: Francis Gundu - Port Moresby Nature Park.

nutrition. Their diet included fruit flies (*Drosophila melanogaster*), grasshopper nymphs (*Valanga irregularis* and other available species), ground cockroach nymphs (*Pycnoscelus surinamensis*), mini mealworms (*Tenebrio molitor*), and cricket nymphs (*Acheta domesticus*). Feeding was conducted three times per week to maintain their health and support their breeding potential.

Breakthrough in breeding success

After four years, a major breakthrough occurred in December 2024. As the rainy season commenced, the breeding vivarium's misting system was operated continuously but at an adjustable speed, simulating natural rainfall. Observations on 13 September and early December 2024 indicated amplexus (Figure 4). On the night of 15 December 2024, breeding took place, and eggs were laid across various locations within the vivarium's pond.

Tadpole development

The eggs, though not directly observed, hatched into tadpoles, visible on 16 December approximately 12 hours after spawning (Figure 5). The tadpoles were found attached to yolk sacs in various locations in the pond, including glass walls, plant leaves, and rocks. The tiny tadpoles were observed to be 1 mm in body length. Measurements taken five days post-hatching revealed tadpoles averaging 0.15 g in weight and 11 mm in snout-tail length. This marked a significant achievement for the Nature Park, validating years of dedicated



Figure 4: Amplexus of *Litoria congenita*. Photo: Francis Gundu - Port Moresby Nature Park.



Figure 5: Few hours old tadpoles of *Litoria congenita* in the pond of the breeding vivarium. At this stage the tadpoles were observed to be less than 1 mm in body length. Photo: Francis Gundu - Port Moresby Nature Park.

effort and experimentation with a little-known endemic species of frog.

Future directions

The successful breeding of *L. congenita* marks a new chapter for the Port Moresby Nature Park. The current focus is on raising tadpoles into froglets, ensuring their survival through meticulous care and monitoring.

These advancements not only strengthen local expertise but also provide a template for similar conservation efforts worldwide. By continuing to refine husbandry techniques and expand public awareness, the Park contributes to the broader mission of amphibian conservation in Papua New Guinea; using the species as a proxy to later develop populations of species which are conservation dependent or particularly susceptible to the chytrid fungus.

Conclusion

The breeding of *L. congenita* at Port Moresby Nature Park demonstrates the potential for ex situ conservation programs in safe-guarding endemic amphibian species in Papua New Guinea. Through persistent efforts, habitat research and development, and adaptive management, the Park has achieved a milestone in amphibian conservation, offering hope for the future of Papua New Guinea's unique amphibian biodiversity.

Acknowledgements and collaboration

This achievement was made possible through the dedication of the herpetology team at PMNP and the support of various partners, including: Zoos Victoria,

Amphibian Ark, IUCN SSC Amphibian Specialist Group and The Conservation and Environment Protection Authority of Papua New Guinea (CEPA).

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Unravelling a harlequin toad (*Atelopus*) species complex from Amazonia - how threatened are the particular species?

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Harlequin toads, genus *Atelopus*, are a species-rich lineage of New World bufonids. More than 100 species are recognised from tropical humid lowland and montane environments across 11 countries in Central and South America. In view of the ongoing global amphibian declines (1), *Atelopus* have become the sad face of this extinction crisis. Since the late 1980s, most species have faced dramatic population declines. The main reasons include habitat destruction or alteration, and the spread of the amphibian chytrid fungus *Bd* (2). Of the 97 *Atelopus* species assessed for The IUCN Red List of Threatened Species (3), most are threatened with extinction (Critically Endangered 66, Endangered 11, Vulnerable 1) and 3 are even Extinct. In contrast, only a small fraction is considered Near Threatened (2 species) or Least Concern (5 species), while for 9 species we lack information (Data Deficient).

Many *Atelopus* species are microendemic or have highly restricted geographic distributions, particularly in the Andes, while others have much broader ranges, especially in lowland Amazonian regions. Taxonomic uncertainties—such as potential synonymies, cryptic species hidden under the same name, and several of undescribed (yet likely already threatened) species—have hindered the planning and implementation of effective conservation actions for the genus (2).

Moreover, until recently, harlequin toad research and conservation efforts were largely conducted in

isolation, with limited collaboration among researchers and conservationists across different countries. As a result, despite being one of the most threatened amphibian genera, *Atelopus* suffered from a lack of information sharing, coordinated efforts, funding, and concrete on-the-ground conservation actions. Recognising the urgency of the situation, the *Atelopus* Survival Initiative (ASI) was established in 2021 as a collaborative, regionally coordinated effort to prevent the extinction of harlequin toads (4). True to its mission, ASI has become a central hub for fostering collaboration, increasing financial and technical investment, and advancing both in situ and ex situ conservation initiatives.

Thanks to data-sharing efforts among ASI's members across all range countries, a comprehensive conservation status update for the genus *Atelopus* was published in 2023 (2). Now, in 2024 and 2025, new collaborative studies—emerging from ASI's network—are shedding light on the taxonomy of the genus, resolving key issues that have long hindered the implementation of effective conservation strategies.

The studies (5,6) focused on one of the earliest described harlequin toads, *Atelopus spumarius* Cope, 1871 (Figure 1), from the Pebas area in the Río Ampiyacu drainage of Amazonian Peru. For many decades, the numerous populations of these striking colourful amphibians across the Amazon basin have been allocated to *A. spumarius*, suggesting a broad distribution in Colombia, Ecuador, Peru, Brazil, Guyana, Suriname and French Guiana. As a result of the enormous range, conservationists for many years considered *A. spumarius* as one of the few harlequin toads categorised as “Least Concern”. We (5,6) have demonstrated that actually *A. spumarius* belongs to a complex of cryptic species that all have relatively small, allopatric distributions in the upper Amazon basin (5,6). Three species, we described as new, *A. colomai*, *A. harlequin* and *A. histrionicus* (Figure 1B-D). As a consequence of the change in taxonomy, conservation status aspects need to be reconsidered. Here, we highlight and discuss the conservation status of the four species.

Atelopus spumarius sensu stricto: Most parts of the known geographic range are covered in undisturbed primary forest with few human (indigenous) settlements and traditional small-scale agriculture (chacras, slash and burn fields). However, deforestation and pollution are taking place in the immediate Pebas area, about 3 km NE of Pebas. Here, four individuals sampled August 2022 tested negative for *Bd*. Although not yet



Figure 1: From upper left to lower right: *Atelopus histrionicus*, *A. harlequin*, *A. colomai* and *A. spumarius sensu stricto*. Photo: J. Culebras, Photo Wildlife Tours, and (lower right) by C. Heine, Trier University.

formally published, the application of IUCN criteria suggests that this species, as redefined, should be classified as Endangered on the IUCN Red List, based on the species' restricted geographic range.

Atelopus colomai: The area around Puyo in Ecuador is experiencing high rates of deforestation from agriculture, especially sugar cane plantations, and associated road construction, and human settlements. The type locality experienced deforestation of remaining habitat in late 2022 but in early 2025 some forest still remained. Fieldwork in August 2023 and December 2024 revealed the presence of fewer individuals than in previous years in a remaining 10 m wide fragment of forest along one side of the stream. In the remaining four sites, we have witnessed continuing declines in the extent and quality of remaining habitat. Despite the presence of *Bd* with high prevalence and infection loads in *A. colomai* and syntopic anurans, no declines related to *Bd* have been

observed to date, similar to other lowland *Atelopus* species but different to highland species (7-9). Although not yet formally published, the application of IUCN criteria suggests that this species will be classified as Endangered on the IUCN Red List.

Atelopus harlequin: While the majority of this species' range is covered in undisturbed primary forest with few human settlements, the populations on the easternmost edge of its distribution, along the Iquitos-Nauta road, are highly affected by habitat loss caused by large-scale logging, human settlements, agriculture and road construction. Populations in this area, including the type locality, persisted into the 2010s, but the species' presence could not be confirmed here in 2022, with almost no suitable habitat remaining. A few kilometres further westwards, one population has remained abundant in a forest fragment despite nearby deforestation. Most other subpopulations have not

been visited in more than 10 years, hampering a thorough assessment of the species' conservation status. Although not yet formally published, the application of IUCN criteria suggests that this species will be classified as Least Concern on the IUCN Red List.

Atelopus histrionicus: Human impact is currently affecting a relatively small portion of the known geographic range. Currently, at least two of the 11 known localities are affected by deforestation caused by small-scale logging, human settlements, agriculture and road construction. Although not yet formally published, the application of IUCN criteria suggests that this species will be classified as Least Concern on the IUCN Red List.

Overall, the Amazonian members of this remarkable genus are among the few that have remained so far. This is perhaps due to the reduced impact of *Bd*, although the mechanisms behind the coexistence with lowland *Atelopus* as hosts remain poorly understood (2). The ever-increasing anthropogenic pressure on their habitats, however, has started to drive these emblematic survivors closer towards extinction, as in the case of *A. colomai*. Future perspectives are uncertain given that climate change is predicted to change western Amazonian lowland environments more than most other Neotropical ecosystems (2). With reduced impact of *Bd*, there is still a chance to safeguard Amazonian harlequin toads. Protecting and restoring resilient lowland ecosystems, as well as the empowerment of local

communities to act as guardians of these colourful toads, will be key to achieve this goal.

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The unlikely success of monitoring and conservation actions on the agile frog (*Rana dalmatina*) population in the Castelli Romani Regional Park, Central Italy.

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In recent years, many conservation actions were found not to stop the apparently irreversible decline of many wildlife species in the world. It is as if the point of no return has been passed, however, a population of amphibians that seemed condemned to disappear was instead found in just three years to have its population size increased tenfold. This is the case of *Rana dalmatina*, a species listed as Least Concern but declining by the IUCN Red List of Species (1), and breeding in the large but temporary wetland 'Doganella' in one of the most important areas, from a naturalistic point of view, of the Castelli Romani Regional Park, in Lazio, Central Italy.

The Doganella site is located in the municipality of Rocca Priora, which together with the nearby Cerquone forest, is part of the Special Conservation Area ITA6030018 'Cerquone - Doganella', included in the European Natura 2000 Network. The Doganella wetland is located within a vast caldera depression along the Praton del Vivaro and occupies an alluvial plain located at about 570 m above sea level, with an area of about 2.5-3 hectares. Water level varies seasonally, until it disappears during late spring and summer. The plain is heavily grazed and the wetland is covered with semi-submerged and submerged aquatic vegetation, including knot grass (*Paspalum distichum*), the water buttercup (*Ranunculus tricophyllus*) and callitriche (*Callitriche* sp.).

In Doganella, since 2010, many environmentalist volunteer citizens and some herpetologists, aggregated in the Lazio Section of the Societas Herpetologica Italica

(SHI), have found a compact and structured synergy, discontinuously supported by the Park. All project members were appropriately trained to respect the health issues that can threaten amphibian populations, and all were authorised according to the current regulations of this Area of National Herpetological Importance (AREN) ITA056LAZ001.

Methods and results

The conservation program consisted of annual actions to save migrating individuals through two very busy roads during the breeding season, the Tuscolana Provincial Road and the Praton del Vivaro Provincial Road, with the installation of hundreds of meters of polyethylene barriers. In addition, the program also undertook annual actions to support metamorphosis by preventing egg masses and tadpoles from drying from the too rapid retreat of water and the increasingly long periods of drought. Finally, the program supported continuous scientific monitoring to determine the status of each amphibian species occurring at the site, and particularly for the agile frog (*Rana dalmatina*), a species in Annex IV of the Habitats Directive 92/43/EEC.

There are several long-term monitoring projects concerning important amphibian species in Italy, but the one on the agile frog population of Doganella has allowed herpetologists to activate important and significant actions for the conservation of the site and whose success seems to be demonstrated by the population trend in the study period.

This dataset on amphibian populations of Doganella is due to research carried out between 2001 and 2003 (2), on behalf of the Park. From the end of February until the end of July (when rainfall guarantees such a long presence of water), six species of amphibians migrate into Doganella: common toads (*Bufo bufo*), agile frogs (*Rana dalmatina*), smooth newts (*Lissotriton vulgaris*), Italian crested newts (*Triturus carnifex*), Italian tree frogs (*Hyla intermedia*) and green frogs (*Pelophylax lessonae* complex). Significant reproductive movements come from the nearby Cerquone Forest and the slopes of the neighbouring Monte Tagliente.

The long-term monitoring of the amphibian populations began in the spring of 2010, by Ferri V. as the contact person appointed for the AREN by SHI and Sarrocco S. for the Lazio Region. The estimates and data collected have been published in scientific works (2, 3) and used for the 2013-2018 reporting of the Habitats Directive 92/43/EEC by the Lazio Region. All surveys were

carried out with the appropriate Ministerial, ISPRA and Park's authorizations. The population size of *R. dalmatina* is estimated by counting clutches (4). This is considered the optimal method to annually evaluate the minimum size of the female population of *R. dalmatina* which is an explosive breeder (5) as mating is concentrated in a specific period of the year, during which each female lays a single mass of eggs.

Given the strong variability of flooded area and the difficulty in maintaining transects for sighting and counting egg masses over time and in agreement with the standard recommendation of 100 m long transects at a fixed position, it was decided to apply from 2017 the "Double Observer" protocol (7,8). Here, clutches were counted over a transect established as the deposition-observation limit of the marsh in the year in question and identified by a first detector, subsequently repeated by a second detector. Both detectors were trained and had good knowledge of the area.

To avoid counting errors, we proceeded as follows: Observer 1 identified and counted egg masses and at the same time set his survey path with GPS (usually overlapping the complete perimeter of the Doganella wetland and the main channels). Observer 2 received the data and the GPS track and repeated the count within a

few days of the first transect. For each year, the highest number of clutches counted was considered for the analyses. In the years of monitoring, replications were carried out to try to annually trace the extension of the reproductive period of the species or at least of the period of spawning, calculated from the first egg-laying event to the last "fresh" egg-laying found.

The results show an increase in the number of clutches of *Rana dalmatina* counted in the Doganella wetland between 2010 and 2025 (Figure 1). The spawning period maintained a certain cyclicity within this period, with a peak in the first half of February. The duration of the breeding event varied in relation to rainfall: from 12 to 48 days between the first and the last egg-laying.

The amount of water available in the Doganella wetland is completely dependent on rainfall and therefore amphibian ability to reproduce successfully is increasingly linked to management interventions carried out by volunteers, officially and duly authorized. Since 2021, in fact, members of the Lazio Section of the SHI and organised volunteers have been monitoring water levels so that in an emergency (drying of the peripheral pools), they can move egg masses and tadpoles towards the central part where the water "stays" longer. This actually happened in 2022, under the supervision

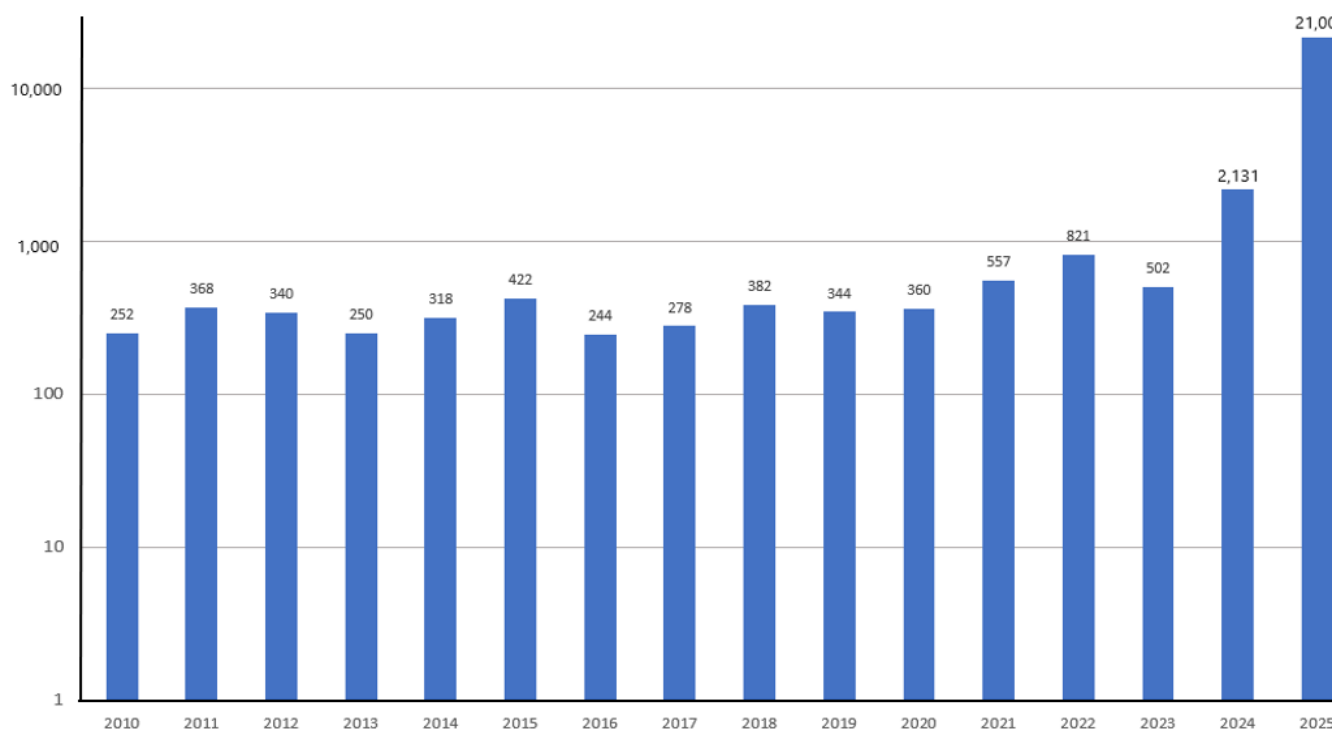


Figure 1 Number of clutches of *Rana dalmatina* counted in the Doganella wetland during monitoring years 2010 – 2025).

of technicians and park rangers and in compliance with the instructions received from the Park Management.

Conclusions

The Doganella wetland and the neighbouring Cerquone Forest host one of the most important populations (in terms of numerical consistency) of *Rana dalmatina* in the entire Lazio Region, and the management of the site and the species represents an important challenge that the Castelli Romani Regional Park will have to take up to ensure an adequate state of conservation for these amphibians.

The results allow us to unequivocally confirm the extreme relevance of the wetland as an area of particular naturalistic and herpetological interest, on which particular attention should be paid in terms of management and conservation. From the estimates made, it is probable that the nesting nucleus (in fact the number of females, one per egg mass detected, is certain while for males the number is probably lower) in the wetland may consist of a minimum of 40,000 adults (based on a sex ratio of 1:1).

The first counts estimated around 250 breeding adults of *R. dalmatina* at the beginning of 2000. Already in 2021, however, the many conservation activities had led to estimates of at least a thousand individuals moving towards Doganella, with 500-800 egg masses safely laid and equally safely monitored by volunteers. But here is the surge in 2024: more than 2,000 egg masses counted, with a probable 4,000 breeding individuals! In 2025, an extraordinary number of egg masses were spawned, with more than 21,000 egg masses in the water at the end of February (Figure 2).

The increase in breeding females of *R. dalmatina* in recent years has no certain explanation for now. Perhaps it is the achievement of sexual maturity of individuals metamorphosed with great success in the two-year period 2019-2020, thanks to the combined effects of good water availability and almost absent road traffic due to the Covid-19 pandemic. It should be kept in mind that every year on the roads surrounding Doganella, hundreds of adult and metamorphosed amphibians end up killed due to road traffic: in 2024, the carcasses of more than 500 individuals of *R. dalmatina* and at least 150 of *Bufo bufo* were detected.

The spring concentration of other amphibians is also noteworthy, accounting for at least 1,000 pairs of



Figure 2: Egg masses of the agile frog, *Rana dalmatina*, in Doganella wetland, Castelli Romani Regional Park in Central Italy. Photo: V. Ferri, 27 February 2025.

common toad, a few hundred breeding individuals of Italian tree frog, Italian crested newt, smooth newt and green frog (*Pelophylax lessonae* complex). These estimates certainly need to be re-evaluated, as the potential extension of the populations should include a larger area in which further suitable habitats for the species mentioned are distributed.

Acknowledgements

All this success is due to the volunteers (of “TerAnomala ODV” and of the “Coordinamento Natura e Territorio”, but in particular to Letizia Stagno, Daniela Tremolati and Roberto Salustri). The Authors also thank their scientific “supervisors”. We also thank all the other monitoring collaborators, the many occasional volunteers and those in the territorially competent administrations, over the years, who have supported conservation actions.

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Ilustrador: O. Armeño, IG: armeñoart

Figure 1: Graphic representation of the Amphibian Conservation Project in Norte de Santander, showcasing the integration of amphibian protection efforts with the active involvement of local communities. Illustration: Orlando Armeño.

Sound and biodiversity routes of northeastern Colombia's amphibians: science and community action for conservation

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Over the past three decades, efforts to explore and understand Colombia's biodiversity have intensified significantly. This momentum has led to an exponential increase in the number of species identified across multiple groups of vertebrates, revealing not only new species but also deepening our understanding of those that, although always present, had gone unnoticed. Amphibians are a clear example: in just a decade, over

100 new species have been described, bringing the total to 902 recognised species in Colombia (1). Alarmingly, over 40% of these species are endemic to the country, and the same percentage faces serious threats of extinction.

Colombia is one of the most biodiverse countries in the world. However, this extraordinary natural wealth comes with an immense responsibility, which has unfortunately been marred by insufficient management and an urgent need for concrete conservation actions. Among the regions where these gaps are most evident is the region of Norte de Santander, an area that, over the past 15 years, has seen serious and sustained efforts to document and understand its amphibian fauna. Although the initial focus was strictly scientific, it was always clear to us that the true goal was to go beyond research towards a more sensitive, participatory, and socially engaged science.

This vision gave rise to the Norte de Santander Amphibian Conservation Project (Figure 1; Instagram: @conserva_anfibios_ns), an initiative that today integrates over a decade of fieldwork with the strengthening of science-community ties. Through this process, we have identified around 60 amphibian species in the region, with approximately one-third of them listed in a threat category (2). But even more importantly, we have witnessed the deep interest and commitment of local communities to support these initiatives. It has become clear that conservation must focus on people: on their education, on future generations, and on how to connect them with their natural surroundings.

Faced with this challenge, we asked ourselves: how can we go beyond basic education to achieve a true community ownership of local biodiversity? What tools could facilitate this process in communities with limited communication and access to information?

A tool for communities and conservation.

We understood that conservation must begin with tools that are both visually and audibly engaging. To this end, we selected the best photographs, field recordings, and audiovisual materials to translate scientific knowledge into an accessible language. We incorporated onomatopoeias to help recognise frog calls, for instance, the sound "pip-pip-pip" (/pɪp pɪp pɪp/) of *Dendropsophus microcephalus*, the distinctive "wop-wop-wop" (/wɒp wɒp wɒp/) of *Phyllomedusa venusta*, or the vibrant "brrrr-brrrr-brrrr" (/brrrr brrrr brrrr/) of *Rhinella margaritifera*. Integrating these onomatopoeias and International Phonetic Alphabet (IPA) not only facilitated species recognition but also expanded the communities' knowledge of frog calls.

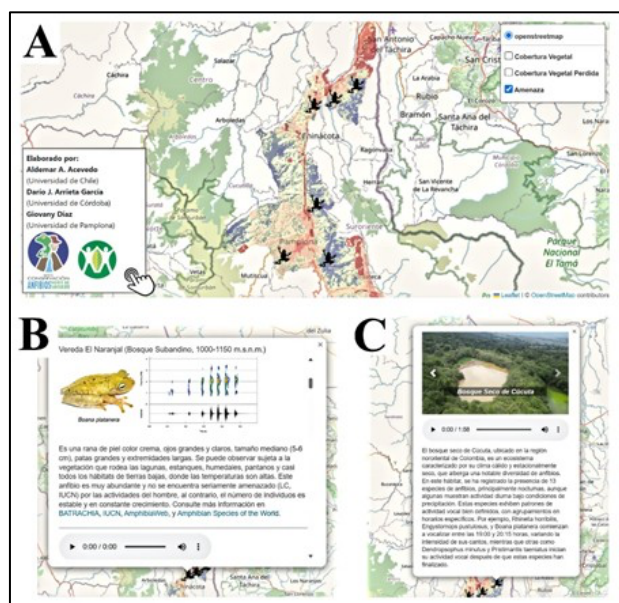


Figure 2: The Acoustic Page of Frogs from the Department of Norte de Santander, Colombia. (A) General structure of the website. (B) Species-specific information, including images, recordings, and descriptions. (C) Habitats and locations where frogs and toads were recorded. Website: <https://anfibiacallsns.web.app/>. Developed by: Aldemar A. Acevedo

A key innovation was incorporating call structures into everyday language, allowing workshop participants to imitate the sounds and recognise them during their daily activities. These spaces promoted not only

auditory learning but also emotional connection: the excitement of recognising a species by its call fosters both curiosity and pride in the local environment. In parallel, we developed educational materials that combine onomatopoeias, habitat descriptions, and graphical representations of calls, making learning more accessible in schools and community settings.

This collective effort materialised in our latest interactive platform: The Bioacoustic Route, based on the Amphibian Acoustic Page of Norte de Santander (<https://anfibiacallsns.web.app/>).

This pioneering tool aims to showcase and map the astonishing diversity of frogs and toads in the region. Thanks to the enthusiasm and active participation of local communities, we have documented nearly 50% of the species recorded in the region (3). Among them are highly threatened species that survive amid livestock, agriculture, and mining activities, such as *Tachiramantis lentiginosus* (4).

The website allows users to interact with various areas of the regions, explore information about the authors, partners, threats, and land cover. Each frog icon on the map opens a window into a world of sounds and images: photographs, recordings of calls, general descriptions, and links to additional resources. Furthermore, it



Figure 3: Children from local communities (northern Cúcuta, Colombia) connecting with frogs and toads—for many, their first direct encounter with these animals. Activity held at the Julio Pérez Ferrero Educational Institution, Norte de Santander. Shown here: the Horribilis toad (*Rhinella horribilis*). Photo: Orlando Armesto.

provides information about the habitats where these species were found, enriched with soundscapes that recreate the experience of being there (Figure 2).

Moreover, the portal continues to grow by including new layers of information, it is expected to incorporate community narratives, updated threat maps, and self-diagnostic modules where users can upload their own sound recordings to identify species living near their homes. This constant growth aims to turn communities into biodiversity sentinels, strengthening the role of bioacoustics as a participatory monitoring tool.

Importantly, the platform remains a work in progress. We aim to integrate new features such as accessible descriptions of calls in textual, onomatopoeic, and phonetic formats, to support learning in both schools and community spaces. In the future, we hope that users themselves will contribute by uploading their recordings, further expanding the collaborative database.

Many of these discreet and secretive species are hard to see but easy to hear. This was our gateway: through the power of sound, we brought rural communities closer to the amphibians that share their lands. When we played the calls during workshops and community gatherings, the results were remarkable. We discovered

that people, especially younger participants, could recognise the calls they hear daily during their walks and routine activities. They not only identified the species but also pinpointed the specific sites where these amphibians could be found (Figure 3). This auditory recognition transformed into curiosity and, ultimately, into direct engagement with the frogs, fostering a deep emotional connection (Figure 4).

Conservation perspectives

The development of initiatives such as The Bioacoustic Route opens new pathways for amphibian conservation in rural contexts, where barriers to information and educational opportunities persist. Community ownership of knowledge is not just an educational tool but the foundation of a genuine culture of conservation.

In the short term, we aim to expand this tool to include new species, territories, and local human voices, incorporating even community stories and traditional knowledge. In the medium term, we aspire to transform it into a community monitoring platform, building local capacity for biodiversity observation and protection. In the long term, we envision this tool contributing directly to the design and implementation of the National Action Plan for Amphibian Conservation in Colombia, consolidating concrete actions in education, habitat restoration, and the protection of priority species.

Looking ahead, this initiative aligns directly with the objectives of the National Action Plan for Amphibian Conservation in Colombia, which promotes environmental education, the restoration of critical habitats, and the strengthening of local capacity for monitoring threatened species.

Moreover, this strategy represents an invaluable opportunity to rethink the role of science: science that listens, decentralises, and is built collectively with communities as protagonists, not just beneficiaries. The future of conservation in Norte de Santander will depend on inclusive models, sensitive to social realities, that strengthen the bonds between scientific knowledge and local wisdom, recognizing that conservation is not an isolated task but a shared responsibility.

Acknowledgments

We are deeply grateful to the rural communities of Norte de Santander for sharing their time, knowledge, and enthusiasm in exploring the sounds of nature. Special thanks to the children, youth, and community



Figure 4: Educational activities integrating frog sounds and dance at the Cristo Rey School (Sede Cristo Rey), Villa del Rosario, Norte de Santander, Colombia, with a background mural created by the community featuring regional biomes and amphibian species. Photo: Lorena Quintana Páez.

leaders for their hospitality, curiosity, and active participation.

We also thank the team behind the Norte de Santander Amphibian Conservation Project for their dedication to research and outreach, and the Conservation Leadership Programme (CLP) for the essential financial and technical support that made this initiative possible. Finally, we appreciate the invaluable contributions of our colleagues, volunteers, and allies, whose efforts have enriched the development of this tool and its content.

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Figure 1: A female bleeding toad from Mt. Gede-Pangrango National Park. Note that the eggs are clearly visible. Photo: Nathan Rusli.

A small step in saving the Critically Endangered bleeding toad

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The bleeding toad (*Leptophryne cruentata*) is a small species, measuring only 20-46 mm in length, with females being larger than males (Figure 1). It is highly restricted in range, found only in two active volcanic mountain ranges in West Java: Mt. Gede-Pangrango and Mt. Halimun-Salak. The species faces the grave threat of extinction if these volcanoes erupt. Additionally, the toads are increasingly endangered due to tourist disturbances and the chytrid fungus (1, 2, 3). Currently

listed as Critically Endangered on the IUCN Red List (4), the bleeding toad is the only amphibian species in Indonesia with legal protection (5).

In late 2022, the Herpetological Conservation Breeding Laboratory (HCBL) was established as part of a collaborative project between IPB University and Chester Zoo, led by Indonesian frog expert Mirza Kusri, a professor of herpetology at the university. Since 2023, the lab has been co-managed by IPB University and the Indonesia Herpetofauna Foundation, with support from Chester Zoo and IUCN-ASAP (Asian Species Action Partnership). The team at HCBL consists of two units, working on different components of the project to achieve a common goal. Mirza oversees both in situ and ex situ components, managed by Rizki Tohir and Nathan Rusli respectively. Risma Aprilianti has been the amphibian technician since 2023, responsible for the day-to-day maintenance of the captive frogs. On occasion, she also carries out fieldwork, directly or indirectly relevant to the husbandry of *Leptophryne* species. In September 2024, Erick Sarwono joined our team as a veterinarian, in charge of animal health and diagnostics.



Figure 2: A male hourglass toad at HCBL. Photo: Nathan Rusli.

Our mission is to integrate both in situ and ex situ efforts to enhance our understanding of the bleeding toad through ecological research and conservation breeding. We are currently focused on understanding the husbandry requirements of *Leptophryne* species, with plans to establish a dedicated facility to maintain an assurance population of bleeding toads.

Before focusing on the Critically Endangered bleeding toad, we aimed to understand the general husbandry of the genus. The hourglass toad (*Leptophryne borbonica*), a more widely distributed species listed as Least Concern on the IUCN Red List (6), was selected as our model species (Figure 2). In 2023, we set up a dedicated room at IPB University to house and breed hourglass toads, as no prior literature exists on their captive

management (Figure 3). By October 2023, we had successfully collected our first batch of hourglass toads and, after over a year of trial and error, managed to induce breeding by November-December 2024, with tadpoles appearing in January 2025 (Figure 4). Despite many setbacks, our work with the hourglass toad has given us a brief understanding of their captive care and breeding, marking a promising step toward eventually establishing an assurance population of bleeding toads.

Very little is known about the natural history of *Leptophryne* species in the wild, especially concerning their tadpoles and reproductive biology (2). As we move forward, we continue to face challenges in maintaining these frogs in captivity due to the lack of available information. While we are still working with model species, we believe in situ research is crucial for refining husbandry practices and minimising harm to animals under our care. Several field excursions have been conducted to improve our understanding of these frogs' ecology and enhance their captive management (Figure 5).

One key takeaway from this project has been the need for flexibility and adaptability when working with species that lack established husbandry guidelines. Being able to adjust our approach as new insights arise has been essential. The slow progress in developing husbandry protocols for the hourglass toad has underscored the importance of adjusting expectations and timelines accordingly.



Figure 3: The rain chamber used to induce breeding in hourglass toads. Photo: Restu Dwikelana.

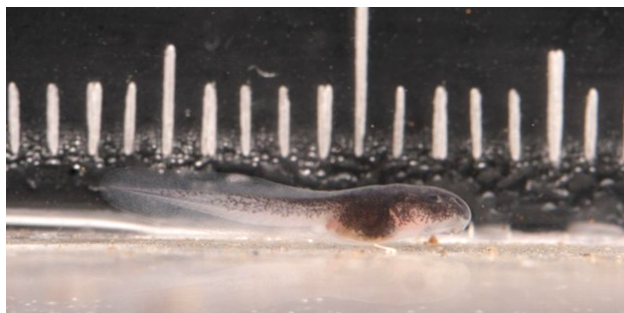


Figure 4: A tadpole of the hourglass toad, hatched at HCBL. Photo: Nathan Rusli.

Looking ahead, we also recognise the importance of planning and establishing a proper facility early in the process. Designing a biosecure facility for bleeding toads is a priority, and we are currently developing plans to ensure the necessary infrastructure is in place when the time comes.

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Figure 5: Fieldwork at Mt. Gede-Pangrango National Park, to understand the microhabitat of *Leptophryne* frogs. Photo: Restu Dwikelana.



Figure 1: Searching for Andean water frogs during a light snowfall in the Humahuaca Department (Jujuy, Argentina). Photo: Mauricio Akmentins

Five years of monitoring the threatened Andean water frogs in the complex context of northwestern Argentina

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Our journey began in early 2020, when we initiated the first long-term monitoring of the conservation status of threatened Andean water frogs of the genus *Telmatobius* in Jujuy Province, northwestern Argentina. This monitoring program includes updates on the extent of occurrence, determination of population parameters, behaviour, and ecophysiology, as well as chytrid fungus screening and environmental data logging. The

program was launched thanks to the logistical and financial support from the National Scientific and Technical Research Council (CONICET) and the National Agency for the Promotion of Scientific and Technological Research (ANPCyT) of Argentina.

After a promising first survey in January 2020, our efforts had advanced with some setbacks. In March 2020, our plans were suddenly interrupted. On this occasion, we were in the field near the locality of Abra Pampa (~3500 m asl, Central Andean Puna), approximately 300 km from our home in San Salvador de Jujuy (1,259 m asl, Southern Andean Yungas). Local radio stations began reporting that the local communities were meeting to decide what measures to take in response to the spread of COVID-19. The quarantine measures and limitations to the circulation among localities seemed a strong possibility. Thus, after a one-day fieldwork, we had to return home. Two days later, the national government announced the “ASPO”, the preventive and mandatory social isolation to prevent the spread of COVID-19. Intermittent lockdown measures were extended throughout 2020 and part of 2021. Even so, we were able to collect and report novel data on the diet of the Pozuelos’ rusted frog, *Telmatobius rubigo* (1). During 2021, we’ve seen a significant improvement with new records of Andean water frog populations and environmental data (Figure 1). Our participation in the

second Conservation Needs Assessment for Amphibians of Argentina facilitated by the Amphibian Ark (<https://www.conservationneeds.org/reports/nationalassessments>) allowed us to incorporate novel data for the *Telmatobius* species of Jujuy province (*T. hypselocephalus*, *T. oxycephalus*, *T. platycephalus*, *T. rubigo* and *T. cf marmoratus*), resulting in the recommended conservation actions of in situ conservation and research, and conservation education. Also, the descriptions of reproductive behaviour (2) and cannibalism (3) of the Pozuelos' rusted frog made important contributions to the natural history and ecological knowledge for the largely unknown Andean water frogs. We also strengthened our relationship with local communities through educational activities conducted in schools and recreational areas, which enabled us to exchange knowledge about Andean water frogs and ancestral traditions related to this unique species (Figure 2).



Figure 2: Picture taken during educational activities at the Elementary School in Santa Catalina, Jujuy, Argentina. Photo: Mauricio Akmentins

The year 2023 was a watershed for our conservation efforts. We decided to test an emerging technology, the automated recording units HydroMoth (Open Acoustic Devices, UK), for monitoring the underwater calling activity of *Telmatobius rubigo*. However, another event had a significant impact on the social context of the province. In June 2023, the approval of a provincial constitutional reform prompted demonstrations by Indigenous communities and other social sectors, who raised concerns that participation and consultation—rights recognised by the National Constitution, the ratification of ILO Convention No. 169, and the adoption of UN Declaration on the Rights of Indigenous Peoples—

were not fully ensured. This context affected the regular development of ongoing fieldwork and research, as it led to growing mistrust among Indigenous communities toward external actors. In addition, our project ran out of national funds, and up to that point, we had not succeeded in securing external funding.

In 2024, we applied the knowledge gathered about the Pozuelos' rusted frog to assess how mining activities and their associated infrastructure in the Lithium Triangle could impact species inhabiting the scarce wetlands of the arid Central Puna (4). In addition, our description of the advertisement call of *Telmatobius rubigo* using HydroMoths (5) encouraged us to propose the underwater passive acoustic monitoring (UPAM) as a promising tool for monitoring threatened Andean water frog species. This project received financial support from the 2024 WILDLABS Award, granted by WILDLABS.NET (<https://wildlabs.net/>). It has been carried out in collaboration with personnel from the National Park Administration at the MAB-UNESCO Laguna de Pozuelos Biosphere Reserve (located over 3500 m asl, Central Andean Puna, Jujuy province, Argentina) (Figure 3). We also continued our outreach campaign in local communities and schools to raise awareness about the importance of *Telmatobius* frogs and our work in their territories. Nevertheless, concern has



Figure 3: Underwater passive acoustic monitoring using HydroMoth was carried out on *Telmatobius rubigo* populations in collaboration with Laguna de Los Pozuelos Natural Monument - National Park Administration personnel. Photo: Mauricio Akmentins

deepened, as national defunding of science and education threatens the continuity of these efforts.

By 2025, we added new insights into the vulnerability of the Pozuelos' rusted frog to a warming climate, using air and water temperature records collected with data loggers, along with other proxy measurements (6). In addition, we plan to analyse the collected data to provide tools and information that support the conservation of the *Telmatobius* populations of Jujuy, contribute to completing the IUCN Red List assessment for these species in Argentina, and continue our collaborative work with the National Parks Administration. We also aim to expand the UPAM to other *Telmatobius* species and to continue our educational outreach in local schools through our initiative CANOA (Initiative for Amphibian Conservation in NW Argentina). We hope to secure additional external funding to sustain our monitoring program for threatened Andean water frogs and to develop targeted conservation action plans.

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We express our profound gratitude to all the local people with whom we have shared knowledge along the way. We thank Carina Rodríguez, the intendant of Laguna de Los Pozuelos Natural Monument and all personnel of the protected area for their support with the UPAM. We thank Ariel Prieto for volunteering to join us in the last field surveys and activities of the CANOA initiative. We are grateful for the funding of the Agencia

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Using visual art to raise awareness of amphibian conservation

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Public engagement and education are critical yet often overlooked actions to advance amphibian conservation (1), and many have turned to the power of arts-based approaches to find creative ways to spread the word. In particular, environmental visual arts have received increased attention for their powerful ability to heighten emotional connection with environmental and ecological subjects (2, 3). Visual arts projects across the globe have proven effective in promoting knowledge acquisition, emotional engagement, and behavioural changes related to conservation and sustainability (2, 4–6).

Within this area of research, our group has begun experimental work that has revealed an interesting pattern: compared to more traditional forms of communication and education, artistic depictions of amphibian research are better for engendering heightened interest, but less effective for promoting acquisition of knowledge.

In one study, we collaborated with an undergraduate student artist, Benjamin McLaughlin, to create an interactive art exhibit about the impacts of disease on amphibians. Adult visitors to the exhibit reported increased interest in research, and this effect was especially true for people with less background education in science, technology, engineering or math (STEM) fields (7). In another project, we created an original graphic novel, in collaboration with students Nora Hines, Christina Jacob, Apurva Singh, Kathleen Lu, and Emma Glembocki, and used it as a supporting resource for a primary school lesson on amphibian conservation. Here, we found that children who received the lesson with the graphic novel as a supporting resource reported more positive perceptions of science than children who received the same lesson using a more “traditional” slideshow as a supporting resource (8).



Figure 1: “The Wetlands & You,” an art exhibit developed by the Hua Lab in collaboration with students Angela Luo, Ingrid Shen, Lila Pomerantz, Nagasri Thota, Olivia Cashimere, and Kathleen Lu. Photo: Kyra Ricci

In these same studies, we examined how art affects knowledge acquisition. We found that undergraduate students who attended Ben’s exhibit had lower knowledge quiz scores than their peers who read the academic publications used to create the exhibit (7). The primary school children who learned using the graphic novel also had lower quiz scores than their counterparts who learned using the slideshow resource (8).

While these studies vary in their methodology, audiences, and artistic media, the similar outcomes align with other works and suggest that art can be highly effective in promoting more emotional or affective aspects of engagement (e.g., interest, attitudes, positive perceptions). However, when in situations where accurate knowledge acquisition is more important, it may be better to utilise other methods of communication that prioritise clarity of information.

Separately, one significant benefit to engaging in arts-based approaches lies not in the outcomes for audiences, but in the process of creating the artwork itself. Artists are constantly seeking creative ways to expand their horizons and engage in opportunities for professional development (9). Interdisciplinary collaboration between researchers and artists thus poses an exciting opportunity to meet these professional development goals of artists while also furthering the communication goals of amphibian conservationists.

Our most recent work (in review) aims to explore this dynamic from the perspective of student artists. We

collaborated with undergraduate and graduate students Angela Luo, Ingrid Shen, Nagasri Thota, Olivia Cashimere, Lila Pomerantz, and Kathleen Lu to create an exhibit highlighting the multitude of threats to amphibians and the ways that researchers are working to study them. Interviews with the artists at the conclusion of the collaboration revealed that they appreciated the experience, particularly for the opportunities in professional development: building portfolios, designing artistic products for a client, exchanging peer critiques, exhibiting artwork, conducting research, and experimenting with new techniques. Furthermore, by engaging with amphibians as artistic subjects, these artists, who largely joined our team unaware of the imperilled status of amphibians, gained new understanding of the importance of conservation.

Overall, our research and practice support that arts-based conservation communication can be a win-win for researchers, conservationists, and artists seeking to effectively engage audiences.

For a free digital pdf of the graphic novel (*Amphibian Adventurers: Beyond the Vernal Pool*), please contact the authors at kdricci@wisc.edu or jhua23@wisc.edu. Copies are available in English, and we are currently working on a Spanish translation. Other artistic works used for these projects may be shared on a case-by-case basis at the discretion of the artists.

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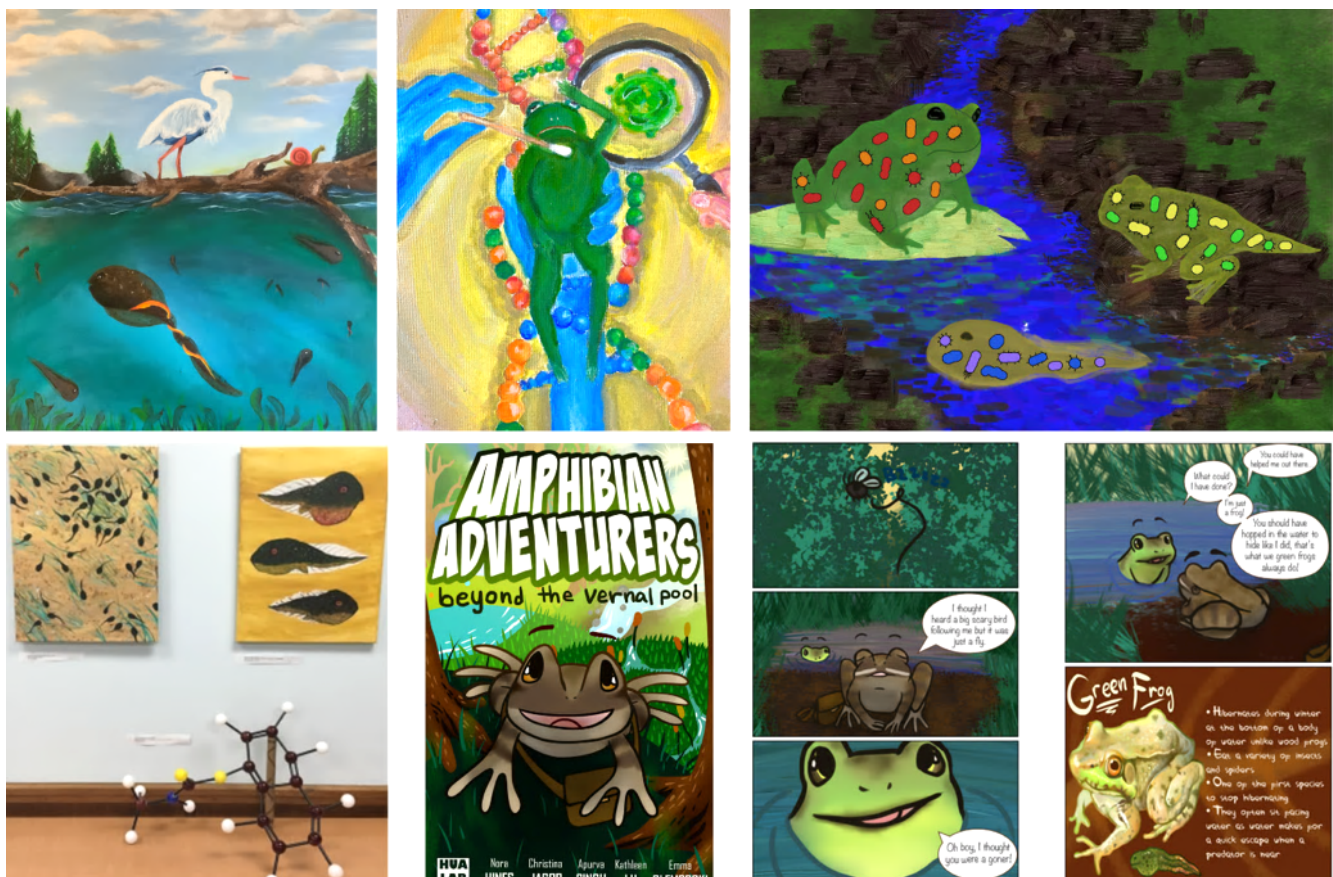


Figure 2: Examples of visual arts projects. Artwork by Olivia Cashimere (top left), Angela Luo (top middle), Lila Pomerantz (top right), Benjamin McLauchlin (bottom left). Comic book (bottom middle, right) by the Hua Lab, Kathleen Lu, Emma Glembocki, Nora Hines, Christina Jacob, and Apurva Singh. Photo: Kyra Ricci

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Updates on amphibian recovery programs from Melbourne Zoo, Australia

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In response to the 2019/2020 black summer bushfires which burned through significant areas of eastern Australia, Melbourne Zoo constructed a purpose-built amphibian conservation facility named the “Amphibian Bushfire Recovery Complex” (ABRC). The facility was completed in February 2022 and has significantly increased Melbourne Zoo’s capacity to house and breed some of Victoria’s most imperilled frog species, with the goal of releasing genetically robust offspring back into the wild.

Specifically, this facility has enabled the expansion of Melbourne Zoo’s baw baw frog (*Philoria frosti*) recovery program. Baw Baw Frogs are listed as Critically Endangered on the IUCN Red List and found only in the Baw Baw plateau of Victoria (1). Wild populations have declined drastically due to chytridiomycosis and habitat degradation linked to human activities (1). Twelve new modifiable breeding/holding enclosures were constructed to increase housing and breeding capacity, as well as two new compartmentalised tadpole tanks designed specifically for raising large numbers of baw baw frog eggs and tadpoles. The new tadpole tanks comprise one large glass tank divided into ten smaller compartments, sectioned off by removable fly-mesh divides (Figure 1). Water is cycled from one end of the tank to the other, to create a gentle flow between all compartments. Tadpoles of this species are initially devoid of pigment and develop in complete darkness (2), and so each compartment is blacked-out to block as much light as possible. These tadpole tanks have proved extremely successful and the 2024 breeding season saw the largest single release of baw baw frogs to date, with 2,970 newly metamorphosed frogs returned to the wild. Assisted reproductive technologies in the form of hormone injections were trialled on this species in 2022 and have improved breeding outcomes, with calling, amplexus and oviposition occurring within a few days after injection. This has also been a useful tool in more reliably pairing genetically distinct individuals and has

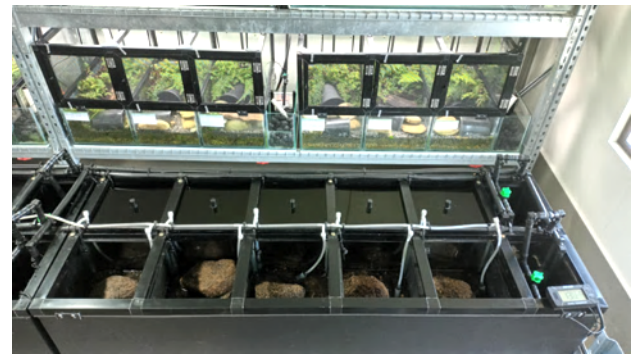


Figure 1: Newly designed baw baw frog tadpole tanks. Photo: Ryan Moes.

been utilised over the last several breeding seasons. A subset of adult baw baw frogs were released in early 2025 equipped with radio-transmitter harnesses to aid post-release monitoring. This, in conjunction with the use of detection dogs, has provided a useful set of tools for surveying this cryptic species.

The ABRC is also home to Melbourne Zoo’s southern giant burrowing frog (*Heleioporus australiacus flavopunctatus*) recovery program. The southern giant burrowing frog is endemic to fragmented forest habitats in south-eastern Australia and is listed as Endangered under the IUCN Red List, with key threatening processes including habitat loss through logging, and altered fire regimes (3). Tadpoles of this species were collected in 2021 after the black summer fires, and have since been raised to adulthood, with many individuals showing signs of sexual maturity in early 2024. It was decided that an attempt to breed this little-known species would be made, to build on the paucity of husbandry knowledge available. Breeding tanks were constructed incorporating a multi-level waterbody, and ample terrestrial space for foraging/burrowing. Males of this species will call from sheltered sites in or near waterbodies with little-to-no flow, and so artificial breeding hollows were created using upside-down terracotta pots with entrance holes carved into the front, and placed in a shallow section of the waterbody (Figure 2). Males showed strong fidelity to these breeding sites and after simulation of multiple heavy rain events, were observed calling. Females were introduced to the males after it was clear the males had established breeding sites, and amplexus and oviposition were observed on multiple occasions, always following simulated heavy rain events. This constitutes the first breeding of southern giant burrowing frogs in captivity, and has afforded significant insight into environmental parameters necessary to encourage breeding behaviour in this species.



Figure 2: Female southern giant burrowing frog during oviposition. Photo: Ryan Moes.

The third species housed within the ABRC is the spotted tree frog (*Litoria spenceri*). The spotted tree frog is a Critically Endangered species endemic to mountainous river systems in southeastern Australia, with key threatening processes including chytridiomycosis, predation by non-native fish, and habitat degradation due to climate change and human activities (4). Significant improvements to water quality management over the last two years has seen dramatic increases in viable offspring bred for release. Historically, all amphibian conservation programs at Melbourne Zoo have utilised reverse osmosis filtration for any water coming into contact with eggs, tadpoles or frogs. Catalytic carbon filtration is now the preferred filtration type and all reverse osmosis systems have been discontinued. After extensive testing of water quality parameters pre/post both filtration systems, it was found that catalytic carbon filtration removed all unwanted elements and heavy metals from the water, while still maintaining the general hardness of the pre-filtered water. Reverse osmosis filtration completely stripped the general hardness of the water. Having improved the water quality, we saw an exponential increase in the number of spotted tree frog tadpoles successfully metamorphosing, with viability rates climbing from 61% (reverse osmosis filtration), to 85% (catalytic carbon filtration).

Finally, Melbourne Zoo initiated another species recovery program in 2023 for the Watson's tree frog (*Litoria watsoni*), a forest-dependent species with a propensity for breeding in shallow, ephemeral pools and classified as Endangered on the IUCN Red List (5). Tadpoles were collected in 2023 and began showing signs of sexual maturity in mid-2024 (Figure 3). Ten breeding enclosures were constructed, incorporating a large water-body and ample terrestrial and arboreal space, as well as dense vegetation for refugia. Breeding was successful on multiple occasions, and constitutes the first time



Figure 3: Watson's tree frog tadpole undergoing metamorphosis. Photo: Tom Fair.

this species has been bred in captivity. A further eight breeding enclosures have been constructed and are currently being set up, to further increase capacity to breed this species.

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Himalayan endemic frogs threatened by pollution and degradation of natural water systems in Murree-Kotli Sattian-Kahuta National Park, Pakistan.

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Mountains not only supply freshwater to half of the world's population, but they also host half of the world's biodiversity hotspots and 30 percent of key biodiversity areas (1). The Murree Hills frog (*Nanorana vicina*) and Hazara torrent frog (*Nanorana hazarensis*; Figure 1) are two endemic species of the western Himalayas. *N. vicina* is reported in both Pakistan and India, while *N. hazarensis* is reported only in Pakistan. Both species are listed as Least Concern (LC) by the IUCN Red List of Threatened Species (2,3); however, the global population of *N. vicina* is declining (2). For *N. vicina*, the threats listed by the IUCN Red List include: 1) housing and urban areas, 2) dams and water management, 3) habitat shifting and alteration, and 4) temperature extremes. For *N. hazarensis*, the listed threats include: 1) tourism and recreation areas, 2) roads and railroads, 3) recreational activities, 4) dams and water management, 5) garbage and solid waste, and 6) droughts. Both species exist in at least one protected area (2,3). We have observed a noticeable decline in the populations of both species at sites with habitat degradation, pollution, and stream modification, pointing towards anthropogenic disturbance and reduction in suitable habitat.

Both *N. vicina* and *N. hazarensis* are found in the Himalayan foothills of Pakistan, which are under pressure from rapid urbanisation due to increasing tourism. We have observed that these areas use freshwater streams for domestic and commercial water supply (e.g.,

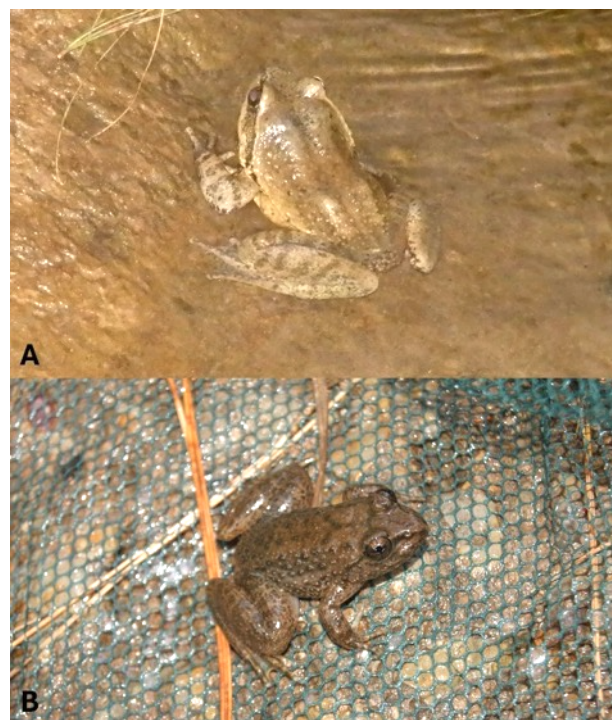


Figure 1: (A) Murree Hills frog (*Nanorana vicina*) in Perhana, Murree, Pakistan. (B) Hazara torrent frog (*Nanorana hazarensis*) found near Ghanuian, Kotli-Sattian, Pakistan Photo: Faraz Gill.

restaurants and car-washing areas), regardless of whether the area is within the boundaries of a protected area (Figure 2). The streams that locals generally use as water resources are avoided for wastewater discharge. Some of these sites have been modified to improve water storage (small dams), which can potentially create barriers within the streams (4). During an informal interview with a local, we discovered that these frogs are being traded; however, further evidence is needed to pursue this claim.

In addition to serving as a water supply, we have observed that these streams are also used as dumping sites for plastics and household waste (kitchen waste and sewage). Plastic waste pollution is particularly high in streams near restaurants and local markets (Figure 2). We have also noted that sewage and other household waste are being discharged into these streams. Although rare, the pollution can become so severe that the water flow consists entirely of household wastewater, with no visible signs of life. We have observed that the water flow increases during the spring and rainy seasons, which helps flush household waste downstream. However, during the dry winter months, when water flow decreases significantly, the concentration of domestic wastewater may become extremely



Figure 2: (A) Murree Hills frog (*Nanorana vicina*) female in a stream used by locals for water supply near Kaseri, Murree, Pakistan. Photo: Muzna Kashaf. (B) Polluted permanent freshwater stream next to a tourist spot in Ratta kas, Murree, Pakistan. Photo: Sumbul Gill.

high (Figure 3). The exact differences between stream water flow need to be studied to assess the exact threat level, as high levels of domestic wastewater in urban areas have been identified by previous studies as a key factor contributing to skewed sex ratios (5) and increased intersex traits in amphibians (6). In addition to toxic materials, household waste can cause oxygen depletion and thermal fluctuations in the streams. The focal frog species are sensitive to temperature changes, with fatalities observed at elevated temperatures ($>26^{\circ}\text{C}$) in *N. hazarensis* tadpoles, while *N. vicina* appears to be more sensitive to these changes (7).

Given these issues, the question arises: "What needs to be done?". We suggest some recommendations to help mitigate the situation in these areas. As a signatory to the Convention on Biological Diversity (CBD), Pakistan has committed to enhancing biodiversity conservation and sustainable practices (8). By implementing these actions from the country's National Biodiversity Strategy and Action Plan (NBSAP), these initiatives will not only protect these Himalayan endemic frogs but also contribute to broader environmental sustainability, addressing multiple Sustainable Development Goals (SDGs) related to water quality, health, education, and climate action (9,10).

- a) *Educating the local communities:* The NBSAP emphasizes the importance of awareness and

education as a key strategy to achieve biodiversity conservation goals. Specifically, Objective 3 of the plan focuses on raising awareness among the public, stakeholders, and decision-makers about the value of biodiversity and the threats it faces. Educating local communities about the ecological role of species like *N. vicina* and *N. hazarensis*, and promoting their conservation, aligns with these efforts to empower communities to engage in biodiversity protection. SDGs Addressed: SDG 4 (Quality Education), SDG 15 (Life on Land), SDG 12 (Responsible Consumption and Production).

- b) *Monitoring streams for species presence:* Monitoring biodiversity and assessing the status of species is critical for informed decision-making and effective conservation planning. Objective 5 of the NBSAP emphasises the need to strengthen biodiversity monitoring systems and ensure proper management of key species and ecosystems. Monitoring streams where *N. vicina* and *N. hazarensis* are present helps track their population dynamics and habitat changes, which is crucial for targeted conservation interventions. SDGs Addressed: SDG 6 (Clean Water and Sanitation), SDG 15 (Life on Land), SDG 13 (Climate Action).
- c) *Improving sanitation systems:* The NBSAP outlines sustainable management and restoration of ecosystems, with a focus on reducing pollution and improving habitat quality. Objective 6 addresses



Figure 3: Natural permanent freshwater stream in Perhana, Murree, Pakistan. (A) Rainy season. Photo: Sumbul Gill. (B) Dry season Photo: Faraz Gill.

the need to mitigate threats from pollution and promote the sustainable use of natural resources, especially water bodies. Improving sanitation in highland urban areas directly contributes to improving the quality of freshwater streams, thus benefiting amphibian species by reducing pollution, particularly plastic waste and domestic sewage. SDGs Addressed: SDG 6 (Clean Water and Sanitation), SDG 3 (Good Health and Well-being), SDG 11 (Sustainable Cities and Communities)

- d) *Promoting rainwater harvesting:* Rainwater harvesting is a key strategy in Objective 7 of the NBSAP, which promotes the sustainable use of water resources. This action helps alleviate pressure on freshwater streams, reducing human impact on these water bodies, which are critical habitats for amphibians like *N. vicina* and *N. hazarensis*. It also contributes to climate resilience, an important aspect of the NBSAP's goals to adapt to and mitigate the impacts of climate change on biodiversity. SDGs Addressed: SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), SDG 9 (Industry, Innovation, and Infrastructure).

Moving forward, it is crucial to reassess the conservation status of *N. vicina* and *N. hazarensis* through

collaborative efforts with local government authorities, ensuring that these species are properly categorised by the IUCN Red List for targeted and effective conservation planning. These efforts, coupled with continued monitoring and public awareness campaigns, are essential for safeguarding the fragile ecosystems of the western Himalayas and securing the long-term survival of these unique amphibians.

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Generating knowledge on reproductive mode for amphibian conservation

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Webinar held 18th December 2024

Knowledge generation and understanding the reproductive modes of amphibians is crucial for understanding evolutionary biology and conservation efforts, particularly in the face of climate change and habitat loss. The reproductive diversity within Rhacophoridae, a family encompassing approximately 6% of the world's amphibians, provides a compelling case study. My research, spanning over two decades, has focused on the evolution and ecology of Sri Lankan tree frogs (*Pseudophilautus*), a genus that exemplifies direct development—a reproductive mode in which embryos bypass the free-swimming tadpole stage to emerge as froglets.

This work has elucidated the relationship between reproductive strategies, climatic adaptation, biogeographic patterns, and diversification in Rhacophorids, providing significant insights for amphibian conservation. Hence, I will argue for amphibian conservation through a renewed focus on breeding biology, integrating conventional methods and technological advancements.



The challenging conservation of the amphibian megadiversity in Madagascar

Franco Andreone^{1,2}

¹Museo Regionale di Scienze Naturali, Turin, Italy;

²IUCN SSC Amphibian Specialist Group, Regional Group Madagascar

Webinar held 4th February 2025

Madagascar is one of the world's most important biodiversity hotspots, home to a huge number of unique organisms that can't be found anywhere else in the world. Among its rich fauna, the native amphibians stand out, as they are all frogs (with more than 430 species) and every single species is endemic to the island (except for two introduced ones). Unfortunately, many of these frog species are now threatened with extinction. The main cause of their decline is habitat loss due to extensive deforestation and fires, but other major threats include climate change, emerging infectious diseases and invasive species that disrupt the local ecosystem. Over the past 15 years, efforts to conserve these amphibians have been strengthened by the Sahonagasy Action Plan initiative (SAP). This initiative has played a crucial role in identifying necessary conservation actions, relevant stakeholders and the financial requirements for effectively implementing these actions. The conservation efforts outlined in the SAP are being implemented at different levels: some at the national level, some at the broader landscape level, and others targeted at specific geographical areas or focused on individual species. Here I present an overview of the activities and needs to ensure the persistence of this peculiar fauna and its ecosystems, facing a worrying situation due to socio-economic and ecological factors.



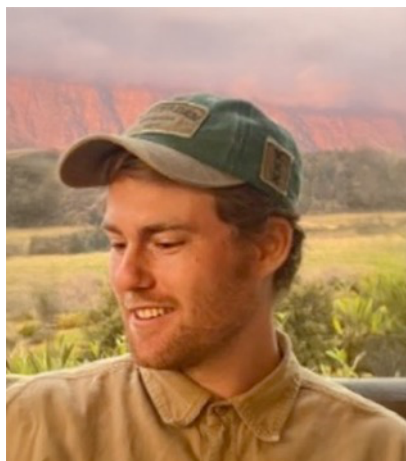
Developing genomic approaches and resources for increasing amphibian resilience

Tiffany A. Kosch¹

¹ Faculty of Science, University of Melbourne

Webinar held 18th March 2025

Amphibians in Australia and globally face severe threats from the devastating fungal disease chytridiomycosis. Since this disease cannot be eradicated in the wild, solutions are needed that allow amphibians to survive in its presence. The genomics revolution provides an excellent opportunity to exploit these rapidly developing new tools and resources to increase amphibian disease resilience. My research leverages genomic tools to identify the genetic basis of chytrid resistance and explores how these insights can be applied through Targeted Genetic Intervention (TGI) to enhance amphibian survival. Additionally, I will discuss some of the resources I am developing to support these efforts, including establishing the Amphibian Genomics Consortium (AGC).



Hidden in Plain Sight: discovering a new *Cacosternum* species from the Cederberg region of South Africa

Oliver Angus

Webinar held 30th April 2025

In this presentation, I will give a brief overview of South African frog diversity, with a focus on the family Pyxicephalidae and the genus *Cacosternum*. I will highlight ongoing challenges in South African frog taxonomy and biogeography, and discuss ways forward for resolving these issues. Against this background, I will present a case study from the Cederberg, where a historically misidentified population assigned to *Cacosternum karoicum* is shown to represent a new species. Using molecular, morphological, and acoustic data, I will outline how this population forms a distinct lineage within the *C. capense* group, alongside *C. capense* and *C. namaquense*. I will conclude with a discussion of the species' natural history, distribution, conservation concerns, and how studies like this one contribute to a clearer and more stable taxonomy for the region.



The amphibian vet: the urge for veterinarian professionals

Iago Junqueira^{1,2}

¹Universidade Estadual de Santa Cruz, Brazil

²IES Educa, Instituto Espaço Silvestre

Webinar held 20th June 2025

In a compelling recent webinar, Dr. Iago Junqueira, a veterinarian specializing in wildlife and zoo medicine, shed light on the pivotal role vets play in ensuring amphibian health and their very survival. Today's amphibians face unprecedented threats, from aggressive diseases like the chytrid fungus to widespread habitat destruction. This dire reality makes the expertise of veterinary professionals, like Dr. Junqueira, not just valuable, but absolutely essential. Dr. Junqueira emphasized that caring for amphibians demands specialized knowledge due to their unique biology, which differs significantly from other animals. His work spans crucial areas: from ensuring welfare in frog production facilities and providing proper health care for amphibians to managing health in zoo and conservation centres and addressing challenges in wild populations. He cited the devastating chytrid fungus outbreak as a stark reminder of how quickly diseases can decimate species, highlighting the critical need for a "One Health" approach where animal, ecosystem, and human health are interconnected. Conservation, he stressed, is a transdisciplinary effort, and veterinarians, with their deep understanding of animal physiology and disease

dynamics, are uniquely positioned to lead. Dr. Junqueira passionately urged more veterinary professionals to join this vital field, advocating for increased knowledge sharing and collaboration to protect these incredibly vulnerable creatures for future generations.

Book Review

Status of Decline and Conservation of Amphibians of the Middle East

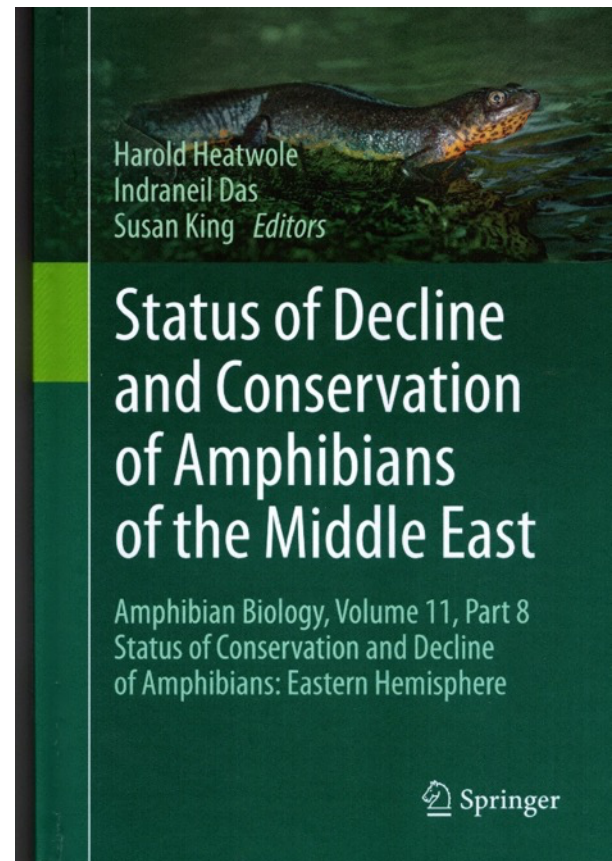
C. Kenneth Dodd, Jr.¹

¹ Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature

Contact information: terrapene600@gmail.com

The latest volume in Hal Heatwole's edited Amphibian Biology series encompasses one of the most difficult regions in the world for amphibians and those who study them. The 300-page book surveys the amphibians of Syria, Lebanon, Israel, the West Bank and Gaza, Jordan, Iraq, Iran, Kuwait, Saudi Arabia, Qatar, United Arab Emirates, Yemen and Oman. Dedicated to Dr. Ahmad M.M. Disi of Jordan, its 14 chapters are a fitting tribute to his career studying the herpetofauna of the Middle East. Each country is covered in a single chapter, with a separate chapter dedicated to the West Bank and Gaza, about which little is known or readily available to batrachologists.

As with previous editions of Amphibian Biology, the book's purpose is to document the status of amphibians within national boundaries, identify threats to them and their habitats, and to review past and ongoing conservation efforts. Given the history of violence and ever-present disputes among various governments and factions vying for control of the region, it is a tribute to the many contributors to have compiled such a comprehensive review bringing together the latest information on amphibians from fieldwork and pertinent literature. Indeed, the large numbers of references provide a unique summary of the herpetofaunal literature, much of which will not be accessible to scientists outside the Middle East. Chapters range from 8 to 38 pages (some countries have very few amphibians!) and cover the physiography of the country or region discussed, the methods of determining status, a review of the amphibian fauna (frequently with full colour dot distribution maps and photos of species), historical information on amphibian research including museum



Heatwole, H., I. Das, and S. King (eds.). 2025. Amphibian Biology, Volume 11, Part 8. Springer Nature Publishing, Cham Switzerland. xii + 301 pp. USD \$99.99. ISBN: 978-3-0316-8984-0.

records, and threats to habitats and fauna; suggestions are also provided for conservation actions and research.

Given the paucity of information on some species and the difficulties of research, the extent of available material varies considerably among chapters. This in no way, however, detracts from the value of the book to naturalists, researchers, NGOs, and government agencies. The authors and editors should be thanked for their efforts in compiling this information into a compact source for current and future researchers

