www.iucn-amphibians.org | Issue 128 (June 2026) | Volume 32, number 1 | ISSN: 1026-0269 | eISSN: 1817-3934

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

FrogLog

ASG IUCN SSC Amphibian Specialist Group

Boophis madagascariensis, Photo: Tsirimanjaka Tsinjoary Ranaivojaon

Amphibians reach 9,000 described species!

ASG NEWS

ASG establishes a new Melanophryniscus Task Force

CONTRIBUTED ARTICLES

Scientific research and community engagement for amphibian conservation in Madagascar

ASG WEBINAR ABSTRACTS

Amphibians of India: insights into behaviour, ecology, and the urgent need for collaborative conservation

CONTENTS

Dear Readers,

Earlier this year the 9,000th amphibian species was described! Amphibian taxonomy changes quickly (at the time of writing we are now up to 9,072 described species) and newly described species are more likely to be threatened so keeping track of these changes is critical for effective conservation. In celebration of the 9,000 species milestone, in this issue you will find an article outlining the ongoing taxonomic trends, challenges and opportunities (p 18) as well as our recognition of the important role Amphibian Species of the World plays as the taxonomic authority for both the Amphibian Red List Authority and CITES (p 13). We start with a guest editorial from Dr. Darrel Frost, who conceived and continues to maintain the Amphibian Species of the World database, the amphibian taxonomy followed by the ASG.

Amaël Borzée, Sally Wren and Franco Andreone
FrogLog Editors

(Almost) Fifty years to name a world: why taxonomic catalogues still matter

This is an abbreviated version of the long article provided by Dr. Frost. The full article is available as a ***blog post on the ASG website****.*

Taxonomic catalogues are often treated as static reference tools—necessary, but rarely celebrated. Yet the nearly fifty-year history of Amphibian Species of the World (ASW) reveals that catalogues are not merely lists of names. They are dynamic infrastructures at the intersection of science, technology, conservation, and judgment.

ASW emerged at a moment when biology was still anchored to paper, while computing was rapidly redefining how information could be stored, accessed, and shared. Early computers were massive, fragile, and opaque to most scientists, but their trajectory was clear: information would eventually move faster than print. When ASW was first published in 1985, it represented a heroic effort—years of library work, physical journals, and manual synthesis—yet it was already technologically obsolete on the day it appeared. What it offered instead was something more enduring: a shared taxonomic language at a time when international conservation regulation, particularly under CITES, demanded clarity and consistency.

The subsequent evolution of ASW mirrors the broader transformation of science itself. As the internet became public, databases replaced books, and static editions gave way to continuously updated resources. By moving ASW online in 1999, the catalogue crossed a critical threshold: it became globally accessible, searchable, and free. For the first time, taxonomists and conservation practitioners in amphibian-rich but resource-poor regions could engage with the same primary taxonomic framework as colleagues in well-funded institutions. This democratisation of access may be ASW's most consequential legacy.

Importantly, ASW never aspired to be all things to all users. It did not attempt to replace conservation assessments, specimen databases, or ecological syntheses. Instead, it focused on doing one thing well: curating taxonomic names, synonymies, and distributions with care, transparency, and accountability. Over time, however, its audience expanded. Conversations with conservation practitioners highlighted that "minor" information—range extensions, acoustic data, obscure citations—can have outsized impacts on Red List assessments and policy decisions. The catalogue adapted, not by abandoning rigour, but by recognising how taxonomic decisions propagate through conservation systems.

Today, amphibian diversity exceeds 9,000 recognised species, more than double the count in 1985, and projections suggest many more remain undescribed. At the same time, the tools for managing information have become more powerful than ever. Artificial intelligence now digests literature, links databases, and surfaces taxonomic changes almost instantaneously. This raises an uncomfortable question: will machines soon replace human curators of taxonomic knowledge?

In the short term, the answer is no. Taxonomy is not only analytical; it is interpretive. It requires judgment—about evidence quality, sampling sufficiency, methodological limits, and the communicative usefulness of names. AI can process data at scale, but it cannot yet recognise when a species diagnosis rests on fragile genetic evidence, misidentified specimens, or poorly justified taxonomic inflation. Nor can it resolve the persistent tension between calls for "stability" and the scientific necessity of revising classifications to reflect evolutionary reality.

Looking ahead, taxonomic catalogues will increasingly become hybrid enterprises: human judgment augmented by machine efficiency. The challenge will not be technological, but institutional—how to ensure that expertise, openness to paradigm change, and responsibility to users beyond taxonomy itself remain central. ASW's history suggests that catalogues endure not because they are authoritative, but because they are responsive.

In an era of accelerating biodiversity loss and information overload, taxonomic catalogues remain essential—not as monuments to stability, but as living tools that help science, conservation, and policy speak the same language.

Darrel Frost

ASG News

Figure 1: Picture of some of the ASG members attending the congress. Photo: Sky Button.

Scaling up global and regional amphibian conservation: the XII Latin-American Congress of Herpetology

Amaël Borzée[1], Bela Barata[1,2,3], Maria Jose Chang[1,4], Janice Chanson[1,5] and Katie Hoffman[1,6]

[1] Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature, Switzerland
[2] Durrell Wildlife Conservation Trust, UK
[3] Insitut Biotropicos, Diamantina, Minas Gerais, Brazil
[4] Asociación de herpetología de Guatemala (AGHerp), Guatemala
[5] Re:Wild, USA
[6] Center for Species Survival New Mexico, ABQ BioPark, USA

Contact information: amaelborzee@gmail.com

In an effort to scale up amphibian conservation across one of the most biodiverse yet threatened regions of the world, five members of the ASG Secretariat attended the XII Latin-American Congress of Herpetology, joining numerous ASG members at the conference. The meeting, hosted by the University of Costa Rica in San José from 23–27 February 2026 (Figure 1), brought together a diverse community of researchers, practitioners, and conservation leaders from across Latin America and beyond (Figure 1).

The ASG's mission is to act globally to enhance local conservation action (Amphibian Specialist Group, 2024). Participation in this major regional congress directly contributed to this mission by fostering collaboration, strengthening professional networks, and supporting the generation of science-based conservation strategies. Specifically, the ASG aimed to stimulate and promote research that informs amphibian conservation and habitat management, support the assessment and monitoring of threats to amphibian populations, and raise awareness of conservation priorities among both specialists and the broader public.

International conferences such as this provide critical platforms for knowledge exchange and collaboration. Researchers and conservation practitioners presented new findings that contribute to advancing conservation science (Figure 2A; e.g., presentation about the STAR Metric) and improving extinction risk assessments (Figure 2B; e.g., case studies on highly threatened taxa such as large-bodied Andean amphibians, *Calyptocephalella gayi*), and also advances on action planning efforts for highly threatened species (Figure

Figure 2: Pictures of some of the presentations highlighting scientific developments for conservation, including (A) the development of the STAR metric, (B) providing new data for extinction risk assessments, (C) interactions between the ASG Secretariat and the ASG members, and (D) meeting to move forward conservation planning. Photos: Amaël Borzee.

2C, Telmatobius Action Plan). These gatherings also play a central role in reinforcing and mobilising the ASG's global network (Figure 2D). Face-to-face interactions remain essential for building trust, aligning priorities, and accelerating coordinated action.

Notably, the congress facilitated several key in-person discussions that would have been difficult to achieve remotely. For example, members of the Telmatobius Task Force met directly with an ASG Co-Chair and the Deputy Chair, enabling more effective coordination on the conservation of this highly threatened Andean genus (Figure 2C). Similarly, productive exchanges took place between representatives of the Amphibian Red List Authority and multiple Regional Working Group Co-Chairs. These discussions focused on addressing current imbalances in geographic and thematic coverage, with the goal of strengthening assessment capacity in underrepresented regions. The potential re-discovery of a "Lost Species" was even part of the conversation (Long and Rodriguez, 2022)!

The ASG also contributed to the scientific programme through a presentation highlighting recent global conservation updates (Figure 3). Drawing on results from the Second Global Amphibian Assessment, the presentation underscored the global importance of the Neotropics, which harbour 3,862 amphibian species—approximately 48% of global diversity. Alarmingly, the region also contains nearly 60% of the world's threatened amphibian species, including 25 Highly Threatened Genera (www.iucn-amphibians.org/htg/). The vast majority of species (92%) are affected by significant habitat loss and degradation, exacerbating their vulnerability to emerging diseases and climate change. These findings emphasise the urgent need for coordinated large-scale conservation action (Re:wild *et al.* 2023).

Encouragingly, the presentation also highlighted that conservation efforts can and do make a difference. Analyses indicate measurable improvements in extinction risk status, with 35 species downlisted between 1980 and 2004, and 86 species between 2004 and 2022. These positive trends are largely associated with targeted conservation interventions, particularly habitat protection, creation, and restoration (Borzée et al. 2025; Figure 4). Such successes provide critical evidence that sustained investment in conservation yields tangible outcomes.

Preventing further amphibian declines and extinctions requires a nuanced understanding of regional contexts, including the complex interactions between human development needs and environmental pressures. In this regard, strengthening the ASG's presence at key regional events is essential. By investing in leadership, capacity building, and targeted funding opportunities, the ASG can empower local experts and institutions to implement effective conservation actions on the

Figure 3: Presentation highlighting the work of the ASG. Photo: Melisa Rolon.

ground.

Looking ahead, the ASG has initiated discussions with the organisers of the next Latin American Congress of Herpetology, scheduled to take place in Chile in 2029.

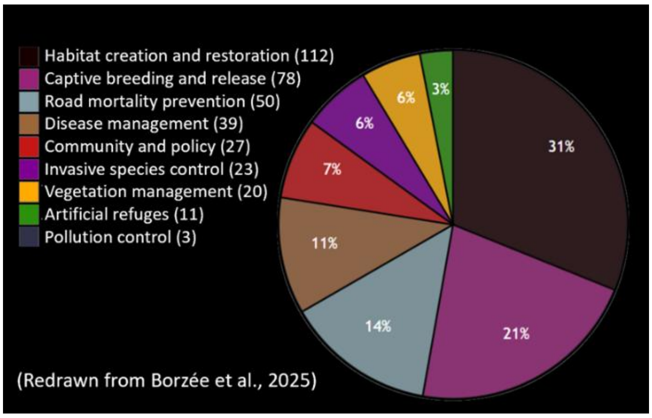


Figure 4: Highlight of the conservation actions from which species have benefited, as defined by the Conservation Evidence Database (www.conservationevidence.com). Redrawn from Borzée et al. 2025.

Plans are underway to enhance ASG engagement through dedicated workshops and training activities, with the aim of further increasing impact, fostering collaboration, and supporting the next generation of amphibian conservationists in the region.

References

[ASG] IUCN SSC Amphibian Specialist Group (2024). The Amphibian Conservation Action Plan (ACAP): A status review and roadmap for global amphibian conservation. IUCN Occasional Paper. Gland, Switzerland.

Borzée A., Prasad V. K., Neam K. … Wren S. (2025). Conservation priorities for global amphibian biodiversity. Nature Reviews Biodiversity, 1, 754–771. 10.1038/s44358-025-00101-5

Long B. and Rodríguez J. P. (2022). Lost but not forgotten: a new nomenclature to support a call to rediscover and conserve lost species. Oryx, 56, 481-482. 10.1017/S0030605322000618

Re:wild, Synchronicity Earth, and IUCN SSC Amphibian Specialist Group (2023). State of the World's Amphibians: The Second Global Amphibian Assessment. Re:wild, available at https://www.iucnamphibians.org/wp-content/uploads/sites/4/2023/10/SOTWA-final10.4.23.pdf.

The IUCN SSC ASG Melanophryniscus Task Force: supporting the conservation of South American redbelly toads

Mariana Retuci Pontes[1,2,3*], Izabela Menezes Barata[4,5,6], Diego Baldo[1,7], Luis Marin da Fonte[1,8], Márcio Borges-Martins[1,9], Raúl Maneyro[1,10] and Michelle Abadie[1,9,11]

[1] Melanophryniscus Task Force, Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature.
[2] Laboratório de História Natural de Anfíbios Brasileiros, Instituto de Biologia, Universidade Estadual de Campinas, Campinas, São Paulo, Brazil
[3] Instituto Boitatá, Goiânia, Goiás, Brazil.
[4] Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature.
[5] Durrell Wildlife Conservation Trust, Jersey, UK
[6] I nstituto Biotrópicos, Diamantina, Brazil
[7] Laboratorio de Genética Evolutiva, Instituto de Biología Subtropical "Claudio Juan Bidau", CONICET - Universidad Nacional de Misiones, Posadas, Misiones, Argentina
[8] Synchronicity Earth, AmphibianProgramme
[9] Laboratório de Herpetologia, Instituto de Biociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil.
[10] Laboratorio de Herpetología, Facultad de Ciencias. Universidad de la República, Montevideo, Uruguay.
[11] Coordenação de Planejamento de Ações para Conservação de Espécies Ameaçadas de Extinção, Instituto Chico Mendes de Conservação da Biodiversidade, Brasília, Distrito Federal, Brazil.

Contact information: melanotaskforce@gmail.com

Commonly known as redbelly toads, the genus *Melanophryniscus* (family Bufonidae) is endemic to South America, and is distributed across tropical and subtropical regions including, Uruguay, southern, southeast and central Brazil, northern and central Argentina, Paraguay, and central Bolivia (Frost, 2026) (Figure 1). Comprising 31 species, this genus is most diverse in Brazil (22 species), followed by Argentina (10), Uruguay (6), Paraguay (6) and Bolivia (1) (Frost, 2026) (Figure 2).

With a remarkable colour pattern, *Melanophryniscus* species are among the most conspicuous anurans in the Neotropical region and are well known for their aposematic coloration (Figure 3). They exhibit great ecological and reproductive diversity, with explosive breeding in streams, ponds, or in small water bodies retained by plants (phytotelmata). Inhabiting a wide range of ecosystems, from tropical savannas and open grasslands to biodiversity hotspots such as the Atlantic Forest, some redbelly toads have highly restricted distributions and reduced population sizes.

Figure 1: (A) *Melanophryniscus montevidensis* (Argentina, Brazil and Uruguay), Photo: Diego Baldo; (B) *M. biancae* (Brazil), Photo: Hudson Garcia; (C) *M. rubriventris* (Argentina and Bolivia), Photo: Diego Baldo; (D) *M. setiba* (Brazil), Photo: Pedro Peloso; (E) *M. klappenbachi* (Argentina, Brazil and Paraguay), Photo: Diego Baldo; (F) *M. admirabilis* (Brazil), Photo: Michelle Abadie.

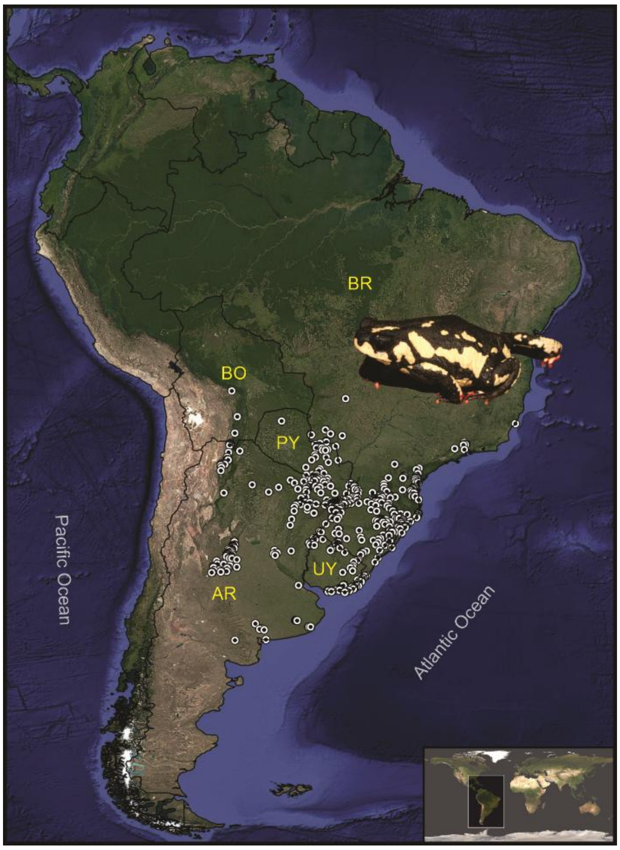


Figure 2: Geographic distribution of species of the genus *Melanophryniscus* in South America. The map highlights the main distributional ranges of the genus, with records concentrated in southern and southeastern Brazil (BR), Uruguay (UY), Paraguay (PY), Bolivia (BO), and northern Argentina (AR).

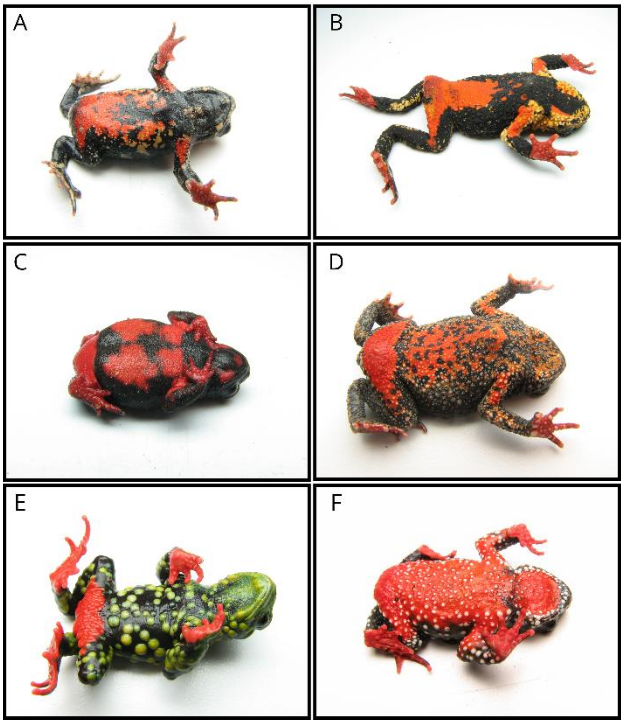


Figure 3: Examples of ventral coloration patterns in Redbelly toads (*Melanophryniscus* spp.) Photographs show the variation in belly pigmentation and spotting among species. (A) *Melanophryniscus sanmartini;* (B) *Melanophryniscus* spectabilis*;* (C) *Melanophryniscus dorsalis;* (D) *Melanophryniscus pachyrhynus;* (E) *Melanophryniscus admirabilis*; (F) *Melanophryniscus macrogranulosus.* Photos: Márcio Borges-Martins.

Of the 29 species assessed on the IUCN Red List, 41% are currently listed as Vulnerable, Endangered, or Critically Endangered (IUCN, 2025). Nine of the 12 threatened species show declining population trends and are experiencing ongoing habitat degradation (IUCN, 2025). One CR species, *Melanophryniscus peritus*, is possibly extinct (IUCN, 2025), while two species (*M. diabolicus* and *M. nigricans*) are yet to be assessed.

Given the high proportion of threatened species and the urgent need for targeted conservation actions, the IUCN SSC Amphibian Specialist Group established the *Melanophryniscus* Task Force in 2025. The primary goal of the Task Force is to catalyse evidence-based conservation efforts for *Melanophryniscus* species across their geographical range.

In addition, the *Melanophryniscus* Task Force is currently working to define its conservation targets and priority indicators, ensuring alignment with the Amphibian Conservation Action Plan (ACAP; ASG, 2024) and the 2026-2029 IUCN Species Strategic Plan. This will enable the Task Force to track progress through measurable outcomes, including strengthened partnerships and funding mechanisms, improved conservation planning, implementation of targeted actions for threatened species, and increased communication and outreach. Initial actions will include organizing and strengthening a network of collaborators, planning, organizing and conducting an in-person workshop to develop a *Melanophryniscus* Action Plan to guide effective conservation efforts for the genus, and engaging relevant stakeholders to support the development of a collaborative conservation strategy.

References

[ASG] IUCN SSC Amphibian Specialist Group (2024). The Amphibian Conservation Action Plan (ACAP): A status review and roadmap for global amphibian conservation. IUCN Occasional Paper. Gland, Switzerland.

Frost D. R. (2026). Amphibian Species of the World 6.2, an Online Reference, https://amphibiansoftheworld.amnh.org/ (2026).

IUCN (2025). IUCN Red List of Threatened Species. Version 2025-2 (IUCN; www.iucnredlist.org).

Who guides the direction, setbacks, and success of a conservation project for threatened species?

Patricia Mendoza Miranda [1,2], Luis Fernando Marin da Fonte[2,3,4], Izabela Barata[4,5,6], Pria Ghosh[3], Grace Iara Souza[3]

[1] Bolivian Amphibian Initiative, Cochabamba, Bolivia.
[2] Telmatobius Task Force, IUCN SSC Amphibian Specialist Group.
[3] Synchronicity Earth, London, UK.
[4] IUCN SSC Amphibian Specialist Group, Gland, Switzerland.
[5] Durrell Wildlife Conservation Trust, Jersey, Channel Islands.
[6] Instituto Biotrópicos, Diamantina, Minas Gerais, Brasil.

Contact information: patricia.m@bolivianamphibian.org

The title opens the conversation with anyone that somehow works in programmes or projects focusing on threatened species conservation. Over time, the scientific community has heard the following:

- It is difficult to work with local communities, which is why I don't work with conservation.
- Conservation projects don't really engage local communities.
- Decisions must come solely from local communities.
- I don't want to get involved in the social aspects because it's too complicated.

Several of these statements make sense when a conservation project encounters conflicts with local communities. However, for too long, conservation programmes and projects have been so romanticized that any setbacks along the way are something to be hidden. Therefore, we understand that it is time to make visible the reality of working with local communities and, amidst its nuances, better understand and learn how to create a suitable relationship for the project's success.

We set ourselves the goal of hearing firsthand the thoughts of local communities, their interests, concerns, and main fears regarding the projects in their territory. We also wanted them to see the reality of conservation organisations, our limitations, and our role within the local community. Furthermore, we aimed to create community networks between countries, connecting them through their representatives, so that this experience could then be shared with their entire local community or Indigenous group.

With this in mind, the XIII Latin American Congress of Herpetology provided the ideal background for setting a meeting. Held in San José, Costa Rica, from February 23-27, 2026, the conference had over 530 participants from 31 countries across all continents. We organized a one-day symposium *"Community Based Conservation: Perspectives and Perceptions Between Traditional Knowledge and Science".* The symposium allowed us to listen, analyse, and understand the perceptions, experiences, and lessons learned by various representatives from local communities, Indigenous peoples, and the scientific community. For one day, five participants representing local communities from Brazil, Bolivia, Costa Rica, Guatemala, and Peru, along with representatives from eight institutions in Latin America and Europe, fostered a rich environmental discussion with feedback from all participants that we now take home with us to apply to our conservation projects. We chose to move away from the typical conference symposium format, which usually focuses on one-way presentations with little room for dialogue, and instead structured our symposium into sessions featuring a small number of talks, led by the community members themselves, with ample time for discussion (Figure 1).

Figure 1: Time for discussion between research, students and communities' members. Photo: Grace I. Souza.

It became clear that good communication and a deep understanding of the needs of local communities are vital for the development of conservation projects. This, alongside a multidisciplinary team coordinating projects, a long-term commitment and respect for the community and their rights. Furthermore, it is crucial to find a balance between the local communities and the species being protected because, let's be honest, they are the ones who will ultimately live alongside the species, and they must be our allies throughout the entire process.

The symposium allowed representatives of local communities to better understand our reality as researchers and institutions, our limitations and concerns, and how we are also vulnerable to the local community (Figure 2). We understood that our role as researchers and conservationists is to achieve a balance between species of interest, local communities, authorities, and our own research team; yet reaching this point is a process often exhausting.

Figure 2: Member of the Tircus community in Peru. He is talking about the project developed by the Pro Wildlife Association – Ayacucho. Photo: Grace I. Souza.

Finally, and answering the initial question, we are certain that local communities and conservationists, together with the institutions they represent, guide the course, setbacks, and successes of conservation projects. Clearly, one without the other could not advance to the extent that the threatened species requires. We must not forget that most institutions are overburdened to fulfil roles that are often the government's responsibility which, in many cases, bring a lot of expectations from the local community. However, we understand that basic communal needs are met horizontally with a harmonious coexistence with the species we set out to protect (Figure 3).

To illustrate the importance of such work, we share here two presentations that can teach us valuable lessons. The first case study, from Bolivia, with the project "Todos en acción, *Atelopus tricolor* nos mueve" (Everyone in action, *Atelopus tricolor* moves us), led by

Figure 3: This space allowed us to hear stories that changed the lives and perceptions of communities and people who now protect and co-inhabit nature. Photo. Grace I. Souza.

the Bolivian Amphibian Initiative (BAI). The work with the communities started in 2023. With a little population of *A. tricolor* and two communities, BAI made key connections. The objectives were the stakeholders to appropriate of three-coloured harlequin toad. That was very important when this project has faced setbacks, which were overcome thanks to the commitment of the people who, during this time, have embraced the target species that shares their environment. Now the project continues, with more compromise of community members and BAI.

From Brazil, the second case study started in 2021. It is led by Instituto Biotrópicos and Durrell Wildlife

Figure 4: Communities member of Bolivia, Brazil, Peru and Guatemala in the XIII Congreso Latinoamericano de Herpetología, San José, Costa Rica, 2026. Photo: Grace I. Souza.

Conservation Trust, who work with local communities to mitigate the impacts caused by fire that affects both local communities and the targeted frog species (*Crossodactylodes itambe*). With 19 people in a fire fighting brigade, the Capivari community protects species habitat while also securing long-term water availability for their future.

We are sure that every conservation project has a history to count. Opening this safe space for two-way communication was enriching for all participants and attendees. As such, we would like to encourage this type of event to be replicated in as many scenarios as possible so that together we can continue working for the species that needs it the most.

Acknowledgements
We would like to thank all participants from the symposium, speakers, community members and attendees that gave their time and thoughts into bringing our community together at this time. Thank you for your valuable contribution. Also, to congress organisers and volunteers for all support to prepare and doing the symposium.

GAA3 in motion: updates on the Third Global Amphibian Assessment, November 2025 - March 2026

Louise Hobin[1], Janice Chanson[1,2]

[1] IUCN SSC Amphibian Specialist Group, Gland, Switzerland.
[2] Re:wild, USA.

Contact information: lhobin@amphibians.org

As we enter the third year of our new five-year GAA3 timeline (2024-2028) it's a good moment to reflect on progress made so far. Of the 52 regional groups established to deliver the GAA, 44 are now up and running with their regional updates. It is great to see momentum building, and there are already more assessment workshops planned for this year for various countries. A total of 227 assessments were submitted to the Red List Unit for the first Red List update of 2026, which will be published on the website in July. There are still eight regions across South America, the Caribbean and North Africa that have yet to begin, however our team aims to get them started later this year.

The completion of Southern Africa assessments

The first big achievement of 2026 is the completion of the GAA3 update for southern Africa. As of March, all 312 assessments for the region have been finalised by the southern Africa network of experts. All endemics have either already been published or submitted for publication on the Red List in July this year, while non-endemics have been updated for southern Africa and are now ready for other regions to complete their updates. This achievement is a result of the fantastic work and collaboration of our regional partners Anura Africa and Endangered Wildlife Trust, with a big thanks going out to all experts who contributed to this work, and especially Jeanne Tarrant, Josh Weeber and Julian Alexander Nieto Lawrence who led the coordination of this process.

Part of this work has contributed towards the amphibian component of the National Biodiversity Assessment for South Africa (Tarrant et al. 2026), which was launched in December 2025. Insights from the Red List update for South African amphibians have helped provide a national overview of the threatening

Figure 1: Amphibian Red List Authority (ARLA) regional partnership as of March 2026.

processes they face, as well as the level of protection afforded to this species group. The National Biodiversity Assessment also drew on other processes such as the Conservation Needs Assessment process developed by Amphibian Ark (AArk) to identify endemic species in need of *ex-situ* conservation efforts. More details can be found here: https://nba.sanbi.org.za/content/species/sp_amphibians.html.

A major milestone for amphibians reached: 9000 species!

The beginning of this year also marked a significant milestone for amphibian taxonomy, with the number of described species reaching 9,000. This number continues to rise each month with new species still being described, at a steady pace of around one every three days, and definitely keeps us on our toes as we adjust to a constantly changing goalpost for the GAA3.

ARLA would like to thank Darrel Frost for his dedication to maintaining the Amphibians of the World (ASW) database that provides the taxonomic backbone for our work in amphibian Red Listing. Our database and process would certainly take much longer without his meticulous dedication to ASW.

Regional GAA Partnerships

Our regional partnerships are still expanding and, most recently, Universiti Malaysia Sabah (Figure 1) has become our regional partner for Malaysia which is a very welcome addition. ARLA now has 11 partner organisations across 9 countries, with more planned for the near future.

The current ARLA Regional Coordinators and partners are listed on the ASG website: https://www.iucn-amphibians.org/arla-regional-partnership/. We continue to welcome anyone interested in contributing to the GAA3 to reach out to the relevant ASG Regional Chairs/ARLA Regional Coordinators or contact the ARLA team.

References

Tarrant J., Weeber J., Raimondo, D. C. … Hendricks S. E. (2026) Amphibians. SANBI National Biodiversity Assessment. https://nba.sanbi.org.za/content/species/sp_amphibians.html.

About ASG: Taxonomic Authority

The Amphibian Species of the World (ASW) database, maintained by Dr. Darrel Frost and colleagues at the American Museum of Natural History, serves as the taxonomic backbone for global amphibian conservation (see the editorial p. 2 of this FrogLog issue for more information on its history). This standardised taxonomy is essential for international conservation frameworks, providing the nomenclatural foundation upon which conservation assessments and legal protections are built.

Most critically, ASW serves as the official taxonomic authority for both the IUCN Red List of Threatened Species and the Convention on International Trade in Endangered Species (CITES). This dual role ensures that conservation assessments and trade regulations operate from the same taxonomic framework, preventing confusion that could arise from conflicting species boundaries or nomenclature. The ASG's Amphibian Red List Authority relies on ASW taxonomy to maintain the Global Amphibian Assessment's list of species for regular assessments in each country (see p. 12 for GAA3 progress update). Similarly, when CITES regulators determine whether traded specimens belong to listed species, they refer to ASW for definitive identifications (see the article p. 32 of this issue for more information on CITES).

This standardisation is particularly valuable given the dynamic nature of amphibian taxonomy, with the 9000th species described this year (see article p. 18 for more information). As molecular techniques continue to reveal cryptic diversity and taxonomic revisions split or lump species, ASW provides a constantly updated reference point. Without this central authority, differing taxonomies between countries could potentially result in threatened species slipping through regulatory gaps or creating enforcement challenges for international agreements.

The database's accessibility and regular updates make it an indispensable tool for conservation practitioners worldwide. By providing a single, authoritative taxonomic framework, ASW enables consistent communication among researchers, policymakers, and enforcement agencies across borders—a prerequisite for effective international conservation actions in an era of accelerating biodiversity loss.

The 2025 Red List assessments for the genus *Telmatobius* in Argentina: from the workshop organisation to data compilation

María Soledad Gastón[1,2,3], Ana Laura Sureda[4], Mauricio Sebastián Akmentins[1,2,3] and Marcos Vaira[1,3]

[1]Argentina Regional Working Group, Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature.
[2]Iniciativa CANOA - Conservación de Anfibios del Noroeste Argentino, Argentina.
[3]INECOA, UNJU, CONICET, Argentina.
[4]Dirección Regional NOA, Administración de Parques Nacionales, Argentina.

Contact information: asg.uicn.arg@gmail.com; marcos.vaira@gmail.com

Launched in response to lessons learned from the first two Global Amphibian Assessments processes (GAA 1 & 2), that highlighted the need for regular reassessments of the extinction risk of all described amphibian species using the IUCN Red List Categories and Criteria, the Amphibian Red List Authority (ARLA) proposed a new GAA initiative (GAA3). This initiative consists of a five-year cycle (2024-2028) designed to ensure the species assessments remain up to date and better inform conservation planning. To achieve this goal, ARLA engaged institutions at both national and regional levels to conduct alternating cycles of comprehensive and focused updates. These implementing partners are responsible for compiling baseline data for the assessments, hosting expert workshops, preparing draft species assessments that will then be reviewed by ARLA, and maintaining regular involvement with the GAA3 process.

Figure 1: *Telmatobius oxycephalus*, one of the species that was re-categorised in the new Red List assessments. Photo: Mauricio Akmentins.

In Argentina, members of the Amphibian Specialists Group (ASG, SSC - IUCN) were engaged to run the first focused GAA cycle, which will reassess all non-LC species and complete first-time assessments for any newly described species in our country during the period 2025-2028. Under ARLA's coordination, this focused cycle began with the evaluation of the 14 *Telmatobius* species present in Argentina (Figure 1). A workshop was organized in a hybrid format in July 2025 and took place over two days at the facilities of the Municipality of Salta city, in northwestern Argentina. Prior to the workshop, four ASG members participated in the Red List training sessions and Red List Q&A meetings held in May and June 2025. These sessions were delivered by Louise Hobin (Programme Officer - GAA Coordinator for Africa, Europe and Asia | IUCN SSC Amphibian Red List Authority), and Janice Chanson (Species Assessment and Australasia Manager - Re:wild; Global Coordinator - Amphibian Red List Authority / IUCN SSC Amphibian Specialist Group; Co-chair - IUCN SSC Australian Species Specialist Group).

In June 2025, invitations were sent via email to researchers with field experience with *Telmatobius* species in Argentina who could contribute information on species distribution, ecology, behaviour, threats, and taxonomy. Additionally, for the first time in the GAA process in Argentina, staff from the National Parks Administration (Administración de Parques Nacionales, APN) working in national protected areas where *Telmatobius* species occur were invited to participate. Once specialists confirmed their participation, they were granted access to a shared online folder containing ARLA documentation on the evaluation process, along with the species fact sheets from previous GAA assessments.

A total of 11 researchers and 3 APN staff contributed data during the pre-assessment phase. Experts from the provinces of Jujuy and Salta attended the workshop in person, while participants based in Tucumán, San Juan, Misiones and Buenos Aires joined remotely

Figure 2: Hybrid workshop for the reassessment of *Telmatobius* in Argentina. Photo: Administración de Parques Nacionales.

Figure 3: An introductory session and overview on the GAA strategy was delivered by the Chair of the Argentina Regional Working Group, ASG, SSC, IUCN. Photo: Administración de Parques Nacionales.

(Figure 2). Only four participants had previous experience with the GAA methodology. Therefore 70% of assessors and contributors were engaging in the GAA process for the first time. Additional APN staff also attended the workshop as observers, receiving an introductory overview of the IUCN Red List and the GAA assessment process.

At the beginning of the Third GAA workshop for *Telmatobius* in Argentina, an introductory session on the key steps involved in conducting an assessment for the IUCN Red List of Threatened Species and an overview of the GAA strategy, was delivered by the Chair of the IUCN SSC ASG Regional Working Group of Argentina, who also coordinated the evaluation (Figure 3). During the two days of work, the information contained in each species' fact sheet was reviewed and updated. Over the following two months, distribution maps were refined, and assessors and contributors continued editing the species accounts remotely. Finally, assessors and facilitators applied the IUCN Red List Criteria to propose an updated Category for each species. In November 2025, the completed *Telmatobius* assessments were submitted to ARLA for review prior to their submission to the IUCN Red List for publication.

The incorporation of new experts working on *Telmatobius* species and their habitats represents an important step forward for Red List assessments in Argentina. Their participation contributed to improving the quality and reliability of the updated assessments, providing stronger evidence to inform the conservation status of each species. Furthermore, the information compiled during the third GAA process for *Telmatobius* in Argentina served as an important input for the workshop held in October 2025 in Chile to develop the Conservation Plan for *Telmatobius,* organized by the *Telmatobius* Task Force (https://www.iucn-amphibians.org/telmatobius-task-force/) and the IUCN SSC Conservation Planning Specialist Group (CPSG).

Looking ahead, future assessment cycles will aim to broaden stakeholder participation. The Argentina ASG intends to actively involve technical staff from provincial environmental agencies responsible for biodiversity management, as well as additional personnel from protected-area systems and research institutions. Strengthening collaboration with these stakeholders will help improve the availability of local information, enhance data validation at provincial scales, and promote stronger integration between Red List assessments and conservation planning. Expanding this network of contributors will therefore be a key component of the implementation of the third GAA cycle in Argentina, in close collaboration with ARLA and national partner institutions.

Acknowledgments

We would like to thank the workshop participants who contributed their valuable knowledge and expertise to the reassessment of *Telmatobius* species in Argentina: Rebeca Acosta, Sebastián Barrionuevo, Andrés Brunetti, Carlos Cabrera, Daniela Cano, Sofia Castro Cavichini, Judit Dopazo, Tomás Martínez, Flavio Moschione, Eduardo Sanabria, Rolando Vera. Also, we are thankful to the Municipality of Salta city for the facilities.

Remembering Justin Claude Rakotoarisoa

Adapted from a piece by Devin Edmonds[1] originally published in the Amphibian Ark March 2026 Newsletter No. 73.

[1] Amphibian Ark, Apple Valley, MN, USA

Contact information: devin@amphibianark.org

We were incredibly saddened to hear about the passing of Justin Claude Rakotoarisoa, a founding member of Association Mitsinjo and one of Madagascar's most respected amphibian conservation practitioners. For more than two decades, Justin Claude — known affectionately as JC — was a steady, confident, and reassuring presence within Association Mitsinjo, the Andasibe community, and the wider conservation world.

As the lead running Mitsinjo's amphibian conservation programs, JC carried himself with quiet confidence, offering guidance that was honest, kind, and grounded in personal experience. He brought people together and led by example, earning the respect of colleagues, visiting researchers, and the many technicians, students, and interns he worked alongside over the years. He was reliable, thoughtful, and dedicated, and someone you could always count on.

JC grew up in Ankaizinina, a small village in Analamazaotra Forest Station near Andasibe. His connection to the forest began early. His father patrolled the forest station and JC spent much of his youth interacting with Madagascar's unique

Figure 1: Justin Claude Rakotoarisoa. Photo: Devin Edmonds

Figure 1: Justin Claude Rakotoarisoa at the amphibian breeding facility. Photo: Nirina H. Rakotoson

biodiversity. As a child, he caught chameleons and stood by the road to Andasibe displaying the largest Parson's chameleon he could find to passing buses of tourists. He later became one of Mitsinjo's top guides, specializing in amphibians and reptiles, and later contributed to the Malagasy translation of the 2007 Glaw and Vences Field Guide to the Amphibians and Reptiles of Madagascar.

In 2009, JC was one of six Mitsinjo members to establish the organisation's amphibian breeding facility – the Amphibian Survival Assurance Center in Andasibe - in collaboration with the national government and the ASG Madagascar Regional Group (Edmonds et al. 2012), where he served as lead technician from 2010 onward. Here JC led work which has significantly increased the understanding of the ecology of Malagasy amphibian species, with notable contributions to understanding reproductive biology of analogues to threatened species identified at a 2015 Amphibian Ark Conservation needs Assessment workshop (Rakotoarisoa et al. 2025).

He was generous with his expertise, hosting and training staff from other institutions at Mitsinjo's facility and traveling to share his knowledge elsewhere. He worked with the Madagascar Fauna and Flora Group at Parc Ivoloina to strengthen their amphibian conservation program and husbandry practices. After having received Durrell's Endangered Species Management certificate in Jersey, he supported a staff member from the Durrell Wildlife Conservation Trust in captive husbandry protocols for their ploughshare tortoises. He also coordinated amphibian disease screening initiatives for Andasibe.

In recent years, JC oversaw Mitsinjo's captive assurance colony of the golden mantella frog (*Mantella* *aurantiaca*), classified as Endangered on the Red List. This programme produced tadpoles and juveniles for release into restored habitat (Rakotonanahary et al. 2017). His work strengthened amphibian conservation in Andasibe and built capacity that will endure far beyond his lifetime.

We honour Justin Claude for his leadership, kindness, and commitment to Madagascar's amphibians. He will be deeply missed.

References

Edmonds D., Rakotoarisoa J. C., Dolch R. … Robsomanitrandrasana E. (2012). Building capacity to implement conservation breeding programs for frogs in Madagascar: Results from year one of Mitsinjo's amphibian husbandry research and captive breeding facility. Amphibian and Reptile Conservation, 5, 57–69.

Rakotoarisoa J. C., Rakotoarison A., Rasoanantenaina S. … Edmonds D. (2025). Captive breeding reveals insights into the ecology and reproductive biology of 11 little-known Malagasy frog species. Zoo Biology, 44, 24–35. 10.1002/zoo.21876

Rakotonanahary T. F., Dawson J., Andreone F., Rakotoarisoa J. C. and Edmonds D. (2017). Amphibian captive breeding programs for Madagascar: Where we are now and the road ahead. FrogLog, 118, 37–39.

Contributed Articles

Amphibians reach 9,000 described species: a summary of ongoing trends, challenges, and opportunities

Sky T. Button[1], Franco Andreone[2,3] and Amaël Borzée[1,2]

[1]Laboratory of Animal Behaviour and Conservation, College of Life Sciences, Nanjing Forestry University, Nanjing, China
[2]Amphibian Specialist Group, Species Survival Commission, International Union for Conservation of Nature
[3]Museo Regionale di Scienze Naturali, Via G. Giolitti, 36, I-10123 Torino, Italy

Contact information: sky.tc.button@gmail.com

Amphibians have officially reached 9,000 described species, according to Amphibian Species of the World (Frost, 2025). Although considerable work remains, this benchmark in described species represents a major milestone for both taxonomy and conservation, resulting from thousands of individual studies conducted by countless amphibian research teams. Notably, these teams have persevered despite chronic underfunding, pandemics, and several other research challenges for this notoriously secretive and imperilled group (Gratwicke et al., 2012; Sterrett et al., 2019; Riccaboni and Verginer, 2022). Despite considerable hurdles, the number of recognised amphibian species has more than doubled within the past 40 years (Figure 1), and the number of annual new species descriptions (Figure 2) appears to have peaked only recently, at 180 and 179 new species in 2017 and 2020, respectively. Assuming an approximately logistic relationship between time and the number of recognised amphibian species (i.e., few species described at first, followed by a considerable spike in new descriptions originating in the late 20th century, and an eventual plateau later), true species richness is crudely estimable as double the known richness of the inflection point year (2017 or 2020), yielding ~15,000–16,000 total species as a reasonable (albeit highly uncertain) "best guess" (Murray, 2007). An empirical logistic model (fitting a global species accumulation curve (SAC) for amphibians better than alternative sigmoidal curve shapes, e.g., Gompertz) supports a

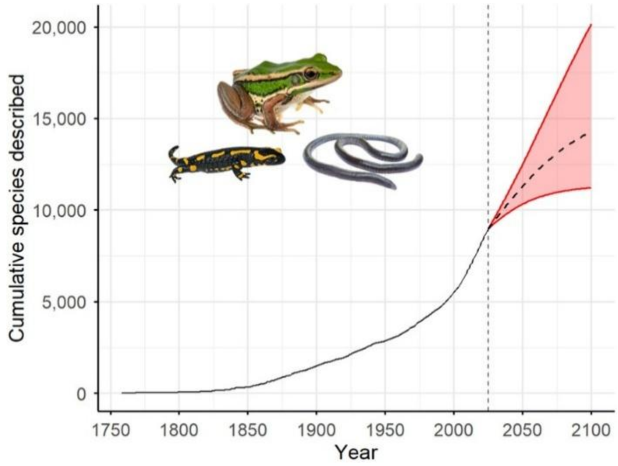


Figure 1: The cumulative number of described amphibian species by past year (solid line) until present (thin, vertical dashed line), plus a model-based estimate of future totals (thick dashed line) and 95% confidence interval (red shading). A logistic model was fit to past species description data while assuming a 2020 inflection point in the overall annual species description rate (see Figure 2). Data: Frost, 2025. Photos: Didier Descouens and Brian Gratwicke.

similar conclusion, predicting 15,372 amphibian species overall, with a 95% confidence interval of ~12,000–20,000 species described by 2100 (Figure 1). A substantial number of amphibian species (potentially ~6,000–7,000, although perhaps far greater or fewer) thus likely remain undescribed, although cumulative knowledge of 9,000 species is nonetheless highly significant and may plausibly represent more than half of all species. Below, we summarise major trends in species descriptions across amphibian orders and continents and suggest potential implications for future research and conservation efforts.

Species description trends by order

Frogs, salamanders, and caecilians all continue to be described at rapid rates (Figure 3), albeit with large differences in absolute numbers. Anurans have been consistently observed as the most speciose amphibian group over hundreds of years and currently comprise ~88% of all known amphibians, with their dominance unlikely to change. Further, both anurans and salamanders (the latter representing ~9% of all amphibians) have followed the same general trend in descriptions as for amphibians overall, with a long, historical period of relatively slow species descriptions transitioning to a rapid spike in description rate near the end of the 20th century, possibly peaking in 2017–2020, although subsequent higher peaks cannot yet be ruled out. Notably, although the description rate for both groups has slowed slightly in the past four years, it is not yet possible to disentangle SAC-based explanations for this decline from impacts of the COVID-19 pandemic, which slowed overall scientific research immensely (Riccaboni and Verginer, 2022). Compared to anurans and salamanders, however, even greater uncertainty exists for caecilians, as the relatively small number of species in this group (*n* = 231, as of mid-December 2025; only ~3% of amphibians) and onerous nature of studying them (Gower and Wilkinson, 2005; Wilkinson and Nussbaum, 2006)—often via manual excavation (Measey, 2004)—mean that the increases in known caecilian richness have been strongly influenced by individual flurries in new research, following a less stable long-term pattern than for anurans or salamanders. Therefore, while logistic model-based estimates predict a modest future attenuation in the number of new caecilian descriptions over time, predictions for this group should be viewed as exceptionally speculative.

Species description trends by continent

Amphibian biodiversity varies considerably between continents, but overall trends in species descriptions also appear driven—to an equal or perhaps greater degree—by historical sampling effort and regional development. Amongst amphibian species with geographic range data, the largest proportion (~37%) occur in South America, followed by Asia (~23%), North America (~17%), Africa (~15%), Oceania (~9%), and Europe (~1%; Frost, 2025). However, these raw percentages do not provide a complete picture, considering that continents differ substantially in their size and current stage of biodiscovery. After correcting (crudely) for area by dividing each continent's proportion of globally known amphibians by its proportion of global (excluding Antarctica) land area (Briggs and Smithson, 1986), South America has by far the highest ratio (proportion of global amphibians ~2.8x higher than proportion of global land area), followed by Oceania (~1.6), North America (~0.9), Asia (~0.7), Africa (~0.7), and Europe (~0.2). Notably, Europe is by far the least amphibian-biodiverse continent (regardless of metric) yet has received arguably the most research attention and shows an approximate inflection point in its SAC in ~1895 (Figure 4), more than 100 years earlier than any other continent. In contrast, SACs appear to have reached an inflection point in ~2016 for Africa and Oceania, and ~2020 (or possibly later, depending on continental-scale COVID-19 impacts and exact ranges of newly-described species) for Asia, North America, and South America. Correspondingly, Europe, despite being the least consequential continent for amphibian conservation, is also the only continent poised to reach an asymptote in new species descriptions (i.e., describe nearly all species) by 2100. This trend not only reflects Europe's low overall biodiversity, but also an ongoing fundamental misallocation of research funds, in favour of economically privileged regions (Peterson and Bode, 2021; Zhang et al., 2023). Notably, this phenomenon also favours disproportionate research within large portions of North America and Oceania (specifically the United States, Canada, Australia, and New Zealand), but comparatively inadequate research funding in other portions of these continents (e.g., within Central America and Papua New Guinea) has ensured that SACs for amphibians in these continents are not yet nearing their plateaus. Only ~2% of known species occur on more than one continent, highlighting the exceptional endemism of amphibians in comparison to other major groups of vertebrates.

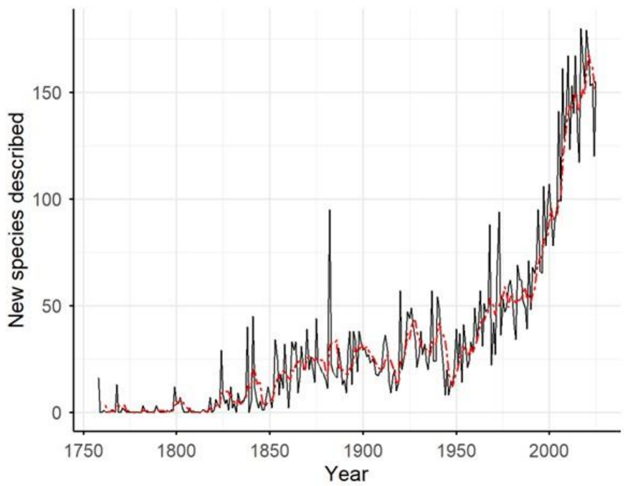


Figure 2: Trends in the description rate of new amphibians, showing actual annual trends (solid black line) and five-year running averages (dashed red line). Data: Frost, 2025.

Impacts of broader trends in taxonomy

Across all orders and continents, long-term trends in new amphibian species descriptions have been affected both by overall scientific interest and technological progress. For example, increased species description rates during the past several decades have coincided with increases in amphibian research overall (Womack et al., 2022). During the latter half of this period, modern, integrative taxonomy tools have also become rapidly more widespread and are now frequently used to describe new species (Streicher et al., 2020). However, the tendency for most new species to be described by taxonomists means that a shortage of these

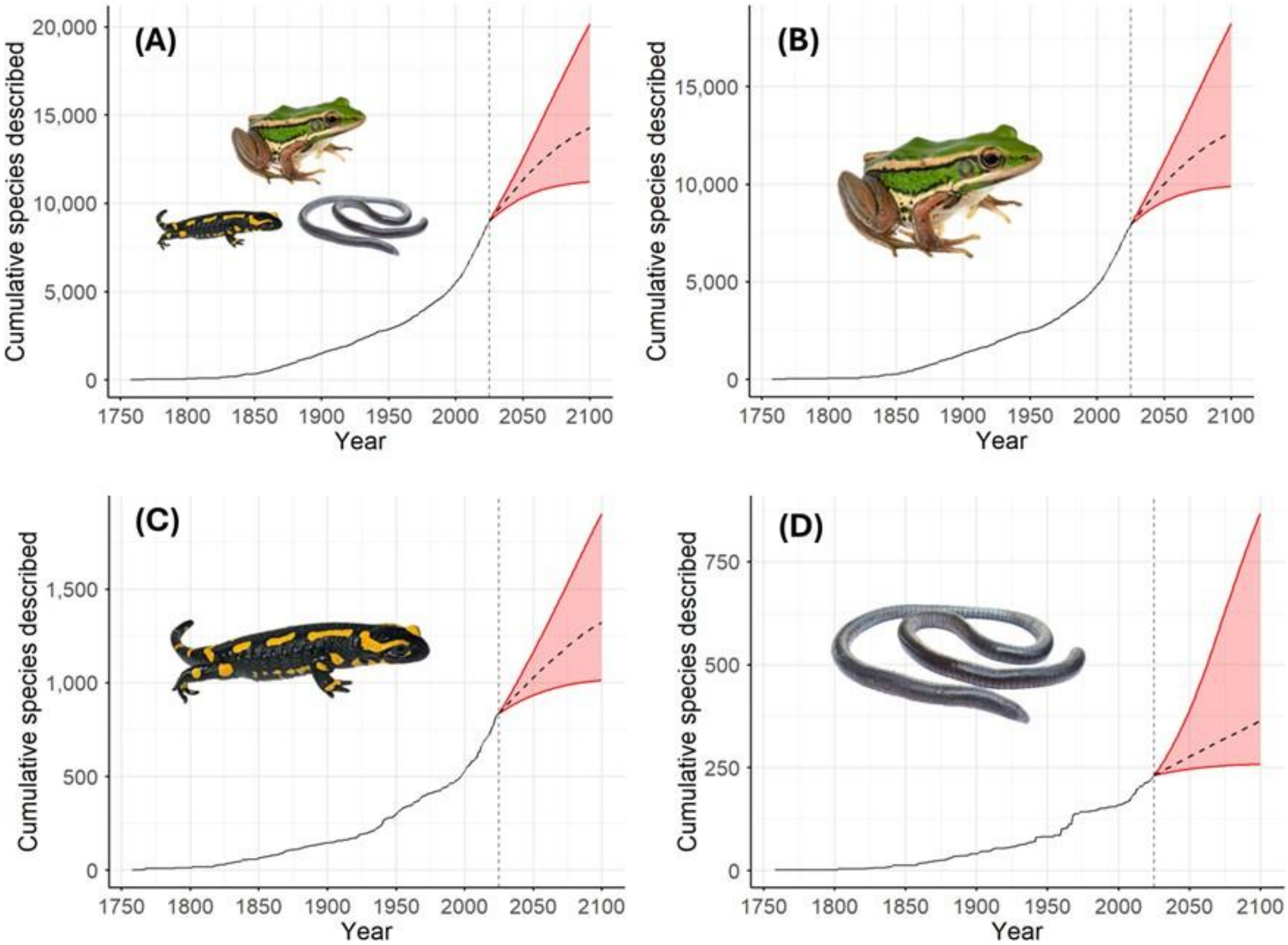


Figure 3: The cumulative number—grouped by taxonomic order—of described amphibian species by past year (solid line) until present (thin, vertical dashed line), plus a model-based estimate of future totals (thick dashed line) and 95% confidence interval (red shading). Plots represent all species (A), anurans (B), salamanders (C), and caecilians (D). A logistic model was fit to past species description data while assuming a 2020 inflection point in the overall annual species description rate (see Figure 2). Data: Frost, 2025. Photos: Didier Descouens and Brian Gratwicke

specialists can seriously limit description rates, even when access to relevant technology is high (Engel et al., 2021). As a result, the underappreciation of taxonomists by institutions and funding bodies —particularly in recent decades (Löbl et al., 2023)—has been implicated in “taxonomic impediment”, wherein species are not described quickly enough to identify and address relevant threats to their conservation (Raposo et al., 2021). Relatedly, ongoing institutional pressures on taxonomy could ultimately decrease future rates of species descriptions beyond those projected by SACs, in turn limiting conservation assessment tools wherein species serve as fundamental units (Mace, 2004). If taxonomy remains undervalued, resulting threats to undescribed species may be severe overall: while nearly half of all described amphibians are threatened or declining (Luedtke et al., 2023), undescribed species are even more likely to be threatened (Liu et al., 2022) and may have extinction risks amplified by taxonomic uncertainty (Angulo and Icochea, 2010). Nevertheless, improved data-sharing between taxonomists and non-taxonomists may partially improve certain conservation outcomes, as this practice ensures that conservation assessments and management plans can be more rapidly formulated as new species are eventually described (Tapley et al., 2018).

Conclusion

The description of 9,000 amphibian species is nothing short of remarkable considering the ongoing taxonomy funding crisis (Al-Asif and Nerurkar, 2024). However, while overall species description rates have potentially peaked in the past decade (Figure 1), subsequent declines should nonetheless be considered modest and inconclusive given additional research challenges posed by COVID-19 in these same years (D. Frost, pers.

comm.). Regardless of the precise peak year for new species descriptions, any future plateau appears distant; 2025 has—as of mid-December—yielded >95% of the peak number of annual descriptions. Based on this continually high species description rate, it appears unlikely that fewer than ~3,000 additional amphibians will be described by 2100, with ~15,000–16,000 species appearing as a reasonable "best guess" (based both on empirical models and rule-of-thumb heuristics) for the total number of extant species.

Based on a combination of the trends described herein and in previous studies, a simple but alarming thought experiment is possible. Assume that (a) a few thousand

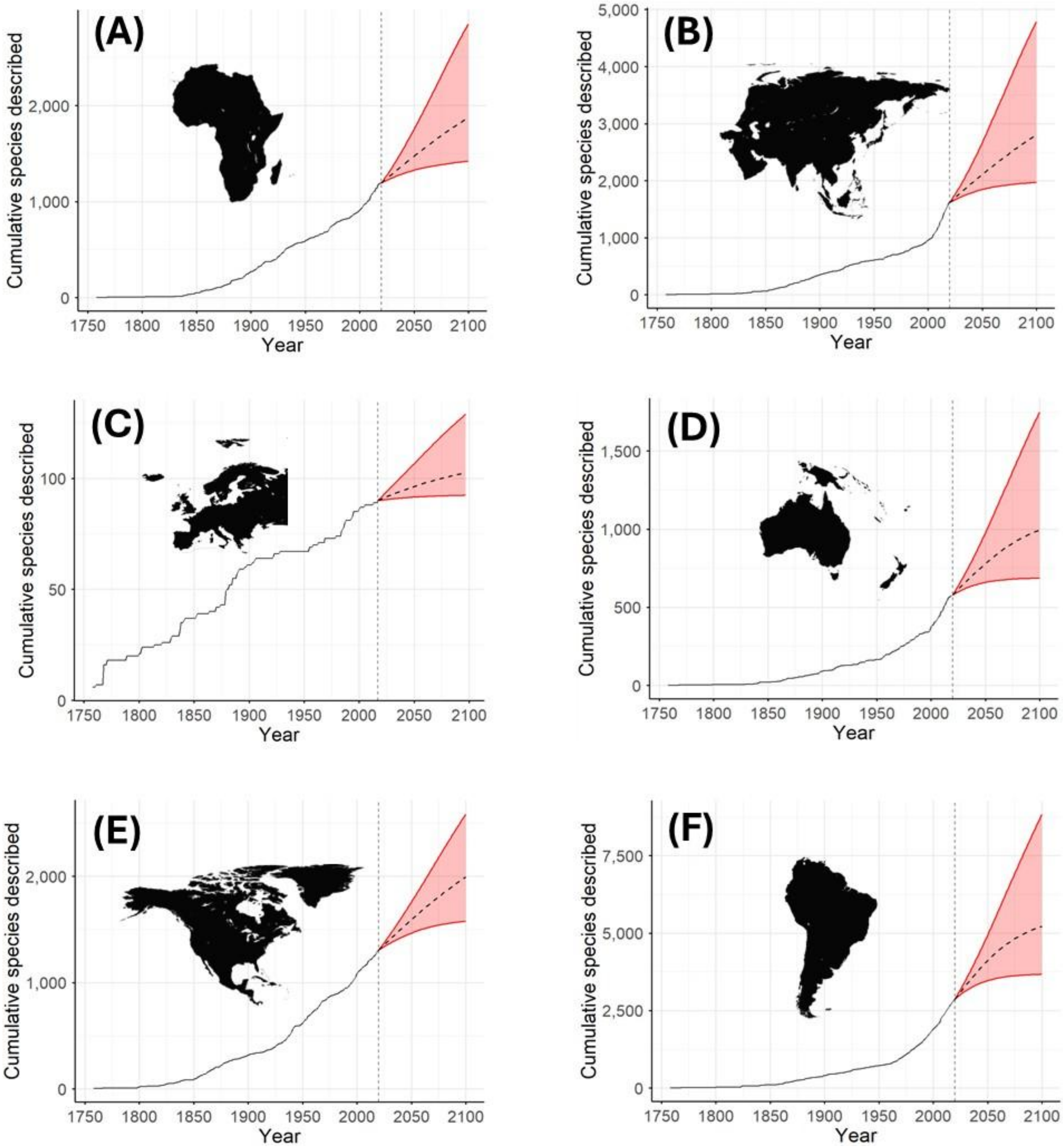


Figure 4: The cumulative number—grouped by continent—of described amphibian species by past year (solid line) until 2020 (thin, vertical dashed line), plus a model-based estimate of more contemporary and future totals (thick dashed line) and 95% confidence interval (red shading). Plots represent Africa (A), Asia (B), Europe (C), Oceania (D), North America (E), and South America (F). A logistic model was fit to past species description data while assuming an inflection point year of 2020 for Asia, North America, and South America, 2016 for Africa and Oceania, and 1895 for Europe. Threshold years were chosen for each continent based on its estimated peak in the rate of new species descriptions. Species described after 2020 were excluded from continent-specific models, due to a lack of available geographic range polygons for the majority. Data: Frost 2025.

amphibian species (~2,000–8,000) remain undescribed by 2050 (Figure 1), (b) ~30–50% of these species are at risk of extinction without new conservation interventions (Luedtke et al., 2023), and (c) ~10–70% (unknown in practice; thus assigned a wide range) of these threatened, undescribed species will not incidentally benefit from other future conservation developments at a sufficient level to avoid extinction by 2050. The product of these three ranges of possibilities—which are intentionally cautiously broad—is that insufficient biodiscovery is on track to be implicated in 60–2,800 amphibian extinction events by 2050. These extinctions are likely—based on ongoing knowledge gaps (Figures 3–4)—to span all three amphibian orders, yet be particularly pervasive within South America, Africa, Asia, and underfunded portions of North America and Oceania. Therefore, augmentation and better allocation of taxonomy funding to these regions is urgently needed and may help prevent dozens (at minimum), hundreds, or even thousands of future extinction events, considering that describing new species is often an important first step towards conserving them (Costello et al., 2015). These steps will undoubtedly require rapid institutional overhaul in a manner that reprioritises taxonomy, while simultaneously deprioritising geographically misallocated (e.g., Eurocentric) research with roots in geopolitical inequality.

References

Al-Asif A. and Nerurkar S. (2024). Taxonomy in crisis: addressing the shortage of taxonomists in a biodiversity hotspot era. Journal of Aquatic Research and Sustainability, 1, 1–4.

Angulo A. and Icochea J. (2010). Cryptic species complexes, widespread species and conservation: lessons from Amazonian frogs of the *Leptodactylus marmoratus* group (Anura: Leptodactylidae). Systematics and Biodiversity, 8, 357–370. 10.1080/14772000.2010.507264

Briggs D. and Smithson P. (1986). Fundamentals of physical geography. Bloomsbury Publishing PLC.

Costello M. J., Vanhoorne B. and Appeltans W. (2015). Conservation of biodiversity through taxonomy, data publication, and collaborative infrastructures. Conservation Biology, 29, 1094–1099. 10.1111/cobi.12496

Engel M. S., Ceríaco L. M., Daniel G. M. … Agarwal I. (2021). The taxonomic impediment: a shortage of taxonomists, not the lack of technical approaches. Oxford University Press.

Frost D. R. (2025). Amphibian Species of the World 6.2, an Online Reference, https://amphibiansoftheworld.amnh.org (2025).

Gower D. J. and Wilkinson M. (2005). Conservation biology of caecilian amphibians. Conservation Biology, 19, 45–55.

Gratwicke B., Lovejoy T. E. and Wildt D. E. (2012). Will amphibians croak under the endangered species act? BioScience, 62, 197–202.

Liu J., Slik F., Zheng S. and Lindenmayer D. B. (2022). Undescribed species have higher extinction risk than known species. Conservation Letters, 15, e12876. 10.1111/conl.12876

Löbl I., Klausnitzer B., Hartmann M. and Krell F.-T. (2023). The silent extinction of species and taxonomists—An appeal to science policymakers and legislators. Diversity, 15, 1053.

Luedtke J. A., Chanson J., Neam K. … Stuart S. (2023). Ongoing declines for the world's amphibians in the face of emerging threats. Nature, 622, 308–314. 10.1038/s41586-023-06578-4

Mace G. M. (2004). The role of taxonomy in species conservation. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 359, 711–719.

Measey G. J. (2004). Are caecilians rare? An east African perspective. Journal of East African Natural History, 93, 1–21.

Murray J. D. (2007). Mathematical biology: I. An introduction. Springer Science & Business Media.

Peterson K. and Bode M. (2021). Using ensemble modeling to predict the impacts of assisted migration on recipient ecosystems. Conservation Biology, 35, 678–687.

Raposo M. A., Kirwan G. M., Lourenco A. C. C. ... Stopiglia R. (2021). On the notions of taxonomic 'impediment', 'gap', 'inflation' and 'anarchy', and their effects on the field of conservation. Systematics and Biodiversity, 19, 296–311.

Riccaboni M. and Verginer L. (2022). The impact of the COVID-19 pandemic on scientific research in the life sciences. PLoS One, 17, e0263001. 10.1371/journal.pone.0263001

Sterrett S. C., Katz R. A., Brand A. B. … Grant E. H. C. (2019). Proactive management of amphibians: Challenges and opportunities. Biological Conservation, 236, 404–410.

Streicher J. W., Sadler R. and Loader S. P. (2020). Amphibian taxonomy: early 21st century case studies. Journal of Natural History, 54, 1–13.

Tapley B., Michaels C. J., Gumbs R. … Rowley J. J. (2018). The disparity between species description and conservation assessment: A case study in taxa with high rates of species discovery. Biological Conservation, 220, 209–214.

Wilkinson M. and Nussbaum R. A. (2006). Caecilian phylogeny and classification. In: Reproductive Biology and Phylogeny of Gymnophiona (Caecilians). Exbrayat J.-M. (Ed.) 39–78.

Womack M. C., Steigerwald E., Blackburn D. C. … Spencer C. L. (2022). State of the Amphibia 2020: A review of five years of amphibian research and existing resources. Ichthyology & Herpetology, 110, 638–661.

Zhang L., Yang L., Chapman C. A. … Fan P.-F. (2023). Growing disparity in global conservation research capacity and its impact on biodiversity conservation. One Earth, 6, 147–157.

Scientific research and community engagement for amphibian conservation in Maromizaha Reserve, Madagascar

Dina L. Ramamonjisoa[1], Randriamialisoa[2], Andolalao Rakotoarison[3], Franco Andreone[4,5], Angelica Crottini[6]

[1] Miaro ny Sahona Association, RM-101 Antananarivo, Madagascar
[2] Groupe d'Etude et de Recherche sur les Primates de Madagascar, RM-101 Antananarivo, Madagascar
[3] Mention Environnement, Université de l'Itasy, Faliarivo Ambohidanerana, 118 Soavinandriana Itasy, Madagascar; School for International Training, VN 41A Bis Ankazolava Ambohitsoa, RM-101 Antananarivo, Madagascar
[4] Museo Regionale di Scienze Naturali, I-10123 Torino, Italy
[5] IUCN SSC Amphibian Specialist Group, CH-1196 Gland, Switzerland.
[6] Department of Biology, University of Florence, Sesto Fiorentino I-50019, Italy

Contact information: miaronysahona@gmail.com

In 2024, the MISA association (Miaro ny Sahona), under the supervision of ASG Madagascar (the Regional Working Group of the Amphibian Specialist Group in Madagascar), and GERP (Groupe d'Etude et de Recherche sur les Primates de Madagascar) signed a collaboration agreement so that Maromizaha Reserve could be established as a MISA's pilot site for amphibian conservation. Since 2025, these organizations have carried out several on-site activities, many of which involve local communities.

Maromizaha is an evergreen mid-elevation tropical forest located in eastern Madagascar (Rakotomalala *et al*. 2015). It belongs to a mosaic of forest patches which includes Analamazaotra, Mantadia, Vohimana, and Vohidrazana, and is part of the CAZ (Corridor Ankeniheny-Zahamena) (Rabemananjara, 2016), and it is known to contribute to maintaining the biodiversity of the CAZ by acting as a biological bridge.

Due to close collaboration between the park managers and local communities, Maromizaha has not experienced any forest fires since 2018 (GERP, 2026). The main threats faced by Maromizaha's biodiversity are multiple and includes attempts at forest conversion by shifting slash-and-burn agriculture (tavy) practices, charcoal production and illegal logging, primarily in peripheral areas, but also hunting and mining in more internal areas, although these activities seem to be under some control within the Reserve (FAPBM, 2026). However, population growth in the region is increasing local communities' needs for land use and extraction of forest products (GERP, 2023), requiring the strengthening of conservation and local development activities.

Figure 1: Nocturnal survey in Maromizaha. Photo: Tsirimanjaka Tsinjoary Ranaivojaona.

Protected areas such as Maromizaha are essential for maintaining the biological diversity and ecological processes necessary for ecosystem survival. To implement an effective conservation strategy, it is essential to have an up-to-date database on the species inhabiting the Reserve. In the case of Maromizaha, little information is available on the amphibians inhabiting the Reserve, despite a few surveys having already been conducted on this group in the past. In fact, most of these surveys were conducted during the day, which meant that diurnal species were primarily recorded. In addition, some were carried out during the dry season, when amphibians are less active. To compile an exhaustive list of amphibian species inhabiting the area, MISA, in collaboration with L'Institut Supérieur des Sciences, de l'Environnement et du Développement Durable (University of Toamasina), Madagascar Fauna and Flora Group, Museo Regionale di Scienze and the Universities of Torino and Florence supported the implementation of an amphibian survey of the Reserve in early 2026 (Figure 1). This survey allowed the identification of approximately 60 amphibian species in Maromizaha (Figure 2). Among these species, six to 12 were recorded for the first time in the Reserve. The information collected under this initiative will help identify candidate species and the amphibian species that require urgent conservation actions. This will guide managers in developing

Figure 2: A. *Boophis lichenoides*; B. *Mantidactylus opiparis*; C. *Mantella baroni*; D. *Boophis madagascariensis*. Photo: Tsirimanjaka Tsinjoary Ranaivojaona.

strategic plans for the conservation of different amphibian species, and will contribute to the development of a photographic guide to the amphibians of Maromizaha.

The safeguard of protected areas is often associated with limitations to the use of environmental resources. For this reason, training and capacity-building initiatives are a way to support local communities to diversify their sources of income. In 2025, MISA organized training in embroidery and basic cutting and sewing techniques (Figure 3) for the women from the Maromizaha Women's Association. This association was selected because the work of these women is a source of income for their families, and with this training it was possible to equip them with new skills and to provide equipment to these communities so that they could integrate their own income and become more self-reliant. The products produced by this association are sold to visitors of the Reserve, and today, embroidery represents one of the income-generating activities for women in Maromizaha.

In Maromizaha, most of the field guides come from surrounding villages, and many of them did not pursue higher education. MISA and GERP organized a capacity-building program in French and English to support the

Figure 3: Women from local communities embroidery crafts. Photo: Michel Strogoff.

Figure 4: Group photo of participants in the training course on identifying amphibians and reptiles of Madagascar. Photo: Michel Strogoff.

Figure 5: Training for local guides on identifying Malagasy amphibians and reptiles with Prof. Dr. Miguel Vences. Photo: Michel Strogoff.

training of local guides and to professionalize visitor services, facilitate the sharing of knowledge and thereby enhance the site's ecotourism value. They also received targeted training in field techniques to identify Malagasy amphibians and reptiles from Prof. Dr. Miguel Vences, one of the major experts in Madagascar's herpetofauna (Figure 4). The goal of this training was to strengthen their scientific expertise in identifying the site's amphibians (Figure 5). In the future, this will enable them to actively participate in data collection and long-term species monitoring and to assist researchers conducting studies on the amphibians of Maromizaha.

Our vision is that, in the coming years, also with the continuing support of MISA, the combined efforts of scientific research and community engagement will strengthen amphibian conservation in Maromizaha. This synergy will ensure sustainable socioeconomic development, transforming the reserve into a model of resilience where science and local expertise come together to ensure the long-term protection of the reserve.

Acknowledgments
We would like to sincerely thank Synchronicity Earth for funding our amphibian conservation activities in Madagascar, and the GERP team in Maromizaha for their enthusiasm and collaboration in supporting us in carrying out all these activities on the ground. We also thank Prof. Dr. Miguel Vences and his team, Nasoavina Christin and Andriantsoa R. T. Rakotovazaha for training the local guides, as well as the local guides and the association of women in Maromizaha. We thank Tsirimanjaka Tsinjoary Ranaivojaona and Michel Strogoff for providing access and use of their pictures.

References
FAPBM, https://www.fapbm.org/aire_protegee/reserve-maromizaha/ (2026)

GERP Madagascar (2023). Plan d'Aménagement et de Gestion de la Réserve de Maromizaha 2023-2027. GERP, available at https://www.fapbm.org/app/uploads/2020/08/FAPBM-PAG-MAROMIZAHA.pdf

GERP, https://www.association-gerp.org/maromizaha (2026)

Rabemananjara B. H. (2016). Dynamique spatio-temporelle de la forêt de Maromizaha et ses périphéries. Mémoire de Master, Université d'Antananarivo.

Rakotomalala F. A., Rabenandrasana J. C., Andriambahiny J. E. ... Grinand C. (2015). Estimation de la déforestation des forêts humides à Madagascar utilisant une classification multidate d'images Landsat entre 2005, 2010 et 2013. Revue Française de Photogrammétrie et de Télédétection, 211-212, 11–23. 10.52638/rfpt.2015.537

Wildlife photography plus unethical guiding imperils two of Costa Rica's rarest amphibians

César L. Barrio-Amorós[1]

[1] CRWild, Tinamastes, San José, Costa Rica.

Contact information: cbarrioamoros@crwild.com

The rise of amphibian tourism and its hidden costs
Photography of nature was once an elite pursuit, limited by cost and access. Today, digital cameras, social media, and booming ecotourism have democratized close encounters with rare wildlife around the world. Images of charismatic amphibians now spread globally, aiding documentation, awareness, responsible tourism and conservation (Barrio-Amorós 2025). Yet, the drive for "must-see" shots has shifted priorities for some guides and photographers, turning respectful observation into harmful pursuits that endanger the species they celebrate.

A nature guide serves as a professional interpreter of the natural world, bridging the gap between scientific data and the visitor's experience. In addition to leading hikes or boat expeditions, they translate complex ecological relationships into engaging narratives, managing group safety and logistics in often-unpredictable tropical environments. Their role is as much about education as it is about conservation ethics, ensuring "Leave No Trace" principles are followed to minimize human impact on fragile ecosystems. In Costa Rica, the profession is highly regulated; most guides are certified by the ICT (Costa Rican Tourism Board), requiring deep knowledge of local natural history and risk management. While many are generalists, there is a distinct category of specialists- experts in fields such as herpetology, ornithology, or photography - who provide high-level technical insights for scientific expeditions and specialized tourism.

But also, there is the other side of the coin. Unethical guiding harms animals (amphibians in this case) through repeated disturbances that alter behaviour, disrupt breeding, and heighten predation risks. Handling without precautions causes stress, injury, and pathogen spread, while microhabitat destruction - like flipping rocks or clearing vegetation - degrades essential environments. These threats are dire for range-restricted endemics surviving in tiny populations, where even small losses can tip the balance toward extinction.

Figure 1: An individual of *Atelopus varius* in a natural population. Photo: César Barrio-Amorós, taken *in situ.*

Spotlight on two threatened endemics
Here, we highlight impacts on two of Costa Rica's rarest amphibians: the Critically Endangered variable harlequin toad *Atelopus varius* (endemic to Costa Rica and Panama) and the high-elevation plethodontid salamander *Bolitoglossa pesrubra* (endemic to the central Talamancan Range in Costa Rica). Observations draw from long-term monitoring of *A. varius* (Barrio-Amorós et al. 2021; Barrio-Amorós et al. 2024) and field experience in highland salamander habitats. Precise locations are omitted to prevent further harm.

Atelopus varius (Figure 1) once thrived along Costa Rican streams but suffered massive declines from chytridiomycosis and human pressures (Barrio-Amorós et al. 2021). Only a few low-density populations remain in Costa Rica. One relatively stable and accessible site, attracts both permitted research and unregulated tours, creating conservation conflicts (Jiménez-Monge et al. 2019).

Bolitoglossa pesrubra (Figure 2), a paramo specialist, was historically abundant under rocks and in moist ground cover (Vial 1968). Now rarely seen despite many personal (and from colleagues) searches, its decline likely stems from microhabitat degradation. As a microhabitat-dependent species relying on cool, humid refuges, it's highly vulnerable to disturbances like

Figure 2: *Bolitoglossa pesrubra* from the Highlands of Talamancan mountains in Costa Rica. Photo: César Barrio-Amorós, taken *in situ.*

trampling or object flipping, which could erase local subpopulations.

Documented cases of harmful practices

At a key *A. varius* location, we are aware of repeated nighttime visits by licensed and unlicensed guides advertising "guaranteed" encounters via social media (especially Instagram). Groups enter streams, trample breeding banks, walk along *Atelopus* territory and use headlamps to locate the sleeping toads, and even collect animals (Figure 3) for a better place to set their pictures. Animals are often handled bare-handed, repositioned on props for photos, and passed around - ignoring stress, injury, or desiccation risks. Intense flashes (Figure 4) can disrupt metabolic functions like courtship and oviposition, potentially decreasing reproductive success in already fragile populations. Even more alarming, some of these visitors will know the place and can come back after for illegal collecting and/or poaching.

For *B. pesrubra*, I have seen, along salamander territory, so many flipped rocks (Figure 5) and logs, often left inverted or displaced, exposing moist underside microhabitats and compacting vegetation. This destroys humid microclimates vital for cutaneous respiration, and refuges for invertebrates, which are the basic food of the salamanders. Alarmingly, 95% of suitable rocks along popular paths in national parks (e.g., Los Quetzales, Chirripó, and Tapantí) are flipped and left in that way, making those microhabitats not viable in the following years (own data).

Social media amplifies the issue: posts with staged images and location hints draw more visitors, creating a "tragedy of the commons" (Rajkumar et al. 2025). Guides, driven by profit, sometimes lead unvetted

Figure 3: A tourist with an *Atelopus varius* in a bag. There is no justification to capture any Critically Endangered species without research permits. AI generated comics-style picture used to illustrate behaviour.

tourists - risking illegal collection for the pet trade. In my experience, even trusted former colleagues have betrayed sites by bringing paying groups, underscoring the need for stricter controls.

Biosecurity failures and their consequences

These practices usually violate biosecurity protocols,

Figure 4: A careless tourist taking pictures at night with flash (without diffuser). AI generated comics-style picture used to illustrate behaviour.

Figure 5: In the habitat of *Bolitoglossa pesrubra* is possible to encounter many (as much as 95% in certain paths) rocks flipped and left like this. This reckless action destroys suitable microhabitats not only for salamanders but for many other species. Photo: César Barrio-Amorós.

which mandate minimal handling, gloves, and disinfection to curb pathogens like *Batrachochytrium dendrobatidis* (*Bd*) (Lobos et al. 2011; Barrio-Amorós 2024 CRWild biosecurity recommendations); bare-handed contact spreads diseases across individuals and sites, exacerbating declines. In contrast, permitted research shows low-impact methods are possible: using tools, disinfecting gear, avoiding sensitive areas, and prioritizing animal welfare over the ultimate targeted species photo for a selfish prize.

Pathways to ethical reform

To safeguard these species, Costa Rica (and all other countries) must enforce ethical standards for amphibian tourism and photography by:

1) Developing a national code of conduct prohibiting handling, repositioning, night visits to breeding sites, intense lights, and microhabitat flipping.
2) Requiring biosecurity compliance and visitor forms with contact details for accountability.
3) Incorporating conservation training into guide licensing with evaluations on ethics, which is not just increasing the client's satisfaction. Empower rangers through workshops with herpetologists and NGOs to intervene in violations.
4) Imposing fines, license revocations, and permit denials for offenders. Media platforms should reject unethical images and promote responsible examples.
5) The herpetological community must document impacts, publish guidelines, and engage stakeholders. Survival of *A. varius* and *B. pesrubra* (just taken as representative models, as this affects not only these two species) hinges on ethical behaviour alongside disease and habitat management - without change, tourism may hasten their loss.

Acknowledgements

Thanks to Costa Rican authorities for permits (ACOSA/INV/01417), CRWild volunteers for monitoring, and local communities for supporting ethical practices. Matt Moran helped adapting some ideas to the English text.

References

Barrio-Amorós C. L. (2024). Why shouldn't amphibians be touched with bare hands? Biosecurity protocols for amphibians, https://www.crwild.com/single-post/why-shouldn-t-amphibians-be-touched-with-bare-hands.

Barrio-Amorós C. L. (2025). An overview on herping diversity in Caribbean Costa Rica. *Responsible* Herpetoculture Journal, 23, 22–40.

Barrio-Amorós C. L., Chaves G. and Puschendorf R. (2021). Current status and natural history of the critically endangered Variable harlequin toad (*Atelopus varius*) in Costa Rica. *Reptiles & Amphibians*, 28, 374–388. 10.17161/randa.v28i3.15818

Barrio-Amorós C. L., Chaves G. and Puschendorf R. (2024). Estado de conservación e historia natural del sapito arlequín variable *Atelopus varius* en Costa Rica. In: Atelopus, ¿un género en vías de extinción? Blanco A. and Barrio-Amorós C. L. (Eds.) EXPLORA Ed. Especial, 88–111.

Jiménez-Monge A., Montoya-Greenheck F., Bolaños F. and Alvarado G. (2019). From incidental findings to systematic discovery: locating and monitoring a new population of the endangered harlequin toad. Amphibian & Reptile Conservation, 13, 115–125.

Lobos G. A., Vidal M., Labra M. A. … Soto C. (2011). Protocolo para el control de enfermedades infecciosas en Anfibios durante estudios de campo. Red chilena de herpetología.

Rajkumar K. P., Tapley B., Das J., Das S. and Easa P. S. (2025). Unethical wildlife photography imperils the Western Ghats endemic galaxy frog, *Melanobatrachus indicus* Beddome, 1878. Herpetology Notes, 18, 1169–1174.

Vial J. L. (1968). The ecology of the tropical salamander, *Bolitoglossa subpalmata*, in Costa Rica. Revista de Biologia Tropical, 15, 13–115.

Designing encountering paths for humans and newts: transdisciplinary design interventions

Laura Boffi[1] and Angiolina De Angelis[2]

[1] Spirited Design Office, Rome, Italy
[2] Società Agricola DA come una volta, Caramanico Terme, Italy

Contact information: boffilaura@gmail.com

How can a shepherd, her sheep and newts co-exist and thrive together while sharing the drinking trough as a common resource in grazing areas?

This was the transformative challenge that emerged from the fieldwork that we (the designer Laura Boffi, and the shepherd Angiolina De Angelis) run together in the mountainous areas of Abruzzo in central Italy. Covering a period from October 2022 to September 2023, we have been focusing on traditional farming traditions in the protected mountain areas of the Abruzzo region, whose agropastoral practices are historically rooted in local communities' culture. We conducted participatory observation, shadowing sessions, digital ethnography activities and in-depth interviews with farmers and shepherds belonging to the Majella and Gran Sasso massif territories, who have chosen to return to the mountains to revive traditional sheep herding and farming practices. Ethnographic accounts foreground an embodied eco-commoning approach to farming which has been inherited from ancestors and has contributed to shaping, enriching and preserving the current environmental landscape. On the other hand, the re-activation of traditional agropastoral activities in the current context may present novel challenges and even hidden risks of unintentionally failing in reciprocal care among farmers/shepherds and the more-than-humans, due to modified environmental and anthropic conditions, the current different approach to environmental conservation, and the knowledge gap between growing scientific knowledge and inactive local environmental knowledge (Boffi, 2023).

During one of our fieldwork Angiolina pointed exactly in this direction. While driving on a "pasture safari" during the ethnographic research, she was prompted by the sight of a drinking trough in the middle of the field and, suddenly turning to a reflective mode, started sharing the episode when a ranger admonished her and almost issued a fine, because she could have potentially harmed newts breeding as she had been cleaning the drinking trough from green plants growing inside. She was just taking care of her flock, making sure they would drink clear water, and couldn't really understand why her care would cause such harm (Figure 1). She was unaware of the existence of newts, never having seen one in her life or being told about them by her shepherd ancestors; how could she even care for them? Newts are elusive and cryptic by nature, and due to wetlands shrinking, nowadays they often choose artificial troughs as their habitat (Buono et al., 2019). Based on this, we conceptualised "an encountering path" for the participant shepherd and the newts, which would reveal their presence, or even a sense of

Figure 1: The trough as a common for the shepherd, sheep and newts. Photo: Angiolina De Angelis

their proximity, when they are concealed in mud or in the egg phase. Such an “encountering path” consisted of shepherd Angiolina performing an environmental DNA analysis (eDNA) of the trough water while opening up her thoughts to me, busy video-recording the session, about sheep husbandry regulations, challenges and unwanted frictions with biodiversity conservation (Figures 2 and 3). The video is available at this web address: https://youtu.be/jdxn1sDE8l8.

Figure 2: A frame from the video of the shepherd performing the eDNA analysis. Photo: Laura Boffi

Would this enacted reflection bring a new awareness of, and connection to, the newts? Would Angiolina stop or plan the cleaning so to care about newts presence? This is the aim of the design intervention.

Figure 3: You can scan this QR code to watch the video.

Similarly, during her ethnographic fieldwork in the mountainous inner land of Abruzzo, we found that newts were also breeding in the artificial troughs of Montebello di Bertona village. The village has developed in recent years a community tradition: dedicating a so-called “ecological day” to cleaning the public areas of the village in order to enhance the experience for excursionists (Figure 4). This meant that

Figure 4: People busy in cleaning nearby the trough. Photo: Laura Boffi

local people would clear the mud and vegetation from the drinking troughs, being mostly unaware of the potential harm inflicted on populations of newts that are likely breeding in such water. In agreement with the local municipality and associations, on the same ecological day of 2023 we organised a parallel bioblitz at the troughs, with the scientific support of ecologist Francesco Cerini (Figure 5). The bioblitz was meant to pause any cleaning and gather people to attend to the organisms living in the water, such as the many newly born newts (Figure 6). A physical, embodied suspension of disbelief. This participatory action successfully stopped the removal of green elements and mud from the troughs on that day, as people discovered biodiversity living in them (Figure 7). The action culminated in an eDNA analysis of the water of a trough. That analysis was particularly interesting because it apparently revealed the presence of *Salamandrina terdigitata*, whose distribution had so far been recorded in southern territories compared to Montebello di Bertona. This result alone does not constitute a scientific fact, but it certainly fosters curiosity and pushes for further investigation in that

Figure 5: The ecologist Francesco Cerini guiding the bioblitz at the troughs. Photo: Laura Boffi

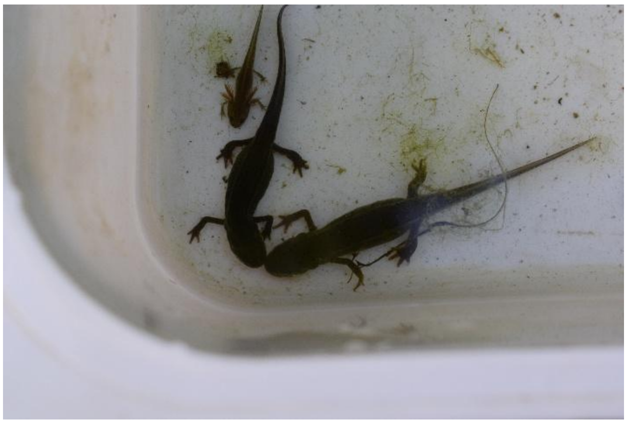


Figure 6: Some newts from the trough. Photo: Laura Boffi

area, which other scientists could take on. The eDNA results were returned to the community. They were collectively enacted during a co-creation workshop aimed at retracing and updating the entanglements between humans and newts (Figure 8). The impact of this intervention was significant: in the following years (2024 and 2025), the Montebello di Bertona community ceased all cleaning activities in the Marianna trough, where eDNA analysis had been conducted. They intend to maintain this approach in the future. In 2026, they also decided to designate the trough as a local landmark by installing signage to inform residents, trekkers, and visitors about newt breeding and the importance of its conservation.

The encountering paths for humans and newts are transdisciplinary design interventions which try to address human–newt coexistence through a creative and reflective approach grounded in scientific methodologies (Mesa-Jurado et al., 2025). As well, this approach deliberately refrains from any didactic or punitive stance, instead fostering situated reflection and curiosity about the presence of newts. Science is

Figure 7: Performing the eDNA analysis in the Marianna trough in Montebello di Bertona. Photo: Laura Boffi

Figure 8: During the workshop, participants created excursion paths to visit the troughs. Photo: Laura Boffi

enacted in untraditional domains, embedded in a performative framework, prompting reflection in people and hopefully changes in the way they think about and relate to newts. This endows such design interventions with transformative potential.

Acknowledgments

The work described in this paper has been partially funded by a research fellowship by University Ca' Foscari Venice. We deeply thanks ecologist Francesco Cerini who collaborated in the bioblitz in Montebello di Bertona with extreme dedication and professionalism, as well as the Associazione Culturale Montanari Bertoniani for coordinating the activity locally and for funding the eDNA analysis of Montebello di Bertona trough. Many thanks to Leonardo Vignoli for providing newts samples for eDNA modelling and scientific insights. We also acknowledge the collaboration with Spygen Lab for the eDNA analysis and guidance by Alice Valentini. The bioblitz in Montebello di Bertona couldn't be organized without the motivation and commitment of some of the members of the Beeodiversity Park: Alessandro Buccella, Gianni Crescia, Antonello Iannacci, Valentina Buccella, who also helped in the eDNA analysis.

References

Boffi L. (2023). Updating natureculture practices in Abruzzo: Towards the prototyping of new ecological relationships between shepherds, farmers, animals and plants. *In:* Proceedings of the 11th International Conference on Communities and Technologies. Association for Computing Machinery.

Buono V., Bissattini A.M., Vignoli L. (2019). Can a cow save a newt? The role of cattle drinking troughs in amphibian conservation. In: Aquatic Conservation: Marine and Freshwater Ecosystems.

Mesa-Jurado M.A., Novo P., Calderón-Contreras R. … Balvanera P. (2025). Meaningful transdisciplinary collaborations for sustainability: local, artistic, and scientific knowledge. In: Ecology and Society.

The role of the twentieth meeting of the Conference of the Parties (COP20) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in amphibian conservation

Amaël Borzée[1, 2, 3], Amir Hamidy[4], Oliver Tallowin[5]

[1] Laboratory of Animal Behaviour and Conservation, College of Life Sciences, Nanjing Forestry University, Nanjing 210037, People's Republic of China.
[2] Department of Zoology and General Biology, Faculty of Life Sciences, Fergana State University, Fergana 150100, Uzbekistan.
[3] Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature, Gland, Switzerland.
[4] Laboratory of Herpetology, Museum Zoologicum Bogoriense, Reseach Center for Biosystematics and Evolution, National Research and Innovation Agency, Bogor, Indonesia.
[5] International Union for Conservation of Nature, David Attenborough Building, Cambridge, UK.

Contact information: amaelborzee@gmail.com

Summary
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)is an intergovernmental agreement that monitors and regulates international trade in over 40,000 species of plants and animals, including 384 amphibian species. Decisions on proposals to amend the CITES Appendices are generally informed by evidence on species' conservation status and threats, with Parties submitting proposals for consideration and vote at the Conference of the Parties. Here, we report on the debate and decisions made regarding the amphibian trade at the CoP20 in Uzbekistan, in November and December 2025. Specifically, we provide an overview of the discussion relating to the proposal to list four European *Pelophylax* species in the CITES Appendix II, and what it might mean for the future conservation of amphibians.

The role of CITES
More than one-third of amphibians are exploited, and among these, 58.8% are threatened with extinction (Luedtke et al., 2023). Among the species threatened by human consumption, 11 are extinct, 498 are Critically Endangered, 806 are Endangered and 489 are Vulnerable (01 December 2025; iucnredlist.org). Threatened species principally originate from Asia, Africa and South America, with the largest volume

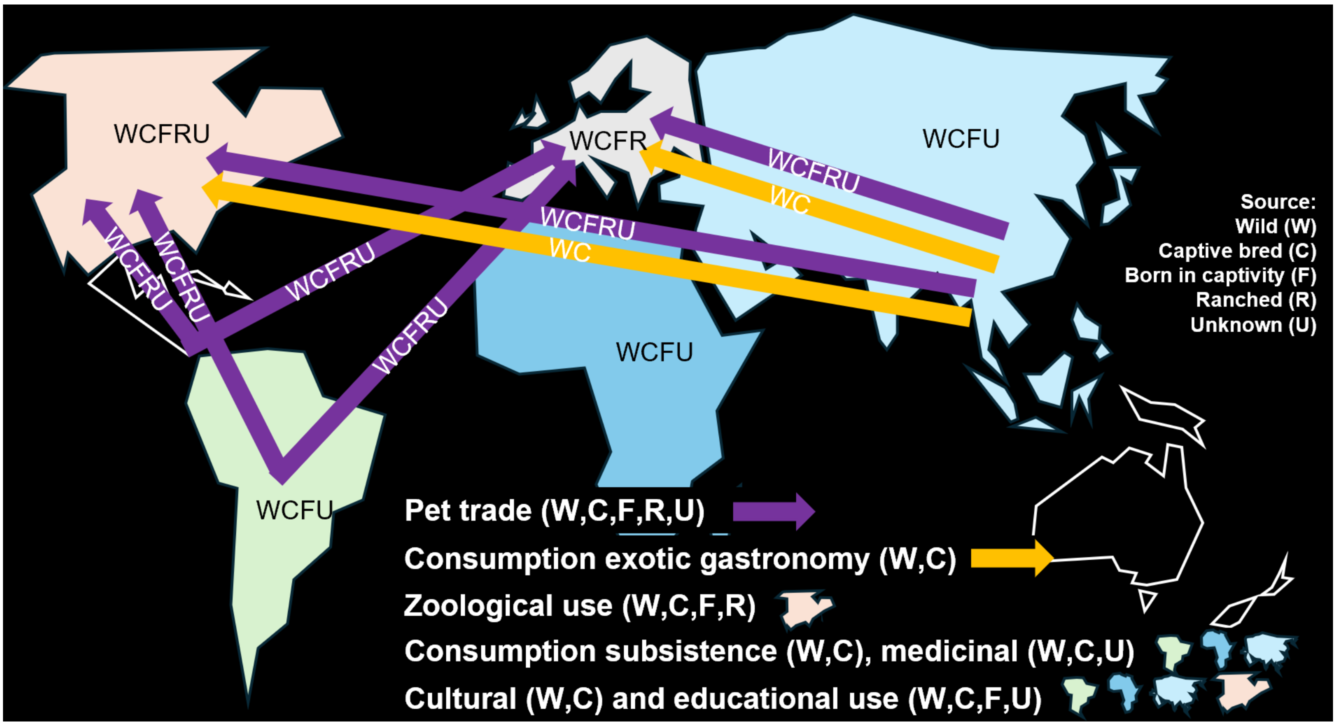


Figure 1: Graphical representation of the trade results presented in the global Amphibian Conservation Action Plan (Kolby et al., 2024) highlighting tropical regions as the source of the trade, principally towards Europe.

traded for exotic gastronomy (Kolby et al., 2024; Figure 1).

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments with a clear role: to ensure that the global trade in wild animals and plants does not threaten their survival in the wild (cites.org). CITES fulfils this role primarily through a permit system that monitors and regulates international trade in CITES-listed species. Inclusion of species in CITES Appendices I and II is decided by a vote of the Parties during plenary at the Conference of the Parties, with decisions generally informed by evidence on the species' biological status and levels of trade. In contrast, listings in Appendix III are made unilaterally by individual Parties, without a vote, when a country seeks international cooperation to control trade in species for which it already has domestic protection. CITES is legally binding on its 185member Parties (countries and regional economic integration organizations that have voluntarily joined the Convention), but it functions by providing a framework that each Party must implement through its own national laws. Over 40,900 species of plants and animals are listed across three appendices, which provide different levels of protection:

-Appendix I: Trade in these species from the wild is prohibited, except in very special circumstances like scientific research, for which permits can be obtained. The trade only allows for specimens produced from captive breeding, of which the captive breeding facility have been registered in the secretariat CITES (https://cites.org/eng/common/reg/e_cb.html)
-Appendix II: Includes species that might not be at risk of extinction, but which require controlled trade to avoid exploitation incompatible with their survival in the wild. This also includes "look-alike" species to ensure effective control of trade in the protected ones.
- Appendix III: Contains species protected in at least one country that has asked other CITES Parties for help in controlling its trade.

The goal of CITES is to make the international trade in listed species legal, sustainable, and traceable, and to serve as a critical instrument for safeguarding global biodiversity from over-exploitation.

CITES and amphibians
Following the CITES CoP 19 in Panama City in 2022, the Conference of the Parties adopted Decisions 19.197 to 19.199 on "Conservation of amphibians (Amphibia spp.)". In these Decisions, the CITES directed the Secretariat, subject to resources and in consultation with the Animals Committee, to conduct workshops on amphibian trade. The workshops had to assess species for potential CITES listing, evaluate trade sustainability, compile harvest data, examine disease threats like chytrid fungus, and review enforcement. The Secretariat also had to explore cost-effective implementation and report on progress. Subsequently, the Animals Committee reviewed this report and made recommendations to the Standing Committee, and to the COP20, to develop its own recommendations for the Conference of the Parties.

In preparation for the CoP20, the Animals Committee, in consultation with the Chair of the Standing submitted the agenda document on Conservation of Amphibians (Amphibia spp.; CITES, 2023; CoP20 Doc. 75). The Document details the outcomes of two Secretariat-led online workshops, which aimed to help participants identify amphibian species in trade, review relevant national legislation, assess whether current trade levels are sustainable, explore disease risks associated with traded amphibians, examine enforcement efforts against illegal or unreported trade, and identify and address key data and knowledge gap. However, key tasks such as evaluating whether current levels of trade in amphibians are compatible with their conservation in the wild were undertaken and it was evident that information on current levels of trade and on harvesting levels of non-CITES listed amphibian species subject to high volumes of international trade is limited. Document 75 also highlighted critical trade issues, including inconsistent data recording; and principally the absence of conversion between the weight of frogs (generally traded as legs by weight) versus the number of individual animals, frequent species misidentification in shipments, and a need for better traceability for captive-bred specimens.

Discussions on Document 75 during the COP20
The CITES CoP20Conservation of Amphibians (Amphibia spp.; CITES, 2023; CoP20 Doc. 75) was discussed on 25 November 2025, inviting the Committee to adopt the draft decisions on the conservation of amphibians (Amphibia spp.) contained in the Annex and to delete Decisions 19.197 to 19.199. The European Union (EU) and its Member States, Singapore, and the United Republic of Tanzania supported adoption of the draft decisions. The EU noted the limited value of developing conversion factors for CITES-listed amphibians and proposed deleting paragraph 20.BB b). Singapore clarified that

although cited in a background document as a source of three amphibian species, these species are not native to Singapore, and any exports would be re-exports rather than specimens taken locally from the wild. Brazil, speaking on behalf of Argentina, Belize, the Plurinational State of Bolivia, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Panama and Uruguay, and supported by Indonesia, proposed an addition to paragraph 20.AA a) ii) to include evaluation of whether trade levels are compatible with species conservation. The Committee accepted the draft decisions in the Annex to CoP20 Doc. 75 with the amendment to draft decision 20.AA proposed by Brazil.

Decisions of the Conference of the Parties to CITES in effect after its 20th meeting specifically relating to the Conservation of Amphibians (Amphibia spp.)

Based on the outcomes of CoP20 on the conservation of amphibians (CITES, 2025; Working document for CITES CoP20), Parties are invited to collect and submit information on priority amphibian species (especially CITES-listed species) covering national legislation (including habitat protection), current trade levels and their compatibility with conservation, harvesting levels for species in high-volume international trade, and captive breeding, and to implement biosecurity protocols (Decision 20.161). The Secretariat, subject to external funding and in close consultation with the Animals Committee and experts, will update the revised species prioritisation matrix with Party submissions, develop conversion factors for CITES-listed amphibian specimens, identify existing identification materials suitable for frontline officers, and report its findings with draft recommendations to the Animals Committee (Decision 20.162). The Animals Committee will consider the Secretariat's report and make recommendations to CoP21 (Decision 20.163).

Amphibian species in CITES Appendices

The amphibian taxonomy used by CITES follows the Taxonomic Checklist of CITES listed Amphibians, and is based on species information extracted from Frost, D.R. (Ed.) 2015. Amphibian Species of the World (Version 6.0, May 2015) ([CoP16 Doc. 43.1 (Rev. 1) Annex 1](https://)), with additional comments provided by the Nomenclature Specialist of the CITES Animals Committee, as reflected in [Annex 5 of CoP17 Doc. 81.1](https://).), similarly to the IUCN Red List of Threatened Species, and can be found online (www.checklist.cites.org). This information can be obtained via the Checklist of CITES Species(checklist.cites.org/#/en) and Species+ (www.speciesplus.net/species). After the 20thConference of Parties in Samarkand, Uzbekistan, in November 2025, the list of amphibians listed in the CITES Appendices included 384species, after removing the non-CITES listed species included in EU WTR Annex D, from a total of 414 species on the file downloaded. The Appendix I includes 24 species in total, split into 4 families: Cryptobranchidae (*Andrias davidianus* and *A. japonicus*), Salamandridae (*Neurerguskaiseri*), Telmatobiidae (*Telmatobius culeus*) and Bufonidae (comprising six genera: *Altiphrynoides* (1 species), *Atelopus* (1), *Incilius* (1), *Nectophrynoides* (13), *Nimbaphrynoides* (1), and *Sclerophrys* (2)). Appendix II includes 355 species, including10 families (Ambystomatidae (2), Aromobatidae (5), Centrolenidae (158), Dendrobatidae (102), Dicroglossidae (2), Hylidae (7), Mantellidae (16), Microhylidae (7), Ranidae (4), Salamandridae (52)). Appendix IIIincludes4 families with a total of five species, Calyptocephalellidae (*Calyptocephalella gayi*), Cryptobranchidae (*Cryptobranchus alleganiensis*), Hynobiidae (*Hynobius amjiensis*) and Salamandridae (*Echinotriton andersoni* and *Salamandra algira*).

Discussion on amphibians at CITES COP 20

In relation to the Document 75 and Proposal 27, numerous analyses, views and suggestions were submitted prior to CoP20 (Figure 2), highlighting the policy positions from the different parties, NGOs and IGOs. Specifically in relation with the Proposal 27 to list four *Pelophylax* species, a side event to present the scope and ecological impact of the international trade in frog legs was organised by the organisations ProWidlife and Robin des Bois (Figure 3).

Figure 2: Example of some of the documents provided during the CITES COP20 presenting view and analyses on the proposals. Photo: Amaël Borzée.

Discussion on Prop. 27 to list 4 *Pelophylax* species on CITES Appendix II

The EU and its Member States, together with Israel and

Figure 3: Side event organised in support of Proposal 27 to list four *Pelophylax* species on CITES Appendix II. Photo: Amaël Borzée.

North Macedonia as co-proponents, introduced CoP20 Proposal 27 recommend the listing to include *Pelophylax epeiroticus, Pelophylax lessonae, Pelophylax ridibundus* and *Pelophylax shqipericus* in CITES Appendix II, with the listing to take effect after an 18-month delay (CoP20 Proposal 27). After the EU introduced the proposal, several parties supported the proposal, namely and in order, Ethiopia in agreement with the proactive activity in range States, Monaco, Togo to combat threats resulting from the trade and habitat loss, Cameroon to prevent further overexploitation and maintain the ecological functions provided by the species, Zimbabwe, Israel as co-proponent, Armenia supporting range states, South Africa, and Canada noting that despite the challenges in trade not being identifiable at the species level, it is important to make sure tools are available to reach the intended effect.

In contrast, in order and interspaced within the supporting intervention, four parties opposed the proposal, China due to the unstable taxonomy of the genus, highlighting the lack of data, the United Kingdom of Great Britain and Northern Ireland after noting the information gap on population size data that makes meeting the criteria unclear and the absence of species specific trade data – but instead recommending inclusion on Appendix III. The Russian Federation noted the absence of trade data and especially for *P. lessonae*, and Japan as species in the genus hybridise readily and it is difficult to identify the species based on traded legs and data on regulation is insufficient.

Due to the opposition to the proposal by four of the parties, the proposal was submitted to a regular vote (not anonymous), with the EU approval (as proponent of the proposal). A total of 92 parties (66%) voted in favour of the proposal, while 21 parties opposed (15%), and 26 parties abstained (19%), and the proposal was therefore accepted. As a result, the trade of *P. epeiroticus*, *P. ridibundus*, *P. shqipericus*, and *P. lessonae* – but also any other species described in the future as a split of these species – will be included in CITES Appendix II, with the listing entering into effect 18 months after adoption on 5 December 2025 (i.e. from 5 June 2027).

Next steps for the focal species, and amphibians in general

As the proposal has been accepted for the four *Pelophylax* species, after 5 June 2027 when the listing enters into force, their trade will require a non-detriment finding (NDF) by any exporting party intending to trade the species internationally. NDFs are science-based assessments confirming that the international trade of a CITES-listed species is not detrimental to its survival. NDFs are made by a Scientific Authority and consider the biology, conservation status, trade levels, and harvest management of a species.

As the publication and acceptance of a NDF might result in delay and difficulties, and because of the demand for frog legs for exotic gastronomy has already resulted in the geographic shift of the origin of amphibian trade, it is a wildlife threatening possibility that instead of importing *Pelophylax* frog legs from species with broad ranges and comparatively large populations, the EU will turn the trade towards regions where amphibians are generally more abundant and the trade less regulated. These regions include tropical areas due to the better ecological adaptation of ectothermic species, but also areas where amphibian species ranges are generally smaller. Therefore, while it is possible that *Pelophylax* species will be protected from the trade of some of their populations, other species with small ranges might become extirpated, similarly to what happened when national export bans in India and Bangladesh during the late 1980s–1990s resulted in a sharp decline in international commercial trade in this species and therefore did help the species to recover.

The adoption of the proposal is certainly a positive development for the survival of *P. shqipericus*, a threatened species with a small range and declining population (Mizsei et al., 2024). In contrasts, the most commonly traded amphibian species for meat, *Lithobates catesbeianus*, will not be targeted for imports as the species is listed as a species of Union concern under the EU Invasive Alien Species (IAS) framework (Regulation (EU) No 1143/2014). Under this Regulation (EU) No 1143/2014, species on the Union List are subject to strict EU-wide prohibitions, including bans on import into the EU, keeping and breeding, sale and commercial use, and transport and release into the environment.

This discussion highlights the fact that amphibians are the least represented species among vertebrates in the CITES appendices (Challender et al., 2023), and there is a need to use CITES as a resource for the conservation of species internationally traded. A few examples from Madagascar can guide further implementation. For instance, for *Mantella* species, the whole genus becoming CITES listed in 2000 has helped regulate export volumes (Carpenter & Andreone, 2023). For *Dyscophus antongilii*, the true tomato frog, the transition from Appendix I to Appendix II was a success in that the species is now assessed as Least Concern by IUCN (Amphibian Specialist Group, 2017), and CITES has been credited with having effectively halted commercial exploitation in Madagascar (Carpenter & Andreone, 2023). For *Scaphiophryne* species the picture remains more precarious: habitat loss and persistent overcollecting for the pet trade continue despite the CITES listing, and conservation gains are far from consolidated. An alternative example is worth mentioning: a national export ban for *Mantella cowanii* introduced by Madagascar in 2003, outside of CITES measures, had a significant conservation impact for the species (Carpenter & Andreone, 2023). This conservation improvement resulting from national legislation suggests that national-level action can, in certain circumstances, be more immediately effective than international mechanisms, and are provide stronger conservation measures.

Based on the overlap across the databases for the 2nd Global Amphibian Assessment (Luedtke et al., 2023), we identified *Nanorana unculuanus* (VU; Amphibian Specialist Group, 2020a), *Quasipaa shini* (EN; Amphibian Specialist Group, 2020b) and *Tylototriton shanjing* (VU; Amphibian Specialist Group, 2020c) as species for which exploitation is the principal threat. However, both *N. unculuanus* and *Q. shini* are principally exploited domestically and are unlikely to meet the criteria for CITES listing. Only *T. shanjing* is listed by CITES, in the Appendix II. It would be important to reassess other species in the international trade for CITES listing as their inclusion might decrease the pressure on these species. It is now clear that conservation interventions have a positive impact, but they need to become widespread, and across all the board of possibilities (Borzée et al., 2025).

References

[ASG] IUCN SSC Amphibian Specialist Group (2017). *Dyscophus antongilii*. In: The IUCN Red List of Threatened Species. e.T6937A84159360. 10.2305/IUCN.UK.2017-2.RLTS.T6937A84159360.en

[ASG] IUCN SSC Amphibian Specialist Group (2020a). *Nanorana unculuanus*. In: The IUCN Red List of Threatened Species. e.T58248A63851279. 10.2305/IUCN.UK.2020-2.RLTS.T58248A63851279.en

[ASG] IUCN SSC Amphibian Specialist Group (2020b). *Quasipaa shini*. In: The IUCN Red List of Threatened Species. e.T58438A63886075. 10.2305/IUCN.UK.2020-3.RLTS.T58438A63886075.en

[ASG] IUCN SSC Amphibian Specialist Group (2020c). *Tylototriton shanjing*. In: The IUCN Red List of Threatened Species. e.T59485A63871498. 10.2305/IUCN.UK.2020-2.RLTS.T59485A63871498.en

[ASG] IUCN SSC Amphibian Specialist Group (2024). *Pelophylax shqipericus*. In: The IUCN Red List of Threatened Species. e.T58715A207982996. 10.2305/IUCN.UK.2024-2.RLTS.T58715A207982996.en

Borzée A., Prasad V. K., Neam K. … Wren S. (2025). Conservation priorities for global amphibian biodiversity. Nature Reviews Biodiversity, 1:754–771. 10.1038/s44358-025-00101-5

Carpenter A. I. and Andreone F. (2023). Malagasy amphibian wildlife trade revisited: Improving management knowledge of the trade. Animals, 13:2324. 10.3390/ani13142324

Challender D. W., Cremona P. J., Malsch K. … Conde D. A. (2023). Identifying species likely threatened by international trade on the IUCN Red List can inform CITES trade measures. Nature Ecology & Evolution, 7:1211–1220. 10.1038/s41559-023-02115-8

CITES (2023). CoP20 Doc. 75: Conservation of Amphibians (Amphibia spp.).

CITES (2025). Decisions of the conference of the parties to CITES in effect after its 20th meeting.

Kolby J. E., Borzée A., Poo S. … Muñoz A. (2024). Trade and sustainable use. In: The Amphibian Conservation Action Plan (ACAP): A status review and roadmap for global amphibian conservation. Wren S., Borzée A., Marcec-Greaves R. and Angulo A. (Eds.) IUCN Occasional Paper, 57.

Luedtke J. A., Chanson J., Neam K. … Stuart S. N. (2023). Ongoing declines for the world's amphibians in the face of emerging threats. Nature, 622, 308–314. 10.1038/s41586-023-06578-4

Assessing the effect of water quality on the survival of Pickersgill's reed frog (*Hyperolius pickersgilli*) tadpoles

Mlando Dlomo[1], Piet Malepa[1], Winnie Dlomo[1], Bongeka Ngubane[1], Andiswa Khumalo[1], Quintin Shirindza[1], Cornelia Wolmarans[1], Nompumelelo Zitha[1]

[1] Johannesburg City Parks and Zoo, Jan Smuts Avenue, Parkview, Randburg 2122 Johannesburg.

Contact information: mdlomo@jhbcityparks.com; piet.malepa@jhbcityparks.com

Abstract

The Pickersgill's reed frog, *Hyperolius pickersgilli* (Raw, 1982) is endangered species (IUCN, 2016) endemic to KwaZulu Natal province, South Africa (Raw, 1982; Tarrant and Armstrong, 2013). Johannesburg Zoo is currently housing *H. pickersgilli* captive insurance population in its facility. As part of an ongoing conservation and research effort in Johannesburg Zoo research centre, water quality was assessed following the high mortality rate of *H. pickersgilli* tadpoles during the 2023 breeding season. This study was established to determine water parameter values suitable for the survival and development of the *H. pickersgilli* tadpoles. Water from Johannesburg Zoo aquarium RO system was tested against RO water from a commercial provider. The following water parameter values were recorded from each source respectively; JHB Zoo aquarium RO system, chlorine; 0, pH; ≥6.0, ammonia; ≥0, nitrite; ≥0 and nitrate; ≥0, Commercial provider, Chlorine; 0, pH; 5.5, ammonia; 0, nitrite; 0, nitrate; 0. The mortality and survival rate of the *H. pickersgilli* tadpoles housed in the RO water collected from the above-mentioned sources were recorded over a period of three breeding seasons (2023-2025). The results showed high mortality rate of *H. pickersgilli* tadpoles housed in the water collected from JHB Zoo aquarium RO system with inconsistent water parameter values. Meanwhile low mortality rate of *H. pickersgilli* tadpoles was recorded from Commercial provider with the above stated consistent water parameter value. The above results revealed that even a slight difference in water parameter values could cause mortality to *H. pickersgilli* tadpoles. Therefore, established standard water parameter values should always be maintained for the *H. pickersgilli* tadpoles.

Introduction

The latest IUCN Red List assessment classified the Pickersgill's reed frog (*Hyperolius pickersgilli*) as Endangered (ASG and SA-FRog, 2016). The discovery of new sites following survey effort had resulted in a change from Critically Endangered to Endangered (Tarrant and Armstrong, 2017). However, the ongoing threat to the species natural habitat caused by anthropogenic activities increases the need for conservation research, including continued monitoring and development of ex-situ breeding programmes (Tarrant and Armstrong, 2017). Johannesburg Zoo initiated an amphibian conservation project (ACP) in 2006 to support conservation and research efforts for threatened amphibian species endemic to South Africa (Visser, 2012). The Pickersgill's reed frog was introduced to the programme due to its Critically Endangered status back then (Visser, 2012).

Following the appropriate arrangements and preparations the first batch of 30 *H. pickersgilli,* comprising adults and juveniles were caught in the wild and brought to the Zoo in March 2012 (Visser, 2012). Breeding from the first batch had little success, however the Zoo continued to house and care for the frogs for 5 years (Tarrant and du Plessis, 2018). Although the painted reed frog (*Hyperolius marmoratus*) was used as surrogate for the preparations prior to the introduction of *H. pickersgilli* in the Zoo environment (Visser, 2012), The first *H. pickersgilli* collected provided a baseline information for husbandry practice of the actual species in captivity. The response of the first batch of *H. pickersgilli* to the ex-situ environment paved the path for continuous welfare improvement and breeding research for the species.

The primary purpose for bringing the species to Johannesburg Zoo was breeding research and compiling a comprehensive husbandry manual (Visser, 2012). Subsequently, the goal was to establish a captive insurance population for future reintroduction to the suitable natural habitat identified (Visser, 2012). In collaboration with Ezemvelo KZN Wildlife and University of KwaZulu Natal (UKZN), Johannesburg City Parks and Zoo (JCPZ) the team of the amphibian research project compiled and published the Pickersgill's reed frog husbandry manual in 2022 (du Plessis et al., 2022). Between 2018 and June 2020, the amphibian research project at Johannesburg Zoo managed to successfully breed and reintroduced 317 *H. pickersgilli* individual back to the suitable natural habitat within KwaZulu Natal, South Africa (du Plessis and Malepa, 2020).

Figure 1: Building where the breeding of *H. pickersgilli* took place, JHB Zoo. Photo: Mlando Dlomo.

In November 2020, 400 *H. pickersgilli* captive-bred individuals were released in the suitable habitat in KwaZulu Natal and televised on a Dstv channel (People' Weather). As an effort to mitigate the risk of extinction for *H. pickersgilli,* a Biodiversity Management Plan for the species (BMP-S) was compiled (Tarrant and Armstrong, 2017). Subsequently the BMP-S was gazetted by the minister of Environmental Affairs of South Africa in 2017 (Kotze et al., 2019). The primary aim of the BMP-S was to improve the conservation status of *H. pickersgilli* and ensure it's forever existence in the wild (Tarrant and Armstrong, 2017). One of BMP-S objective was to conduct research that would generate knowledge and provide information relevant to the conservation management, both in-situ and ex-situ (Tarrant and Armstrong, 2017). Therefore, this study emanates from that objective, with a focus on water quality requirement for the survival and development of *H. pickersgilli* tadpoles in captivity.

Although a husbandry manual was published for the species in 2022, further research became required when mortality was observed and recorded during the 2023 breeding season ex situ. Everything was done according to the published manual guidelines, however mortality of *H. pickersgilli* tadpoles persisted and the decision to assess water quality was taken. Water purified through reverse osmosis was purchased from a commercial provider and tested against the reverse osmosis water collected from Johannesburg Zoo system. A slight difference in the water parameter values was noticed when comparing testing results but enough to impact the *H. pickersgilli* tadpoles as they are the most vulnerable at this stage (du Plessis et al., 2022). This was once again witnessed in Johannesburg Zoo breeding centre between 2023-2025 when a slight change caused the mortality of some *H. pickersgilli* tadpoles.

Study area

This study was conducted in Johannesburg Zoo where the setup for the Pickersgill's reed frogs was stationed and all the experiment, observation and data collection was conducted (Figure 1).

Materials and methods

Pickersgill's reed frog tadpoles from three breeding seasons (2023-2025) in Johannesburg Zoo breeding centre were used for the purpose of this study (Figure 2). All specimens were housed in an open square 1 litre plastic container with RO water inside, Figure 3. The same amount of RO water (half in every container) was added in all the containers housing the tadpoles. Pebble stones were added in all the containers to

Figure 2: *Hyperolius pickersgilli* tadpoles, JHB Zoo. Photo: Andiswa Khumalo.

Figure 3: Plastic container that was used to house the tadpoles, JHB Zoo. Photo: Andiswa Khumalo.

provide hiding for the tadpoles. Each container would house a maximum of 25 tadpoles in the first week of hatching and the number decreased as the tadpoles metamorphosed. The ambient temperature fluctuated between 25-30 degrees Celsius and the humidity between 50 and 60 percent. Water temperature fluctuated between 19-28 degrees Celsius. The same food (Spirulina and crushed fish flakes) was given to the tadpoles on day 3 after hatching (Becker et al., 2019). One hundred percent Water change was done daily in every container housing the tadpoles.

The first batch of *H. pickersgilli* tadpoles hatched between October 2023 and February 2024. All the tadpoles were housed in the reverse osmosis water collected from Johannesburg Zoo. The second batch of *H. pickersgilli tadpoles* hatched between December 2024 and February 2025. The third batch hatched in August 2025. The second and third batch of tadpoles were housed in the reverse osmosis water collected from a commercial provider of reverse osmosis water. The same husbandry practise that was applied to all the batches of tadpoles. The water parameters were tested the same way, for chlorine, pH, ammonia, nitrate and nitrite. The hatchlings, mortality rate, and survival rate and water test results were recorded diary during all three breeding seasons.

Result

Water test results from Johannesburg Zoo reverse osmosis water system showed variable values, greater or equal to the adequate values (Table 1). In contrast, water from the commercial provider showed consistent adequate values each time water was tested (Table 1)

The mortality from the first breeding season (October 2023 to March 2024) was higher when the tadpoles were raised from the water collected from JHB Zoo water system (Table 2). A lower mortality was recorded in the second and third breeding seasons when the tadpoles were housed in the water collected from the commercial provider (Table 2).

Discussion

Pickersgill's reed frog tadpoles reared in Johannesburg Zoo amphibian research breeding centre showed a negative response to slight changes in water parameter value. This was observed during breeding season in 2023 when there was high mortality in tadpoles housed in the water from Johannesburg Zoo aquarium reverse osmosis water system. The five water parameters (Cl, NH_4NH_3, pH, NO_2, and NO_3) were tested following the high mortality event and were found to be inconsistent across time. in the results that we were getting when testing the water. The value of the NH_4NH_3, NO_2, and NO_3 ranged around ≥0mg/l and pH ≥6.0. It is possible that the inconsistent water results were caused by water shedding in the surrounding area, as a similar variation was observed with the water purchased from a commercial provider.

According to du Plessis et al. (2022), the chlorine and ammonia content in the water for the *H. pickersgilli* tadpoles must be 0.00 ppm. This was also confirmed by this study because when the ammonia content in the water was greater than >0mg/l, high mortality of the tadpoles was observed, but when it was 0 mg/l, a lower mortality was recorded. The nitrate and nitrite parameters were also tested for the purpose of this study and when the content of this parameter was greater than >0 mg/l, high mortality of the tadpoles was observed, in contrast to low mortality when it was 0 mg/l. We also noticed that each time the ammonia was greater than 0mg/ml the nitrate and nitrite was as well. Based on the observation by du Plessis et al. (2022), water pH value of 6.5-7.0 are adequate for the survival and development of the *H. pickersgilli* tadpoles. However, mortality

Table 1: Showing water test results from two water sources.

Water sources	Chlorine	pH	Ammonia	Nitrate	Nitrite
JHB Zoo Aquarium RO water system	0	6.0-6.5	0mg/l-1mg/l	0mg/l-1mg/l	0mg/l-1mg/l
Commercial provider	0	5.5	0mg/l	0mg/l	0mg/l

Table 2: Showing mortality and survival rate of Pickersgill's reed frog tadpoles during 2023,24 and 25 breeding season.

Water source	Tadpoles hatched	Mortality	Survival
October 2023 to March 2024			
JHB Zoo Aquarium RO water system	572	469	103
Mortality and Survival %		82%	18%
October 2024 to February 2025			
Water source	Tadpoles Hatched	Mortality	Survival
Commercial provider	43	7	36
Mortality and Survival %		16%	84%
August 2025 to November 2025			
Water source	Tadpoles Hatched	Mortality	Survival
Commercial provider	39	7	32
Mortality and Survival %		18%	82%

was observed and recorded during the breeding seasons of 2023 when the pH value was >5.5.

This study revealed the importance of testing water quality before using it to house *H. pickersgilli* tadpoles. The effectiveness of the reverse osmosis water system can be disturbed by external causes such as the water shedding, causing the water parameters to change. Due to the sensitiveness of the *H. pickersgilli* tadpoles, comprehensive water testing should be conducted on the water quality before it is used to house the tadpoles.

Conclusion

An established standard water quality for rearing *H. pickersgilli* tadpoles in captivity is crucial for breeding success. This was observed when the inconsistent water parameters were causing mortality of the tadpoles during the 2023 breeding season in Johannesburg Zoo breeding centre. This study establishes 3 water parameter values (pH-5.5, nitrate 0 mg/l and nitrite 0 mg/l) as suitable for rearing *H. pickersgilli* tadpoles. These water parameters are an addition to what the published Pickersgill's reed frog husbandry manual stipulated. As du Duplesis et al. (2022), stated, the *H. pickersgilli* tadpole stage is the most vulnerable one. It is therefore critical that water is tested every time before using it to house the *H. pickersgilli* tadpoles.

Acknowledgements

We would like to thank the Johannesburg City Parks and Zoo (JCPZ) management for supporting the project and approving the purchase of the required upkeep items. Also, a special thanks is extended to the Ezemvelo KwaZulu Natal Wildlife for allowing us to collect the Pickersgill's reed frog parental stock in their area.

References

[ASG] IUCN SSC Amphibian Specialist Group and South African Frog Re-assessment Group (SA-FRoG) (2016). *Hyperolius pickersgilli*. In: The IUCN Red List of Threatened Species. e.T10644A77165927. 10.2305/IUCN.UK.2016-3.RLTS.T10644A77165927.en

Becker C. A., du Plessis I., Malepa P. L. … Netsianda T. (2019). Observation on the impact of nutrition and feed presentation on leg development in the Pickersgill's reed frog. Amphibian Ark Newsletter, 47, 13–14.

du Plessis I., Armstrong A., Becker C. … Grey C. (2022). JCPZ ARP Pickersgill's Reed Frog Husbandry Manual. Amphibian Ark, 8–15.

du Plessis I., Becker C. A. and Malepa P. L. (2020). Project planning for the Implementation of the Pickersgill's reed frog at the amphibian research project of the Johannesburg City Parks and Zoo. AArk Newsletter, 50, 19–20.

Kotze A., Ralph T. M. C., Barrow L. N. … Dalton D. L. (2019). Lack of phylogeographic structure in the endangered Pickersgill's Reed Frog; *Hyperolius pickersgilli* (Raw, 1982). African Journal of Herpetology, 68, 1–17. 10.1080/21564574.2018.1462064

Raw L. R. (1982). A new species of Reed Frog (Amphibia: Hyperoliidae) from the coastal lowlands of Natal, South Africa. Durban Museum Novitates, 13, 117–126. https://journals.co.za/doi/pdf/10.10520/AJA0012723X_2275

Tarrant J. and Armstrong A. J. (2013). Using predictive modelling to guide the conservation of a critically endangered coastal wetland amphibian. Journal for Nature Conservation, 21, 369–381. 10.1016/j.jnc.2013.03.006

Tarrant J. and Armstrong A. J. (2017). Biodiversity Management Plan for Pickersgill's Reed Frog (*Hyperolius pickersgilli*). Department of Environmental Affairs, Pretoria, South Africa. National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). Government Gazette Notice No. 40883.

Tarrant J. (2018). A frog first: The introduction of the endangered Pickersgill's Reed Frog back into the wild. AArk Newsletter, 45, 2–3.

Visser I. (2012). Ex-situ Amphibian Conservation in Southern Africa: Regional Focus Sub Sahara Africa. FrogLog, 20, 17–19. https://www.iucn-amphibians.org/wp-content/uploads/sites/4/2018/10/FrogLog103.pdf

When water becomes hormonal: endocrine disruption in the marsh frog

Martyna Frątczak[1,2], Mikołaj Kaczmarski[1], Łukasz Myczko[1], Katarzyna Szkudelska and Piotr Tryjanowski[1]

[1] Department of Zoology, Poznan University of Life Sciences, Wojska Polskiego 71C, PL-60-625 Poznan, Poland.
[2] Department of Animal Physiology and Biochemistry, Poznan University of Life Sciences, Wołynska 35, PL-60-637 Poznan, Poland

Contact information: martynafrt@gmail.com

Most species of amphibians inhabit the interface of water and land, where they can encounter many pollutants. Their permeable skin, aquatic early development, and tightly regulated hormonal systems make them particularly vulnerable to chemical disturbances. For this reason, endocrine-disrupting compounds (EDCs), now commonly detected in aquatic ecosystems, may have especially strong effects on them. EDCs are external chemicals originated from diverse sources (e.g. from plastics, pharmaceuticals, or personal care products), that interfere with the endocrine system of animals. Much of what we know on impact of EDCs on amphibians comes from laboratory studies on model organisms as *Xenopus leavis*. It is increasingly clear, however, that understanding real ecological consequences requires moving beyond the lab and focusing on widespread non-model species (Frątczak et al., 2025).

One such species is the marsh frog, *Pelophylax ridibundus* (Pallas, 1771), a common inhabitant of European water bodies, often exposed to wastewater-derived pollutants (Figure 1). Recent research using outdoor mesocosms, semi-natural experimental system, has provided new insights into how two EDCs in environmentally-relevant concentrations, bisphenol A (BPA) and 17α-ethinylestradiol (EE2), affect amphibian development (Frątczak et al., 2026). BPA is widely used in the production of plastics and epoxy resins, while EE2 is a synthetic estrogen used in contraceptive drugs. Both compounds commonly enter aquatic environments through municipal wastewater and industrial effluents.

One of the most striking findings concerns body condition. Individuals subjected to the BPA at the concentration 1×10^{-7} M and to EE2 at the 1×10^{-9} M showed a clear reduction in somatic condition, as measured by the scaled mass index (SMI). In ecological terms, this is not a trivial effect. Body condition reflects energy reserves and overall physiological state, which are directly linked to survival, growth, and future reproductive success. Even subtle declines at early-life stages may translate into reduced fitness in the wild, particularly during critical periods such as overwintering or dispersal after metamorphosis.

Figure 1: Newly metamorphosed individual of the marsh frog (*Pelophylax ridibundus*). Photo: Martyna Frątczak.

Even more pronounced effects were observed in sex ratios. Exposure to EE2 resulted in a dramatic shift toward females, with approximately 1:9 male-to-female proportion. Ecological consequences of such event may be profound. In natural populations, a strong imbalance between sexes can disrupt mating systems, increase competition for mates, and ultimately reduce reproductive output. The impact in representatives of *Pelophylax esculentus* complex may be particularly interesting, due to their complex genetics and reproductive biology. In many European populations, they occur within the unique, hybridogenetic systems, in which hybrids rely on mating with a parental species to persist (Berger, 1977). A shortage of males of one species could alter mating patterns, potentially affecting gene flow and long-term population persistence (Skierska et al., 2023).

At the level of gonadal development, the effects of the two compounds differed markedly. EE2, unsurprisingly, acted as a potent feminizing agent, not only shifting sex ratios but also inducing clear abnormalities. Some individuals developed intersex or mixed-sex characteristics, possessing both ovarian and testicular tissue (Figure 2). These changes indicate profound disruption of the normal pathways of sexual differentiation.

Bisphenol A, in contrast, did not significantly alter the

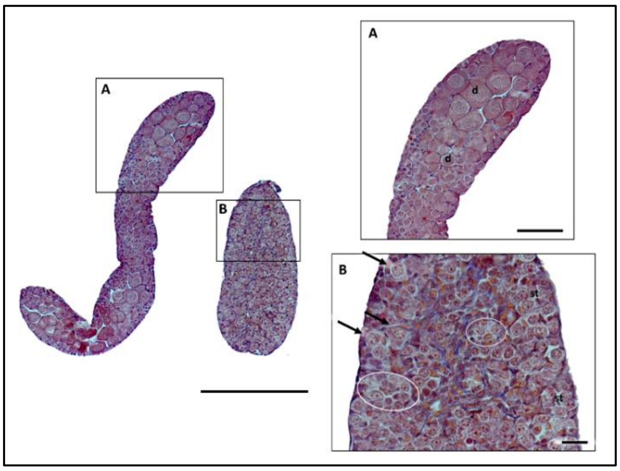


Figure 2: Gonads of an intersex frog from the group exposed to EE2, with an ovary (A) and a contralateral, abnormal gonad (B). The ovary (A) is filled with diplotene oocytes (d), surrounded by germ cells of younger classes. The other gonad (B) contains residual tubular elements (outlined) characteristic for testes, as well as few diplotene oocytes (indicated by arrows). Scale bar 100 µm. Figure modified from Frątczak et al., 2026.

sex ratio. However, this does not mean it was harmless. Histological analyses revealed widespread structural damage to the gonads in exposed individuals. In males, degeneration of seminiferous tubules and loss of germ cells were common, in some cases suggesting impaired or even lost reproductive capacity. In both sexes, abnormal structures such as rudimentary gonadal segments were also observed, indicating disrupted development at earlier stages.

Taken together, these findings highlight two different modes of endocrine disruption. EE2 primarily alters the direction of sexual development, effectively "reprogramming" individuals toward a female phenotype. BPA, on the other hand, appears to interfere with the integrity and proper formation of gonadal tissue, leading to developmental abnormalities without necessarily changing phenotypic sex.

Importantly, all these effects were observed at concentrations considered environmentally relevant-levels, already detected in European surface waters, including rivers and wastewater-impacted habitats. This suggests that such disruptions are not limited to extreme contamination scenarios but may already be occurring in natural populations.

From a broader perspective, the study underscores the importance of using ecologically realistic experimental systems. Mesocosms, exposed to natural temperature fluctuations, sunlight, and other environmental factors, capture variability that cannot be reproduced in standard laboratory assays. As a result, they provide a more accurate picture of how pollutants affect organisms in the wild.

Amphibians have long been regarded as bioindicators of environmental health. The observed changes in body condition, sex ratios, and gonadal structure reinforce this role, showing how even low-level chemical exposure can interfere with key biological processes. In a time of global amphibian declines, understanding these subtle but far-reaching effects is essential, not only for protecting these species, but also for assessing the broader impacts of human activity on freshwater ecosystems.

References

Berger, L. (1977). Systematics and hybridization in the *Rana esculenta* complex. The Reproductive Biology of Amphibians, 367–388. 10.1007/978-1-4757-6781-0_12

Frątczak, M., Kaczmarski, M., Szkudelska, K., and Tryjanowski, P. (2025). Assessing species bias in amphibian research on endocrine disruptors: Beyond *Xenopus laevis*. Frontiers in Environmental Science, 13. 10.3389/fenvs.2025.1556788

Frątczak, M., Szkudelska, K., Grobelna, M. … Tryjanowski, P. (2026). Impact of bisphenol A and ethinyloestradiol on sex, body condition and digit ratio of the marsh frog *Pelophylax ridibundus* in the mesocosm exposure system. Aquatic Toxicology, 294, 107788.10.1016/j.aquatox.2026.107788

Skierska, K., Lagner, A., Rozenblut-Kościsty, B. ... Ogielska, M. (2023). Population structure, mate choice, and genome transmission in naturally formed pairs in a *Pelophylax lessonae - Pelophylax esculentus* hybridogenetic system. Behavioral Ecology and Sociobiology, 77(8), 92. 10.1007/s00265-023-03366-y

Disease in the endemic high Andean frog *Niceforonia nana*: a wake up call

Raul Andres Galvis-Cordoba[1] and Juan Manuel Carvajalino.Fernández[1]

[1] Laboratory of Adaptations to Extreme Environments and Global Change Biology, Departamento de Biología, Facultad de Ciencias, Universidad Nacional de Colombia - Sede Bogotá, Ciudad Universitaria, Bogotá, Colombia.

Contact information: ragalvisc@unal.edu.co

Colombia is a Neotropical country distinguished by its extraordinary biodiversity, hosting more than 890 amphibian species across a wide range of ecosystems (Acosta Galvis, 2024). The complex Andean orography, with three main mountain ranges, generates strong environmental gradients and diverse local climatic conditions that promote high habitat heterogeneity (Espinoza et al., 2020; Vuilleumier, 1970). Within this context, Andean páramos are high-altitude ecosystems located approximately between 2,800 and 4,700 m a.s.l. and arranged along the northern Andes in a pattern comparable to an archipelago of "continental islands" (Espinoza et al., 2020; Madriñán et al., 2013; Luteyn, 1999). These ecosystems harbour outstanding levels of species richness and endemism in both plants and vertebrates, making them unique and highly attractive systems for evolutionary, ecological and conservation research (Madriñán et al., 2013; Saboyá and Urbina, 2023; Luteyn, 1999; Navas, 2002). Geological and climatic dynamics of the Andes have driven repeated cycles of isolation and connectivity, favouring speciation and diversification (Doan, 2003). However, endemic species in páramos are increasingly threatened by deforestation, habitat fragmentation, global warming and emerging infectious diseases (Lips, 1998).

Amphibians are currently the most threatened group of vertebrates globally (Stuart et al., 2004). Multiple stressors converge to drive their declines, but among the main proximate threats are two infectious diseases: chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis* (Bd), and infections caused by ranaviruses (Azat and Alvarado-Rybak, 2024). The Bd fungus has been responsible for the decline and disappearance of numerous amphibian populations worldwide (Olson et al., 2022). Its pathogenicity and spread can be exacerbated by climate change, making it a particularly serious threat to the persistence of susceptible species (Rohr et al., 2008). Ranaviruses are a group of viruses that also negatively affect amphibian populations (Duffus et al., 2015). Their virulence varies among host species and viral strains, and in some cases they can be highly lethal to both anurans and caudates (Gray et al., 2011). Both Bd and ranaviruses can cause mass mortality events and abrupt declines in wild populations, as they frequently use aquatic environments as transmission pathways and contaminated water bodies can act as effective vectors (April and James, 2005; Densmore and Green, 2007). Emerging infectious diseases such as these have contributed to substantial biodiversity loss in amphibian communities (Lips et al., 2006), and their impacts interact with climate change and habitat degradation to push many species closer to extinction (Neam and Borzée, 2023).

The frog *Niceforonia nana* (Goin and Cochran, 1963) is an endangered species endemic to the eastern cordillera of Colombia, for which there is little information on natural history, ecology or adaptive traits. It primarily inhabits páramos and high Andean forests in the departments of Boyacá, Santander and Norte de Santander, generally above 3,000 m a.s.l. (Acosta Galvis et al., 2018) (Figure 1A). According to the IUCN Red List, *N. nana* is currently categorized as Vulnerable (ASG, 2019). Despite this, very few studies have focused on its ecology or on the potential threats it faces in its restricted range. During a recent exploration within the known distribution of the species, we discovered individuals of *N. nana* with evident signs of disease caused by an unknown pathogen in the Guantiva-La Rusia páramo complex (Figure 1B). This finding suggests the presence of an emerging or previously undetected pathogen that could represent an additional threat to already vulnerable populations.

The first diseased individual was encountered opportunistically at night near a small water body at approximately 3,700 m a.s.l., during the rainy season, under environmental temperatures around 5 °C (Figure 1C) Based on this initial observation, we established a transect in the surrounding area to search for additional individuals of *N. nana* and visually assess whether they exhibited similar external signs of disease. We focused our efforts on microhabitats where the species is most likely to occur, including vegetation at the edges of water bodies and moist ground among tussocks and rocks. Along this transect we observed five *N. nana* individuals, all showing signs consistent

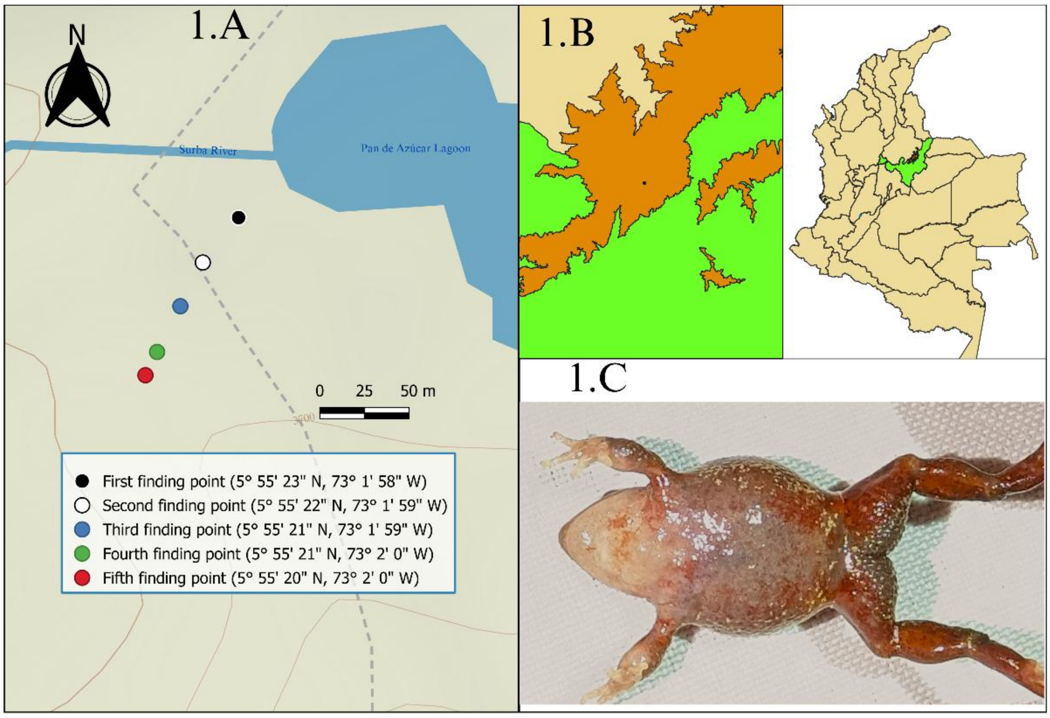


Figure 1: (A) Location of the sites where individuals of *Niceforonia nana* showing signs of disease were found within the Guantiva-La Rusia páramo complex, eastern cordillera of Colombia. (B) Map showing the position of the Guantiva-La Rusia páramo complex within Boyacá Department (right) and the location of Boyacá within Colombia (left). (C) Ventral view of the first affected *N. nana* individual observed, illustrating erythematous skin on the hind limbs and ventral surfaces and the progression of the lesions toward the anterior region. Photo: Raul Andres Galvis-Cordoba.

with infection by a pathogen. The skin of the hind limbs exhibited erythema, which extended in irregular patches of varying size resembling bruises along the flanks and ventral surfaces. In some individuals, erythematous areas extended from the hind limbs along the belly and reached the gular region. In addition to these skin alterations, all frogs presented impaired basic motor skills, including an inability to jump normally or to right themselves when flipped onto their dorsum. None of the individuals displayed obvious avoidance or escape behaviour when approached or handled. After examination, each frog was returned to its original location and revisited 30 minutes later to evaluate its mobility. In all cases, individuals remained in the same position, showing no apparent locomotor activity.

The detection of this disease in *N. nana* is alarming considering the potential impact that pathogens can have on high Andean and páramo amphibians, including rapid population declines and local extinctions. Aquatic microhabitats frequented by these frogs may serve as efficient transmission foci for waterborne pathogens, and the lack of targeted surveillance and diagnostic studies in many páramo complexes magnifies the risk to amphibian diversity in the region. In Colombia and neighbouring countries, Bd and ranaviruses are increasingly reported from high-elevation environments. In other Colombian páramo complexes, Ranavirus has been detected in both direct-developing and indirectly developing amphibian species, implying that viral spread is not strictly dependent on aquatic larval stages and that terrestrial species may also be affected (Flechas et al., 2023). Similarly, work in other high-elevation tropical amphibian communities has revealed the simultaneous presence of multiple pathogens, with potentially synergistic impacts on host populations (Urgiles et al., 2021). Moreover, several amphibian lineages characteristic of high-elevation habitats, such as *Atelopus* harlequin toads, have already undergone severe population collapses in recent decades (Lötters et al., 2023). Species-rich genera such as *Pristimantis*, which include species known to be infected by ranaviruses in nearby Colombian páramos (Flechas et al., 2023), may also be at increased risk.

Globally, amphibian populations continue to decline at an alarming rate (Lips et al., 2006). Emerging infectious diseases, abrupt climatic shifts and ongoing habitat loss are recognized as major drivers of this crisis (Neam and Borzée, 2023). In the Boyacá region, there is a notable lack of systematic monitoring for pathogens and diseases in amphibians. A previous review that examined only two individuals from the Guantiva-La Rusia páramo complex did not detect Bd (Vásquez et al., 2012), and, to our knowledge, no Ranavirus screening has been conducted in high-mountain amphibians from this specific region. Our observations therefore highlight an urgent need to investigate emerging diseases in the páramo amphibian assemblages of Boyacá and more broadly across Colombia. Such work is crucial to assess the vulnerability of species with restricted distributions, such as *N. nana*, and to inform evidence-based conservation actions aimed at preventing further declines in these fragile high mountain ecosystems.

Acknowledgments
The study would not have been possible without the support of the Laboratory of Adaptations to Extreme Environments and Climate Change and its members. We thank our colleagues from TAXBOUN for their assistance in the field, as well as the organization Gata Negra and the young conservationist Luis Melo, who is dedicated to páramo conservation and guided us through the area. Juan Manuel Carvajalino Fernández was supported by the Departamento de Biología of the Universidad Nacional de Colombia - Sede Bogotá. We recognize the importance of justice, equity, diversity and inclusion (JEDI) in conservation and acknowledge the contributions of local communities and young conservation leaders in páramo stewardship.

References
Acosta Galvis A. R. (2024). Lista de los Anfibios de Colombia: Referencia en línea V.13.2023 (11/07/2024). Batrachia, Villa de Leyva, Boyacá, Colombia.

Acosta.Galvis A., Streicher J., Manuelli L. ... Sá, R. (2018). Molecular insights into the phylogenetic placement of the poorly known genus *Niceforonia* Goin & Cochran, 1963 (Anura: Brachycephaloidea). Zootaxa 4514, 487–500.

April J. J. and James F. X. W. (2005). Amphibian virology. Veterinary Clinics of North America: Exotic Animal Practice. 8, 53–65.

[ASG] IUCN SSC Amphibian Specialist Group (2019). *Niceforonia nana*. The IUCN Red List of Threatened Species 2019: e.T57219A85895597. 10.2305/IUCN.UK.2019.1.RLTS.T57219A85895597.en.

Azat C. and Alvarado-Rybak M. (2024). Emerging infectious diseases and their impacts on South American amphibians, in Ecology of Wildlife Diseases in the Neotropics, G. Acosta-Jamett, A. Chaves, Eds. Springer, Cham.

Densmore C. L. and Green D. E. (2007). Diseases of amphibians. ILAR J. 48, 235–254.

Doan T. M. (2003). A south to north biogeographic hypothesis for Andean speciation: Evidence from the lizard genus *Proctoporus* (Reptilia, Gymnophthalmidae). Journal of Biogeography. 30, 361–374.

Duffus A. L. J., Waltzek T. B., Stöhr A. C. … Marschang R. E. (2015). Ranaviruses – lethal pathogens of ectothermic vertebrates. In Ranaviruses: Lethal Pathogens of Ectothermic Vertebrates. Springer International Publishing, New York.

Espinoza J. C., Garreaud R., Poveda G. ... Scaff, L. (2020). Hydroclimate of the Andes. Part I: Main climatic features. Frontiers in Earth Science. 8, 64.

Flechas S. V., Urbina J., Crawford A. J. … Amézquita A. (2023). First evidence of Ranavirus in native and invasive amphibians in Colombia. Diseases of Aquatic Organisms. 153, 51–58.

Gray M., Debra M. and Storfer A. (2011). Ecopathology of ranaviruses infecting amphibians. Viruses 3, 2351–2373.

Lips K. R. (1998). Decline of a tropical montane amphibian fauna. Conservation Biology 12, 106–117.

Lips K. R., Brem F., Brenes R., … Collins J. P. (2006). Emerging infectious disease and the loss of biodiversity in a Neotropical amphibian community. Proceedings of the National Academy of Sciences of the United States of America. 103, 3165–3170.

Lötters S., Plewnia A., Catenazzi A., ... La Marca E. (2023). Ongoing harlequin toad declines suggest the amphibian extinction crisis is still an emergency. Communications Earth & Environment. 4, 412.

Luteyn J. L. (1999). Páramos: A Checklist of Plant Diversity, Geographic Distribution and Botanical Literature. New York Botanical Garden Press, New York.

Madriñán S., Cortés A. J. and Richardson J. E. (2013). Páramo is the world's fastest evolving and coolest biodiversity hotspot. Frontiers in Genetics. 4, 191.

Navas C. A. (2002). Herpetological diversity along Andean elevational gradients: Links with physiological ecology and evolutionary physiology. Comparative Biochemistry and Physiology A. 133, 469–485.

Neam K. & Borzée A. (2023). Climate change and habitat loss push amphibians closer to extinction. Nature 621, 16–18.

Olson D. H., Canessa S., Lips, K. R. ... Grant, E. H. C. (2022). Updated occurrence patterns of *Batrachochytrium dendrobatidis* in amphibians: Data from 2013 to 2019 and comparison with previous records. Frontiers in Veterinary Science. 9, 798527.

Rohr J. R., Raffel T. R., Romansic J. M. … Hudson P. J. (2008). Evaluating the links between climate, disease spread, and amphibian declines. Proceedings of the National Academy of Sciences of the United States of America. 105, 17436–17441.

Saboyá L. P. and Urbina J. N. (2023). Current state of knowledge of páramo amphibians in Colombia: Spatio-temporal trends and information gaps to be strengthened for effective conservation. Tropical Conservation Science. 16, 1–18.

Stuart S. N., Chanson J. S., Cox N. A., … Waller, R. W. (2004). Status and trends of amphibian declines and extinctions worldwide. Science 306, 1783–1786.

Urgiles V., Ramírez E., Cristian I., … Savage, A. (2021). Three pathogens impact terrestrial frogs from a high elevation tropical hotspot. EcoHealth 18, 321–331.

Vásquez A., Flechas S. V., Amézquita A. … Galeano S. P. (2012). Detection and quantification of *Batrachochytrium dendrobatidis* in amphibians of the Central and Eastern Andean, Orinoco and Amazon regions of Colombia. Herpetotropicos 8, 13–22.

Vuilleumier F. (1970). Insular biogeography in continental regions. I. The northern Andes of South America. The American Naturalist. 104, 373–388.

Thirty-five years of captive breeding and translocation of *Liuixalus romeri*: impacts and lessons learned

Michael Lau[1,2]

[1] Hong Kong Wetlands Conservation Association, Hong Kong Special Administrative Region, People's Republic of China
[2] Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature, Gland, Switzerland

Contact information: michael.mwn@gmail.com

Romer's tree frog (*Liuixalus romeri*) is a tiny frog that used to be called *Philautus romeri,* currently listed as Endangered on the IUCN Red List of Threatened Species (ASG, 2020). It was once thought to be endemic to Hong Kong Special Administrative Region but was recently discovered in nearby islands in Zhuhai, Guangdong Province, China(Luo *et al.,* 2023). The species was found by the late John. D. Romer in a small remote cave on Lamma Island in 1952 and described in 1953 (Smith, 1953). The same year the cave collapsed and no individuals could be found until it was re-discovered on the island in 1984 (Karsen *et al.*, 1986). With familiarization of its distinctive staccato call, it was subsequently found on the neighbouring Lantau and Chek Lap Kok Islands, in Hong Kong SAR.

The Chek Lap Kok Island was chosen as the site for the new airport in 1989. Conserving that population of Romer's tree frog became the major environmental issue for the new airport which was a core component of the Port and Airport Development Strategy. The issue was deemed of high news value, and the project attracted a lot of media attention. The Royal Hong Kong Jockey Club Charities Ltd. provided research funding to the University of Hong Kong (HKU) to implement the conservation project.

With the exception of a small hill (which was later found to support a remnant population; Lynch, 2001; Fung, 2015) at the southern tip of the island that was retained as a noise barrier, the entire Chek Lap Kok Island would be flattened for the construction of the airport. Therefore, Romer's tree frog on the island had to be captured and translocated. Although there was an argument to simply release them to Lantau and/or Lamma Islands where the species was known to occur, it was ruled out. The reason was that these insular populations would have been separated when sea level rose after the last Ice Age and probably had distinctive genetic make-up, which was subsequently proven in genetic studies (Lau, 1998; Caviedes Solis *et al*., 2024). Moreover, releasing more individuals into existing unaffected population might have led to competition or over-crowding. Therefore, it was decided to release the frogs to locations outside the species known range. Before that could be carried out, a detailed study was crucial to find out the habitat preference of this hitherto little-known frog so that suitable release sites could be identified.

Construction of the new airport could not be delayed until the completion of the ecological study and suitable release sites identified. The rescued individuals had to be kept in captivity for over one year. A captive breeding programme was set up to increase the number of individuals for future translocation and to gain understanding on their breeding biology, development etc. which were otherwise difficult to study in the wild.

Project summary

Rescue operation

When construction started at the northern part of Chek Lap Kok Island, no conservation programme had been initiated for *Liuixalus romeri* apart from a small rescue operation undertaken by World Wide Fund for Nature Hong Kong in which a total of 40 adults and a handful of juveniles, tadpoles and eggs were collected (Lau, 1998). These became part of the breeding stock for the captive breeding programme.

The actual project began in late 1991.After some discussion with the Provisional Airport Authority, I was given 14 months to collect Romer's tree frogs in the still-untouched southern part of the island. After zero success in the winter months, a total of 220 adults (150 males and 70 females), plus a small number of juveniles and tadpoles were collected (Lau, 1998; Dudgeon and Lau, 1999). It was heavily male-biased because most individuals were collected at the breeding sites where only gravid females ready to lay eggs would visit. In the first nine months of the rescue operation, only a fraction of the males encountered were captured to leave some breeding males behind to "entice" the females. In the last three months, all individuals including tadpoles were collected. These individuals, including tadpoles that metamorphosed and matured, formed the bulk of the breeding stock. Initially egg clutches were also collected but the fragile eggs suffered a high mortality and abnormal development due to the long sea and land journey (Lau, 1998). Hence, egg collecting was subsequently abandoned.

Captive-breeding programme

The bulk of captive population was maintained in the University of Hong Kong. Thirty adults were also sent to each of Melbourne Zoo and Zoo Berlin, which had kindly agreed to help in the programme. They were kept in small groups of up to 25 adults with twice the number of males than females in acrylic terrariums mimicking the forest floor environment and a tray of shallow water for them to breed (Lau, 1998; Banks *et al.*, 2008). The programme at HKU and Melbourne Zoo were successful in which at least 188 egg clutches were obtained at the former and 706 frogs were sent back from the latter to Hong Kong for release (Lau, 1998; Dudgeon and Lau, 1999, Banks *et al.*, 2008).

Ecological study

A total of 165 localities covering all Hong Kong habitat types were surveyed with their environmental parameters measured and Romer's tree frog was discovered on Po Toi Island (Lau, 1998). Multivariate analysis showed that Hong Kong amphibians could be broadly separated into three groups based on their breeding habitats: the lentic species, the lotic species and the those breeding in shaded sites with much submerged leaf litter. Romer's tree frog was in the last group, and its breeding sites were also characterized by the absence of fish (Lau, 1998, Dudgeon and Lau, 1999). A fish predation experiment confirmed that the small tadpoles were highly vulnerable to predation, particularly to the exotic Mosquito Fish which could cause an average of 95% mortality (Lau, 1998). Together with information on the non-breeding habitat use, it was concluded that Romer's tree frog is a forest-floor species which breed in small, unpolluted standing or slow-flowing waters with no fish (Lau, 1998; Dudgeon and Lau, 1999).

Translocation

With the support of Agriculture & Fisheries Department (AFCD) of Hong Kong Government, Kadoorie Farm & Botanic Garden (KFBG), and The Hong Kong Zoological & Botanical Gardens (ZBG), eight release sites with suitable habitats within protected areas were selected (see Figure 1) (Lau, 1998; Dudgeon and Lau, 1999).

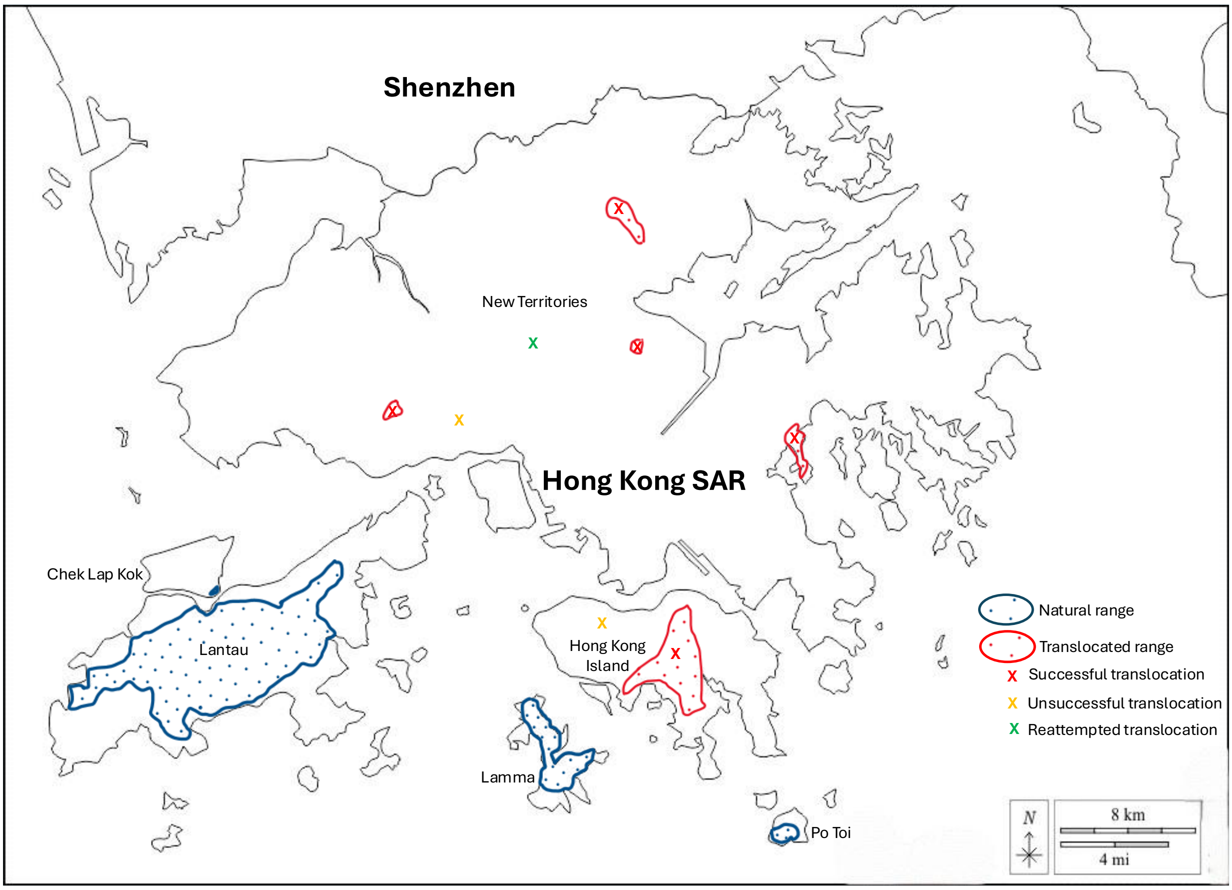


Figure 1: Distribution of *Liuixalus romeri* in Hong Kong SAR. Data: Michael Lau.

Availability of breeding habitats was the most important limiting factors as many of the protected forests in Hong Kong are on slopes. Hence, small earthen/plastic containers and/or small artificial pools were provided at the release sites (Figure 2). Trial release of tadpoles were first carried out at three sites in 1993 with weekly monitoring and adults were only released after the tadpoles were found to be able to survive and develop (Lau, 1998).After obtaining short-term success, defined as such because calling males had been found within 12 months of the initial release and indicated that the habitats expected to be suitable were adequate, the release were expanded to eight sites (two on Hong Kong Island and six in the New Territories). A total of 1,170 frogs and 1,622 tadpoles translocated (Lau, 1998; Dudgeon and Lau, 1999).

As of 1998, the year that the project ended, breeding populations were established in seven out of the eight release sites (Lau, 1998; Dudgeon and Lau, 1999). However, the translocated population size remained small and only one has expanded its range to about 2 km further.

Figure 2: *Liuixlus romeri* readily breeds in small pots. Photo showing an adult male, tadpoles and eggs. Photo: M. Lau

Impacts

Range expansion
Post-release monitoring for *Liuixalus romeri* has continued after completion of the project and was taken up by AFCD since 2002. Although the translocated populations at two more sites (ZBG and KFBG) have disappeared despite initial breeding for several years, breeding populations have been established in both the New Territories and Hong Kong Island (IUCN SSC Amphibian Specialist Group, 2009; AFCD, 2022). Based on personal observations and other records (e.g. https://www.inaturalist.org/observations?taxon_id=1473426), their range has expanded in some of the release sites (Figure1). Hence it should be safe to say the project has led to a significant range expansion of this highly restricted species.

Better protection
The key natural habitats of Romer's tree frog were identified in the project and recommendations were made to protect them as Site of Special Scientific Interest (SSSI). Most of these have now been zoned as SSSI or Conservation Areas (CA) and their land use is controlled by Town Planning Ordinance. Romer's tree frog and two other thought-to-be endemic amphibians (*Amolops hongkongensis* and *Paramesotriton hongkongensis*) were added to the Hong Kong protected species list in 1992, shortly after the project had started. The media attention and the possible elevated collecting risk probably caused the authority to amend the legislation. This is quite remarkable considering that no other animal species has been added to the protected list since.

Although collecting has not become a threat to this small frog, it is being treated as a Conservation Concern species to be considered in development planning applications and Environmental Impact Assessments. As such, negative impacts should be avoided, minimized and mitigated as much as possible. Romer's tree frog directly affected would often require mitigation translocation (e.g., Mott MacDonald, 2021). However, the conservation effectiveness of such measures is difficult to determine because it is not possible to mark such a tiny frog and distinguish the translocated frogs from the native ones in post-release monitoring. In a rare case on Lamma Island where a marsh was temporarily affected by slope work, the affected Romer's tree frogs were captured, bred in captivity and later released into the rehabilitated site (Halcrow, 2008). Post-release monitoring showed the species readily bred in newly created pools (personal observation).

Coordination of actions
A Species Action Plan has also been formulated (Amphibian Specialist Group, 2009) and updated (Agriculture, Fisheries and Conservation Department, 2022). Allowing key players to discuss, plan and review the conservation, monitoring, research, education and publicity actions.

Extinction risk lowered
In 2019, Romer's tree frog was assessed as globally Endangered in the IUCN Red List because of small extent of occurrence and area of occupancy, occurring in five or fewer locations, and continuing decline in the extent and quality of its habitat (ASG, 2020). In 2025, Romer's tree frog was assessed as of Low Risk of extinction in Hong Kong (Or and Chan, 2025) because its population size was no longer in decline and the range had expanded. This is in part due to better protection given to this species and the establishment of new translocated populations. Another contributing factor is the increase in both the forest cover and its quality, which resulted in the expansion of its natural range on the larger islands.

Lessons learnt

Science is key to success
When the project started in 1991, Romer's tree frog had only been re-discovered for seven years, and little was known about its habitat requirements and ecology. Moreover, there had been very few published amphibian reintroductions/translocations, and the IUCN Reintroduction Guidelines had not been published yet. The ecological study provided the foundation to selecting suitable release sites and creating the right breeding habitats. The knowledge gained also helped to identify the key habitats for protection, for future development-related habitat restoration and translocation measures and in media engagement.

Fame matters
The high level of media and society attention made the conservation of Romer's tree frog a priority and no doubt contributed greatly to the adoption of additional conservation measures. The project enables the study of the entire amphibian fauna and recommendations were also made to protect other rare amphibian species (*Occidozyga obscura* and *Hylarana taipehensis*) and to designate species-rich lowland sites as SSSIs. However, none have been adopted thus far, and some sites have been destroyed or degraded.

Sustainability depends on partnership
The research linked to the project had a fixed funding amount and duration. Hence, the sustainability of the conservation, management and monitoring measures were considered at the planning stage. Early engagement with relevant Government bodies and key stakeholders, seeking their support and active involvement, resulted in a partnership being formed. These helped sustain the conservation efforts beyond the project period. Media coverage provided positive incentive and distributing recognition to those involved always help. Kadoorie Farm & Botanic Garden lost the original translocated population a few years later because the large native *Quasipaa exilispinosa* moved to the breeding containers near a stream and predated on Romer's tree frog while those on steep hillside were difficult to maintain. Another round of translocation has been attempted in a new area with flat ground since 2013 (Kadoorie Farm and Botanic Garden, 2026).

People is as important as plans
Plans/papers are not always read by the those involved in the extended conservation of Romer's tree frog, especially people newly charged to supervise or undertake some of the actions. Institutional memory might not always occur, particularly when key staff leaves. Maintaining direct formal and/or informal communication always help. One thing to watch out for is the importance of conserving genetic diversity, particularly when establishing captive populations or in translocation.

Learning, sharing and improving
Much time and effort have been collectively put in the conservation and monitoring of this species by different agencies, organizations and individuals. It makes perfect sense to always think of learning, sharing and improving the actions. Knowledge sharing can lead to knowledge creation. For instance, there are new research interests in studying the impacts of the exotic Greenhouse Frog (*Eleutherodactylus planirostris*) and mosquito larvicides by the Lingnan University (https://www.ln.edu.hk/research-and-innovation/LU-research/project-highlights/conservation-of-romer-s-tree-frogs-assessment-of-population-status-across-lantau-and-impacts-of-emerging-threats)

The translocated populations are thriving and their range is expanding. It makes detailed monitoring of their breeding and range increasingly difficult. On the other hand, citizen scientists are recording new distribution in iNaturalist. The formal monitoring can be reduced and restricted to checking the artificial breeding pools and containers at the translocation sites once a year to see if maintenance is needed. This would free up valuable manpower for the conservation of other threatened species.

Concluding remark
Romer's tree frog is a tiny, drab-brown frog of no commercial value. It has become one of the best known

and sustained conservation case in Hong Kong. The controversy it created for the airport project played a big part in attracting the media and society interest. Another contributing factor is that the rescue, captive-breeding and release were positive actions that could easily resonate with people. Not all conservation projects would have such an unusual background. However, for those with positive actions such as captive-breeding followed by reintroductions, it is worth the while to explore the interesting story to communicate that may turn the project into something extraordinary.

Acknowledgements

Many organizations, friends and people have contributed to the Romer's tree frog project and the subsequent conservation measures. Only the key ones are mentioned here. I would like to thank Prof. David Dudgeon, for his guidance, trust and support from the University of Hong Kong. The Hong Kong Jockey Club Charities Ltd. generously offered funds for the project. The Agriculture, Fisheries and Conservation Department (AFCD) of the Hong Kong government, the Zoological and Botanical Gardens and the Kadoorie Farm and Botanic Garden and their staff supported the relocation and subsequent management and monitoring. Melbourne Zoo (MZ) and Zoo Berlin took part in the captive-breeding programme, in particular Chris Banks and his staff in looking after the captive population at MZ. The Provisional Airport Authority and Greiner Maunsell for permission and logistical support to work on Chek Lap Kok. AFCD, Planning Department and Lands Department for their advice in selecting the release sites. Ocean Park Conservation Foundation Hong Kong and Lingnan University for actively involved in the formulation and implementation of the Species Action Plan.

References

[ASG] IUCN SSC Amphibian Specialist Group. (2020). *Liuixalus romeri*. In: The IUCN Red List of Threatened Species 2020: e.T58794A63851099. 10.2305/IUCN.UK.2020-3.RLTS.T58794A63851099.en.

[ASG] IUCN SSC Amphibian Specialist Group (2009). Species Action Plan for Romer's Tree Frog (*Liuixalus romeri*) in Hong Kong. https://www.iucn-amphibians.org/wp-content/uploads/sites/4/2025/11/Romers-Tree-Frog-Action-Plan-Revised-April-2009.pdf

Agriculture, Fisheries and Conservation Department. (2022). Romer's Tree Frog (*Liuixalus romeri*) Species Action Plan. Hong Kong.https://bih.gov.hk/filemanager/newsletter/en/upload/33/Romers_Tree_Frog_SAP_2022-2027.pdf

Banks C. B., Lau M. W. N. and Dudgeon D. (2008). Captive management and breeding of Romer's tree frog *Chirixalus romeri*. International Zoo Yearbook, 42, 99–108.

Caviedes Solis I. W., Lau M., Lam I., Cai W. H., Fong J. J. (2024). Evaluating the long-term effect of successful translocation on the genetic diversity of Romer's tree frog (*Liuixalus romeri*) in Hong Kong: small steps lead to giant leaps. 10th World Congress of Herpetology. Kuching, Malaysia

Dudgeon D. and Lau M. (1999). Romer frog re-introduction into a degraded tropical landscape, Hong Kong, P.R. China. Re-introduction News!, 17,10–11.

Fung L. Y. (2015). Romer's tree frog on Scenic Hill, Chek Lap Kok. M.Sc. thesis, the University of Hong Kong.

Halcrow China Ltd. (2008). Agreement No. CE 18/2004 (GE) 10 Year Extended LPM Project Phase 5, Package H. Translocation Manual for *Philautus romeri*. Feature o. 15W-C/C, Sok Kwu Wan, Lamma Island, Hong Kong SAR.

Kadoorie Farm and Botanic Garden (2026). https://www.kfbg.org/en/fauna-conservation/romers-tree-frog

Lau M. W. N. (1998). Habitat use by Hong Kong amphibians, with special reference to the ecology and conservation of *Philautusromeri*. Ph.D. thesis, The University of Hong Kong.

Luo H., Lan Y., Ma S. and Xie M. (2023). Discovery of the Romer tree frog in Zhuhai City, Guangdong Province.. Sichuan Journal of Zoology, 42(2), 182.

Lynch P. (2001.) Wild Corner. Porcupine! 23:27.

MacDonald M. (2021). Habitat enhancement and translocation plan for amphibian species of conservation importance for Tung Chung New Town extension (West).EP No. EP-519/2016.

Or C. K. M. and Chan B. P. L. (2025). The state of Hong Kong biodiversity 2025. WWF-Hong Kong. Hong Kong SAR.

Smith M. A. (1953). Description of a new species of frog of the genus *Philautus*. Annals and Magazine of Natural History, 6, 477–478.

Figure 1: A) Adult male of the Restinga Toadlet (*Melanophryniscus setiba*), a critically endangered species endemic to the Espírito Santo state, Brazil. B) Restinga formation, a mosaic of vegetation types ranging from open herbaceous communities and shrublands to forest formations. Photo: Pedro Peloso.

Restinga toadlet: a symbol of amphibian conservation of Brazil

Ibere Farina Machado[1,2], Mariana R. Pontes [1,3,4], Beatriz da Silva Brito[5], Tainara de Alencar[6], Juliana Dias Salgueiro[7], Pedro Peloso[1,8]

[1] Instituto Boitatá
[2] Amphibian Specialist Group - Brazil
[3] Universidade Estadual de Campinas (UNICAMP)
4 Melanophryniscus Task Force, IUCN SSC Amphibian Specialist Group
5 Universidade Federal do Rio de Janeiro
6 Universidade Federal do Espírito Santo
7 Instituto Estadual do Meio Ambiente do Espírito Santo
8 California State Polytechnic University, Humboldt

Contact information: iberemachado@institutoboitata.org

Amphibians are the most threatened class of vertebrates, with approximately 40.7% of species at risk of extinction (Luedtke et al., 2023; IUCN and Instituto Boitatá, 2026). In the Neotropical region, this decline is driven primarily by habitat loss, emerging infectious diseases, and the accelerating impacts of climate change. Brazil, which harbors the highest amphibian diversity on the planet, with more than 1,200 described species (Frost, 2026; Drummond et al., 2026), plays a central role in global amphibian conservation. Within this immense diversity, species with extremely restricted distributions, particularly those associated with fragile and highly threatened ecosystems, represent some of the most vulnerable components of the country's fauna.

Among these species, the Restinga toadlet *Melanophryniscus setiba* (Peloso et al., 2012; Figure 1a) is currently classified as Critically Endangered by the IUCN (IUCN and Instituto Boitatá, 2026) and as Vulnerable (D2) in the Brazilian National Red List (Bastos et al., 2026). Popularly known in Brazil as *setibinha*, its known distribution is confined to a small area within a State protected land - *Parque Estadual Paulo César Vinha* (Paulo César Vinha State Park, PEPCV - in the municipality of Guarapari. Therein, the species inhabits highly specific vegetation formations associated with coastal dune environments (Figure 1b). The Restinga ecosystems are a unique coastal habitat associated with sandy Quaternary marine deposits along the Brazilian Atlantic coast (Oliveira and Rocha, 2015). Restinga forms a mosaic of vegetation types ranging from open herbaceous communities and shrublands to forest formations, developing under nutrient-poor sandy soils, high solar radiation, strong winds, and marked water stress. Despite their ecological importance and high levels of endemism (Agapito et al., 2023), Restinga are extremely fragile ecosystems and are among the most threatened coastal environments in Brazil due to urban expansion, tourism infrastructure, and historical habitat conversion (Machado et al., 2021).

Historical background of the species

The discovery of *M. setiba* itself represents a remarkable event in modern herpetology. The species was first detected during field surveys conducted between 2004 and 2005 in the Restinga of Setiba, when pitfall traps installed for reptile sampling unexpectedly captured a small, previously unknown bufonid. Subsequent analyses revealed a species with a unique combination of morphological traits, including reduced digits and a conspicuous humeral crest in males — characteristics that led to its description as an “extraordinary” species when formally described in 2012 (Peloso et al., 2012). Despite intensive searches in other Restinga areas along the Brazilian coast, the species has never been recorded outside its type locality.

More than a decade after its description, however, fundamental aspects of the species’ ecology, distribution, and conservation status remain poorly understood. This knowledge gap is particularly concerning given the vulnerability of Restinga ecosystems, which represent one of the most fragmented and anthropogenically altered coastal habitats in Brazil.

Conservation strategies

In Brazil, conservation strategies for threatened species are coordinated through the National Action Plans for the Conservation of Endangered Species (Planos de Ação Nacionais – PANs), implemented by the Chico Mendes Institute for Biodiversity Conservation (ICMBio). These plans function as collaborative policy instruments developed jointly by governmental institutions, researchers, and civil society, with the primary objective of identifying, prioritizing, and guiding strategic actions to mitigate threats affecting Brazilian biodiversity and the ecosystems where threatened species occur (Machado et al., 2021). For amphibians and reptiles, the implementation of these plans is coordinated by the National Center for Research and Conservation of Reptiles and Amphibians (RAN/ICMBio). Within this framework, in 2024, the 2nd cycle for the National Action Plan for the Conservation of Herpetofauna of Southeastern Brazil (PAN Sudeste).

Within the PAN Sudeste plan, Restinga toadlet is recognized as a priority species requiring targeted conservation efforts. Action 4.3 of the plan specifically calls for detailed studies on the species’ biology and ecology to provide the scientific foundation necessary for effective conservation management. This action is coordinated by Dr. Mariana Pontes (UNICAMP) in collaboration with researchers and institutions, including MSc. João Gasparini (UFES), Dr. Pedro Peloso (Instituto Boitatá / California State Polytechnic University, Humboldt), Dr. Felipe Toledo (UNICAMP), Dr. Ibere Machado (Instituto Boitatá), and MSc. Cybele Lisboa (São Paulo Zoo).

Based on these priorities, Mariana contacted Pedro and Ibere, both from Instituto Boitatá NGO, and together initiated efforts to secure the first funding to support research on *M. setiba*. Subsequently, MSc. Beatriz da Silva Brito (UFRJ) and Tainara de Alencar (UFES) joined the project as collaborating researchers, expanding the scientific team involved in the initiative. These efforts led to the establishment of a conservation initiative, the project “*Sapo Setibinha da Restinga*”, a formally established project within the Instituto Boitatá NGO (Figure 2).

Figure 2: Field teams involved in the study and conservation of *Melanophryniscus setiba* are conducting sampling activities within *Clusia*-dominated Restinga forests in Paulo César Vinha State Park (PEPCV), southeastern Brazil. (A–B) Research teams and study area within Restinga habitats; (C–F) Nocturnal fieldwork and microhabitat surveys, including active searches and documentation within leaf litter and bromeliad-associated environments characteristic of *Clusia* forest formations. Photo: Pedro Peloso.

Restinga toadlet conservation initiative

The conservation initiative was officially initiated on January 1st, 2024, with financial support from the German conservation foundation Stiftung Artenschutz to Instituto Boitatá NGO. Subsequently, additional funding was secured by Dr. Mariana Pontes through SAVE THE FROGS! and the Fonseca Species Conservation Fund (Re:wild), further strengthening and expanding the scope of the initiative. The conservation initiative is currently ongoing and is structured around two complementary approaches: a scientific research component, aimed at generating critical ecological and biological knowledge about *M. setiba*, and a conservation-oriented component, focused on environmental education, threat mitigation, and strengthening management actions within Paulo César Vinha State Park (PEPCV).

The scientific component seeks to address major knowledge gaps regarding the species' distribution, habitat use, population structure, and health status. Given the extremely restricted distribution of *M. setiba* and the scarcity of ecological information available since its description, the generation of robust baseline data is considered essential for guiding conservation planning and management decisions. To investigate the ecology and conservation status of the Restinga toadlet, the Active project employed a multidisciplinary set of field and laboratory approaches with searches and plot surveys; Passive acoustic monitoring; Environmental DNA (eDNA); Non-invasive photo-identification; and Skin swab sampling. More detailed analyses addressing specific aspects of the species' ecology, health status, and habitat use are currently being developed as separate manuscripts intended for submission to specialized peer-reviewed journals.

In addition to the scientific research component, we implemented a set of conservation-oriented actions focused on environmental education, stakeholder engagement, and threat mitigation within Paulo César Vinha State Park (PEPCV). Environmental education and awareness-raising activities were conducted primarily in partnership with the management team of PEPCV. A training workshop was organized in December 2024 with the participation of all 11 park staff members, including rangers and administrative personnel. During the training, project researchers presented information on threatened fauna occurring within the park. The course combined scientific presentations, field-based knowledge, and management-oriented discussions. The historical context of research in PEPCV was also discussed, including the discovery of *M. setiba* and the long gap in scientific research before the current project.

Ongoing research activities were presented to park staff, including population surveys, habitat use studies, and screening for the *Bd*. Spatial data generated were also shared, including detailed maps illustrating the extremely restricted distribution of the species within specific vegetation types. Wildfire prevention was incorporated as a key theme in outreach and training activities, reflecting the identification of fire as one of the main threats to the species' habitat. During the workshop, park staff engaged in discussions about the ecological consequences of recurrent fires, particularly along forest edges where *M. setiba* occurs.

Educational materials and public Outreach

A set of educational materials has been developed to support environmental awareness activities targeting visitors, tourists, and local communities (Figures 3 and 4). These materials are now routinely used by PEPCV staff in outreach activities with visiting school groups and the general public, and include:

- An interpretive sign installed along the park's main trail titled "Here is the only home of Setibinha", featuring a QR code linking to an audio description in Portuguese to promote accessibility for visually impaired visitors.
- A portable educational banner used during guided visits and school activities.
- Twelve life-size 3D-printed models of *M. setiba*, hand-painted to accurately represent the species' coloration and morphology.
- A children's book in which the species appears as a character, authored by a project collaborator and currently used in local schools.

Threat assessment

Figure 3: Environmental education, scientific communication, and outreach activities associated with the conservation of *Melanophryniscus setiba*. (A) Training session conducted by Ibere Machado for park staff at Paulo César Vinha State Park (PEPCV); (B) Mariana Pontes presenting research on *M. setiba* at the Brazilian Congress of Herpetology (2025, Manaus); (C) public outreach activity led by Pedro Peloso, including presentations for school groups and an exhibition of illustrations and wildlife photography; (D) visitor engaging with photographic material related to the species and its habitat. Photo: 3a,b,d Pedro Peloso; 3c Gabryella Mesquita.

In addition to ecological findings, the project generated important insights into the threats affecting the species and its habitat within PEPCV. Recurrent wildfires were identified as the most immediate threat to the species within the park. Although previously considered accidental, field observations and discussions with park staff indicated that many fires originate from intentional ignition events, often associated with conflicts related to enforcement actions against illegal sand extraction in surrounding areas.

Tourism pressure also represents an emerging threat. PEPCV is a popular destination for visitors, and trampling of leaf-litter microhabitats used by *M. setiba* may negatively affect the species. In recent years, proposals for expanding tourism infrastructure in state parks have been discussed, including plans for private management concessions aimed at increasing tourism capacity. At one point, proposed infrastructure developments included the construction of tourist accommodation and entertainment facilities in areas overlapping with the species' known distribution.

Climate change represents an additional long-term concern, as the species occurs in a low-lying coastal ecosystem; projected sea-level rise may lead to flooding of the only known habitat where the species currently occurs.

Lessons learned and conservation implications

The implementation of this conservation initiative generated important technical, ecological, and management-related lessons that are directly applicable to the conservation of *M. setiba* and other micro-endemic amphibians associated with Restinga ecosystems.

One of the main lessons emerging from this project is that species with extremely restricted distributions may occupy far smaller functional areas than initially predicted based solely on habitat availability. Despite extensive surveys of potentially suitable Restinga habitat, *M. setiba* was detected exclusively within a continuous and highly specific habitat mosaic inside PEPCV. This finding reinforces the importance of prioritizing habitat quality, structural integrity, and microhabitat availability rather than simply the extent of protected area coverage when designing conservation strategies for range-restricted species.

From a methodological perspective, the project also highlighted both the strengths and limitations of commonly used monitoring tools. Passive acoustic monitoring generated an extensive dataset and successfully documented the activity of multiple amphibian species within the park. However, it failed to detect vocalizations of *M. setiba*, suggesting that species with low-intensity calls or highly specific calling microhabitats may remain undetected using acoustic monitoring alone. These results emphasize the importance of combining complementary approaches such as active searches, microhabitat-focused surveys, and behavioural observations when studying cryptic amphibian species. Another important methodological outcome involved the validation of non-invasive monitoring techniques. The use of ventral coloration patterns as individual identifiers demonstrated that photo-based capture–mark–recapture approaches can be effectively applied even to very small-bodied amphibians.

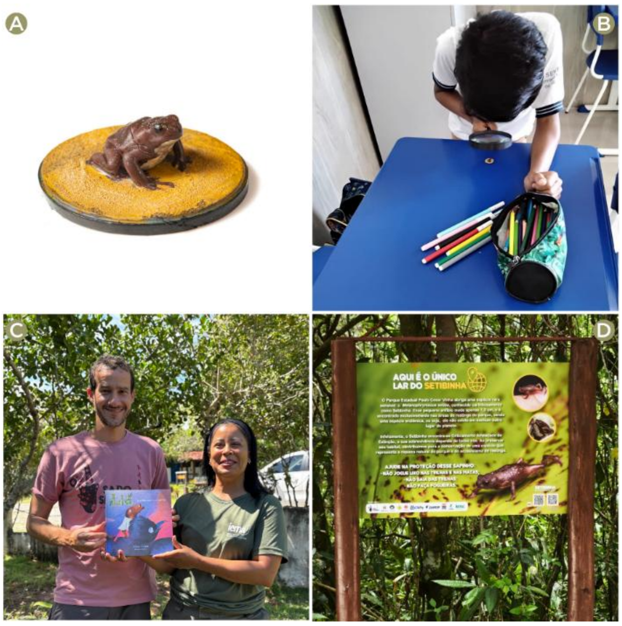


Figure 4: Educational materials and outreach tools were developed to support conservation awareness of *Melanophryniscus setiba*. (A) Life-size 3D-printed model of the species used for environmental education activities; (B) student observing the model with a magnifying glass, illustrating hands-on learning approaches; (C) delivery of the children's book "Lia – a Salamandra Viajante" by Pedro Peloso to Juliana, head of Paulo César Vinha State Park (PEPCV); (D) interpretive sign installed along the access road crossing the species' habitat, featuring a QR code with an audio description to ensure accessibility for visually impaired visitors. Photo: 4a,d Pedro Peloso; 4b. Juliana Salgueiro; 4c. Ibere Machado.

From a conservation management perspective, the project demonstrated the importance of integrating scientific research directly into protected area decision-making processes. The sharing of spatial and ecological data with park managers allowed ongoing infrastructure and fire-management planning to be reassessed in light of the species' distribution and habitat requirements. In particular, the reconsideration of a proposed internal road crossing the species' core habitat illustrates how timely scientific information can help prevent unintended impacts on highly vulnerable species.

Finally, the project highlighted the value of incorporating environmental education and stakeholder engagement as integral components of conservation efforts. By combining research activities with training for park staff, outreach to visitors, and interactions with local communities, the project helped increase awareness about the ecological importance and vulnerability of *M. setiba*. These efforts also facilitated dialogue about wildfire prevention and responsible park use, contributing to the long-term protection of the species' habitat.

Future directions

Building on the results generated by the Restinga Toadlet conservation initiative, a Strategic Amphibian Conservation Plan (PECAn) for *Melanophryniscus setiba* is currently being developed for the 2026–2031 period under the coordination of the Amphibian Specialist Group (ASG) Brazil. The plan aims to establish a coordinated framework to ensure the long-term persistence of the species through the integration of governance mechanisms, in situ population management, and climate resilience strategies.

The first pillar focuses on governance and institutional coordination. This involves the establishment of a multi-institutional collaborative network composed of research institutions, non-governmental organizations, and governmental agencies. The network will monitor and provide technical input regarding the implementation of the Sustainable Development Program for Conservation Units (PEDUC) and other management initiatives affecting Paulo César Vinha State Park. This action is particularly important given the identification of technical inconsistencies in previously proposed infrastructure plans that could potentially affect the core habitat of *M. setiba*.

The second pillar addresses long-term *in situ* population monitoring. A standardized monitoring program based on capture–mark–recapture (CMR) protocols is being implemented to track population dynamics over time. Using specialized analytical software, the aim is to estimate demographic parameters such as population size, survival rates, and the probability of local extinction. These data will provide the quantitative basis necessary to support adaptive management strategies for the species within the park.

In parallel, an *ex situ* conservation program is already being implemented through collaborations with partner institutions, including the Instituto Butantan and Amphibian Ark. These efforts aim to establish assurance colonies and develop husbandry protocols for *M. setiba*, creating an additional safeguard for the species in the event of severe population declines in the wild (Figure 5). The development of *ex situ* populations also provides opportunities for future conservation actions, such as population reinforcement or reintroduction into restored habitats, should such measures become necessary.

Figure 5: (A) Ventral view of *Melanophryniscus setiba* individuals showing species-specific belly coloration patterns used for individual identification in photo-based capture–mark–recapture studies; (B) aquaterrarium system designed to replicate microhabitat conditions of Restinga environments, including bromeliad-associated structures, used in ex situ conservation efforts at Instituto Butantan. Photo: Ibere Machado.

Acknowledgments

The project expresses its sincere gratitude to Stiftung Artenschutz, SAVE THE FROGS! ONG, Re:wild, FAPESP, and CNPq for providing the essential financial and technical support. We are grateful to Dr. Felipe Toledo and the Amphibians Natural History Lab for their constant support of the Setibinha project. We also thank the administration and staff of the Paulo César Vinha State Park (PEPCV/IEMA) for their invaluable partnership and logistical support. Finally, we acknowledge the dedication of all people involved with *M. setiba*, whose multidisciplinary collaboration continues to drive the conservation of this unique species.

References

[ASG] IUCN SSC Amphibian Specialist Group and Instituto Boitatá de Etnobiologia e Conservação da Fauna (2023). *Melanophryniscus setiba*. In: The IUCN Red List of Threatened Species. e.T78520120A86254262. 10.2305/IUCN.UK.2023-

1.RLTS.T78520120A86254262.en

Agapito B. P., de Sá C. F. C., de Andrade A. C. S. and de Araujo D. S. D. (2023). The conservation value of forest fragments in a coastal "Restinga" forest in southeastern Brazil. Journal of Coastal Conservation, 27(38), 1–16.

Bastos R. P., Martins, M. R., Guidorizzi, C. E. ... Zank e C. (2026). *Melanophryniscus setiba*. In: Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio. 10.37002/salve.ficha.21867

Brasil. Ministério do Meio Ambiente e Mudança do Clima (2022). Portaria MMA No. 148, de 7 de junho de 2022.

Drummond L. O., Santana, D. J., Lima, A. P. And Toledo, L. F. (2026). List of Amphibians of Brazil. Herpetologia Brasileira, 10(1), 1–38. 10.5281/zenodo.18340087

Frost D. R. (2026). Amphibian Species of the World 6.2, an Online Reference, https://amphibiansoftheworld.amnh.org (2026).

Luedtke J. A., Chanson J., Neam K. … Stuart S. N. (2023). Ongoing declines for the world's amphibians in the face of emerging threats. Nature, 622, 308–314. 10.1038/s41586-023-06578-4

Machado I. F., Borges-Martins M., Abrahão C. R. … Tinoco M. S (2021). Planos de Ação para a Conservação da Herpetofauna Ameaçada de Extinção: Onde Ocorrem, Quem Protegem e Como Participar. In: *Herpetologia Brasileira Contemporânea*. Toledo L. F. (Ed.) Sociedade Brasileira de Herpetologia, 224–235.

Oliveira J. C. F. and Rocha C. F. D. (2015). A review on the anurofauna of Brazil's sandy coastal plains. How much do we know about it? Journal of Coastal Conservation, 19, 35–49. 10.1007/s11852-014-0354-8

Peloso P. L. V., Faivovich J., Grant T. … Haddad C. F. B. (2012). An extraordinary new species of *Melanophryniscus* (Anura, Bufonidae) from southeastern Brazil. American Museum Novitates, 3762, 1–32. 10.1206/3762.2

Re:wild, Synchronicity Earth, and IUCN SSC Amphibian Specialist Group (2023). State of the World's Amphibians: The Second Global Amphibian Assessment. Re:wild, available at https://www.iucn-amphibians.org/wp-content/uploads/sites/4/2023/10/SOTWA-final-10.4.23.pdf.[reference:1]

Trapped in concrete: a call for micro-scale conservation of amphibians in anthropogenic landscapes

Yuxi Peng[1,2], Chengbin Yang[2], Wenxuan Yu[2], Dallin B. Kohler[3], Jiayuan Zhang[2], Chongzhe Zhong[2], Wenda Shi[2] and Ying Li[2]

[1] School of Natural Resources, Faculty of Geographical Science, Beijing Normal University, 100875, P. R. China
[2] College of Geography and Ocean Science, Yanbian University, Hunchun, Jilin 100101, P. R. China
[3] Laboratory of Animal Behaviour and Conservation, College of Life Sciences, Nanjing Forestry University, Nanjing, P. R. China

Contact information: 2184231366a@gmail.com

On a global scale, roughly one-third of amphibian species exploit anthropogenic habitats, which encompass agricultural lands, irrigation channels, urban green spaces, and even artificial ponds within university campuses (Valdez et al., 2021). Seemingly, these taxa demonstrate a capacity to adapt to a human-altered world, but the underlying reality is less encouraging: species that frequently utilize these environments tend to be those not yet facing severe conservation threats, while anthropogenic landscapes themselves are not necessarily safe havens, often acting as ecological traps where survival does not equate to long-term population health (Siddons et al., 2020).

In Hunchun, Northeast China, we documented urban amphibian activity at the Hunchun Campus of Yanbian University from 2021 to 2025. Our recording efforts were modest in scope, consisting largely of repeated encounters with individuals along roadsides, in grassy areas, and within drainage ditches, followed by simple photographic documentation and data logging. These firsthand, opportunistic observations constitute the primary dataset analysed in this study. Yet, these fragmented observations painted a clear picture over time: the threats confronting amphibians in anthropogenic landscapes are highly concrete and immediate.

Situated at the transboundary of China, Russia, and North Korea, and adjacent to the Northeast China Tiger and Leopard National Park, Hunchun represents one of the most biodiverse regions in Northeast China. Consequently, the area is characterized by the juxtaposition of persisting wild ecosystems and expanding human-built environments. The friction between these two realms is particularly evident in places like university campuses (Mo, 2022).

Stranded in a concrete matrix

The Hunchun Campus of Yanbian University is situated on the urban fringe. Historically, the surrounding landscape consisted of agricultural fields interspersed with small, naturally occurring ponds (locally known as "Paozi"), which served as vital breeding and foraging habitats for amphibians. Since the opening of Yanbian University's Hunchun Campus in 2017, the rapid expansion of new buildings, road networks, and paved surfaces has severely fragmented the formerly continuous natural environment into isolated patches.

On a clear autumn day, a black-spotted pond frog (*Pelophylax nigromaculatus*) was observed stranded on a concrete road (Figure 1). Lacking physical cover, the individual could only seek refuge in a shrinking patch of tree shade. For an organism reliant on cutaneous respiration with permeable skin, this was not an instance of "basking," but rather a lethal countdown: failure to relocate before the shade dissipated could likely result in death by desiccation.

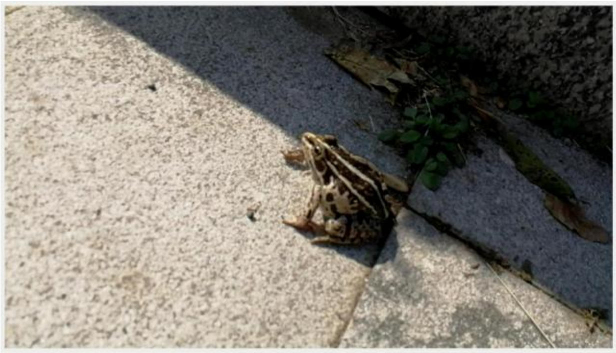


Figure 1: A survival countdown under the sun. The rising sun illuminates the concrete pavement, leaving a tree's shadow as the final refuge for this stranded black-spotted pond frog (*Pelophylax nigromaculatus*). As the temperature rises and the shadow recedes, can it successfully escape this lethal artificial landscape on its own before succumbing to dehydration? Photographed on October 11, 2024, in Hunchun, Jilin Province, China. Photo: Yuxi Peng

Another, more cryptic danger stems from the artificial structures themselves. For instance, toads (*Bufo sachalinensis*) struggle to move from paved surface to the adjacent vegetation because of vertical street curb (Figure 2). While this height is negligible to humans, it constitutes an impassable barrier for the amphibian. Despite repeated attempts to scale the obstacle, the toad remained stranded. Such occurrences were exceedingly common in our observations (>10 individuals recorded within a single month of peak activity). Many individuals are not navigationally disoriented; rather, they are physically trapped within environments offering no means of escape.

Casualties on the asphalt

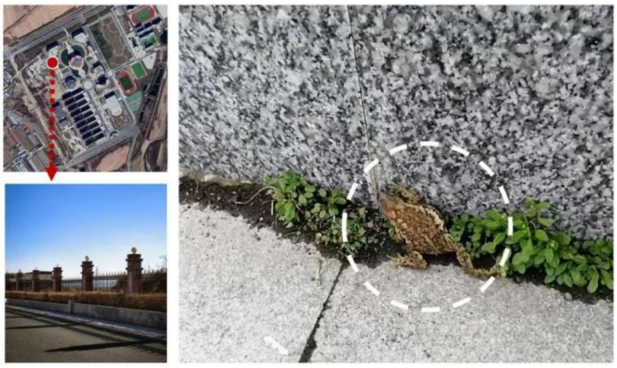


Figure 2: An insurmountable micro-barrier. A toad (*Bufo sachalinensis*) attempting to escape the paved surface and return to the vegetation encounters a fatal blockade in the artificial landscape. A towering, smooth vertical curbstone wall completely cuts off its retreat, rendering all climbing efforts futile. Photographed on May 24, 2025, in Hunchun, Jilin Province, China. Photo: Yuxi Peng

Beyond physical entrapment lies a more immediate threat: direct mortality. Following rainfall events, shallow puddles frequently accumulate on the asphalt surfaces of the campus. These ephemeral pools exert a strong attractant effect on amphibians, which utilize them as temporary moist microhabitats, often lingering for extended periods (Wang et al., 2022).

The critical peril, however, lies in the volatility of such micro-environments. As the shallow water rapidly evaporates, the dark asphalt absorbs solar radiation, triggering a rapid increase in surface temperatures. Consequently, the perceived "wetland" is abruptly transformed into an exposed, desiccating surface. Individuals failing to relocate promptly face fatal consequences, succumbing to severe thermal stress and desiccation, as exemplified by the toad *Bufo sachalinensis* (Figure 3a). Furthermore, initiating movement does not guarantee survival, as continuous vehicular traffic poses its own deadly and immediate threat (Figure 3b). Within the same localized area on campus, we often documented mortalities from both thermal desiccation and direct vehicular collision. We administered an online questionnaire to students on campus (n = 37), confirming the presence of several mortality "hotspots" across the campus, primarily concentrated on asphalt surfaces (Figures 4a and b). Respondents reported numerous instances of both crushed remains (roadkill) and intact, desiccated carcasses (Figure 4c). Crucially, these fatalities are not

Figure 3: Lethal asphalt: From deceptive oasis to fatal trap. Within human infrastructure, temporary refuges easily become execution grounds. Puddles forming on the asphalt after rain (a) instinctively attract amphibians seeking moisture. However, as the water evaporates and the pavement rapidly absorbs heat, this microhabitat swiftly turns into a death trap. Individuals unable to escape the exposed surface in time, like this toad (*Bufo sachalinensis*) can suffer fatal dehydration under the extreme heat (b). Nearby, another toad was ruthlessly crushed by a passing vehicle, a victim of roadkill. Photographed on October 26, 2023, in Hunchun, Jilin Province, China. Photo: Yuxi Peng

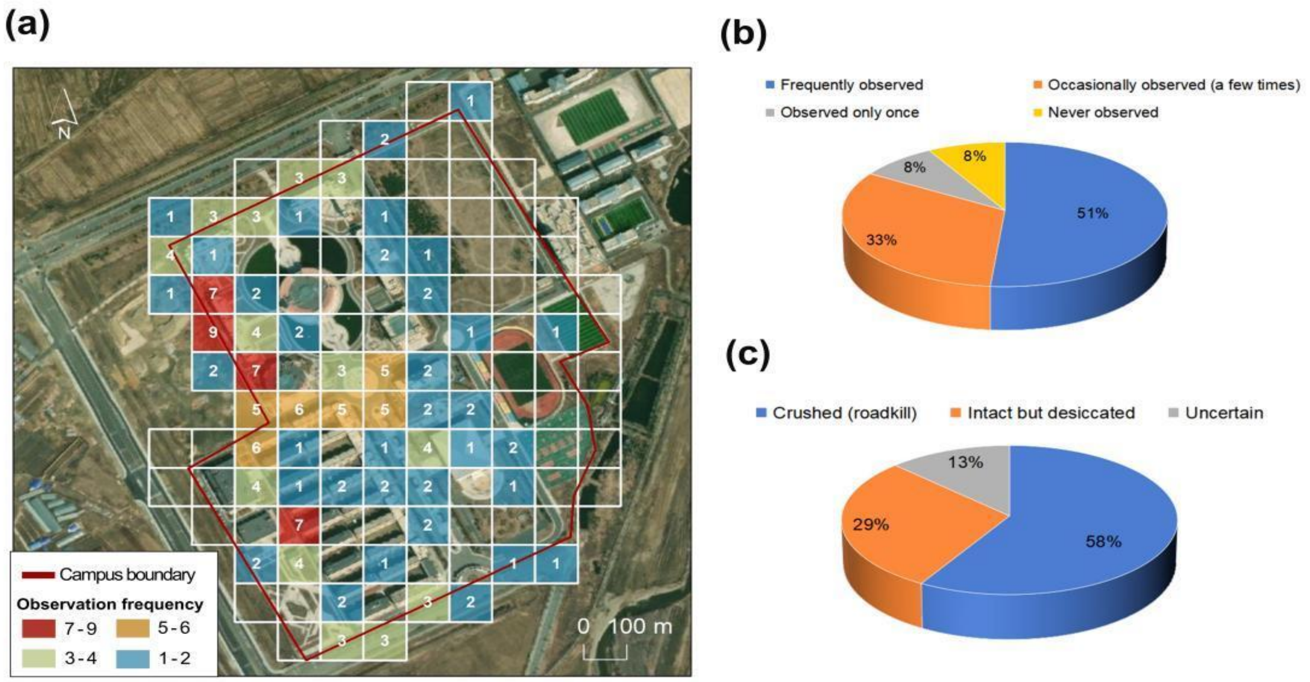


Figure 4: Spatial distribution and questionnaire-based observations of amphibian mortality on campus. The spatial distribution of reported amphibian mortality events is shown across 100m×100m grid cells defined by the authors (a). Data were collected through an online questionnaire survey (*n* = 37), in which respondents reported the grid numbers corresponding to their observations of amphibian mortality on campus. Numbers within each grid cell indicate the total of reported observations. The red boundary outlines the campus area. No temporal constraints were applied during data collection, and the reported observations were based on respondents' recollection, which may introduce potential bias. The questionnaire results summarize the reported frequency of observing amphibian remains on asphalt surfaces (b), and the reported condition of the remains, including crushed (roadkill), intact but desiccated, and uncertain cases (c). Data collected via online questionnaire; campus located in Hunchun, Jilin Province, China.

isolated incidents; rather, they represent systematic, recurring events triggered under specific temporal and environmental conditions: ecological "traps" that appear to may be temporarily alluring but pose significant mortality risks (Robertson and Hutto, 2006).

Mitigation strategies: direct rescue versus landscape optimization

In response to these immediate threats, the student monitors attempted direct interventions. In one documented instance, a black-spotted pond frog (*P. nigromaculatus*) was found trapped within a composite artificial structure of wood and stone, exhibiting severe signs of desiccation (Figure 5a). Following simple manual rehydration efforts (Figures 5b and 5c), the individual gradually recovered and was subsequently released into adjacent grassy habitat. While such ad hoc interventions can indeed benefit the survival of isolated individuals, their broader efficacy is inherently limited. Such rescue efforts rely entirely on opportunistic human presence and cannot be spatially

Figure 5: Micro-rescue intervention from a desperate trap. Recorded on April 29, 2021 (daily maximum temperature of 16^{0}C). An individual black-spotted pond frog (*Pelophylax nigromaculatus*; a) suffered severe dehydration after being trapped in a desiccating artificial landscape made of wood and stone. Following timely manual rehydration (b), the frog successfully regained its vitality and was released back into the grassland (c). Photographed on April 29, 2021, in Hunchun, Jilin Province, China. Photo: Yuxi Peng

scaled to encompass all high-risk areas across the campus.

In contrast, proactive environmental modifications offer a significantly more viable and effective approach (Lee et al., 2022). Often, the necessary structural alterations are surprisingly simple. Moor et al., 2022 demonstrated that habitat restoration through landscape-scale pond creation improves amphibian conservation outcomes by reversing population declines and stabilizing species within human-dominated landscapes. Continuous vegetated corridors can deter road entry, while sloped curbs facilitate the return of individuals to adjacent refuges. Although these campus-scale designs require site-specific testing, they align with broader road-ecology evidence that guidance structures and tunnels reduce road mortality and restore movement connectivity (Dodd et al., 2004; Jarvis et al., 2019; Helldin & Petrovan, 2019). In addition, applied conservation guidance identifies kerbs and gully pots as micro-scale barriers or traps for amphibians, supporting the use of dropped, low-profile, or otherwise escapable curb designs where road edges intersect amphibian movement routes (Amphibian and Reptile Conservation Trust, 2025). Though modest in scale and implementation, these micro-habitat adjustments may make meaningful differences for the long-term viability of urban amphibian populations. (Figure 6a). Alternatively, modifying vertical street curbs into sloped designs may help individuals that stray onto pavement return to adjacent vegetated refuges (Figure 6b). Though modest in scale and implementation, these micro-habitat adjustments can make fundamental differences for the long-term viability of urban amphibian populations.

Future perspectives

It is a common misconception to conventionally frame amphibian conservation as an issue confined to remote wetlands, pristine forests, and designated nature reserves; conservation challenges and opportunities exist in urban environments too. A stretch of paved road, a drainage ditch, or a segment of vertical street curb can all act as definitive determinants of life and death.

Macro-level conservation addresses species persistence, while micro-level efforts focus on individual survival against anthropogenic hazards. Though welfare and conservation are distinct, mitigating human-induced mortality supports local persistence, bridging individual welfare with broader conservation outcomes (Paquet and Darimont, 2010; Dubois et al., 2017). The seemingly anecdotal rescue

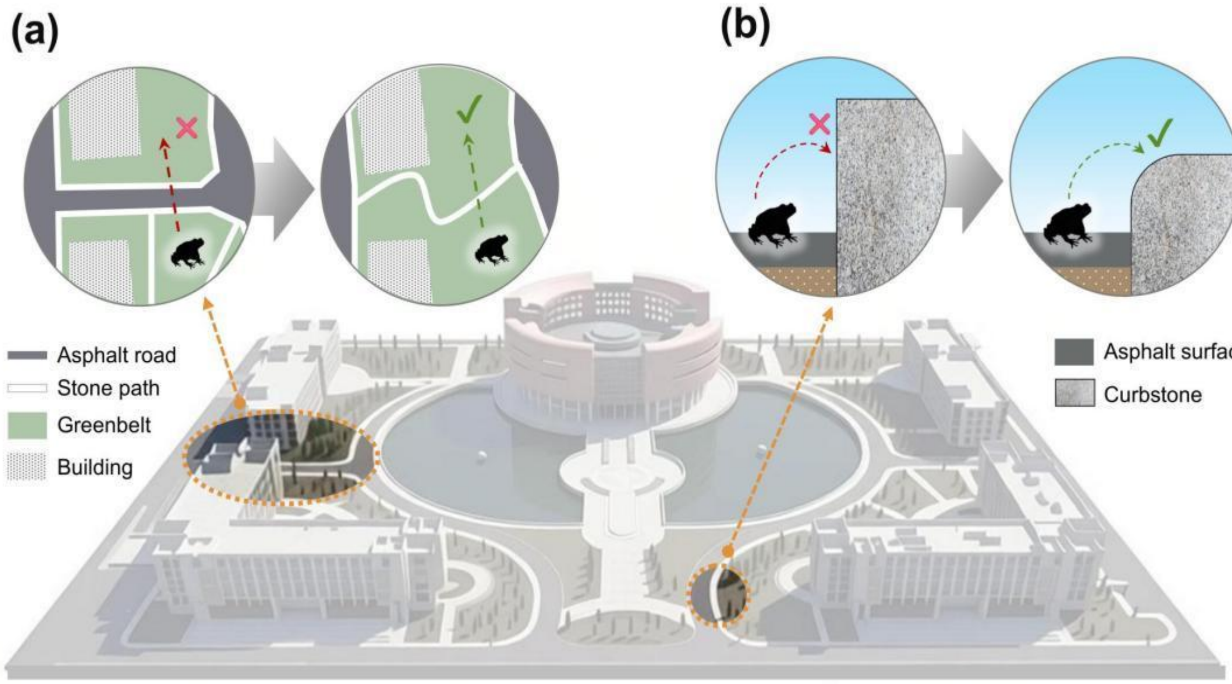


Figure 6: Conceptual designs for amphibian corridors integrating micro-conservation. Two micro-level interventions to mitigate artificial barriers: (a) planning continuous greenbelts to guide amphibians away from scorching asphalt roads; (b) replacing tall, 90-degree curbstones with low-profile curbs with gentle slopes, enabling amphibians that stray onto the pavement to easily climb and escape. Illustration: Peng Yuxi

efforts described herein highlight a crucial ecological reality: individual amphibians are highly vulnerable to localized failures within anthropogenic landscapes. Regretfully, a mature, standardized framework to mitigate these micro-scale risks has yet to be established.

Although broader conservation guidelines currently exist for road ecology and macro-scale urban planning, localized spaces such as university campuses and residential communities remain largely devoid of specific, actionable protocols. The real problem is not a lack of scientific knowledge, but a lack of action from those who shape our cities. Saving urban wildlife depends less on new research on paper and more on whether urban planners and decision-makers choose to make it a priority in their designs.

Acknowledgments

We extend our sincere gratitude to the student members of the Tiger and Leopard Study Group (currently the Eco-Environmental Protection Society) at Yanbian University. The long-term observations and data collection underpinning this research relied fundamentally on their sustained participation and cumulative efforts across various temporal scales and adverse weather conditions. Their routine yet meticulous documentation has brought these otherwise easily overlooked individual events to light.

References

Amphibian and Reptile Conservation Trust. (2025). A holistic approach to protecting amphibians from road mortality.

China Daily, Yanbian University Hunchun Campus officially inaugurated, https://jl.chinadaily.com.cn/2017-09/11/content_31840225.htm (2017)

Dodd C. K. Jr., Barichivich W. J. and Smith L. L. (2004). Effectiveness of a barrier wall and culverts in reducing wildlife mortality on a heavily traveled highway in Florida. Biological Conservation, 118(5), 619–631.

Dubois S., Fenwick N., Ryan E. A. … Fraser D. (2017). International consensus principles for ethical wildlife control. Conservation Biology, 31(4), 753–760.

Helldin J. O. and Petrovan S. O. (2019). Effectiveness of small road tunnels and fences in reducing amphibian roadkill and barrier effects at retrofitted roads in Sweden. PeerJ, 7, e7518.

Jarvis L. E., Hartup M. and Petrovan S. O. (2019). Road mitigation using tunnels and fences promotes site connectivity and population expansion for a protected amphibian. European Journal of Wildlife Research, 65, 27.

Lee T. S., Randall L. A., Kahal N. L. … Duke D. (2022). A framework to identify priority wetland habitats and movement corridors for urban amphibian conservation. Ecological Solutions and Evidence, 3(2), e12139. 10.1002/2688-8319.12139

Mo M. (2022). Reptiles and Amphibians on a University Campus in a Peri-urban Area of Sydney, New South Wales, Australia. Reptiles & Amphibians, 29(1), 122–133.

Moor H., Bergamini A., Vorburger C. ... Schmidt, B. R. (2022). Bending the curve: Simple but massive conservation action leads to landscape-scale recovery of amphibians. Proceedings of the National Academy of Sciences, 119(42), e2123070119.

Paquet P. C. and Darimont C. T. (2010). Wildlife conservation and animal welfare: two sides of the same coin? Animal Welfare, 19(2), 177–190.

Robertson B. A. and Hutto R. L. (2006). A framework for understanding ecological traps and an evaluation of existing evidence. Ecology, 87(5), 1075–1085.

Siddons S. R., Bray M. C. and Searle C. L. (2020). Higher infection prevalence in amphibians inhabiting human-made compared to natural wetlands. Journal of Wildlife Diseases, 56(4), 823–836. 10.7589/2019-09-220

Valdez J. W., Gould J. and Garnham J. (2021). Global assessment of artificial habitat use by amphibian species. Biological Conservation, 257, 109–129. 10.1016/j.biocon.2021.109129

Wang Y., Yang Y., Han Y. … Merrow J. (2022). Temporal patterns and factors influencing vertebrate roadkill in China. Transportation Research Interdisciplinary Perspectives, 15, 100662. 10.1016/j.trip.2022.100662

Two decades of Amphibian Ark and the launch of the Amphibian Rescue podcast

Renata I. Vaz[1,2]*, María Braeuner[1,3], Devin Edmonds[1], Luis Carrillo[1], Cybele S. Lisboa[1,2,4], María José Chang[1], Beatriz Velásquez[1], Elizabeth Townsend[1,3], Jonathan Wilcken[1]

[1] Amphibian Ark, Apple Valley, MN, USA
[2] Amphibian Specialist Group, Species Survival Commission, International Union for the Conservation of Nature, Gland, Switzerland
[3] Conservation Planning Specialist Group, Apple Valley, MN, USA
[4] Reserva Paulista - Zoológico de SP, Av. Miguel Stefano 4241, 04301-905 São Paulo, SP, Brasil.

Contact information: renata@amphibianark.org

In 2026, Amphibian Ark (AArk) celebrates 20 years of global efforts rescuing amphibians in crisis and giving threatened species a second chance at survival. To mark this milestone, AArk has launched its podcast, Amphibian Rescue (Figure 1A-D). The podcast offers a retrospective on the amphibian conservation movement and explores the role that AArk has played over the past two decades in ex situ conservation. The first three episodes cover the history of AArk in depth, featuring perspectives from the earliest responders to the amphibian crisis and key figures in amphibian conservation. Future episodes, released monthly, will explore success stories of ex situ conservation programs around the world.

Amphibian Ark is an international organization created in response to the global amphibian crisis, with the mission of protecting species that cannot be safeguarded in their natural habitats (Zippel et al., 2011). From the 1970s to the 1990s, many amphibian species were disappearing before researchers could fully understand the causes and develop effective conservation actions (Barinaga, 1990). By the late 1990s, scientists discovered that an emergent pathogen, *Batrachochytrium dendrobatidis* (*Bd*), was one of the major causes of numerous declines and extinctions worldwide (Berger et al., 1998; Longcore et al., 1999; Lips et al., 2005; learn more about the early crisis in Episode 1 of the Amphibian Rescue podcast; Figure 1B).

Figure 1: The *Amphibian Rescue* podcast, launched by Amphibian Ark (AArk) to celebrate its 20th anniversary. (A) Podcast cover. (B) Episode 1 explores the emergence of the global amphibian crisis and the discovery of the chytrid fungus. (C) Episode 2 focuses on the growing awareness of amphibian declines and the development of AArk. (D) Episode 3 highlights the role of *ex situ* conservation and presents AArk's key actions to prevent amphibian extinctions. Images B-D © Jaime Culebras.

Over the following years, a series of international meetings and discussions focused on identifying strategies to address the amphibian crisis. These efforts led to the creation of the Amphibian Ark in 2006, initially as an amphibian conservation program within the IUCN SSC Conservation Breeding Specialist Group (CBSG, now Conservation Planning Specialist Group, CPSG), in collaboration with the IUCN SSC Amphibian Specialist Group (ASG), and the World Association of Zoos and Aquariums (WAZA). In 2007, Amphibian Ark was formally established as an independent organisation (learn more about the conception of AArk in Episode 2 of the Amphibian Rescue podcast; Figure 1C).

Since its inception, AArk has supported amphibian ex situ conservation worldwide through training, funding, and technical guidance (learn more about AArk actions in episode 3 of the Amphibian Rescue podcast; Figure 1D). A central component of AArk's work is the evaluation of species through the Conservation Needs Assessment (CNA), a structured decision-making process designed to identify priority species and guide appropriate conservation actions. With around 41% of assessed amphibian species classified as threatened (Luedtke et al. 2023), it is essential to allocate limited conservation resources strategically, recognising that not all species require the same type or level of intervention. The CNA addresses this by assessing species through a standardised set of questions with weighted scores, which are used to prioritise conservation needs and assign recommended actions. These actions may include in situ measures, research, education initiatives, and ex situ interventions. Importantly, CNAs complement the IUCN's Red List assessments. While the Red List evaluates a species' global extinction risk, the CNA identifies the most appropriate conservation actions at national or regional scales. Consequently, a species categorised as Least Concern globally may still require urgent local interventions if its status within a specific region is more precarious.

One potential outcome of the CNA process is the identification of species assigned to the “rescue” category, referring to species facing imminent threats that cannot be mitigated in time to prevent extinction in the wild. In such cases, the recommended strategy involves the establishment of ex situ assurance populations with the goal of future reintroduction. Species assigned to this category become a central focus of AArk's efforts. To date, AArk has facilitated the assessment of 3672 species across 55 countries, identifying 462 species as rescue priorities, of which over 75 now have dedicated ex situ conservation programs or strategies in place.

Another core activity of AArk is capacity building. Over the past 20 years, AArk has led and supported numerous amphibian ex situ conservation courses across 40 countries, training more than 2,800 participants in amphibian management, husbandry, and health care. In addition to in-person training, AArk provides a library of resources on its website, including videos, guidelines, and scientific publications on amphibian husbandry, veterinary care, and conservation.

While technical knowledge is essential for successful conservation programs, financial support is equally critical, especially in the early stages of a rescue program. Since 2009, with the financial support of its network of donors, AArk has funded 57 institutions working to establish and strengthen amphibian rescue initiatives worldwide. Currently, AArk offers grants to help establish new rescue programs, support participation in workshops, and provide emergency assistance.

Today, AArk maintains a growing network of coordinators representing multiple countries and continents. Through partnerships with conservation organisations, research institutions, zoos and aquariums, and donors around the world, AArk continues to support initiatives that safeguard amphibian diversity for the future. As the organisation marks its twentieth anniversary, the Amphibian Rescue Podcast offers a new way to share the stories, people, and conservation efforts behind this global movement.

About the Amphibian Rescue Podcast

The podcast is available on major streaming platforms. Additional information, references, and transcripts, can be found on the Amphibian Ark news page on its website (https://www.amphibianark.org/news/). Amphibian Rescue is produced and hosted by María Braeuner, with original music by Pablo Bolaños (Biota Specimens). Episodes are reviewed and fact-checked by the Amphibian Ark team of experts: Luis Carrillo, Devin Edmonds, Renata Ibelli Vaz, Jonathan Wilcken, Cybele Lisboa, Elizabeth Townsend, María José Chang, and Beatriz Velásquez. Cover image and intro and outro video footage by © Jaime Culebras.

References

Barinaga M. (1990). Where have all the froggies gone? Science 247, 1033–1034. doi.org/10.1126/science.247.4946.1033

Berger L., Speare R., Daszak P. … Parkes H. (1998). Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. Proceedings of the National Academy of Sciences of the United States of America 95(15), 9031–9036. doi.org/10.1073/pnas.95.15.9031

Longcore J. E., Pessier A. P., and Nichols D. K. (1999). Batrachochytrium dendrobatidis gen. et sp. nov., a chytrid pathogenic to amphibians. Mycologia 91(2), 219–227.

Lips K. L., Brem F., Brenes R. … Collins L. P. (2005). Emerging infectious disease and the loss of biodiversity in a Neotropical amphibian community. Proceedings of the National Academy of Sciences of the United States of America 103(9), 3165–3170. doi.org/10.1073/pnas.0506889103

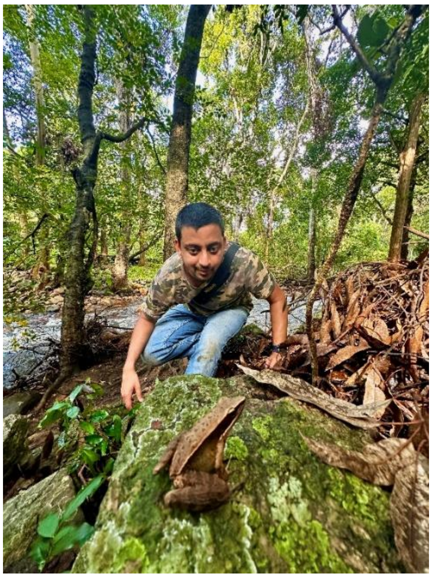
Luedtke J., Chanson J., Neam K. … Stuart S. (2023). Ongoing declines for the world's amphibians in the face of emerging threats. Nature, 622, 308–314. 10.1038/s41586-023-06578-4

Zippel K., Johnson K., Gagliardo R. ... Elizabeth T. (2011). The Amphibian Ark: A global community for ex situ conservation of amphibians. Herpetological Conservation and Biology 6(3), 340–352. herpconbio.org/Volume_6/Issue_3/Zippel_etal_2011.pdf

Webinar Abstracts

Please visit our website to find out how to contact our webinar officers if you are interested in presenting, or to register to be informed about future webinars: **https://www.iucn-amphibians.org/resources/asg-webinar-series/**

Recordings of ASG Webinars can be found here: **https://www.youtube.com/@ASGWebinars2024**



Amphibians of India: insights into behaviour, ecology, and the urgent need for collaborative conservation

Robin Suyesh[1]

[1]University of Delhi

Webinar held 14th January 2025

Amphibians display one of the most diverse and fascinating arrays of reproductive strategies among all tetrapod vertebrates. From foam nests and direct development to parental care and complex mating calls, their reproductive behaviour reflects remarkable evolutionary adaptations. Gaining a comprehensive understanding of their reproductive ecology is essential not only for advancing scientific knowledge but also for informing and implementing effective conservation strategies. India, with its expansive tropical and subtropical rainforests covering approximately 7–8% of its land area, provides a rich and varied habitat for amphibians. These forests support a majority of the country's 458 described amphibian species. Despite this diversity, the reproductive biology and natural history of many Indian amphibians remain underexplored, limiting our capacity to protect them. Compounding the concern, over 30% of these species are currently listed as threatened under IUCN Red List criteria, making the need for detailed ecological studies even more urgent. Between 2014 and 2024, I undertook extensive fieldwork across India—spanning areas of biodiversity hotspots such as the Western Ghats, the Himalayas, and the northeastern hills—primarily during the monsoon months of June to September. These efforts focused on observing and documenting the reproductive behaviour of over 30 amphibian species in situ. Particular attention was given to acoustic communication, which plays a central role in mate attraction, territorial defence, and species recognition during the breeding season. The data collected revealed numerous novel behaviours, including rare and reciprocal call exchanges, underwater vocalizations, species-specific call repertoires, complex courtship rituals, and unique oviposition strategies. Additionally, the studies provided new insights into activity patterns, microhabitat selection, and breeding synchrony. Such behavioural observations are critical not only for understanding amphibian life history but also for identifying species-specific vulnerabilities to environmental changes. These findings are especially relevant as any of these species now face escalating threats from anthropogenic pressures, including habitat fragmentation, deforestation, pollution, road mortality, and the unpredictable effects of climate change—all of which imperil amphibian reproduction and survival. Detailed knowledge of reproductive ecology is indispensable for designing targeted conservation actions, including habitat management, captive breeding, and landscape-level habitat restoration. Through this talk, I aim to not only share insights into the secret lives of Indian amphibians but also to extend a call for international collaboration. Global partnerships across disciplines—behavioural ecology, bioacoustics, conservation biology, and climate science—are urgently needed to protect these vulnerable species. I invite fellow researchers, conservationists, and institutions to join in advancing a coordinated, science-driven effort to conserve amphibians across South and Southeast Asia.

Unravelling the ecology and threats to *Micrixalus kottigeharensis*: insights into riparian habitats and distribution patterns

Madhushri Mudke[1,2]

[1]Ashoka Trust for Research in Ecology and the Environment (ATREE)
[2]Janapada Seva Trust, India

Webinar held 22nd December 2025

Micrixalus genus, dancing frogs, ranks fifth among the world's most threatened amphibian genera. These endemic, foot-flagging frogs occupy the Western Ghats of India and face threats due to habitat loss and stream modifications. This study presents the habitat associations, distribution, and threats to *Micrixalus kottigeharensis* using occurrence points confirmed through molecular identification to fit N-mixture and ensemble species distribution models. Our results show that the frog occupies fast- to slow-flowing forested streams associated with > 70% canopy cover. Regression models show a strong positive association with atmospheric humidity and a negative association with drizzle, intermittent/heavy rain, and rock surface temperatures. Species distribution models under one anthropogenic and two climate scenarios suggest that the species remains restricted to mid-elevation moist evergreen forests of the central Western Ghats. Future climate scenarios project an increase in suitable habitat, likely linked to shifting rainfall patterns; however, habitat suitability within existing protected areas declines. This is the first detailed ecological and spatial study on *M. kottigeharensis*.

Hidden epidemics: fine-scale dynamics of chytrid infection in Darwin's frogs

Andrés Valenzuela Sánchez[1,2]

[1]Institute of Zoology, Zoological Society of London
[2]NGO Ranita de Darwin

Webinar held 15th April 2026

Understanding how the chytrid fungus spreads in space is central to amphibian conservation, yet infection dynamics are often studied at spatial scales that may overlook critical processes. In this webinar, Andrés will present new insights from the article *"Localized transmission of an aquatic pathogen drives hidden epidemics and population collapse in a terrestrial host"* (Nature Ecology & Evolution, 2026). Using high-resolution spatial capture-recapture data, long-term monitoring, and an individual-based model, this work shows that Bd infection can vary dramatically over distances of just a few metres due to highly localised transmission. These dynamics can generate intense, spatially clustered epidemics, leading to rapid subpopulation declines—up to 98% within a year—that may remain undetected at broader scales. Together, these findings highlight how the spatial scale of observation shapes our ability to detect and respond to disease, with important implications for monitoring and conserving threatened amphibians.

Robert Dimla with an individual *Sclerophrys maculata*. Photo: Amaël Borzée