Disease-driven decline of Darwin's frogs:

Mitigating the impacts of the chytrid fungus into the largest known populations of Darwin's frogs

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Context

- Darwin's frogs are the only known amphibians where males brood developing tadpoles inside their vocal sac. These frogs only inhabit **Chile and Argentina**.
- Darwin's frogs (*R. rufum* and *R. darwinii*) are **EDGE species** (7th and 21st, respectively, on the 2023 EDGE species list).
- *Rhinoderma rufum* was **last seen in 1981** and today is classified as **Critically Endangered (Possibly Extinct)**. *Rhinoderma Darwinii* is **Endangered**.

A male Darwin's frog incorporating developing larvae into its vocal sac, observed by our team in Tantauco Park in 2010. This is the only known record of this behaviour in nature.

Context

- **ZSL and ONG Ranita de Darwin** have been involved in Darwin's frog conservation **since 2009.** We collaborate with key local and international partners, such as UNAB, Universidad de Concepción, SAG, and Leipzig Zoo, to implement research and conservation actions focused on these species.
- IoZ Research Fellow and president of ONG Ranita de Darwin Andrés Valenzuela-Sánchez was elected **president of the governance committee of the Binational Conservation Strategy for Darwin's Frogs** in 2024.
- In addition to our conservation work, we have co-authored several **research papers** about these species, including publications in journals such as Science, Journal of Animal Ecology, Journal of Zoology, and Proceedings of the Royal Society B


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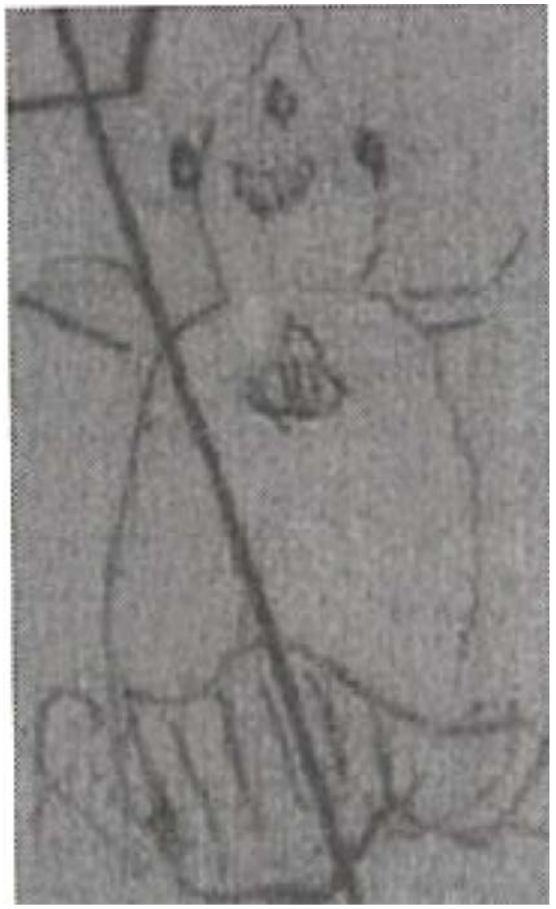
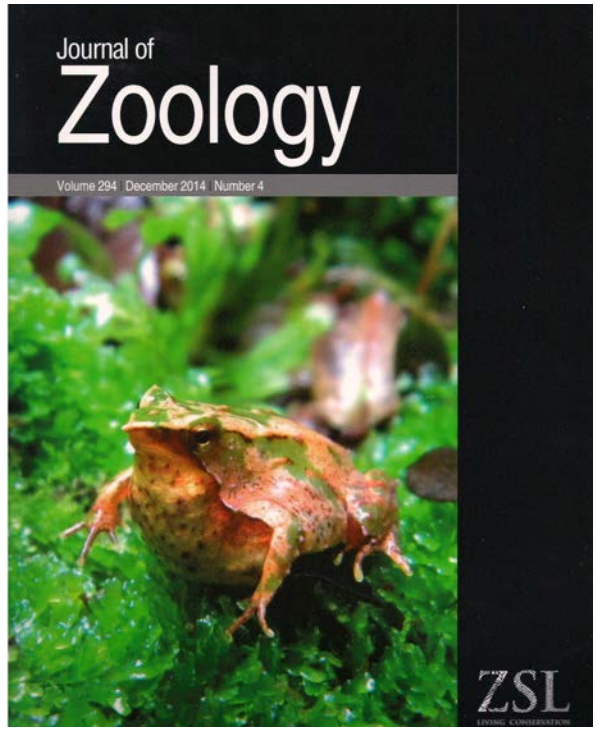
Location

- We have been monitoring Darwin's frogs in Tantauco Park **since 2010**.
- This private protected area is located in the **Chiloé Archipelago, southern Chile**, where **Charles Darwin** first collected the species in **1834**.
- Our research conducted in Tantauco was featured on the cover of the **Journal of Zoology** in 2014.



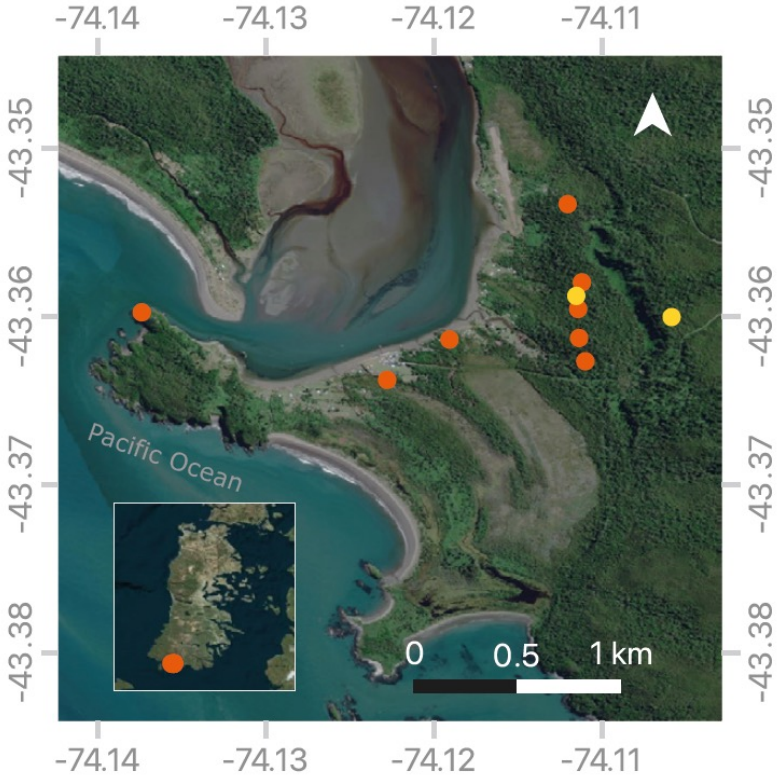
A drawing of a Darwin's frog created by Charles Darwin in 1834. He first encountered this frog in the Chiloé Archipelago.



Location

- Tantauco Park used to host the **largest known populations of Darwin's frogs**.

- This private protected area **was** thought to be a **refuge from chytrid fungus infection** and a stronghold for Darwin's frog conservation.



Map. Study area in Tantauco Park, southern Chile, showing sites where amphibians were sampled for Bd infection during 2010, 2011, and 2014 (orange circles). From 2015 to 2024, only sites TAN1 and TAN2 (yellow circles) were monitored for Bd infections in Darwin's frogs and syntopic amphibians.

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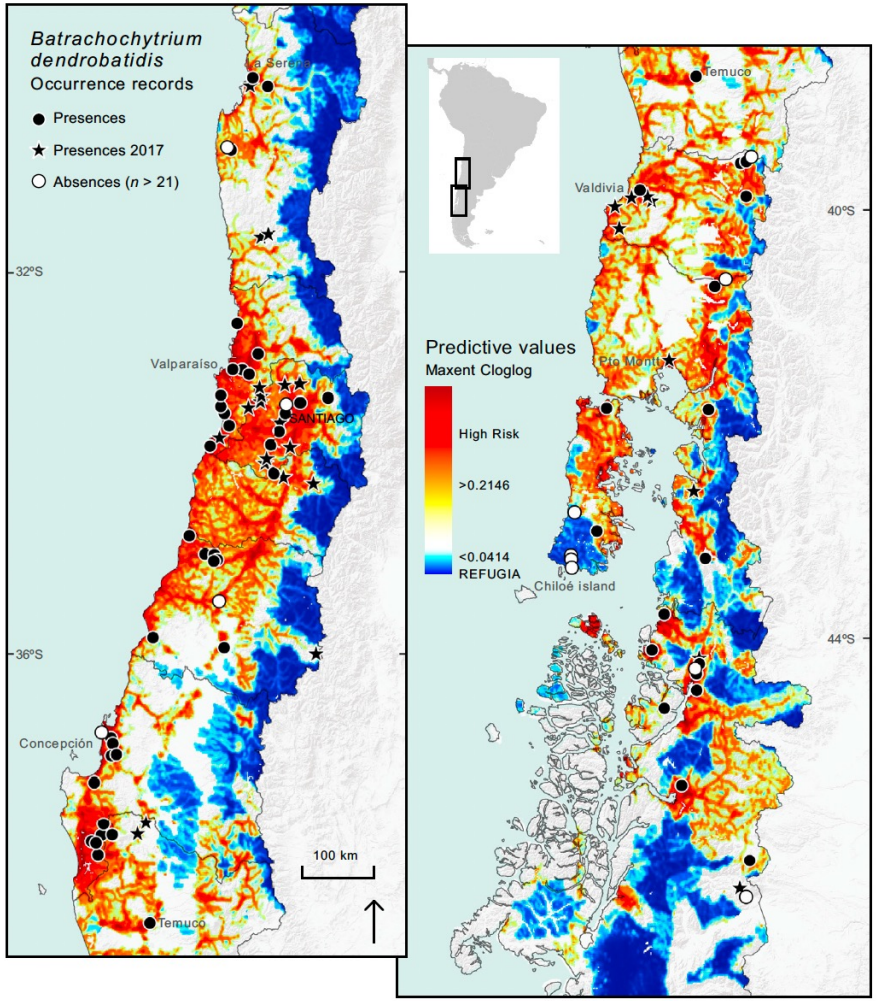

(a)

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PLOS ONE

Is Chytridiomycosis Driving Darwin's Frogs to Extinction?

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PROCEEDINGS B

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Cryptic disease-induced mortality may cause host extinction in an apparently stable host–parasite system

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Research

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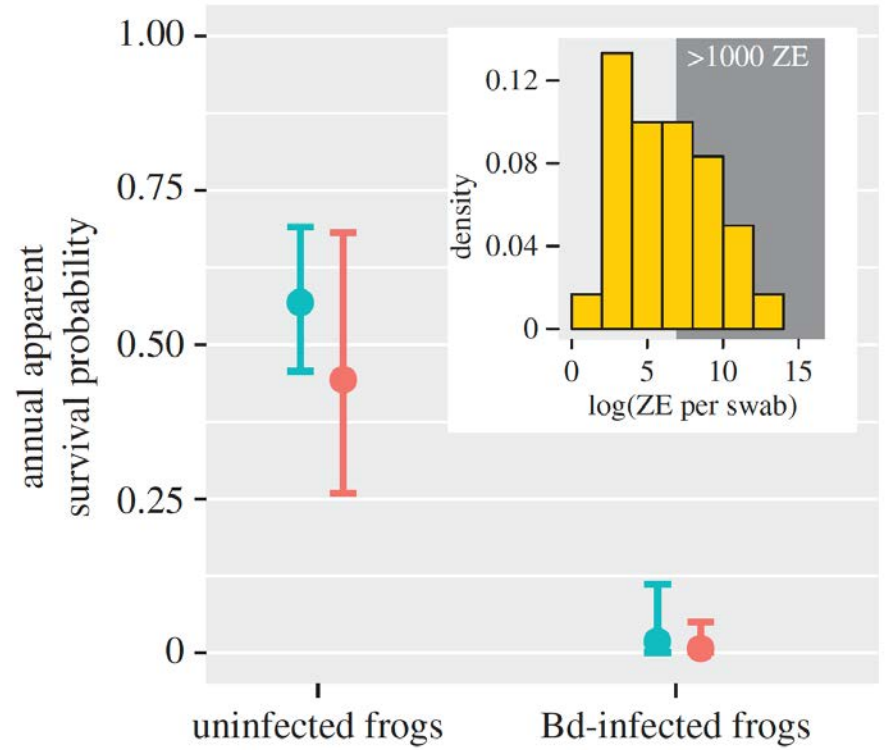

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Journal of Animal Ecology

RESEARCH ARTICLE

Interpopulation differences in male reproductive effort drive the population dynamics of a host exposed to an emerging fungal pathogen

Andrés Valenzuela-Sánchez[1,2,3] | Claudio Azat[3] | Andrew A. Cunningham[4] | Soledad Delgado[1] | Leonardo D. Bacigalupe[5] | Jaime Beltrand[1] | José M. Serrano[1,6] | Hugo Sentenac[4,7] | Natashja Haddow[3,4,7] | Verónica Toledo[8] | Benedikt R. Schmidt[9,10] | Hugo Cayuela[11]

DOI: 10.1111/1365-2656.13605

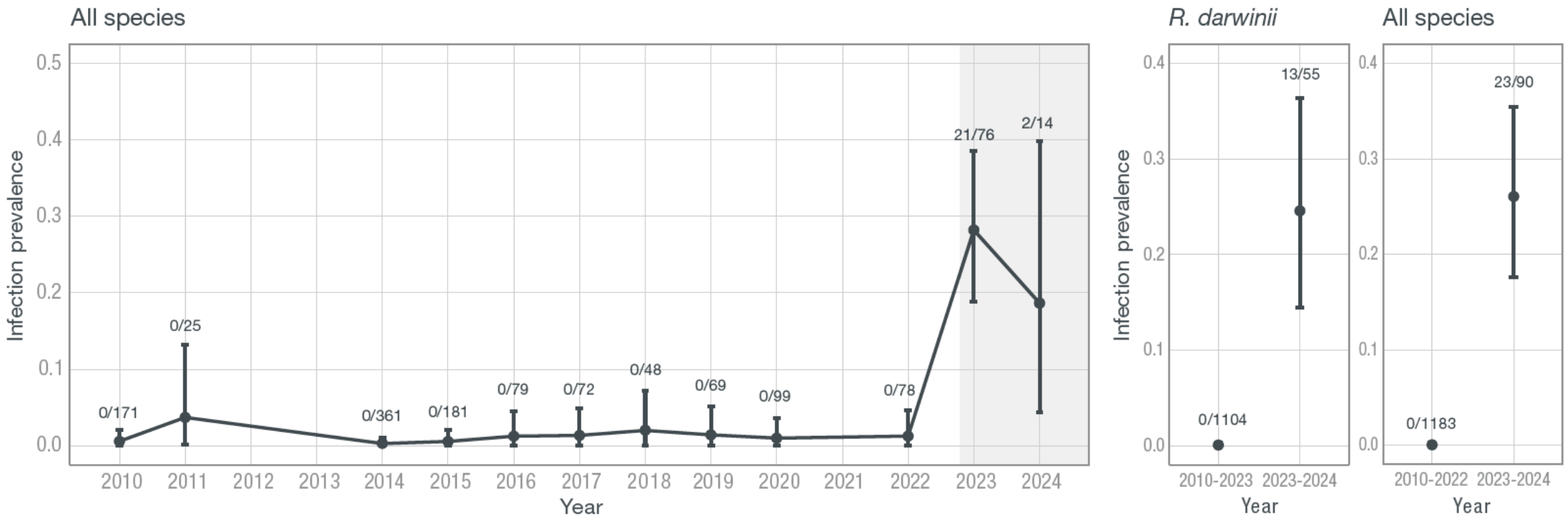
RAPID COMMUNICATION

WILEY

Genomic epidemiology of the emerging pathogen *Batrachochytrium dendrobatidis* from native and invasive amphibian species in Chile

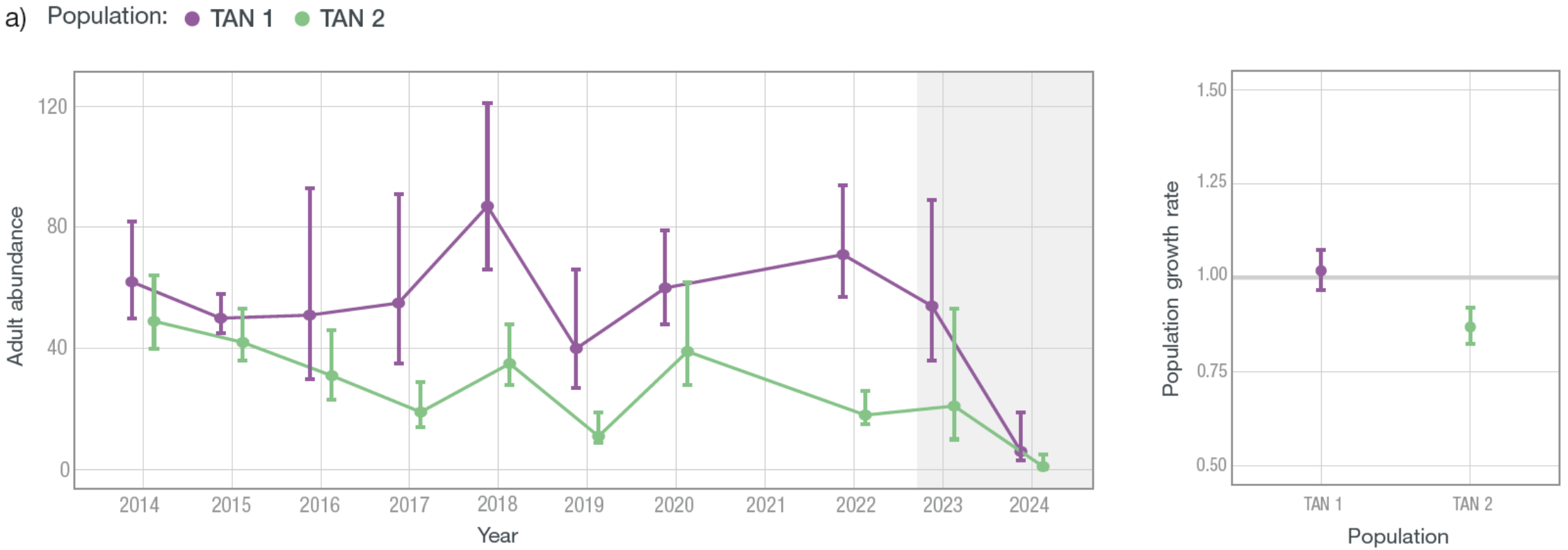
A. Valenzuela-Sánchez[1,2,3] | S. J. O'Hanlon[4] | M. Alvarado-Rybak[1,3] | D. E. Uribe-Rivera[2] | A. A. Cunningham[3] | M. C. Fisher[4] | C. Soto-Azat[1]

Chytrid fungus infection in Tantauco Park



Prevalence of Bd infection in amphibians from 2010 to 2024 (left panel) and grouped by the period before the first detection of Bd (i.e., 2010 to 2022) and when Bd was present (i.e., 2023 and 2024) (right panel). The numbers represent no. Bd(+) individuals / no. individuals sampled

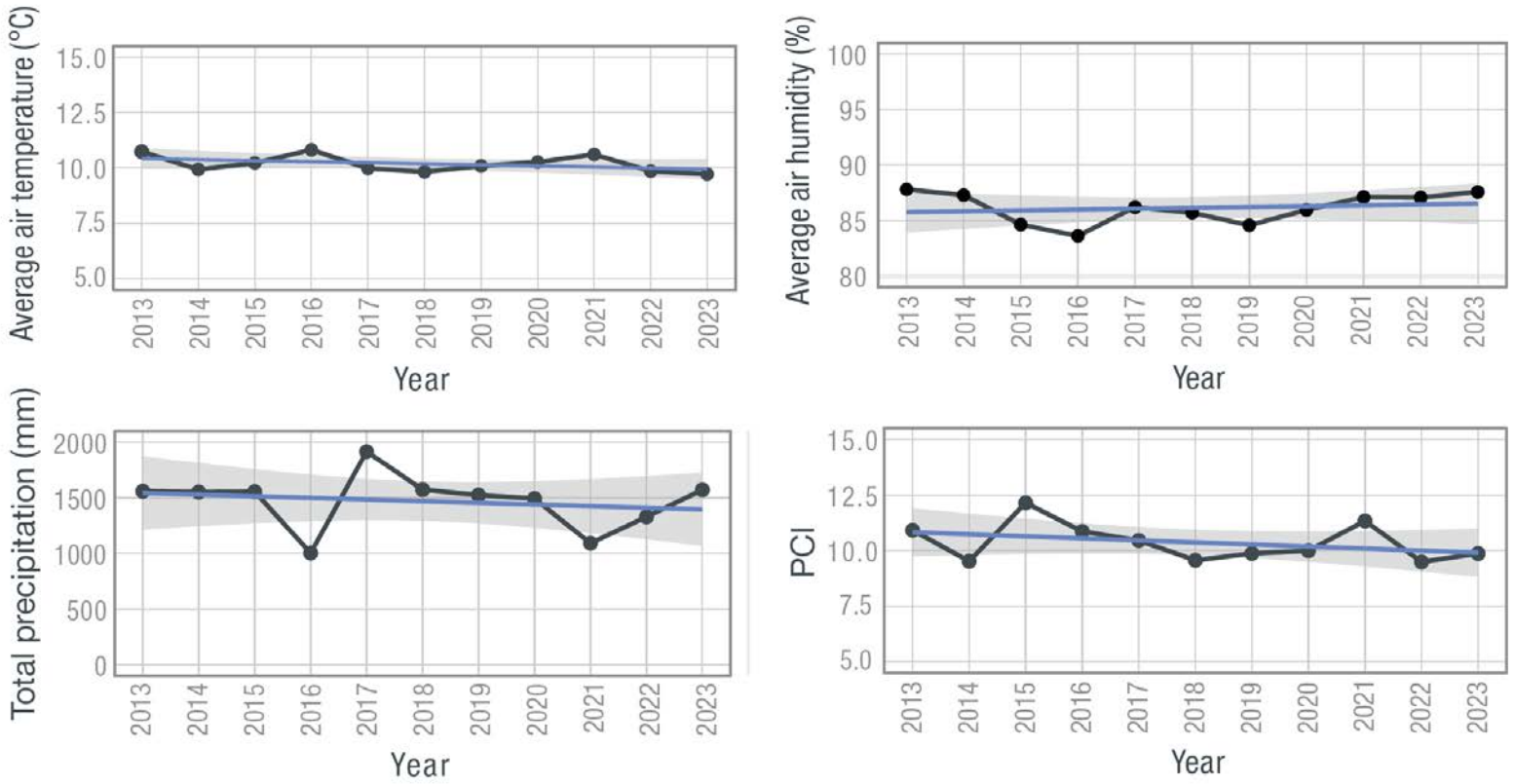
Population trends in Darwin's frogs in Tantauco Park



(a) Adult abundance estimated using a closed capture-recapture model (left panel) and geometric mean population growth from 2014 to 2022 (right panel) showing both populations **were close to stability (i.e. growth rate equal to 1) prior the first detection of Bd.**

After the introduction of the chytrid fungus, from 2023 to 2024, adult abundance was reduced by 89.1% and 95.5% in TAN1 and TAN2, respectively.

Climatic variation



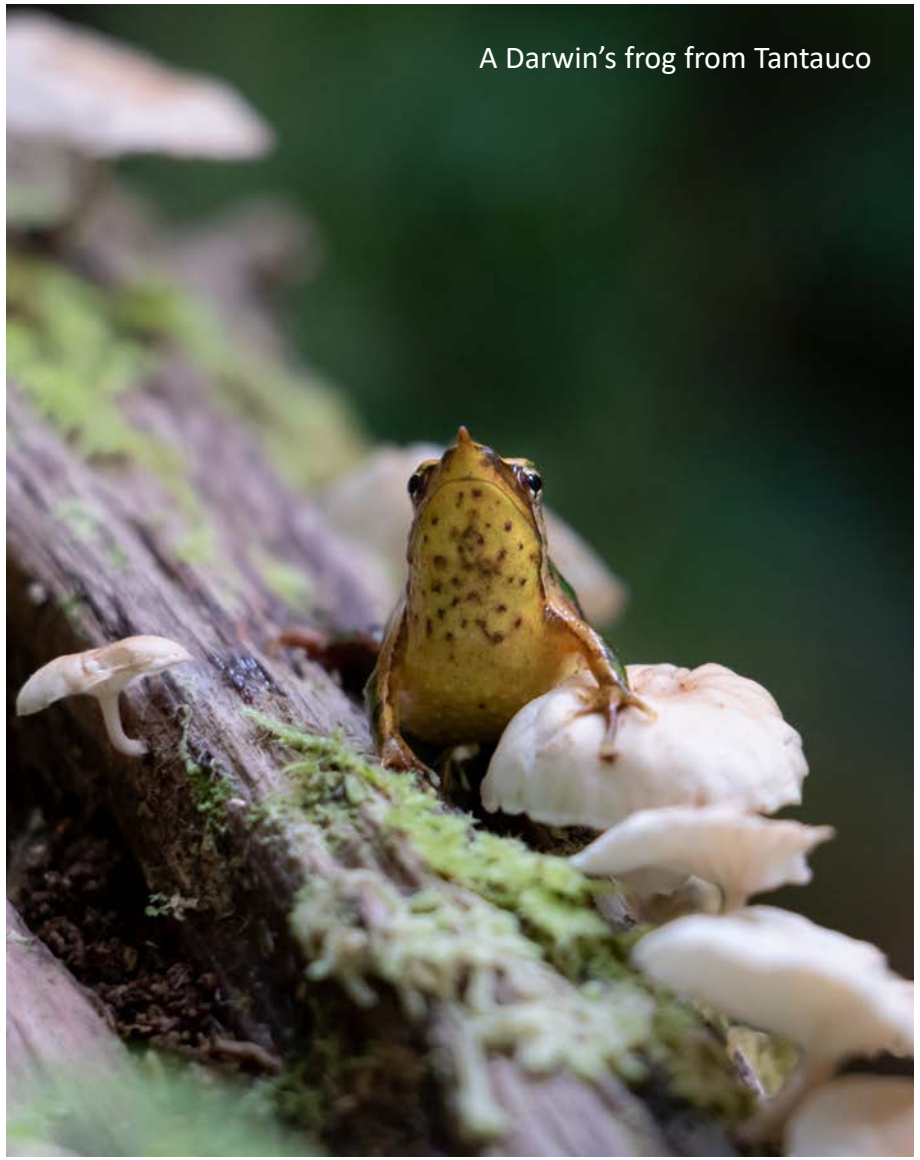
Climatic data recorded at a weather station located in Chiloé Island, approximately 75 km from the monitored populations. PCI stands for the “Precipitation Concentration Index”, which was calculated on a daily precipitation series. These data suggest that climate did not contribute to the emergence of chytrid fungus infection nor the collapse of Darwin’s frog populations, as the climatic conditions in 2022 and 2023 were average.

Recovery plan

- Our **long-term goal** is to restore the *R. darwinii* populations within Tantauco Park to their pre-chytrid fungus state, characterised by abundant and stable populations widely distributed across the park, as observed prior to 2023.

- To achieve our long-term goal, we have outlined two stages: an **emergency response phase** followed by a **recovery phase**. The long-term goal will be fulfilled during the recovery phase.

- In this project, we **will collaborate with key partners** from Chile and Europe including NGO Ranita de Darwin, Tantauco Park, captive breeding facility from Universidad de Concepción, Leipzig Zoo, and Universidad Andrés Bello, among other members of the Binational Conservation Strategy for Darwin's Frogs.



A Darwin's frog from Tantauco

Emergency response phase

The **general objective** for the emergency response phase is:

By 2028, the genetic diversity of Darwin's frogs in Tantauco Park has been adequately protected, enabling the initiation of the recovery phase.

Our **specific objectives** for this phase (2024-2028) are as follows:

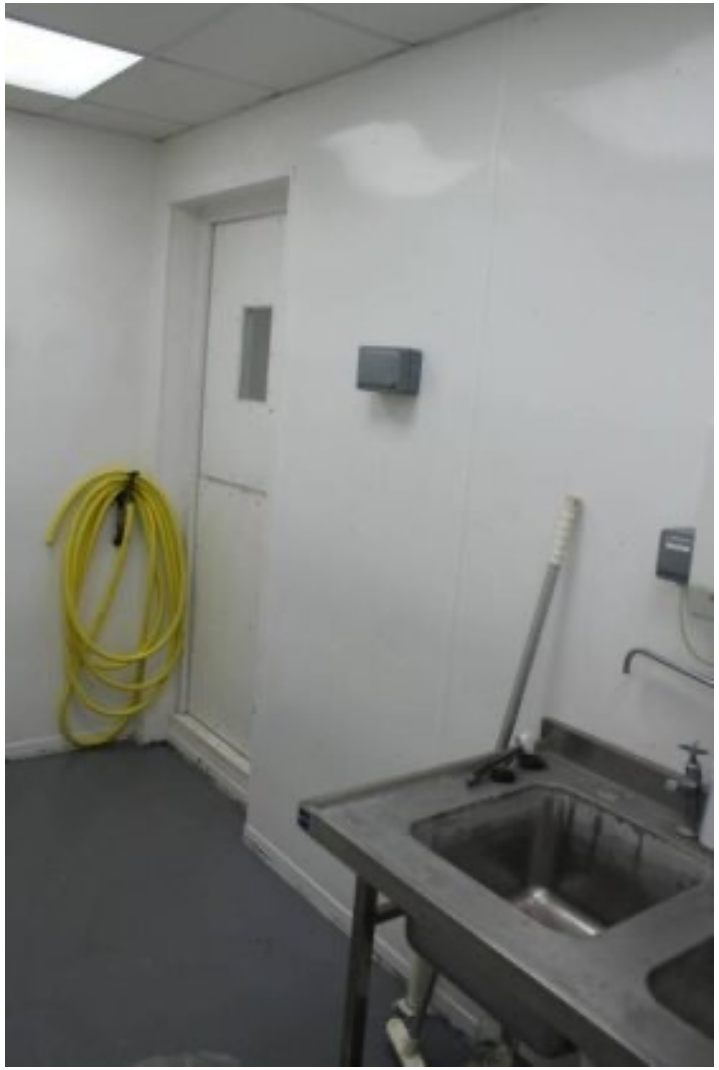
1. Assess the extent and severity of the impact caused by the introduction of Bd into Tantauco Park.
2. Safeguard at least 150 reproductive *R. darwinii* frogs from Tantauco Park through placement in wild enclosures and **captive-breeding facilities**.
3. Identify the most effective management strategy for achieving our long-term goal and secure the required funding for its initial implementation.

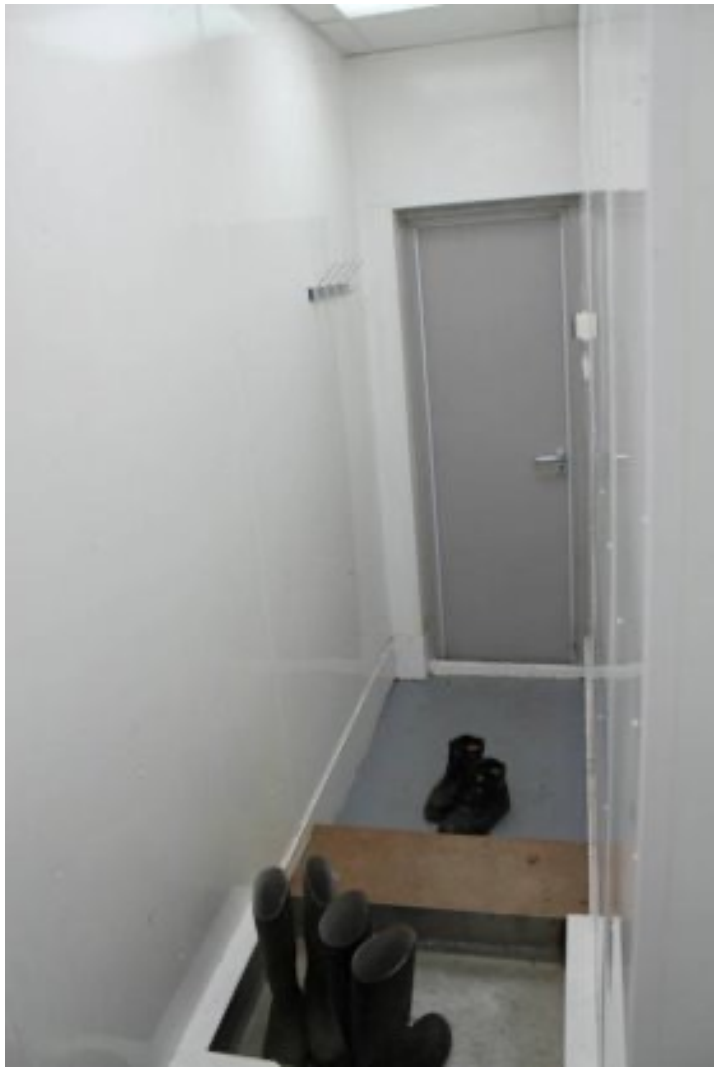
Emergency response phase

1. Assess the extent and severity of the impact caused by the introduction of Bd into Tantauco Park.

Emergency response phase

Captive breeding: London Zoo





- Dedicated changing area
- Existing water supply
- Water source
- Water treatment in place
- Some climate control in place

LONDON ZOO

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How they need to be upgraded

- Deep clean
- Repaint floor
- Replace ceiling tiles

- New shelving
- New tanks
- Portable chiller

- Improve ventilation
- Misting system
- Interpretation

>£8,000 (excluding interp)

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