

Master's Thesis Opportunity in the application of Environmental DNA for the study of Freshwater biodiversity in South America

Topic: Biodiversity and biological invasions in Chilean river systems

Potential title: “Environmental DNA metabarcoding to assess endemic and invasive freshwater fish along a Chilean latitudinal gradient”

Background

Chile is one of the most geographically and climatically diverse countries in the world, extending over more than 4,000 km in latitude and spanning from arid northern regions to temperate and highly rainy southern ecosystems. This strong climatic and environmental gradient, combined with the isolation imposed by the Andean Cordillera and the Pacific Ocean, has promoted high freshwater isolation and the development of distinct biogeographic regions. However, over recent decades, Chilean freshwater ecosystems have experienced increasing pressure from the introduction and spread of non-native fish species, mainly associated with aquaculture, recreational fishing, and ornamental trade. These invasive species are progressively expanding their distribution and competing with endemic fauna, leading to community restructuring, biodiversity loss, and biotic homogenization across river basins. Understanding the current distribution of endemic and invasive freshwater fishes across environmental gradients is therefore a priority for conservation and sustainable management. Environmental DNA (eDNA) metabarcoding has emerged as a powerful, non-invasive tool for biodiversity monitoring, enabling standardised, efficient, and sensitive detection of aquatic species. This approach is particularly suitable for large-scale ecological assessments and for detecting rare, cryptic, or declining species. When applied to multiple river basins using standardised sampling protocols, eDNA can provide new insights into spatial patterns of biodiversity, invasion processes, and conservation priorities.

Objectives

The overall objective of this thesis is to develop an eDNA-based framework to characterise freshwater fish biodiversity and biological invasions along a latitudinal gradient in Chile.

Specific objectives include:

1. Characterising fish community composition across 15 Chilean rivers sampled with a standardised eDNA protocol.
2. Estimating the relative occurrence and spatial distribution of endemic, native, and non-native (invasive) fish species.
3. Evaluating patterns of beta diversity among river basins.
4. Assessing whether invasive species contribute to biotic homogenization across Chilean freshwater ecosystems.
5. Identifying river basins that represent biodiversity hotspots or conservation priorities for endemic freshwater fish.

Key research questions may include:

- How does freshwater fish diversity vary along the Chilean latitudinal and climatic gradient?
- Which rivers show the highest proportion of invasive species and lowest endemism?
- Are river basins becoming more similar in species composition due to widespread invasive taxa?
- Which systems still maintain high levels of regional uniqueness and conservation value?

Study Area

The project will focus on 15 river systems distributed across Chile and spanning the Andes-to-Pacific gradient: Maullín, Petrohué, Rahue, Bueno, Calle-Calle, Toltén, Cautín, Biobío, Itata, Maule, Teno, Cachapoal, Aconcagua, Choapa, and Maipo.

These rivers represent a wide range of hydrological regimes, climatic conditions, and biogeographic regions.

Expected Outcomes

- A comprehensive, spatially explicit inventory of freshwater fish biodiversity based on eDNA metabarcoding.
- Improved understanding of the distribution and relative importance of endemic versus invasive species across Chile.
- Identification of patterns of community similarity and potential biotic homogenization.
- Detection of biodiversity hotspots and priority conservation basins.
- A reproducible and scalable framework for long-term freshwater biodiversity monitoring using eDNA.

The results will contribute to conservation planning, biodiversity monitoring, and management of invasive species in Chilean freshwater ecosystems.

Candidate Profile

We are seeking a motivated Master's student with:

- Background in ecology, environmental science, biology, conservation biology, molecular ecology, or related fields.
- Interest in freshwater ecosystems, biodiversity, and biological invasions.
- Willingness to learn quantitative and bioinformatic skills (R or Python).
- Interest in ecological modelling, community ecology, and spatial analysis.
- Ability to work independently and manage datasets.

Experience with eDNA, molecular laboratory work, GIS, or modelling is an advantage but not mandatory.

Practical Information

- **Duration:** 6–12 months
- **Start date:** Flexible
- **Location:** Laboratory of Experimental Ecology and Aquaculture
- **Supervision:** Tommaso Russo.
- **Co-supervision:** Arnold Rakaj

Interested candidates should send a CV and a short motivation letter describing their background and research interests to tommaso.russo@uniroma2.it .

