ARPHA Conference Abstracts 9: e219150
doi: 10.3897/aca.9.e219150

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Conference Abstract

From Clear to Turbid: Long-Term Ecological Changes in a Pyrenean Lake Associated with Climate Change and Minnow Introduction

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Received: 12 Oct 2026 | Published: 26 Oct 2026

Citation: Gacia E, Baqué-Díaz E, Buchaca T, Sabas I, Bunay D, Osorio V, Catalan Aguila J, Robira Q, Ventura M, Ballesteros E (2026) From Clear to Turbid: Long-Term Ecological Changes in a Pyrenean Lake Associated with Climate Change and Minnow Introduction. ARPHA Conference Abstracts 9: e219150. https://doi.org/10.3897/aca.9.e219150

Abstract

High-mountain lakes are among the freshwater ecosystems most vulnerable to global change. Alongside climate-driven impacts, biological invasions can profoundly alter food webs, ecosystem functioning, and biodiversity. Rosari d'Arreu Lake (1,996 m a.s.l.), a glacial lake in the Pyrenees, provides a unique opportunity to assess long-term ecological change associated with the establishment of the introduced minnow *Phoxinus* spp., a species known to affect planktonic communities and endemic quillwort populations.

We analysed long-term datasets spanning 37 years, including water chemistry (1987, 1998, 2017, 2023), aquatic vegetation (1987, 1997, 2017), zooplankton biomass (1998, 2017, 2024), and fish community composition (1987, 1997, 2018). Results revealed a

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progressive decline in isoetid cover accompanied by shifts in water chemistry and zooplankton community structure, consistent with the combined effects of climate change and *Phoxinus* proliferation.

Over time, the lake transitioned from a clear-water oligotrophic system characterized by indicator species of pristine conditions, including *Subularia aquatica*, *Isoetes echinospora*, *I. creussensis*, and *Sparganium angustifolium*, to a more turbid state dominated by taxa associated with mesotrophic conditions, such as *Potamogeton berchtoldii*, *Ranunculus aquatilis*, and filamentous algae. Zooplankton biomass patterns further suggest strong predation pressure by minnows, reducing grazing on phytoplankton and increasing water turbidity.

These findings demonstrate a long-term ecological shift driven by interacting climatic and biological pressures, highlighting the value of long-term monitoring for conservation and management of mountain lakes.

Keywords

High-mountain lake, Global Change, Biological invasion, *Phoxinus* spp., Aquatic macrophytes, Zooplankton biomass, Trophic interactions, Regime shift, Long-term monitoring, Freshwater conservation

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Presented at

LTER-BG 2026

Acknowledgements

Aigüestortes i Estany de Sant Maurici (AT) directors, parc rangers and tecnitians. LTER_AT Research Node.

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Conceptualization and Study Design: EB, EG, MV; Data Collection and Fieldwork: EB, EG, MV, QRP, IS, DB, VO, TB, EBD, LIC; Data Analysis and Interpretation: EG, MV, QRP, EBD, IS, DB, VO; Writing Abstract: EG; Funding Acquisition: EG, EB, MV, TB, JC

Conflicts of interest

The authors have declared that no competing interests exist.