The 2nd International Conference on
Sustainability in Hydropower 2023
–Ecological mitigation, best practises and governance

FWF
Der Wissenschaftsfonds.

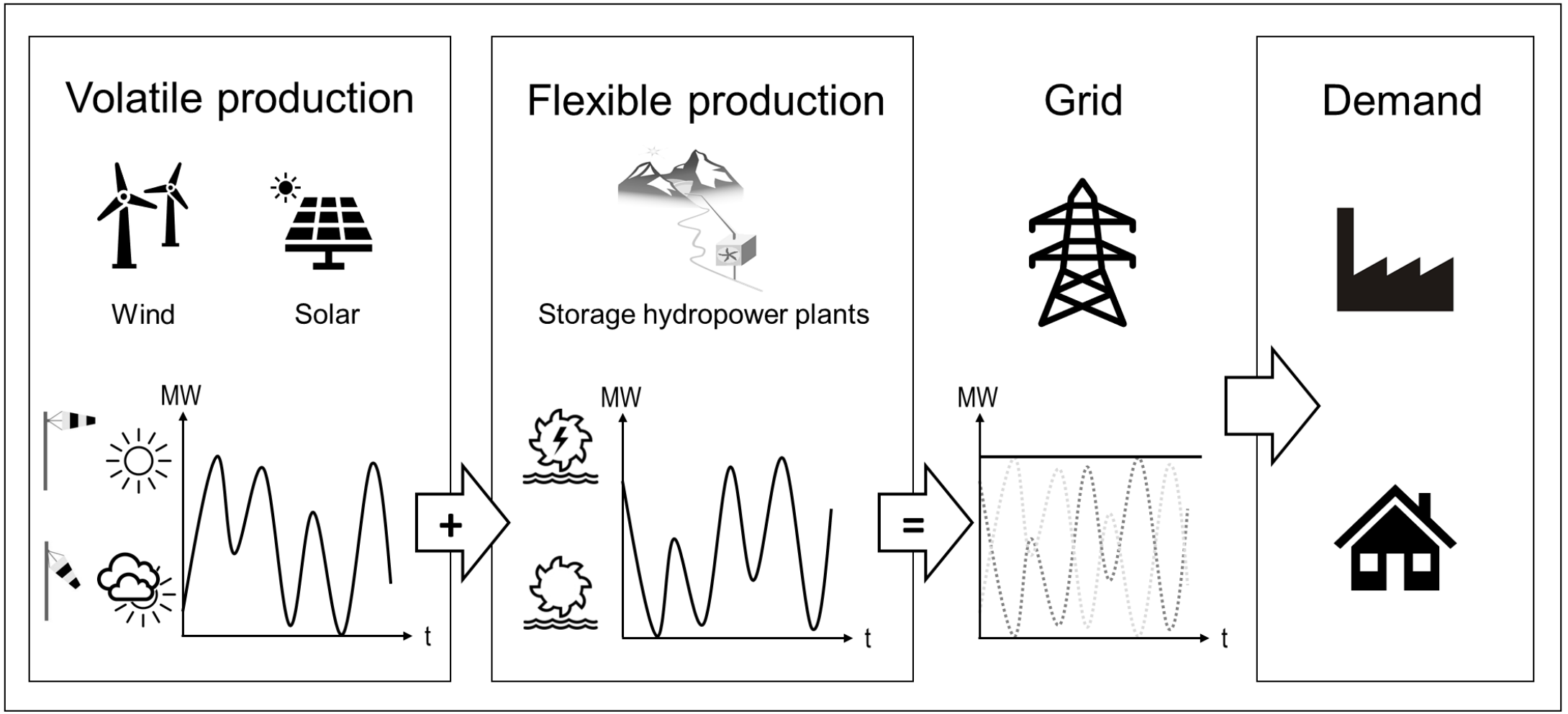
BOKU
IHG
Institute of Hydrobiology and Aquatic Ecosystem Management

Unravelling the complex relationship between artificial flow fluctuations and cyprinid fish: a comprehensive analysis

Daniel S. Hayes, Stefan Auer, Stefan Schmutz, Bernhard Zeiringer, Franz Greimel, Jeremy Piggott, Simon Führer

Foto: Stefan Schmutz

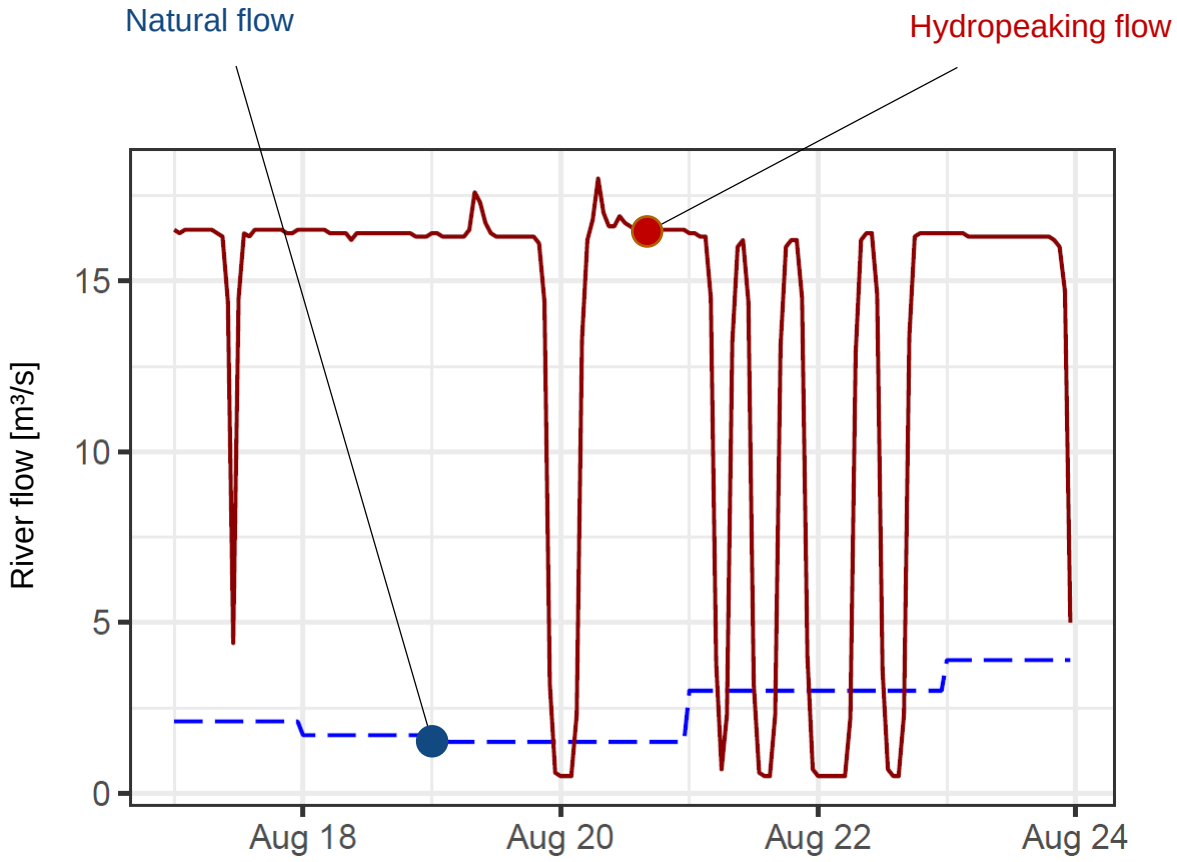
Flexible hydropower and the energy system



Hayes et al. (2022). In: Encyclopedia of Inland Waters, 2nd edition.

Fluctuating water levels due to hydropeaking

IHG
Institute of Hydrobiology and Aquatic Ecosystem Management



Data from Casas-Mulet et al. (2016). *Sci. Tot. Env.*, 573: 1660–1672.

A growing body of hydropeaking research, but …

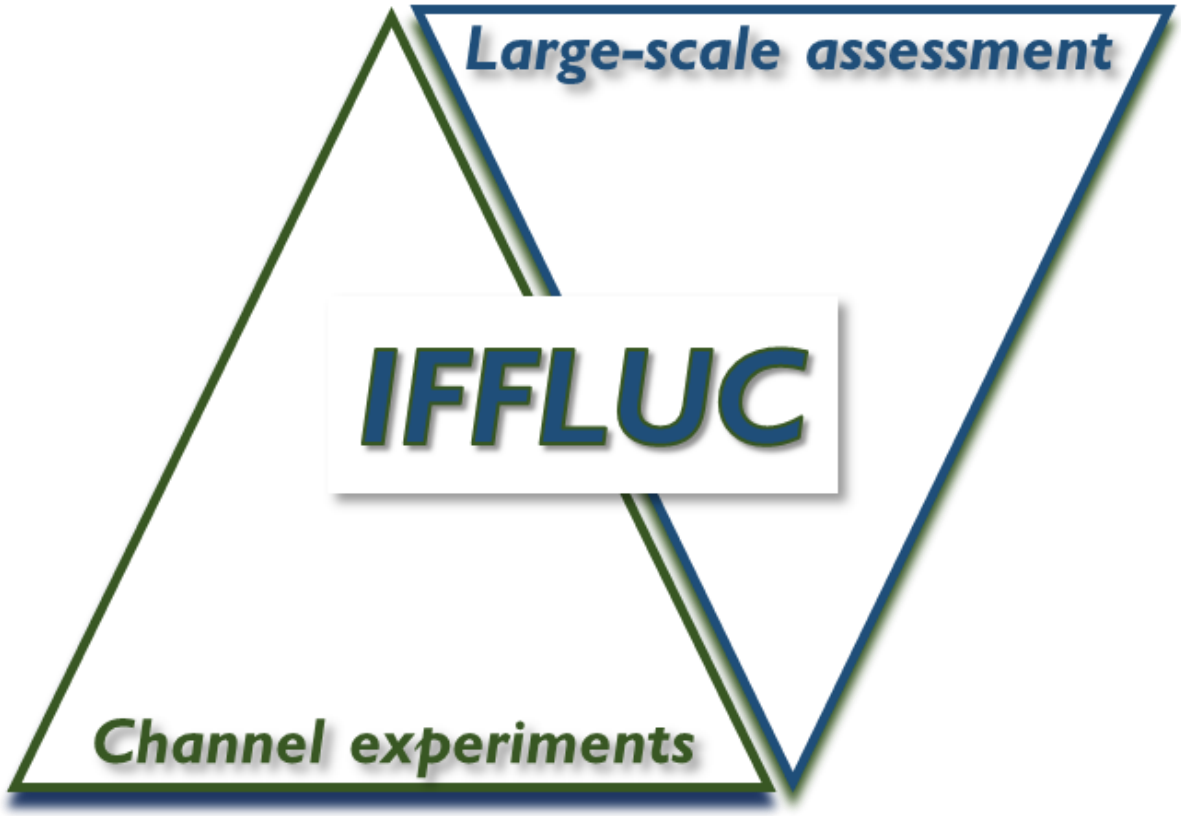
“No thresholds or mitigation targets for cyprinids“[1]

Fotos: Wikipedia

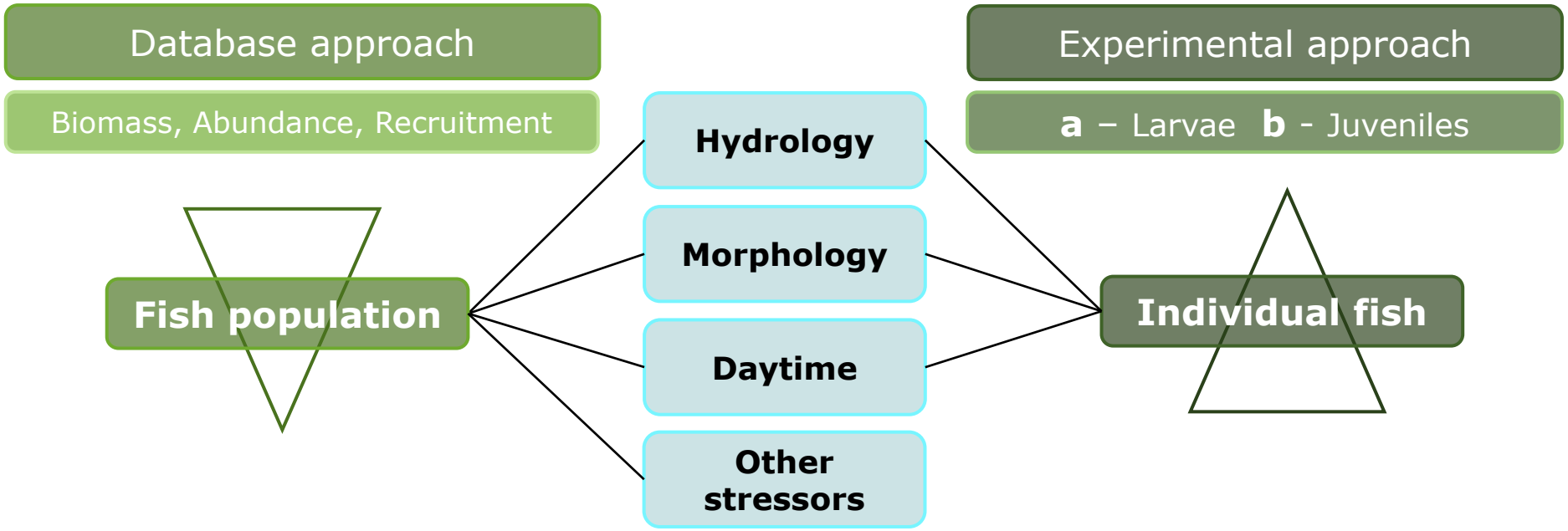
Moreira et al. (2019). Sci. Tot. Environ.
https://doi.org/10.1016/j.scitotenv.2018.12.107

Project aims

1. To study how hydropeaking affects cyprinid fish populations nation-wide.
2. To assess how single and multiple hydropeaking events impact early life-stages of the target species.

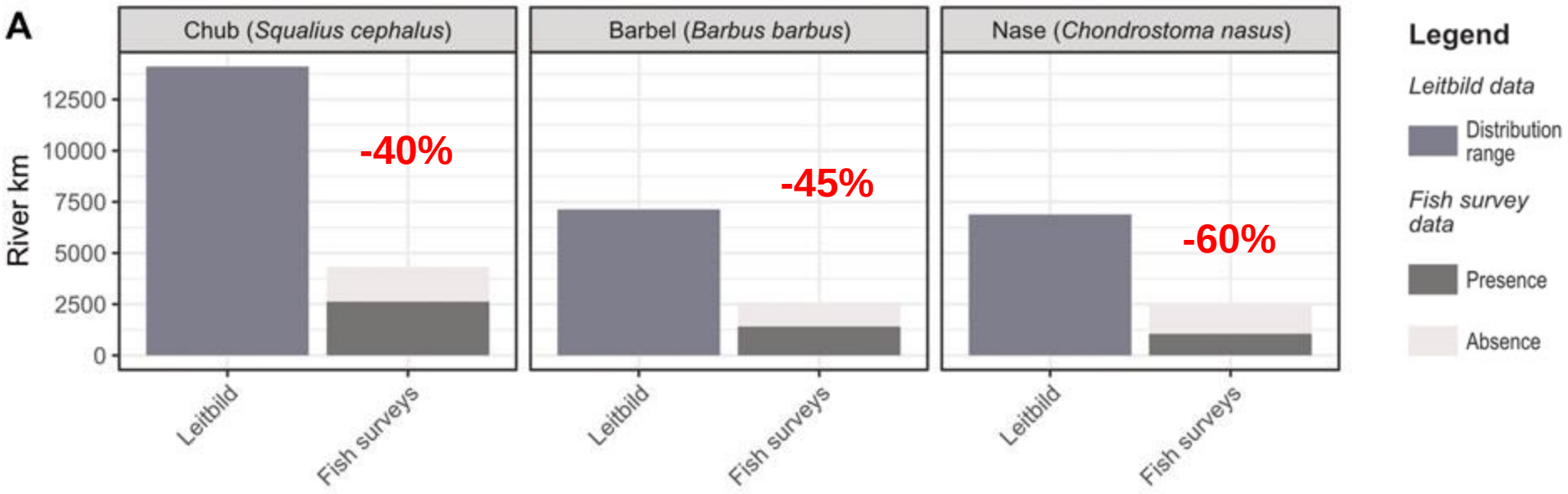


Methods


Database approach
Biomass, Abundance, Recruitment
Experimental approach
a – Larvae b - Juveniles
Hydrology
Morphology
Daytime
Other stressors
Fish population
Individual fish

Database approach

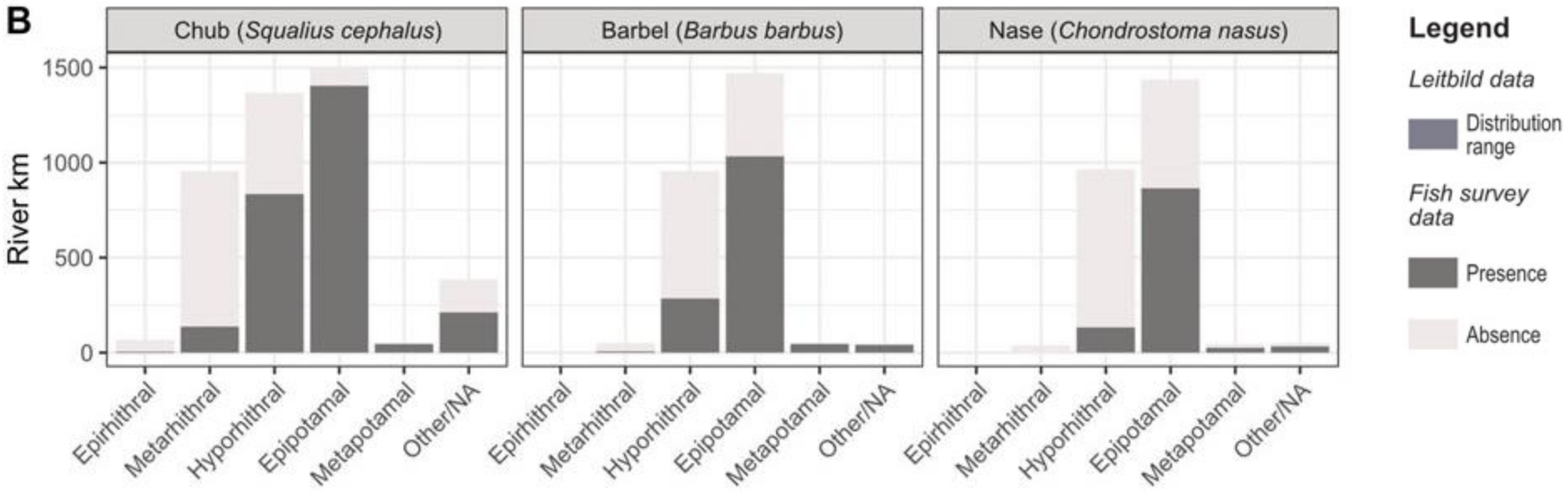
Presence/absence of cyprinid fishes in Austria



n=1,430 n=763 n=730

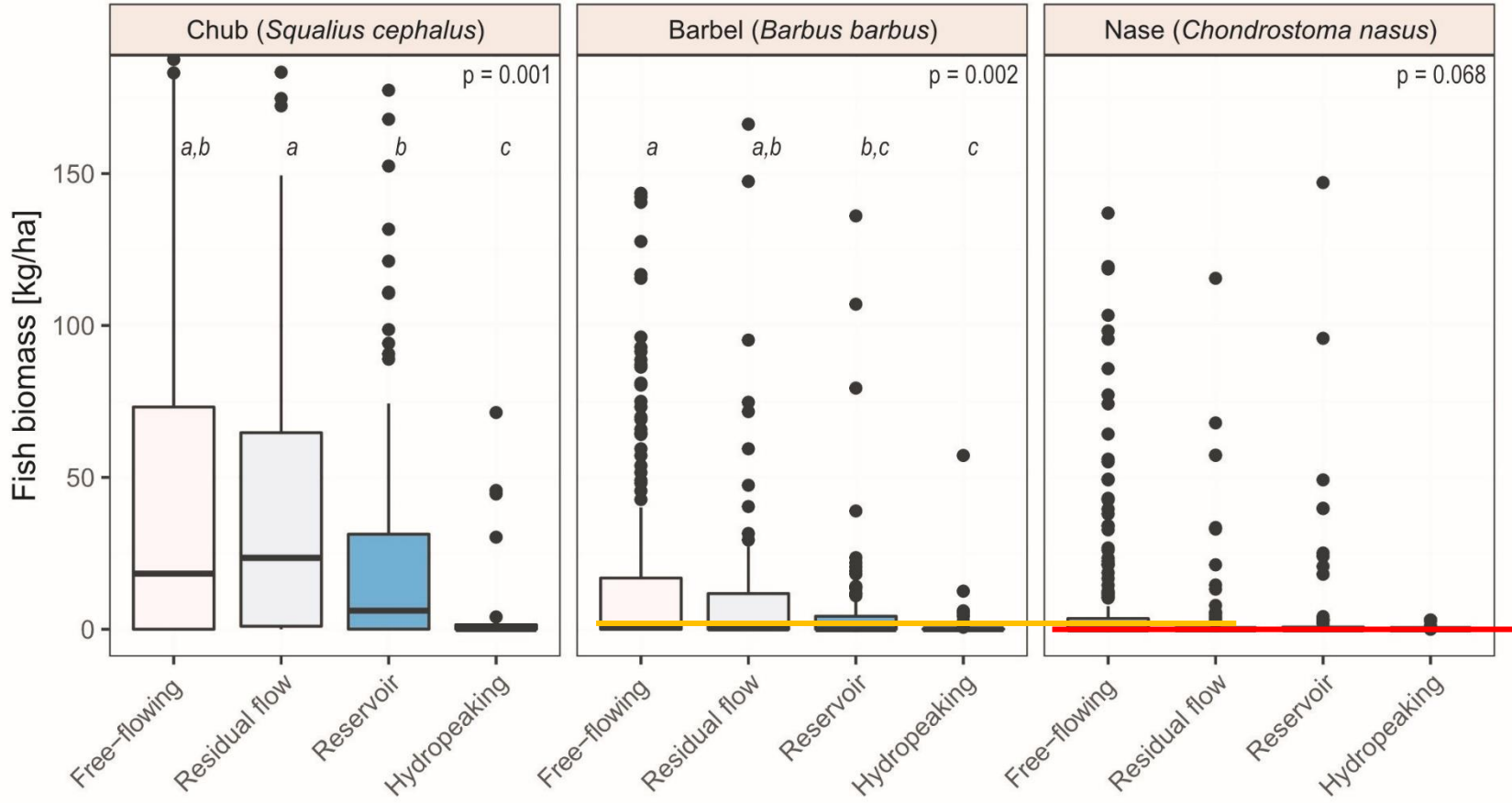
Hayes et al. (2022). Front. Environ. Sci.
https://doi.org/10.3389/fenvs.2022.991722

Presence/absence of cyprinid fishes in Austria



Hayes et al. (2022). Front. Environ. Sci.
https://doi.org/10.3389/fenvs.2022.991722

Population status of cyprinid fishes in Austria

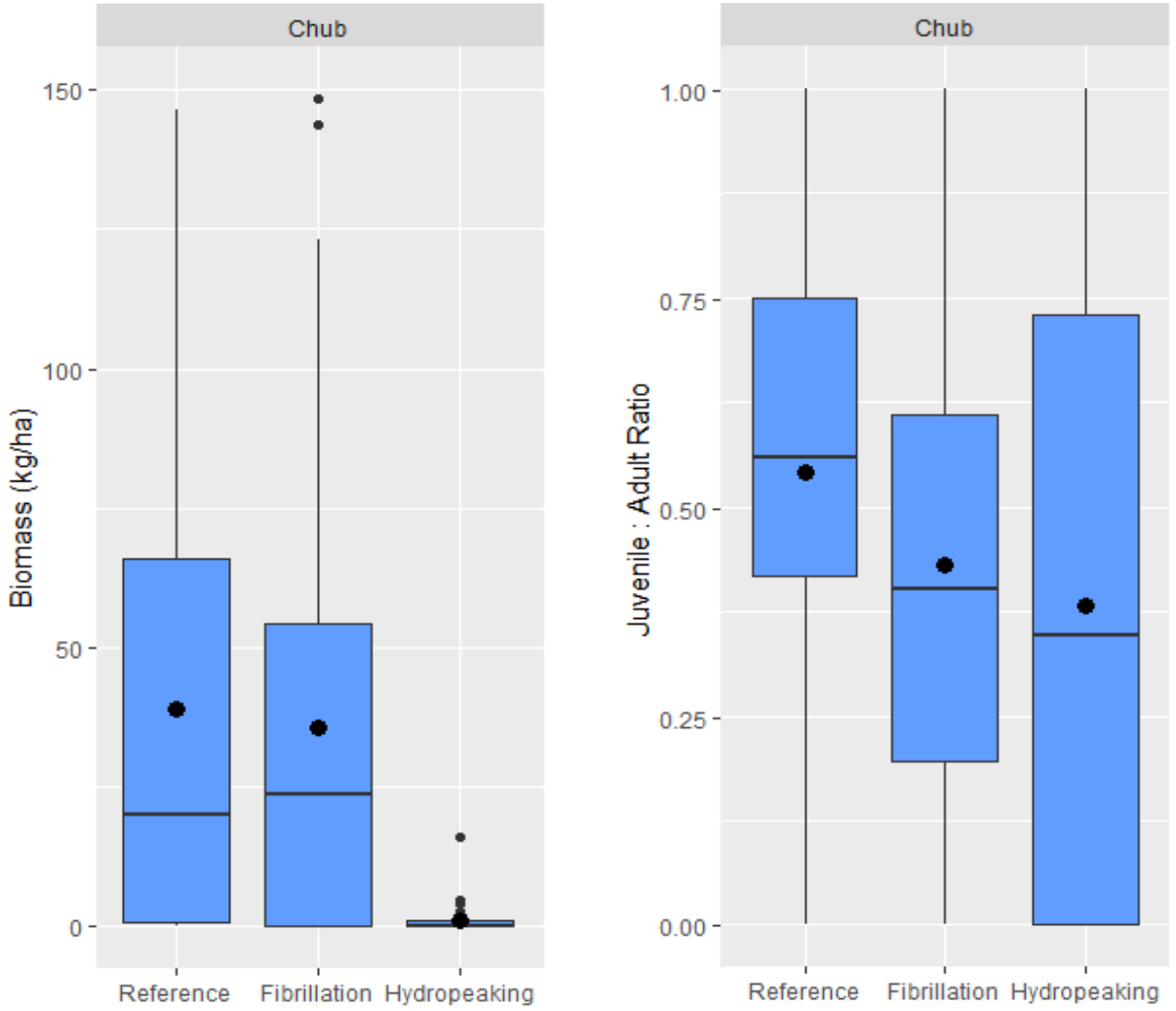


Barbel:
Grand median: 0.02 kg/ha

Nase:
Grand median: 0.0 kg/ha

Hayes et al. (2022). Front. Environ. Sci.
https://doi.org/10.3389/fenvs.2022.991722

Chub – first results



Experimental approach

Fluctuating water levels due to hydropeaking

Institute of Hydrobiology and Aquatic Ecosystem Management

Foto: Führer et al. (2022). Front. Environ. Sci. https://doi.org/10.3389/fenvs.2022.966418

Video: Daniel Hayes

Channel experiments

- Mesocosm experiments in nature-like channel (HyTEC: http://hydropeaking.boku.ac.at)

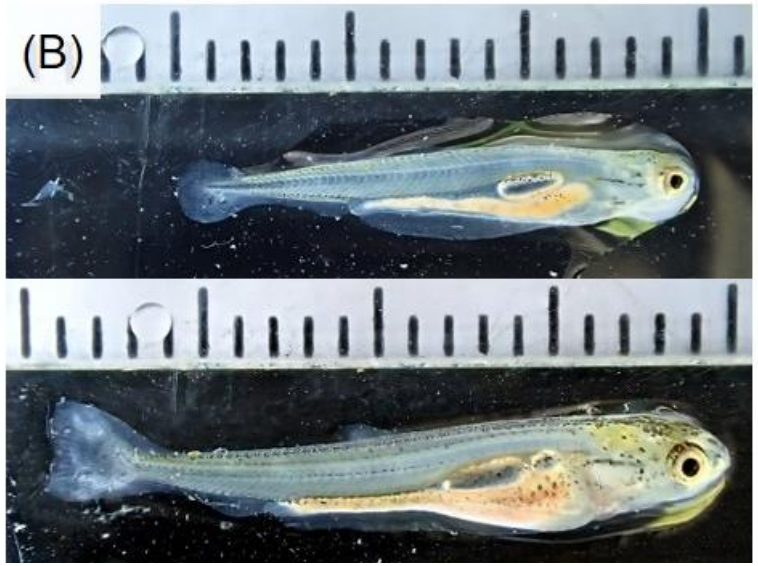


Foto: Führer et al. (2022)

Foto: Thomas Hasler, in: Mameri et al. (2023)

Channel experiments

- Test parameters:
  - Down-ramping rate
  - Time of day
  - Gravel bar slope
  - Morphological structures
  - Fish size & larval stage
  - Fish species
  - Thermopeaking
  - Multi-peaking

Video: David Graf

Methods

Nase: flat gravel bar

- 2 lateral slopes [2%, 5%]
- 5 different ramping rates [0.7, 1.1, 1.5, 2.0, 3.0 cm min^{-1}]
- Day/night
- 2 different larval stages[1] [III-IV, V]

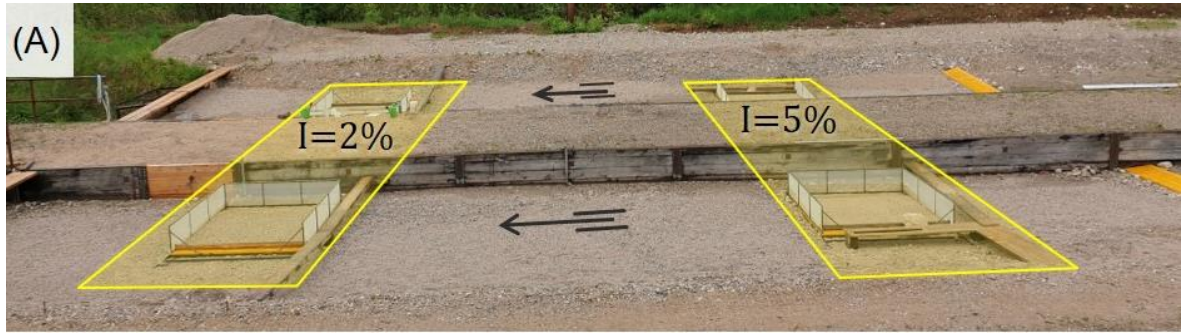


Foto: Führer et al. (2022)

Nase: riverbank structures

- 2 morphological setups:
  a. Flat gravel bar
  b. Structured river bank (sill and ditch)
- Day/night

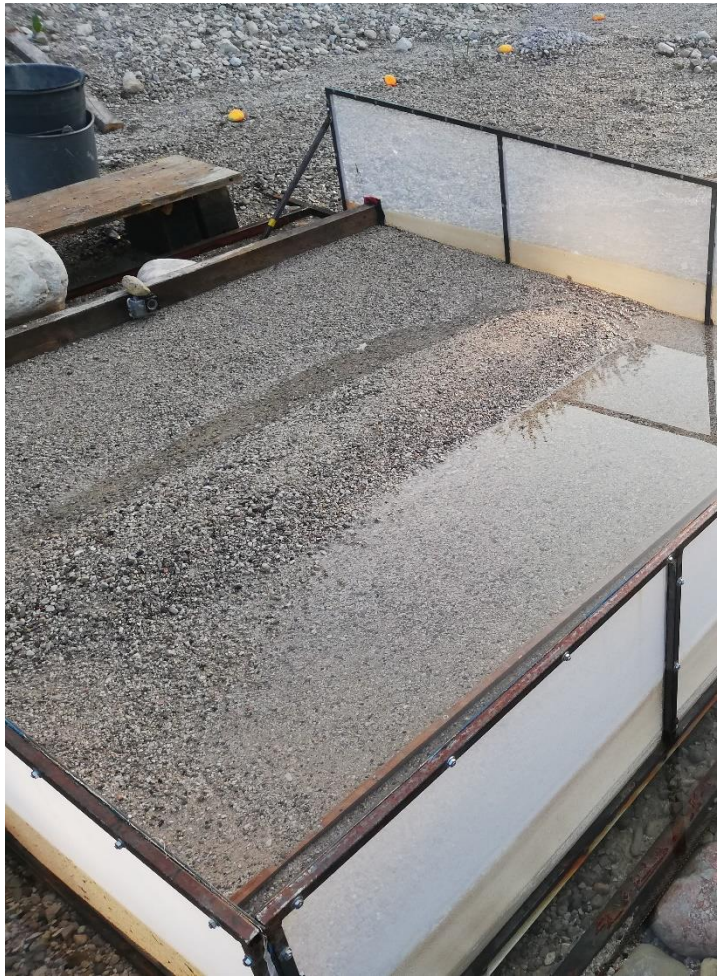
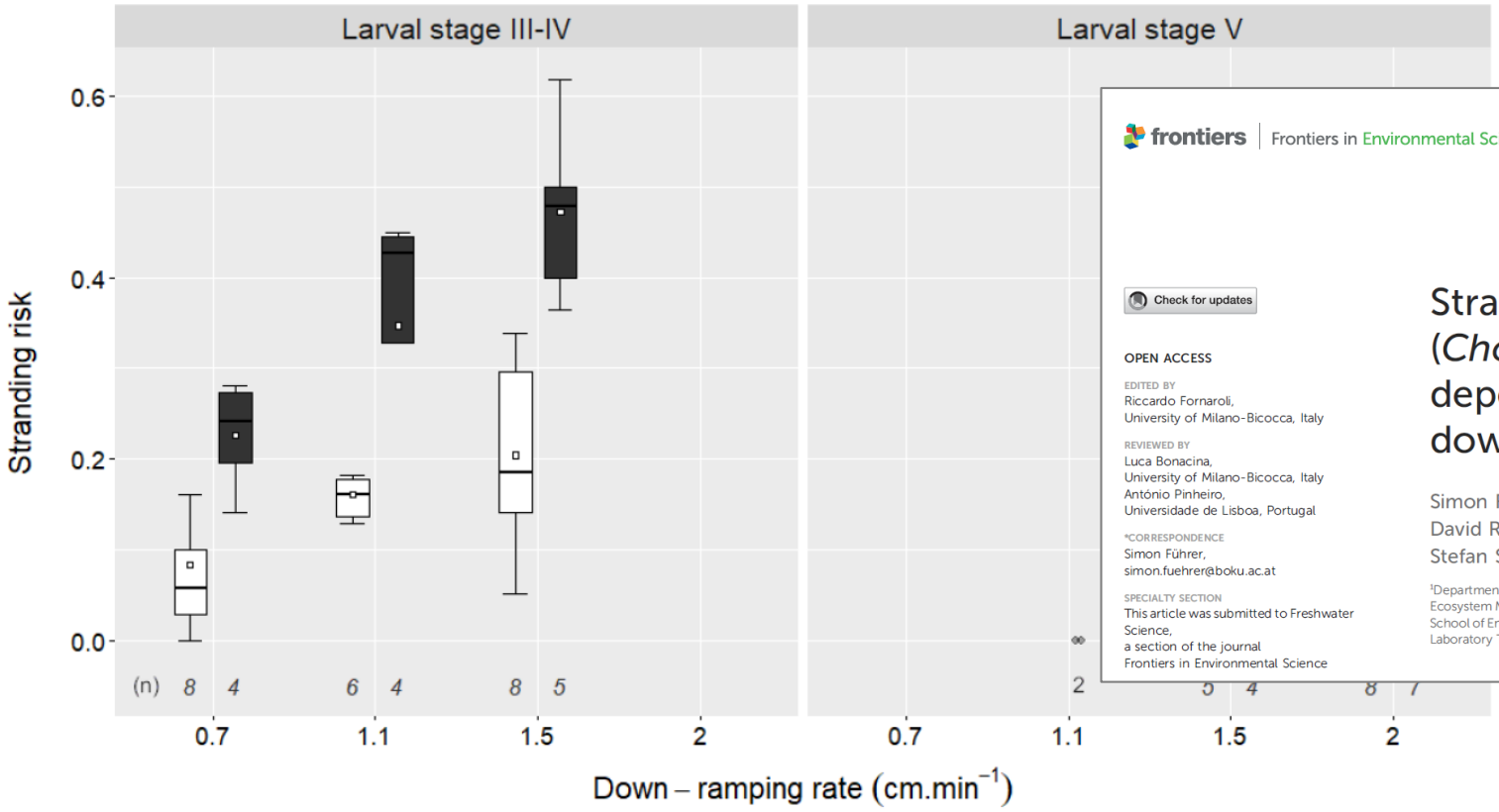


Foto: Thomas Hasler

[1] Peňáz (1974). Zoologické Listy, 23(3), 275-288

Results

Part A



frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 23 August 2022
DOI 10.3389/fenvs.2022.966418

Check for updates

OPEN ACCESS

EDITED BY
Riccardo Fornaroli,
University of Milano-Bicocca, Italy

REVIEWED BY
Luca Bonacina,
University of Milano-Bicocca, Italy
António Pinheiro,
Universidade de Lisboa, Portugal

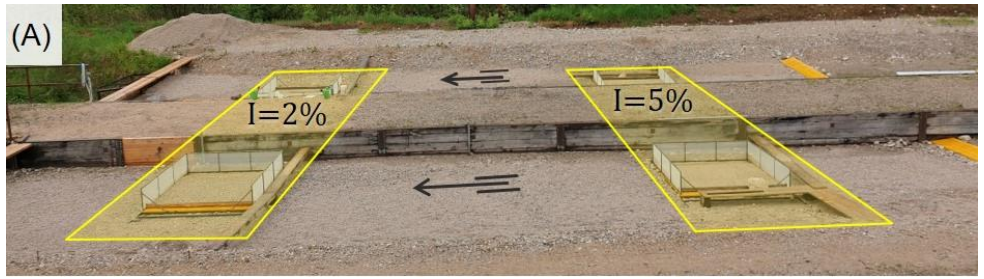
*CORRESPONDENCE
Simon Führer,
simon.fuehrer@boku.ac.at

SPECIALTY SECTION
This article was submitted to Freshwater Science,
a section of the journal
Frontiers in Environmental Science

Stranding of larval nase (*Chondrostoma nasus* L.) depending on bank slope, down-ramping rate and daytime

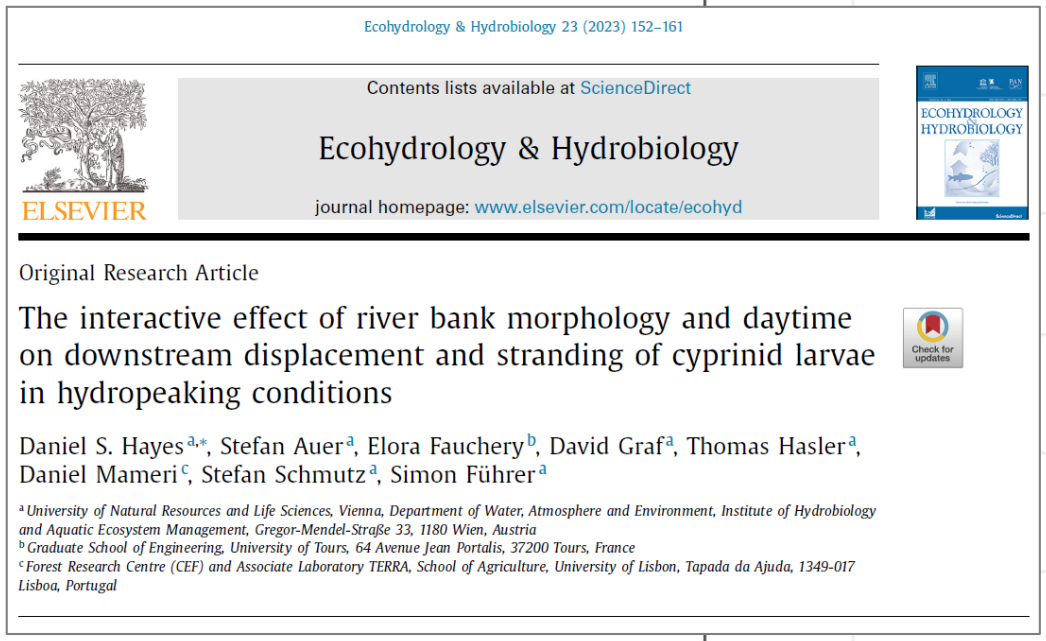
Simon Führer[1]*, Daniel S. Hayes[1], Thomas Hasler[1], David R. M. Graf[1], Elora Fauchery[2], Daniel Mameri[3], Stefan Schmutz[1] and Stefan Auer[1]

[1]Department of Water, Atmosphere and Environment, Institute of Hydrobiology and Aquatic Ecosystem Management, University of Natural Resources and Life Sciences, Vienna, Austria, [2]Graduate School of Engineering, University of Tours, Tours, France, [3]Forest Research Centre (CEF) and Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Lisboa, Portugal



Results

Part B



Ecohydrology & Hydrobiology 23 (2023) 152–161

Contents lists available at ScienceDirect

Ecohydrology & Hydrobiology

journal homepage: www.elsevier.com/locate/ecohyd

Original Research Article

The interactive effect of river bank morphology and daytime on downstream displacement and stranding of cyprinid larvae in hydropeaking conditions

Daniel S. Hayes[a,*], Stefan Auer[a], Elora Fauchery[b], David Graf[a], Thomas Hasler[a], Daniel Mameri[c], Stefan Schmutz[a], Simon Führer[a]

[a] University of Natural Resources and Life Sciences, Vienna, Department of Water, Atmosphere and Environment, Institute of Hydrobiology and Aquatic Ecosystem Management, Gregor-Mendel-Straße 33, 1180 Wien, Austria
[b] Graduate School of Engineering, University of Tours, 64 Avenue Jean Portalis, 37200 Tours, France
[c] Forest Research Centre (CEF) and Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Tapada da Ajuda, 1349-017 Lisboa, Portugal

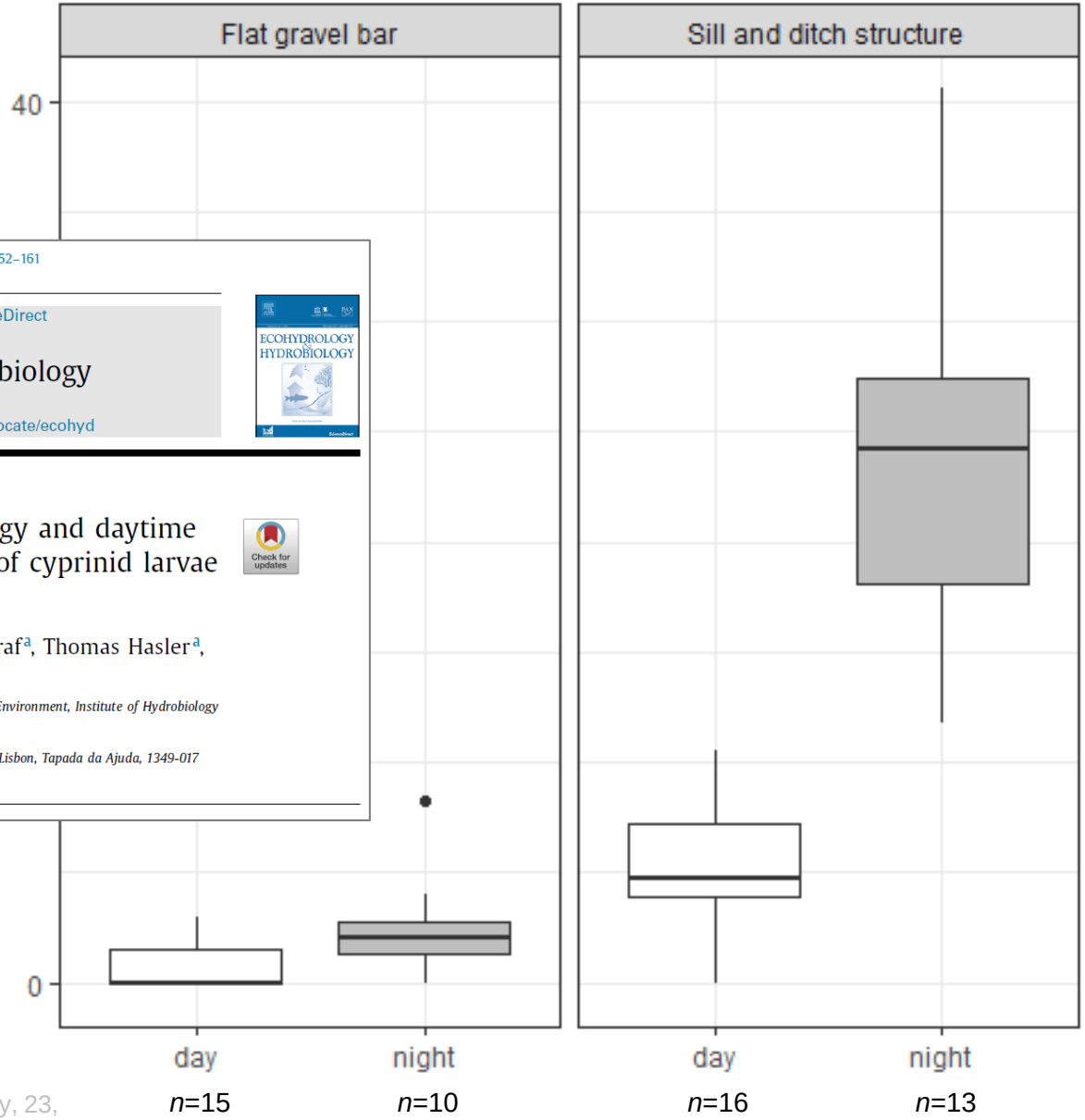
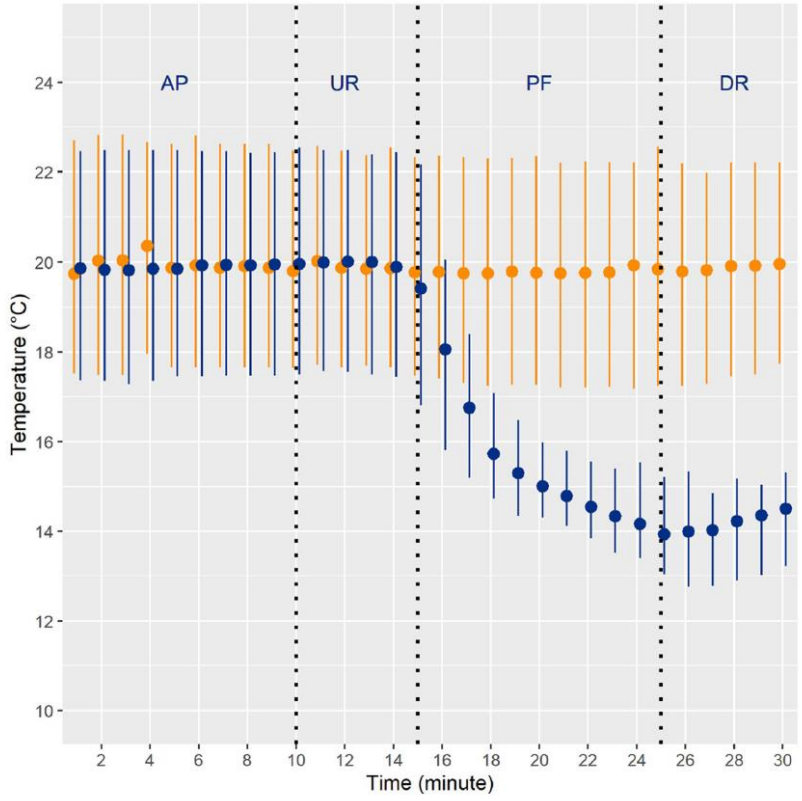


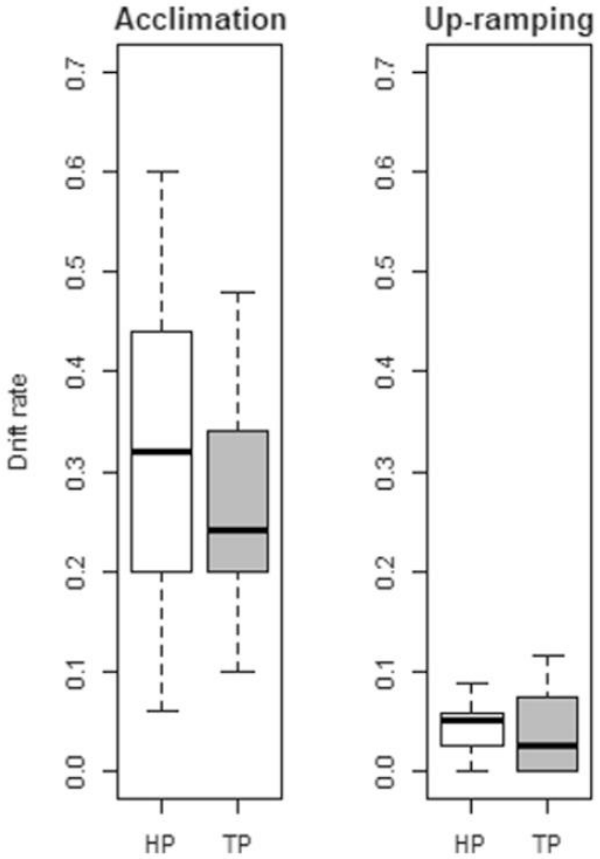
Foto: Thomas Hasler

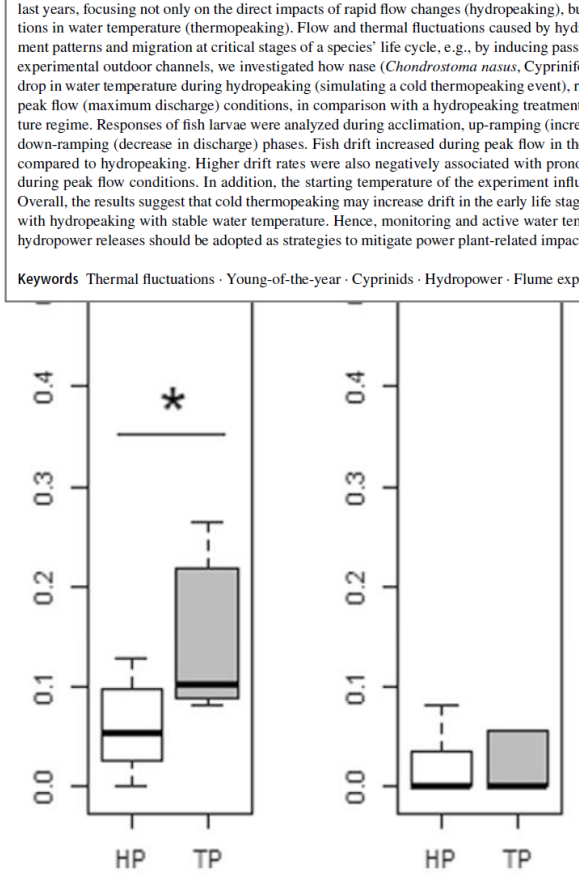
Hayes et al. (2023). Ecohydrology & Hydrobiology, 23, 152-161. https://doi.org/10.1016/j.ecohyd.2022.12.001

Results

Thermopeaking







Aquatic Sciences (2023) 85:56
https://doi.org/10.1007/s00027-023-00955-x
Aquatic Sciences
RESEARCH ARTICLE

Cold thermopeaking-induced drift of nase *Chondrostoma nasus* larvae

D. Mameri[1] · D. S. Hayes[2] · S. Führer[2] · E. Fauchery[3] · S. Schmutz[2] · A. Monserat[4] · T. Hasler[2] · D. R. M. Graf[2] · J. M. Santos[1] · M. T. Ferreira[1] · S. Auer[2]

Received: 12 June 2022 / Accepted: 8 March 2023

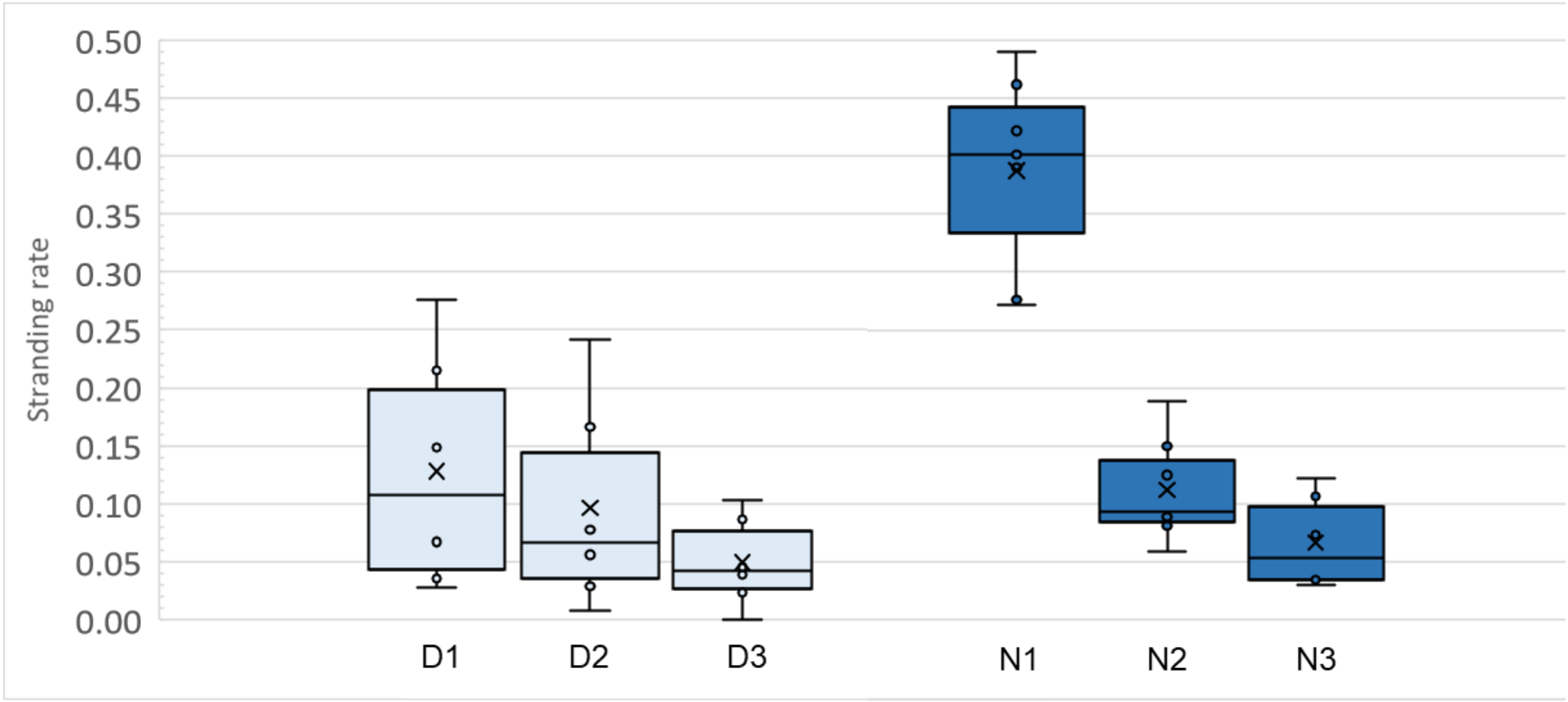
Abstract
Research on how intermittent water releases from hydropower plants affect the early life stages of fish has advanced in the last years, focusing not only on the direct impacts of rapid flow changes (hydropeaking), but also on the short-term fluctuations in water temperature (thermopeaking). Flow and thermal fluctuations caused by hydropeaking may affect fish movement patterns and migration at critical stages of a species' life cycle, e.g., by inducing passive downstream drift. Using two experimental outdoor channels, we investigated how nase (*Chondrostoma nasus*, Cypriniformes) larvae respond to a rapid drop in water temperature during hydropeaking (simulating a cold thermopeaking event), reaching on average 5.5 °C under peak flow (maximum discharge) conditions, in comparison with a hydropeaking treatment with a constant water temperature regime. Responses of fish larvae were analyzed during acclimation, up-ramping (increase in discharge), peak flow and down-ramping (decrease in discharge) phases. Fish drift increased during peak flow in the cold thermopeaking treatment compared to hydropeaking. Higher drift rates were also negatively associated with pronounced water temperature drops during peak flow conditions. In addition, the starting temperature of the experiment influenced drift during up-ramping. Overall, the results suggest that cold thermopeaking may increase drift in the early life stages of cypriniform fish compared with hydropeaking with stable water temperature. Hence, monitoring and active water temperature adjustments following hydropower releases should be adopted as strategies to mitigate power plant-related impacts on aquatic organisms.

Keywords Thermal fluctuations · Young-of-the-year · Cyprinids · Hydropower · Flume experiments · Pulsed flows

Mameri et al. (2023). Aquatic Sciences, 85, 56.
https://doi.org/10.1007/s00027-023-00955-x

Results

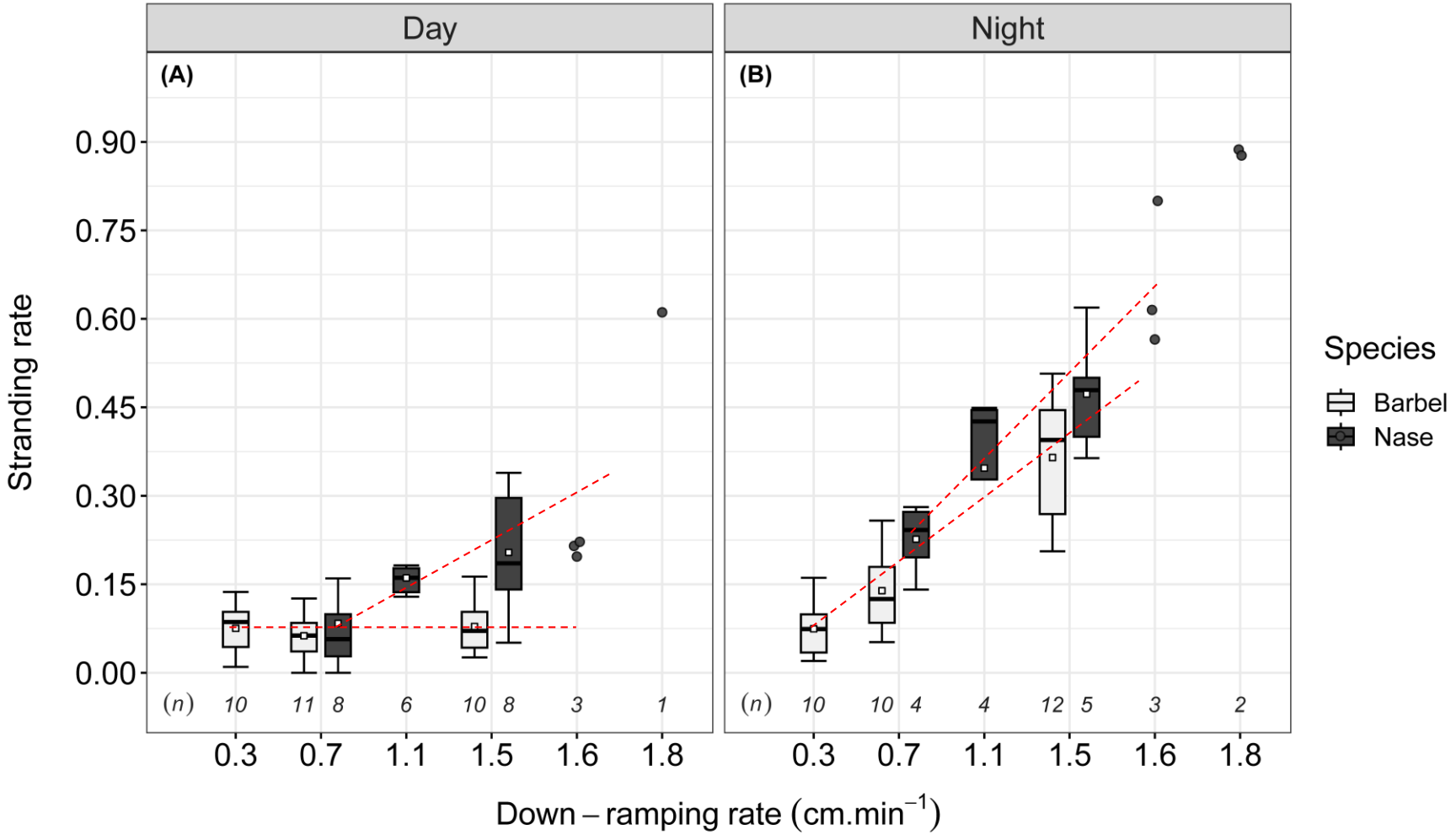
Multipeaking



Auer et al. (in prep.)

Results

Species comparison



Führer et al. (in prep.)

The 2nd International Conference on
Sustainability in Hydropower 2023
–Ecological mitigation, best practises and governance

FWF
Der Wissenschaftsfonds.

BOKU | IHG

Unravelling the complex relationship between artificial flow fluctuations and cyprinid fish: a comprehensive analysis

@DanielSHayes

Daniel S. Hayes
Gregor-Mendel-Straße 33/DG
1180 Vienna, Austria
Tel.: +43 1 47654-81223
Email: daniel.hayes@boku.ac.at
Website: www.danielhayes.at

ECOENet
Early Careers on Ecohydraulics Network