### **Growing and surviving in dynamic floodplains** How does habitat heterogeneity drive young fish in the lower river Rhine?

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Setting goals for dynamic nature: paradox or solution

Kopenhagen, 2 May 2024





#### Freshwater biodiversity crisis CONSERVATION . .

#### BIOLOGICAL REVIEWS

Biol. Rev. (2019), 94, pp. 849-873. doi: 10.1111/brv.12480

### Em The freshu cha *biodiversi*

Andre Peter A Iulian Kleme

The 2018 Living Pla shows that populat -30 cies have declined l since 1970, a far ste restrial or marine s for freshwater spec ally high (2). For each (2)extinction rates in Europe have been than 100 times the Meanwhile, wetlan high as forest loss tion of freshwater as "the ultimate co requiring "immedi © FNSP - Sciences Po. Atelier de cartographie. 2018 underscores that actions taken since nave

been grossly inadequate.



Average decline in abundance of populations by type of habitat (% compared to 1970)



#### <u><u>u</u>obal freshwater fish biodiversity</u>

<sup>5</sup>, Shengli Tao<sup>1</sup>, Sébastien Villéger<sup>6</sup><sup>+</sup>, Sébastien Brosse<sup>1</sup><sup>+</sup>

ie world's vertebrates and provide irreplaceable goods and numan activities. A new index, Cumulative Change in ges in biodiversity in >50% of the world's rivers covering and >37% of the world's river length, whereas <14% of the st impacted. Present-day rivers are more similar to each other erse morphologies and longer evolutionary legacies. In een greatest, biodiversity changes were primarily due to river tive species.

11% of stantial 00 fish 1rth of hwater tability

biomass production and regulation of trophic networks and nutrient cycles (4). Freshwater fishes also contribute to human welfare as key food resources (5) and for recreative and cultural activities (2, 6).

For centuries, human populations have directly affected fish biodiversity (7) through tion to

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# **Modified lower river Rhine**

Rivers are the most modified freshwater ecosystems in the world, severely adapted for **flood safety**, **energy production**, **navigation**, and **agricultural land use** 

#### **Resulting in**

- 1) Reduced lateral and longitudinal **connectivity**
- 2) Severe decline in (nursery) habitat heterogeneity

River Waal, Nijmegen, The Netherlands (Photo: Johan Roerink)



# A dynamic river





### Morphological changes over time





Resulted in a loss of river-floodplain connectivity and habitat heterogeneity!

# Importance of habitat connectivity and heterogeneity



**Rheophilics A** 

Specialists: prefer flowing water throughout life



**Eurytopics** 

Generalists: can thrive in a wide range of habitats





**Rheophilics B** 

Specialists: prefer flowing water in certain life stages



Specialists: prefer standing water and water plants





### Morphological changes over time









### Floodplain restoration since 1990s





### Study design

#### Aim

Assessment of the ecological functioning of river restoration projects as fish nurseries to improve biodiversity

#### Design

Large-scale evaluation of 46 restoration projects

#### Period

2017-2020

#### Focus

Habitat heterogeneity, lateral connectivity

### Fish community response Biodiversity and abundances



**Eurytopics** 

**Rheophilics** 

Limnophilics



# **Fish communities**

# **Fish communities**

Stoffers et al. (2022), Science of the Total Environment

AMINATION

# Local habitat

# Local habitat

# Nursery function of restoration projects



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### Management is important in dynamic floodplains





# Habitat heterogeneity

#### **A.** Habitat clusters for Hurwenen (2SC)



5.29° E

5.30° E

5.31° E

**C.** Cluster description









# **Ontogenetic habitat shift by YOY fishes**



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# **Ontogenetic habitat shift by YOY fishes**

Multinomial logistic regression models



# Variability in habitat availability for fishes





Stoffers et al. (2024; under review), Journal of Applied Ecology

# **Concluding remarks**

- 1. We highlight the significance of **habitat heterogeneity** in dynamic restored floodplains, with ontogenetic shifts in habitat use varying among species, emphasising the need for tailored restoration strategies.
- Restoration efforts are restricted within the boundaries of modified dynamic forces of regulated rivers → Whether a river section is free-flowing or impounded dictates the scope and efficacy of restoration projects
- 3. Within a river section, **multiple complementary restoration projects** might be key to mitigate freshwater fish biodiversity loss
- 4. An essential element for success is that these projects should **retain permanent lateral connection** to the main channel
  - **Prioritise low-velocity shallow habitats** while also incorporating deeper shelter and fast-flowing dynamic habitats to address the diverse needs of riverine fish species
  - Include **deep-water refuges** within floodplain restoration projects, particularly in light of increasing summer discharge variability due to climate change



# Thank you very much for your attention!

If you have any questions, please contact:

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