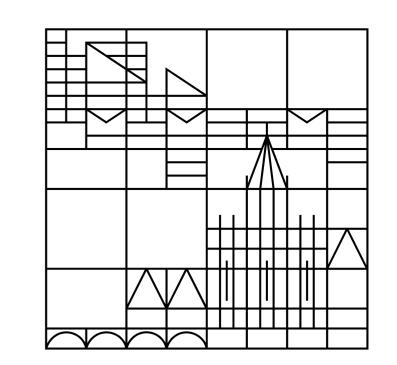
**R<sup>3</sup> – Responses to biotic and abiotic** changes, Resilience and Reversibility

### of lake ecosystems

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# P1: Sticklebacks in Lake Constance

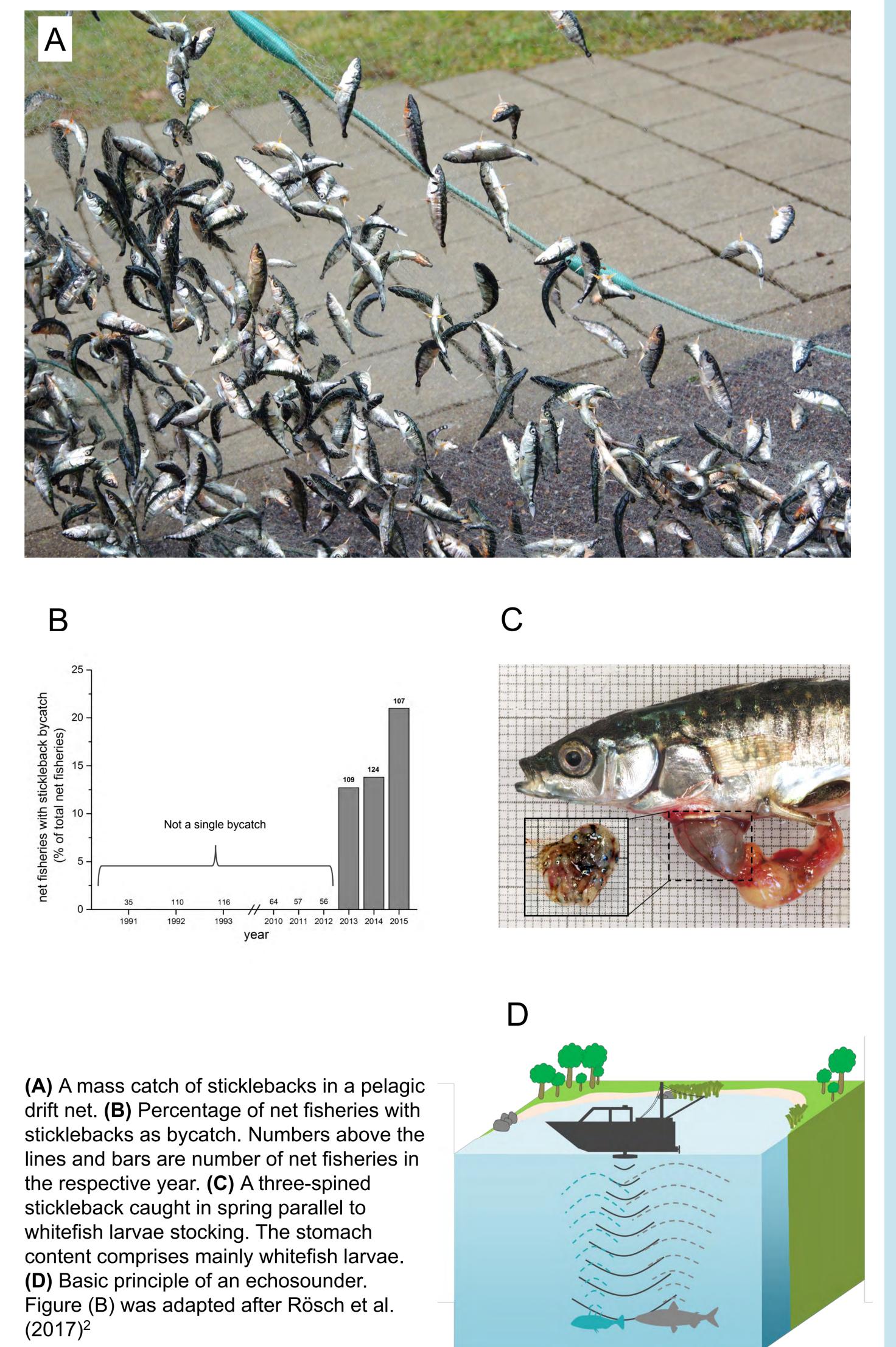
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## Background

The recent massive increase of the neozoic three-spined stickleback (Gasterosteus aculeatus) following over 50 years of inconspicious existence in Lake Constance was, besides the oligotrophication, the decisive factor which affected native fish community including severe implications for local fishery. More than 80% of all the fish in the lake are sticklebacks (96%) in the pelagic zone of the lake – the habitat of historically dominating fish species whitefish)<sup>1</sup>. The invasive stickleback acts as a direct competitor for food, especially for whitefish. Sticklebacks also feed on eggs and larvae which probably decrease recruitment of native fish species. The situation is a unique case for a large, oligotrophic lake like Lake Constance. The reasons for mass occurrence remain unknown.

# Hypotheses

- Sticklebacks learn to exploit neozoans (eg. Limnomysis benedeni) as a **diet**
- Stocked whitefish larvae may contribute as **stickleback prey** following winter (cf. figure C)
- Sticklebacks might have **developed** a **pelagic form** which succeeded in capturing the pelagic habitat



#### Methods

- Hydroacoustic examinations: multi-frequency splitbeam echosounder  $\rightarrow$  Species differentiation, stock assessment, movement
- **Electro and net fisheries**  $\rightarrow$  Spatial spawning behaviour, abundance assessment and habitat overlap
- Gut content & stable isotope analyses  $\rightarrow$  food niche overlap and recruitment effects
- Age determination via otoliths  $\rightarrow$  age composition and growth of sticklebacks
- Morphometrics (landmarks) → form differentiation
- Parasitic infection (tapeworm Schistocephalus **solidus**  $\rightarrow$  Parasite-induced stock control?

#### Goals

- Investigation of the sticklebacks autecology
- **Identification of possible reasons for mass** occurrence
- **Development of fishery management options**



#### References

- <sup>1</sup>Alexander et al. (2016) Artenvielfalt und Zusammensetzung der Fischpopulation im Bodensee. Project Lac, Eawag, Kastanienbaum.
- <sup>2</sup>Rösch et al. (2017) Impact of the invasive three-spined stickleback (*Gasterosteus aculeatus*) on relative abundance and growth of native whitefish (*Coregonus wartmanni*) in Upper Lake Constance. Hydrobiologia