evropský sociální fond v ČR
EVROPSKÁ UNIE
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Inovace studia hydrobiologických disciplín s důrazem na rozšíření možností uplatnění absolventů biologických oborů PřF UP v praxi.

reg. číslo: CZ.1.07/2.2.00/28.0173

Experimental examination of behavioural interactions among fish

3. 12. 2014

ZS 2014/2015

Tomasz Kakareko

Academic background

•2000 (November), **PhD** in Fish Ecology at the Department of Hydrobiology, Nicolaus Copernicus University in Toruń, Poland. Title: „**Ecology of common bream (*Abramis brama* L.) in the Włocławek Reservoir**".

Professional experience

•**Lecturer** (1/12/2003 – to present); Department of Hydrobiology, Nicolaus Copernicus University, Poland

•Assistant Lecturer (02/10/2001 – 30/11/2003); Department of Hydrobiology, Nicolaus Copernicus University, Poland

Main Research experience

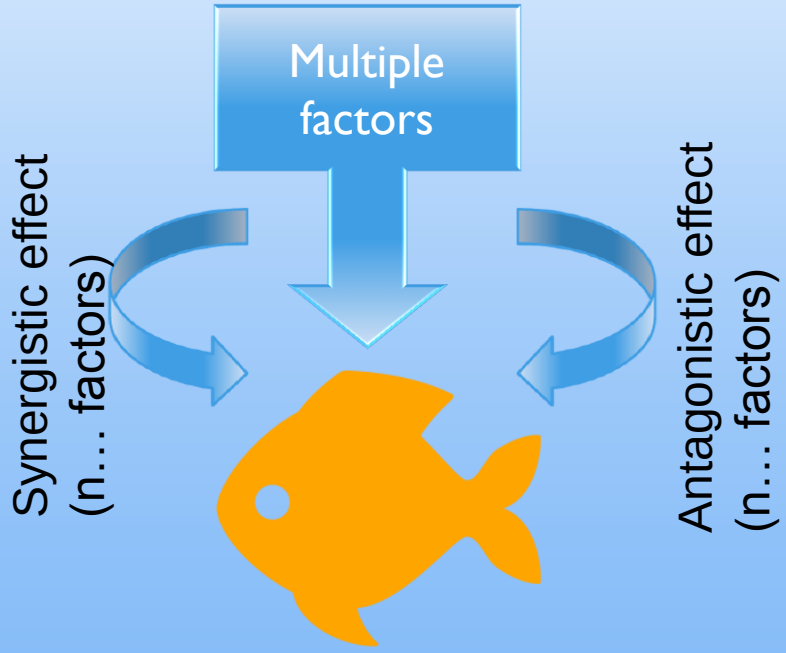
•Biology and ecology of **Ponto-Caspian gobiids**, with particular emphasis on their interactions with other organisms, factors affecting their distribution in novel environments

•Role of **chemical signalling in courtship behaviour** of nest-guarding cyprinid fish

…. **from 2005** I am involved mostly in experimental lab work

Fish responses

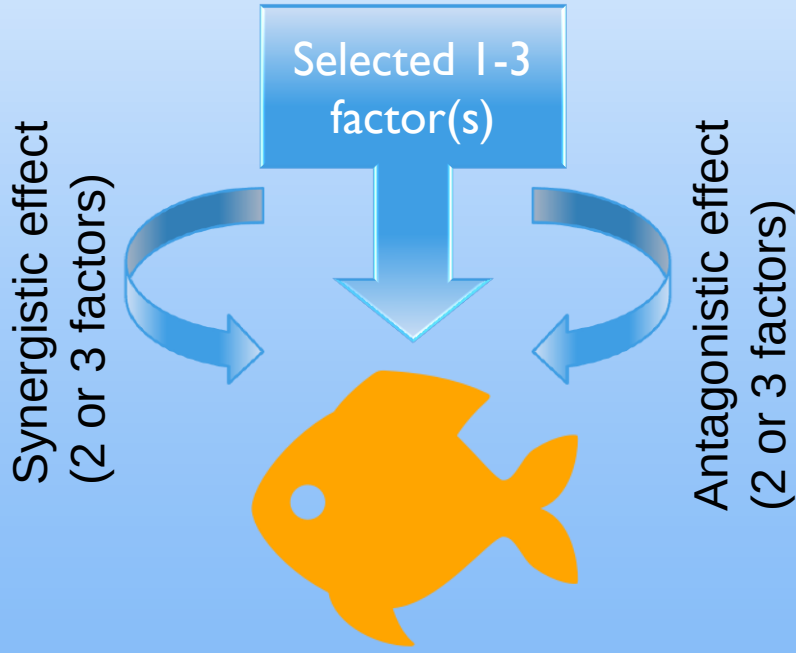
Descriptive study in environment



We could analyze the effects of all variables on the responses of fish…

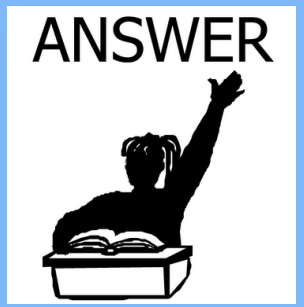
… but it is difficult to see the effect of a particular factor..

Experimental examination in lab



We could analyse the effects of each factor 1,2,3 and interactions among factors (e.g. 1*2*3)

… but we could determine the effect of a specific factor and interaction



Experimental designing – efficient procedure for planning experiments so that the data obtained can be analyzed to yield valid and objective conclusions

TIME

50%

Conceptual framework:

- Defining question/problem
- Defining fish population
- Defining experimental design (which conditions, factors, responses, tools, and treatments are to be included or used)

30%

Preparing and conducting the experiment

- Preparing the experimental setup
- Sampling
- Adaptation of the fish in stock tanks
- Pre-test trials
- Adjusting the exp setup

10%

- **Conducting the experiment**

"There's a flaw in your experimental design. All the mice are scorpios."

Ethical constraints

We are as happy as in the wild

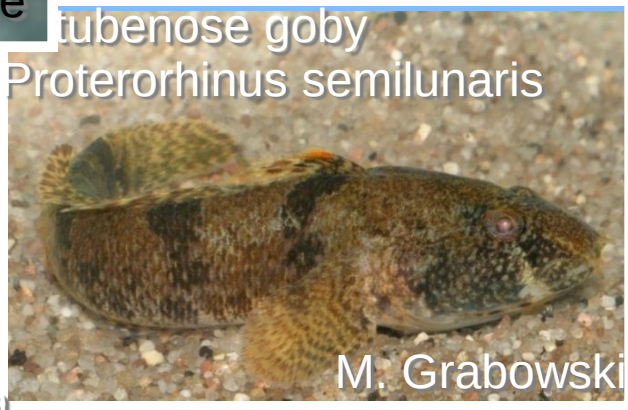
Example of how our experimental lab work is useful to interpret results from field work

Field study

Lab experiments

So far, six Ponto-Caspian gobiids are expanding in Europe

- territorial, aggressive bottom dwellers
- using crevices as shelters and nesting sites
- feeding on benthic invertebrates



So far, six Ponto-Caspian gobiids are expanding in Europe

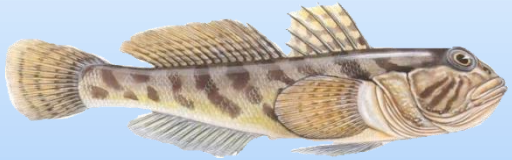
- territorial, aggressive bottom dwellers
- using crevices as shelters and nesting sites
- feeding on benthic invertebrates

- This make them potential competitors with native fishes of similar biology for:
  - space
  - spawning grounds
  - feeding areas and food

North America

Europe

Aim



racer goby

?

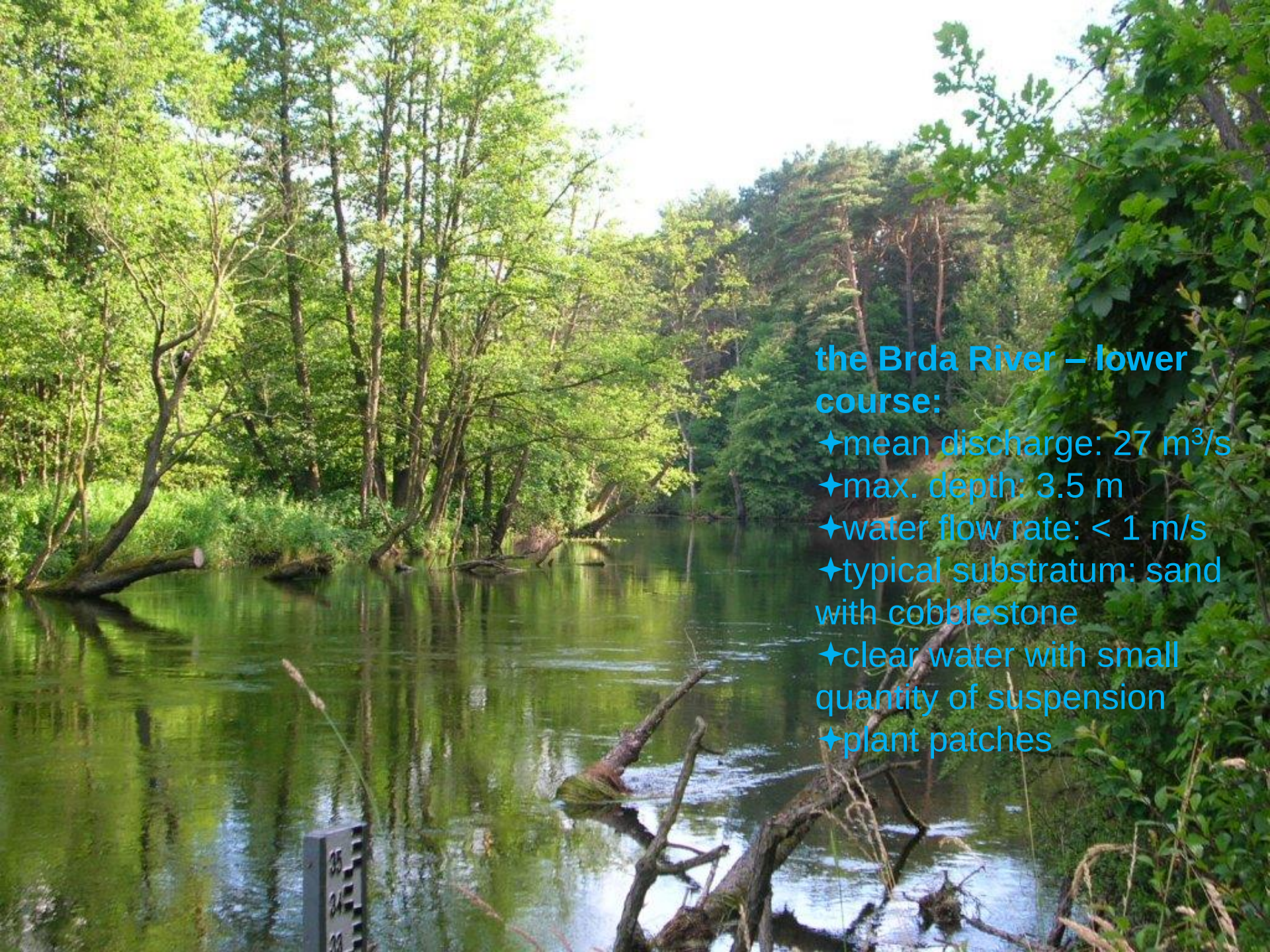
European

Do racer goby are more aggressive fish and stronger competitors for resources than European bullhead, and displace them from their habitas?

- ***In situ*** **investigations (scuba diving) in the Brda River (Vistula River basin, Poland)**
- **Study on competitive interactions for food or space (shelters) in laboratory**

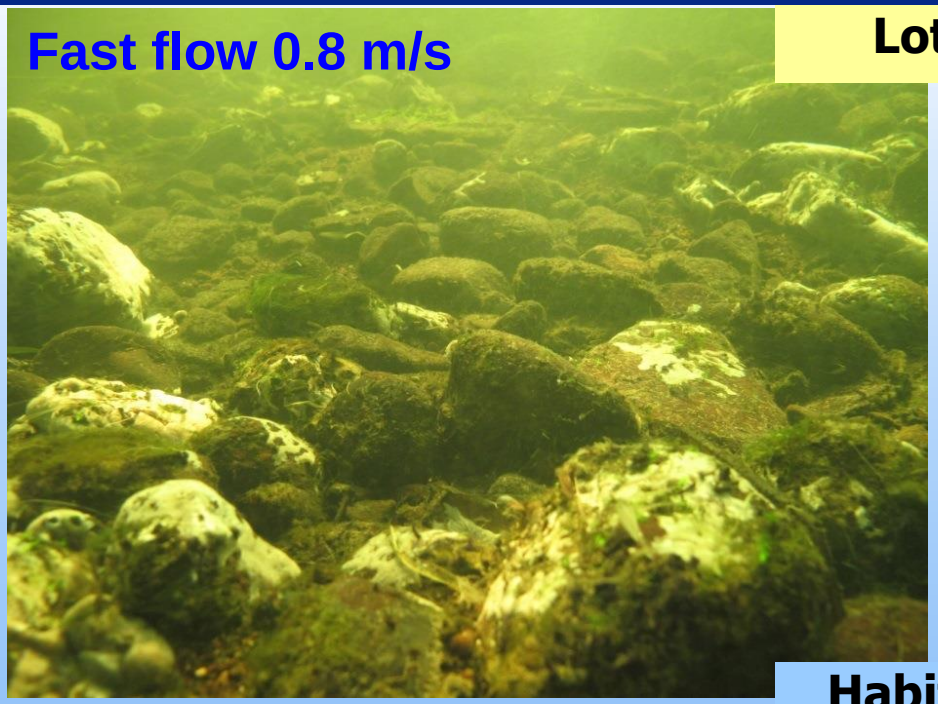
Underwater visual surveys in a section of a European river inhabited by both species in order to determine their:

- habitat partitioning (resource specialisation?, competition avoidance?)
- negative relationship between the species in areas where they overlap (potential displacement?)

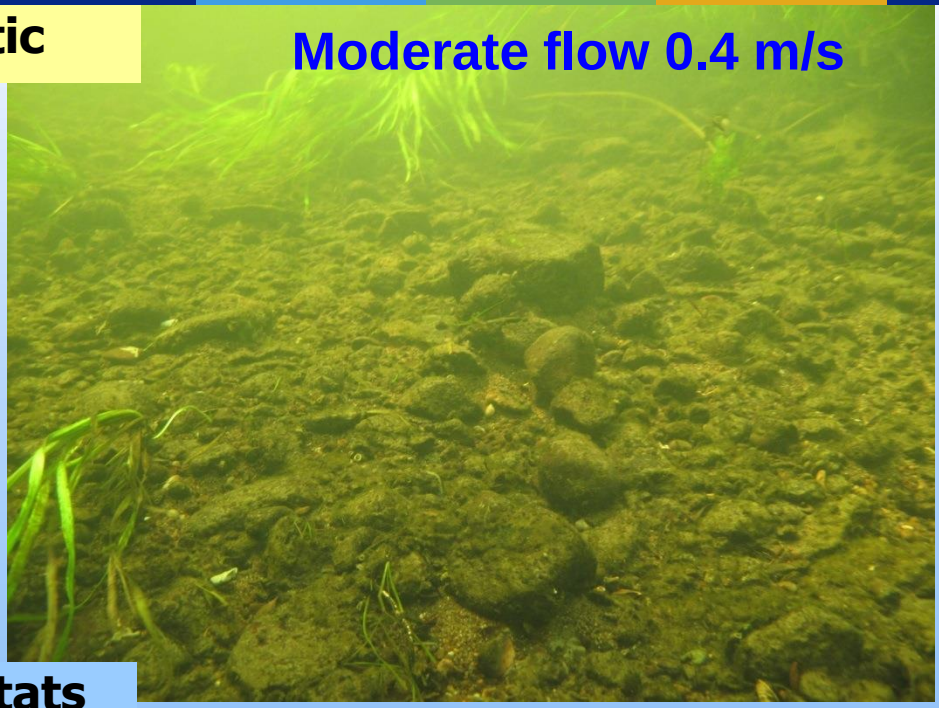


the Brda River – lower course:

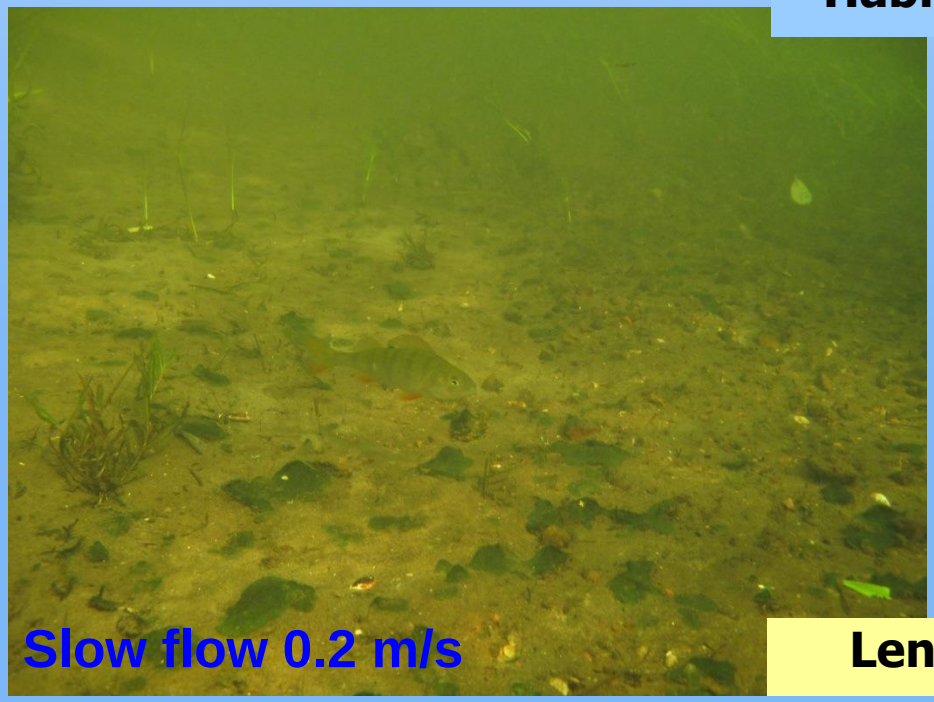
- ✦mean discharge: 27 m^3/s
- ✦max. depth: 3.5 m
- ✦water flow rate: < 1 m/s
- ✦typical substratum: sand with cobblestone
- ✦clear water with small quantity of suspension
- ✦plant patches



Lotic



Habitats



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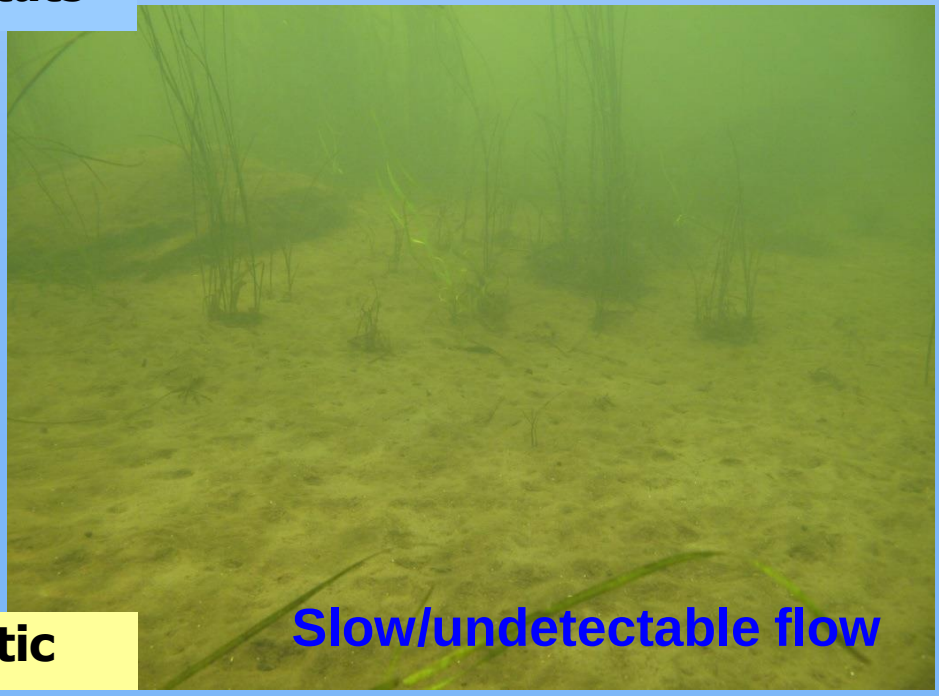
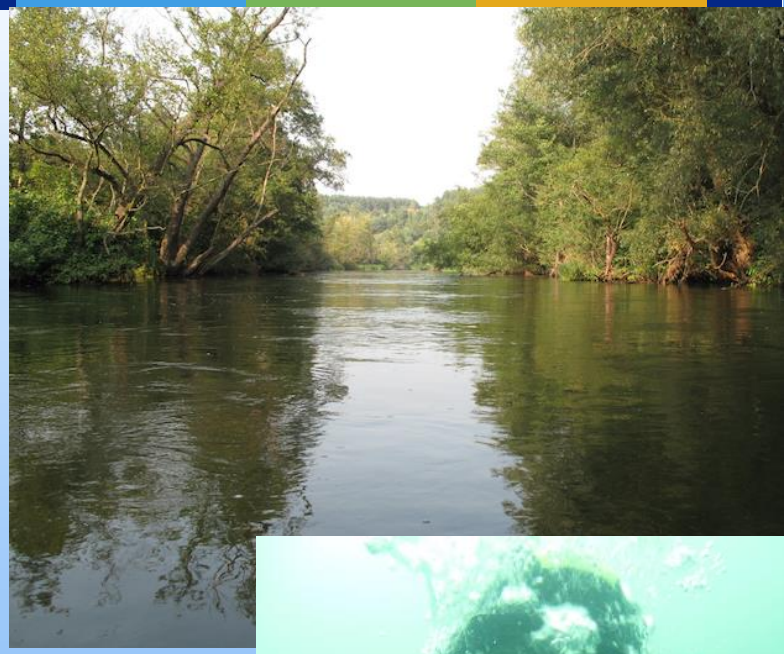


Methods

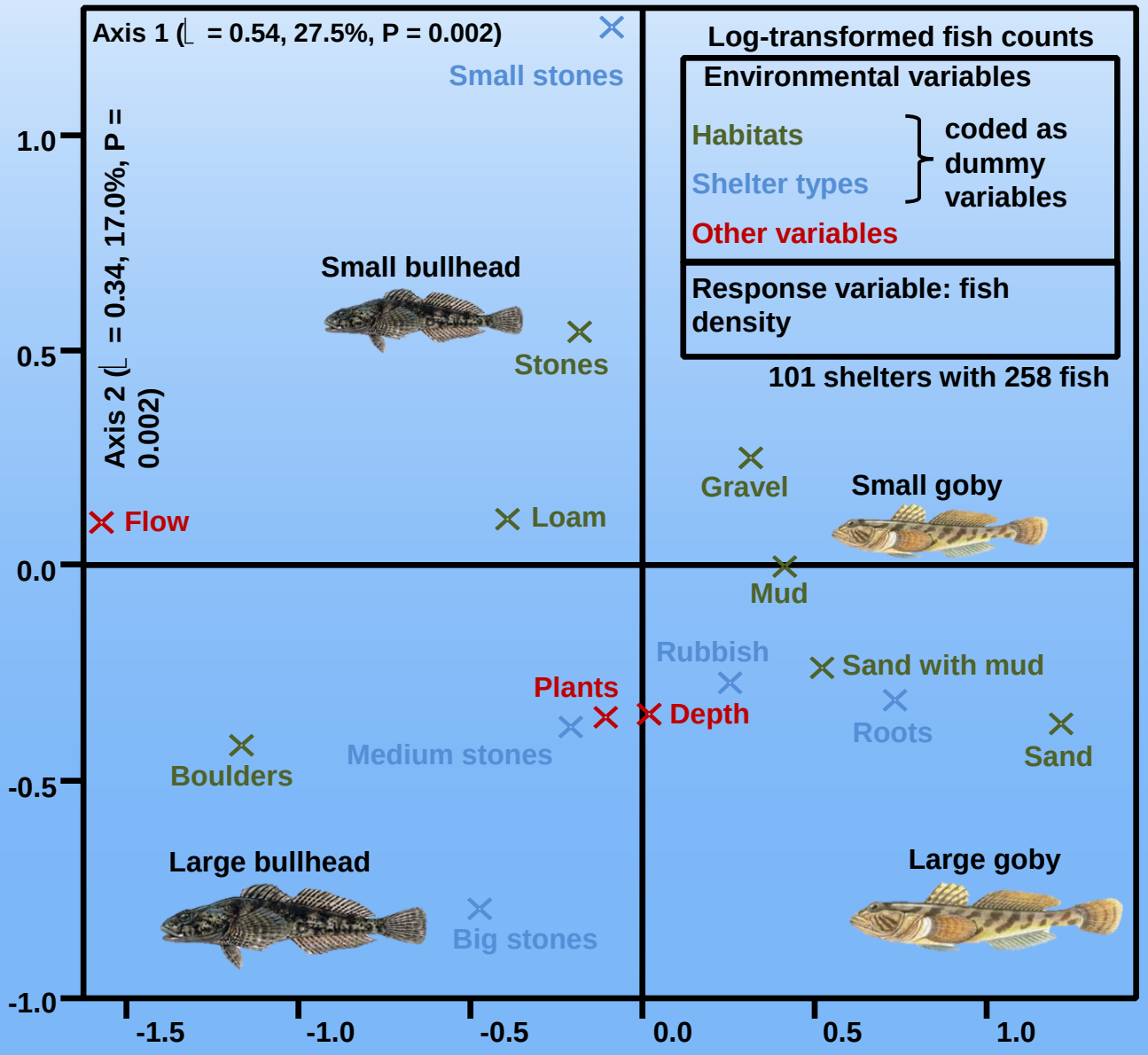
- June-September 2011
- 88 SCUBA diving and snorkelling explorations (4-45 min.) in areas with homogenous conditions (1-25 m^2), from the bank to the main current
- Counting fish, assessing environmental parameters



Measured parameters

- **Fish size**: ▪ large (>6 cm) ▪ small (<6 cm)
- **Habitat**: ▪ sand ▪ gravel ▪ loam ▪ mud ▪ sand & mud ▪ stones ▪ boulders ▪ shells
- **Shelter** (object at which fish were spotted): ▪ small stones (<15 cm) ▪ medium stones (15-30 cm) ▪ big stones (>30 cm) ▪ roots ▪ rubbish ▪ plants
- **Flow rate**: ▪ undetectable ▪ weak (0.2 ±0.07 SD m/s) ▪ moderate (0.4 ± 0.10 m/s) ▪ fast (0.8 ± 0.09 m/s)
- **Plant coverage**: ▪ no plants ▪ sparse plants ▪ a plant bed nearby ▪ within a plant bed
- **Water depth**: 0-3.5 m

Multivariate analysis (CCA)



Altogether 395 fish:

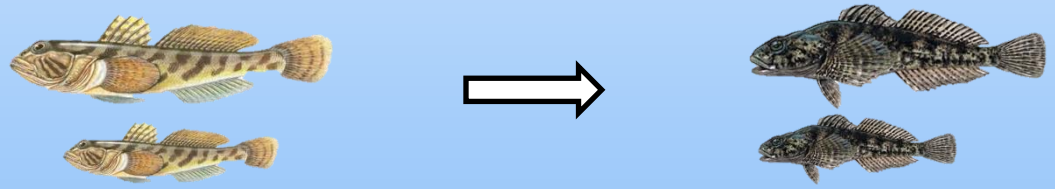
- 68 large goby (23),
- 194 small goby (113),
- 38 large bullhead (34),
- 95 small bullhead (88)

- Goby: sand, mud, weak flow, roots and rubbish as shelters
- Bullhead: boulders and stones, fast flow
- Small fish: stones and gravel, small-sized shelters
- Large fish: large-sized shelters
- No effects of plants and depth

Habitat types

General Linear Model: habitat type (grouping variable), another species density (continuous variable)

Testing the effects of:

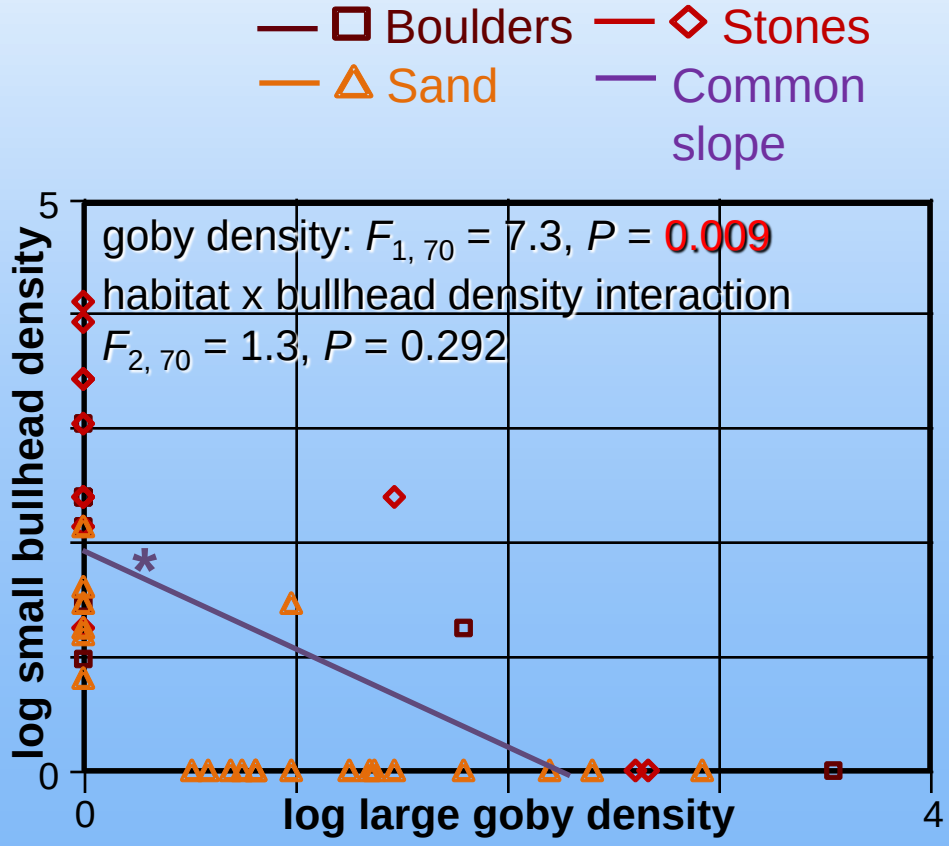


- large and small goby on large and small bullhead

- large goby on small goby

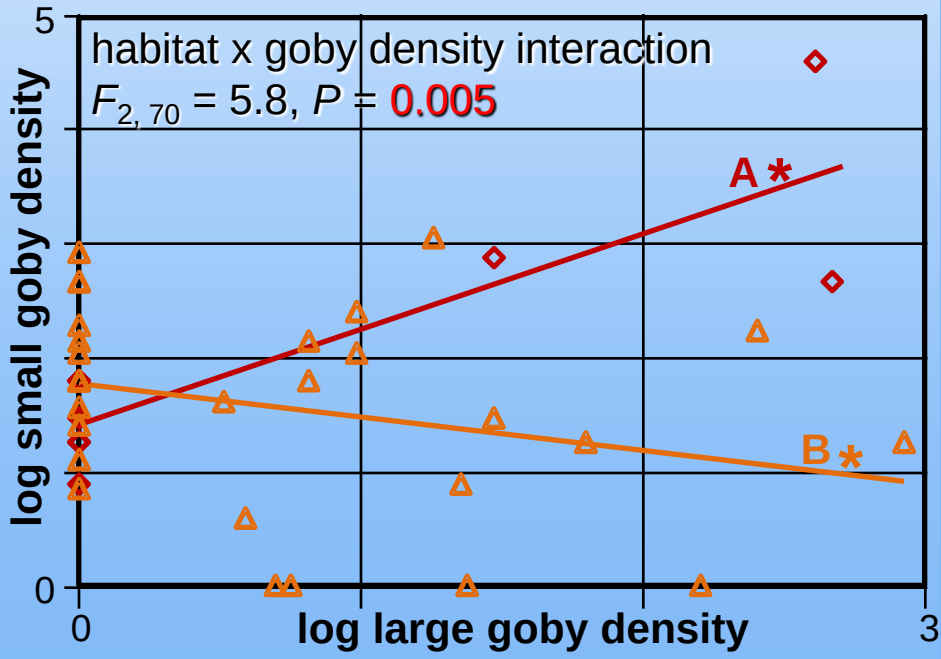
- large bullhead on small bullhead

Habitat types



∗ - Slopes <> 0

Letters (AB) show slopes that do not differ from one another



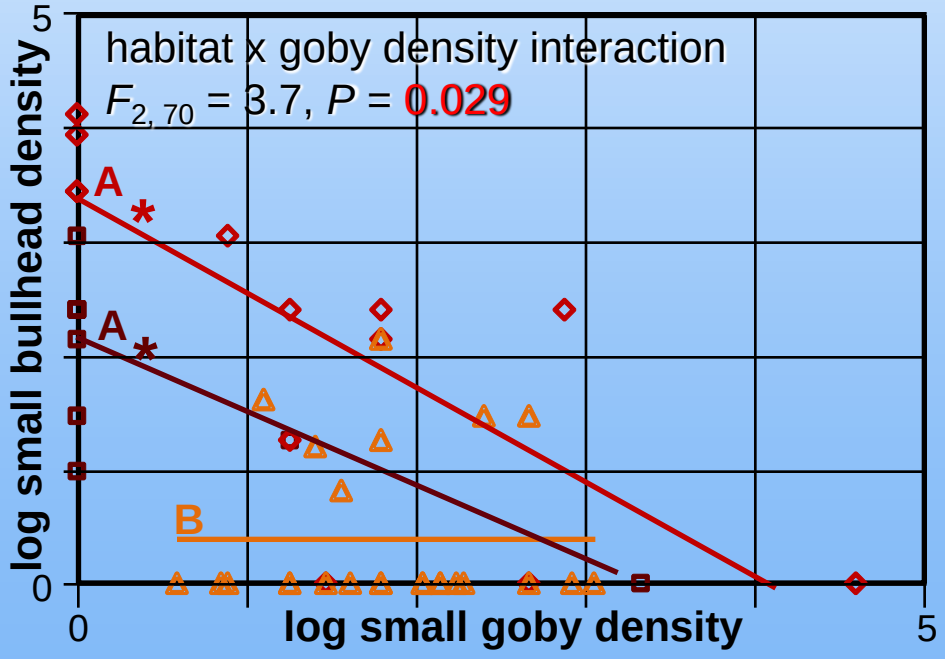
- Negative effect of large goby on small bullhead on all substrata (left)
- Negative effect of large goby on small goby on sand; positive effect on stones (right)
- No significant effects of goby on large bullhead (not shown)

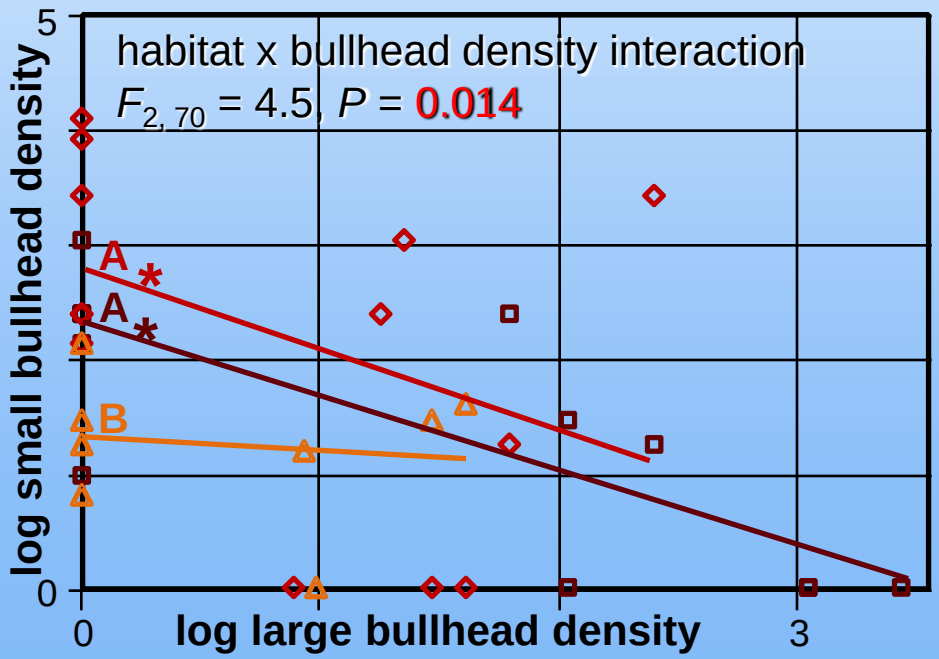
Habitat types

Boulders Stones
Sand Common slope

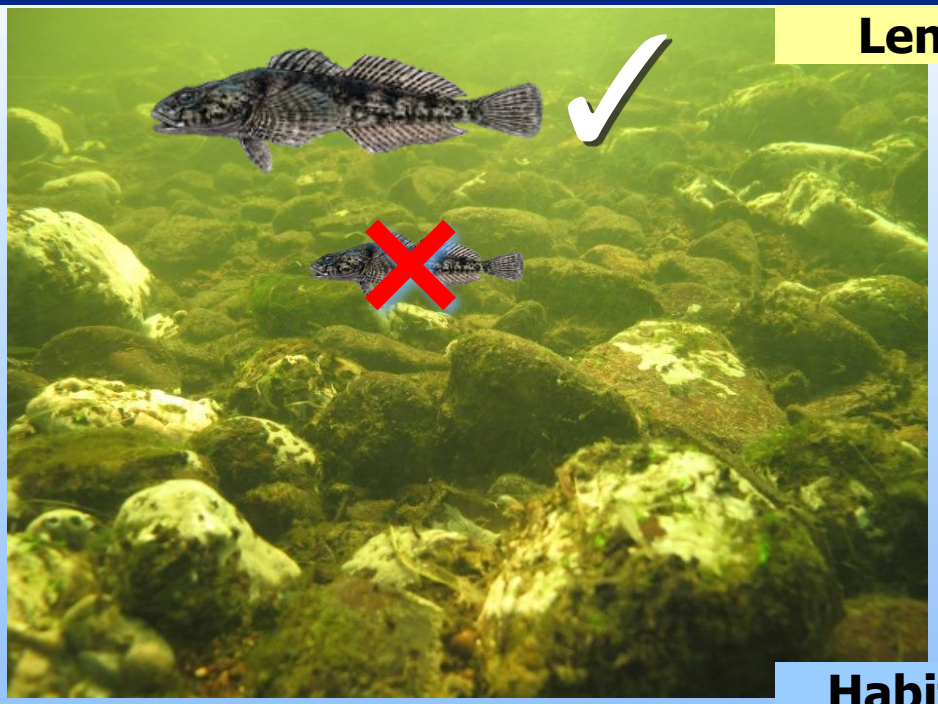
* - Slopes <> 0

Letters (AB) show slopes that do not differ from one another

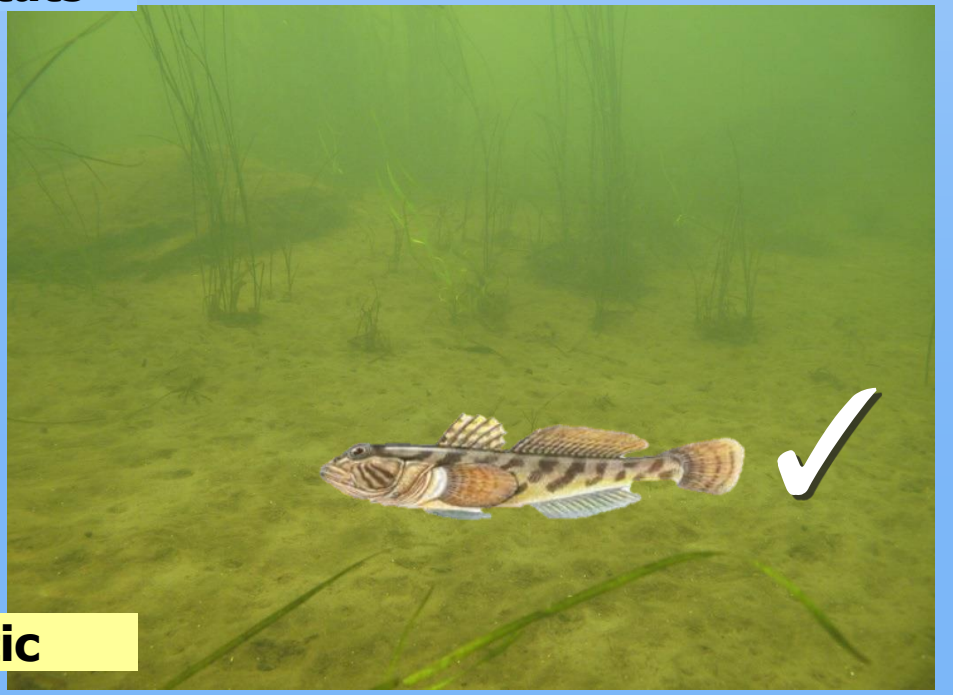




- Negative effect of small goby (left) and large bullhead (right) on small bullhead on boulders and stones, no effect on sand

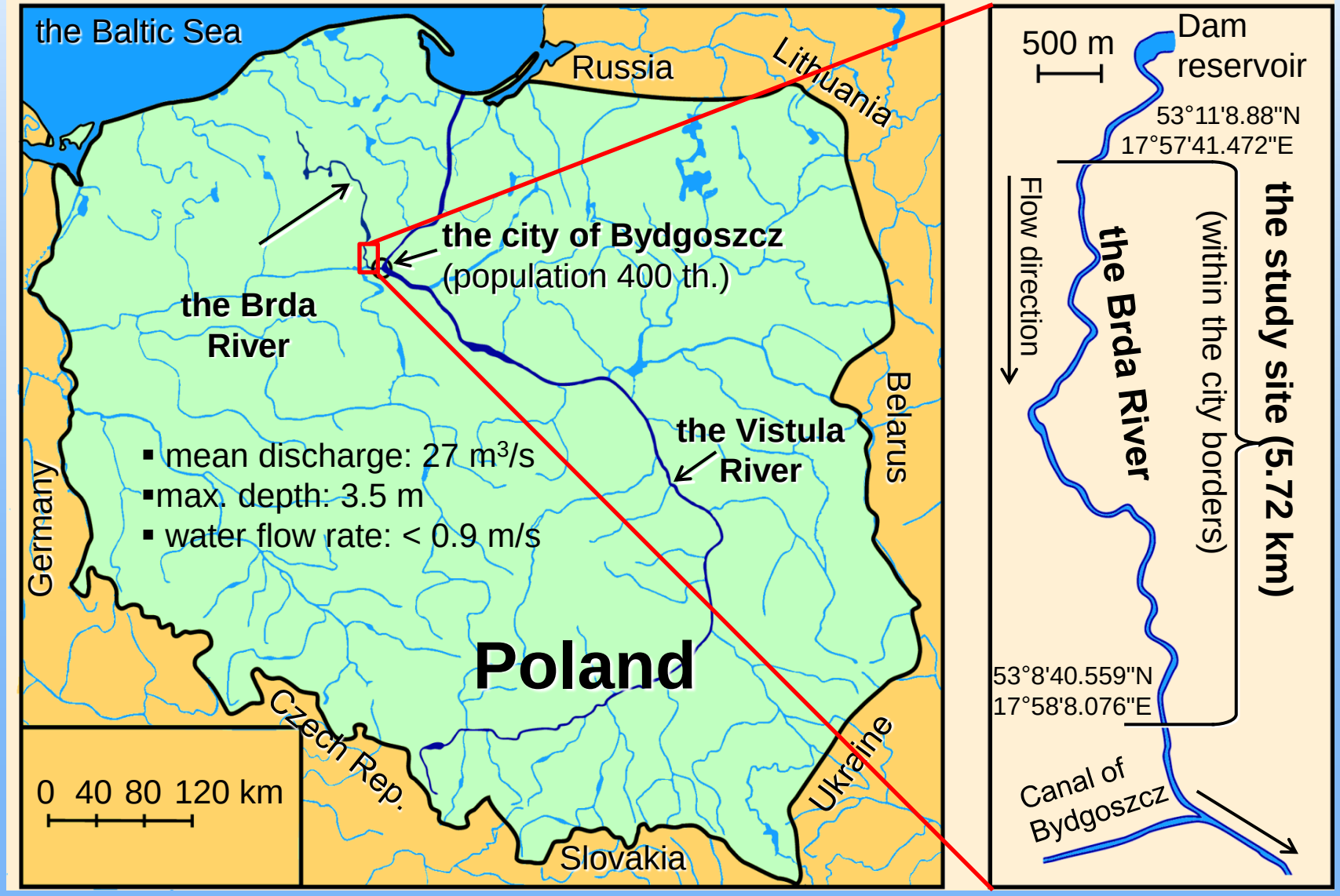

Lentic


Habitats

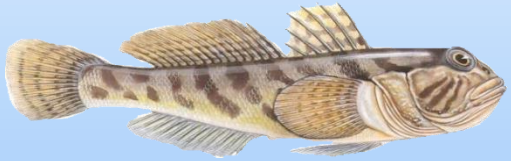

Lotic

Study area

Brda River - lowland river in central Europe



Aim



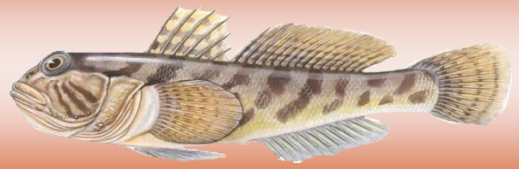
racer goby ? European bullhead

Do racer goby are more aggressive fish and stronger competitors for FOOD than European bullhead?

How to check the impact of racer goby?

N = …

Tested fish



TREATMENT

N = …

Tested fish

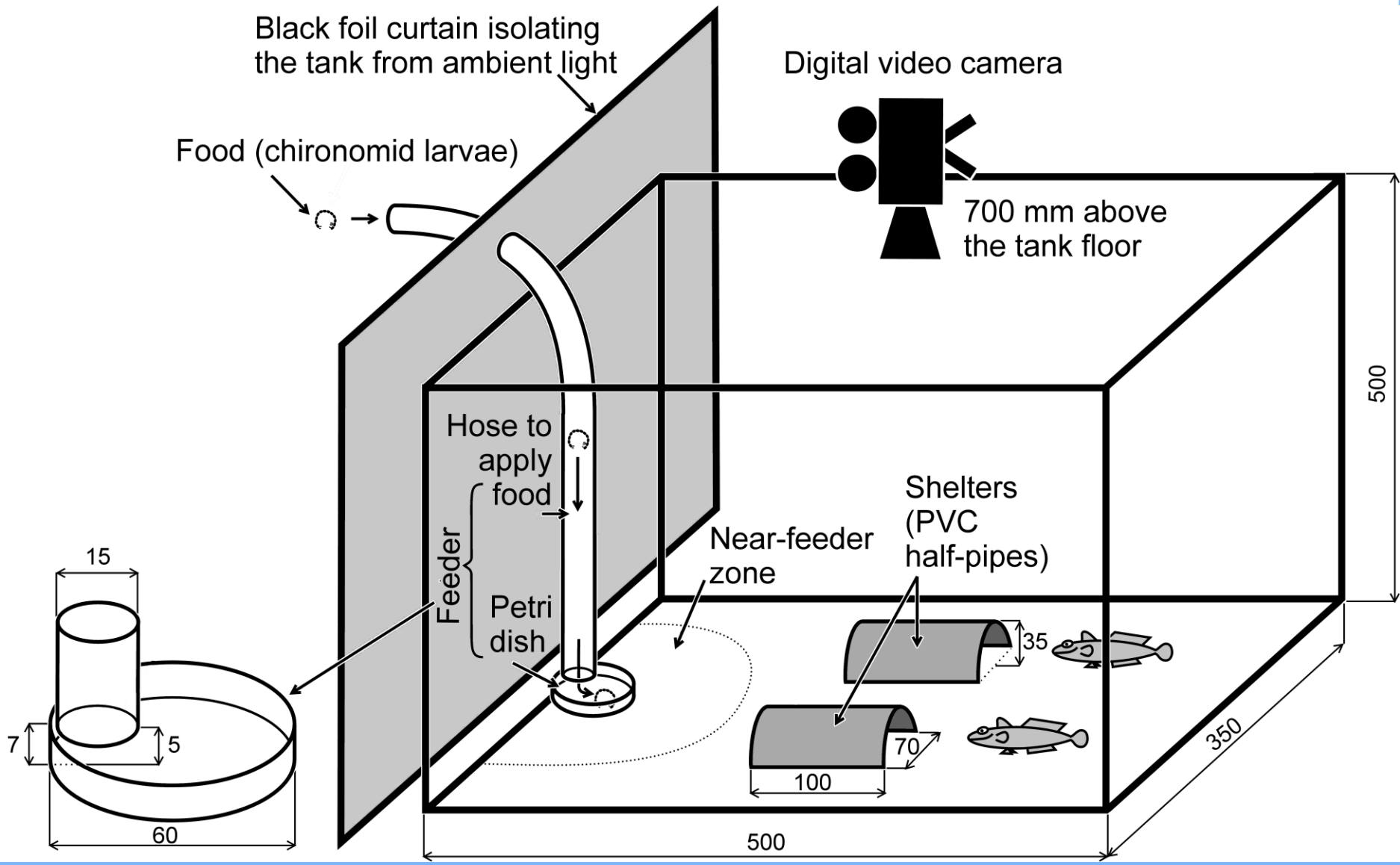
CONTROL

If

foraging less efficiently than

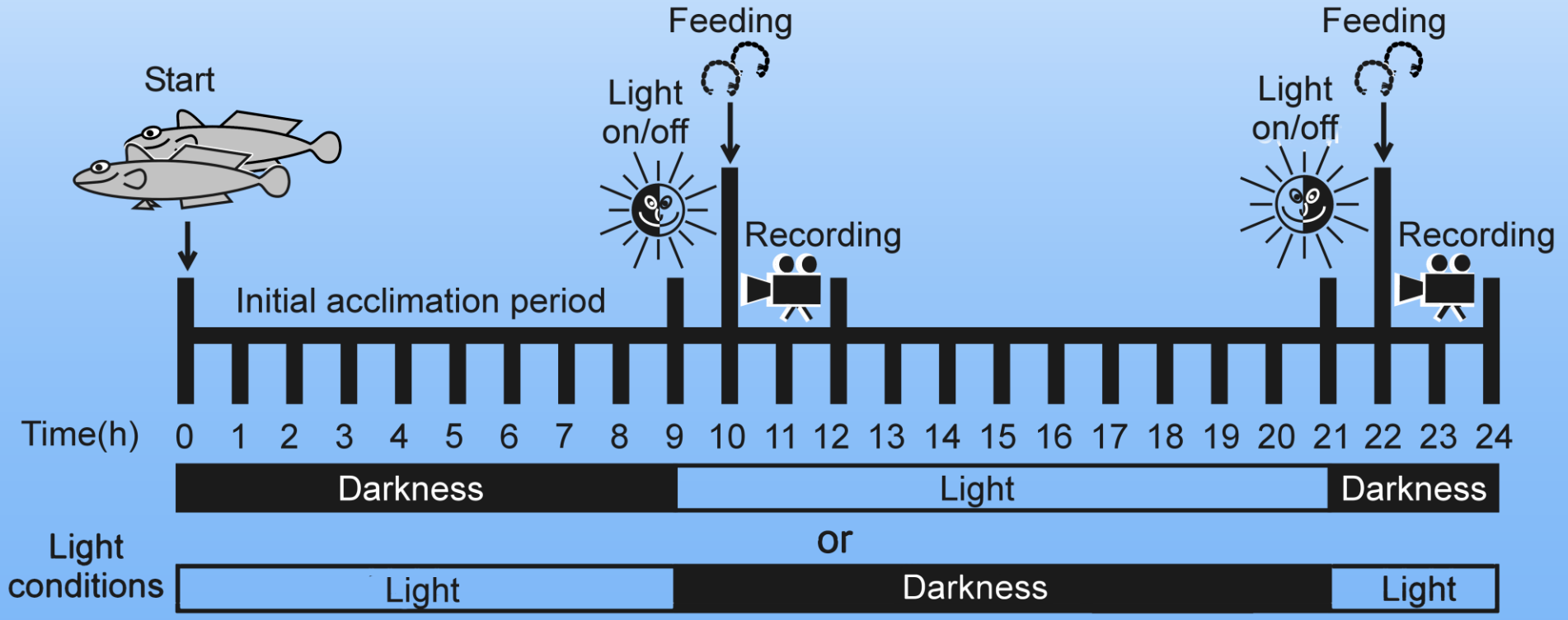
= goby negatively affect foraging efficiency of the bullhead

Experimental setup



Kakareko, T., Kobak, J., Grabowska, J., Jermacz, Ł., Przybylski, M., Poznańska, M., et al. (2013). Competitive interactions for food resources between invasive racer goby *Babka gymnotrachelus* and native European bullhead *Cottus gobio*. Biological Invasions, *15*(11), 2519–2530.

Experimental setup



Kakareko, T., Kobak, J., Grabowska, J., Jermacz, Ł., Przybylski, M., Poznańska, M., et al. (2013). Competitive interactions for food resources between invasive racer goby *Babka gymnotrachelus* and native European bullhead *Cottus gobio*. Biological Invasions, *15*(11), 2519–2530.

Recorded events - aggressive interactions

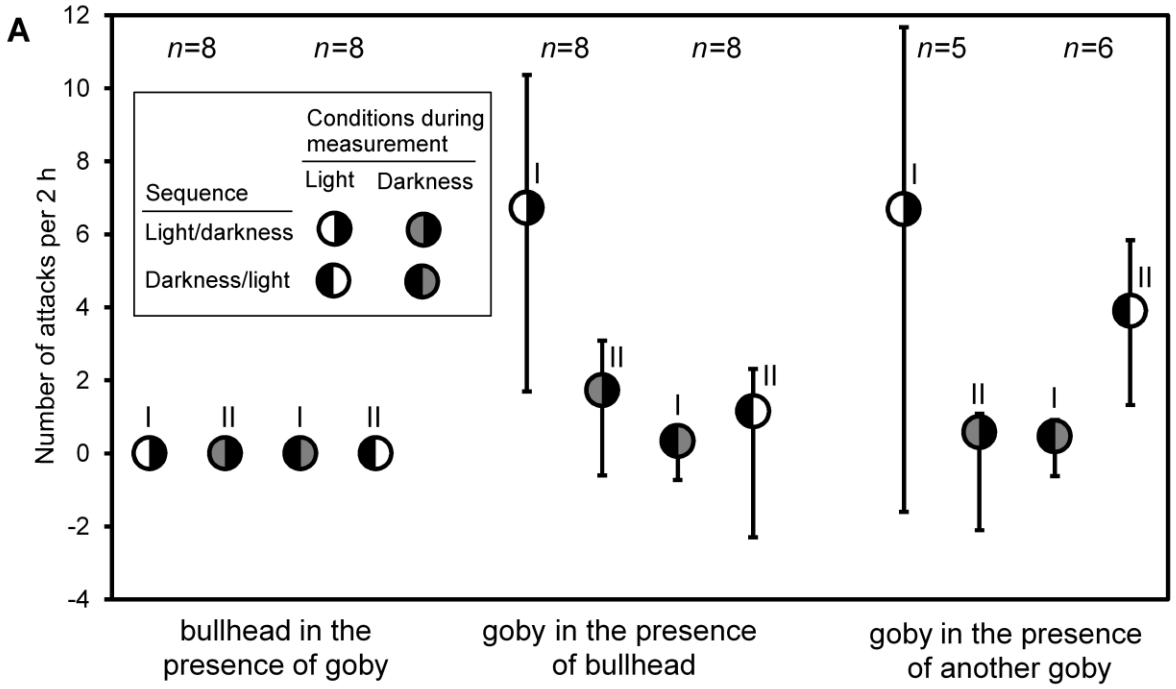
1. **Bite and/or chase**

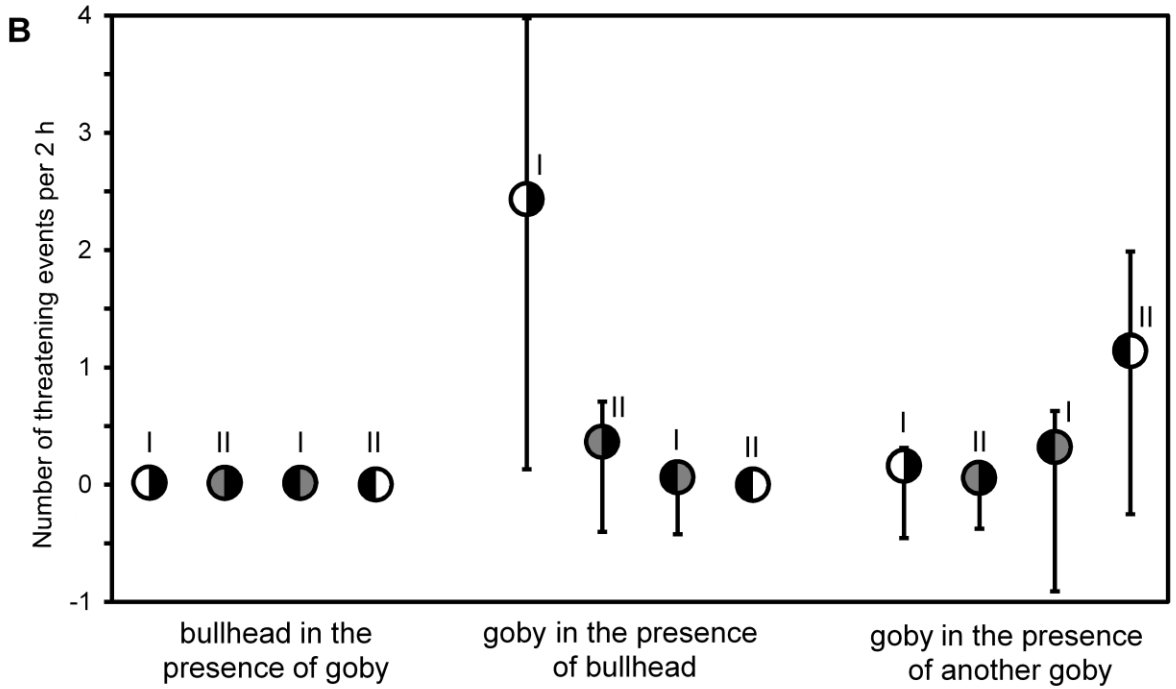
2. **Threaten acts**

Recorded events – feeding efficiency

1. Time spent close to the feeder
(fish occupies the area of feeding but doesn’t eat)

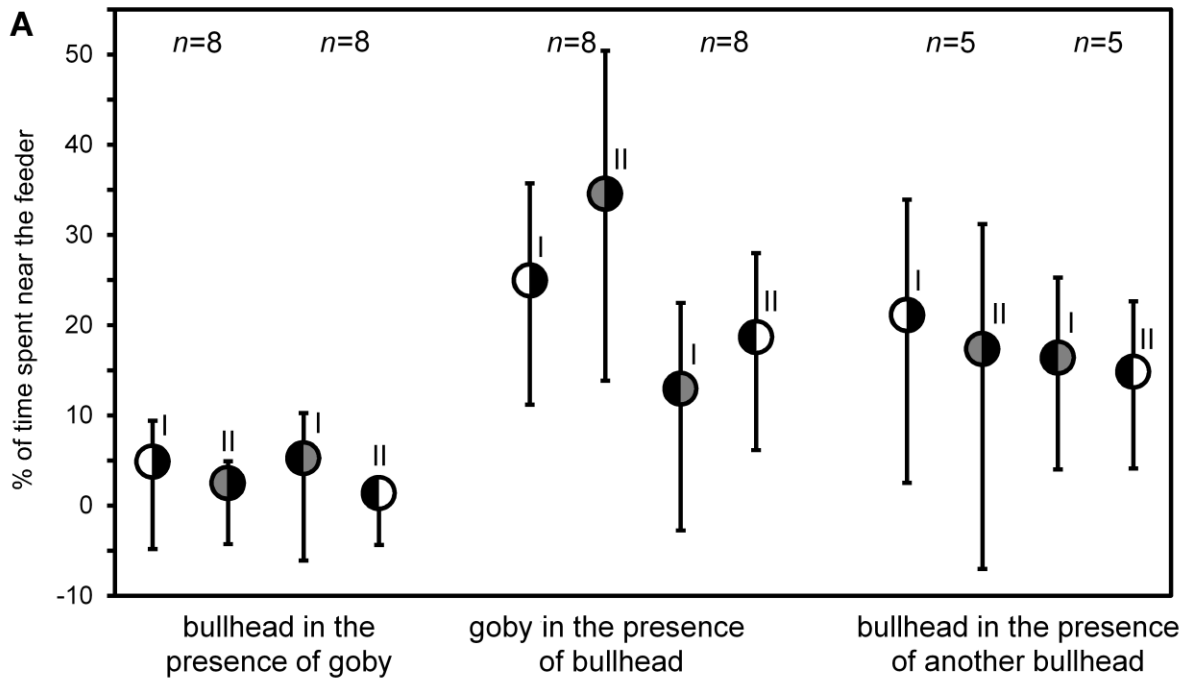
2. Time spent inside the feeder (fish forages inside the feeder)

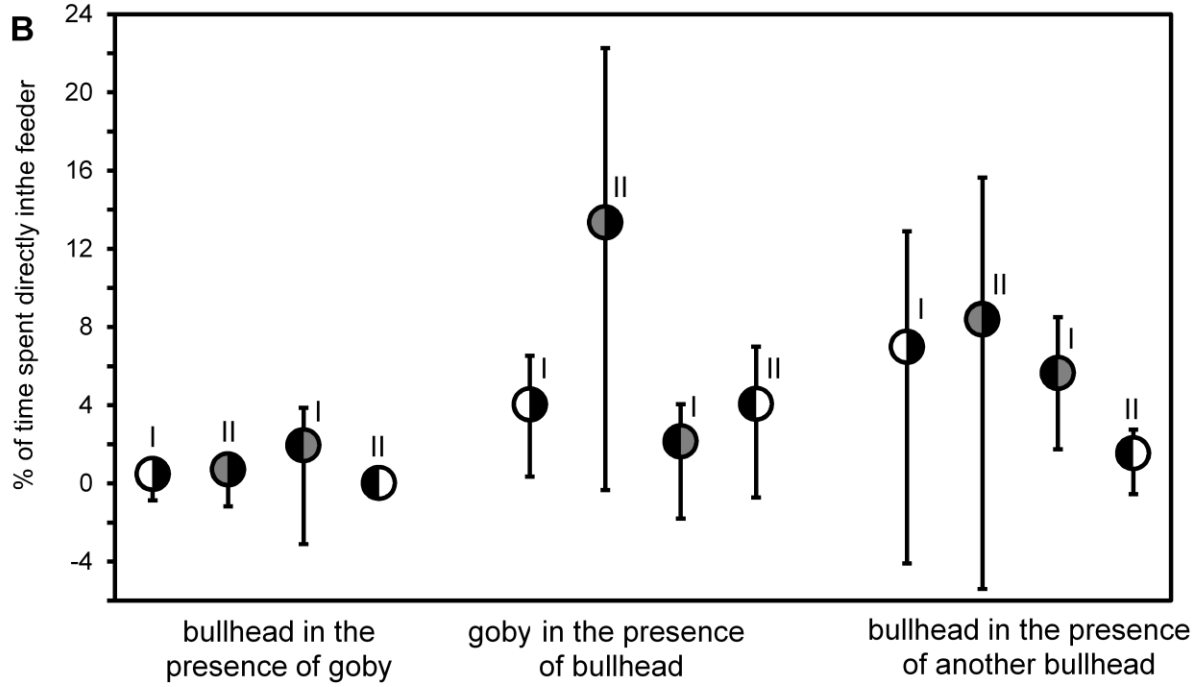




Aggressive interactions

- **racer goby is more aggressive than the bullhead**

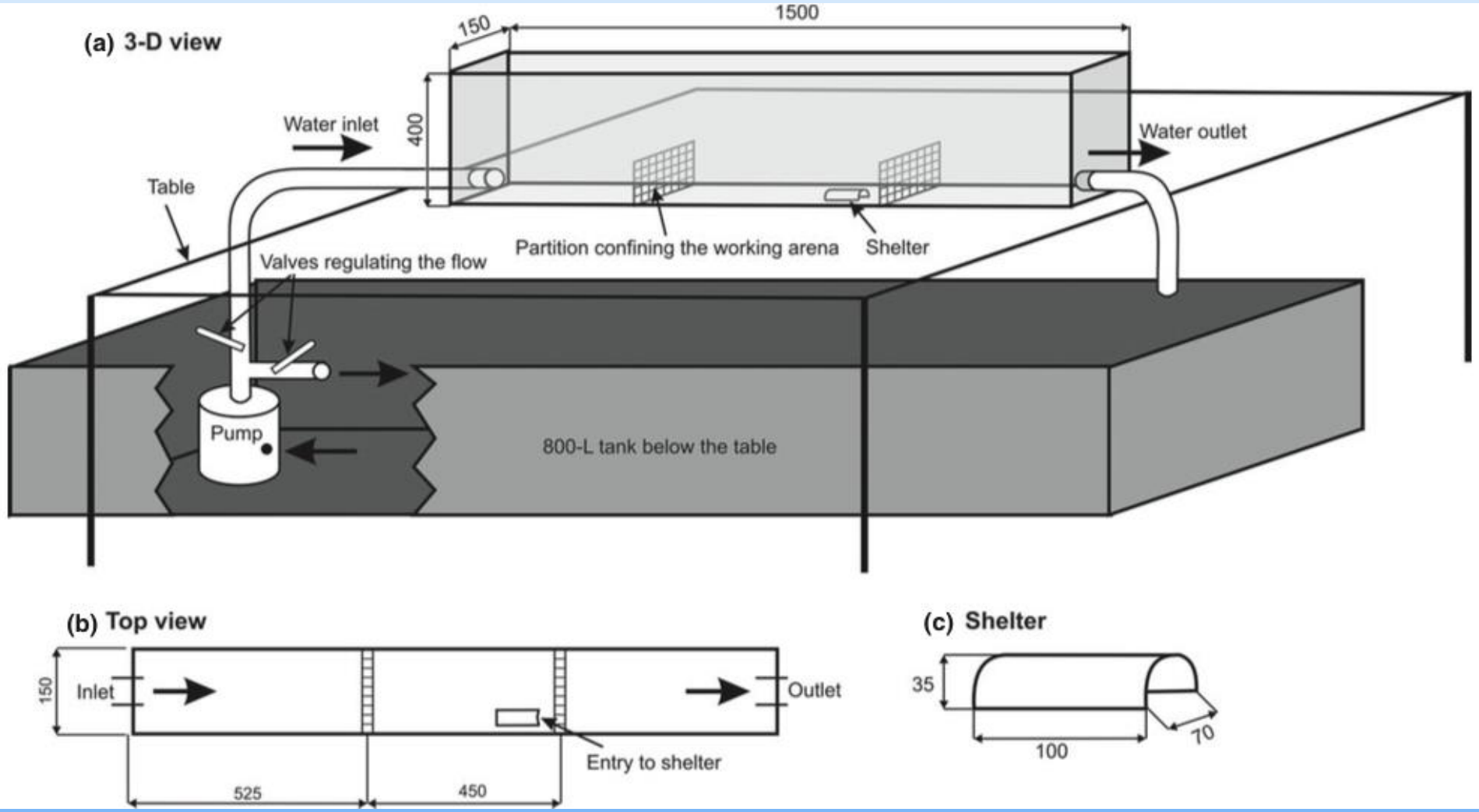




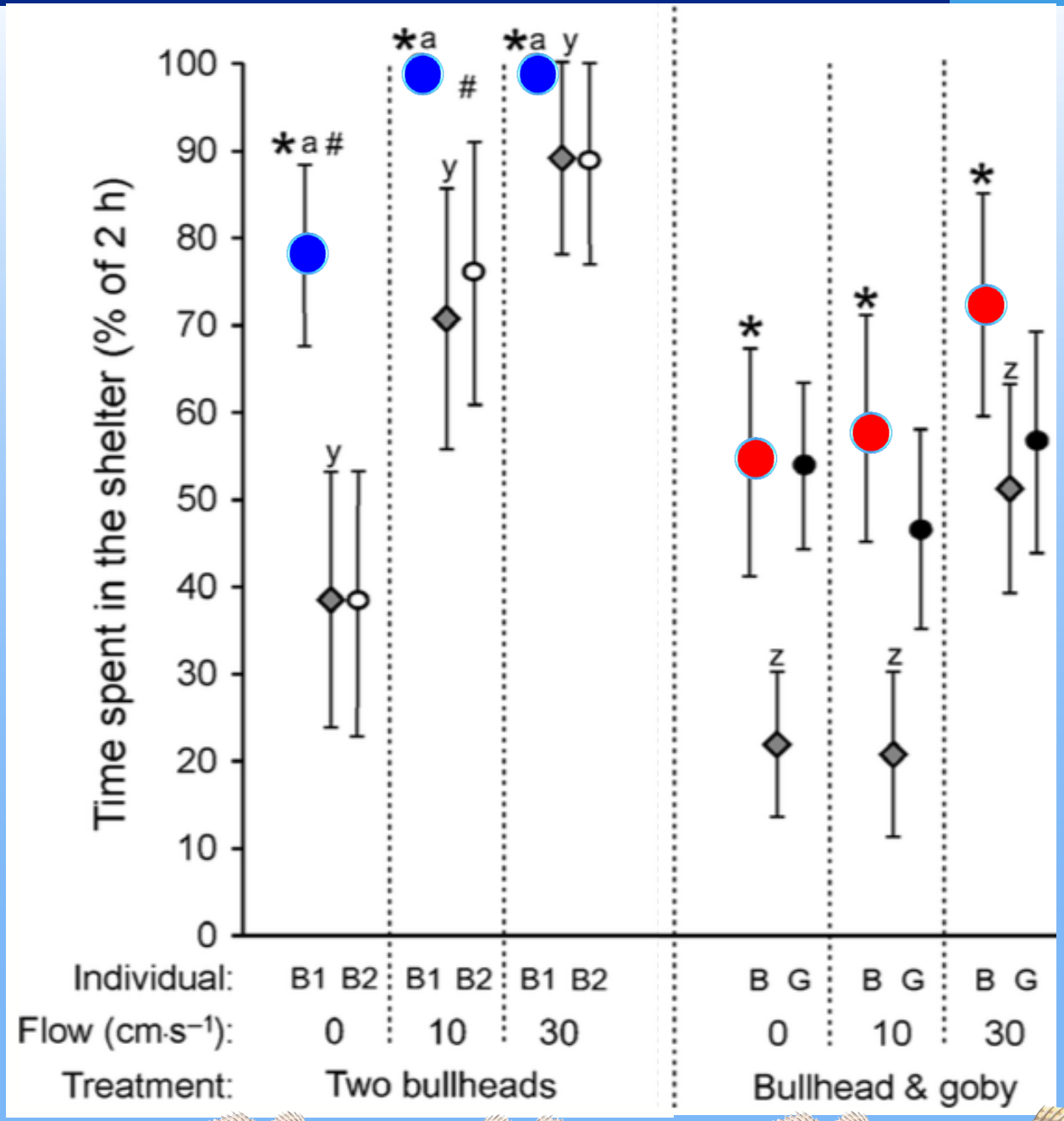
Feeding efficiency

- racer goby is more efficient competitor than the bullhead

Effect of flow on the competition between the species

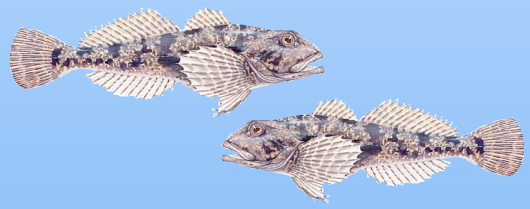


Jermacz, Ł., Kobak, J., Dzierżyńska, A., & Kakareko, T. (2014). The effect of flow on the competition between the alien racer goby and native European bullhead. *Ecology of Freshwater Fish*, n/a–n/a. doi:10.1111/eff.12162



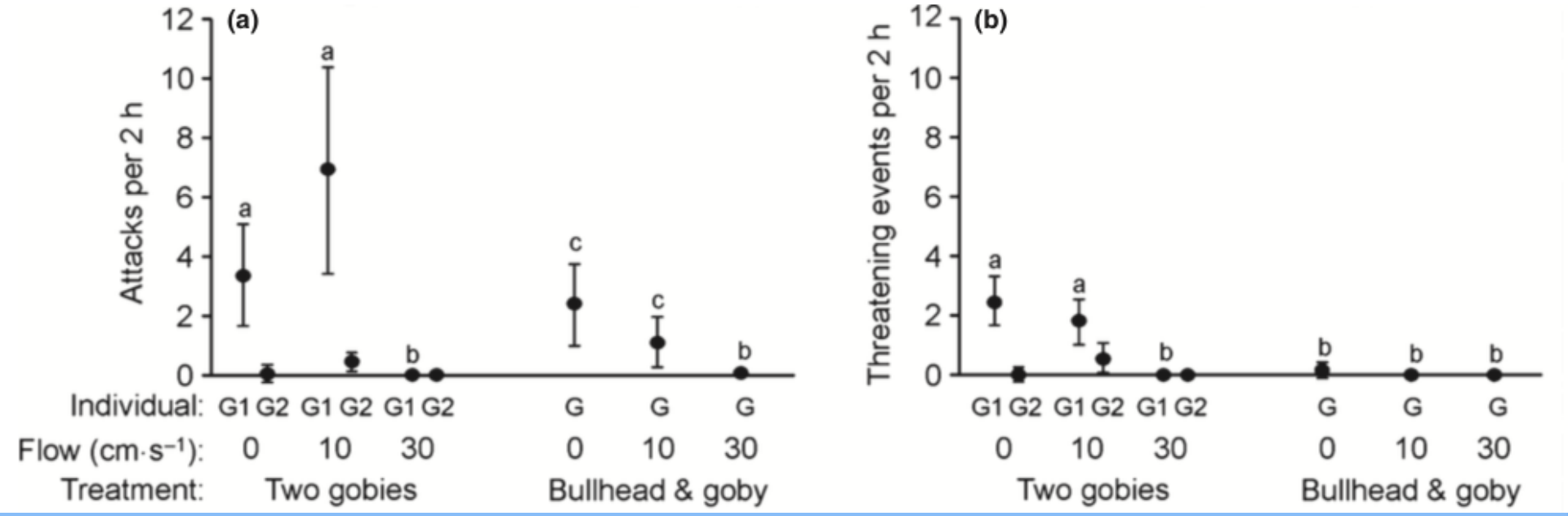
Jermacz et al. 2014 (changed)

Dominant bullhead in control



bullhead in treatment

Effect of flow on the competition between the species



- flow of 30 cm/s inhibited racer goby aggression

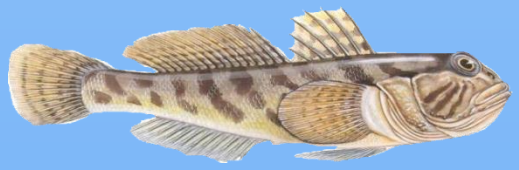
Conclusions

In laboratory conditions:

- ❑ Large racer goby exhibited aggressive behaviour towards the bullhead,
- ❑ Large racer goby forced bullhead from the feeders and outcompeted them for food.

- ❑ We tested interactions between the species in water flows 0, 10 and 30 cm/s and found that racer goby negatively affect shelter occupancy by the bullhead (Jermacz et al. 2014)

- ➢ This confirms that in the field large racer goby could displace bullhead from their optimum habitats to the areas that are less suitable with regard to food conditions.



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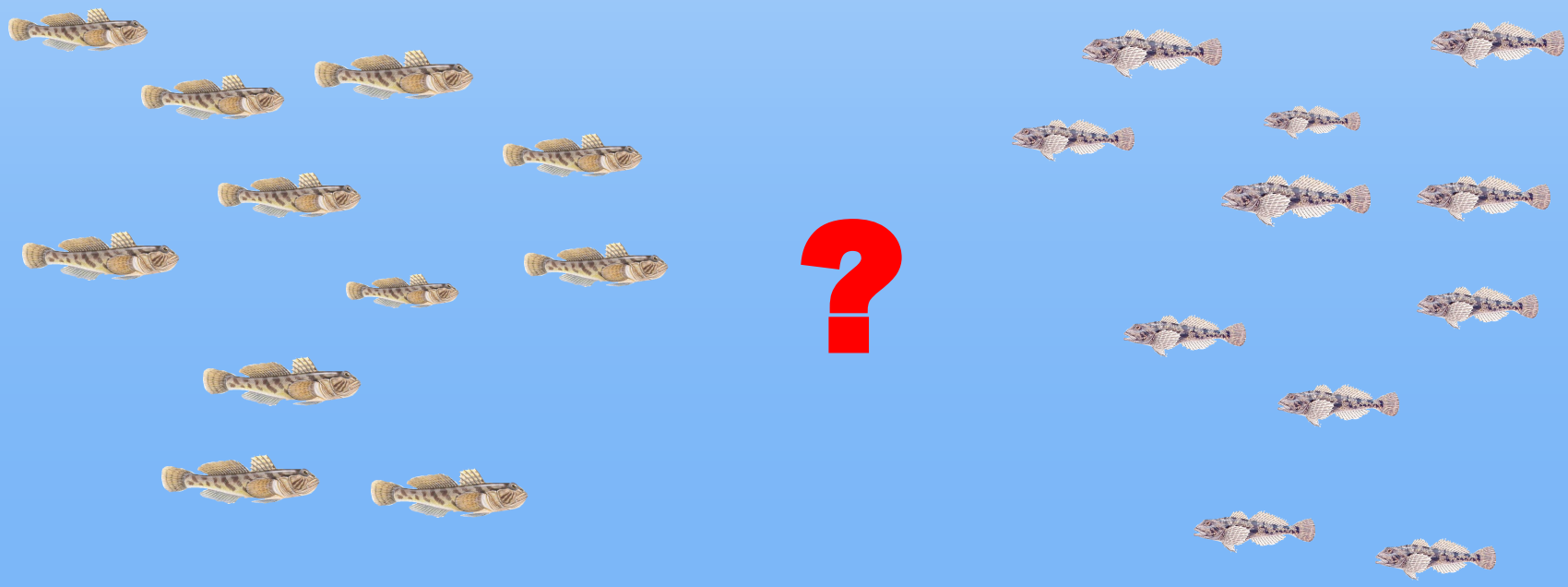
Question

- **SMALL racer goby overlap with SMALL European bulhead in the river**
- **NEGATIVE relationship between SMALL racer goby and SMALL bullhead has been recorded in the river**

- **So… do SMALL racer goby are stronger competitors for resources than SMALL European bullhead, and displace them from their habitas?**



Thank you for your attention