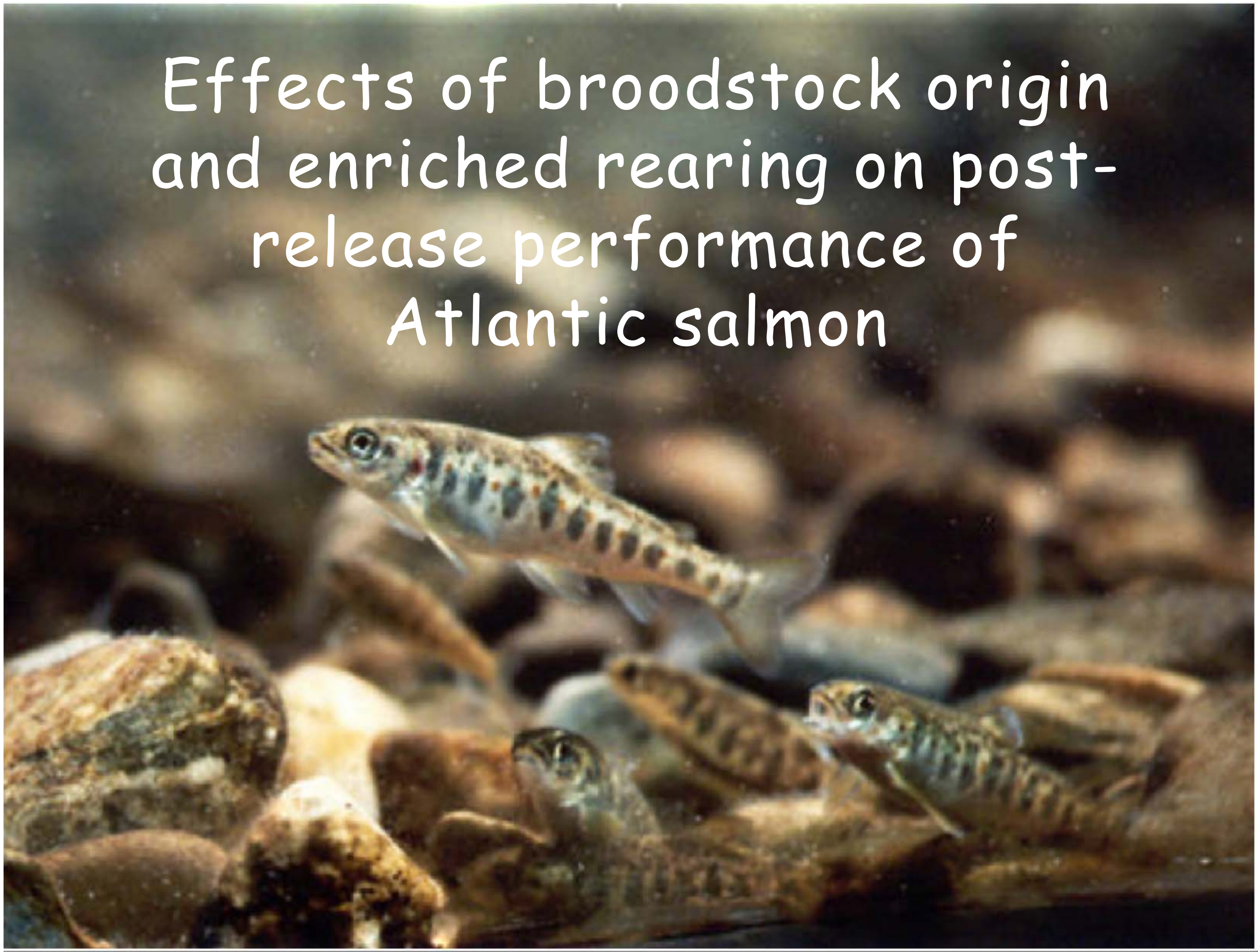
"Why should we bring artificial reefs into the lab?"

Petra Rodewald, NTNU Sealab

Effects of broodstock origin and enriched rearing on post-release performance of Atlantic salmon



UNIVERSITY OF HELSINKI

GAME AND FISHERIES RESEARCH

Study Background

- **Many Atlantic salmon populations endangered.**

- **Restocking programmes to overcome depletions.**

  → Hatchery reared fish

- **Restocking counteracted extiction.**

  → Low fitness and survival of hatchery reared fish.

Study Background

- Poorly developed **antipredator** and **foraging** behaviour in hatchery fish:
  - High mortality directly after release.
  - Forage less and on fewer prey types than wild conspecifics.
  - Inapropriate antipredator behaviour.
- Releases are ethically and econmically unsustainable.

Study Background

- Many populations depend on restocking.

- Better methods needed to ease adaptation to the wild:

  e.g.

  - Forage on natural prey
  - Avoid predators

- We need to determine what shapes and influences fish cognition and behaviour to manage populations appropriately.

Teixeira et al. 2007; Braithwaite & Salvanes 2008

Study Background

Main reasons for low survival of hatchery reared salmon:

1. Genetic domestication
2. Unnatural rearing environment

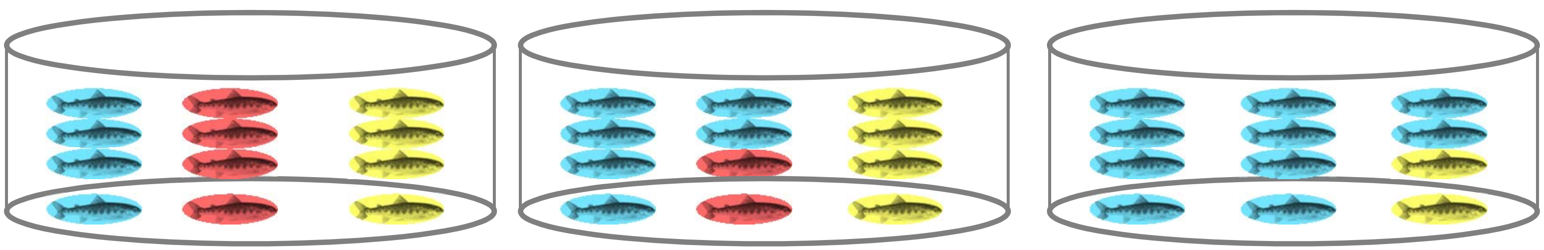
Produces fish poorly adapted to a life in the wild.

a) Genetic domestication

Main reason:

- Genetic drift caused by
    - hatchery selection (can occur quickly)
    - relaxed natural selection (over generations)

Genetic drift



Original population　　second generation　　Generation X

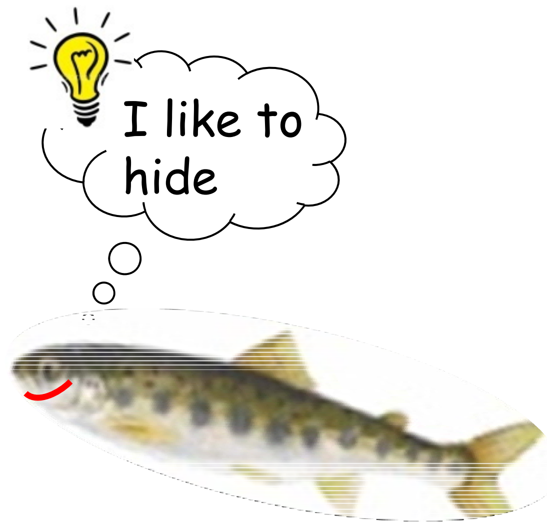
b) Rearing environment

HATCHERY
- Invariable water and food
- No predators
- No structure

WILD
- Variable water and food
- Predators
- Structure

We know:

- Structural enrichment
  - improves learning and memory
  - neural plasticity and cognition
  - decreases metabolic demand
  - decreases stress levels
  - affects brain size



e.g. Brown et al. 2003; Salvanes & Braithwaite 2005; Kishlinger & Nevitt 2006; Millidine et al. 2006, Strand et al. 2010; Näslund et al. 2013; Salvanes et al. 2013

We know:

- Fish need variation in order to develop adaptable behaviour

→ To produce more "wild-like" fish we need to simulate the variation of the wild.

Natural variation:

- e.g. high or low water levels
- variation in water velocity → spring flood



Reference:
Ebbesson & Braithwaite 2012

We don't know:

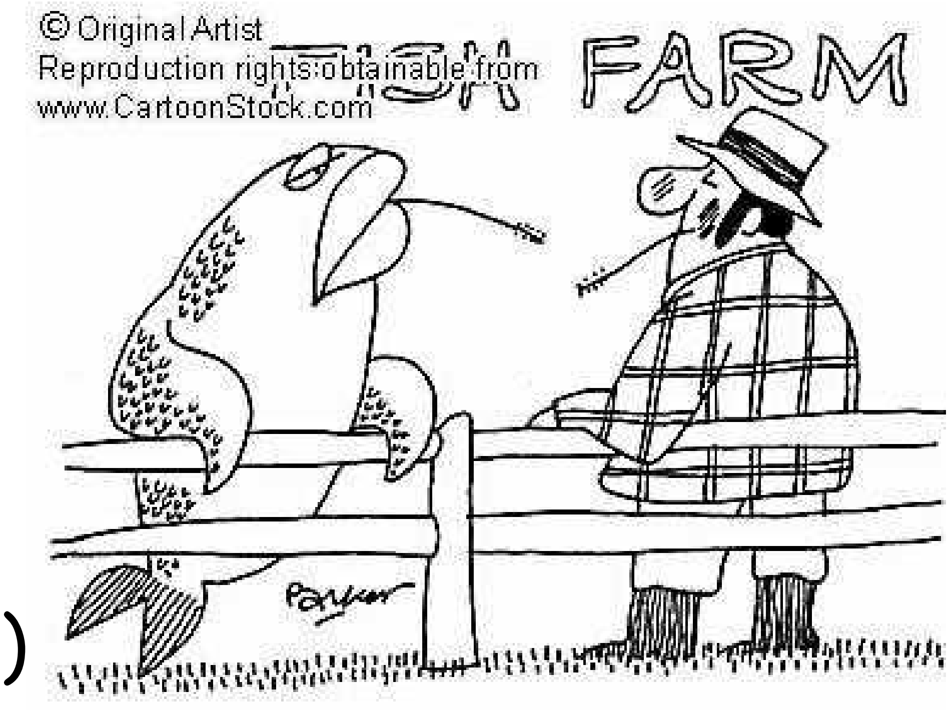
How

A) Hatchery selection (G)

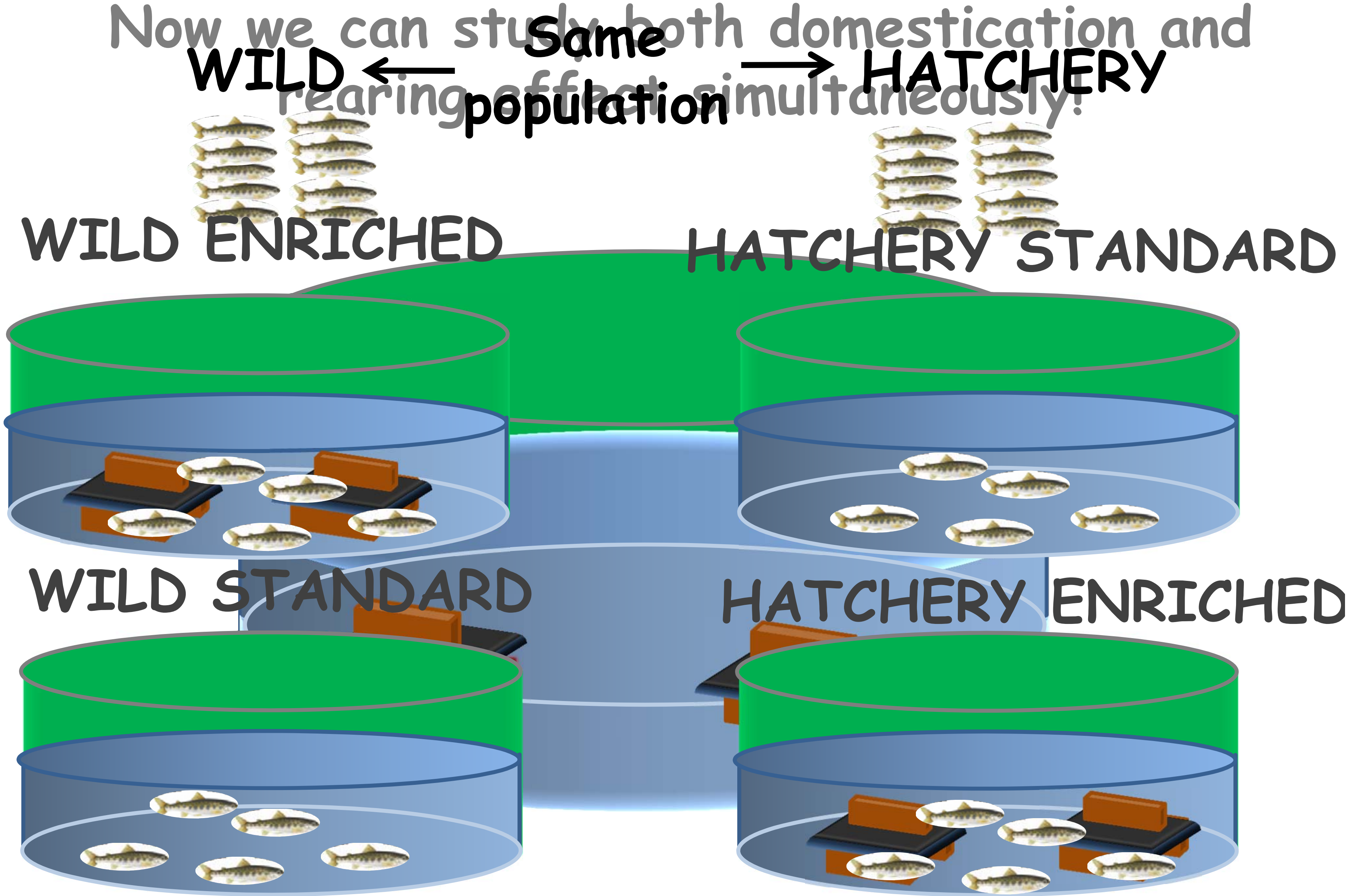
B) Rearing environment (E)

C) interaction of both (G x E)

influence development of phenotype



Now we can study both domestication and rearing effect simultaneously!



Giving us 4 treatments

- Hatchery standard (hs)
- Hatchery enriched (he)
- Wild standard (ws)
- Wild enriched (we)

ExpectationsWho copes best?

- Assumptions:
  - **Wild** origin resemble wild fish genetically
  - **Enriched** rearing creates better learners

wild > hatchery

enriched > standard

we > ……. > hs

Effect of a) broodstock origin and b) rearing environment on post-release performance

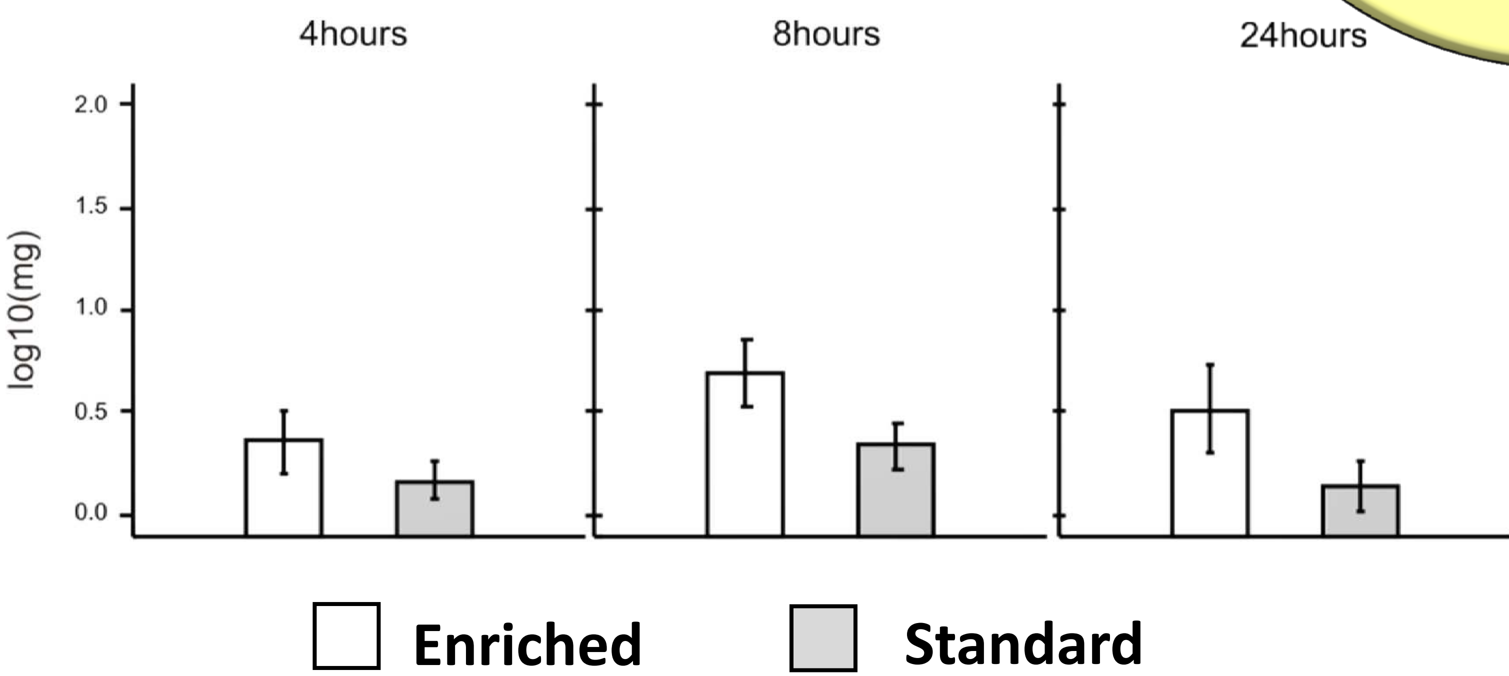
Mesocosm studies (semi-natural)

Nature

Study I: Foraging of parr after release into a semi-natural environment with/without the risk of predation

Intake rate natural food

ENRICHED REARING INCREASED FOOD INTAKE.

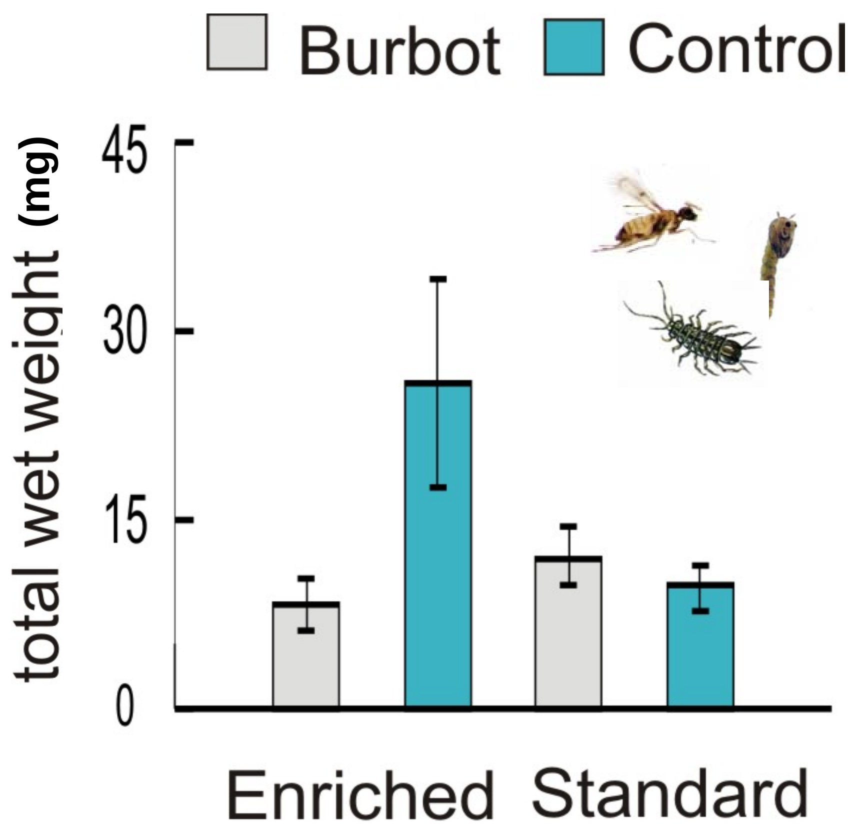


Insect Larvae

Rodewald , Hyvärinen & Hirvonen (2011) Ecol. Freshw. Fish

Intake rate novel natural prey

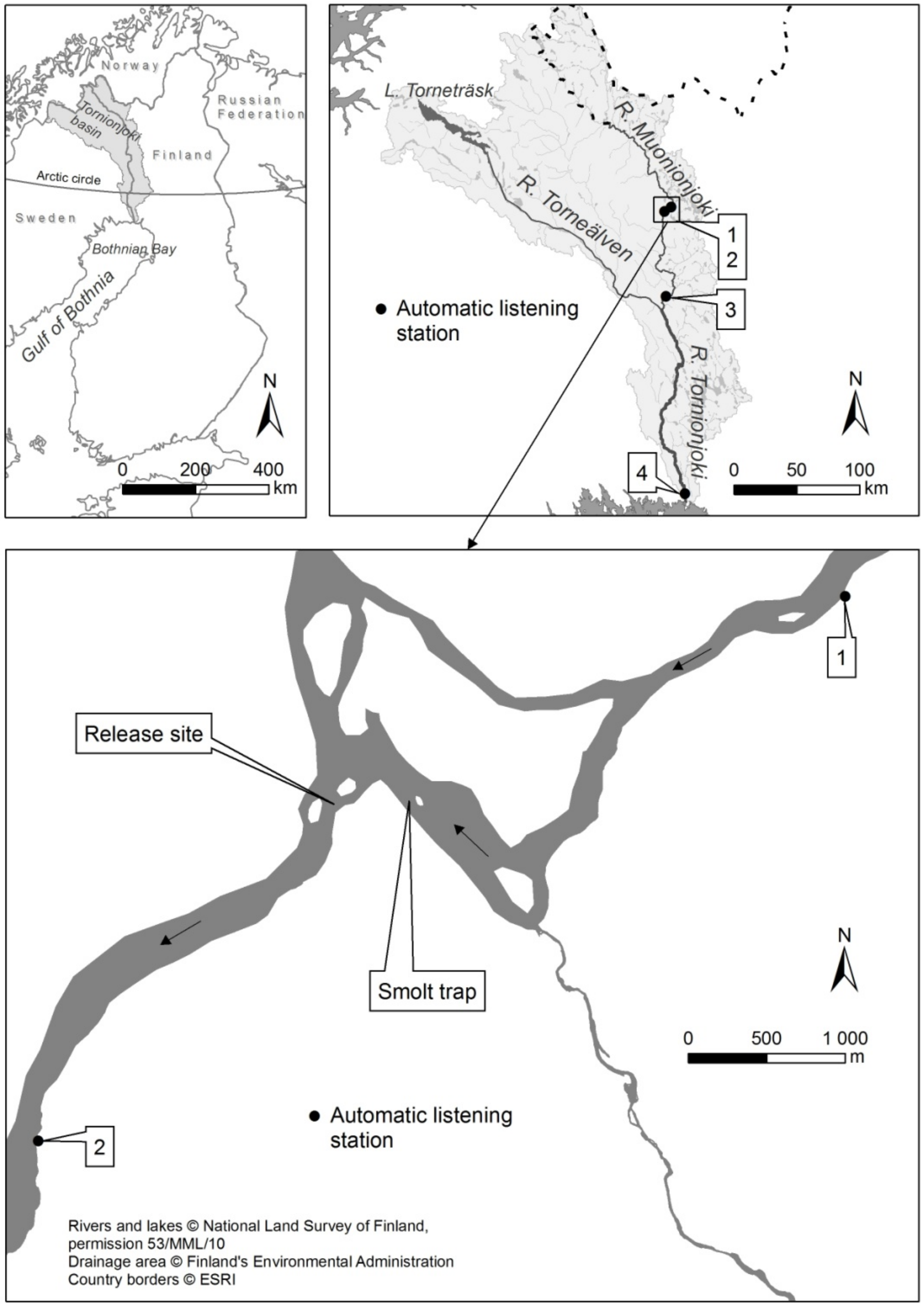
Enriched fish decreased feeding under predation risk!



Study III: Post-release migration and survival of Atlantic salmon smolts in the wild

Radio-tagged 2+ smolts from the River Tornionjoki population

"It's an endangered salmon.
Quick, tag it before you eat it."



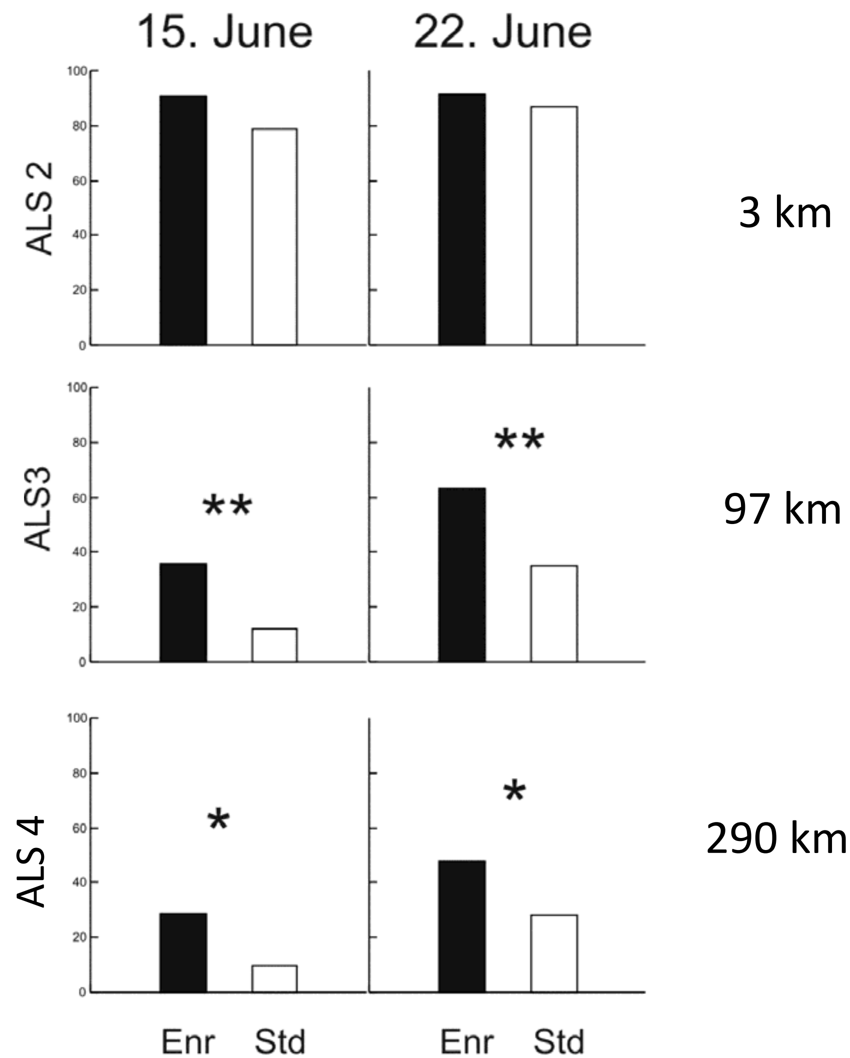
Manual tracking from land

Manual tracking by boat

Automatic listening station

More enriched fish survived than standard fish

No effect of broodstock origin



Hyvärinen & Rodewald (2013) Can. J. Fish. Aquat. Sci.

Survival until Sea

Nature smolts 3.0 times
Enriched smolts 2.0 times

Higher survival than standard smolts

- Standard → ~20 %
- Enriched → ~40 %
- Nature → ~60%

Hyvärinen & Rodewald (2013) Can. J. Fish. Aquat. Sci.

General conclusion

- There is great potential to improve stocking programmes by improving the quality of the fish.

- This will additionally increase welfare of captive animals as they are allowed to express more natural behaviour.

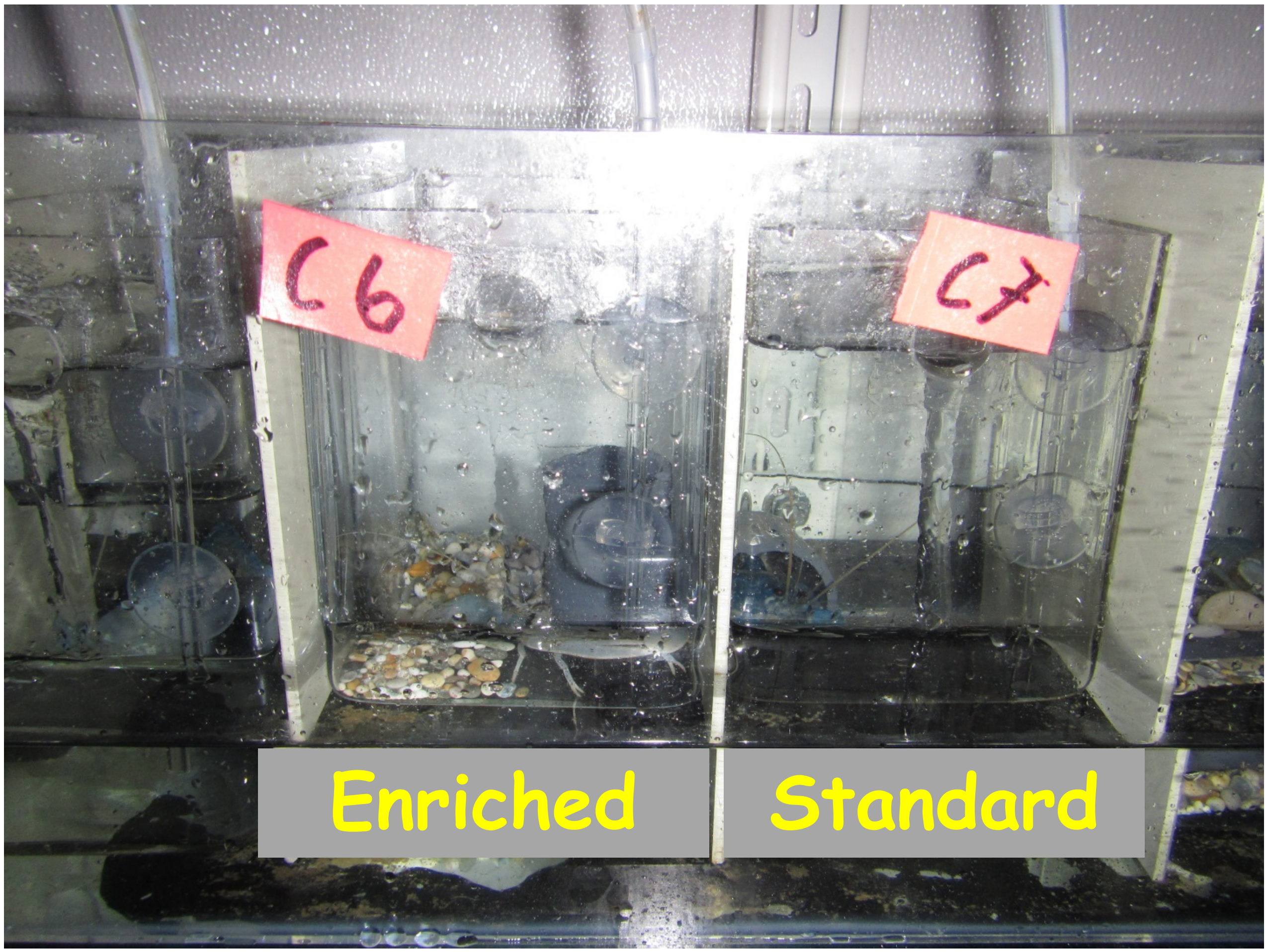
European lobster (*Homarus gammarus*)

Are there individuals that are less prone to aggression and cannibalism?

Questions

- Is there variation in behaviour between individuals? (bold/shy)
- Does it differ across contexts? (Are the bold always bold?)
- Can behaviour be explained by environment? (is there are difference in behaviour between enriched and standard lobster?)

Standard (std, shelter)
Enriched (enr, gravel + shelter)


C6
C7
Enriched
Standard

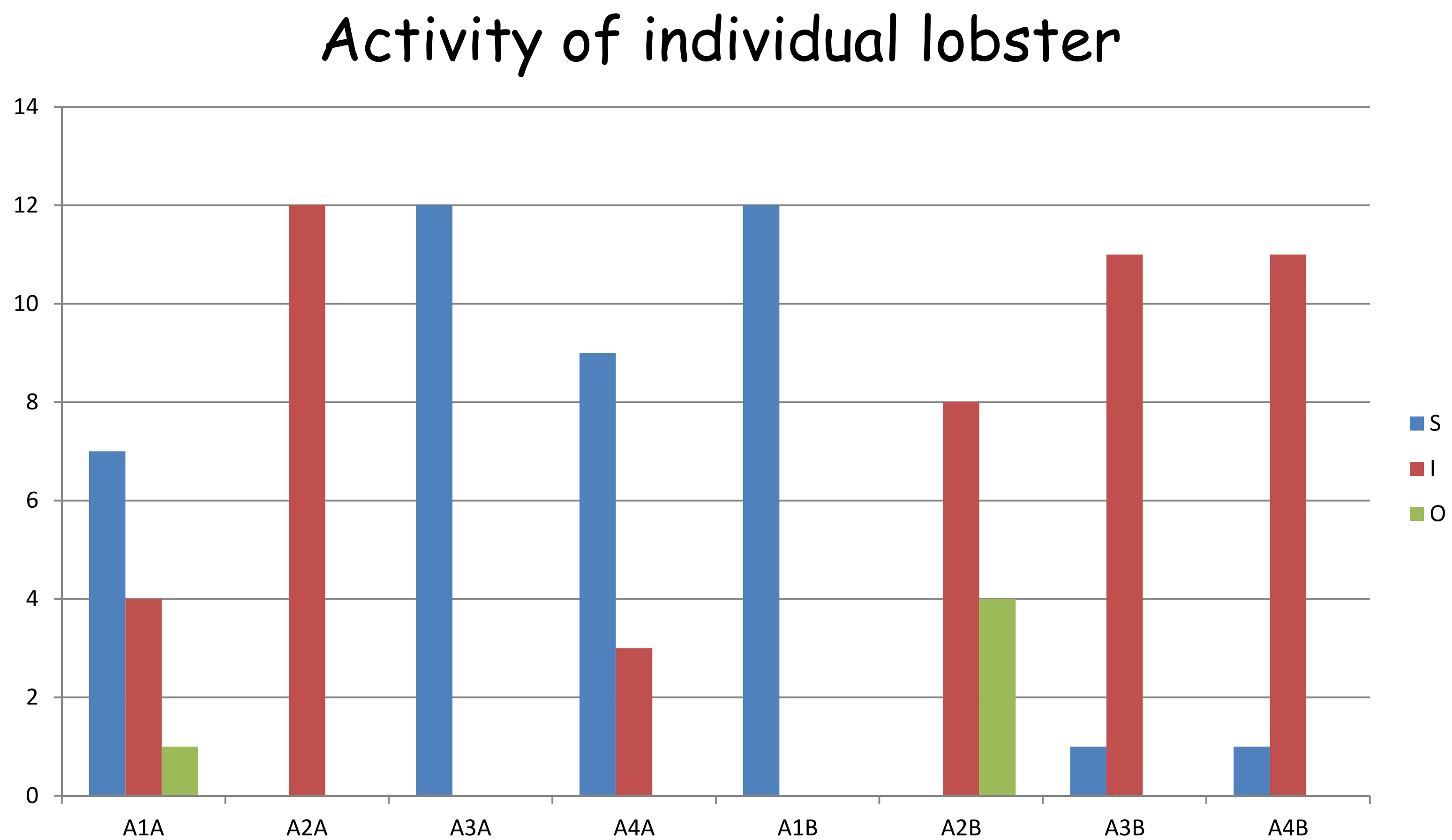
Trials:

a) Exploration/Activity/sheltering behaviour
b) Novel object (walnut)
c) Novel prey (net with 4g pellets)

Analyzed with ethovision

N = 60 (30 enr, 30 std
Average size 74mm CL
Size range 52 – 102 mm)

Preliminary results



Approach to novel object by individual lobster

	First approach	Second approach	Third approach	Fourth approach	Fifth approach	Sixth approach	Seventh approach	Eight approach	Ninth approach
A1	17.41								
A2	03.07	55.18	77.21						
A3	0.18	15.02	20.15	26.34	31.45	72.06			
A4	8.11	8.14	19.30	21.32	22.32	42.07	54.05	63.06	74.56

Approach to novel prey by individual lobster

	First approach	Second approach	Third approach	Fourth approach
A1	**3.35**	**30.14**		
A2	**5.01**	**7.31**	**8.13**	**9.30**
A3	**2.53**	**4.48**		
A4	**12.16**			

New plans (NorReef) lab studies and mesocosm

Why?

→What do species require of their habitat at different ontogenetic life stages

→ Design artificial reefs with increased complexity to include all life stages

→Many factors influence behaviour and survival in nature.

→Lab studies can give good indications on habitat choice

→Mesocosm studies combining several species can give us more realistic indications (e.g. intra- and interspecific competition, predator-prey interactions)

Laboratory experiments

- How?
  - European lobster

a) Testing habitat selection when offering different shapes of shelter with/without predation risk.

b) Densities (individuals per shelter)

→ Three life stages: 1) larvae IV, 2) juvenile 10-12cm, 3) mature adults

Bilde: Tora Bardal

Mesocosm studies

c) Habitats of different complexity will be tested using shelters from the previous experiment a) and b).

→Mini eco systems
→Including predators and prey.
→Three life stages: 1) larvae IV, 2) juvenile 10-12cm, 3) mature adults