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# AQUACULTURE EUROPE 2021

# Development of an *in silico* method to design new species polyculture in aquaculture


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INRAE la science pour la vie, l'humain, la terre

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# Curent context of polyculture

The production of two or more fish species in the same physical space at the same time (adapted from Stickney 2013)

One of the oldest fish rearing practices in the world
(Beveridge and Little 2002; Stickney 2013)

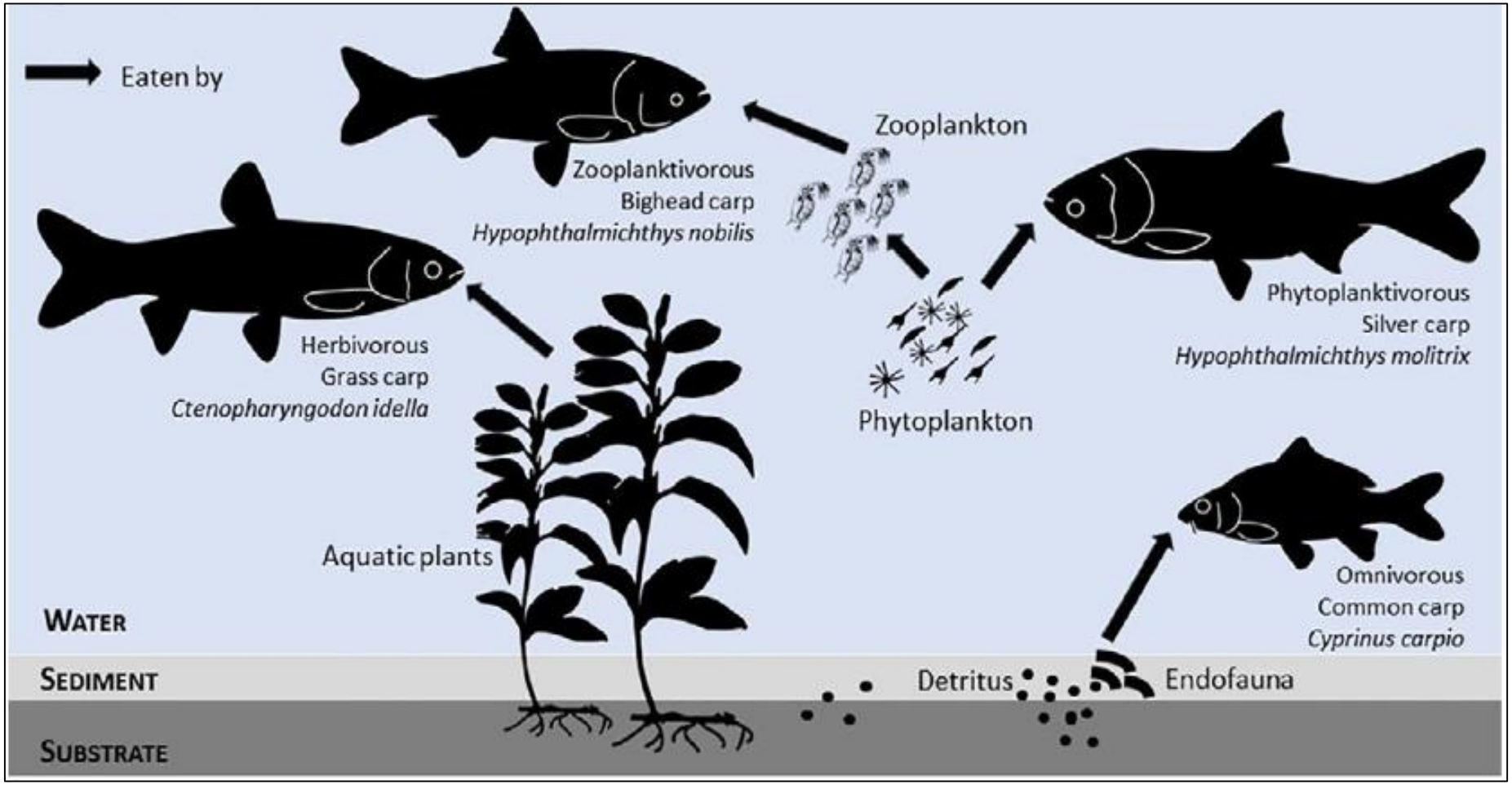
**An option to address the challenges of 21st century aquaculture**

- Climate change
- Diversification
- New societal demands
- New technology developments

(Kozlowski et al. 2014; Boyd et al. 2020; Thomas et al. 2021)

# Compatibility, a requirement to optimize polyculture

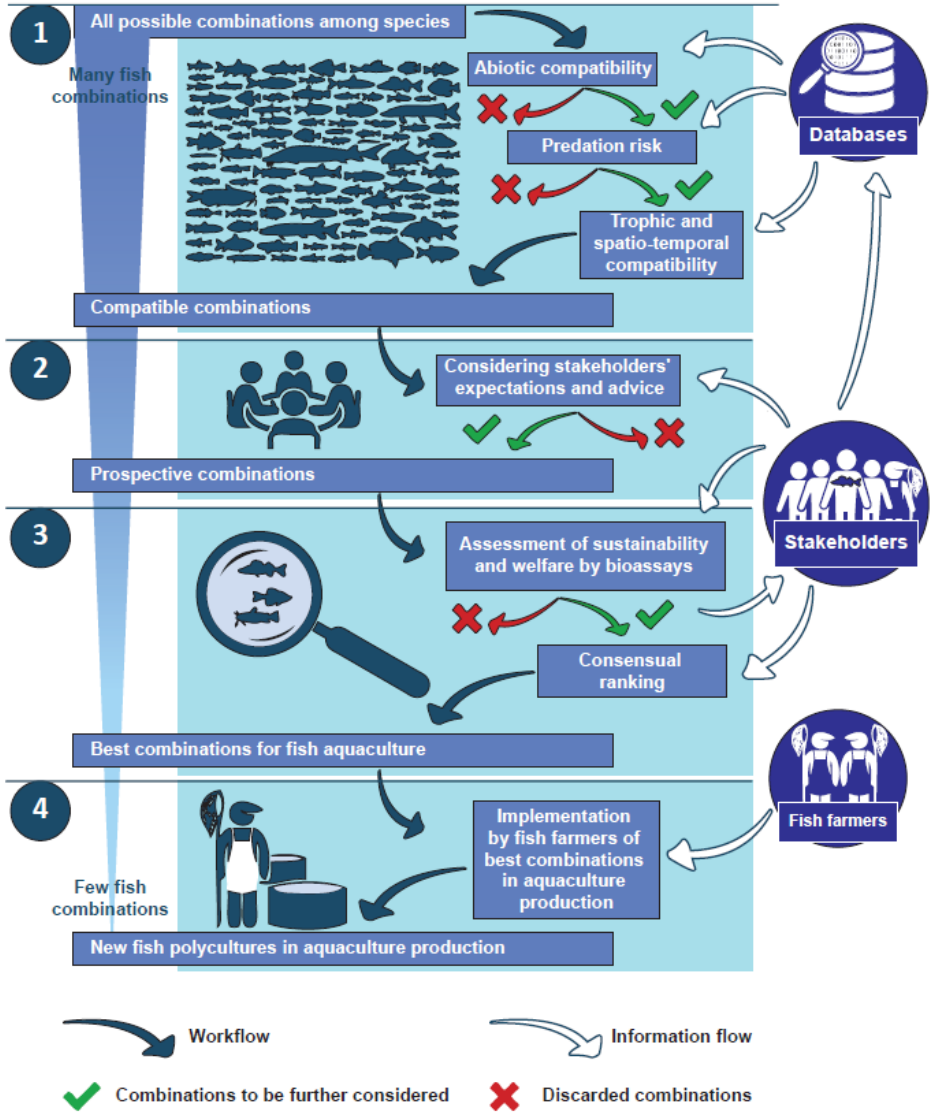
Species which can live in the same production system without detrimental interactions or competition for resources (spatio-temporal & trophic)




(Thomas et al. 2021)

# Findings

## ❖A vast field of possibilities in terms of species combinations




(Lecocq et al. 2021; *in review*)

**Step 1** Predicting *in silico* the potential compatibility between fish species

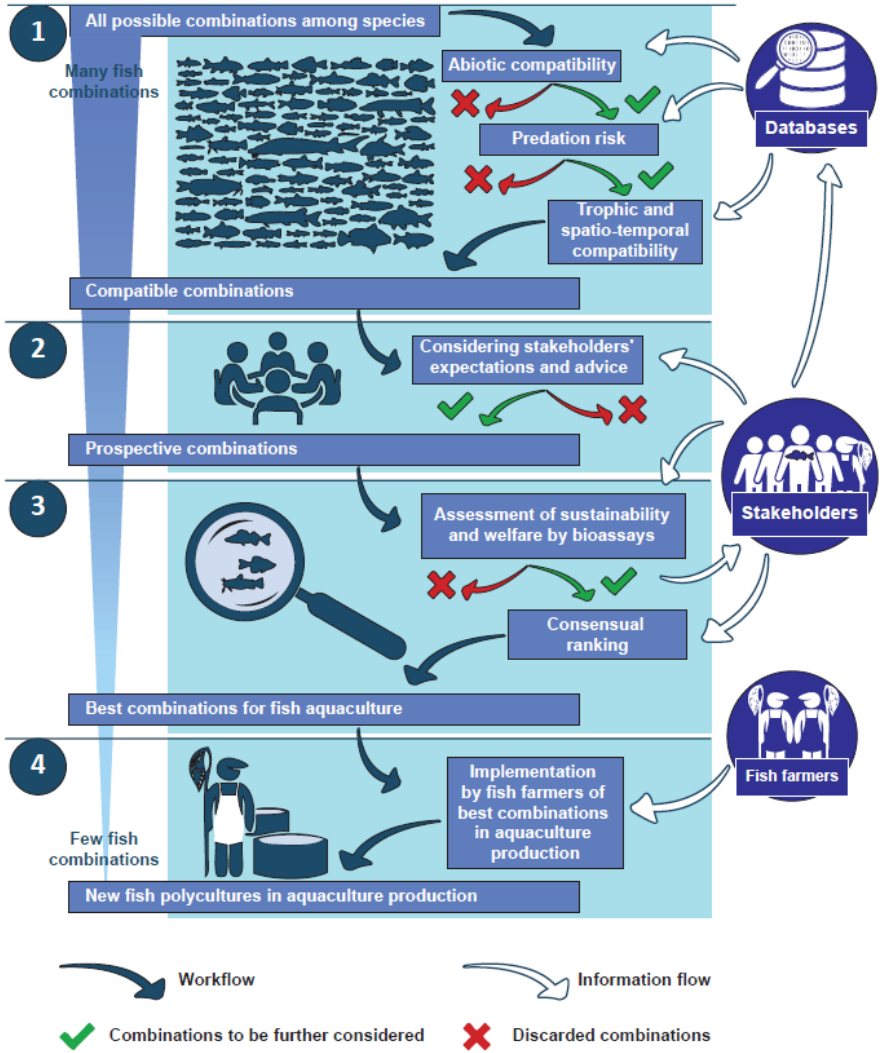
**Step 2** Co-construction with stakeholders

**Step 3** Assessing the sustainability of combination and welfare of each species

**Step 4** Transfer of technology in Aquaculture Production

# What is the main problem?

## ❖ No tools to operationalize the workflow steps




**Step 1** Predicting *in silico* the potential compatibility between fish species

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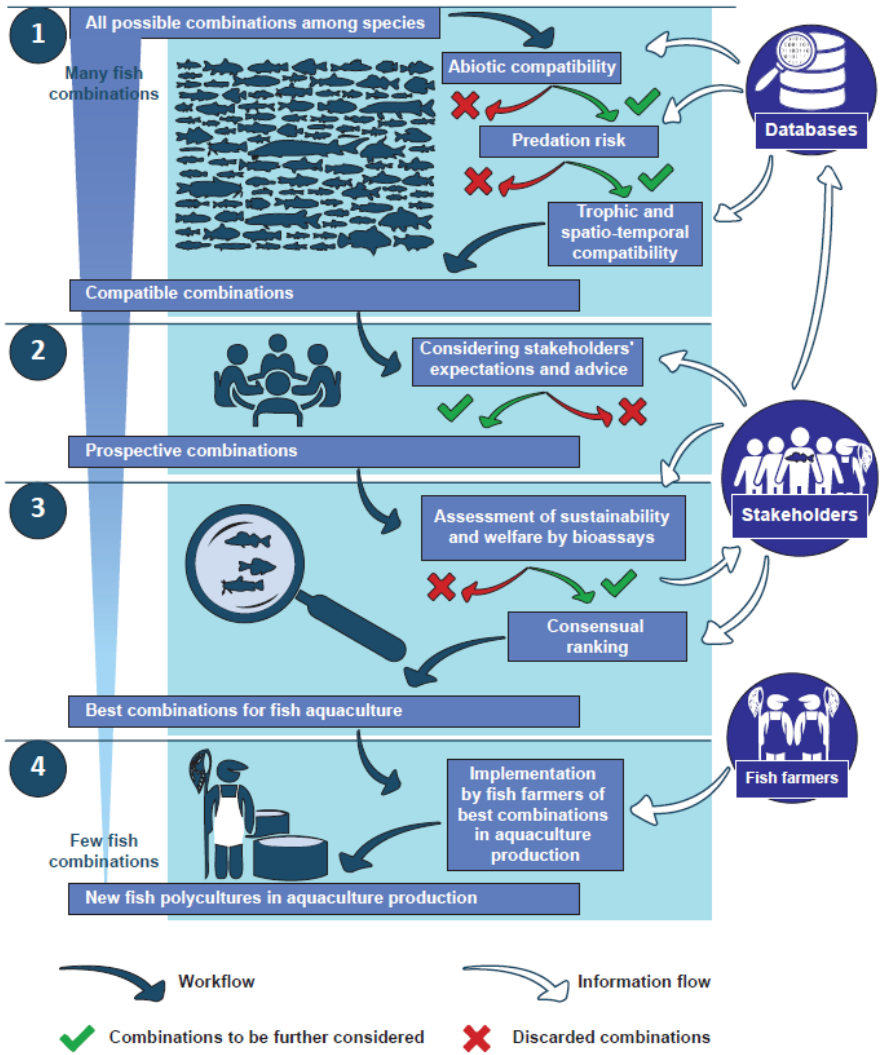
# What is the main problem?

## ❖ No tools to identify compatible species




**Step 1** Predicting *in silico* the potential compatibility between fish species

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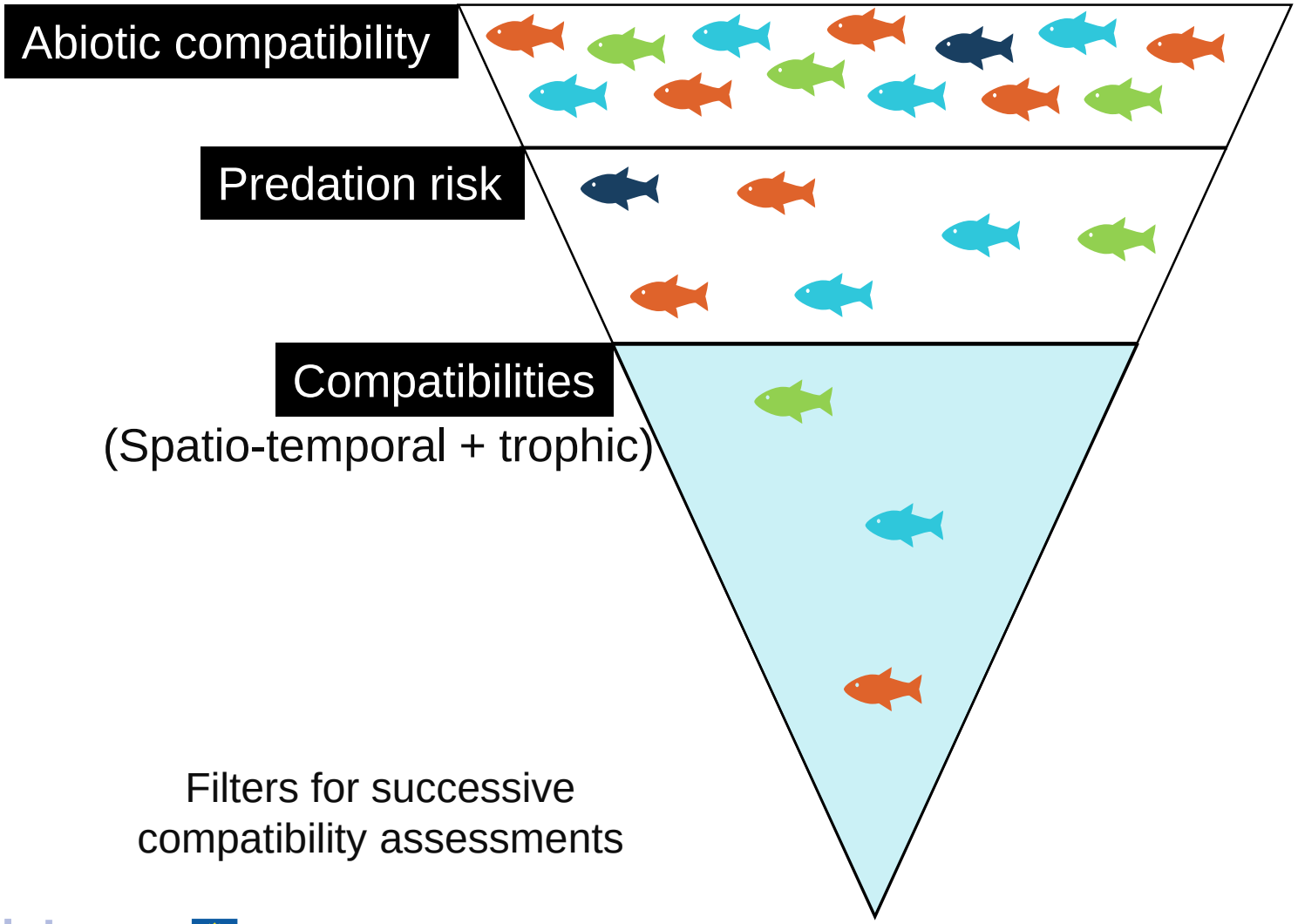
# How could it be solved?

## ❖ Assessing species compatibility




Filters for successive compatibility assessments

- Selecting relevant abiotic variables
- Comparison of abiotic niche similarity

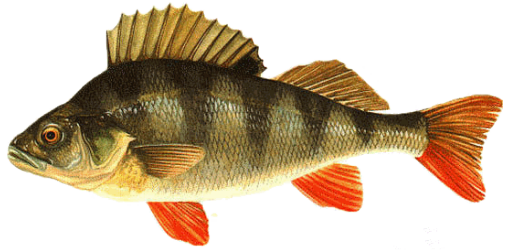
- Selecting relevant functional traits (RFT)
- Estimation of predation risk

- Selecting RFT from databases (e.g.TOFF: www://toff-project.univ-Lorraine.fr/)
- Building distance matrices
- Computing a compatibility index
- Identifying compatible combinations

→ Median and quartiles approach (Q1, Q3)

**Compatible combinations**

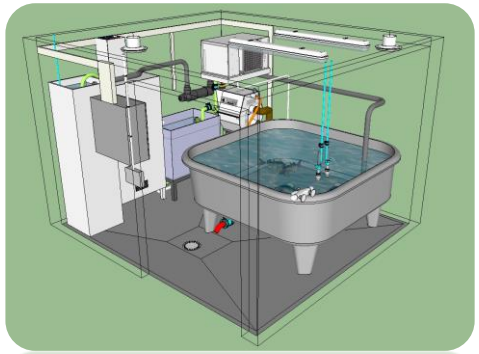
# Towards a validation of the *in silico* method

| HP1 (Trio)→ Polyculture with high compatibility index (> Q3) | HP2 (Duo) → Polyculture with high compatibility index (> Q3) | LP → Polyculture with low compatibility index (< Q1) |
|---|---|---|
|  *Pikeperch* |  *Pikeperch* |  *Pikeperch* |
|  *Common carp* |  *Common carp* |  *Blackbass* |
|  *Perch* | | |

# Testing compatible combinations

❖A case study

PEA
PLATEFORME EXPÉRIMENTALE EN AQUACULTURE



Scheme (top) & photo (bottom) of an ecotron (2 m³)

3 modalities x 3 replicas = 09 bassins (EU)


- Regular monitoring of mortalities
- Control of physico-chemistry
- Feeding 1 x / day → « *Pellets* »

➢ Chronogram - Measures - Sampling


Zootechnical and behavioral measurements

❑ **Growth Control (GC)**

→ Each 20 days: 30 ind / species

- **Total length (cm) - Weight (g) - General aspect**

❑ **Behavioral recording**

→ 1 - 5 days before GC
→ Study on a subsample of fish

- **Intra- interspecific interactions**

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# Data processing

Species scale | Community scale

| | Set of indicators considered | Indicators with significant effect |
|---|---|---|
| Zootechnical | Final weight (g)<br>Specific growth rate (% Day-1)<br>Condition index<br>Survival rate (%)<br>Weight variation<br>Total biomass (Kg)<br>Biomass gain (%) | Final weight (g)<br>**Specific growth rate (% Day-1)**<br>Condition index<br>Survival rate (%)<br>**Weight variation**<br>**Total biomass (Kg)**<br>**Biomass gain (%)** |
| Behavioral | Agonistic<br>Flight | Agonistic<br>**Flight** |

# What are the main results?

❖ **Zootechnical indicators at T90**

**HP1**

Pikeperch
Common carp
Perch

**HP2**

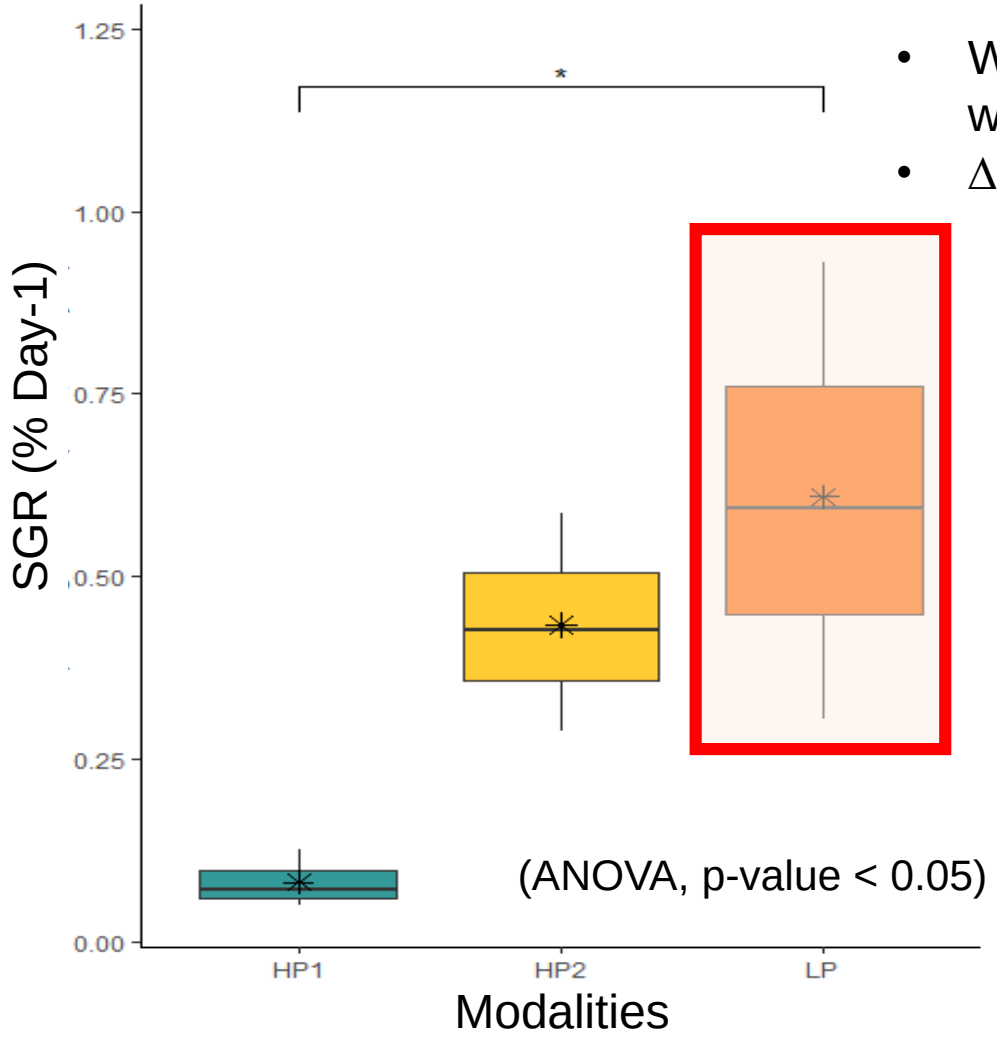
Pikeperch
Common carp

**LP**

Pikeperch
Black-bass

## Specific growth rate (SGR) of pikeperch

$$SGR = (((\ln(Wf) - \ln(Wi)) * \Delta T\text{-}1) * 100)$$




(ANOVA, p-value < 0.05)

- Wi & Wf = initial & final mean weight of all fishes of an EU
- ΔT = duration of the trial

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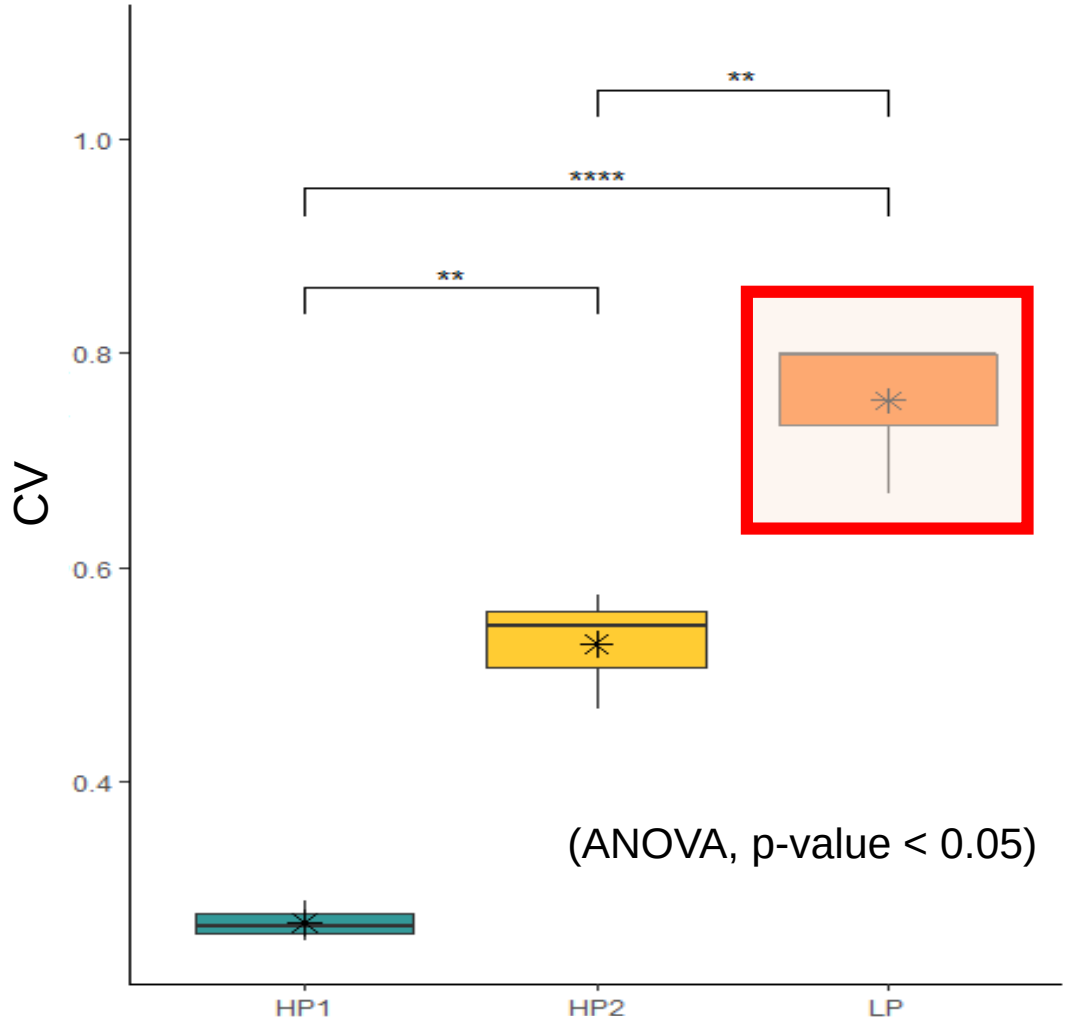
**Weight variation (CV) of pikeperch**

CV = (Wf (SD) * 100) / Wf (mean)

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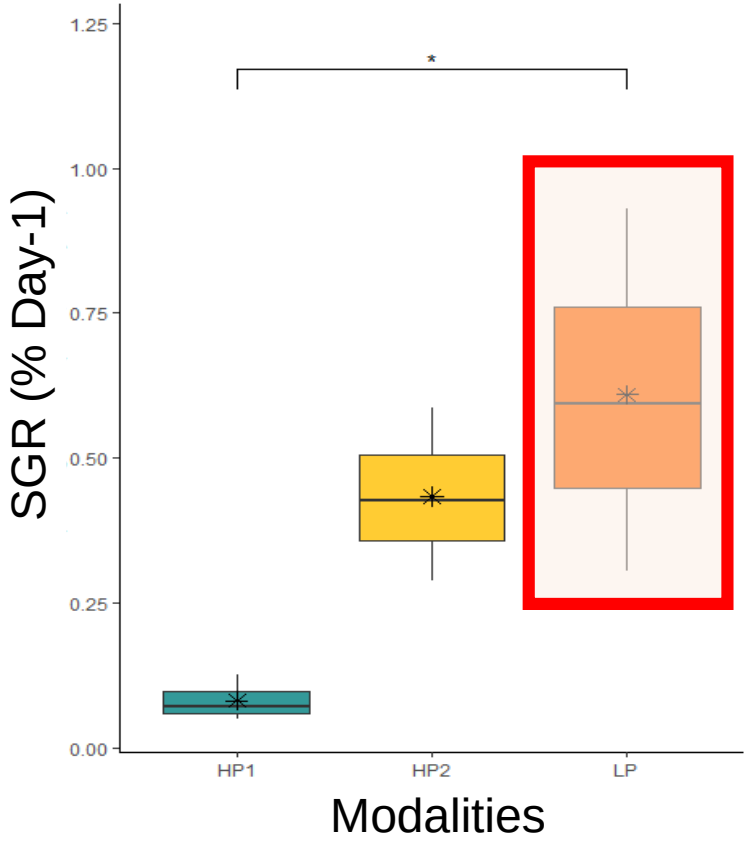
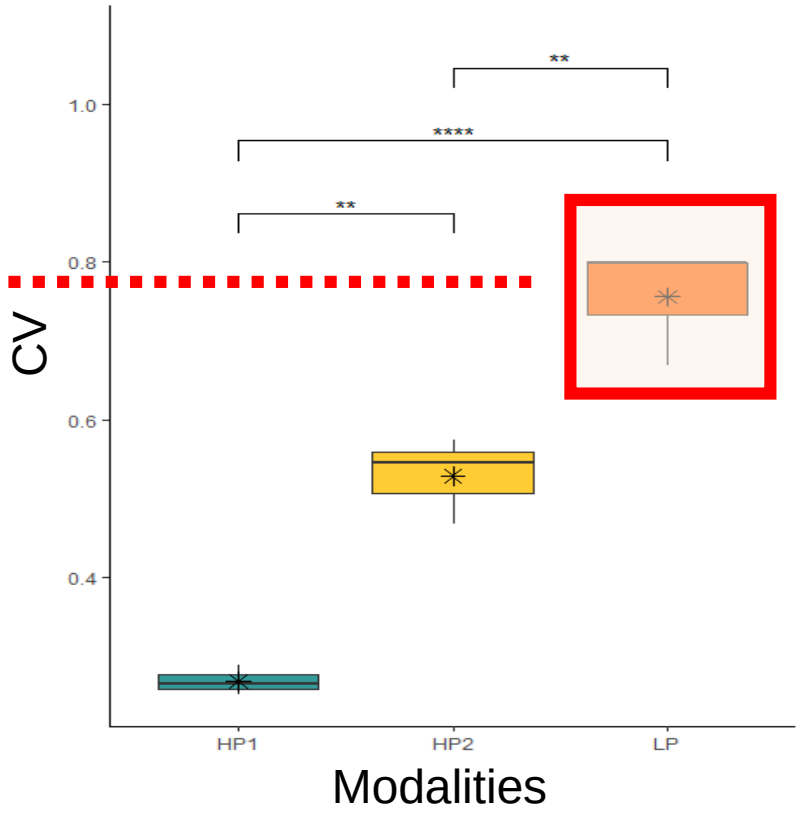



## Weight variance (CV) of pikeperch

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**HP2** 
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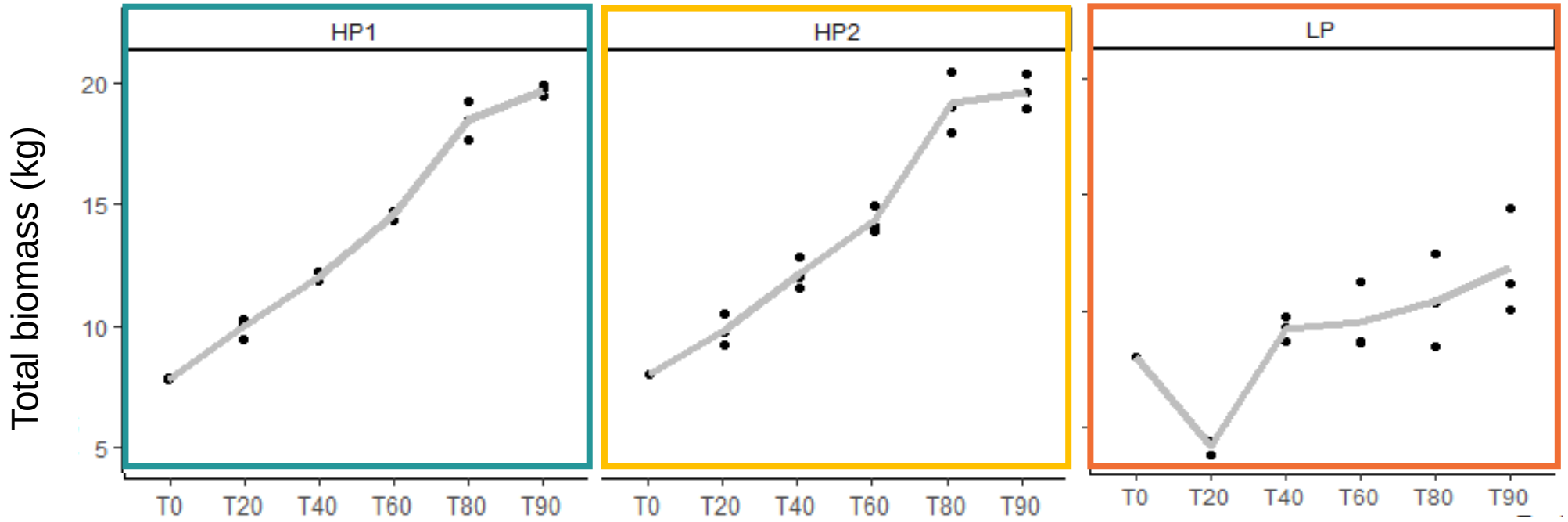
Black-bass

**Total biomass (TB) of fish community**

TB = ∑ weight of all the fish contained in an EU



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Pikeperch
Common carp
Perch

**HP2**

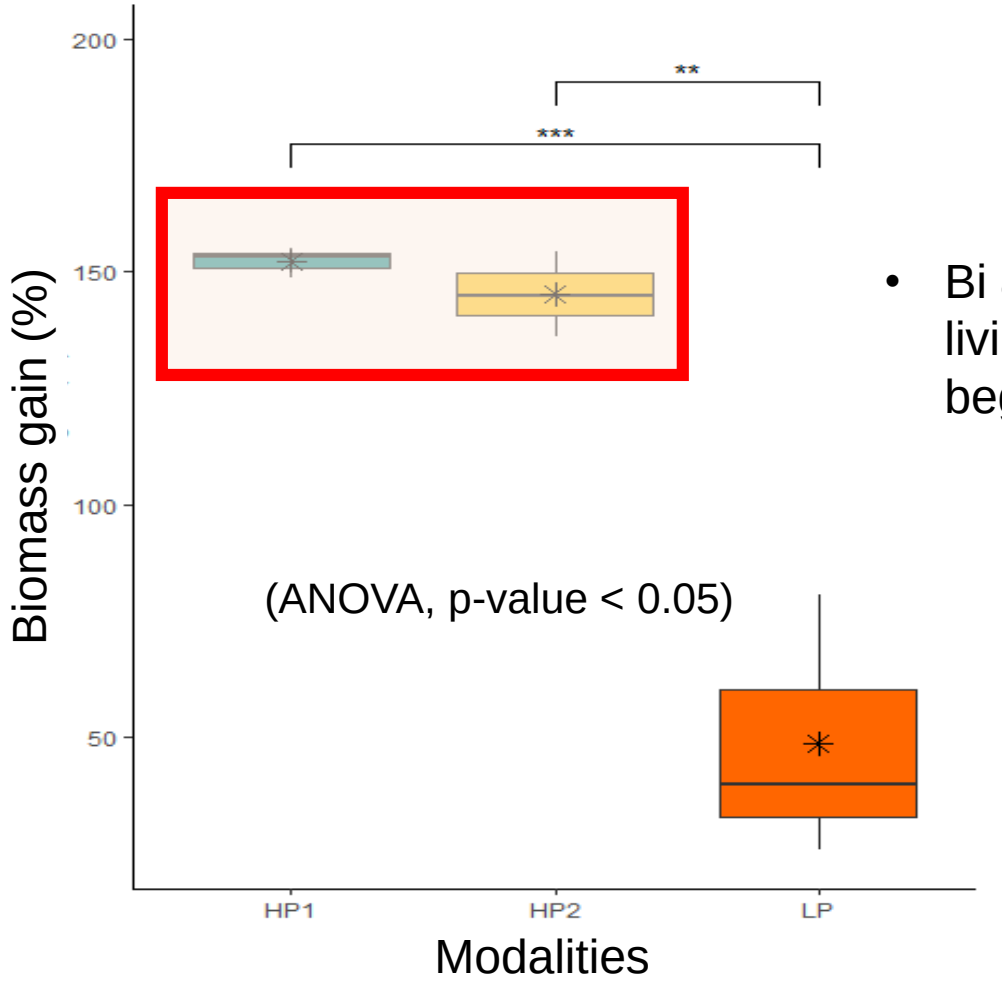
Pikeperch
Common carp

**LP**

Pikeperch
Black-bass

## Biomass gain (BG) of fish community

BG = Biomass Gain (%) = (Bf – Bi) * 100 / Bi




- Bi & Bf= total biomass of all living fish in the tank at the beginning & end of the trial

# What are the main results?

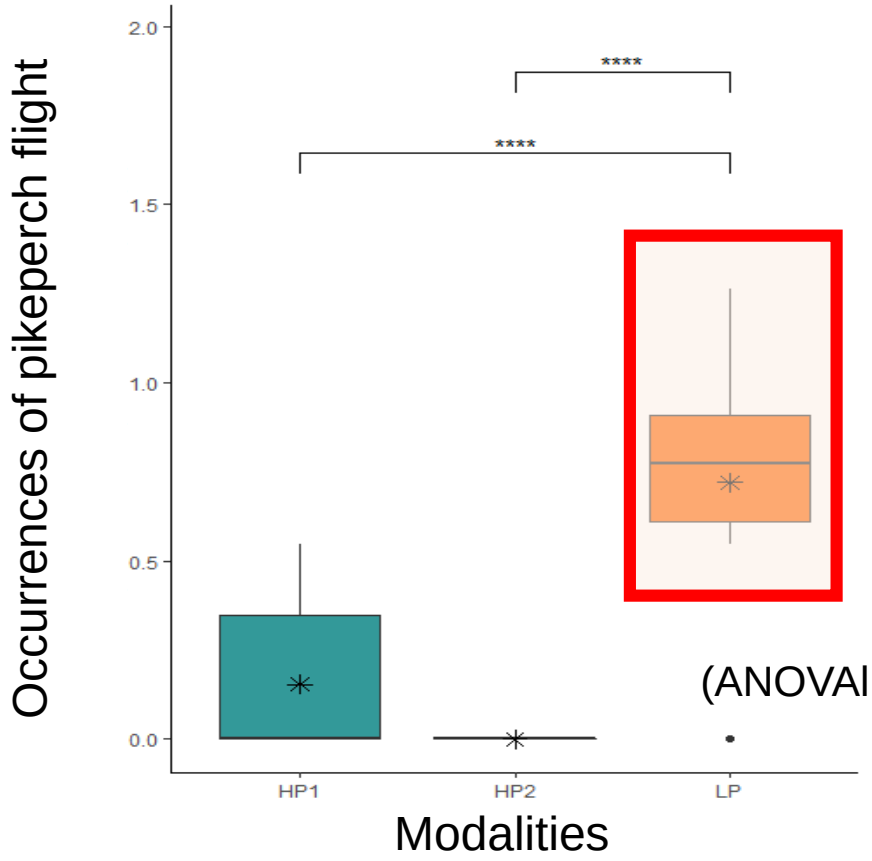
❖ **Behavioral indicators at T90**

**HP1** 
Pikeperch
Common carp
Perch

**HP2** 
Pikeperch
Common carp

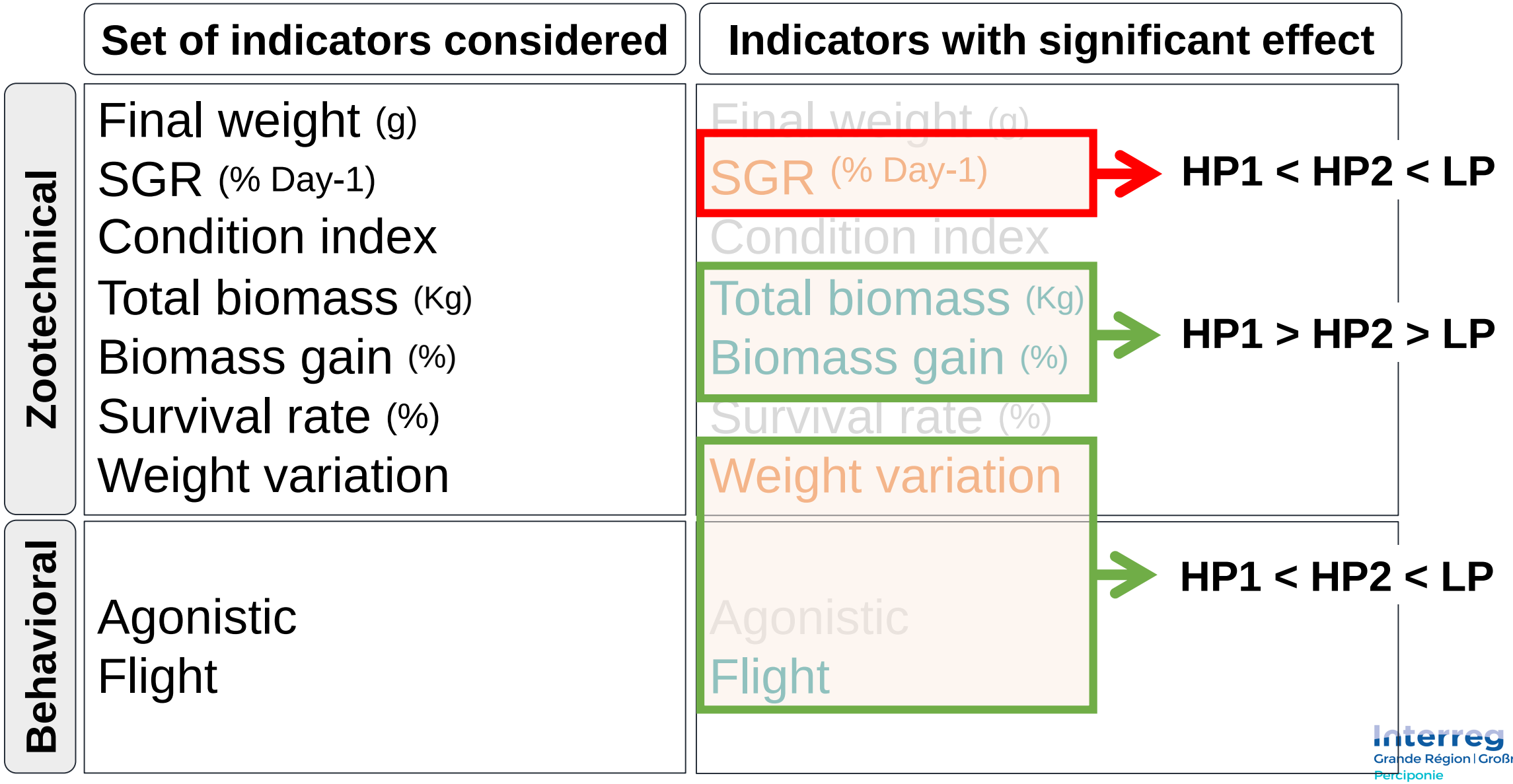
**LP** 
Pikeperch
Black-bass

## Interspecific interaction (Flight)




(ANOVAlmer, p-value < 0.05)

# What about the *in silico* method efficiency?



# What about the *in silico* method efficiency?

**Indicators with significant effect**

Final weight (g)

SGR (% Day-1) → **HP1 < HP2 < LP**

Condition index

Total biomass (Kg)

Biomass gain (%) → **HP1 > HP2 > LP**

Survival rate (%)

Weight variation

Agonistic

Flight → **HP1 < HP2 < LP**

4/5 indicators

→ Expected results

# What next?

- Identify other polycultures and test them
- Developing a global index, considering the set of indicators/criteria
- Expand the set of indicators/criteria measured (e.g. Physiological criteria)

# THANK FOR YOUR ATTENTION

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