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## Passage Performance of two Cyprinids with Different Ecological Traits in a Fishway with Distinct Vertical Slot Configurations

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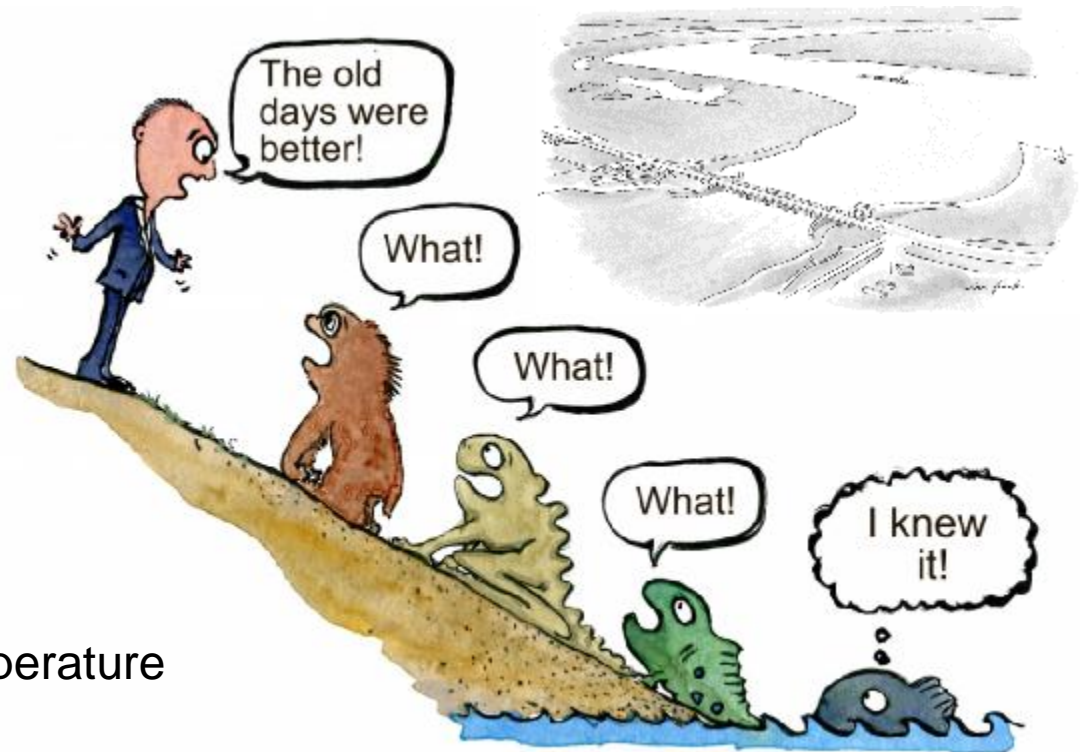
Ana L. Quaresma, Paulo Branco, José M. Santos, Susana Amaral, Maria T. Ferreira,  
Teresa Viseu, Christos Katopodis, António N. Pinheiro

# INTRODUCTION



Worldwide, anthropogenic obstructions on watercourses have negative impacts on migratory fish

- Blocking migratory pathways
- Loss of habitat and degradation
- Isolating fish populations
- Changes in water quality and temperature
- Decline in fish diversity and abundance or even extinction

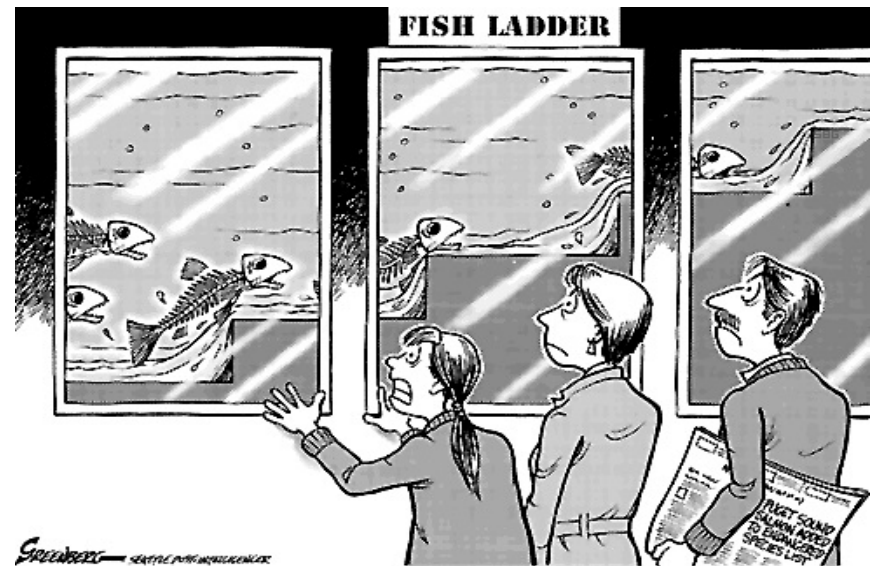


By Frits Ahlefeldt

# INTRODUCTION

## Fish Passage Facilities

- Pool-Weir
- Denil
- **Vertical Slot**
- Nature-like
- Fish Locks
- Fish Lifts
- Collection and Transportation Facilities

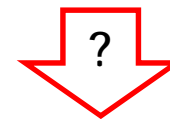
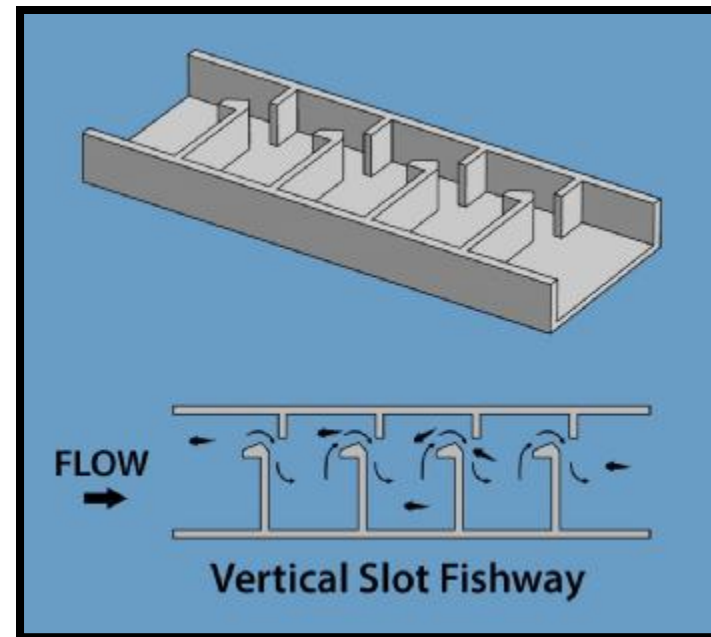


- Delay the migration of target species
- Lack of flow to attract fish to the entrance
- Unsuitable entrance location
- Inadequate maintenance
- **Poor hydraulic conditions**

# INTRODUCTION

## Vertical Slot Fish passes

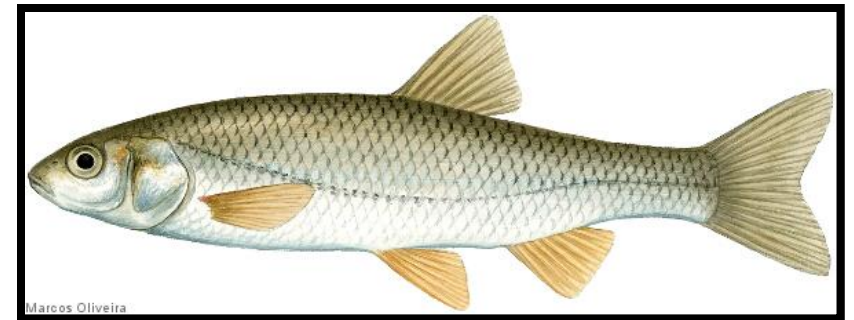
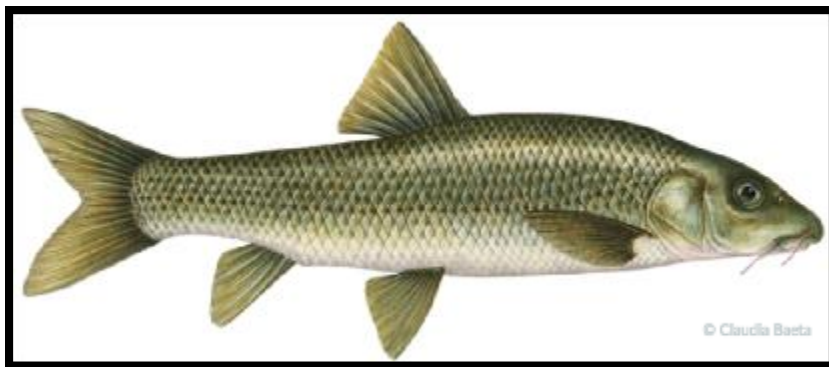
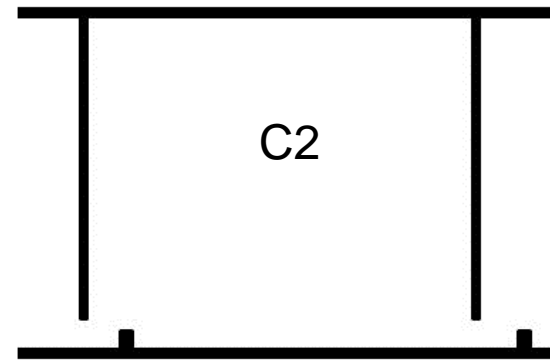
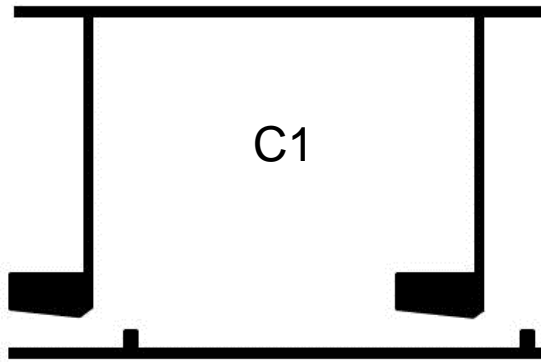
- One of the best type of technical fishway
- Remain operational with water depth changes
- Fish can swim through the slot at any desired depth



- Accomodate a wider range of species
- Reduce their operational costs

# OBJECTIVE

Assess the passage performance of two cyprinid species with different ecological traits in VSF with distinct slot configurations



Iberian Barbel  
(*Luciobarbus bocagei*, Steindachner, 1864)

Iberian Chub  
(*Squalius pyrenaicus*, Günther, 1868)

# METHODS

## Fish trials

- Acclimation period of 30 minutes
- Experiments lasted 90 minutes per trial (n=100)
- Visual and video monitoring
- Number of upstream movements
- Timing and number of successful fish ascending the fishway
- Entrance time
- Entry efficiency



# METHODS

## Hydraulics

- ADV (model Vectrino 3D, Nortek AS)
- 2 horizontal planes, h1 (50 cm) and h2 (62.5 cm)
- 110 sampling points (25Hz, 180s)
- Velocity, TKE and RSS





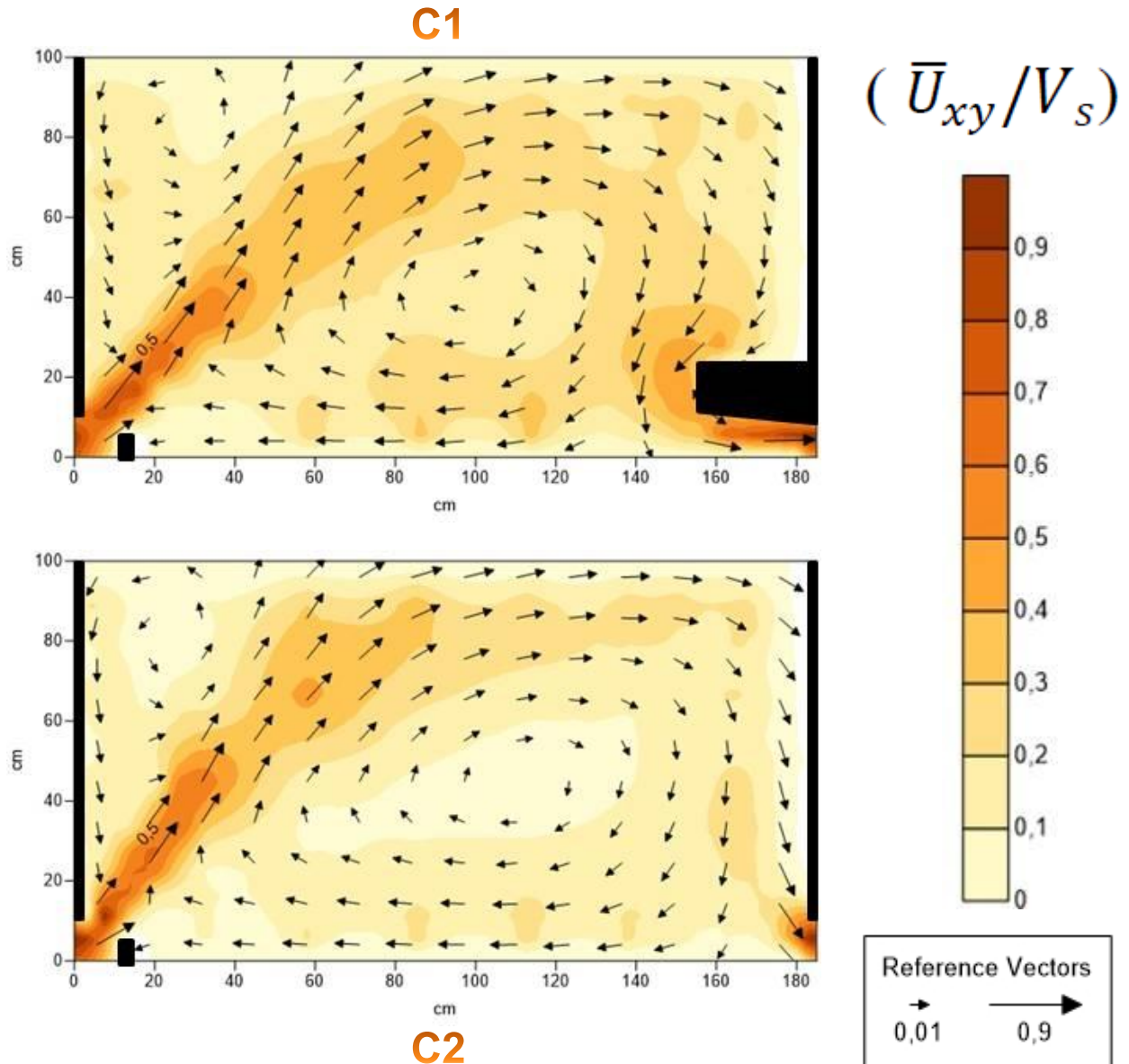
# RESULTS

## Hydraulics - Velocity

- Slot C1 – max. vel. 1.6 m.s<sup>-1</sup>
- Slot C1 – mean vel. 0.51 m.s<sup>-1</sup>
- Slot C2 – max. vel. 1.7 m.s<sup>-1</sup>
- Slot C2 – mean vel. 0.37 m.s<sup>-1</sup>

$$(\bar{U}_{xy} = \sqrt{\bar{u}^2 + \bar{v}^2})$$

$$V_s = \sqrt{2g\Delta H}$$



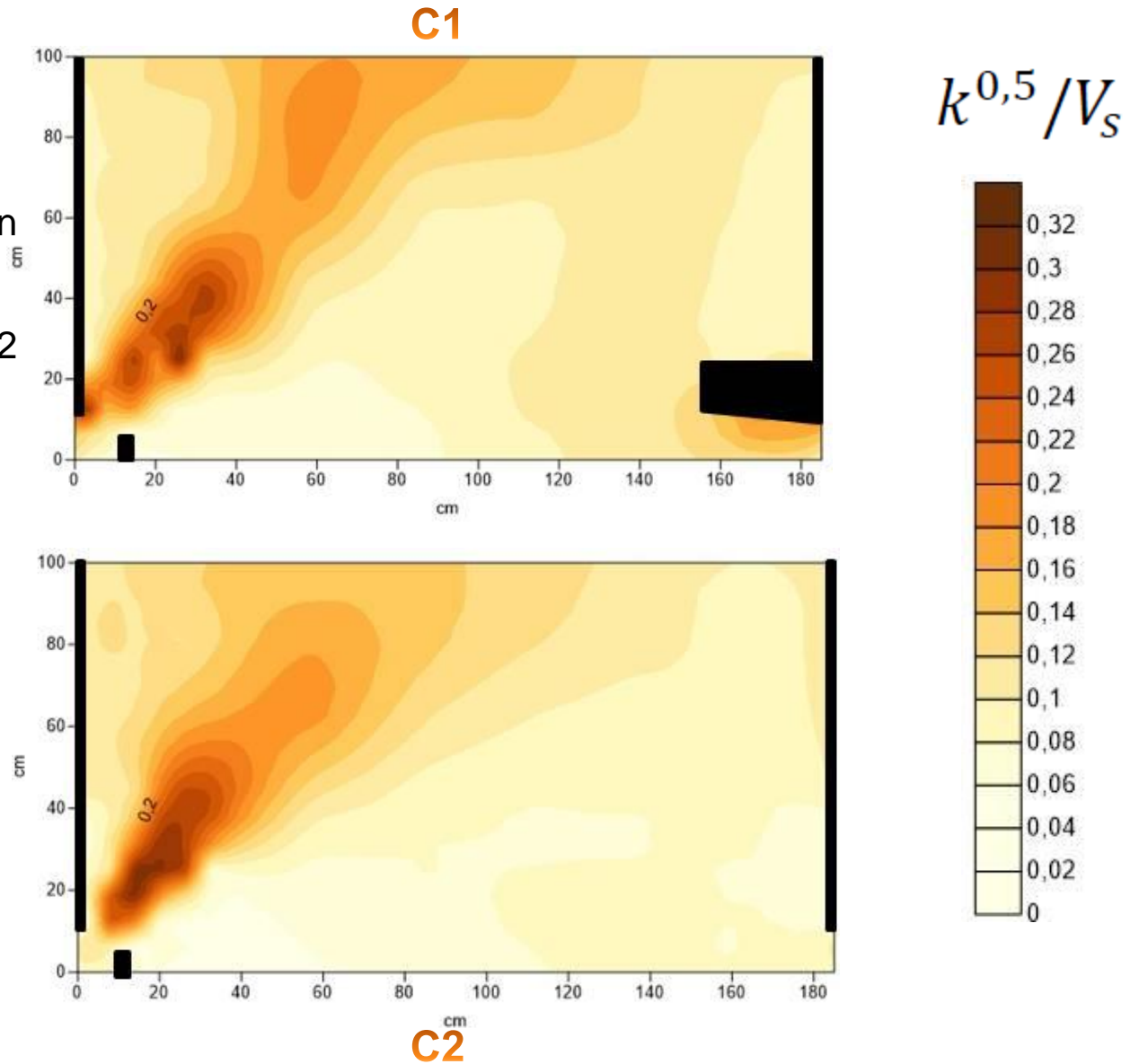
# RESULTS

## Hydraulics – TKE ( $k$ )

- $k$  has a higher mean magnitude in C1
- Max. values were found in h2 in C1

$$k = 1/2 (\overline{u'^2} + \overline{v'^2} + \overline{w'^2})$$

$$V_s = \sqrt{2g\Delta H}$$

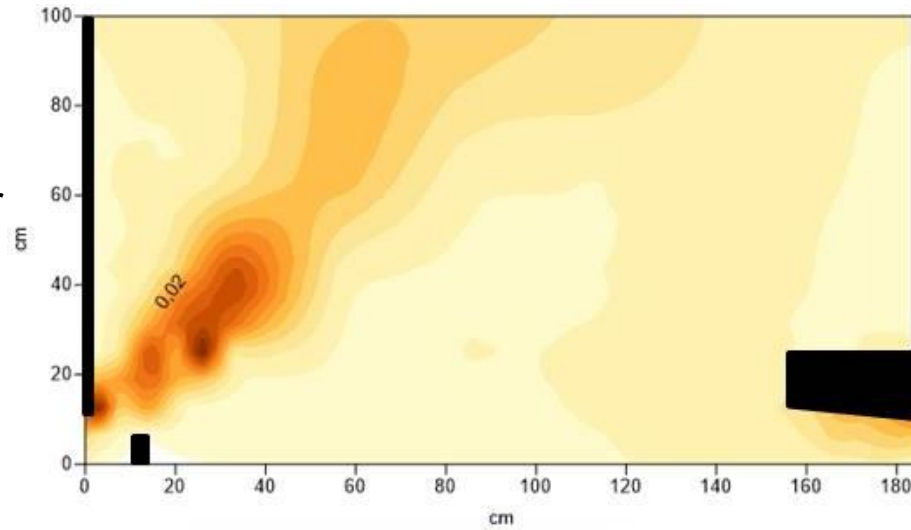


# RESULTS

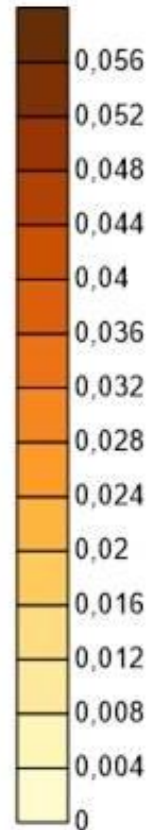
## Hydraulics – RSS

- RSS has a mean higher magnitude in C1
- Max. values were found in C1 at h2

C1

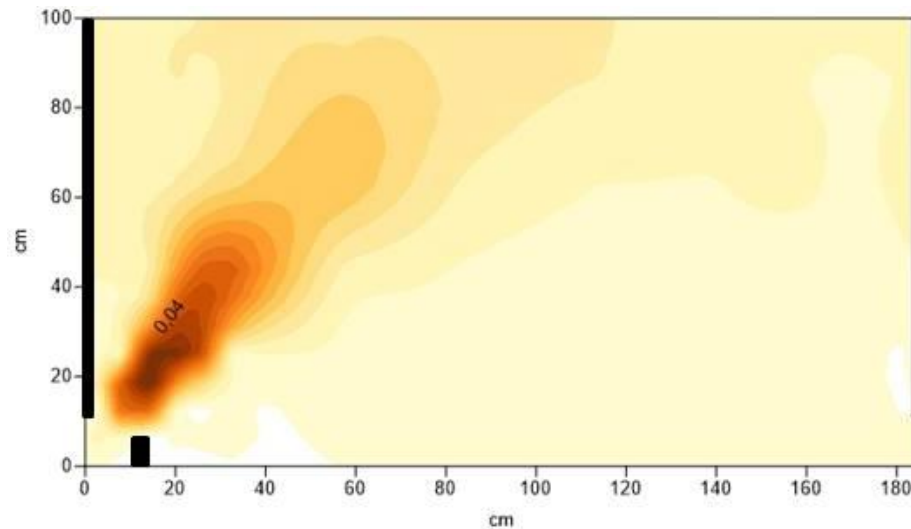


$\tau_{uv}/(\rho V_s^2)$



$$\tau_{uv} = -\rho \overline{u'v'}$$

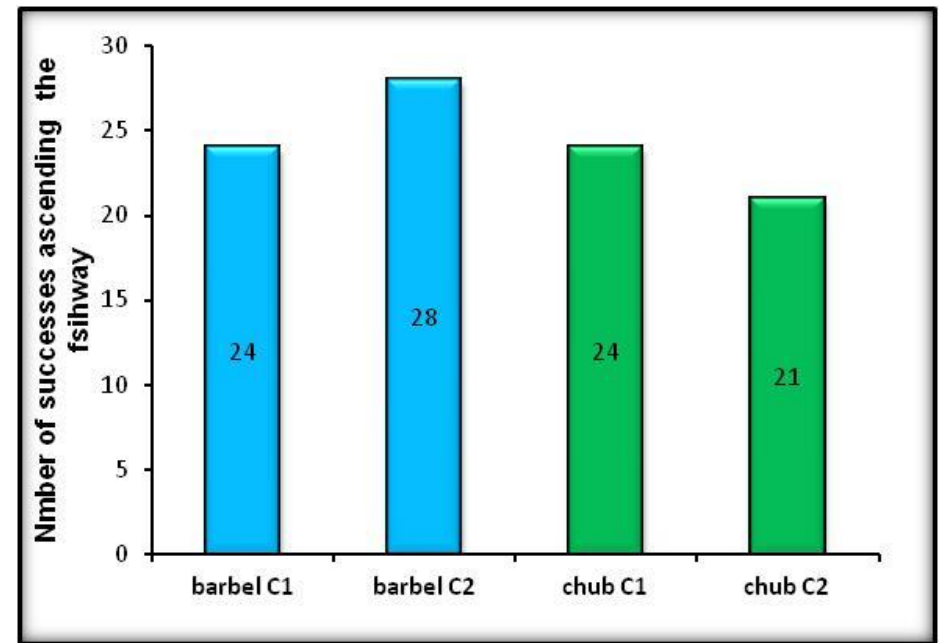
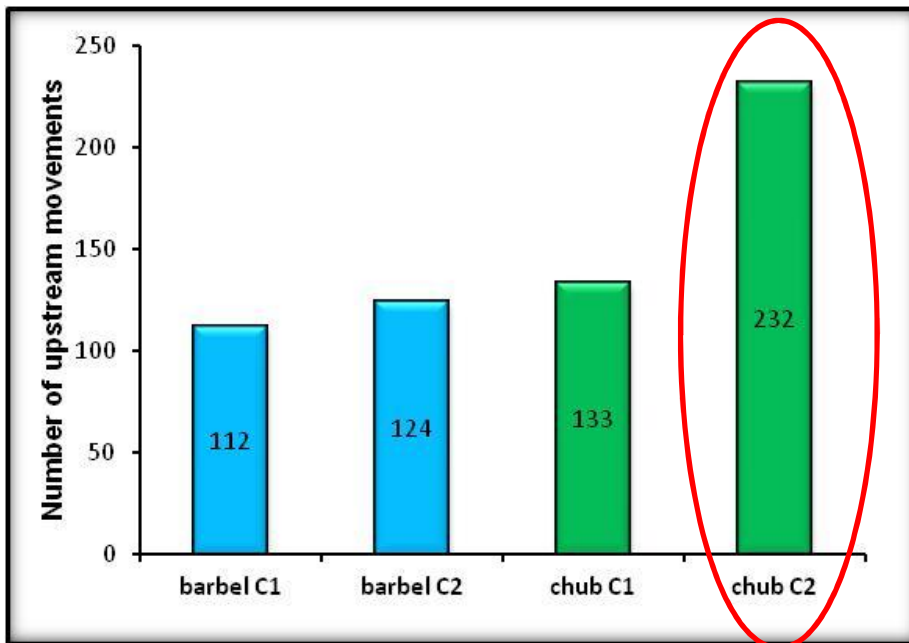
$$V_s = \sqrt{2g\Delta H}$$



C2

# RESULTS

## Fish trials

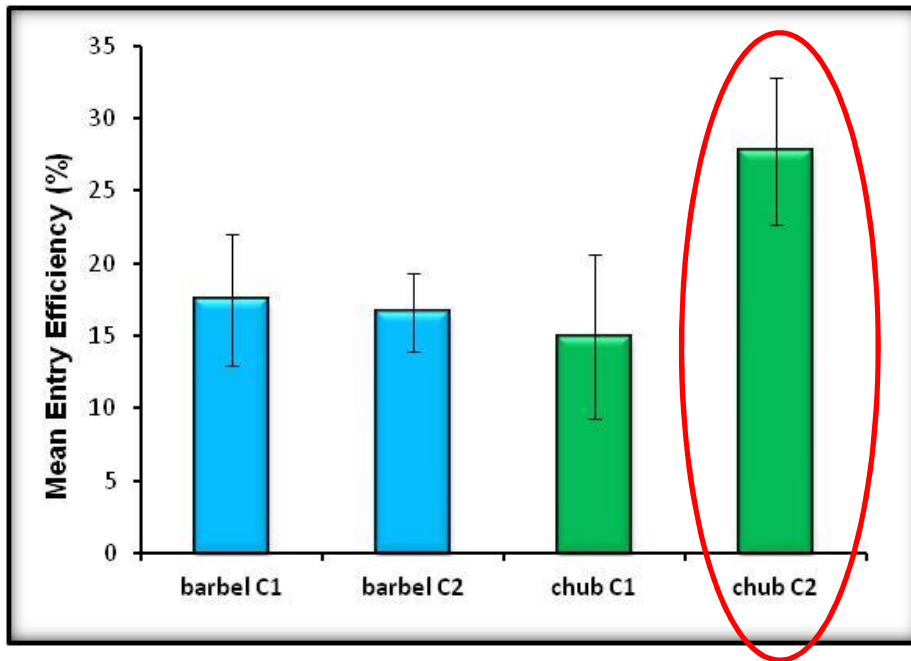


- Chub – C1 (36.4%) and in C2 (63.6%)
- Barbel – C1 (52.5 %) and in C2 (47.5%)

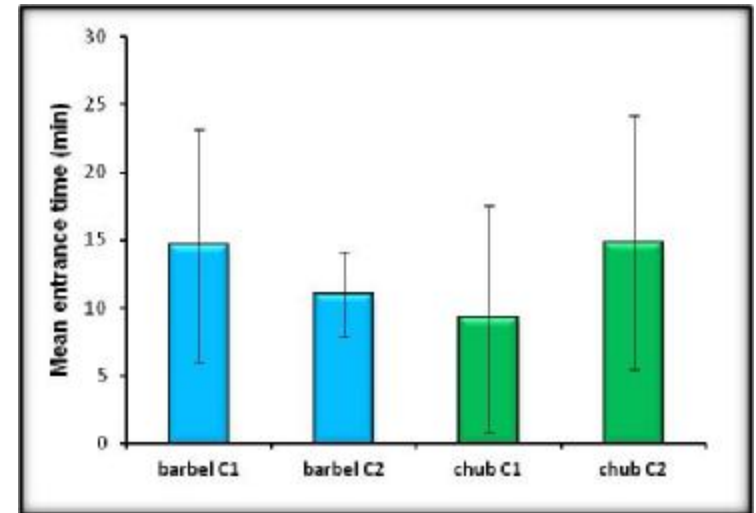
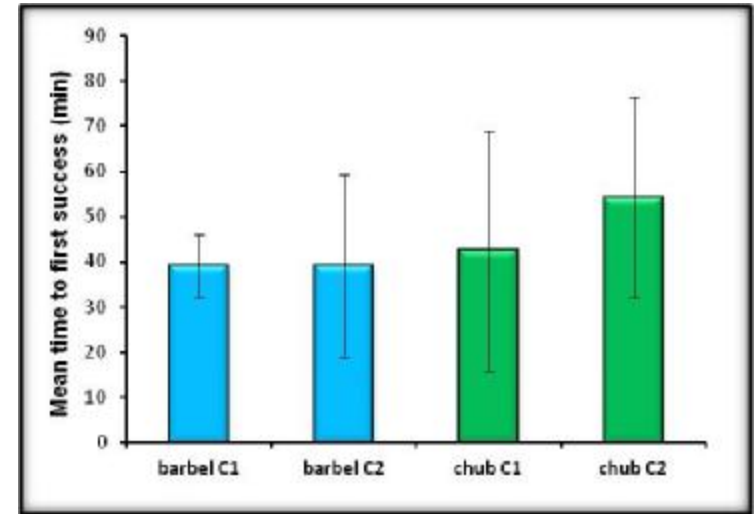
- No differences were detected

# RESULTS

## Fish trials



- Chub – C1 (15%) and in C2 (28%)
- Barbel – No differences detected



- No differences were detected

## CONCLUSIONS



- C2 requires lower discharge (26%) to operate for the same mean water depth
- C2 is a more cost-effective VSF design than C1
- C2 is a better option in areas where water resources are scarce
- C1 and C2 are equally suitable for cyprinids with different ecological traits
- C2 may be a better option for rheophilic stream-dwelling cyprinids in Mediterranean regions

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Thank you for your attention!



Questions?

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