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Item Type	event;event
Authors	Romão, Filipe;Quaresma, Ana L.;Branco, Paulo;Santos, José M.;Amaral, Susana;Ferreira, Maria T.;Viseu, Teresa;Katopodis, Christos;Pinheiro, António N.
Download date	2025-02-16 15:21:13
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Passage Performance of two Cyprinids with Different Ecological Traits in a Fishway with Distinct Vertical Slot Configurations

Filipe Romão
PhD Student
filipe.romao@tecnico.ulisboa.pt

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

CERIS
CIVIL ENGINEERING RESEARCH AND INNOVATION FOR SUSTAINABILITY
TÉCNICO LISBOA

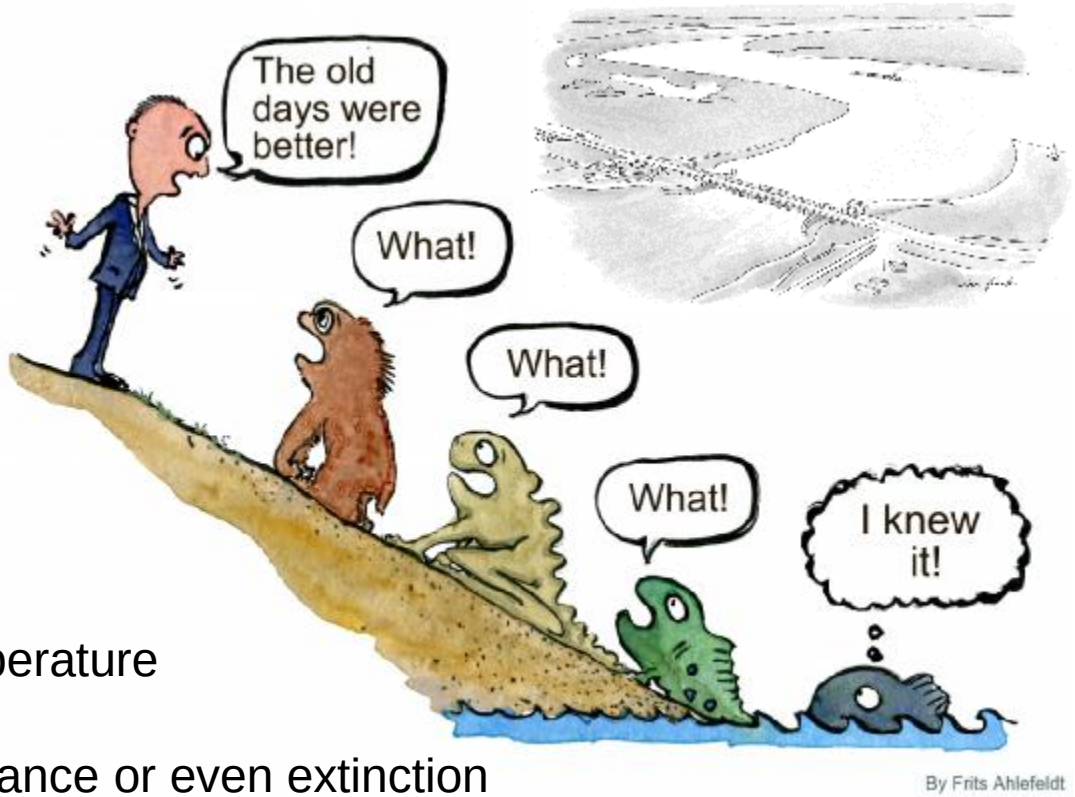
INSTITUTO SUPERIOR DE AGRONOMIA
Universidade de Lisboa

Katopodis Ecohydraulics Ltd.

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

INTRODUCTION

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

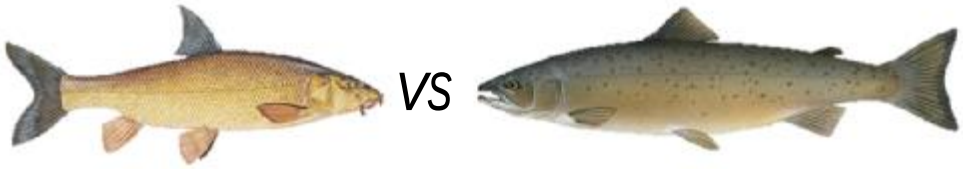


- Blocking migratory pathways
- Loss of habitat and degradation
- Isolating fish populations
- Changes in water quality and temperature
- Decline in fish diversity and abundance or even extinction

INTRODUCTION

Fish Passage Facilities

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

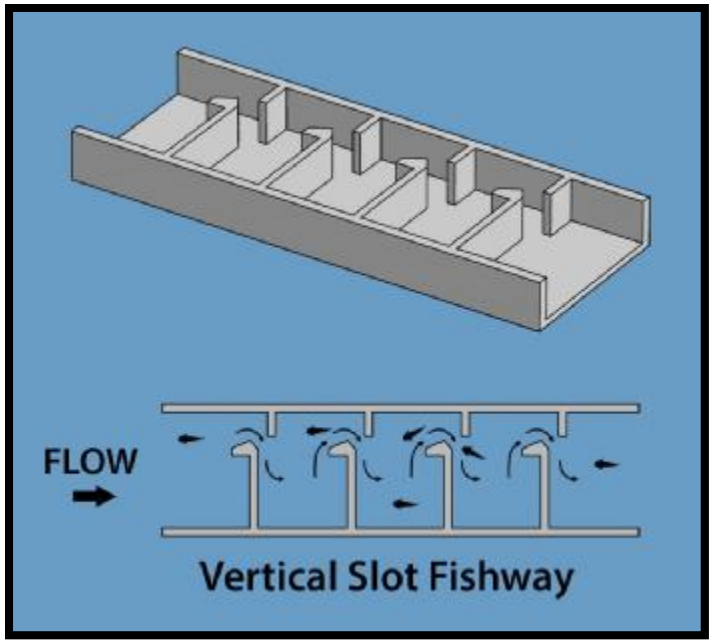


- Delay the migration of target species
- Lack of flow to attract fish to the entrance
- Unsuitable entrance location
- Inadequate maintenance
- Poor hydraulic conditions

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



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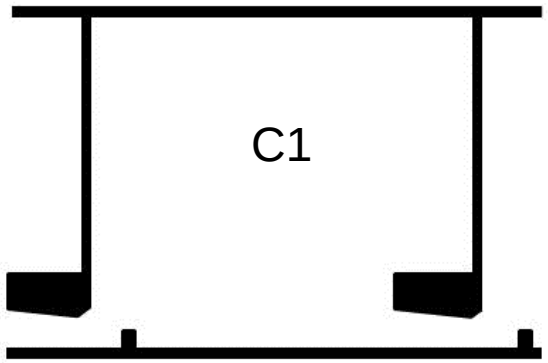
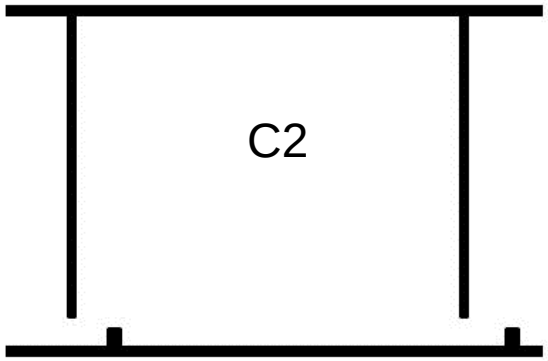
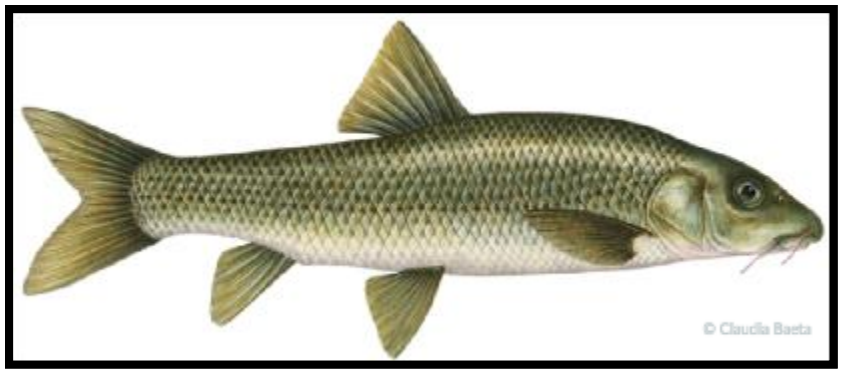
- Accomodate a wider range of species
- Reduce their operational costs

OBJECTIVE

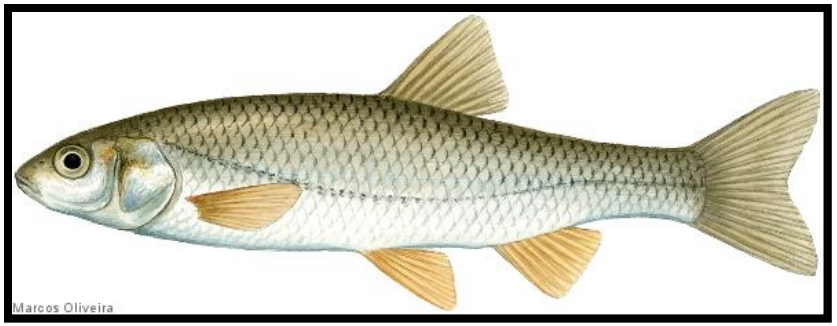
Assess the passage performance of two cyprinid species with different ecological traits in VSF with distinct slot configurations







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

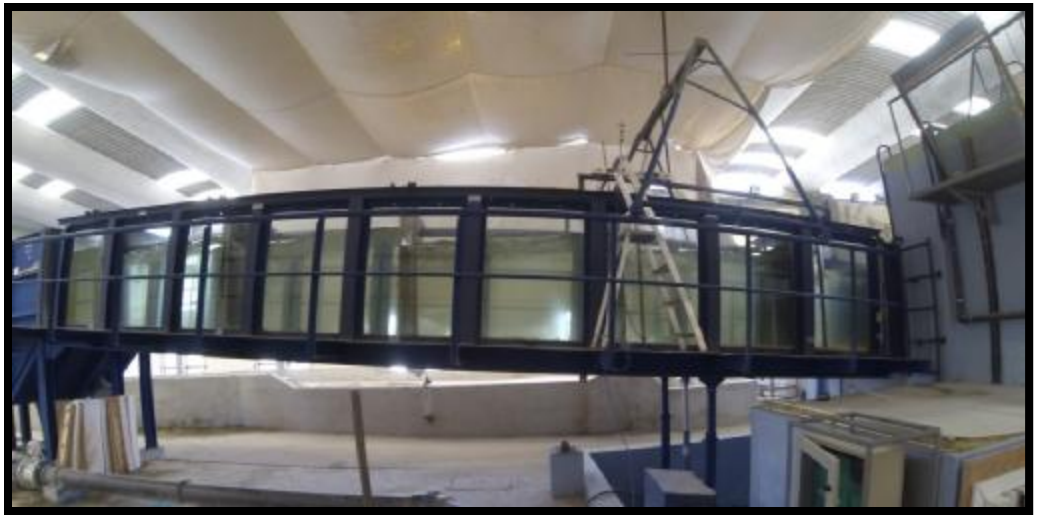


Iberian Chub
(*Squalius pyrenaicus*, Günther, 1868)

METHODS

Fish trials

- Acclimation period of 30 minutes
- Experiments lasted 90 minutes per trial (n=100)
- Visual and video monitoring

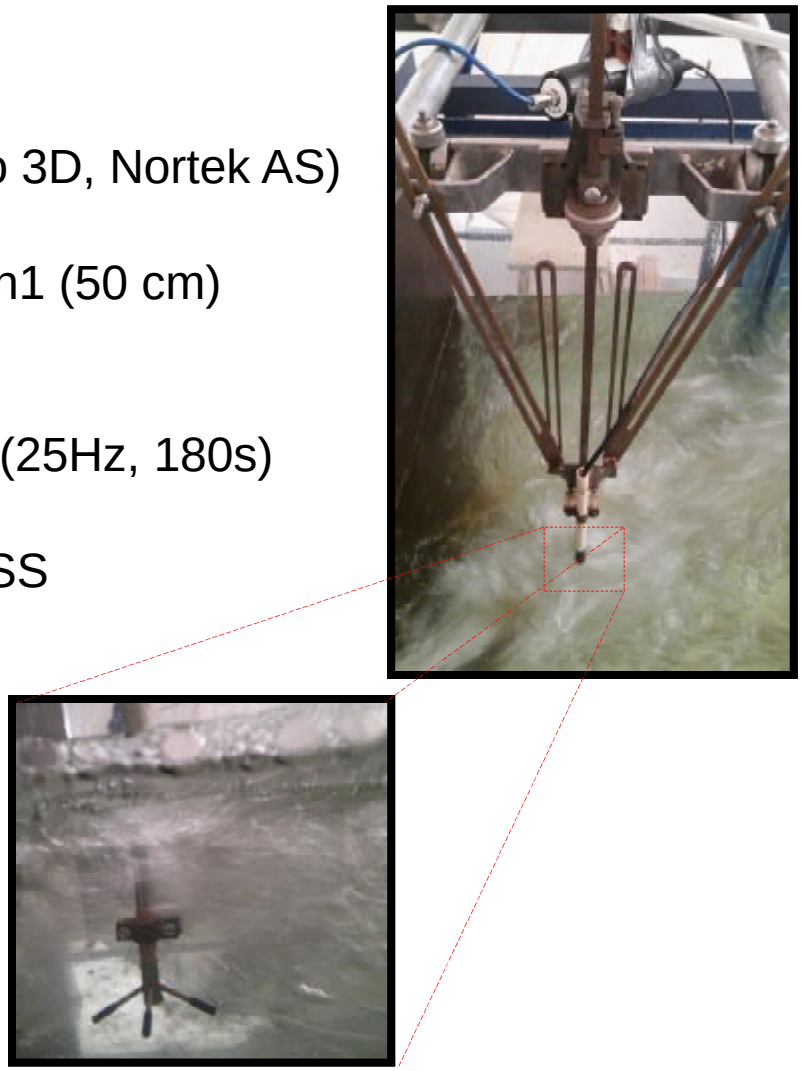


- Number of upstream movements
- Timing and number of successful fish ascending the fishway
- Entrance time
- Entry efficiency

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



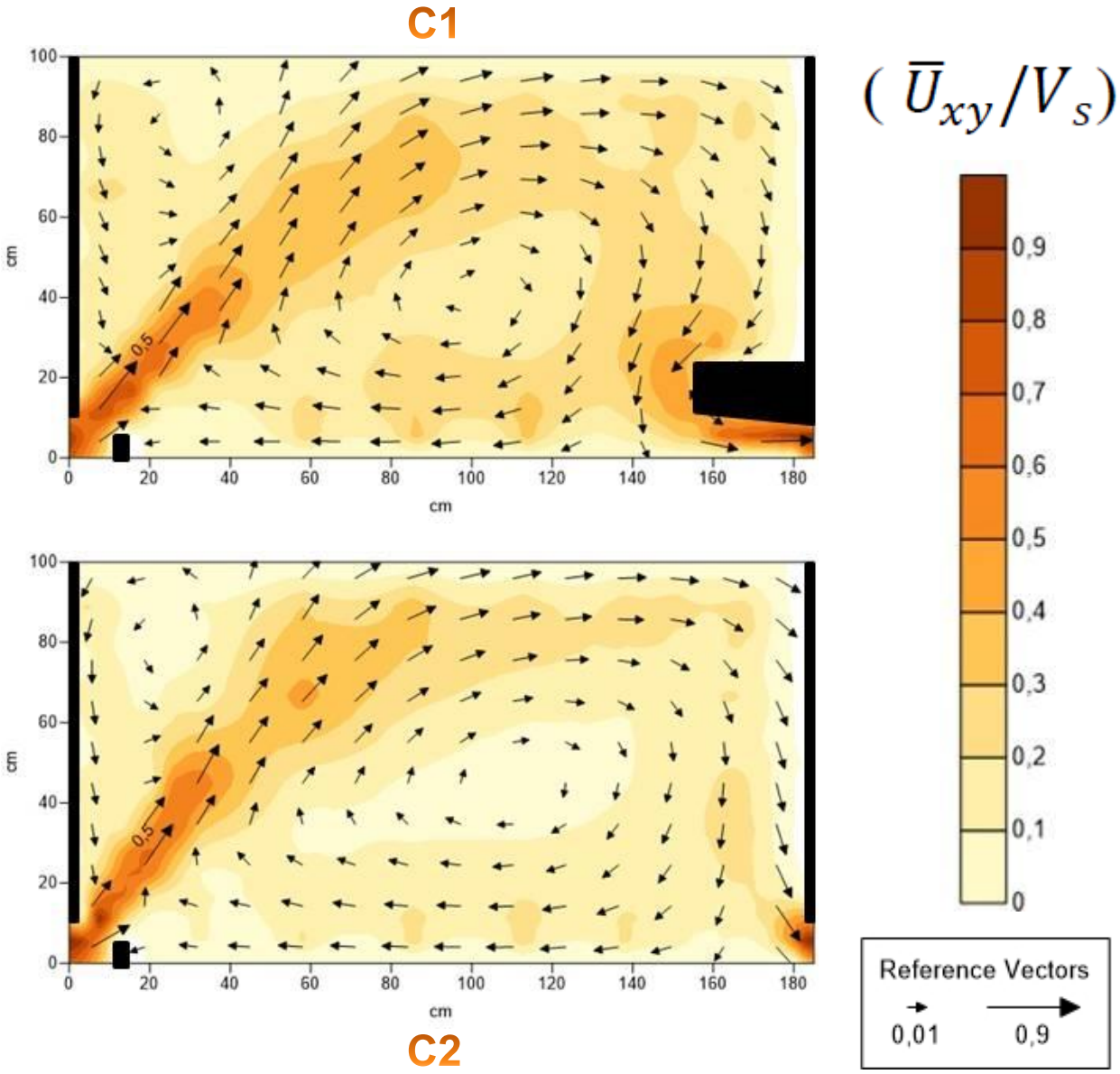
RESULTS

Hydraulics - Velocity

- Slot C1 – max. vel. 1.6 m.s^{-1}
- Slot C1 – mean vel. 0.51 m.s^{-1}
- Slot C2 – max. vel. 1.7 m.s^{-1}
- Slot C2 – mean vel. 0.37 m.s^{-1}

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

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



RESULTS

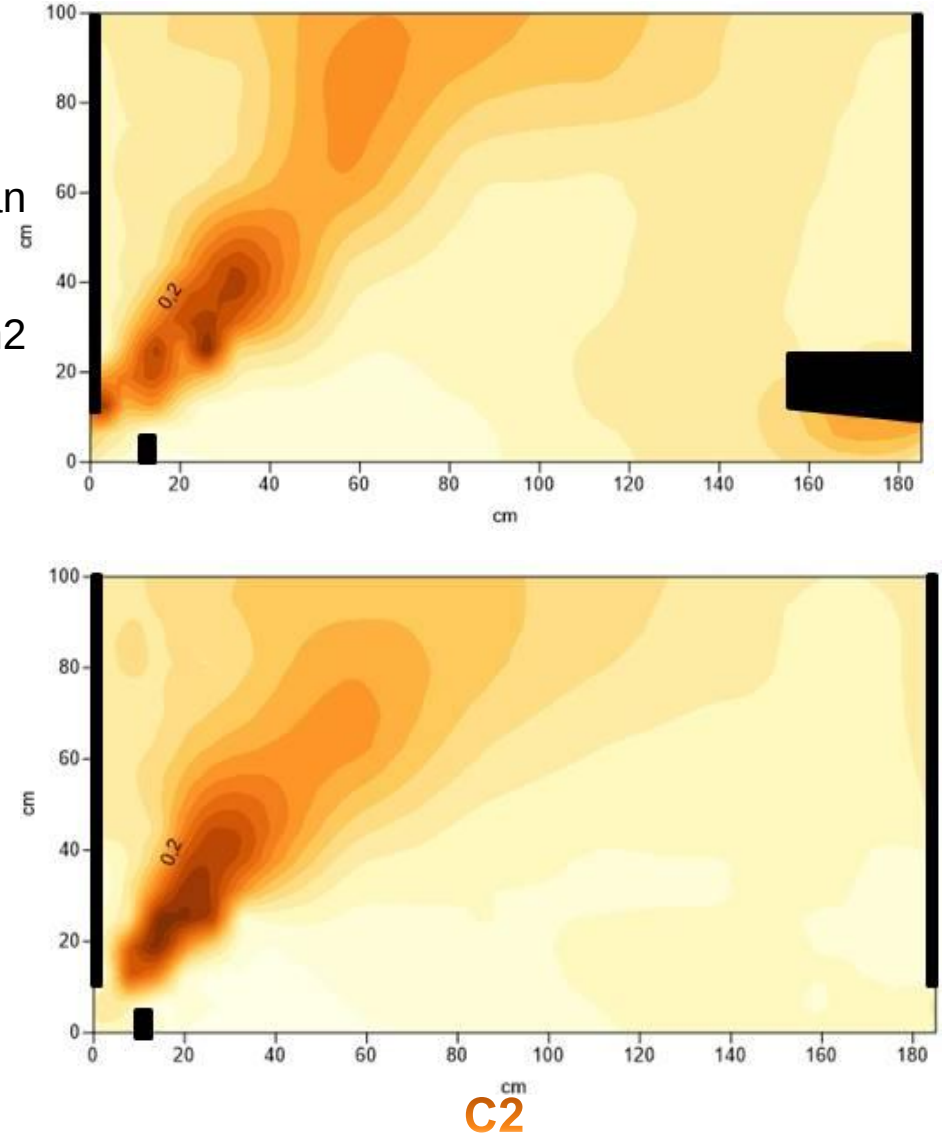
Hydraulics – TKE (*k*)

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

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

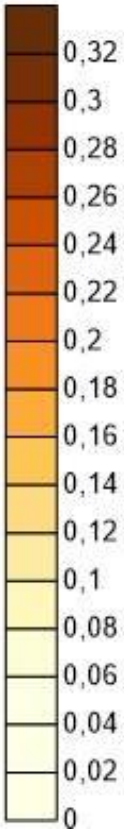
$$V_s = \sqrt{2g\Delta H}$$

C1



C2

$k^{0,5}/V_s$



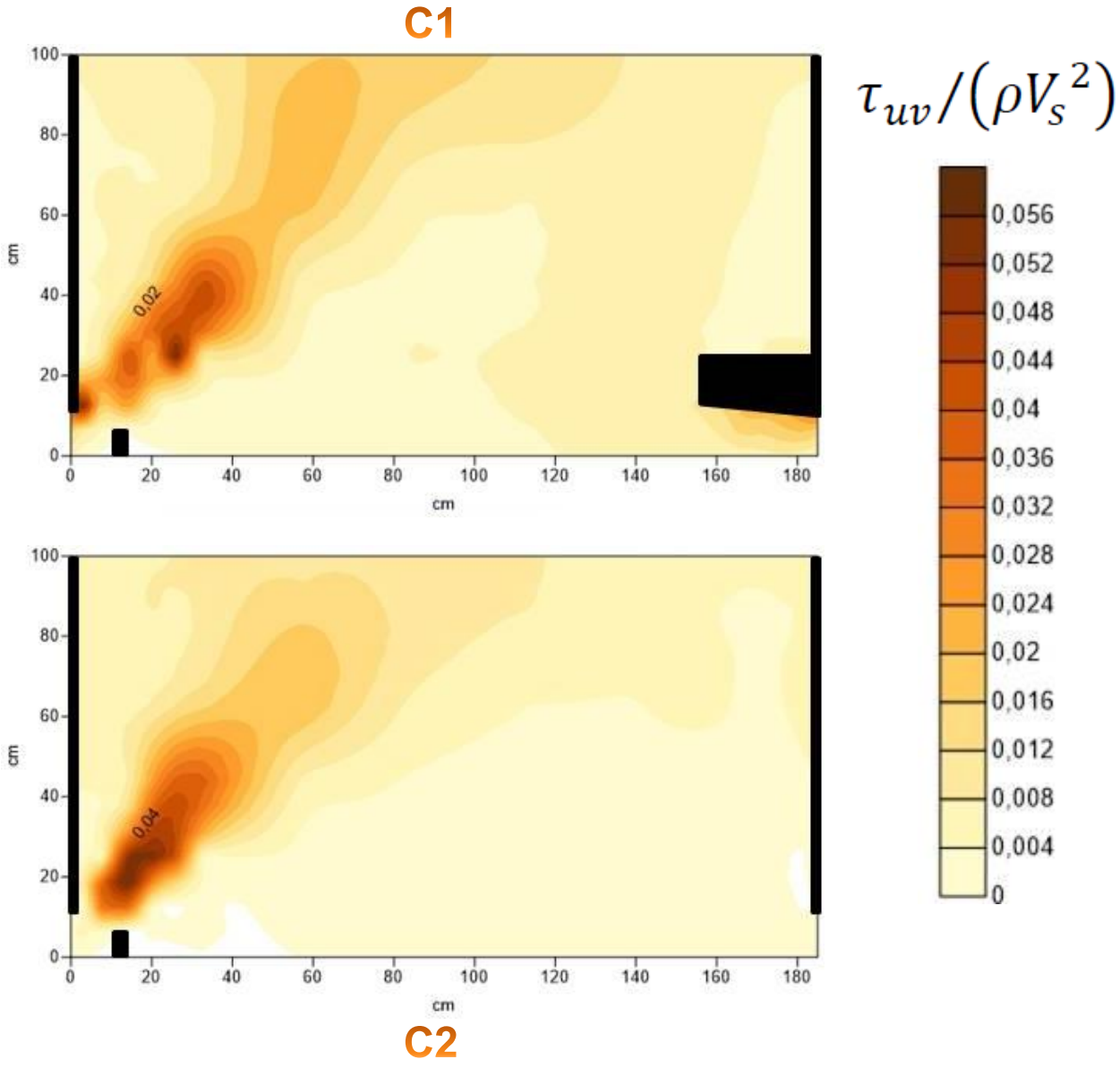
RESULTS

Hydraulics – RSS

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

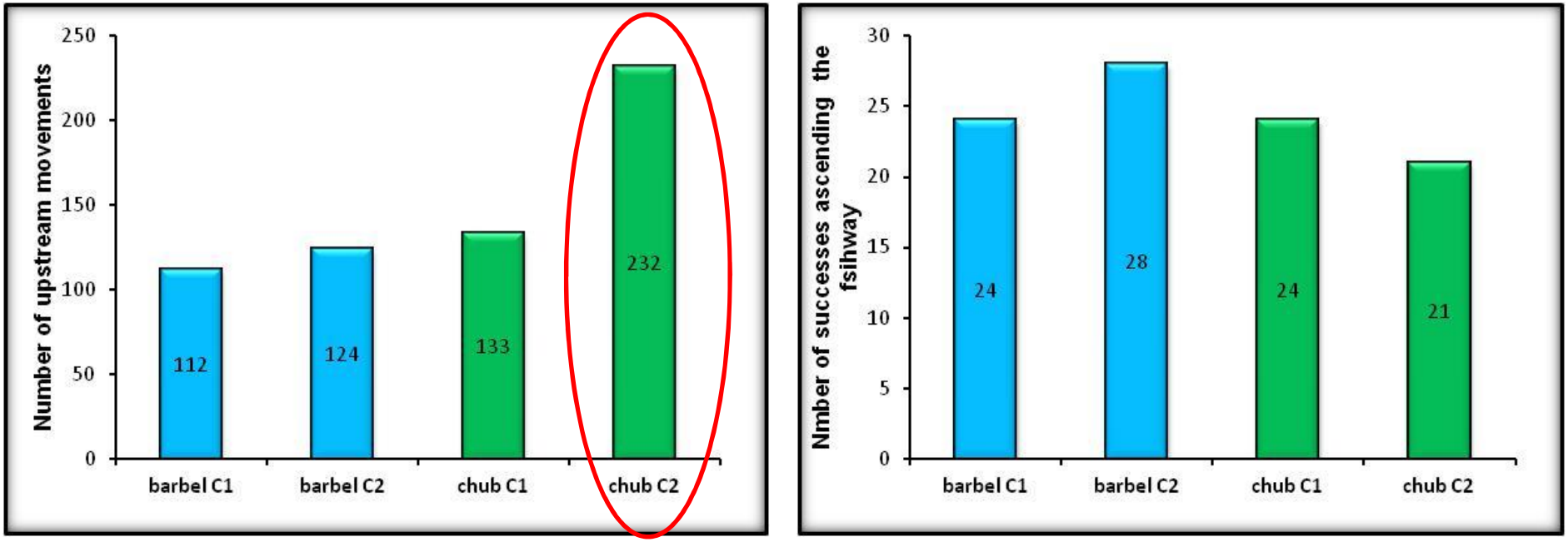
$$\tau_{uv} = -\rho \overline{u'} \overline{v'}$$

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



RESULTS

Fish trials



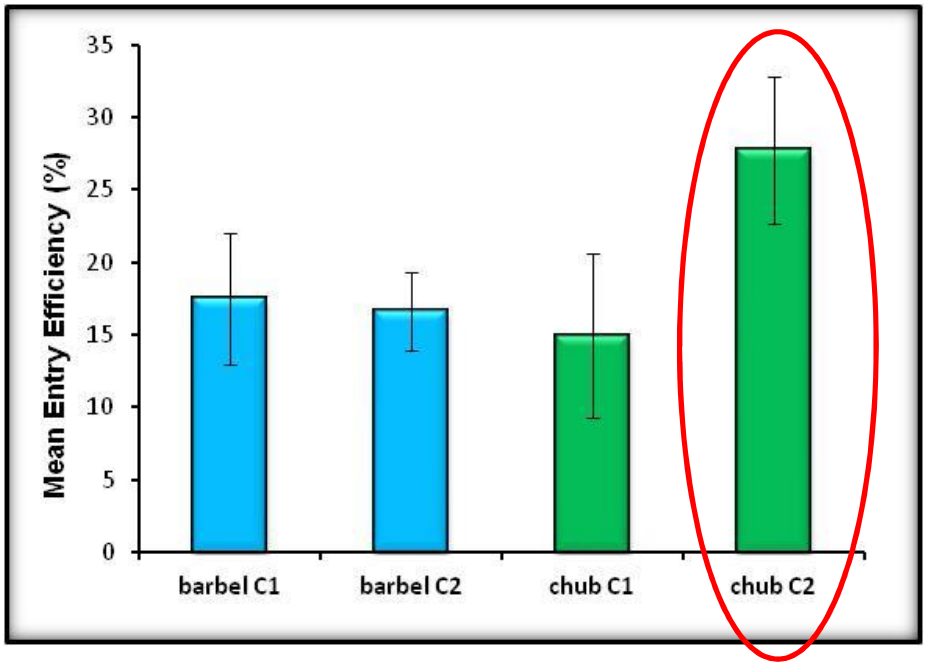
- Chub – C1 (36.4%) and in C2 (63.6%)
- Barbel – C1 (52.5 %) and in C2 (47.5%)

- No differences were detected

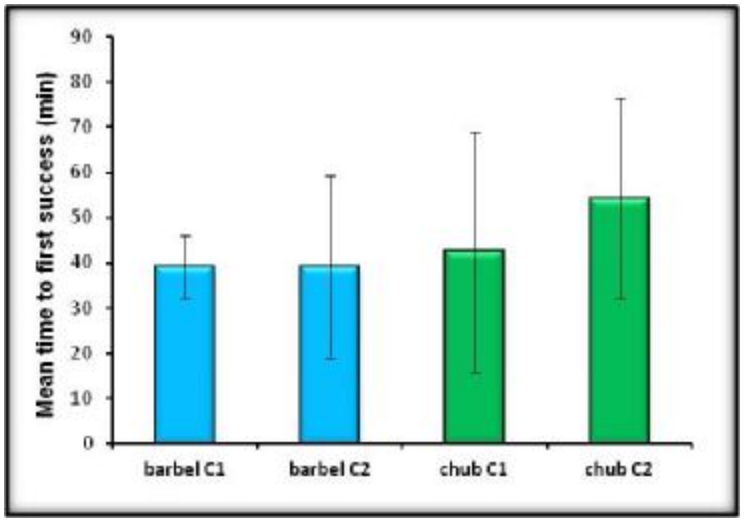
RESULTS

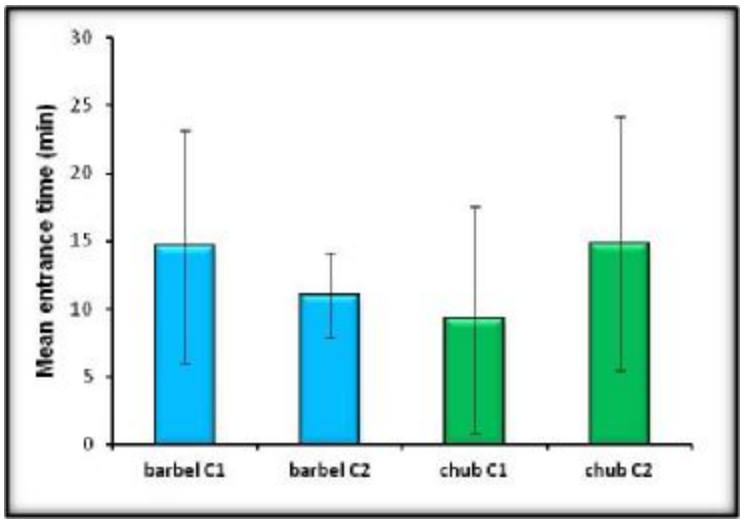
Fish trials

Barbel
Chub



- 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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Acknowledgments

Filipe Romão (PD/BD/52512/2014) and Ana Quaresma (SFRH/BD/87843/2012) and were supported by PhD grants from Fundação para a Ciência e Tecnolologia (FCT). Paulo Branco (SFRH/BPD/94686/2013) was funded by a post-doctoral grant from FCT and José Maria Santos was funded by post-doctoral grant (MARS/BI/2/2014) from the MARS project (http://www.mars-project.eu/). A special thanks to the staff of LNEC for all the support during the experiments.

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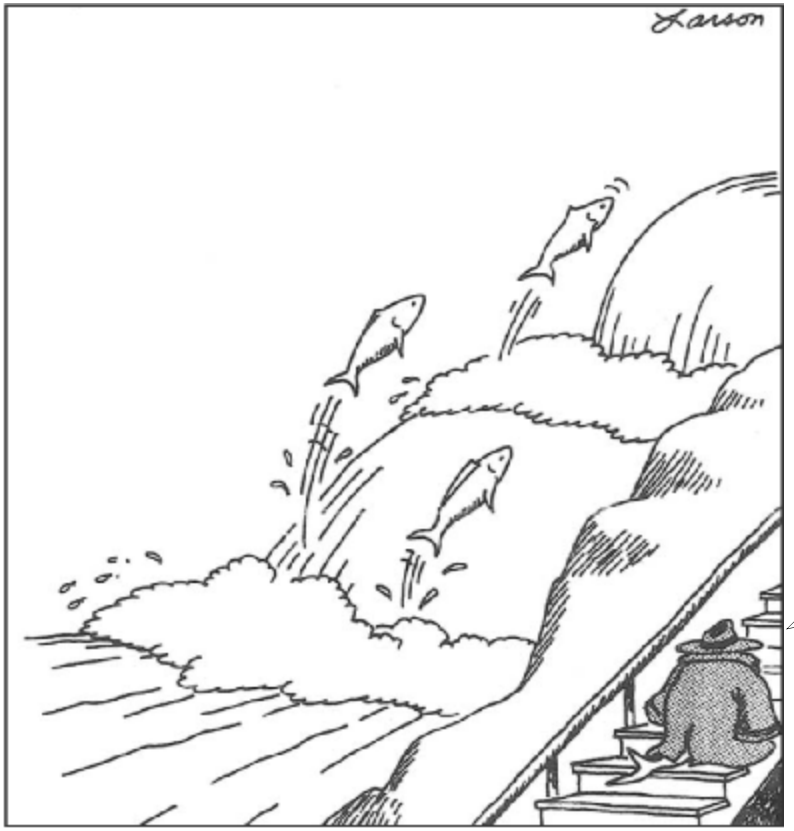

Filipe Romão
filipe.romao@tecnico.ulisboa.pt

António N. Pinheiro
antonio.pinheiro@tecnico.ulisboa.pt