Session B9: Influence of Biometric Parameters, Flow Condition and Water Temperature on Iberian Fish Sprinting Behavior: Volitionally Swimming Performance

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Influence of biometric parameters, flow condition and water temperature on Iberian fish sprinting behavior: volitionally swimming performance.

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0.- PRESENTATION
1.- INTRODUCTION
2.- OBJECTIVES
3.- METHODS
4.- RESULTS
5.- CONCLUSIONS
Who are we?

- Professors & PhD Students
- Collaborators

www.gea-ecohidraulica.org
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0. PRESENTATION

What do we do?

Public funding

- Research projects
- Projects: instream flows, environmental impact, river restoration, fish management, ...

Private funding

- Fish passage projects

Research

- Divulgation

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1. INTRODUCTION

- Knowing the swimming ability of fish is important to detect movement limitations through hydraulic structures:

<table>
<thead>
<tr>
<th>PROBLEMATIC</th>
<th>VELOCITY BARRIERS</th>
</tr>
</thead>
</table>

- FISHWAY (VT. SLOTS)
- FISHWAY (SUMERGED NOTCH)
- WALLS OF DAMS
- GAUGIN STATIONS
- BRIDGES FOUNDATIONS
- CULVERTS

- All these obstacles are collectively referred to VELOCITY BARRIERS
1. INTRODUCTION

VELOCITY BARRIERS

- Flow speed
- Slope
- Length
- ...

FISH BEHAVIOR

- Fish swimming performance
- Fish motivation

SUCCESS OR FAILURE
1. Knowing the **swimming performance** (maximum distance travelled, swimming speed and endurance) for two species of Iberian fish.

2. Determining the **influence** of biometric (length and mass), hydraulic (flow speed) and environmental (water temperature) **parameters** in this **swimming performance**.

3. **Applying this information** to detect velocity barriers in order to make optimum and effective **design of fish passes**, etc.
3. METHODS

MATERIAL

OPEN CHANNEL FLOW

STAGING AREA

SWIM SPEED FLUME

HEAD TANK
3. METHODS

MATERIAL

FISH SOURCE

ELECTROFISHING

NASE
*Pseudochondrostoma duriense*

BARBEL
*Luciobarbus bocagei*

MASS & LENGTH

BIOMETRIC RELATIONSHIP

\[
\text{Mass (g)} = a \times \text{Fork Length (cm)} + b
\]

For *L. bocagei* (Barbel):
- Mass = 0.320 \times \text{Fork Length} + 10
  - \( R^2 = 0.93 \)

For *P. duriense* (Nase):
- Mass = 0.070 \times \text{Fork Length} + 10
  - \( R^2 = 0.95 \)
### 3. METHODS

**MATERIAL MONITORING SYSTEM**

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIDEOCAMERAS</td>
<td>+ PIT (Passive Integrated Transponder)</td>
</tr>
<tr>
<td></td>
<td>+ TUNING CAPACITORS</td>
</tr>
<tr>
<td></td>
<td>+ POWER SUPPLY</td>
</tr>
<tr>
<td></td>
<td>+ SOFTWARE PROCESS DATA</td>
</tr>
</tbody>
</table>

= MONITORING SYSTEM
3. METHODS

**INSTRUMENTATION**

- **Distance**
  
- **Fatigue Time**
  
- **Ground Speed**
  
- **Absolute Speed**

- $D_{\text{max}} = \text{“PIT antenna”}$
- $F_T = \text{“PIT antenna”}$
- $U_g = D_{\text{max}}/F_T$
- $U_s = U_g + U_{\text{flow}}$

**EXPERIMENTATION**

[Diagram of Swim Speed Flume with various components labeled]
3. METHODS

INSTRUMENTATION TRIALS

FLOW VELOCITY FIELD

3.0 m/s

2.5 m/s

1.5 m/s

TEMPERATURE

18.5 °C

13.5 °C
3. METHODS

Maximum distance ($D_{\text{Max}}$)

$D_{\text{Max}}$, we used parametric Accelerated Failure Time models (AFT) that follow the form:

$$\ln (D_{\text{max}}) = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k + \varepsilon$$

where $D_{\text{Max}}$ is the maximum distance in meters, $\beta$s are coefficients, $X_i$s are the $k$-covariates, and $\varepsilon$ is the error term.

Swim speed–fatigue time relationship

Moving-point regression approach (Castro-Santos 2005; Castro-Santos et al. 2013). This approach fits successive models that follow the form:

$$\ln (T) = \beta_0 + \beta_1 C_{ps} + \beta_2 U_s + \beta_3 C_{ps} U_s + \varepsilon$$
4. RESULTS

INFLUENCE PARAMETERS

HYDRAULICS

Flow velocity

BIOMETRICS

Fork length

Mass

ENVIRONMENTAL

Water temperature

Performance parameters:

- Flow velocity
- Fork length
- Water temperature

Influence parameters:

- Mass

M: Mass
FL: Fork length
4. RESULTS

MAXIMUM DISTANCE

Flow velocity + Water temperature = DISTANCE
4. RESULTS

FATIGUE TIME-SWIM SPEED RELATIONSHIP

Castro-Santos et al., 2013
5. CONCLUSIONS

1.- Flow velocity and water temperature are the primary variables influencing the distance both species were able to travel.

2.- Performance of both species is similar at high flow velocities, with fish attaining absolute speeds superior to 20 BL_F\cdot s^{-1}. Nevertheless, barbel is a more resistant swimmer than nase at low flow velocities.

3.- Swimming endurance and speed greatly exceeds previously published observations for barbel and nase and are similar to what has been observed for salmonids.

4.- These data have important implications for restoring river connectivity, including design specifications for culverts and fishways.
THANKS !!!!