Jun 22nd, 11:10 AM - 11:25 AM

Session D1: Modelling the Efficiency of a Vertical Slot Fishway for Anadromous Fishes

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Presenter Information
Gabriela R. Cardoso, Ana F. Belo, Catarina S. Mateus, Carlos M. Alexandre, Esmeralda Pereira, Ana Telhado, João Ferreira, Felisbina Quadrado, Bernardo R. Quintella, and Pedro R. Almeida

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MODELLING THE EFFICIENCY OF A VERTICAL SLOT FISHWAY FOR ANADROMOUS FISHES

Gabriela R. Cardoso, Ana F. Belo, Catarina S. Mateus, Carlos M. Alexandre, Esmeralda Pereira, Ana Telhado, João Ferreira, Felisbina Quadrado, Bernardo R. Quintella & Pedro R. Almeida
Presenting you:

- Fishway monitoring results
- Modelling attraction efficiency results

For three anadromous fishes:

- **sea lamprey, Petromyzon marinus L.**
- **allis shad, Alosa alosa L.**
- **twaite shad, Alosa fallax (Lacépède, 1800)**
• Highly impounded;
• Açude-Ponte dam → first insurmountable obstacle for migratory fish species.
ANADROMOUS SPECIES THAT OCCUR IN THE RIVER MONDEGO

- River Mondego represents an important stronghold for anadromous species.
  - Gastronomic delicacies;
  - Professional fisheries development;
  - Local and regional incomes.
TARGET SPECIES

sea lamprey, Petromyzon marinus L.  
allis shad, Alosa alosa L.  
twaite shad, Alosa fallax (Lacépède, 1800)

Classified as Vulnerable (VU)
Classified as Endangered (EN)
Classified as Vulnerable (VU)

...in the Portuguese Red List of Threatened Species.

Threats:

- Loss of longitudinal connectivity;
- Overfishing and poaching;
- Water pollution;
- Destruction of ammocoetes beds through inert extraction.
AÇUDE-PONTÉ DAM AND A VERTICAL SLOT

MONITORING BUILDING

BASINS AND VERTICAL SLOTS

23 POOLS

DOWNSTREAM ENTRANCE

Flow discharge: 1-1.5 m³s⁻¹
Attraction flow: 1.5-2.5 m³s⁻¹

ATTRACTION CHANNEL

UPSTREAM EXIT

FLOW

125 m

DAM GATE

9 GATES

Flow discharge: 1-1.5 m³s⁻¹
Attraction flow: 1.5-2.5 m³s⁻¹

9 GATES
AÇUDE-PONTE DAM AND A VERTICAL SLOT

Optimal flow between: 5-100 m³/s
Efficiency for the target species is being evaluated using several methodologies, namely:

- visual counts;
- Tagging (radio-telemetry and PIT Tags).
• a system to capture and record images;
• Counts made *a posteriori*;
• Continuous recording.
The objective of this technique is to:

• Verify the effectiveness of the fishway;
• Identify specific behavior;
• Estimate the total biomass of fishes that transposed.
**METHODOLOGIES APPLIED: BRT Model**

**Explanatory-Predictive Models** → **Boosted Regression Trees (BRT)**

**Decision Trees**
- Relate the number of counts of the studied species with environmental predictors;
- Works with binary splits.

**Boosting**
- Compose of simple model combinations;
- Has a stochastic component.
**METHODOLOGIES APPLIED: BRT MODEL**

**Explicative-Predictive Models → Boosted Regression Trees (BRT)**

**Objectives**

- **Explicative**
  - Relate the number of individuals that pass the fishway with the environmental predictors.

- **Predictive**
  - Validate the model and predict a period during the migratory season when a big part of the individuals will use the fishway.
Predictors pre-selected to explain the movements of anadromous species:

- Temperature (°C)
- Specific Conductivity (µS/cm)
- Turbidity (FNU)
- Salinity (psu)
- Flow (m³/s)
- *Photoperiod
- Lunar Cycle
- Day Period

*Variables highly correlated ($r > |0.8|$) were excluded from the analysis.
set of data used

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0 600 1200 1800 2400 3000 3600 4200 4800 5400 6000 6600 7200 7800 8400

N

observed counts
observed counts accumulated (%)
RESULTS: BRT MODEL

Explicative part

- **Flow** (81%)
- **SpeCond** (10.8%)
- **Temp** (45.5%)
- **Flow** (42.6%)
- **Turb** (3.2%)
- **Temp** (3%)
- **Turb** (5.1%)
- **SpeCond** (5.4%)
- **DayPer** (1.7%)
- **LunFas** (6.4%)
- **DayPer** (0.4%)
**Results: BRT Model**

Performance of the models

<table>
<thead>
<tr>
<th>Cv correlation</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.55; $se = 0.093$</td>
<td>0.80</td>
</tr>
<tr>
<td>0.523; $se = 0.075$</td>
<td>0.90</td>
</tr>
</tbody>
</table>
RESULTS: BRT Model

Predictive part

---

N sea lampreys

- Observed counts
- Expected counts

6077
4717

N Alosa spp.

- Observed counts
- Expected counts

2835
2044
In 2014;

225 sea lampreys were captured by a fyke net;

Tagging with a Pit-tag;

Antenna installed in the last basin;

Allows to estimate the efficiency of the fishway for sea lamprey.
88% of the passages occurred at a lower flow ($<50 \text{ m}^3/\text{s}$).
RESULTS: COUNTS X RELEVANT PREDICTORS

![Graph showing the relationship between N sea lampreys and flow (m³/s) from 1 Apr 2013 to 31 May 2013. The graph highlights certain time periods with red circles.](image-url)
RESULTS: COUNTS X RELEVANT PREDICTORS

N Alosa spp.

Temperature (Cº)

Flow (m³/s)

time

N Alosa spp.
RESULTS: TRANPOSITION PATTERNS

- Measurements made from the video recordings;
- Length-weight relationship: \[ W = aL^b \]

2013
- 9611.53 kg

2014
- 25375.46 kg

Biomass input
Results: transposition patterns

- 2013: 14310.81 kg
- 2014: 6499.02 kg

Biomass input
Some conclusions...

• BRT models show that:
  • Dam discharges significantly influence the migratory behavior of sea lamprey and *Alosa spp.*;
  • The efficiency was limited during high discharge periods;
  • To *Alosa spp.* the temperature was so importante as flow to the response variation;
  • The pit-tag technique and the relation between data counts and predictors emphasizes the results of the BRT models.
SOME CONCLUSIONS...

Proposal for a measure management

In April

once a week

flow \leq 50m^3/s

Between April and May

MAXIMIZING FISHWAY EFFICIENCY
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- Coimbra fishway monitoring program  
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