Jun 20th, 4:50 PM - 5:10 PM

Attraction and Passage Efficiency of a Vertical-Slot Fish Pass for Sea Lamprey

Bernardo Quintella
C. S. Mateus
C. M. Alexandre
E. Pereira
A. F. Belo

See next page for additional authors

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Quintella, Bernardo; Mateus, C. S.; Alexandre, C. M.; Pereira, E.; Belo, A. F.; Oliveira, R.; and Almeida, P. R., "Attraction and Passage Efficiency of a Vertical-Slot Fish Pass for Sea Lamprey" (2017). International Conference on Engineering and Ecohydrology for Fish Passage. 4.
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Presenter Information
Bernardo Quintella, C. S. Mateus, C. M. Alexandre, E. Pereira, A. F. Belo, R. Oliveira, and P. R. Almeida

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ATTRACTION AND PASSAGE EFFICIENCY OF A VERTICAL-SLOT FISH PASS FOR SEA LAMPREY

Bernardo QUINTELLA, C.S. MATEUS, C.M. ALEXANDRE, E. PEREIRA, A.F. BELO, R. OLIVEIRA, P.R. ALMEIDA
Outline

• Sea lamprey background
• Coimbra fishway (River Mondego)
• Attraction efficiency
  • Lamprey counts / statistical model
• Passage efficiency
  • PIT tagging
• Pre & post operational monitoring
• Conclusions
Sea lamprey background

• Anadromous species (1.2 m length; 2.3 kg weight)
• Worldwide distribution - both sides North Atlantic
• “Vulnerable” (Portuguese Red List, 2005)
• “Least concern” (Global IUCN Red List, 2014)
  • Pop. trend: stable
Socio-economic relevance

Gastronomy festivals

Cultural Heritage
Lamprey Brotherhood
Threats - commercial fishing

FYKE net

Drift TRAMMEL net

PESQUEIRAS (traps)

Hoop net
Threats – obstacles to migration


MINHO – 174 km (69%) habitat loss
DOURO – 496 km (96%) habitat loss
TEJO – 483 km (76%) habitat loss
GUADIANA – 516 km (80%) habitat loss

80% of the habitat lost in the Iberian Peninsula
Available freshwater habitat for anadromous fish: **15 km**
Available freshwater habitat for anadromous fish: \(~60\) km

- 4x habitat increment in River Mondego;
- 5% National level
Coimbra Fishway

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>125m</td>
</tr>
<tr>
<td>Nº pools</td>
<td>23</td>
</tr>
<tr>
<td>Pool dim.</td>
<td>4.5x3.0m</td>
</tr>
<tr>
<td>Pool depth</td>
<td>1.5-2.0m</td>
</tr>
<tr>
<td>Flow discharge</td>
<td>1-1.5 m³s⁻¹</td>
</tr>
<tr>
<td>Attraction flow</td>
<td>+0.5-1.0 m³s⁻¹</td>
</tr>
<tr>
<td>Current veloc. (slots)</td>
<td>1.2-1.5 ms⁻¹</td>
</tr>
<tr>
<td>Dissipated power</td>
<td>&lt;150 Watt/m³</td>
</tr>
</tbody>
</table>

Main target species:

- Sea lamprey
- Allis shad
Attraction efficiency - methods

- 4 spawning seasons 2013-2016
- Continuous video recording system
- Sea lamprey counts made a posteriori
- Statistical models - relate environmental predictors with counts
Attraction efficiency - counts

Total/year
- 2013 = 8,333
- 2014 = 21,977
- 2015 = 9,998
- 2016 = 9,414
Attraction efficiency - counts

Set of data used (subsample - peak of spawning migration)

Lamprey counts (cumulative %)

Date

2013
80%

2014
80%

2015
80%

2016
80%
Attraction efficiency - predictors

Pre-selected predictors to relate with the sea lamprey counts:

- Water **temperature** (Temp - °C)
- Specific **Conductivity** (SpeCon - µS/cm)
- **Turbidity** (Turb - FNU)
- Discharge **Flow** (Flow - m³/s)
- **Lunar Cycle** (LunCyc – Full Moon; Last Quarter; New Moon; First Quarter)
- **Day Period** (DayPer - Night, Sunrise; Day; Sunset)
- **Photoperiod** (Phot - Day length in hours)

N.B: Variables highly correlated (r > |0.8|) were excluded from the analysis
## Attraction efficiency – BRT model

### Predictors explanatory percentages:

<table>
<thead>
<tr>
<th>Year</th>
<th>Flow</th>
<th>Conductivity</th>
<th>Turbidity</th>
<th>Temperature</th>
<th>Day period</th>
<th>Lunar cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>81.0%</td>
<td>10.8%</td>
<td>3.2%</td>
<td>3.0%</td>
<td>1.7%</td>
<td>0.4%</td>
</tr>
<tr>
<td>2014</td>
<td>28.6%</td>
<td>8.5%</td>
<td>14.8%</td>
<td>33.6%</td>
<td>8.9%</td>
<td>5.7%</td>
</tr>
<tr>
<td>2015</td>
<td>6.3%</td>
<td>23.2%</td>
<td>33.9%</td>
<td>25.1%</td>
<td>2.9%</td>
<td>8.3%</td>
</tr>
<tr>
<td>2016</td>
<td>34.5%</td>
<td>13.7%</td>
<td>17.0%</td>
<td>12.7%</td>
<td>21.8%</td>
<td>21.8%</td>
</tr>
</tbody>
</table>

- **2013**: $R^2 = 0.80$
- **2014**: $R^2 = 0.8$
- **2015**: $R^2 = 0.87$
- **2016**: $R^2 = 0.86$
Flow: low flows increase the attraction efficiency for sea lamprey
**Flow:** low flows increase the attraction efficiency for sea lamprey

- **400 m$^3$/s** (High flow)
- **20 m$^3$/s** (Low flow)
Temperature: peak of activity from 15-19 °C
Attraction efficiency – BRT model

Day period: nocturnal activity pattern during fishway negotiation
Passage efficiency – PIT tagging

Capture–Fyke net

PIT tagging

Tagged lampreys release site

15 km

~2 days migration time

Colimbra Dam (fishway)

PIT antenna
#225 sea lampreys **PIT tagged** in April 2014
PIT tagging 2015 spawning season

#103 sea lampreys PIT tagged Jan-Apr 2015
Pre a post operational monitoring

Pre a post operational monitoring – lamprey abundance

Electric fishing monitoring
#34 sampling stations

Ammocoete survey

Coimbra Fishway

downstream  upstream
Pre a post operational monitoring – lamprey abundance

Ammocoete survey

CPUE (nº lampreys/hour)

Year


¢ Downstream fishway
¢ Upstream fishway
Conclusions

• Attraction efficiency of Coimbra fishway for sea lamprey is mainly conditioned by flow and temperature;

• It is possible to improve the attractiveness of the fishway through flow regulation (3 large dams upstream) during a certain period of the spawning migration (water reach 14-18°C temperature) and night period;

• Passage efficiency can be improved but 30% was enough to promote a 38x increment in ammocoete abundance in the upstream stretch.
Acknowledgements

Funding:

- Coimbra fishway monitoring program
  (http://apambiente.wix.com/pppeixescoimbra)

- PROMAR project - Habitat restoration for diadromous fish in River Mondego
  (http://www.rhpdm.uevora.pt/)