Fish Passage Studies I: Sea Lamprey Behaviour During Negotaiton of Technical and Nature-Like Fish Passes

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Sea lamprey behaviour during negotiation of technical and nature-like fish passes

Study site: River Mondego (Central Portugal) – 234 km, 6645 km², mean river discharge 88 m³/s

Available habitat for anadromous fish: ca. 95 km (66 km freshwater)

6 fish passes: (○) 2 vertical slot + (●) 4 nature-like fish ramps
Vertical slots fish pass
 Açude-Ponte dam (Coimbra) – 6.2 m height; 45 km from the river mouth

<table>
<thead>
<tr>
<th>Fish pass characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Nº pools</td>
</tr>
<tr>
<td>Pool dim.</td>
</tr>
<tr>
<td>Pool depth</td>
</tr>
<tr>
<td>Flow discharge</td>
</tr>
<tr>
<td>Attraction flow</td>
</tr>
<tr>
<td>Water velocity (slots)</td>
</tr>
<tr>
<td>Dissipated power</td>
</tr>
</tbody>
</table>
**Fish pass characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>20.4 m</td>
</tr>
<tr>
<td>Width</td>
<td>10 m</td>
</tr>
<tr>
<td>Average slope</td>
<td>7%</td>
</tr>
<tr>
<td>Nr. stone blocks rows</td>
<td>10</td>
</tr>
<tr>
<td>Dist. between rows</td>
<td>1.4 m</td>
</tr>
<tr>
<td>Dist. between blocks</td>
<td>1.4 m</td>
</tr>
<tr>
<td>Water depth</td>
<td>0.3 – 1.0 m</td>
</tr>
<tr>
<td>Flow discharge</td>
<td>Variable</td>
</tr>
<tr>
<td>Attraction flow</td>
<td>Variable</td>
</tr>
<tr>
<td>Water velocity (slots)</td>
<td>&lt; 2.0 ms⁻¹</td>
</tr>
</tbody>
</table>

**Palheiros weir (low flow condition / Sep2015)**

**Palheiros weir (77 m³/s, Mar2016)**
Palheiros weir fish pass (construction final phase)
Mean daily flow and temperature (Jan-May 2015 and 2016)

[Graph showing mean daily flow and temperature trends from January to May 2015 and 2016, with a notable increase in flow and temperature in March 2016.]
cEMG Telemetry

#9 sea lampreys tagged with cEMG R11-18 transmitters (Lotek).

The cEMG transmitters were surgically implanted according to Quintella et al. (2009).

Release in the 2nd pool of the fish pass at the Coimbra Açude-Ponte dam.

cEMG values were standardized (each individual record was divided by the EMG rest value).
RADIO TELEMETRY

#20 sea lampreys tagged with F2020 radio transmitters (ATS) were released downstream from the Açude-Ponte dam (Coimbra) – Feb-Mar 2013

#26 sea lampreys tagged with F2020 radio transmitters (ATS) were released downstream from the Palheiros weir – (#10 – 24Feb2016; #16 – 7Apr2016)

Location was manually detected on a weekly basis until July (2013), and every 2-3 days until July (2016).
Electromyogram telemetry (EMG) proved to be a good method to assess swimming behaviour of upriver migrating sea lamprey.


**Rapid flow stretches (BW):**
- riffles with complex turbulent flow (0.8-2.9 m s⁻¹)

**Slow flow stretches (FS):**
- 1000-m run type reaches (< 0.5 m s⁻¹)

*BW = Blockstone Weir
FS = Free Stretch*
Behaviour of sea lampreys during negotiation of the vertical slots fish pass at the Coimbra Açude-Ponte dam
Downstream of Açude-Ponte dam (Coimbra)

N=3
Activity: 94%

Downstream of Palheiros weir

N=3
Activity: 41%
Swimming Effort (cEMG Classes)

N=3
Activity: 58%
Negotiation of Coimbra Açude-Ponte dam fish pass

Negotiation of Palheiros fish ramp

N=6
Activity: 71%

N=3
Activity: 46%
Radio telemetry results

33% of the sea lampreys successfully negotiated the Coimbra Açude-Ponte dam (10 – 22 days)
Radio telemetry results

42% of the sea lampreys successfully negotiated Palheiros weir (24h – 26 days)
Some sea lampreys turned back after reaching the upstream end of the Palheiros weir fish pass.

It is the less demanding stretch of the fish pass;

This behaviour was also observed in the technical fish pass at Coimbra Açude-Ponte dam.
Final remarks

Sea lampreys present a much higher level of activity trying to negotiate the Coimbra Açude-Ponte dam (94%), comparatively to what happens in the Palheiros weir (47%);

The swimming effort during the negotiation of the nature-like fish pass (46%) is lower when compared to the negotiation of the technical fish pass (71%);

Sea lampreys successfully negotiated the technical fish pass (33%) and of the nature-like fish pass (42%);

Sea lamprey seemed to get suspicious when water velocity is reduced inside fish-passes.
THANK YOU!

Acknowledgements: