Session C7: Tricky Little Lampreys! Efficacy of an Unmodified and Modified Super-Active Baffle Fish Pass for European River Lamprey (Lampetra Fluviatilis)

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Presenter Information
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Tricky little lampreys! Efficacy of an unmodified and modified super-active baffle fish pass for European river lamprey (Lampetra fluviatilis)

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Effective fish passes?

- Several types of fish pass, technical & nature-like, work adequately for fusiform morphotypes (Bunt et al., 2012), but often perform poorly for anguilliform morphotypes, including upstream-migrating lampreys, with relatively poor swimming capacity.
- Lab’ mechanistic studies (e.g. Kemp lab studies) + full-scale field studies
- Foulds & Lucas (2013): two technical fish passes (pool & weir, Denil) - extreme inefficiency for river lamprey (5.0% and 0.0% passage efficiency).
- But….. at Geesthacht double-vertical slot pass (Elbe, Germany, 0.10 m drops 9-m long basins, 1% slope), 88% of river lamprey “used” the pass (Adam, 2012).

Larinier super-active baffled fish passes

- Chevron baffles create relatively fast and slow lanes for upstream passage
- Now UK’s preferred technical pass (by # installed) for wide range of species – untested for lampreys

- Lampreys - positively thigmotactic, serpentine - exploit crevices
- Modular “Eel tiles” with projecting ‘bosses’
- Aim: Is a (modified) single-flight super-active baffle fish pass effective for adult river lamprey?
Methods: Study site

• Buttercrambe, 20-m wide flow-gauging weir
• Part of Humber river system, sustains one of UK’s main river lamprey populations.
• 2013-2014: fish pass (15% slope) before modifications, 2014-2015: after (with wall-mounted tiles)
• Lamprey for tests trapped, tagged and released 150 m d/s Buttercrambe.
PIT telemetry

- Lamprey sedated. Length measured. 32 mm PIT tag implanted.
- HDX PIT system, 13 read-write cycles s\(^{-1}\)
- **Unmodified pass**: 1 antenna inside entrance, 1 at exit
- **Modified pass**: 4 antennae; open-channel entrance + exit; inside contiguous wall-mounted tiles (entrance + exit); tile antennae = deliberately low range ensuring within-tile detection only
- Date + time, antenna number and unique code logged as tagged fish passes

Scale-drawing of Buttercrambe Larinier pass – values are in metres
Acoustic telemetry

PIT antennae interrogate limited area (within pass only), so to assess passage at weir:

- 2013-2014: 319 lamprey PIT tagged, 31 PIT + acoustic tagged over 6 release dates (31 Oct - 06 Dec)
- 2014-2015: 197 lamprey PIT tagged over 5 release dates (28 Oct - 04 Dec)

Sample sizes

$n = 31$ tags  $n = 8$ loggers
**Results: Flow velocities within fish pass**

- Fishway = 15% gradient, 24 rows of 0.15 m high baffles.
- Lamprey use combination of burst swimming alternated with resting behaviour (oral disc attachment to substrate)

**0.4 m above bed**

Velocities measured, using EM flow meter, at $Q_{98}$ only (hundreds of points throughout fishway).

**0.2 m above bed**
Lamprey attempts

- Attraction efficiencies:
  2013-2014: 315/350 (90%)
  2014-2015: 169/197 (85.8%)

- Time until arrival at fish pass:
  (2013-2014): median 25 h (1 - 1386 h). 158/315 (50.2%) within 24 h.
  No sig. diff. Mann-Whitney; U=24201.0, Z= -1.650, p=0.099
Starting 19 Nov 14 flows were decreasing and relatively low.

Two tiles (1 m and 3 m upstream of the lower instrumented one) detached ca. 18 Dec ’14 and were not replaced.

<table>
<thead>
<tr>
<th>Tagging date</th>
<th>Det. at entrance (+ exit)</th>
<th>Attraction efficiency (%)</th>
<th>Passage efficiency (%)</th>
</tr>
</thead>
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<tr>
<td>31 Oct 13</td>
<td>60 (0)</td>
<td>89.5</td>
<td>0</td>
</tr>
<tr>
<td>06 Nov 13</td>
<td>77 (1)</td>
<td>95</td>
<td>1.3</td>
</tr>
<tr>
<td>14 Nov 13</td>
<td>68 (0)</td>
<td>88.3</td>
<td>0</td>
</tr>
<tr>
<td>21 Nov 13</td>
<td>55 (0)</td>
<td>85.9</td>
<td>0</td>
</tr>
<tr>
<td>26 Nov 13</td>
<td>34 (0)</td>
<td>87.2</td>
<td>0</td>
</tr>
<tr>
<td>06 Dec 13</td>
<td>21 (0)</td>
<td>95.4</td>
<td>0</td>
</tr>
<tr>
<td>Total/mean</td>
<td>315 (1)</td>
<td>90.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tagging date</th>
<th>Det. at entrance (+ exit)</th>
<th>Det. at entrance</th>
<th>At d/s tile</th>
<th>At u/s tile</th>
<th>At exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 Oct 14</td>
<td>31 (9)</td>
<td>88.6</td>
<td>29</td>
<td></td>
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</tr>
<tr>
<td>07 Nov 14</td>
<td>8 (2)</td>
<td>57.1</td>
<td>25</td>
<td></td>
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</tr>
<tr>
<td>21 Nov 14</td>
<td>74 (1)</td>
<td>89.2</td>
<td>1.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Nov 14</td>
<td>44 (0)</td>
<td>86.3</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04 Dec 14</td>
<td>12 (0)</td>
<td>85.7</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total/mean</td>
<td>169 (12)</td>
<td>85.8</td>
<td>7.1</td>
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<td></td>
</tr>
</tbody>
</table>
Migration delay

Temporal impacts on migration can reduce spawning success, survival (increased predation, local aggregation).

Minimum delay (time interval between release and last detection at entrance).

Acoustic telemetry

- 29 (93.5%) visited the weir vicinity (4 (13.8%) passed weir directly), fewer (23, 74.2%) visited the fish pass.
- No successful ascents via the fish pass.
Conclusions

• Before modifications: numerous attempts (mean/lamprey: 11.5) at a range of flow conditions by 90.1% of released lamprey, only 0.3% were successful.

• After tiles placed: attraction efficiency: 85.8%
  7.4 mean attempts/lamprey
  7.1% passage efficiency

• Even with lamprey tiles, direct passage of barrier (13.8%) is still higher than through fish pass.

• Should be > 90% efficient for effective population restoration (argued by Lucas & Baras, 2001).

• This fish pass, in original & modified design is ineffective for river lamprey.

Thank you

Thanks to Aldby Park Estate & Greg McCormick for access & assistance
Flow and temp. conditions

2013-2014
excluding release dates:
Lamprey passage attempts with:
    temp ($F_{1,111} = 2.430$, $p = 0.122$, $R^2 = 0.021$);
    flow ($F_{1,111} = 0.316$, $p = 0.575$, $R^2 = 0.003$);
    flow + temp ($F_{2,110} = 1.219$, $p = 0.300$, $R^2 = 0.022$)

2014-2015
excluding release dates:
Lamprey passage attempts with:
    temp ($F_{1,115} = 5.375$, $p = 0.022$, $R^2 = 0.045$);
    flow ($F_{1,115} = 21.242$, $p < 0.001$, $R^2 = 0.156$);
    flow + temp ($F_{2,114} = 11.719$, $p < 0.001$, $R^2 = 0.171$)
Flow and temp. conditions ('13-'14)

No. of attempts in continuous black; discharge in dashed grey; temperature in dotted black
Flow and temp. conditions ('14-'15)

No. of attempts in continuous black; discharge in dashed grey; temperature in dotted black
Flow and temp. conditions (2)

- Cut off at 16 Jan, after which very low migratory activity was recorded.

- **2013-2014**: excluding release dates: Lamprey passage attempts with:
  - temp ($F_{1,70} = 1.893, p = 0.173, R^2 = 0.026$);
  - flow ($F_{1,70} = 4.964, p = 0.029, R^2 = 0.066$);
  - flow + temp ($F_{2,69} = 3.719, p = 0.029, R^2 = 0.097$)

- **2014-2015**: excluding release dates: Lamprey passage attempts with:
  - temp ($F_{1,74} = 1.778, p = 0.187, R^2 = 0.023$);
  - flow ($F_{1,74} = 15.086, p < 0.001, R^2 = 0.169$);
  - flow + temp ($F_{2,73} = 7.538, p = 0.001, R^2 = 0.171$)