Jun 24th, 12:05 PM - 12:30 PM

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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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?

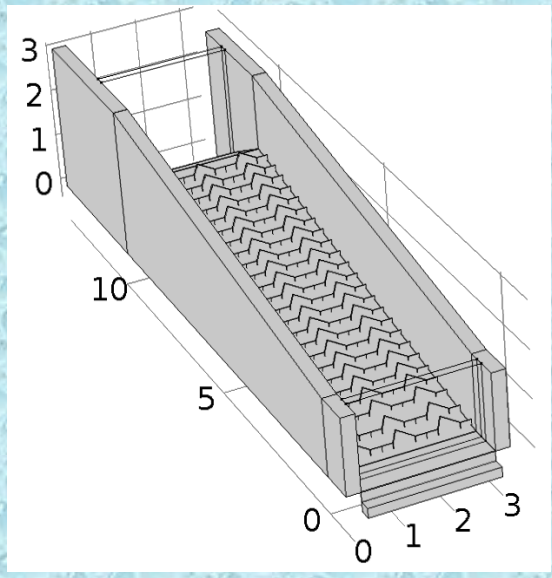
- Several types of fish pass, technical & nature-like, work adequately for fusiform morphotypes (Bunt *et al*., 2012), but often perform poorly for anguilliform morphotypes, including upstream-migrating lampreys, with relatively poor swimming capacity.
- Lab' mechanistic studies (e.g. Kemp lab studies) + 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).

Bunt, C.M., Castro-Santos, T., Haro, A., 2012. *River Res. Applic.* **28**, 457-478; **Foulds, W.L., Lucas, M.C.,** 2013. *Ecol. Eng.* **58**, 423-433; **Adam, B.,** 2012 In: Gough, P., Philipsen, P., Schollema, P.P., Wanningen, H, (Eds) From Sea to Source…… Regional Water Authority Hunze en Aas, AD Veendam, The Netherlands, pp. 214-217.

Larinier super-active baffled fish passes

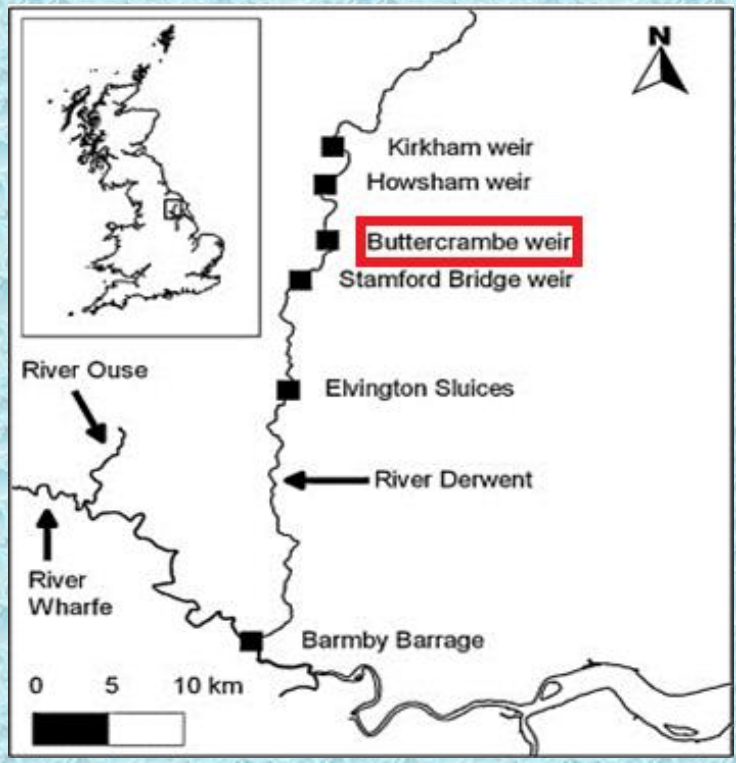
- Chevron baffles create relatively fast and slow lanes for upstream passage
- Now UK's preferred technical pass (by # installed) for wide range of species – untested for lampreys

- 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.

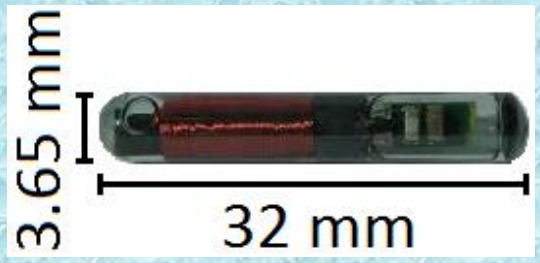


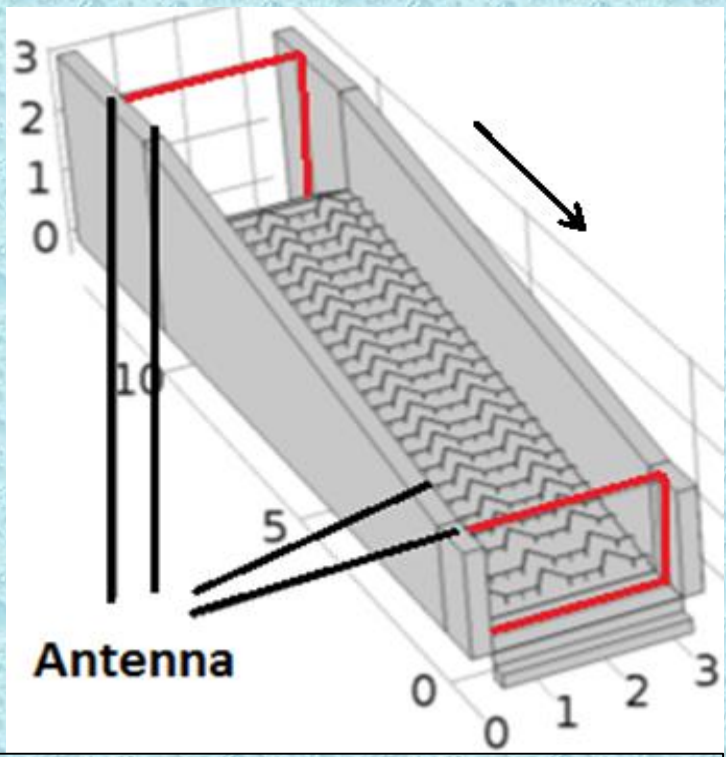
Buttercrambe weir at high flow (velocity over weir *ca.* 3 m/s), showing flow through Larinier pass

Dewatered pass with wall-mounted bossed tiles

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





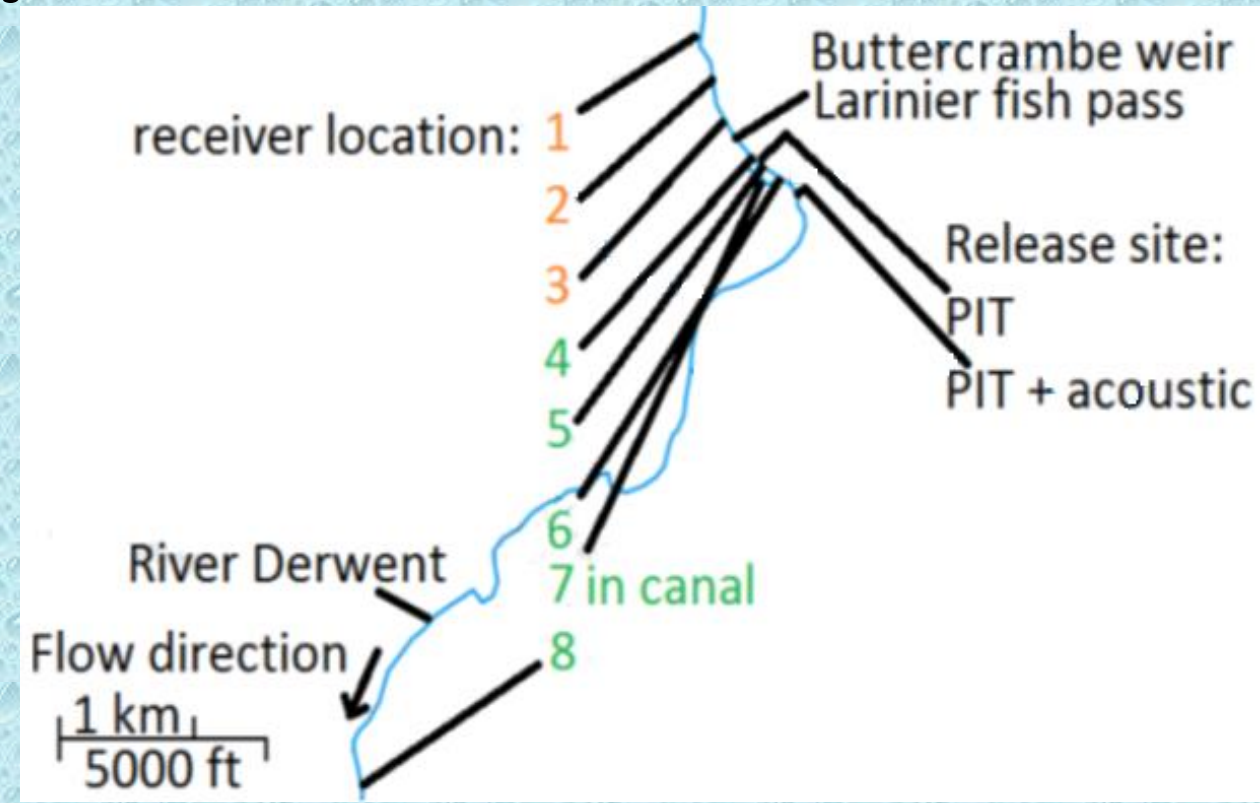
Scale-drawing of Buttercrambe Larinier pass – values are in metres

Acoustic telemetry

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

n = 31 tags

n = 8 loggers



Sample sizes

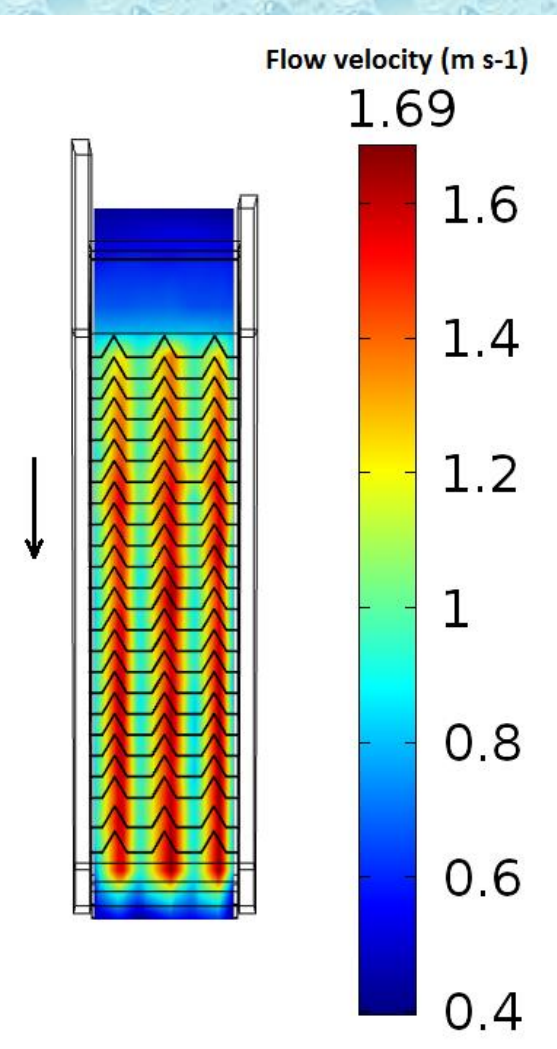
2013-2014: 319 lamprey PIT tagged, 31 PIT + acoustic tagged over 6 release dates (31 Oct - 06 Dec)

2014-2015: 197 lamprey PIT tagged over 5 release dates (28 Oct - 04 Dec)

Results: Flow velocities within fish pass

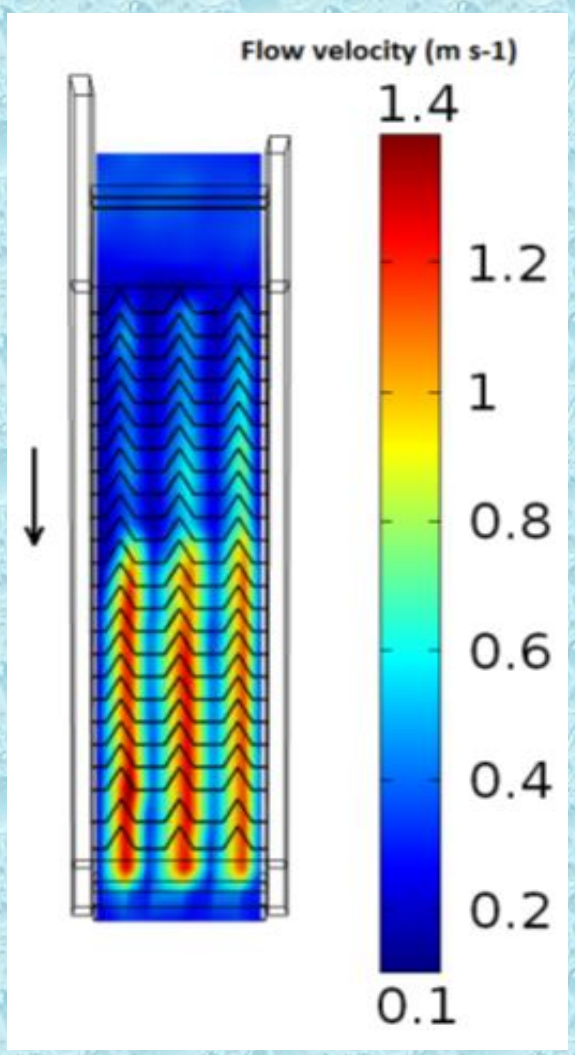
- Fishway = 15% gradient, 24 rows of 0.15 m high baffles.
- Lamprey use combination of burst swimming alternated with resting behaviour (oral disc attachment to substrate)

0.4 m above bed



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

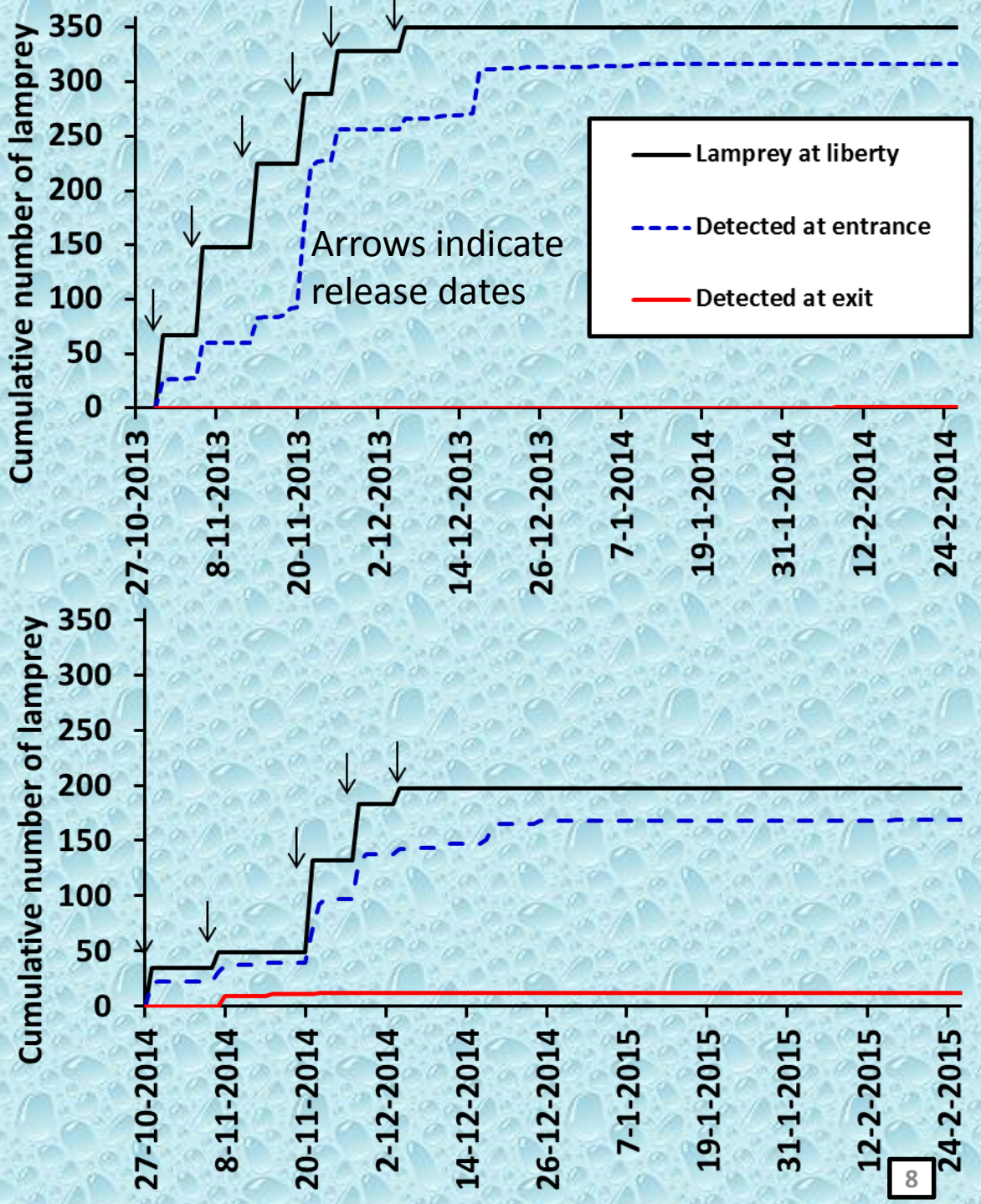
0.2 m above bed



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.
  (2014-2015): median 6 h (2 - 2074 h). 105/169 (62.1%) within 24 h.
  No sig. diff. Mann-Whitney; U=24201.0, Z= -1.650, p=0.099



Tagging date	Det. at entrance (+ exit)	Attraction efficiency (%)	Passage efficiency (%)
31 Oct 13	60 (0)	89.5	0
06 Nov 13	77 (1)	95	1.3
14 Nov 13	68 (0)	88.3	0
21 Nov 13	55 (0)	85.9	0
26 Nov 13	34 (0)	87.2	0
06 Dec 13	21 (0)	95.4	0
Total/mean	315 (1)	90.1	0.3
28 Oct 14	31 (9)	88.6	29
07 Nov 14	8 (2)	57.1	25
21 Nov 14	74 (1)	89.2	1.4
28 Nov 14	44 (0)	86.3	0
04 Dec 14	12 (0)	85.7	0
Total/mean	169 (12)	85.8	7.1

Starting 19 Nov 14 flows were decreasing and relatively low.

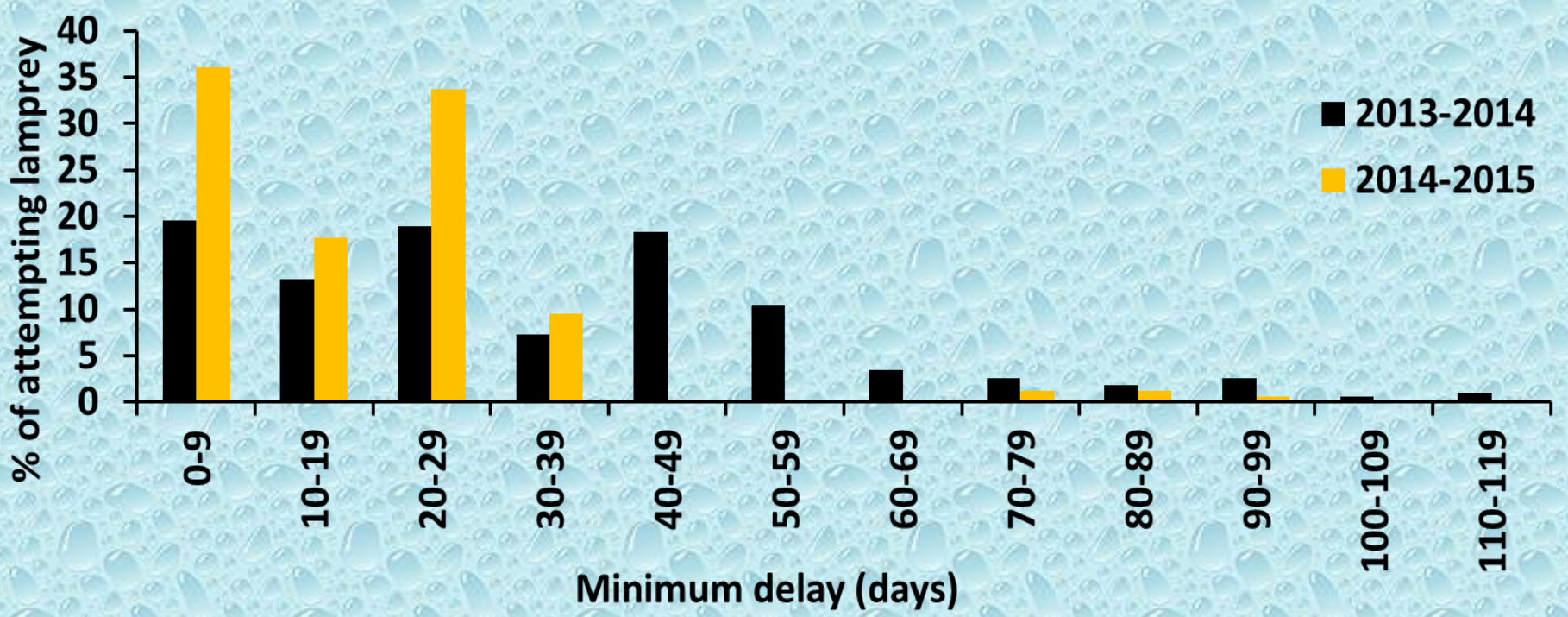
Two tiles (1 m and 3 m upstream of the lower instrumented one) detached *ca*. 18 Dec ’14 and were not replaced.

	Det. at entrance	At d/s tile	At u/s tile	At exit
28 Oct '14 - 18 Dec '14	151	64	14	12
18 Dec '14 - 26 Feb '15	74	15	0	0

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).

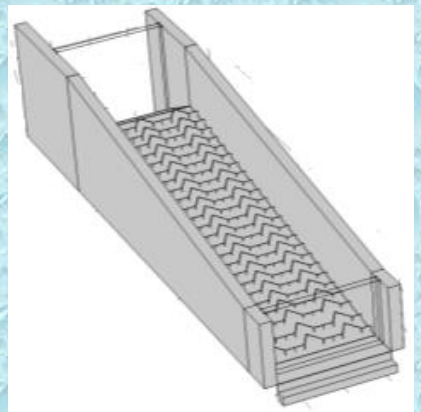


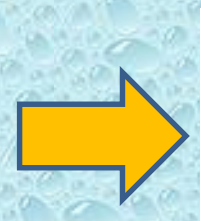
Acoustic telemetry

- 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

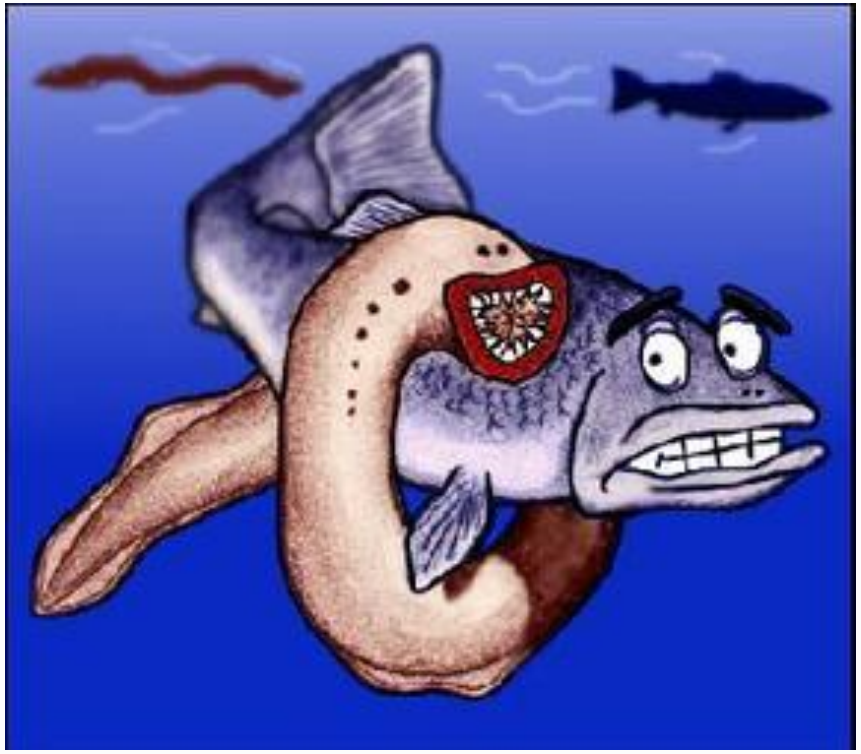
- Before modifications: numerous attempts (mean/lamprey: 11.5) at a range of flow conditions by 90.1% of released lamprey, only 0.3% were successful.
- After tiles placed: attraction efficiency: 85.8%
  7.4 mean attempts/lamprey
  7.1% passage efficiency
- Even with lamprey tiles, direct passage of barrier (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.





Lucas, M.C., Baras, E., 2001. Migration of Freshwater Fishes. Blackwell Science, Oxford.

Thank you



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Thanks to Aldby Park Estate & Greg McCormick for access & assistance

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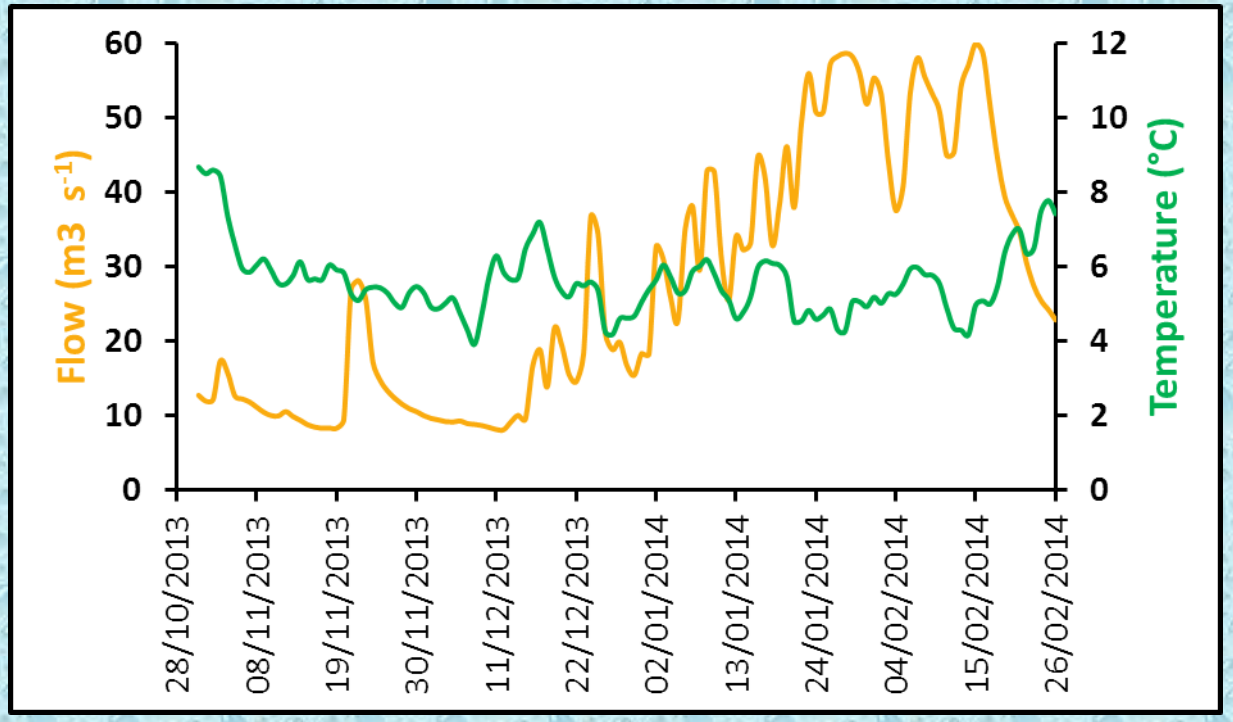
Flow and temp. conditions

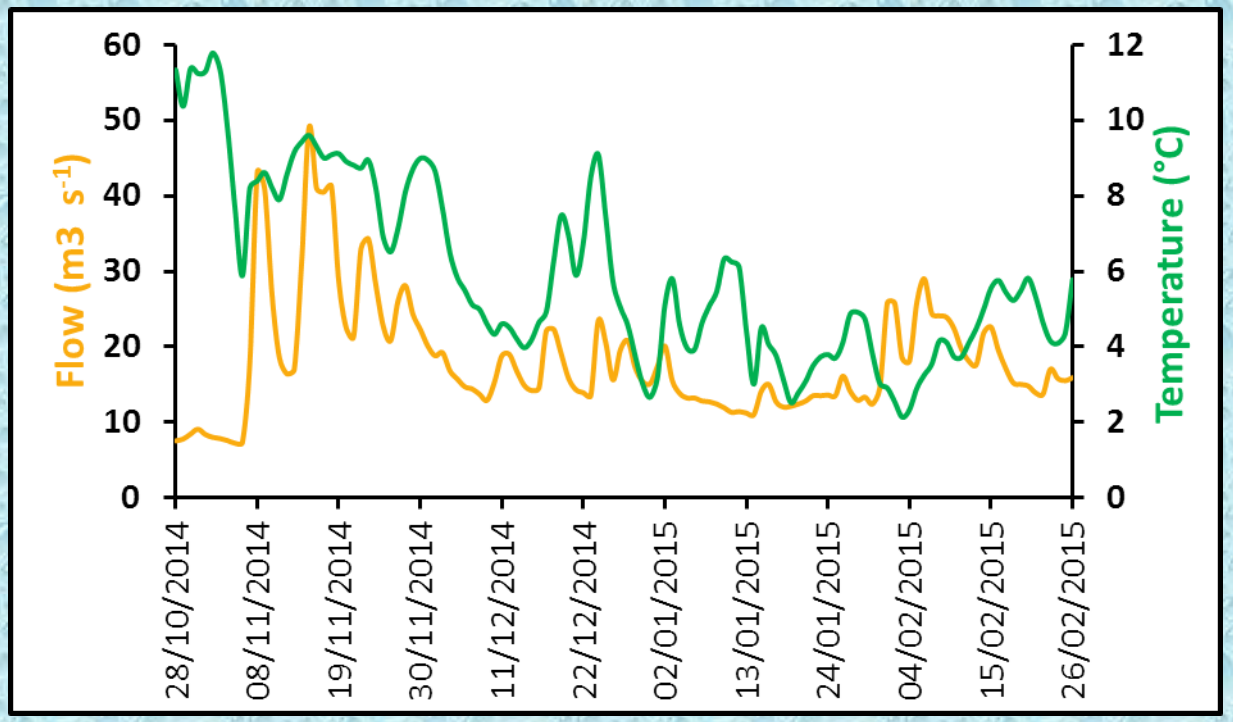
2013-2014

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)

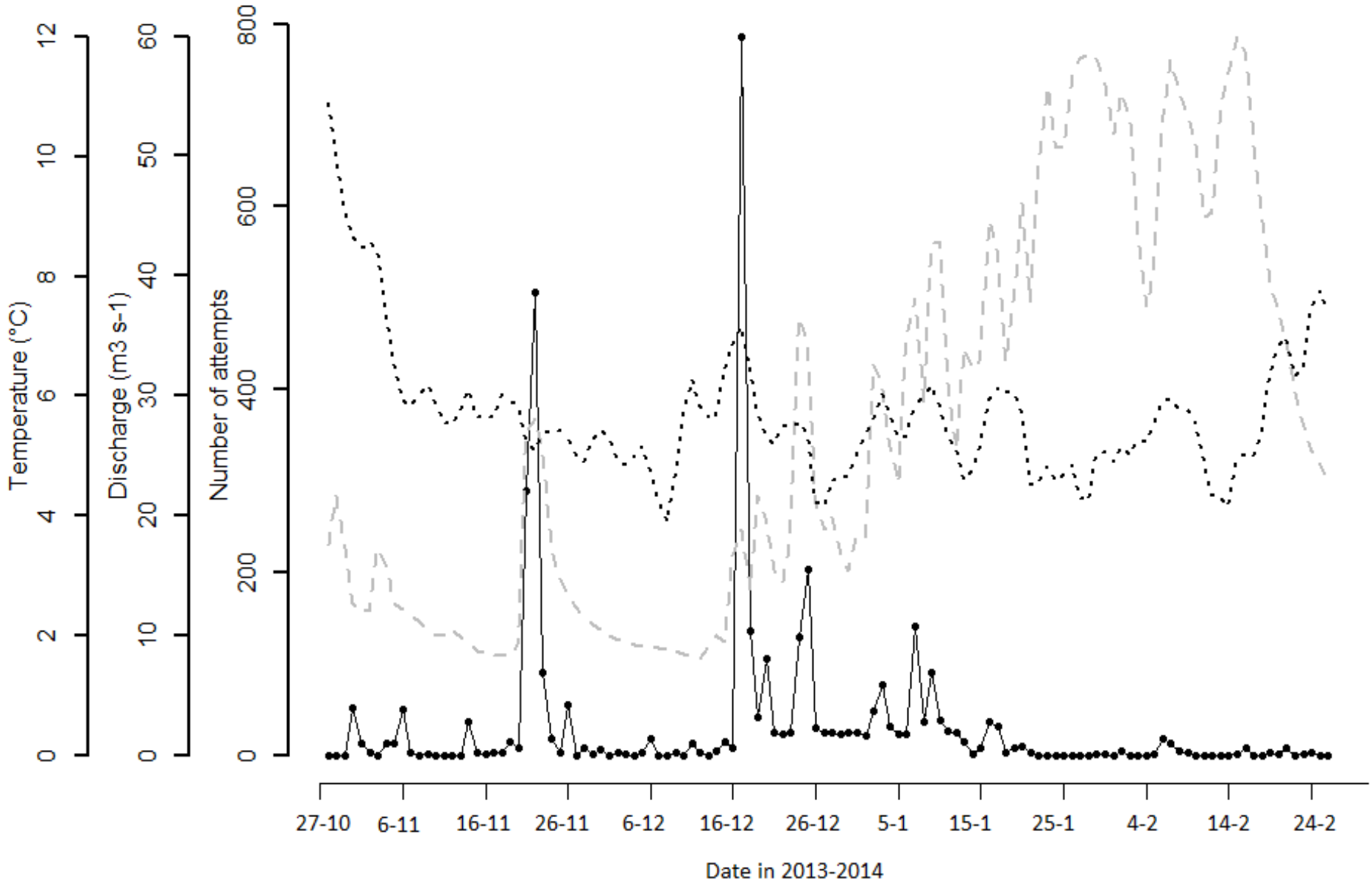


2014-2015

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)

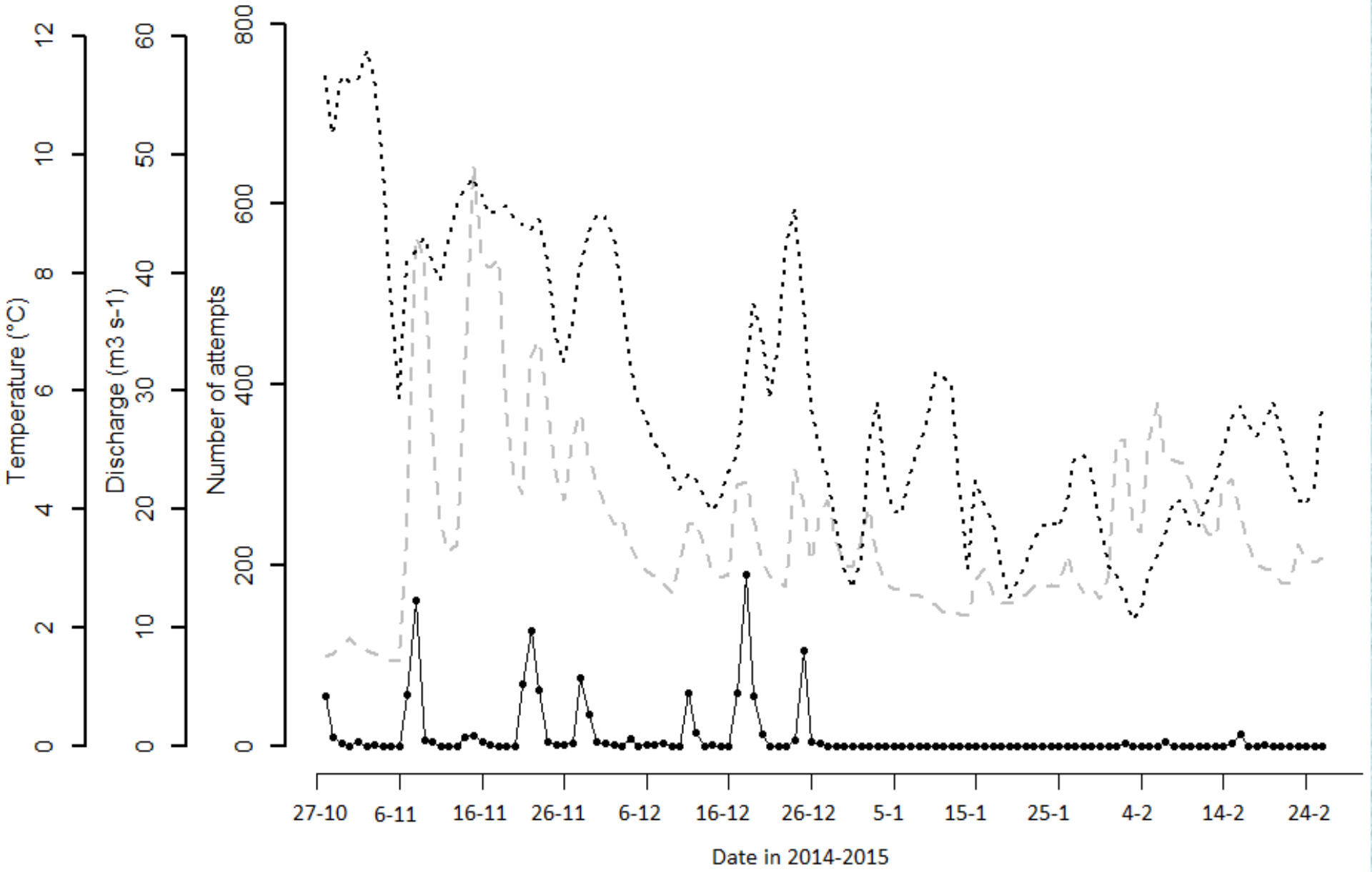


Flow and temp. conditions ('13-'14)



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 ($F_{2,73} = 7.538$, $p = 0.001$, $R^2 = 0.171$)