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Silver eel, *Anguilla anguilla* (Linnaeus, 1758), migration patterns in lowland rivers and lagoons in the North-Eastern region of their distribution range

Silver eel migration patterns

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Summary

Escapement success and migration patterns of silver eels *Anguilla anguilla* (L.) was studied by acoustic telemetry in three natural free-flowing and one dammed river and in Curonian Lagoon in Lithuania. Mean downstream migration speed and escapement success were almost the same in the shorter 210 km dammed river (53%, 10.7 km·day⁻¹) and the considerably longer 300-480 km free-flowing rivers (52.4%, 13.6 km·day⁻¹). Despite the similarity between migration speed in the Curonian Lagoon (14.6 km·day⁻¹) to that in rivers, migration success was significantly higher (71%) in the Lagoon. Although a majority of silver eels in Lithuania start migrating downstream in spring, the peak of eel migration into the Baltic Sea was observed during late fall. Overall migration success in the rivers and the Lagoon was 35%. Relatively low escapement may have negative consequences on the success on eel stock restoration and must be addressed when strategically planning for the production of spawners.

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31

32 **Introduction**

33 Since the 1970s, recruitment of the European eel (*Anguilla anguilla* L.) has declined over 90% due to various
34 causes, such as migration barriers, habitat destruction and pollution, fisheries, diseases and parasites (Dekker &
35 Casselman 2014). Previous studies (Winter et al., 2006; Bruijs & Durif, 2009; Aarestrup et al., 2010)
36 demonstrated that substantial mortality during downstream migration could dramatically reduce the number of
37 silver eels. The main causes of this mortality are fishing and lethal injuries from passage through the turbines of
38 hydropower plants (HPP) (Winter et al., 2006).

39 The practice of stocking eels in Lithuania has endured for decades, but eels were originally released to bolster
40 commercial or recreational fisheries without aiming to facilitate migration to increase spawning. Eels were often
41 stocked above HPP or dams thereby incurring substantial mortalities (Winter et al., 2006) and disruption of
42 migration (Legault et al., 2003). Despite the 98 HPPs and 1025 dams constructed in Lithuania, the main eel
43 migration routes to the Baltic Sea are along free flowing rivers or river sections of up to c. 600 km (Ložys et al.,
44 2008). Despite numerous studies about eel mortality arising from passage through HPPs, there are scant data
45 available on eel escapement success or downstream migration speed within free flowing rivers (e.g. Simon et al.
46 2011; Bultel et al. 2014; Stein et al., 2016) and lagoons (e.g. Amilhat et al., 2008, Charrier et al., 2012).
47 Lithuania's free flowing lowland rivers differ in terms of hydrological conditions (40% of discharge comes from
48 melted snow, 35% from ground water and only 25% from rain), temperature (2–3 months per year rivers are
49 covered with ice); degree of regulation (most large rivers are natural and historically were not regulated); and
50 flow regime (in spring due to melting snow discharge, flows are 2–3 times higher than in other seasons)
51 compared to Western Europe (Gailiusis et al. 2001). In the context of concerted international efforts to restore
52 eel stocks, it is therefore also important to determine the main patterns of silver eel migration in the rivers of
53 North Eastern Europe.

54 The objective of this study was to assess overall escapement success and migration patterns of silver eels
55 migrating through natural free-flowing and dammed rivers in Lithuania, prior to escaping to the Baltic Sea via
56 the Curonian Lagoon.

57

58 **Materials and Methods**

59 **Study area**

60 Eel migration was studied in four rivers: the Neris, Siesartis and Žeimena in which they could migrate freely
61 downstream, and the Nemunas in which eels had to pass through a HPP.

62 The Kaunas HPP with its four low head Kaplan turbines is built on Nemunas River (Fig. 1), c. 223 km from the
63 Curonian lagoon and c. 290 km from Baltic Sea. The height of the dam is 24.6 m, water head 15 m, installed
64 power 100.8 MW with maximum flow of 760 m³·s⁻¹ (Lithuanian hydropower association, 2011). The dam
65 creates the 63.5 km² Kaunas Water Reservoir. There are no other migration barriers or regulating structures
66 which impede river flow between the Kaunas HPP and the Baltic Sea.

67 The Neris River (Fig. 1) is a tributary of the Nemunas River, and besides the Vileika HPP upstream in Belarus,
68 there are no other migration barriers or other flow regulating structures on the river in Lithuanian territory.

69 The Siesartis River is dammed by one HPP with a pool and weir type fish ladder installed 11 km upstream from
70 the river mouth, but eels were released below this HPP. The Žeimena River (Fig. 1) is free-flowing throughout

its entire length. The main morphological and hydrological parameters for each of these rivers are presented in Table 1.

The non-tidal Curonian Lagoon is a shallow semi-enclosed water body covering 1584 km² adjacent to the South Eastern rim of the Baltic Sea (Fig. 1). The southern and central regions of the Lagoon are freshwater while the northern part is oligohaline with irregular salinity fluctuations up to 8 ppt (Zettler & Daunys, 2007). The Nemunas River provides the main water inflow into the Lagoon, which discharges to the Sea through Klaipėda Strait.

Eel tagging

A total of 63 silver eels were caught in four rivers in Eastern Lithuania during their spawning migrations using fyke nets of 16–20 mm mesh size and tagged with Vemco acoustic tags in spring and autumn 2014 (Table 2). Prior to tag implantation, weight, total length, eye diameter, length and height of pectoral fin were measured. The silvering index, based on total body length, body weight, pectoral fin length and mean eye diameter, was determined as described by Durif et al. (2009). All silver eels >55 cm were considered to be females (Tesch, 2003). Prior to surgery eels were anaesthetised with 2-phenoxy ethanol (0.8 ml·l⁻¹) for 8–10 minutes. An incision c. 12–15 mm for V9 tags (weight 4.7 gram in air, length 29 mm, estimated tag life 159 days, emission delay for first 45 days 20–50 s, later 30–60 s) or c. 18–22 mm for V13 tags (weight 11 gram in air, length 36 mm, estimated tag life 262 days, emission delay first 45 days 20–50 s, later 40–100 s) was made on the mid-ventral line, in the posterior quarter of the body cavity. The transmitter was inserted into the intra-peritoneal cavity cranially and positioned 3–4 cm forward of the incision by using a plastic plunger. V9 tags were used to tag eels up to 550 g, while V13 tags were used for tagging eels over 550 g. Transmitter implantation was not expected to affect eel behaviour or cause mortality in this study, as eels were successfully tagged with these transmitters in several other studies (e.g. Westerberg et al. 2007, Simon et al. 2011). The surgery took 5–6 minutes to complete. The wound was sutured with 4/0 Vicryl® Polyglactin soluble surgical thread and treated with antiseptic *Methylrosanilini chloridum* 2% solution. After the surgery eels were transferred to special cages in the site of intended release, where recovery from anaesthesia lasted 30 minutes (Table 2).

All eels were released in their place of capture (Table 2 and Fig. 1) except for those (N=25) released upstream of the Kaunas HPP (eels were caught in a tributary of the Nemunas River c. 60 km upstream HPP).

Installation of receivers

Four Vemco VR2W receivers were installed in the vicinity of the Kaunas HPP water intake to detect eels entering turbines and four receivers were installed just below the Kaunas HPP to detect those eels that had passed through. To detect eels that successfully migrated downstream, four receivers were installed on navigational buoys in the Nemunas Delta and four in the Klaipėda Strait (Fig. 1).

Range tests were performed at each detection station to ensure complete coverage of the area. All eels that were detected were registered by all receivers deployed along their migration route, hence it is a reasonable assumption that all tagged eels passing within the range of a detection station during the study period would have been recorded.

To locate missing eels, downstream of the eel release sites in the Neris, Žeimena and Siesartis Rivers and a 25 km section of the Nemunas River below the Kaunas HPP were scanned two months before the end of the

estimated duration of transmitter batteries, with VR2W receivers installed on a boat drifting downstream. In addition, Žeimenys Lake was scanned in case tagged eels had migrated upstream from the Žeimena River.

Data analysis

Migration success (MS, %) of the tagged eels was calculated according to the formula:

$$MS = 100 - (100 \times ((N_t - N) \div N_t))$$

Where: N – number of tagged eels detected by acoustic receivers (in the Nemunas Delta and/or Klaipėda Strait); N_t – number of all tagged eels. MS for eels released upstream the Kaunas HPP was calculated only for eels which had passed the HPP. The fate of eels not registered in the Nemunas Delta or Klaipėda Strait remains unknown; these eels were omitted from analysis of migration speed.

The speed of long term downstream migration (V_{long}) was calculated as time spent to cover the distance between the release site and the receivers installed in the Nemunas Delta or in the Klaipėda Strait and expressed as $\text{km} \cdot \text{day}^{-1}$. The speed of transient migration (V_{tran}) was calculated in the Nemunas Delta and Klaipėda Strait as the time lag between the first detection of a tag by the first and last receivers (5 km distance in the Nemunas River and 4.6 km in the Klaipėda Strait). Fulton's condition factor (K) representing the condition of the eel was calculated as described by Ricker (1975). River slopes between eel release sites and the Lagoon were taken from the Lithuanian rivers dataset (Jablonskis, 1962).

Data for eel migration speed, K and the distance between the release site and the Baltic Sea were not normally distributed (Shapiro–Wilk's W tests, $p < 0.05$), the non-parametric Mann-Whitney test was used to test for differences in parameters between the eels released in to dammed and free-flowing rivers. Simple linear regression was used to test the effect of distance of release site from the sea, eel length, river slope and K on the speed of downstream migration. Fisher's exact test was used to test eel MS differences between dammed, free-flowing rivers and the Curonian Lagoon.

Results

Mean length ranged between 94 – 51 cm, among the 63 eels that were released into four different rivers (Table 2). Mean weight of these eels ranged between 224 and 1847 g, and mean K between 0.12 – 0.24. Three of these eels were determined to be males at silvering stage MII, 10 eels were females at silvering stage FIV, and the remaining 50 eels were females at silvering stage FV (Table 2).

Migration in free flowing rivers

Eighteen out of the 38 silver eels released into free-flowing rivers of Eastern Lithuania during May – June 2014 were never detected post-release, consequently their fate is unknown. The remaining 20 eels successfully migrated downstream and reached the Nemunas Delta; MS = 53% (Table 3). Mean V_{long} ($\pm$ SD) of these eels was $10.7 \pm 10.7 \text{ km} \cdot \text{day}^{-1}$ (range 2.6 - 46.0 $\text{km} \cdot \text{day}^{-1}$). Migration lasted 77 ± 47.4 days on average (range 8-151 days) to reach the Curonian lagoon after release.

There were no significant differences ($p > 0.05$) in mean length, K and the distance from the release site to the Baltic Sea between eels released to free-flowing rivers that reached the Nemunas Delta and those which apparently did not.

147

148 **Migration in dammed river**

149 Out of 25 eels released upstream of the Kaunas HPP, 21 (84%) moved downstream through the turbines and
150 were detected below the HPP. Twelve eels migrated within 24 hours after release, while nine eels delayed
151 passing through by one to 47 days. Four tagged eels did not migrate downstream and stayed in the Kaunas
152 Reservoir until at least when the transmitter battery became discharged. Their fate remains unknown. Absence of
153 a fish ladder at HPP means that all eels must pass directly through the turbines. Out of the 21 eels which
154 migrated through the HPP, 11 were detected in the Nemunas Delta (MS = 52.4%) (Table 3). Mean V_{long} ($\pm$ SD)
155 of these eels was 13.6 ± 12.0 km·day⁻¹ (range 1.5 - 35.3 km day⁻¹). Migration lasted 59 ± 66.7 days on average
156 (range 6-144 days) to reach the Curonian Lagoon after the release.
157 There was no significant difference ($p>0.05$) between the V_{long} of eels released in free-flowing and dammed
158 rivers.

159 **Migration within the Nemunas Delta**

160 In the rivers of Eastern Lithuania, most of the tagged eels (N = 54, 86%) were released during late May - early
161 June and nine eels (14%) were released in September. Thirty-one eels (49.2% of all eels released) were detected
162 migrating through the Nemunas River Delta: one eel (3%) arrived in May, five eels (16%) were detected in June,
163 eight (26%) in July and one (3%) in September. The majority (N = 15, 49%) were detected in October and the
164 one remaining (3%) was detected in November.
165 V_{tran} , estimated within the Nemunas Delta was 67.2 ± 39.9 km·day⁻¹ (range - from 1 to 124 km·day⁻¹) which was
166 significantly ($p<0.05$) higher compared to V_{long} in rivers.
167 Most (N=22, 71%) eels in the Nemunas Delta were actively migrating between 1 hour after sunset and 4 hours
168 before sunrise. Nevertheless, seven (22.5%) eels migrated within a few hours before sunset or after sunrise; and
169 the remaining two eels (6.5%) were detected migrating around midday.
170 Scanning in smaller rivers (Neris, Žeimena and Siesartis), adjacent lake and section of Nemunas River below the
171 Kaunas HPP did not result in detection of any eels, so the fate of 32 tagged eels (50.8%) remains unknown.

172 **Migration in the Curonian lagoon and Klaipėda strait**

173 Out of 31 eels, which were detected entering the Curonian Lagoon, at least four (13%) were caught in fyke nets
174 by fishermen. Until the end of transmitter battery operation, 22 eels (MS = 71%) were detected in Klaipėda Strait
175 prior to entering the Baltic Sea, while the fate of the remaining 5 eels (16%) remains unknown. The mean V_{long}
176 in the Lagoon was estimated to be 14.6 ± 16.9 km·day⁻¹ (range 0.5 – 66.5 km·day⁻¹). V_{long} (in the rivers, in the
177 Lagoon and total (rivers+lagoon)) was not significantly correlated with distance of the release site from the
178 Baltic Sea, river slope, TL or K. Also, there was no significant difference ($p>0.05$) between the mean V_{long} in
179 rivers (11.6 ± 11.1 km·day⁻¹) and the Curonian Lagoon (14.6 ± 16.9 km·day⁻¹).
180 The V_{tran} , estimated in the Klaipėda Strait was 35.6 ± 25.79 km·day⁻¹ (range from 0.4 to 78.8 km·day⁻¹). There is
181 no significant differences ($p>0.05$) between mean V_{tran} in the Nemunas delta and in the Strait, however V_{tran} was
182 significantly ($p<0.05$) higher compared to V_{long} in rivers and in the Lagoon.

The peak period of eels entering the Baltic Sea was observed during late fall: 18 eels (82%) were detected in the Klaipėda Strait during October-November while the remaining four eels were detected once each in June, July, December and January, respectively.

Discussion

Migration successes and mean migration speed among silver eels performing downstream migrations in free-flowing and dammed rivers was found to be similar. Eel migration speed estimated during the current study was considerably lower compared to those reported elsewhere. Previously reported migration rates in regulated rivers have been highly variable, ranging between 17.3 (Klein-Breteler et al., 2007), 29.4 (Breukelaar et al., 2009), 53 (Verbiest, et al., 2012) and 64.8–93.6 km·day⁻¹ (Tesch, 1994). Data on eel migration speeds in free flowing rivers are scarce, but Simon et al. (2011) reported mean migration speeds for different eel groups that varied between c. 5 and 70 km·day⁻¹, while Bultel et al. (2014) reported a mean migration speed of 4.5 km·day⁻¹. Prior to entering the Baltic Sea, eels pass through the highly eutrophic Curonian Lagoon. The V_{long} in the Lagoon was slightly faster when compared with migration speeds in rivers, but these differences were not statistically significant ($p>0.05$). Speed of downstream migration was independent of eel body length in rivers and in the Lagoon, consistent with results reported by Haraldstad et al. (1985), but in contrast with the conclusion of Bultel et al. (2014) that migration speed was correlated with total length and body weight. The lower migration speeds observed in the current study might be related to seasonal differences among eel spawning migrations. Downstream runs of silver eels in Western Europe typically start in autumn (Bruijs & Durif, 2009), yet along the South-Eastern Baltic coast, most intense spawning migrations start in early March and last until late May (Ložys et al., 2008). The earlier commencement of downstream migration has led to an assumption that eels enter the sea earlier as a consequence, but the results from the current study demonstrated that a majority of migrating eels caught in streams during spring did not enter the Baltic Sea until late autumn (October-November). It was suggested that spawners start their migrations from distant areas (e.g. Lithuania) earlier (in spring) (Bruijs & Durif, 2009). In contrast, more recently Righton et al. (2016) demonstrated that “the timing of autumn escapement and the rate of migration are inconsistent with the century-long held assumption that eels spawn as a single reproductive cohort in the spring time following their escapement from European waterways. They suggested „that European eels adopt a mixed migratory strategy, with some individuals able to achieve a rapid migration, whereas others arrive only in time for the following spawning season“. This may well explain the large differences in the speed of downstream migration observed during the current study where eels were migrating within a range of 1.5 - 46.0 km·day⁻¹. Slow migration speed during the continental migration phase suggests that eel migration in this study was accompanied by long pauses. This is possibly due to longer stopovers for feeding (some eels at silvering stages SFV and SFIV were found to be feeding during downstream migrations (Dainys, unpubl. data; Westin, 2003)) and as suggested by Durif et al. (2005) unfavourable weather conditions for migration in summer (e.g. calm weather, reduced flow velocity) might substantially reduce the rate of eel migration. In line with previous observations (Lowe, 1952) increased migration activity in the current study was observed during less-illuminated phases of the lunar cycle - most of the eels (81%) actively migrated during first and third quarter of the moon, whereas only 13% and 6% were recorded during the new and full moon, respectively. However, some recent studies have reported lunar phase had no significant influence on eel migration (Reckord et al., 2014). Stein et al. (2016) reported that eels tagged in upstream river reaches were less

likely to complete their migration and tended to dwell longer in the river system than eels that were tagged in the lower reaches. In contrast the current study showed no effect of eel release site or river slope on either migration speed or migration success. Moreover, previous studies (e.g. Aarestrup et al. 2008; Simon et al. 2011) have also demonstrated that some eels suspend their autumn migration to resume it during the following spring or autumn and in this way take more than a year to reach the outlet of even smaller rivers, or sometimes even revert from silver to yellow eel stage and cease migration (Svedang & Wickstrom 1997; Durif et al., 2005; Stein et al., 2016). It follows that overall downstream migration success is likely to be higher than was observed if some eels resumed their downstream migration after their tag transmitter batteries had discharged.

Previous behavioural studies (Durif et al. 2003; Boubée & Williams 2006; Calles et al. 2010; Pedersen et al. 2012) suggested that HPPs and dams may have indirect negative effects on eel migration: eels often delay their passage through an obstruction and consequently their migration period becomes extended. Results of the current study partly support this observation as 36% of eels released upstream from the Kaunas HPP also delayed passing through the turbines for periods from one to 47 days, while 16% of eels did not migrate at all. The remaining eels passed through the turbines of the Kaunas HPP within 24 hours after their release. After the eels passed through the HPP only five transmitters (23.8%) were detected as stationary in the proximity of the Kaunas HPP within the period until the transmitter battery was exhausted (these eels presumably suffered lethal injuries), while more than half of all eels (52.4%) that passed through the turbines of Kaunas HPP were detected in the Nemunas Delta. The fate of the five eels (23.8%) remains unknown.

During downstream migration no eels were exposed to commercial fishing (except in the Lagoon) because they were released downstream of licensed fishing sites. The impacts of predation, recreational angling, poaching or other sources of mortality are nevertheless unknown. Scanning with boat-based receivers in the rivers, an adjacent lake, and the section of Nemunas River below the Kaunas HPP did not result in detection of any eels. Presumably the missing eels were either caught by anglers or predators and their tags were taken away from the river, or the eels stayed somewhere in the Nemunas River below the scanned reaches, or perhaps entered small tributaries of the main rivers and were missed during active scanning.

After downstream migration 31 eels entered the Curonian Lagoon. Despite fishing and predation pressure in the Curonian Lagoon being markedly higher (Pūtys, 2012) compared to rivers, the migration distance in the Lagoon was substantially shorter (c. 50 km) and the success rate of migration through the Lagoon was considerably higher. Relatively high migration success in the Lagoon might also be explained by eels reaching the Lagoon at the end of the continental migration phase and, as suggested by Righton et al. (2016), had adopted a rapid migratory strategy, such that most of these eels (N=22) did not cease their migration through the Lagoon. Migration strategies of the four eels caught by fishermen and the five eels whose fate is unknown (they might also have been caught but not reported) remain unclear.

In line with previous findings of Brown et al. (2009) more than two thirds of all eels actively migrated through the Nemunas River Delta during the night time - between 1 hour after sunset and 4 hours before dawn. However, some eels were detected migrating during the daytime or even at midday, especially in the Klaipėda Strait. Vøllestad et al. (1986) and Durif (2003) suggested that eel migration during the daytime is related to increased water turbidity and rate of water flow. Water turbidity in the Curonian Lagoon is generally very high and the depth of Klaipėda Strait is approximately 15 meters, leading to presumed low illuminance conditions at the bottom, which might explain why 10 out of 22 eels migrating through the Lagoon to the Sea emigrated during

the daytime. Eels entered the Baltic Sea when the water temperature was 5.1–10.1°C, which is within the optimal range reported for eel migrations (Vøllestad et al., 1986).

Overall migration success in the current study was 35%, but actual escapement success might be higher, because some tagged eels were never detected after release yet might have reached the Baltic Sea after their transmitter batteries had expired. Our results are consistent with those previously reported for eel migration success rates in regulated rivers, which are highly variable ranging from 10 to 37% (Winter et al., 2006; Verbiest et al., 2012; Marohn et al., 2014). Eel migration success beyond their entry into the Baltic Sea remains unknown. This study highlights that production of spawners for any stock restoration endeavours needs to be calculated with caution by estimating not only impact of HPP but also other possible sources of mortality.

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- 376

377 **Tables:** Table 1. Main parameters of the rivers into which tagged eels were released.

River	Length, km	Catchment area, km ²	Mean annual flow, m ³ ·s ⁻¹	Rain events in the release site		Annual rainfall (mm) in the release site	
				2014	Multiannual average (1981-2010)	2014	Multiannual average (1981-2010)

Nemunas	937	98200	375	154	180	641	637
Neris	510	25100	180	166	175	613	685
Žeimenas	80	2793	27	176	175	713	754
Siesartis	64	616	5	158	176	647	659

Table 2. Morphological parameters of tagged eels, river slope and the distance of migration route from the release site to the Baltic Sea.

Eel catch/release site	Date	N	Length $\pm$ SD, cm	Weight $\pm$ SD, g	K $\pm$ SD	Silvering stage	River slope	Distance to the BS, km
Siesartis	20/05/2014	7	76.6 $\pm$ 9.4	835 $\pm$ 279	0.18 $\pm$ 0.01	FIV; FV; MII	0.21	366.9
Žeimenas, I	21/05/2014	8	70.9 $\pm$ 3.3	636 $\pm$ 106	0.18 $\pm$ 0.02	FV FV; MII	0.27	549.7
	22/05/2014	2	61 $\pm$ 10.0	462 $\pm$ 235	0.19 $\pm$ 0.008	FV; MII	0.27	549.7
	28/05/2014	8	70.3 $\pm$ 8.4	686.9 $\pm$ 272	0.19 $\pm$ 0.03		0.27	549.7
Žeimenas, II	22/05/2014	2	72.0 $\pm$ 2.8	696 $\pm$ 33	0.19 $\pm$ 0.01	FV	0.27	499
Žeimenas, III	02/06/2014	7	69.7 $\pm$ 5.9	608 $\pm$ 200	0.17 $\pm$ 0.02	FV	0.25	482.8
Neris	29/05/2014	4	73.2 $\pm$ 4.9	719 $\pm$ 130	0.18 $\pm$ 0.03	FV	0.24	434.4
Nemunas, (Kaunas water reservoir)	30/05/2014	13	79.6 $\pm$ 8.9	1045 $\pm$ 462	0.2 $\pm$ 0.03	FIV; FV	0.1	278
	13/06/2014	3	79.5 $\pm$ 4.8	892 $\pm$ 167	0.18 $\pm$ 0.003	FV FIV; FV	0.1	278
	07/10/2014	9	70.0 $\pm$ 8.6	686 $\pm$ 248	0.19 $\pm$ 0.03		0.1	278

Table 3. Migration success and long term migration speed (V_{long}) of eels in free flowing and dammed rivers and Curonian lagoon.

Release site (River)	N	Detected in the Nemunas Delta, N; (%)	Mean V_{long} in rivers $\pm$ SD, km day ⁻¹	Detected in the Klaipėda Strait, N; (%)	Mean V_{long} in the Curonian Lagoon $\pm$ SD, km day ⁻¹
Siesartis	7	3 (42.9)	13.1 $\pm$ 12.3	2 (28.6)	49.9 $\pm$ 23.5
Žeimenas	27	13 (48.1)	8.2 $\pm$ 5.5	6 (22.2)	10.0 $\pm$ 12.8
Neris	4	4 (100)	16.7 $\pm$ 20.4	3 (75)	17.5 $\pm$ 14.1
Total (Free-flowing rivers)	38	20 (52.6)	10.7 $\pm$ 10.7	11 (29.0)	19.3 $\pm$ 20.4
Nemunas (dammed river)	25 (21)	11 (52.4)	13.6 $\pm$ 12.0	10 (40)	9.3 $\pm$ 10.7

Figure captions: Fig. 1. Eel release sites in Nemunas, Neris, Žeimenas and Siesartis Rivers; the location of Kaunas and Valtūnai HPPs; and the location of acoustic receivers installed in the Nemunas Delta and Klaipėda Strait (four at each location).

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