FISHERIES & AQUATIC LIFE (2024) 32: 191 - 203
Archives of Polish Fisheries
DOI 10.2478/aopf-2024-0017

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RESEARCH ARTICLE

The first data from non-commercial monitoring of the occurrence and range of river lamprey, *Lampetra fluviatilis*, in selected rivers in northern Poland

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Received – 02 April 2024/Accepted – 29 August 2024. Published online: 30 September 2024; ©National Inland Fisheries Research Institute in Olsztyn, Poland
Citation: Kuczyński, T. (2024). The first data from non-commercial monitoring of the occurrence and range of river lamprey, *Lampetra fluviatilis*, in selected rivers in northern Poland. Fisheries & Aquatic Life 32, 191-203

Abstract. Human impact on fish populations extends beyond mere exploitation. Rivers and streams, essential conduits for these fish migrations, have undergone substantial anthropogenic modifications driven by navigation, hydropower generation, and water regulation imperatives. An example of one species that has been affected from the anadromous lampreys is river lamprey, *Lampetra fluviatilis* (L.). Populations of anadromous lampreys have declined dramatically in European rivers, including in Poland, because of the loss of river connectivity and habitat modification that prevents adult lamprey from reaching their original spawning grounds. The present study was conducted on 11 rivers located in northern Poland in the southern Baltic Sea catchment area. River lamprey spawners were sampled with dedicated traps, and 3,026 specimens of 29 fish species were caught at all the sites investigated. The most abundant, frequent species was river lamprey (n = 1,062), which was recorded in 10 of 11 rivers. Only in one case, were river lamprey specimens recorded above a barrage with a fish pass in a tributary of the Rega River. In all other rivers, lamprey was recorded only at sampling sites below the first barrier. Since most fish passes are not designed to provide passage for weaker swimming or non-jumping species, they are not suitable for non-salmonid species like river lamprey.

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Keywords: anadromous lamprey, fish migration, ecological connectivity, fish passes

Introduction

Over several millennia, human societies have exploited anadromous fish species during spawning migrations as sources of staple foods (Lucas et al. 2001). However, the human impact on these fish populations extends beyond mere exploitation. Rivers and streams, essential conduits for these fish migrations, have undergone substantial anthropogenic modifications driven by navigation, hydropower generation, and water regulation imperatives. These alterations exert profound and enduring impacts on fish assemblages, disrupting pivotal life stages directly or indirectly through cascading effects on stocks (Lucas et al. 2001). An example of such species are anadromous lampreys like river lamprey, *Lampetra fluviatilis* (L.). It is one of the two anadromous species of the family *Petromyzontidae* inhabiting the Baltic Sea Basin, but it is much more abundant than the sea lamprey, *Petromyzon marinus* (L.). River lamprey migrate from the sea to rivers in two distinct peaks in fall and spring and exhibit nocturnal activity until spawning (Aronsuu et al. 2015). River lamprey spawn in rivers and streams with rapid currents from March to May. All adults die after spawning, while larvae (ammocoetes) remain in rivers for three to five years (Hardisty and Potter 1971). After this period, the larvae transform into the smolt stage (macrophthalmia) and migrate downstream. In the sea, river lamprey lead a parasitic lifestyle by feeding on the other fishes.

Populations of anadromous lampreys have declined dramatically in European rivers, including in Poland (Kelly and King 2001, Witkowski 2010). In previous centuries, the river lamprey ascended many rivers throughout nearly all of Poland and were often noted in large numbers. The gradual disappearance and clear decline in the number of river lamprey in southern Poland began as early as the nineteenth century mainly because of pollution, dam construction, and habitat modification (Witkowski 1995). Many researchers postulated that populations of this species were mainly affected by the loss of river connectivity and habitat modification that prevented adult lamprey from reaching their original spawning grounds (Lucas et al. 2009, Mateus et al. 2012, Aronsuu et al. 2015). By the end of the twentieth century, the occurrence of river lamprey in Poland was limited to the north of the country and its catches in traditional areas of exploitation like the lower Vistula river basin and the Vistula Lagoon decreased dramatically, which contributed to the abandonment of lamprey fishery (Witkowski 2010). The official commercial exploitation of river lampreys in Poland ended with the establishment of species protection under national law in 2004 (Furgała-Selezniow and Kujawa 2017). Since then, there has been no data from commercial fishing or dedicated research on the abundance or occurrence of river lamprey in Polish rivers (Radtke et al. 2015). At the same time, various projects have been implemented on rivers in the direct catchment area of the Baltic Sea to improve diadromous fish migration by building fish passes on existing hydrotechnical barrages. In many cases, this is considered a success because it has significantly increased the range and number of sea trout (*Salmo trutta* L.) spawners in the upper sections of rivers, but the effects on other migratory species have not been studied. The aim of this study was to determine the current status of the occurrence and range of spawning migrations of river lamprey in selected rivers in Pomerania, Warmia, and the Lower Vistula region after over a decade of protection.

Material and methods

Study area

The study was conducted on 11 rivers located in northern Poland and the southern Baltic Sea catchment area (Fig. 1). Basic information about the rivers studied is presented in Table 1.

The source of the Bauda River is located on the Warmia Plain at an altitude of 197 m above sea level. It flows north with an average gradient of 3.4‰ and flows into the Vistula Lagoon near Frombork. In its upper reaches it is an unregulated, fast-flowing stream flowing through a deep forest valley surrounded by meadows and pastures. A characteristic feature of the Bauda River is its large fluctuations in flows and frequent water turbidity. Currently, there are no major obstacles for anadromous salmonids in this river basin. The most common species in it are stone loach (*Barbatula barbatula* (L.)) and several lithophils and speleophils, i.e., brook lamprey (*Lampetra planeri* (Bloch)), minnow (*Phoxinus phoxinus* (L.)), and bullhead (*Cottus gobio* L.)(Radtke et al. 2011).

The Chełst River source is in the Żarnowiecka Upland at an altitude of 66 m above sea level. The natural character of the Chełst River has been preserved only in its upper and middle reaches where the river flows meandering in ravines surrounded by old trees. In its lower reaches the Chełst River flows through the coastal Lake Sarbsko, after which it flows into the Łeba Canal, which is within the boundaries of the seaport of Łeba. The most common fish species are brown trout and gudgeon (*Gobio gobio* (L.) (Dębowski et al. 2002).

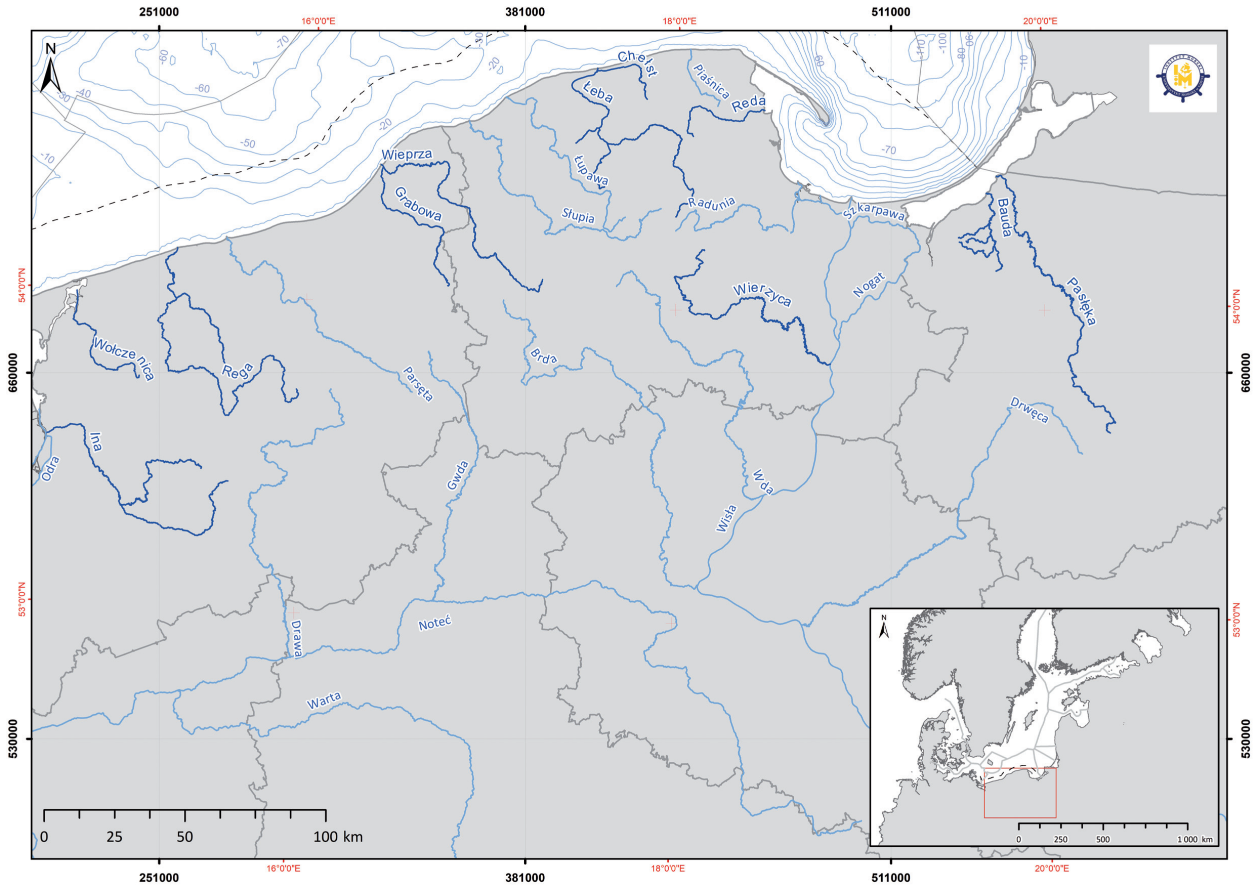

Figure 1. Location of rivers studied (dark blue).

Table 1
Summary of basic information about the rivers studied (nd – no data)

River name	Recipient	Total length (km)	Catchment area (km^2)	Mean flow (SSQ) (m^3 s^{-1})	First barrages: Distance (km)	First barrages: Fish pass type
Bauda	Vistula Lagoon	58.0	342.0	2.8	43.3	-
Chełst	Baltic Sea via Srabsko Lake	32.0	189.0	2.0	15.2	weir gate dismantled
Grabowa	Baltic Sea via Wieprza estuary	70.0	535.0	6.5	11.0	vertical slot
Ina	Szczecin Lagoon	129.1	2151.0	10.0	60.0	pool & weir
Łeba	Baltic Sea via Łebsko Lake	117.0	1801.0	18.5	48.5	pool & weir
Pasłęka	Vistula Lagoon	185.0	2294.0	14.8	9.7	seminatural pool & weir
Reda	Puck Bay (Gulf of Gdańsk)	44.9	485.0	5.5	9.5	-
Rega	Baltic Sea	199.0	2725.0	20.0	15.3	vertical slot
Wieprza	Baltic Sea	133.0	2213.0	17.0	3.3	seminatural pool & weir
Wierzyca	Vistula river	177.3	1600.0	8.9	5.9	-
Wołczenica	Kamieński Lagoon	52.3	494.0	nd	34.0	-

The Grabowa River is the largest tributary of the Wieprza River, the source of which is in the Polanowska Upland at an altitude of 170 m above sea level. Originally, in the early nineteenth century, it flowed directly into the Baltic Sea near the town of Bobolin. Currently, it flows into the Wieprza estuary in Darłówek. The Grabowa riverbed has been anthropogenically transformed for the most part as a result of regulations implemented up to the first half of the twentieth century. In its lower section, the Grabowa is completely canalized and flows in a straight, partially embanked channel through drained agricultural land. Its natural, upland character is preserved only in its upper course and on its smaller tributaries. The most common fish species are three-spined stickleback (*Gasterosteus aculeatus* L.) and migratory and resident brown trout (Dębowski et al. 2002b).

The source of the Ina River is at an altitude of 118.5 m above sea level. The Ina River basin covers the southeastern part of the Szczecin Lowland, the upper, western part of the Drawsko Lakeland, and the northeastern part of the Myślibórz Lakeland, and it flows into the lower Oder River near the Szczecin Lagoon. The individual morphometric parameters of the Ina River and its tributaries are characterised by great diversity. The most common, abundant species in the river system are perch (*Perca fluviatilis* L.), roach (*Rutilus rutilus* (L.)), gudgeon (50%) and both migratory and resident brown trout (Keszka et al. 2013).

The Łeba River is one of the rivers of the Baltic Coast that begins in the Kashubian Lakeland and then flows through the Reda and Łeba Proglacial Valley and the Słowińskie Coast. In its upper reaches it flows through a number of lakes. In the middle reaches there are several weirs, mainly for the needs of fish farming. In its lower reaches it flows through the coastal Lake Łebsko and then into the Baltic Sea in Łeba. The most common fish species are brown trout, three-spined stickleback and ninespine stickleback (*Pungitius pungitius* L.) (Dębowski et al. 2002).

The Pasłęka River flows out of Lake Pasłęk in the Olsztyn Lakeland at an altitude of 153 m above sea level. From its source to the city of Braniewo, it flows within the boundaries of the *Ostoja bobrów na rzece Pasłęce* nature reserve. Its upper catchment area lies in the Olsztyn Lakeland and flows into the Vistula Lagoon on the Old Prussian Coast. In its upper course, it flows through several lakes, and in its lower course, through a reservoir created by the dam at the Pierzchały hydropower station, which is the terminal barrier for anadromous salmonids. The most common fish species are gudgeon, minnow, roach, and bullhead (Dębowski et al. 2004).

The Reda River begins at an altitude of 49 m above sea level, and flows through a common valley with the Łeba River. Initially, it flows through a wide, marshy valley used for agriculture. Further along, it flows through Lake Orle. In the middle part, below the lake and a cement plant weir, the river accelerates flowing strongly as it meanders. In the lower part, the river slows down and enters the coastal marshy plain where the riverbed is straight and regulated. The weir in Ciechocino drains part of the river waters into the Łyski Channel, then it flows into the Puck Bay. The most common and numerous fishes are migratory and resident brown trout and three-spined stickleback (Radtke et al. 2007).

The Rega River flows from its source in the Połczyn-Zdrój region at an altitude of 177.5 m above sea level. The landscape and character of the sections of the river are different. In its upper course, it flows through a rather shallow, partly forested valley. The lower course of the river has been significantly changed by land improvement and hydrotechnical development, while the tributaries of the Rega remain largely in their natural states. The most common, numerous fish species are migratory and resident brown trout and gudgeon (Radkta et al. 2010).

The source of the Wieprza River is located at an altitude of 187 m above sea level in the Bytów Lakeland. It flows north through the Polanów Upland and the Koszalin Coast and flows into the sea near Darłowo. Large parts of the river basin are characterized by a high slope and a gravel-rocky bottom. They are inhabited by numerous populations of lithophilous fishes. However, there is a significant number of hydrotechnical structures throughout the river basin. The most common fishes are brown trout, three-stickleback, and bullhead (Dębowski et al. 2002b).

The Wierzyca River is a left-bank tributary of the Vistula and its source is located in the Kashubian Lakeland. Its natural character has been largely preserved, especially below the mouth of its largest tributary, the Wietcisa River. The river in this section is of a submontane character, cutting deeply into the surrounding terrain. Similar breakthrough fragments of the river are also located in the lower reaches up to the mouth to the Vistula River. At the same time, there are several significant hydrotechnical structures on this section, which dam water for small hydroelectric power plants. The most common fishes are brown trout, roach, perch, and minnow (Radtke and Grochowski 1999).

The Wołczenica River is located in the northern part of the Szczecin Lowland, and its source is located north of Nowogard at an altitude of about 47.5 m above sea level. From the beginning of its course to its mouth, the Wołczenica flows in a north-westerly direction. The river flows into the Dziwna River in the southern part of the Kamieński Reservoir. The Wołczenica riverbed underwent regulation works several times in the last century along nearly the entire length of its course. There is a lack of comprehensive data on the composition of ichthyofauna, but migratory and resident brown trout have been stocked into it (Tański et al. 2018).

Sampling

River lamprey spawners were sampled using dedicated traps. The trap is a 1.5-m-long wingless fyke-net. The first hoop in the trap is comprised of a semi-circle that is 60 cm wide and 35 cm high. The rims are trimmed with a dark twine netting with a mesh size of 8 mm (Radtke and Kuczyński 2020). The traps were deployed at selected, relatively shallow sites with stable currents and attached with a metal rod driven into the river bottom (Fig. 2). In some cases, and only when it was not possible to safely enter the river, the traps were connected together and attached to the bottom with an anchor (Fig. 3).

Catches were conducted six times during two river lamprey migration periods: the fall season from the end of October to December 2016 and the spring

Figure 2. Set of lamprey traps at a sampling site.

Figure 3. Set of connected lamprey traps anchored to the bottom.

Table 2
Sampling dates and site numbers

River name	Sampling event date I	II	III	IV	V	VI	Num. of sampling sites
Bauda	27 Oct. '16	15 Nov. '16	07 Dec. '16	25 Mar. '17	21 Apr. '17	18 May '17	4
Chełst	1 Nov. '16	17 Nov. '16	09 Dec. '16	23 Mar. '17	22 Apr. '17	22 May '17	3
Grabowa	4 Nov. '16	18 Nov. '16	12 Dec. '16	28 Mar. '17	23 Apr. '17	15 May '17	2
Ina	3 Nov. '16	21 Nov. '16	10 Dec. '16	27 Mar. '17	24 Apr. '17	14 May '17	4
Łeba	1 Nov. '16	17 Nov. '16	09 Dec. '16	23 Mar. '17	22 Apr. '17	22 May '17	3
Pasłęka	27 Oct. '16	15 Nov. '16	07 Dec. '16	25 Mar. '17	21 Apr. '17	18 May '17	4
Reda	1 Nov. '16	17 Nov. '16	20 Dec. '16	24 Mar. '17	22 Apr. '17	22 May '17	2
Rega	3 Nov. '16	20 Nov. '16	11 Dec. '16	27 Mar. '17	24 Apr. '17	14 May '17	4
Wieprza	4 Nov. '16	18 Nov. '16	12 Dec. '16	28 Mar. '17	23 Apr. '17	15 May '17	6
Wierzyca	28 Oct. '16	16 Nov. '16	08 Dec. '16	26 Mar. '17	20 Apr. '17	16 May '17	2
Wołczenica	3 Nov. '16	21 Nov. '16	10 Dec. '16	27 Mar. '17	24 Apr. '17	14 May '17	2

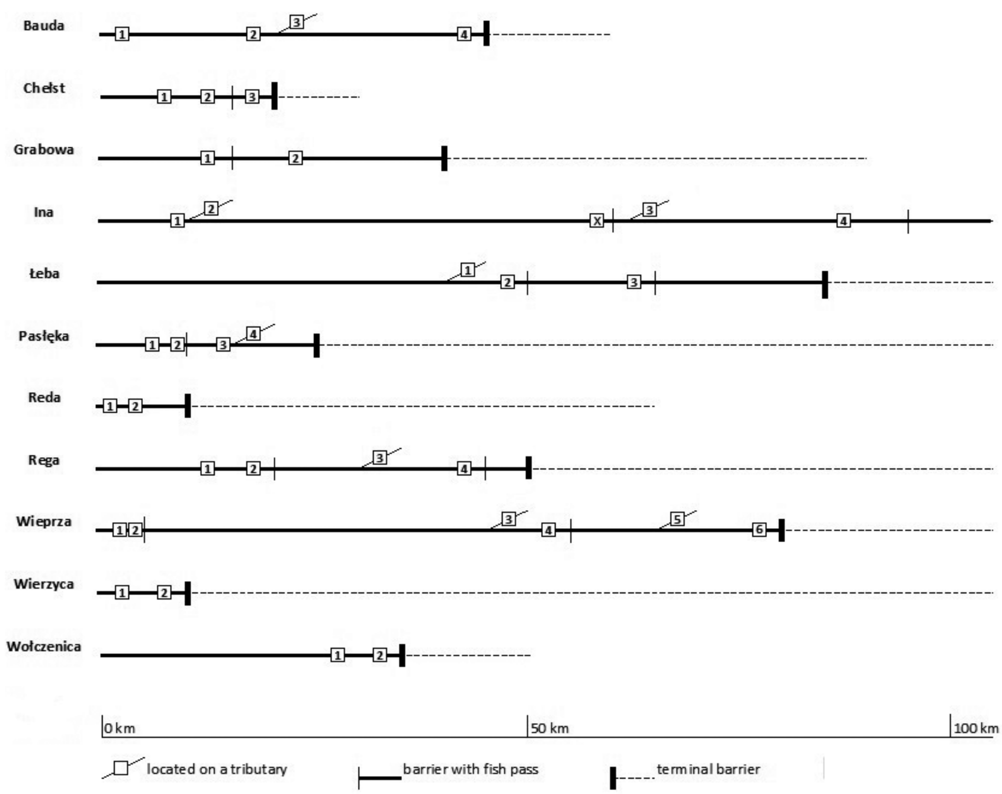

Figure 4. Diagram of the arrangement of sampling sites on the rivers studied in relation to fish migration obstacles (x – location from which traps were stolen).

season and from April to May 2017 (Table 2). During each sampling event, three traps were set overnight on sampling sites located on river sections below migration barriers and above those with fish passes (Fig. 4). At a sampling site located on the Ina River below the weir in the town of Stargard, the traps were stolen during the first two fall sampling sessions. Therefore, fishing was ceased in this place, and these data are not included in the results.

All fishes caught were sorted for species identification and then were released back into the rivers.

Results

From fall 2016 to spring 2017, 3,026 specimens of 29 fish species were caught at all the sites investigated. The most abundant (relative abundance RA=35.1%), frequent species was river lamprey (n=1062, FO=90.9%), which was recorded in 10 of the 11 rivers (Table 3). The only river in which river lamprey was not recorded was the Wołczenica. In the total catch, two of the subdominant species, European smelt, *Osmerus eperlanus* (L.), (n=539, RA=17.8%) and ruffe (*Gymnocephalus cernua* (L.)), were only noted in three rivers each (FO=27.3%). Gudgeon (n=394, RA=13%, FO=72.7%) was the second most frequent species and was relatively abundant. Other significant species included stone loach (n=129, RA=4.3%, FO=45.5%), perch (n=105, RA=3.5%, FO=63.6%), and roach (n=48, RA=1.6%,

Table 3
Fish species occurrence and abundance on studied rivers (Ba – Bauda, Ch – Chełst, GR – Grabowa, In – Ina, Łe – Łeba, Pa – Pasłęka, Rd – Reda, Rg – Rega, Wp – Wieprza, Wr – Wierzyca, Wł – Wołczenica, n – total abundance, RA – relative abundance, FO – frequency of occrrence)

		Species occurence per river												RA	FO
No.	Species	Ba	Ch	Gr	In	Łe	Pa	Rd	Rg	Wp	Wr	Wł	n	(%)	(%)
1.	*Lampetra fluviatilis*	+	+	+	+	+	+	+	+	+	+		1062	35.1	90.9
2.	*Osmerus eperlanus*	+					+			+			539	17.8	27.3
3.	*Gymnocephalus cernua*		+		+					+			514	17	27.3
4.	*Gobio gobio*	+	+		+		+		+	+	+	+	394	13	72.7
5.	*Barbatula barbatula*	+				+	+	+	+				129	4.3	45.5
6.	*Perca fluviatilis*	+	+		+	+		+		+		+	105	3.5	63.6
7.	*Rutilus rutilus*		+		+	+		+		+	+		48	1.6	54.5
8.	*Phoxinus phoxinus*	+								+	+		46	1.5	27.3
9.	*Gasterosteus aculeatus*	+		+				+	+	+	+		45	1.5	54.5
10.	*Leuciscus leuciscus*	+					+			+			32	1.1	27.3
11.	*Lota lota*				+				+	+	+		26	0.9	36.4
12.	*Cottus gobio*	+			+				+	+	+		19	0.6	45.5
13.	*Salmo trutta*	+	+	+	+	+	+		+				14	0.5	63.6
14.	*Blicca bjoerkna*										+	+	11	0.4	18.2
15.	*Alburnus alburnus*	+											8	0.3	9.1
16.	*Neogobius melanostomus*				+			+		+			6	0.2	27.3
17.	*Vimba vimba*										+		5	0.2	9.1
18.	*Neogobius fluviatilis*	+											4	0.1	9.1
19.	*Carassius gibelio*				+								3	0.1	9.1
20.	*Squalius cephalus*						+						3	0.1	9.1
21.	*Tinca tinca*				+								3	0.1	9.1
22.	*Babka gymnotrachelus*						+				+		2	0.1	18.2
23.	*Misgurnus fossilis*						+						2	0.1	9.1
24.	*Anguilla anguilla*				+								1	<0.1	9.1
25.	*Ballerus sapa*										+		1	<0.1	9.1
26.	*Cobitis taenia*				+								1	<0.1	9.1
27.	*Lampetra planeri*					+							1	<0.1	9.1
28.	*Pungitius pungitius*			+									1	<0.1	9.1
29.	*Salvelinus* sp.			+									1	<0.1	9.1

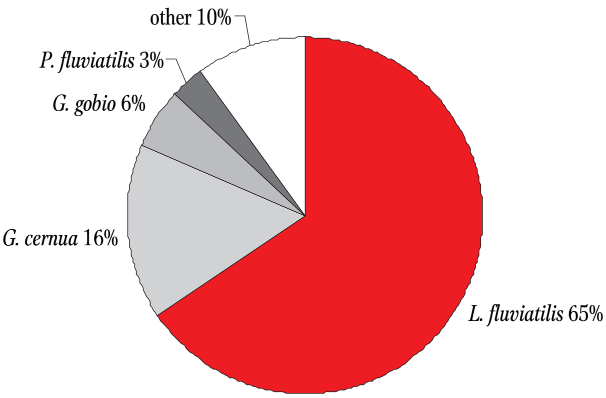

Figure 5. Relative abundance of the most numerous species in fall sampling events.

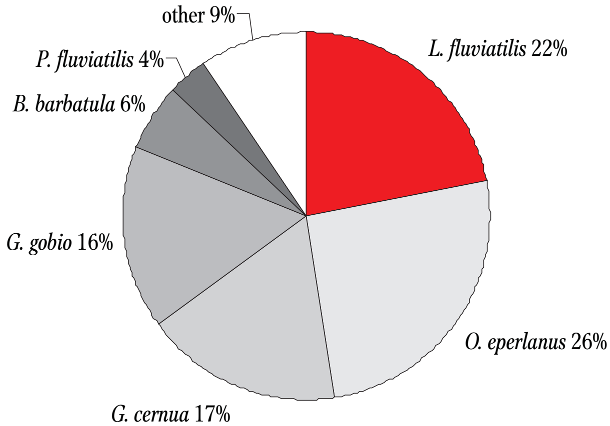

Figure 6. Relative abundance of the most numerous species in spring sampling events.

FO=54.5%). Brown trout, was also among the high frequency species (FO=63,6%), but only 14 specimens (RA=0.5%), mainly juveniles, were recorded.

Total number and structure of species abundance differed between seasons. During three fall sampling events a total of 920 fishes of 19 species were caught. The dominant species was river lamprey (n=602) at 65% of the number of all fishes (Fig. 5), followed by ruffe (n=147, RA=16%), gudgeon (n=52, RA=5.7), perch (n=26, RA=2.8%), and burbot, *Lota lota* (L.), (n=22, RA=2.4%). Fourteen other species were represented by only single or a few specimens.

During spring sampling, over two times more fishes were caught (n=2,106) and the structure of species abundance was more diverse. River lamprey spawners in spring accounted for just 22% of the total number of fishes and were less abundant (n=460) than they were during the fall run (Fig. 6). The most abundant species was European smelt (n=539), but 98% of them were caught at one site on the Bauda River during just one sampling event. The other species were ruffe (n=367, RA=26%), gudgeon (n=342, RA=17%), stone loach (n=123, RA=68%), perch (n=79, RA=4%), minnow (n=46, RA=2.2%), roach (n=41, RA=2%), and three-spined stickleback (n=37, RA=1.8%). Fifteen other species were represented by only single or a few specimens.

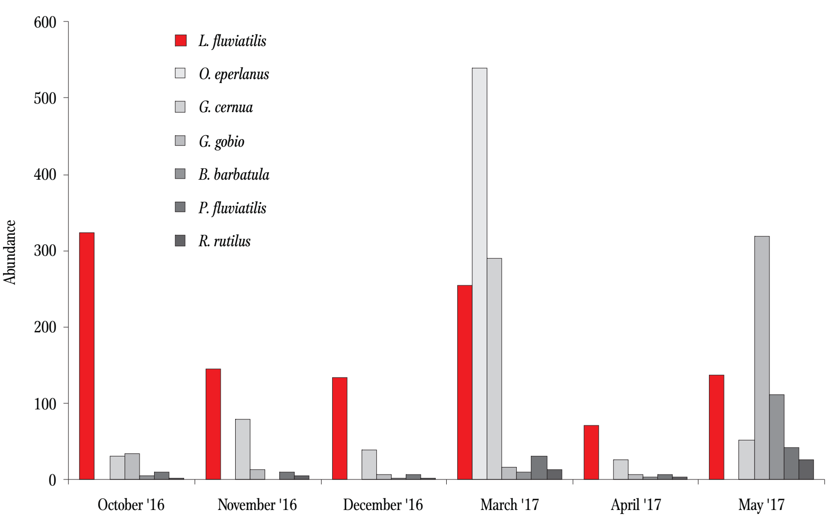

Figure 7. Abundance distribution of the most numerous species in each sampling event.

River lamprey occurred throughout the survey period (mean n=177, mean RA=46%), and during fall sampling and once in spring, it was the most numerous species in the total catch (Fig. 7). The highest number of lamprey (n=324) was recorded in October 2016. In March 2017, two species appeared to be more abundant. The dominant was smelt (n=539, RA=46%), but it only occurred during the sampling events in the lower parts of the Bauda and Pasłęka rivers. The subsequent most numerous species were ruffe n=(290, RA=35%) and river lamprey (n=254, RA=22%). In last sampling in May 2017, river lamprey

Table 4
Distribution of river lampreys abundance at sampling sites (_ – sites located above the barrier with fishpasses)

	Number of *L. fluviatilis* individuals per sample site							
River name	1.	2.	3.	4.	5.	6.	Total (n)	% of fish abundance
Bauda	4	3	4	5	-	-	16	2.0
Chełst	1	1	0	-	-	-	2	0.9
Grabowa	68	0	-	-	-	-	68	75.5
Ina	3	0	0	0	-	-	3	0.5
Łeba	1	21	0	-	-	-	22	56.0
Pasłęka	254	50	0	0	-	-	254	87.0
Reda	22	9	-	-	-	-	31	61.0
Rega	32	26	2	0	-	-	60	74.0
Wieprza	112	328	0	0	0	0	440	72.5
Wierzyca	59	57	-	-	-	-	116	80.5
Wołczenica	0	0	-	-	-	-	0	0

spawners were only 17.5% of the number of fishes (n=136). The dominant species was gudgeon (n=319, RA=41%), and the third most numerous species was stone loach (n=111, RA=14%).

The distribution of river lamprey spawner abundance per sampled river ranged from two to 440 specimens (Table 4). The highest number of lamprey was caught in the Wieprza (n=440), Pasłęka (n=254), and Wierzyca (n=116) rivers. Adult river lamprey was not recorded in the Wołczenica River and only two to three specimens were caught in the Chełst and Ina rivers. In other rivers, lamprey abundance ranged from 16 in the Bauda River to 68 specimens in the Grabowa River. In most of the rivers studied, river lamprey was the main species in the catches comprising from 52 to 87% of the number of fishes. The exceptions were the Bauda, Ina and Chełst rivers, in which relative abundance was significantly lower at 0.5 to 2%.

Lamprey was recorded at 58% of the 36 sites sampled. Only in the Mołstowa River, a tributary of the Rega River, were two specimens of river lamprey recorded above a barrage with a fish pass. In all the other rivers, lamprey was only noted at sampling sites below the first obstacle.

Discussion

In many rivers of the northern and eastern Baltic Sea region (Sweden, Finland, Estonia, Latvia), the river lamprey occurs in large numbers during spawning migrations and plays an important role in freshwater commercial fisheries (Sjöberg 2011, Almeida et al. 2021). In mid-twentieth century Poland, catches of this species were considerable in the lower Vistula River (Jokiel 1983, Thiel et al. 2009). Since 2004, all lamprey species in Poland have been protected under both EU and national law. The data presented here are the first from this period regarding the occurrence of river lamprey in Poland. The field surveys reported on in this paper were performed in accordance with guidelines for monitoring river lamprey protection status by National Environmental Monitoring for Habitat Directive reporting purposes (Kuczyński et al. 2018, Kuczyński 2022). Since one of the indicators used to assess lamprey habitat conditions is the ecological connectivity of rivers, a dedicated method for estimating river lamprey spawner migration range was developed (Radtke and Kuczyński 2020). Dedicated traps were proved to be effective in catching river lamprey spawners. This gear bears some resemblance to that used in some rivers for traditional fishing in Latvia (Abersons and Birzaks 2014) although it is definitely smaller. The low profile of the traps used is probably one of the reasons there was no significant by-catch, especially of anadromous salmonid fishes during the fall migration. The most common species in the by-catch were bottom-dwelling species like gudgeon and stone loach and smelt and ruffe in some rivers in which these species occurred in high abundance. Abundance peaks of non-targeted species were only observed during short periods in spring when anadromous smelt and most potamodromous freshwater fish species were ascending rivers in spawning migrations (Benitez et al. 2015, Benitez et al. 2018, Kotusz et al. 2006). Although all lamprey spawn in the spring, some anadromous species ascend fresh waters as much as a few months before. River lamprey spawning migration is relatively long and occurs between October to May of the next year.

With the exception of the Wołczenica River, river lamprey spawners were confirmed in all the rivers that were sampled during this study. This permits drawing the conclusion that it still has a wide range of occurrence in the rivers of northern Poland. There is no clear explanation for the absence of or too few specimens to detect river lamprey in the Wołczenica River. River lamprey, unlike salmonids, do not exhibit homing behavior. During spawning migrations, spawners are attracted to rivers by both fresh water and pheromones released by their larvae inhabiting rivers (Moser et al. 2015). The Wołczenica River flows into the Kamieński Lagoon via the Rozwarowo Swamps through a common outlet with other watercourses. The discharge of many rivers in Pomerania in recent years has diminished because of drought (Brzeźińska et al. 2023), and this may be the reason why few adult river lamprey migrated from the sea to freshwater for spawning in the Wołczenica River .

The distribution of adult river lamprey at the all sampling sites investigated during the survey showed that, with only one exception in Rega River, all barriers limit upstream migration even if fish passes are installed on rivers. Similarly to other Petromyzontidae species, river lamprey are poor swimmers although they are capable of passing some barriers, even in fast-flowing currents, by swimming in the boundary water layer and using their suckers to attach to hard substrate for periods of rest (Lucas et al. 2001). However, fishes with elongated bodies that also lack paired fins to facilitate stability are likely to find turbulent environments challenging (Liao 2007). Some river lamprey specimens have been observed to negotiate water current velocities as high as 1.66 m s^{-1} (Kemp et al. 2011), but these observations were for single obstacles at relatively high water temperatures. When there are many successive spots in rivers with increased water velocity, during low water temperatures in fall and early spring, the ability to pass subsequent obstacles decreases. This phenomenon was observed during the current study on the fish pass in Braniewo on the Pasłęka River when river lamprey was only observed in the first few pools. This confirms observations from fish passes on Finnish rivers (Laine et al. 1998). Furthermore, unlike pacific lamprey, *Entosphenus tridentatus* (Richardson), river lamprey are unable to climb steep slopes (Russon et al. 2011, Keefer et al. 2010, 2011) or jump, so weirs and riffles are often impassable. The combination of all these features means most fish passes are insufficient for river lamprey (Haro and Kynard 1997, Laine et al. 1998, Lucas et al. 2001). Consequently, the real migration range of river lamprey spawners is, in many cases, significantly smaller than that of diadromous salmonids. These phenomena significantly restrict the migratory range to optimal habitats essential for the reproduction and larval growth of river lamprey (Lucas et al., 2009, Mateus et al. 2012, Foulds and Lucas 2013, Aronsuu et al. 2015). These habitats are typically situated in the upper reaches of river basins and smaller tributaries. Consequently, this restriction adversely affects population sizes. This assertion finds support in electrofishing studies targeting larvae in the lower sections of rivers that were conducted downstream of impoundments delineating migration boundaries that revealed the absence or only minimal presence of lamprey larvae (Kuczyński 2023). Observations like these underscore the limited reproductive efficacy of river lamprey in the lower reaches of rivers despite documented instances of spawning.

However, the method used does not allow for stock size assessment, and there were significant differences in abundance among rivers. The highest number of lamprey were recorded below the barrages in the lower sections of the Wieprza, Pasłęka, and Wierzyca rivers. Only two of a total of 60 specimens from the Rega River were caught in a tributary above the first dam with a vertical slot fishpass, and none were recorded approaching the next barrage in the main river. The results from the Rega River led to the conclusion that even if some fish are able to overcome the fish pass, it is still a significant obstacle limiting the abundance of the migrating population upstream. For comparison, on the Bauda River, where are no barriers for relatively long sections, lamprey numbers were significantly lower in total but similar at each sampling site. The lack of obstacles that are difficult to overcome, where migrating fishes gather, may also be one of the reasons for the low number of river lamprey detected in the lower section of the Ina River. Therefore, the results of the research conducted with this method should be treated as data on river lamprey occurrence and not on population size. On the other hand, successfully repeated surveys over long periods of time may provide some information on the dynamics of river lamprey stocks in the rivers of northern Poland.

Based on the outcomes of this monitoring initiative, it can be concluded that river lamprey remains a consistent component of the anadromous ichthyofauna in northern Poland. Nevertheless, the principal threat to river lamprey populations, which undermines prospects for its effective conservation, is the fragmentation of river basins. This fragmentation establishes migratory impasses and squanders reproductive potential. Despite river lamprey being under protection since 2004, this confirms the justification for increasing the category of river lamprey threat from vulnerable (VU) to endangered (EN) in the updated (after 20 years) Red List of Polish Vertebrates (Głowaciński 2022).

Acknowledgments. The field surveys presented in this paper were conducted under the project "Pilot implementation of species and marine habitat monitoring in 2015-2018" conducted by the Maritime Institute in Gdańsk and commissioned by the Chief Inspectorate for Environmental Protection, Poland.

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