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Fishing Gear Used for River Lamprey *Lampetra fluviatilis* (L.) Catches

Documenting Rivers that Flow into the Baltic Sea

Part I, Sweden

ABSTRACT The river lamprey (*Lampetra fluviatilis* (L.)) is an anadromous fish that has a growth phase in the sea, then migrates up rivers mainly during autumn for spawning next spring. It is during this spawning migration the lampreys are caught in rivers. Lamprey fishing has been documented in the Baltic Sea region at least since the fifteenth century, and some of the fishing gear used has remained largely unchanged for hundreds of years. In recent decades however, new material has replaced wood, although the design of the gear is still often the same as before. In this study lamprey rivers in Sweden, Finland, Latvia and Estonia were visited and the lamprey fishing gear was documented. There are differences in the use of fishing gear both within countries and among countries as regards gear type and the ways in which the fishermen use different fishing techniques to suit the conditions found in various rivers.

KEYWORDS river lamprey, *Lampetra fluviatilis* (L.), river lamprey fishing, fishing gear, Baltic Sea area

Introduction

Fishing for river lamprey (*Lampetra fluviatilis* (L.)) has a long tradition along the European coastal rivers. The distribution of the species ranges from Southern Norway, via the Baltic Sea and North Sea coasts, in Britain up to Northern Scotland, around Ireland, along the Atlantic coast of France and the Iberian Peninsula and into the Mediterranean (e.g. Hardisty 1986*b*; Kelly & King 2001; Maitland 2003). The catches of the lampreys have decreased or ceased during the last decades, to some extent certainly because of changes in consumption habits, but also because of water pollution and obstacles to lamprey migration like hydropower stations and water reservoirs that have restricted access to areas of suitable habitats for spawning and larval development (e.g. Hardisty 1986*a*; Birzaks & Aberson 2011). There does not seem to be any important river lamprey fishing in coastal German and Polish rivers today, but in older times the river lamprey was a commercially exploited fish in for example the rivers Vistula, Oder, Elbe, Weser, and Rhine (e.g. Selegio 1926; Imam *et al.* 1958; Sterba 1962; Hardisty 1986*a*). According to Frimodt (1995): "River lampreys were once a common part of the European cuisine, from Portugal to Finland." In Britain, river lampreys are still fished for, but they are used as bait for fishing (Maitland 2003; Hardisty 2006; Masters *et al*. 2006), apparently not for human consumption nowadays, and that seems to be the case also in Ireland (Igoe *et al*. 2004).

However, in the Baltic Sea area there is still lamprey fishing for food with traditional fishing gear (Sjöberg 2011). Although river lamprey fishing is decreasing there too compared to a few decades ago, it is still performed in rivers emptying into the Gulf of Bothnia, that is, the northern part of the Baltic Sea, both along the lower sections of the Swedish coastal rivers (Soler & Nathanson 2006; Nathanson & Liby 2007; Sjöberg 2011), and along the Finnish side (Tuunainen *et al*. 1980; Tuunainen *et al.* 1986; Seppälä & Sarell 2002; Lehtonen 2006; Aronsuu 2011*a*; Aronsuu 2011*b*; Aronsuu 2011*c*; Aronsuu & Tuohino 2011; Kaski & Oikarinen 2011).

In the southern Baltic region, river lamprey fishing is still important, particularly in Estonia and Latvia (Ojaveer & Gaumiga 1995; Riekstiņš 1999; Saat *et al*. 2003; Kangur *et al*. 2005; Oras (ed.) 2007; Püttsepp & Järv 2010; Riekstiņš *et al*. (eds.) 2010; Birzaks & Abersons 2011).

The river lampreys are caught during their spawning migration into the rivers after having spent a growth period in the sea (for general information about the ecology of the river lamprey, see e.g., Hardisty & Potter (eds.) 1971; Hardisty 1986*a*; Hardisty 1986*b*; and Maitland 2003). The migration takes place in the autumn in the Swedish and Finnish rivers, although it is also possible to catch them during the winter (Sjöberg 1980; Tuunainen *et al*.

1980). The season starts in late August or early September and normally ends in late October or early November when ice forms. In Latvia and Estonia too most of the catches are taken during the autumn, mainly in October and November, but there the season is prolonged compared to the situation in the northern rivers. In the southern Baltic, spring migration has also been documented in some rivers (e.g. Imam *et al*. 1958; Tuunainen *et al*. 1980; Witkowski & Kuszewski 1995). The lampreys are active and migrate during dark nights. During daytime, the lampreys hide on the bottom, under stones and vegetation (e.g. Maitland 2003), so the fishing is in most cases adapted to this (but see the section about Estonia in Part II of this article in the forthcoming issue of the *Journal of Northern Studies*). In Finland the fishing season is between 16 August and 31 March. In Latvia the season starts on 1 August and ends 1 February, in Estonia there is a closed season between 1 March and 1 July. There are no general juridical regulations for lamprey fishing in Sweden.

Hardisty has concluded that:

> For any device aimed at catching upstream migrating fish, the basic design has been broadly similar throughout northern Europe. Any differences in fishing gear are mainly due to the materials available locally for their construction and the physical characteristics of the river in which they are used. In particular, variation in construction will be dictated by the strength of the currents, the width of the channel, the nature of the river bed and the rise and fall of the tides. Nevertheless, the fact that similar types of fish baskets are used in widely separated parts of Europe suggests that the principles involved were already appreciated in prehistoric times and that the design of these traps has since undergone very little modification. (Hardisty 2006.)

The generalisation above is certainly true also for the Baltic Sea area. The types of fishing gear have not changed much in most of the region during recent time, although the material of the gear varies (Storå 1978; Sjöberg 1982; Sjöberg 2011). However, there is a surprisingly large variation in the modifications and application of river lamprey gear in the area, and there are distinct differences both between and within the countries involved in this study as regards lamprey gear and its applications in different fishing methods.

Brinkhuizen (1983) and Gabriel *et al*. (eds.) (2005) make a distinction between active and passive fishing. Active fishing is when the fishermen search for the fish and try to catch it, while with passive fishing the fishermen periodically collect the fish that have been caught in traps or nets. Many lamprey river fishermen in this study have described catching lam-

preys manually, with mittens on their hands to get a better grip on the fish, and the use of nets to catch lampreys attached to hydroelectric plant dams. However, this article concentrates on gear for passive fishing in Sweden, Finland, Latvia and Estonia. The development of the gear as regards type and material during the last decades is demonstrated when possible. The differences between gear types and the methods for using them in different regions and countries are discussed in relation to local tradition, ecology of the river lamprey and physical conditions of rivers.

Thus, the present publication is focused on the fishing gear and how it is used in different regions and countries around the Baltic Sea. It is divided into two parts. In this first part the lamprey fishing in Sweden is described. In a following second part—to be published in the *Journal of Northern Studies*, volume 7, number 2, 2013—the situation in Finland, Latvia and Estonia will be treated. In an earlier publication (Sjöberg 2011) a more general view of the river lamprey fishing in the Baltic Sea area is presented.

Study Area, Material and Methods

The northern rivers in this study are situated at the Fennoscandian Shield, which encompasses roughly the northern half of Sweden, all of Finland, and the westernmost part of European Russia (Tockner *et al.* (eds.) 2009). Cushing *et al*. (eds.) (2006) include the Swedish and Finnish rivers involved in this study in the group Boreal Forest Rivers, which is a subdivision of rivers in the Nordic countries. It is characterized by thin soils overlaying granite/gneiss crystalline-rock substrate. The gradient of this group of rivers tends to be higher than for the southern groups, which has made them more suitable for hydroelectric power and is the reason why many of the rivers have been transformed into a staircase of power plants and their associated reservoirs (Cushing *et al*. (eds.) 2006). The consequence has been that formerly important lamprey fishing has ceased, as the migrating lampreys are stopped at the dams. Furthermore, large areas of spawning habitats and habitats for larvae development have been destroyed by river exploitation. The water level during the year is regulated and can vary dramatically during a 24-hour period, which further could negatively influence the areas where the lamprey larvae grow. Examples are the rivers Luleälven, Umeälven, Ljungan, Ljusnan and Dalälven in Sweden, and the rivers Kemijoki and Oulujoki in Finland. The fish ladders in those rivers are mainly constructed for salmon and trout, and are not suitable for lamprey, although some attempts to improve them have been made in Finland (e. g. Laine *et al*. 1998; Aronsuu 2011*b*).

According to Tockner *et al.* (eds.) (2009), the rivers in Estonia and Lat-

via belong to the Baltic and Eastern Continental Rivers. The larger rivers in this subdivision are meandering, lowland rivers fringed by vast floodplains. They are regulated to some extent, modifying flood regimes and suppressing the migration of fishes (Tockner *et al*. (eds.) 2009). The region is characterized by sedimentary rocks of the same type as the big islands in the Baltic Sea, like Gotland, Öland, and Ösel. The boundary between the sedimentary rock types in the south and the Fennoscandian bedrock passes through the Baltic via The Gulf of Finland and further towards the Lake Ladoga (Petersson 2008).

This article is based on visits to 36 lamprey rivers (Fig. 1). Interviews with lamprey fishermen and documentation with photographs of gear and fishing sites were made in 2010, when 12 rivers were visited along the northern Swedish coast. In Finland 9 lamprey rivers were visited in 2010, from the River Torneälven/Tornionjoki in the north (the border between Sweden and Finland) to the River Kokemäenjoki in the south (emptying on the coast at the town Pori). In 2011, 14 rivers in Sweden and 8 in Finland were visited along the same coastal stretches as in 2010 and in 2012 additional information was collected from 9 rivers in Finland. Some complementary documentation was made in Swedish rivers in 2012 and 2013. In 2010 four lamprey rivers were also visited in Latvia, and in 2011 again four rivers. One river was visited in Estonia in 2011 and two in 2012. The results from those studies are compared with the situation back in 1978 from Northern Sweden and Finland (Sjöberg 1982) when 25 rivers were visited, and from Latvia back in 1992, when 4 rivers were visited.

According to the classification of catching methods in fisheries by Gabriel *et al*. (eds.) (2005), the lamprey gear presented in this article could be subsumed under the subtitle *traps* which

> are implements in which the fish enters voluntarily but is hampered from coming out. Usually in these traps there are one or more chambers which will be closed when the prey enters or which have a retarding device such as a gorge or a funnel. (Gabriel *et al.* (eds.) 2005.)

Under this subtitle there is a group of traps called *baskets*, mostly small traps, three-dimensional, with retarding devices, namely: (a) Pots (made of wood or wire or plastic, mostly without wings and leaders); (b) Conical and drum-like traps (made of netting with hoops and frames; mostly with wings and leaders; sometimes many fyke nets are combined in a catching system); and (c) Box-like traps (made of strong, mostly iron, frames).

Slack-Smith (2001) has a similar approach, when presenting fishing with traps and pots. Here traps are described as simple passive fishing gear

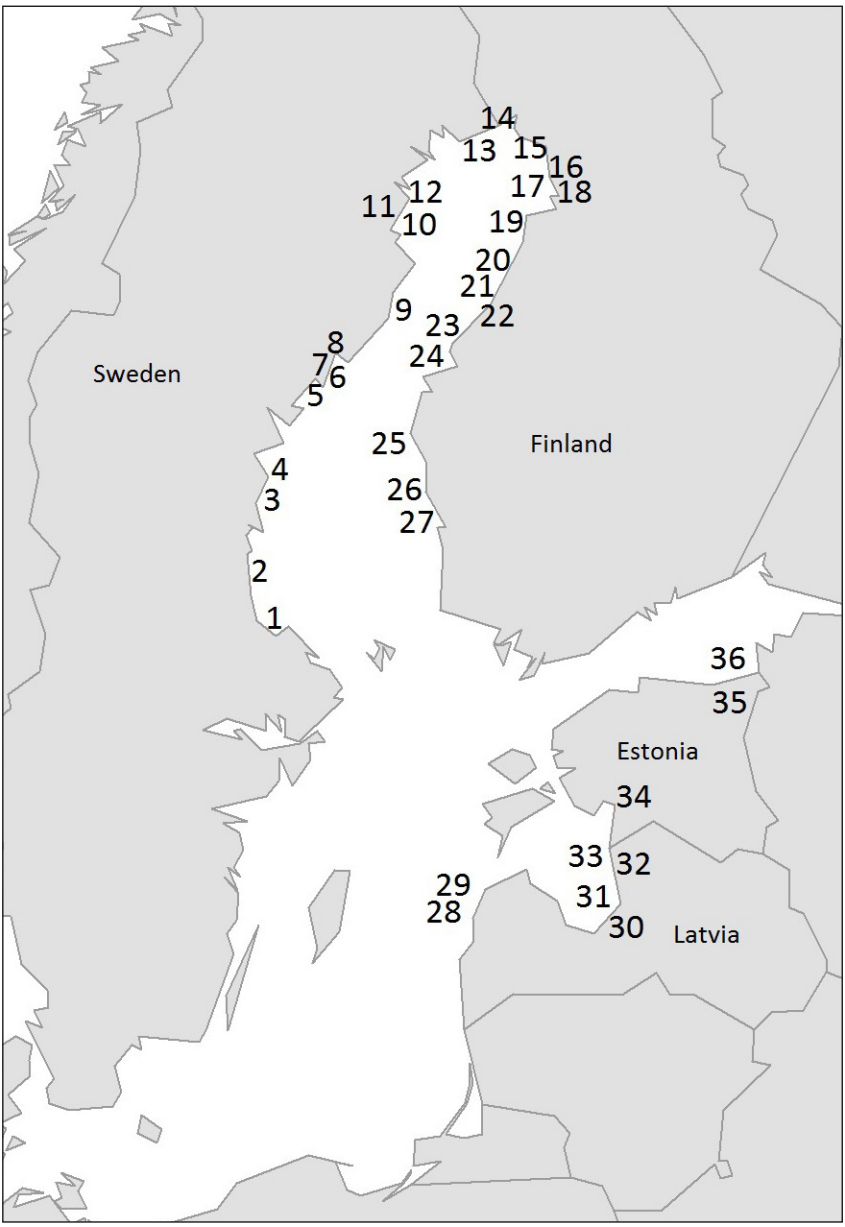

Fig. 1. The lamprey rivers visited during this study and the approximate locations where they flow into the Baltic Sea area:[1] 1. Dalälven; 2. Ljusnan; 3. Gnarpsån; 4. Ljungan; 5. Gideälven; 6. Öreälven; 7. Hörneån; 8. Umeälven; 9. Rickleån; 10. Byskeälven; 11. Åbyälven; 12. Piteälven; 13. Kalixälven; 14. Torneälven/Tornionjoki (the river separating Sweden and Finland); 15. Simojoki; 16. Kuivajoki; 17. Iijoki; 18. Kiiminkijoki; 19. Siikajoki; 20. Pyhäjoki; 21. Kalajoki; 22. Lestijoki; 23. Perhonjoki; 24. Kyrönjoki; 25. Tjöckån/Tiukanjoki; 26. Merikarvianjoki; 27. Kokemäenjoki; 28. Užava; 29. Venta; 30. Daugava; 31. Gauja; 32. Svētupe; 33. Salaca; 34. Pärnu; 35. Toolse and 36. Narva.

that allows fish to enter and then makes it hard for them to escape, for example by putting chambers in the trap or pot that can be closed once the fish enter or have a funnel that makes it difficult for the fish to escape. Furthermore, in general, traps are large structures fixed to the shore. Pots are smaller, movable traps, enclosed baskets or boxes that are set from a boat or by hand (Slack-Smith 2001).

According to the general classification presented by Gabriel *et al*. (eds.) (2005) and Slack-Smith (2001) most, if not all, lamprey gear within the study area fit into the basket types of gear described above, and particularly so those called *pots*.

However, the terminology used for the different types of fishing gear in this article is as follows below. It is not my intention to create a new typology of the gear and methods used for fishing river lamprey in the Baltic Sea area, but it is an attempt to adjust the terminology to the situation in the Baltic Sea area, related to the gear used there. In Fig. 2 the appearance of gear of different groups is illustrated with examples.

Basket: A gear of willow shoots or twigs (osier basket) or other similar flexible material (juniper, spruce, rattan) is called a *basket* (in Swedish *kasse*, *nättingkasse*). The baskets are used both with and without lifting frames. They are either separately placed at the bottom of the river or attached to a weir or obstacle (Fig. 2a).

Log: A gear made of a piece of a hollowed tree trunk is called a *log* (in Swedish *stock* or *nättingstock*). They are normally without lifting frames, and never attached to a weir or obstacle (Fig. 2b). A gear made of wooden boards, square or rectangular in form, is also called a *log* (in Swedish a *stock* or *nättingtock*). They are normally without lifting frames, and never attached to a weir (Fig. 2c).

Pot: A gear made of wooden laths, cylindrical in form, is called a *pot*[2] (in Swedish *tina* or *nättingtina*). They are either placed separately at the bottom of the river or attached to a weir or obstacle (Fig. 2d).

Fyke net: A gear made of netting with hoops and with wings (leading arms) is called a *fyke net* (in Swedish *ryssja med ledarmar*) (Fig. 2e). A fyke net without wings is still called a *fyke net* (in Swedish *ryssja utan ledarmar*) (Fig. 2i).

Net gear: A gear made of netting, equipped with a lifting frame and attached to a weir is called a *net gear* (in Swedish *nättingtina av nät*) (Fig. 2h).

Fishing-net: A gear of finely woven fishing net is called a *fishing-net* (in Swedish *fisknät med täta maskor*) (Fig. 2j).

There are also variations (e.g. Fig. 2f) and combinations of these types, for example, a basket combined with a net (Fig. 2g).

Fig. 2k illustrates cones of plastic or similar material and is separated here as a particular type of lamprey fishing method, as they are placed in a

row at the bottom of the river, where they are attached side by side along a line or pole, and because they catch lampreys during daytime, not at night as all other gear described in this study.

Because some gear types often are equipped with lifting frames and attached to weirs of different constructions in different parts of a country and in different countries, there are short descriptions of those as well. A weir, or *pata* in Swedish (from Finnish *pato*, meaning a barrier in the stream, see Storå 1978) used for lamprey fishing in the studied area is originally a wooden construction, but nowadays sometimes of iron or steel, on which the fishing gear with lifting frames are attached side by side. By means of the weirs the fishermen can place their gear further out in the river with streaming water than otherwise would have been possible, as they are constructed in Sweden and Finland, or reach across a river, such as the weirs in the Latvian River Salaca. In Latvia a weir is called *tacis*.

However, what is called a *weir*, *obstacle*, *barrier* or *pata* in connection to lamprey fishing in the studied area is usually not a barrier as such to the upstream migrating lampreys, but it is the gear placed in the weir, barrier or *pata* that prevents the lampreys from continuing and makes them try to pass by entering into the gear, where they get trapped (e.g. Fig. 25). One exception is a type of weir in Latvia where the migration is prevented by adding sections of wooden barriers in the weir (e.g. Fig. 81 in the forthcoming Part II), and the gear used and its attachment to the weir are designed according to that situation (see section regarding Estonia in Part II).

The river lamprey is called *flodnejonöga* or *nätting* in Sweden, *nahkiainen* in Finland, *upes nêgis* in Latvia and *jõesilm* in Estonia.

Outline of the Variety of River Lamprey Fishing Gear and Methods in the Baltic Sea Area

Basically all the lamprey fishing gear in the studied area is constructed in the same way: a basket, log, pot or a fyke net with small mesh is equipped with one or more funnels with a small entrance in the end which leads the lampreys into the gear (an exception is a finely woven net). The gear (except the net) is usually placed with the entrance in a downstream direction (but there are exceptions here too, see below) on or close to the bottom, either singly, or together side by side in a weir, an obstacle, constructed mainly of wood, but nowadays sometimes iron. When the lampreys migrate up the river during the night they have to find their way among stones and other obstacles in the river. When they meet a gear, they try to pass it to continue the migration. As they are fairly weak swimmers they search for an easy way around. When they come to a fishing gear where the fishermen have tried to

Fig. 2. In this figure an overview of river lamprey gear of different types from the studied rivers is presented. 2a. *A basket constructed by willow, rattan, juniper or spruce, with or without lifting frames.* Traditional lamprey baskets earlier used in the River Umeälven. The basket on the left is made of willow, the second one of rattan, and the third one of willow. 2b. *A log from a tree trunk.* This example is from the River Piteälven. 2c. *A log constructed of wooden boards.* A traditional type of fishing gear, in this case from the River Rickleån in the province of Västerbotten, Sweden, where it still is in use. 2d. *A pot made from wooden laths*. This traditional type of wooden laths used for lamprey fishing is from the River Torneälven. 2e. *Fyke nets of different sizes*. Fyke net for lamprey catching demonstrated in the Finnish River Iijoki, 1978. 2f. *Other types of gear like rebuilt milk pots, rebuilt fire extinguishers, plastic tubes, etc.* Lamprey fishing gear from the River Rickleån. Besides the traditional logs of boards, an invention of gear constructed of milk cans is shown. 2g. *A basket combined with net.* This basket is combined with a net, which is attached to a lifting frame. Photo from the River Salaca, eastern Latvia, in 1992. 2h. *Gear of nets and with lifting frames.* A lamprey gear made by nets and attached to a lifting frame from the River Salaca in Eastern Latvia in 2011. 2i. *Fyke net without wings.* Fyke nets without wings in the River Ušava in Eastern Latvia in 2010. 2j. *Ordinary fishing-nets, tightly woven;* here presented as a drawing of a fishing-net. Ordinary fishing-nets adjusted to lamprey fishing by tightly woven nets are to some extent used in Latvia.[3] 2k. *Cone-formed gear of plastic and similar materials* used for river lamprey fishing in the River Pärnu in Estonia 2011. Photos: Kjell Sjöberg (except 2j).

make the passage around the gear difficult by sealing around it with spruce twigs, mosses or similar material, the lampreys are led towards the entrance in the gear, enter it, and are trapped. In the central part of the gear, regardless of its type or material, there is a funnel with a narrow entrance with a diameter just a bit larger than the thickness of the fish, which the lampreys have to pass to be able to continue. After that they are caught, because they cannot find the narrow entrance and escape backwards from the trap. Thus it is constructed on the same principle as other fish traps, but modified for the size and shape of the lamprey, and for the conditions in the rivers where the lampreys are caught. Several hundred lampreys can be caught in a single gear during one night. However, although the same technique is used, the gear looks different in different geographic regions.

Fig. 2 shows an overview of examples of gear used nowadays (or up to recently) in the different countries. Some of them represent original types, but some are modifications of the original ones, for example by using new materials. The overview also includes gear of similar types, but where the ways of using them are so different that they justify some attention. For details, see the respective sections about fishing in the different countries, presented below.

Table 1 illustrates how the different types of gear shown in Fig. 2 are related to the studied rivers in the different countries. The table also includes some older trap types that are no longer in use, but have been until recent decades. Also, changes in material used when constructing the gear, for example from willow shoots to plastic nets or glass fibre material are indicated. Generally, a certain degree of modernization in the shape and material of the original types of fishing gear is quite common at the fishing sites, but sometimes the changes are so pronounced that they are separated in a specific section in the table. For example, in the River Rickleå, old milk cans, earlier used for transporting milk from farms (Fig 2f; Fig. 17; Fig. 18), have been modified and are now used for lamprey fishing.

The most common trap type in Estonia has also been separated into a specific section in the table (Fig. 2k). Although the construction of the gear is in principle the same as in other lamprey traps, the way in which these gear are used distinguishes them from all other lamprey fishing gear in Sweden, Finland and Latvia. However, for more details, see the description of the fishing methods from the different countries below.

Description of Gear, Lifting Frames and Weirs Used in Different Countries within the Baltic Sea Area

In the following sections a short introduction to the lamprey fishing in the different countries involved in this study is presented, followed by descriptions of the gear used.

		a → a	b	c → c	d → d	e	f	g → h	i	j	k
	Sweden										
1	Dalälven				○ ●						
2	Ljusnan[5]			○ ○	○ ●						
3	Gnarpsån			○	● ●						
4	Ljungan				○ ●						
5	Gideälven		○	○			●				
6	Öreälven	○		● ●							
7	Hörneån			●							
8	Umeälven	○ ○		○ ○							
9	Rickleån	○	○	● ●			●				
10	Byskeälven		○	○ ●							
11	Åbyälven	○		● ●			●				
12	Piteälven	○	○				●				
13	Kalixälven	○ ●			○						
14a	Torneälven	○ ●			● ●						
	Finland										
14b	Tornionjoki	○			● ●	●					
15	Simojoki	● ●									
16	Kuivajoki	● ●									
17	Iijoki	○				●					
18	Kiiminkijoki	● ●									
19	Siikajoki	● ●				●					
20	Pyhäjoki	○ ●				●					
21	Kalajoki	● ●				●					
22	Lestijoki	○ ●				●					
23	Perhonjoki	○ ●				●					
24	Kyrönjoki	○ ●									
25	Tjöckån	● ●					●				
26	Merikarvianjoki	●				●					
27	Kokemänenjoki	○				●					
	Latvia										
28	Užava								●		
29	Venta	○						●			
30	Daugava	○							●	●	
31	Gauja	○							●		
32	Svētupe							●			
33	Salaca	○						○ ●			
	Estonia										
34	Pärnu					●					●
35	Toolse										●
36	Narva	○				●					●

Table 1. In this table an overview of river lamprey fishing gear used in the lamprey rivers visited during this study is presented[4] (see Fig. 1 about the locations of the rivers). The letters along the horizontal line are equivalent to the letters in Fig. 2. An arrow indicates a change of a gear, for example a change in material from willow shoots to plastic nets (for details, see respective sections in the text). A filled circle indicates the present use of gear, an empty circle indicates earlier types of gear used in the river. (a) A basket constructed of willow, rattan, juniper or spruce, with or without lifting frames. (b) A log from a tree trunk. (c) A log of pieces of wooden boards. (d) A pot of wooden laths. (e) Fyke nets of different sizes. (f) Other types of gear like rebuilt milk cans, rebuilt fire extinguishers, plastic tubes, etc. (g) A basket combined with a net. (h) Traps of nets, normally with lifting frames. (i) Fyke net without wings. (j) Ordinary fishing-nets, tightly woven. (k) Cone-formed plastic and metallic gear.

Sweden

Fishing for river lampreys has traditionally been done for hundreds of years along the north-eastern coast of the country in most rivers entering into the Gulf of Bothnia in the northern part of the Baltic Sea, from the River Dalälven (Fig. 1:1) in the south and further north up to the Finnish borders. In the River Ljungan (Fig. 1:4) the first written notes about lamprey fishing date from 1425 (Nordberg 1977). Some of the larger rivers had important lamprey fishing before the construction of hydroelectric power dams, for example, the River Dalälven and the River Umeälven (Sjöberg 1982) (Fig. 1:1 and Fig. 1:8, mean annual discharge 379 and 431 m^3/sec., respectively, see Tockner *et al*. (eds.) 2009), but the fishing has totally or almost totally ceased with dam construction. Nevertheless, lamprey fishing is still going on in at least 14 rivers.

The north Swedish lamprey rivers could be generalized as having sections of white-water rapids or streaming water with stones and boulders on the bottom close to their mouth into the sea (see e.g. Fig. 10). It is there the lampreys are caught during their upstream spawning migration in the autumn. Approximately 50–55 people fish for lamprey (Sjöberg 2011), but none of them are regarded as professional and no fishermen are officially registered as lamprey fishermen. Many of them fish to keep the tradition alive and the catches are distributed locally or are kept in the family. However, surpluses are sold, so it is still possible to buy smoked or grilled/roasted lampreys at the market. There is no longer any statistical information available about the catches of lampreys in Sweden, but the total annual catch is estimated to about 7.5 tons, or about 150,000 lampreys (Sjöberg 2011). The fishing is normally organized within a fish conservation association.

The fishing gear used is of the traditional type, which has been used for decades or centuries, although new, more durable materials are now used to make them. A variety of gear is used or has been in use until a few decades ago, but the more efficient fyke nets, nowadays so dominant in the Finnish rivers, are not in use in Sweden. This might reflect the weak commercial market for lamprey in Sweden and thus a relatively low ambition to make the fishing more efficient.

Below there are descriptions of the different types of lamprey fishing gear used in Sweden.

A basket of shoots or twigs of willow or of rattan and their substitutes of other materials, like plastic nets

One of the passive fishing methods described by Brinkhuizen (1983) is the wickerwork fish-trap, which generally consists of a long funnel made of

twigs of wicker plaited together of willow or some other kind of wood that is similarly pliant. The fish enters into the funnel via a wide opening called the *mouth*, which is often formed by a hoop. The external wall of the trap he calls the outer casing, and the narrow hindmost part of the outer casing is called the tail. Then he distinguishes two kinds of wicker fish-traps: with throats and without throats. The throat consists of a small wicker funnel that is inserted in the big funnel. It could be built in or sticking out of the outer casing. All the wickerwork traps in the study area have a throat built-in in the outer casing.

The wickerwork fish-trap described above, hereafter called the basket type of gear (Fig. 2a), has a long tradition in northern Swedish lamprey fishing rivers, where it is described by Linnæus in 1732 from the River Kalixälven (Linnæus 2003 [1732]). It is made by shoots of willow, or by rattan. Ekman (1910) also described this type in his review of river lamprey fishing gear from Sweden. How such a type of gear (in Swedish *nättingkasse*) is constructed is shown in detail from the River Umeälven in Sweden (Ågren 1978). Two-year-old shoots of willow (*Salix spp.*) were used and they were originally put together with thin roots of spruce or pine, but later on metal wires or some other more easily available and more manageable materials are used. The length of the basket was about 80 centimetres.

The gear of the basket types could be used in two ways: They were placed separately or side by side in the same way as wooden logs (see below), held on the bottom of the river by stones placed on top, or equipped with lifting frames (Fig. 4) and then often attached to a wooden construction, a weir or trestles (in Swedish *pata*) (see below).

The traditional willow baskets are no longer in use in Sweden, but they were the dominant gear in the important River Umeälven (Fig. 3) until 1958, when a hydroelectric power plant dam was constructed at Stornorrfors, about 30 kilometeres from the mouth of the river. However, they were still in use in the River Torneälven/Tornionjoki (Fig. 1:14) (attached to lifting frames) in 1978 and in the River Rickleån in 1991 (Fig. 1:9; Fig. 4; Fig. 5). The wooden material has been succeeded by nets of plastic. Examples of such a change can be seen in the River Kalixälven (Fig. 6) and in Torneälven/Tornionjoki (Fig. 21).

Logs from tree trunks

In principle, an easy way to make a gear for catching river lampreys is to split a tree trunk into two parts, hollow the parts out and, and then put them together again, with addition of a funnel in the entrance constructed of birch bark. Besides the willow basket gear, such a log is mentioned by Linnæus from his journey to the northern part of Sweden in 1732 (Linnæus

Fig. 3. Basket gear from the River Umeälven, kept by Rickard Danielsson. The basket to the left is made of rattan: the one to the right is made of willow. 19 October 2011. Photo: Kjell Sjöberg.

Fig. 4. Willow baskets equipped with lifting frames on the Swedish side of the River Torneälven/ Tornionjoki. This gear type was seen frequently in the river in 1978, but is no longer in use there. Photos: Kjell Sjöberg.

Fig. 5. Bertil Lundberg is emptying traditional willow baskets in the River Rickleå in Northern Sweden in 1991. These basket traps are probably constructed at the River Umeälven, and are not in use any longer in the rivers Umeälven and Rickleån. The traps were placed between stones in the rapid and were held down on the bottom with stones on top of the gear. This type of fishing site is typical of many lamprey rivers in Northern Sweden. The River Rickleån, 1991. Photo: Kjell Sjöberg.

Fig. 6. Fishing gear of plastic mesh in the River Kalixälven 2010. Traditional willow baskets with lifting frames were used here until about 20 years ago. Thereafter they were replaced with plastic gear, and in the *pata* new material is sometimes also used (as shown here), where the *pata* is made mostly of iron. The River Kalixälven, 13 October 2010. Photo: Kjell Sjöberg.

2003 [1732]), and Lundberg (1898) and Ekman (1910) describe it from the River Umeälven. From the River Umeälven the word *nättingstock* is used in documents from the mid-sixteenth century.[6]

Fishing gear of this type is no longer in use, but at least up till the middle of the twentieth century it was still utilized in the Swedish rivers Gideälven, Rickleån, Byskeälven and Piteälven (Fig. 2b; Fig. 7; Fig. 8; Sjöberg 1982).

Logs of wooden boards

Today hollowed out stocks are no longer constructed or used, but the name *nättingstock* ('lamprey log') has been transferred to what seems to have been its direct successor, that is, a log made by wooden boards put together to make a gear with a length of about 70–90 centimetres, and with a funnel-shaped mouth and with a throat adjusted to the width of a lamprey (Figs. 9–14). This type of gear is probably easier to construct than the hollowed stock, and with a flat bottom it is easier to place tight to the bottom of the river. Stones are placed on top to keep it on the bottom, which also is easier if the gear has a flat top.

The traditional log of boards (Swedish *nättingstock)* was used in the River Umeälven along with the willow basket (Berg 1960; Ågren 1978) until the hydropower development in the end of the 1950s. The logs varied considerably in size. Measurements from a sample in the Museum of Västerbotten varied from about 60 to 105 centimetres in length (mean 83 cm, N= 14), and with a width and depth of 46 x 29 centimetres at the entrance of the log (N= 7, from 24 to 57 in width and from 17 to 35 in depth). All the logs in the sample had a funnel of sheet metal leading the lampreys into the log and the diameter of the hole in the end of the funnel which the lampreys

Fig. 7. Log from a tree trunk from the River Rickleån, where this type of gear was in use along with other types up till around the 1960s. The length is 71 centimetres. This one belongs to Bo Bengtsson. 20 August 2012. Photo: Kjell Sjöberg.

Fig. 8. A log made of a tree trunk, hollowed out and put together again, earlier used in the River Piteälven in Northern Sweden, where these gear were left on the shore. 18 October 2010. Photo: Kjell Sjöberg.

have to pass to get trapped in the log was about 2.5 centimetres. Logs of this type are still in use in the Swedish rivers Öreälven and Rickleå (Fig. 1:6; Fig. 1:9; Fig. 2c; Fig. 9–14), but nowadays also with the boards replaced partly or completely with plastic nets (Fig. 14), sheets of metal or, for example, with materials like plywood, as in the Swedish rivers Byske älv (Fig. 1:10) and Åbyälven (Fig. 1:11) respectively. According to Ekman (1910) the funnels of all lamprey gear at that time were constructed of the same material as the rest of the gear, or of birch bark.

Like the baskets, the logs are placed between stones in the rapids, one by one or if possible side by side in positions where the fishermen by experience know that the lampreys usually pass. In the River Umeälven, where both baskets and logs of boards were used in the same rapids, the baskets were used more frequently in the beginning of the season, while the logs were more often used in the end, when ice began to appear in the river (see also Ågren 1978). Larger logs could also be used for keeping lampreys alive for a longer time.

Modified types of lamprey gear, like rebuilt milk pots, rebuilt fire extinguishers, plastic tubes, etcetera

Certainly based on inspiration of the traditional types of lamprey fishing gear that were developed by generations of lamprey fishermen, today there are many modifications because of the availability of new materials. Already mentioned is the trap of plastic nets, as in the River Kalixälven. However, plastic or metallic sheets shaped as a cone, or rebuilt fire extinguishers, etcetera can also be found (Fig. 15). When lampreys are caught near power

Fig. 9. Eric Andersson and Greger Roos are emptying their lamprey logs (Swedish *nättingstockar*) in the River Rickleån in 2013. When possible the logs are placed parallel to the edge of the river and they are weighted down to the bottom with stones. 13 September 2013. Photo: Kjell Sjöberg.

Fig.10. The picture shows a typical habitat for lamprey fishing in a northern Swedish river. Reconstructed milk cans and gear of wooden logs of different sizes and shapes is used for catching the lampreys. The gear is emptied early in the morning by Eric Andersson and Greger Roos. The River Rickleån, 13 September 2013. Photo: Kjell Sjöberg.

Fig. 11a. A wooden log (Swedish *nättingstock)* from the River Öreälven. In the narrower end of the log where the lampreys are emptied out, there is a sliding stopper locked with a latch (see also Fig. 12) and with a piece of chain as handgrip. 26 September 2012. Photo: Kjell Sjöberg.

Fig. 11b. Sliding stopper and its locking wedge (Swedish *stängningslucka med lås*) on a wooden log from the River Umeälven owned by Rickard Danielsson at Klabböle. There is a groove in the sliding stopper where the pin acting as a locking wedge is slid into position. In that way it prevents the stopper from moving in either direction. 18 March 2013. Photo: Kjell Sjöberg.

Fig. 11c. Another wooden log from the River Umeälven kept at the Museum of the Province of Västerbotten (Västerbottens museum), with a similar type of sliding stopper but with another arrangement of the wedge to keep it in a closed position. 15 January 2013. Photo: Kjell Sjöberg.

Fig. 12. Bo Sundqvist is emptying the lampreys from a wooden log (Swedish *nättingstock)* into a sack of jute. The River Öreälven, 26 September 2012. Photo: Kjell Sjöberg

Fig. 13. Lamprey logs (Swedish *nättingstockar*) from the River Rickleån. Here the opening where the lampreys are emptied is sealed with a sliding cover, which is locked by a wooden wedge. The initials of the fishermen are carved in the wood to indicate the owner. The length is about 75 centimetres. 30 August 2011. Photo: Kjell Sjöberg.

Fig. 14. A traditional river lamprey fishing gear, a log constructed of wooden boards, can be seen in the background, while in the front the fishing gear is constructed of a plastic net wrapped around a framework of iron (expanded with a frame as a handle)—clearly the same principle as in the old log. The River Öreälven, Sweden, 2010. The wooden logs in the river are between 70–80 centrimetres long. 22 September 2010. Photo: Kjell Sjöberg.

Fig. 15. The present day lamprey gear in the River Piteälven, made of old fire extinguishers among other things. They are placed one by one in the rapid with the entrance in downstream direction as the traditional gear. 18 October 2010. Photo: Kjell Sjöberg.

Fig. 16. A metallic box used for lamprey catching at the hydroelectric power plant dam in the River Ljusnan, in Sweden. Most of the lampreys are transported and released upstream of the dam. 14 October 2011. Photo: Kjell Sjöberg.

Fig. 17. Lamprey gear from the River Rickleån, province of Västerbotten, Sweden. Logs of wooden boards, where two sides have been replaced by perforated metal. Milk cans remodelled to serve as lamprey traps by creating a funnel in the bottom and with holes on the side to improve the passage of water. The one without a funnel in the bottom is used for storing lampreys. 15 June 1980. Photo: Kjell Sjöberg.

Fig. 18. In 2010 Eric Andersson used the same type of modified lamprey gear in the River Rickleå as shown in Fig. 17, that is, a metallic pot made by a can formerly used for the transportation of milk from farms. 18 November 2010. Photo: Kjell Sjöberg.

Fig. 19. Pots of wooden laths (together with willow baskets) in the River Torneälven/Tornionjoki, 1978. Photo: Kjell Sjöberg.

Fig. 20. An overview of pots of wooden laths. 20a. From the River Torneälven/Tornionjoki. Fig 20b & Fig. 20c. In the River Ljungan the traditional gear of wooden laths is nowadays supplemented by a trap type of stainless steel. 20d. From the River Gnapsån. 20e. From the River Ljusnan. 20f. From the River Dalälven, demontrated by Bjarne Ragnarsson and Hans Andersson.
Photo: Kjell Sjöberg.

Fig. 21. Besides using the traditional gear of wooden laths, the lamprey fishermen test other materials, like plastic mesh, when constructing the gear. The Swedish side of the River Torneälven/Tornionjoki. 26 September 2011. Photo: Kjell Sjöberg.

Fig. 22. A gear of traditional type, but constructed of glass fibre, has begun to replace the traps made of wooden laths in the River Torneälven/Tornionjoki. 13 October 2010. Photo: Kjell Sjöberg.

Fig. 23. Lamprey fishing gear of plastic mesh on weirs at the River Kalixälven (Fig. 1:13). 13 October 2010. Photo: Kjell Sjöberg.

Fig. 24. Lamprey traps attached to two types of weirs, with one and two parallel rows of trestles (Swedish *enryggig* and *tvåryggig strandpata)* in the Rapid Kukkolaforsen on the Swedish side of the River Torneälven/Tornionjoki. 13 October 2010. Photo: Kjell Sjöberg.

Fig. 25. The traditional pots of wooden laths are still frequently used in the River Torneälven/Tornionjoki (here the Swedish side, at the Rapid Kukkolaforsen). At low water it is clearly demonstrated how the pots are attached to a weir, side by side, and how the pots are held in position and pressed to the bottom by a rope from the top of the lifting frame which is attached to the weir. Behind the row of wooden laths, a single trap made of glass fibre is seen. 13 October 2010. Photo: Kjell Sjöberg.

Fig. 26. Kurt Niska is emptying his lamprey traps attached to weirs with one row of trestles (Swedish *enryggig pata*) in the lower part of the Rapid Kukkolaforsen in the River Torneälven/Tornionjoki (Swedish side). 13 October 2010. Photo: Kjell Sjöberg.

Fig. 27. Smaller *patas* (or a *strandpata* in Swedish, meaning *pata* at the shoreline) are built out from the edge of the river, which makes it possible for the fishermen to reach further out into the river with their gear, as demonstrated here by Helge Blomlid on the Swedish side of the River Torneälven/Tornionjoki. 26 September 2011. Photo: Kjell Sjöberg.

plant dams, the traps are adjusted to the local situation, as for example in the River Ljusnan in Sweden, where lampreys are caught with large boxes of metal mesh (Fig. 16) at the side of the dam with the aim of transporting the lampreys around the dam and releasing them upstream of the obstacle. In the River Rickleån in Sweden old milk cans, earlier used for transportation of milk from farms to dairies, are rebuilt with a funnel-shaped entrance from the bottom and by drilling holes in the metal to allow water to flow through (Fig. 17; Fig. 18). The lampreys are then emptied from the can through the ordinary opening on the other end of the gear.

Pots of wooden laths of spruce or pine

There also occurs a type of lamprey gear constructed by wooden laths made of Norway spruce or Scots pine, which still are frequently used in the River Torneälven/Tornionjoki (Fig. 2d; Fig. 19; Fig. 20a).

The same type of lamprey pot has previously been used in the River Kalixälven (Fig. 1:13) and in the River Dalälven (Fig. 1:1), and still (or up to recently) also in the rivers Ljusnan, Gnarpsån and Ljungan (Fig. 1:2; 1:3; 1:4; Fig. 20) (without lifting frames), but they are not noted from the rivers in between in this study (Table 1). In the River Torneälven/Tornionjoki the material of the gear is sometimes replaced with plastic or metallic mesh (Fig. 21), or is totally reconstructed with glass fibre material (Fig. 22). The gear found in the River Torneälven/Tornionjoki is equipped with lifting frames and is attached to barriers that are constructed along the shores of the river. In contrast, the traps previously used in for example the River Dalälven were placed without lifting-frames either singly or were placed in parallel to each other. However, before the regulation of the water due to a power plant dam constructed in 1911–1917, barriers were constructed there, and lifting frames were attached to the fishing gear according to Ehn (1970; Ehn 1986). He also describes that the pots could be kept in place by poles.

In the rivers Dalälven and Ljusnan, lamprey fishing is nowadays only performed at hydroelectric dams, and the gear is made by metallic nets or sheets (Fig. 16), and in the River Ljungan metallic traps are used in parallel to the traditional type (Fig. 20c).

The use of weirs and lifting frames

Ekman (1910) noted that lamprey gear of wood could be placed in the Swedish rivers in three ways.

(1) In the northernmost rivers, such as the River Torneälven/Tornionjoki and the River Kalixälven the gear is equipped with lifting frames and is attached to *strandpator* ('shore weirs') of the same type as are used for whitefish fishing (*Coregonus lavaretus*), which are simpler than those

used for salmon (*Salmo salar*) fishing. He calls them *enryggiga* ('with one backbone'). They were constructed as a row of trestles (*bockar* in Swedish) straight out from the shore (cf. Storå 1978 and Storå 2008). The trestles were tied together with logs or boards placed on them. Stones were placed on the *pata* to make them better withstand the streaming water. So-called *tvåryggiga strandpator* ('with two backbones') had two parallel rows of trestles connected with poles and boards (e.g. Figs. 23–27). The situation today is very much the same as Ekman described in 1910. *Strandpator* are still in use in the northernmost Swedish rivers, and the lamprey fishing gear is attached to them with lifting frames.

(2) In the rivers further south weirs of the *strandpata* type are not used and the fishing gear is not equipped with lifting frames. Instead the trap types still in use there (or in use until a few decades ago), that is, the basket type of willow or rattan and the pot of wooden laths, were distributed one by one among stones on the bottom of the rivers, with stones on top to press them down to the bottom.

(3) The third type, the log with broad wooden boards, has never been equipped with lifting frames, and has never been attached to weirs. However, it often has a handgrip of some kind to make it easier to lift it up from the water (Fig. 11a), and particularly logs of this type but constructed of plastic nets or similar materials are often equipped in this way (e.g. Fig. 14). As mentioned, in older times there was also a kind of weirs in the River Dalälven (Ehn 1970).

NOTES

[1] In the Swedish river names, *älv* means 'river,' in the Finnish river names it is *joki*. When a Swedish river is called an "å," as in *Gnarpsån*, *Hörneån* and *Rickleån*, it means a medium-sized water course, smaller than a river (www.smhi.se/kunskapsbanken/hydrologiska-begrepp-1.29125; access date 3 September 2013).

[2] The terminology about some fishing gear could be a bit confusing. Ekman (1910) used the words *tinor* and *mjärdar* in Swedish for the lamprey gear, but he stressed that there is no big difference between those two terms and there is also a difference between Southern and Northern Sweden. In the northern part *tinor* is sometimes used for the same type of gear that is called *mjärde* in the southern part. So he called a gear equipped with a lifting frame at the entrance a *tina*, and a gear without a lifting frame he called a *mjärde*. Then, for example, the willow basket equipped with a lifting frame should be called a *tina*, and a willow basket without a lifting frame should be called a *mjärde*. Olofsson (1922) also stresses the different uses of the words *mjärde* and *tina*, but regards those used in running water as *tinor*, other ones as *mjärdar* and adds that normally the gear used in running water to catch fish migrating against the water flow is called *tinor*. In Swedish-speaking parts of Finland the word *mjärde* is sometimes used for *tina*. However, in this article I am inclined to accept Olofsson's (1922) opinion, and have adjusted

the terminology to the local traditions of lamprey fishermen at the Swedish rivers where a gear type without lifting frame is called *nättingkasse* if constructed of willow or rattan material. The gear type constructed of wooden boards is called *nättingstock* and the gear of wooden laths is called *nättingtina*. Those with lifting frames are called *tinor* even if constructed either of willow, plastic or metallic mesh or wooden laths (see also Storå 1978 and Storå 2008 for further information).

[3] According to fishermen in Latvia, tightly woven fishing-nets could be used for catching river lampreys. This drawing is a free interpretation of such a gear illustrated by Gun Lövdahl.

[4] The overview of lamprey fishing gear in this table is mainly based on what fishermen presented to me when I visited their fishing sites in 1978 onwards. During the period up till present days some gear types have ceased to be used, but are nevertheless included here. To some extent older types of gear are also noted from different rivers based on personal communication from fishermen, museums, and from the literature, but they are not consistently covered for all rivers, particularly not from the rivers in Latvia and Estonia.

[5.] Ehn (1986) writes in his description of lamprey gear in the River Ljusnan, where besides pots of spruce laths also squared pots of wood with a squared lifting frame were used, and also squared pots of metal sheet.

[6] Riksarkivet: Norrlands handlingar no. 13, 1559. Stockholm.

REFERENCES

Archives

Riksarkivet: *Norrlands handlingar* no. 13 ['The National Archives of Sweden: Documents of Norrland no. 13, 1559']. Stockholm.

Literature

Ågren, K. (1978). "Binda nättingkassj" ['Constructing willow basket'], *Västerbotten* 1978:1, pp. 58–65.

Aronsuu, K. (2011*a*). "River lamprey fishing and rehabilitation of lamprey stocks," Centre for Economic Development, Transport and the Environment in Northern Ostrobothnia. Unpublished data.

— (2011*b*). "Overview of research, monitoring and supplementation efforts in Finland," in *First International Forum on the Recovery and Propagation of Lamprey. Workshop Report. Prepared by ESSA Technologies Ltd., Vancouver, B.C. for the Columbia River Inter-Tribal Fish Commission, Portland, Oregon*, eds. L. Greig & A. Hall; http://host119.yakama.com/Hydro/ILF/ILF.html; access date 31 October 2011.

— (2011*c*). "State of lamprey in Finland," in *First International Forum on the Recovery and Propagation of Lamprey. Workshop Report. Prepared by ESSA Technologies Ltd., Vancouver, B.C. for the Columbia River Inter-Tribal Fish Commission, Portland, Oregon*, eds. L. Greig & A. Hall; http://host119.yakama.com/Hydro/ILF/ILF.html; access date 31 October 2011.

Aronsuu, K. & Tuohino, J. (2011). "Monitoring and research in the natural environment in Finland," in *First International Forum on the Recovery and Propagation of Lamprey. Workshop Report. Prepared by ESSA Technologies Ltd., Vancouver, B.C. for the Colum-*

bia River Inter-Tribal Fish Commission, Portland, Oregon, eds. L. Greig & A. Hall; http://host119.yakama.com/Hydro/ILF/ILF.html; access date 31 October 2011.

Berg, S.E. (1960). "Nättingfisket i Klabböle" ['The river lamprey fishing at Klabböle'], *Svensk Fiskeri Tidskrift*, 69, pp. 29–30.

Birzaks, J. (2011). "Salmon and sea trout populations and rivers in Latvia. HELCOM assessment of salmon (*Salmo salar*) and sea trout (*Salmo trutta*) populations and habitats in river flowing to the Baltic Sea," *Baltic Sea Environment Proceedings* No. 126B. Helsinki Commission. Baltic Marine Environment Protection Commission.

Birzaks, J. & Abersons, K. (2011). "Anthropogenic influence on the dynamics of the river lamprey *Lampetra fluviatilis* landings in the River Daugava Basin," *Scientific Journal of Riga Technical University*, 7, pp. 32–38.

Brinkhuizen, D.C. (1983). "Some notes on recent pre- and protohistoric fishing gear from north western Europe," *Palaeohistoria*, 25, pp. 7–53.

Cimermanis, S. (1998). *Zveja un zvejnieki Latvijā 19. gadsimtā* ['Fishery and fishers in Latvia in the nineteenth century'] (with summaries in German and Russian), Riga: Latvijas Zinātņu Akadēmijas Vēstis.

Claridge, P.N., Potter, I.C. & Hughes, G.M. (1973). "Circadian rhythms of activity, ventilator frequency and heart rate in the adult river lamprey, *Lampetra fluviatilis*," *Journal of Zoology*, 171, pp. 239–250.

Cushing, C.E., Cummins, K.W. & Minshall, G.W. (eds.) (2006). *River and Stream Ecosystems of the World*, Berkeley: University of California Press.

Edén, P., Weppling, K. & Jokela, S. (1999). "Natural and land-use induced load of acidity, metal, humus and suspended matter in Lestijoki, a river in western Finland," *Boreal Environment Research*, 4, pp. 31–43.

Ehn, W. (1970). "Nejonögonfiske i Älvkarleby" ['River lamprey fishing at Älvkarleby'], *Svenska landsmål och svenskt folkliv*, 93, pp. 9–25.

— (1986). "Nejonögonfiske i Sverige. Kort om fiske, fångstmetoder och användning" (Yhteenveto: Nahkiaispyynti Ruotsissa. Pyyntitavat, valmistus ja käyttö) ['River lamprey fishing i Sweden. Short about fishing, catching methods and use'], in *Riista- ja kalatalouden tutkimuslaitos, Kalantutkimusosasto Monistettuja julkaisuja* N. 46, eds. T. Järvenpää & L. Westman, pp. 44–59.

Eklund, J., Niemi, A. & Ojutkangas, E. (1984). "The river lamprey in two regulated Finnish rivers," in *Regulated Rivers*, vol. 2, eds. A. Lillehammer & S. J. Saltveit, Oslo: Universitetsforlaget AS, pp. 417–426.

Ekman, S. (1910). *Norrlands jakt och fiske* ['Hunting and fishery in Norrland'] (Norrländskt handbibliotek 4), Uppsala: Almqvist & Wiksell.

Frimodt, C. (1995). *Multilingual Illustrated Guide to the World's Commercial Coldwater Fish*, Malden: Blackwell Science.

Gabriel, O., Lange, K., Dahm, E. & Wendt, T. (eds.) (2005). *Von Brandt's Fish Catching Methods of the World*, Oxford: Blackwell Publishing.

Grinberga, L. & Spriņģe, G. (2008). "Potential impact of climate change on aquatic vegetation of River Salaca, Latvia," *Proceeding of the Latvian Academy of Sciences*, Section B, 62:1–2, pp. 34–39.

Hardisty, M.W. (1986*a*). "General introduction to lampreys," in *The Freshwater Fishes of Europe.* Vol. 1, Part I. *Petromyzontiformes*, ed. J. Holcík, Wiesbaden: Aula-Verlag, pp. 19–84.

— (1986*b*). "*Lampetra fluviatilis* (Linnaeus, 1758)," in *The Freshwater Fishes of Europe.* Vol. 1, Part I. *Petromyzontiformes*, ed. J. Holcík, Wiesbaden: Aula-Verlag, pp. 249–278.

— (2006). *Lampreys. Life without Jaws*, Cardigan, UK: Forrest Text.

Hardisty, M.W. & Potter, I.C. (eds.) (1971). *The Biology of Lampreys* 1, London: Academic Press.

Hurme, S. (1966). "Nahkiaisjoet Suomen rannikolla" ['Finnish river lamprey rivers'], *Suomen Kalastuslehti*, 5, pp. 135–139.

Igoe, F., Quigley, D.T.G., Marnell, F., Meskell, E., O'Connor W. & Byrne, C. (2004). "The sea lamprey *Petromyzon marinus* (L.), river lamprey *Lampetra fluviatilis* (L.) and Brook Lamprey *Lampetra planeri* (Bloch) in Ireland. General biology, ecology, distribution and status with recommendations for conservation," *Biology and Environment Proceedings of the Royal Irish Academy*, 104B: 3, pp. 43–56.

Imam, A.K.E.S., Lühmann, M. & Mann, H. (1958). "Über Neunaugen und Nenaugenfischerei in der Elbe," *Der Fischwirt*, 8, pp. 249–261.

Järvi, T.H. (1932). *Suomen merikalastus ja jokipyynti* ['Finnish sea fishing and river fishing'], Porvoo & Helsinki: W. Söderström.

Juvelius, E. (1772). "Om Nejnögons Fisket i Österbotten" ['About river lamprey fishing in Ostrobothnia'], *Tidningar utgifne af et sällskap i Åbo*, 20 & 21, pp. 158–160; 162–165.

Kaipainen, H., Frisk, T., Bilaletdin, Ä. & Rauhala, J. (2007). "The impact of climate change on nutrient flows in the catchment of the River Kokemäenjoki," *3rd International ASTRA conference in Riga, 10–12 May 2007, Climate Change and Waters;* www.astra-project.org/sites/download/Kaipainen.pdf; access date 28 October 2013.

Kangur, M., Viilmann, M.-L. & Talvik, Ü. (2005). "Lampern in the rivers of Pärnu and Häädemeeste" (in Estonian with Engl. Summary), in *Fishes and Fisheries of the Gulf of Riga*, eds. T. Saat & H. Ojaveer, Tartu: University of Tartu, Estonian Marine Institute, pp. 129–142.

Kaski, O. & Oikarinen, J. (2011). *Nykytilaselvitys 2011. Nahkiainen. Perämeri Tornio-Kokkola alue* ['Investigation of present state. The lamprey. The Bay of Bothnia, Tornio-Kokkola area']; www.popleader.fi/assets/site/popleader/files/NAHKIAISEN_NYKYTILA_2011_Outi_Kaski1.pdf; access date 7 October 2013.

Kelly, F.L. & King, J.J. (2001). "A review of the ecology and distribution of three lamprey species, *Lampetra fluvatilis* (L.), *Lampretra planeri* (Block) and *Petromyzon marinus* (L.). A context for conservation and biodiversity considerations in Ireland," *Biology and Environment. Proceedings of the Royal Irish Academy*, 101B:3, pp. 165–185.

Laine, A., Kamula, R. & Hooli, J. (1998). "Fish and lamprey passage in a combined Denil and vertical slot fishway," *Fisheries Management and Ecology*, 5, pp. 31–44.

Lehtonen, H. (2006). "Actions taken to protect and restore the river lamprey in Finland," in *ICES Migratory Fish. How Land Managers and Fishing Associations Contribute to the Protection of their Habitats*, Baltic Area Conference 22 June 2006, Copenhagen; www.fdd-fsd.eu/eufish/baltic_conference.php; access date 21 December 2011.

Linnæus, C. (2003) [1732]. *Iter Lapponicum. Lappländska resan 1732. Dagboken* ['The journey to Lapland 1732. The diary'], eds. A. Hellbom, S. Fries & R. Jacobsson, Umeå: Kungl. Skytteanska Samfundet.

Lundberg, R. (1898). "Introductory remarks on the fisheries and fishery-industries of Sweden," *International Fisheries Exhibition at Bergen 1898. Special Catalogue* 1. Stockholm.

Maitland, P. S. (2003). *Ecology of the River, Brook and Sea Lamprey* (Conserving Natura 2000 Rivers Ecology Series 5), Petersborough: English Nature.

Masters, J.E.G., Jang, M.-H., Ha, K., Bird, P.D., Frear, P.A. & Lucas, M.C. (2006). "The com-

mercial exploitation of a protected anadromous species, the river lamprey (*Lampetra fluviatilis* (L.)), in the tidal River Ouse, north-east England," *Aquatic Conservation. Marine and Freshwater Ecosystems*, 16, pp. 77–92.

Nathanson, J.-E. & Liby, H. (2007). "Flodnejonöga *Lampetra fluviatilis*" ['River lamprey'], in *Människan och faunan. Etnobiologi i Sverige* 3, eds. H. Tunón, M. Iwarsson & S. Manktelow, Stockholm: Wahlström & Widstrand, pp. 368–370.

Nordberg, P. (1977). *Ljungan. Vattenbyggnader i den näringsgeografiska miljön 1550–1940* ['Ljungan. Hydraulic constructions in the industrial geographic environment 1550–1940'] (Kungl. Skytteanska samfundets handlingar 18), Umeå: Skytteanska samfundet.

Norrländsk uppslagsbok ['Encyclopaedia of Norrland'] (1993–1996). Umeå: Norrlands Universitetsförlag.

Ojaveer, E. & Gaumiga, R. (1995). "Cyclostomes, fishes and fisheries," in *Ecosystem of the Gulf of Riga between 1920 and 1990*, Tallinn: Estonian Academy Publishers.

Ojutkangas, E., Aronen, K. & Laukkanen, E. (1995). "Distribution and abundance of river lamprey (*Lampetra fluviatilis*) ammocoetes in the regulated river Perhonjoki," *Regulated Rivers. Research & Management*, 10, pp. 239–245.

Olofsson, O. (1922). "Fiskesätt och fiskeredskap" ['Fishing methods and fishing gear'], in *Svenska jordbrukets bok. Sötvattenfiske och fiskodling*, ed. O. Nordqvist, Stockholm: A. Bonniers förlag, pp. 237–323

Oras, K. (ed.) (2007). *Statistical Office of Estonia. Final report of the Grant Agreement No. 71401.2005.001–2005.293. Fish and Fisheries Accounts*.

Petersson, M. (2008). "Kustlandskapets förändring och nyttjande i Estland under förhistorisk tid" ['The transformation and use of the coastal landscape in Estonia during prehistoric time'], in *Leva vid Östersjöns kust. En antologi om naturförutsättningar och resursutnyttjande på båda sidor av Östersjön ca 800–1800. Rapport 2 från projektet Förmoderna kustmiljöer. Naturresurser, klimat, och samhälle vid Östersjökusten före 1800. Ett miljöhistoriskt projekt*, ed. S. Lilja, Huddinge: Södertörns högskola, pp. 15–22.

Püttsepp, J. & Järv, E. (2010). *The River Narva. Rivers with SpecialConservation Areas in Virumaa 2*, Kuru-Tartu: Estonian Environmental Board.

Quensel, C. & Palmstruck, J.W. (1806). "*Neinögon-slägtet*" ['The lamprey genus'], *Svensk zoologi* 1:33, pp. 31–36.

Räsänen, V. (1916). "Simojoen nahkiaisen pyynnistä ja palvaamisesta" ['Catches and smoking of river lampreys in River Simojoki'], *Suomen kalastuslehti*, 23, pp. 49–52.

Riekstiņš, N. (1999). "Current status and trends in inland fisheries in Latvia," in *Current Status and Trends in Inland Fisheries. BAFICO Seminar on Inland Fisheries in Tallinn, May 1999*, Copenhagen: Nordic Council of Ministers, pp. 53–70.

Riekstiņš, N., Joffe, R., Kozlovskis, A., Mitāns, A. & Vītjiņš, M. (eds.) (2010). *Latvijas Zivsaimniecības Gadagramata 2010* ['Latvian Fisheries Yearbook 2010'].

Saat, T., Tambets, J. & Kangur, M. (2003). "Lampern, river lamprey, *Lampetra fluviatilis* (L.)," in *Fishes of Estonia*, eds. E. Ojaveer, E. Pihu, & T. Saat, Tallinn: Estonian Academy Publishers, pp. 48–52.

Selegio, A. (1926). "Die Fischerei in den Fliessen, Seen und Strandgewässern Mitteleuropas," in *Handbuch der Binnenfischerei Mitteleuropas* 5, eds. R. Demoll & H.N. Maier, Stuttgart, pp. 1–422.

Seppälä, T. & Sarell, J. (2002). *Nahkiaisen pyynti, saalis ja nahkiaiskannan koko Lapväärtin ja Himangan välisellä alueella vuosina 1999 ja 2000* ['Lamprey fishing, catch and

size of lamprey stock in the area between Lapväärtti and Himanko in the years 1999 and 2000'] (Regional Environment Publications 270), Kokkola: West Finland Regional Environment Centre.

Sirelius, U.T. (1906). *Über die Sperrfischerei bei den finnisch-ugrischen Völkern. Eine vergleichende ethnographische Untersuchung*, Helsinki: Finsk-Ugriska Sällskapet.

Sjöberg, K. (1977). "Locomotor activity of river lamprey *Lampetra fluviatilis* (L.) during the spawning season," *Hydrobiologia*, 55, pp. 265–270.

— (1980). "Ecology of the European river lamprey (*Lampetra fluviatilis*) in northern Sweden," *Canadian Journal of Fisheries and Aquatic Sciences*, 37, pp. 1974–1980.

— (1982). "Exploitation of Lampreys in Europe," *Ethnologia Scandinavica*, 1982, pp. 94–108.

— (2011). "River lamprey *Lampetra fluviatilis* (L.) fishing in the area around the Baltic Sea," *Journal of Northern Studies*, 5:2, pp. 51–86.

Slack-Smith, R.J. (2001). *Fishing with traps and pots* (FAO Training Series 26), Rome.

Soikkeli, A. (1959). "Nahkiaisenpyyntiä Kokemäenjoessa" ['Lamprey fishing in River Kokemäenjoki'], *Kotiseutu*, 3, pp. 50–54.

Soler, T. & Nathanson, J.E. (2006). "Fiske och fångster av flodnejonöga. Undersökning 2002–2003" ['Fishery and catches of river lamprey. Investigation 2002–2003'], Sötvattenslaboratoriet, Fiskeriverket.

Sterba, G. (1962). "Die Neunaugen (Petromyzonidae)," in *Handbuch der Binnenfischerei Mitteleuropas* 3, eds. R. Demoll, H.N. Maier & H.H. Wundsch, Stuttgart, pp. 259–352.

Storå, N. (1978). "Lamprey fishing in the rivers of the Gulf of Bothnia," *Ethnologia Scandinavica*, 1978, pp. 67–98.

— (1986). "Etnologiska perspektiv på nejonögonfisket i Österbotten" ['Ethnological perspectives on river lamprey fishing in Ostrobothnia'], in *Riista- ja kalatalouden tutkimuslaitos*, *Kalantutkimusosasto Monistettuja julkaisuja* N. 46, eds. T. Järvenpää & L. Westman, pp. 60–73.

— (2008). *Nättingar. Nejonögonfisket i Nykarleby älv* ['River lampreys. The river lamprey fishing in the River Nykarleby'], Nykarleby, Labyrinth Books AB.

Tockner, K., Uehlinger, U. & Robinson, C.T. (eds.) (2009). *Rivers of Europe*, Amsterdam: Academic Press.

Tuikkala, A. (1986). "Nahkiaisen pyynnistä Pyhäjoella ja Simojoella," (Sammandrag: Nejonögonfisket i Pyhäjoki och Simojoki) ['The river lamprey fishing in the rivers Pyhäjoki and Simojoki'], in *Riista- ja kalatalouden tutkimuslaitos*, *Kalantutkimusosasto Monistettuja julkaisuja* N. 46, eds. T. Järvenpää & L. Westman, pp. 89–97.

Tuomi-Nikula, O. (1977). "Nahkiaisen käyttötapoja Suomessa" ['Ways of using lampreys in Finland'], *Kotiseutu*, 1–2, pp. 26–32.

— (1986). "Kala- ja Lestijoen muuttuva nahkiaisenpyynti" (Sammandrag: Det föränderliga nejonögonfisket i Kala- och Lestijoki)" ['The changeable river lamprey fishing in the rivers Kala- and Lestijoki'], in *Riista- ja kalatalouden tutkimuslaitos*, *Kalantutkimusosasto Monistettuja julkaisuja* N. 46, eds. T. Järvenpää & L. Westman, pp. 74–88.

Tuunainen, P., Ikonen, E. & Auvinen, H. (1980). "Lampreys and lamprey fisheries in Finland," *Canadian Journal of Fisheries and Aquatic Sciences*, 37, pp. 1953–1959.

— (1986). "Nahkiainen ja nahkiaisen pyynti Suomessa," (Sammandrag: Nejonöga och nejonögonfiske i Finland) ['River lamprey and river lamprey fishing in Finland'], in *Riista- ja kalatalouden tutkimuslaitos*, *Kalantutkimusosasto Monistettuja julkaisuja* N. 46, eds. T. Järvenpää & L. Westman, pp. 3–14.

Valtonen, T. (1980). "European River Lamprey (*Lampetra fluviatilis*) fishing and lamprey populations in some rivers running into Bothnian Bay, Finland," C*anadian Journal of Fisheries and Aquatic Sciences*, 37, pp. 1967–1973.

Valtonen, T. & Niemi, A. (1978). "The present state of fishing in Lestijoki, a small river in Finland," *Verhandlungen des Internationalen Verein Limnologie* 20, pp. 2085-2091.

Wikgren, B.-J. (1954). "Dygnsrytmiken hos nejonögat (*Petromyzon fluviatilis* L.)" ['The circadian rhythm of the river lamprey (*Petromyzon fluviatilis* L.'], *Memoranda Societatis pro fauna et flora fennica*, 29, pp. 24–27.

Willer, A. (1929). "Ostpreussen, Lettland, Finnland, eine fischereiliche Betrachtung," *Mitteilungen des Deutschen Seefischerei-Vereins*. 45, pp. 157–173.

Witkowski, A. & Kuszewski, J. (1995). "Characteristics of the population of *Lampetra fluviatilis* (L.) entering the Drwęca and Grabowa Rivers (North Poland)," *Acta Ichthyologia et Piscatoria*, 25, pp. 49–56.

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