JOURNAL OF NORTHERN STUDIES Vol. 7 • No. 2 • 2013, pp. 7–74

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

Documenting Rivers that Flow into the Baltic Sea

Part II, Finland, Latvia and Estonia

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

In Part I of this article (*Journal of Northern Studies*, volume 7, number 1), the lamprey fishing gear used in Sweden is described. This follow-up article is a continuation of descriptions of lamprey gear, but now the situation in Finland, Latvia and Estonia is treated. For references to Table 1, Fig. 1, and Fig. 2 in this article, and for background information, see Part I.

Finland

In Finland the river lampreys are traditionally fished for in the same type of rivers and habitats as in Sweden, that is, in rapids with stones and boulders. However fyke nets, which are common fishing gear today, are normally placed in calm water close to the mouth of a river. Nowadays most of the lampreys are caught in the rivers emptying into the Bothnian Bay (Aronsuu 2011*c*), that is, the northern part of the Gulf of Bothnia. The fishing in Finland is more efficient and economically important than in Sweden, but even there the catches of lampreys have decreased. In the early 1970s the numbers were about 2.7–3.0 million lampreys, corresponding to circa 130 tons (Tuunainen *et al*. 1980). Nowadays about 900,000 lampreys are caught annually (Aronsuu 2011*c*), that is, about 41 tons, and fishing is performed in at least 33 rivers (Lehtonen 2006). About 400 fishermen are involved; most of them catch lampreys for their own needs, or are semi-professional. Only a minority of them are professional, and lamprey is never the main target species (Aronsuu 2011*c*).

Fisheries in earlier times in Finland are described by Juvelius (1772), who wrote that lampreys were fished for with two types of gear, baskets and pots (in Swedish "Mjerdor eller så kallade kassar, och med tinor"), which were used in the River Nykarlebyälven/Lapuanjoki. The baskets were made of willow twigs or young shoots and put together with roots of Norway spruce. The funnel was made of the same material. In the narrow end of the basket where the twigs were put together, an access hole (Swedish *sprundhål*) was made where the lampreys were taken out, or an opening was left in the end of the basket, which was closed with a wooden tap. Around the opening of the basket the twigs were arranged as in a wreath, which made the basket more durable. The baskets were of different sizes to be able to fit among stones on the river bottom. They were either attached to a pole between two stones and pressed down to the bottom with stones, or attached to a "bridge." When attached to a bridge, the basket was equipped with a lifting-frame consisting of two poles with cross-pieces under and above the basket and one at the top of the poles, which keep them together. The basket is attached to the bridge with a strong string that is attached to the upper crosspiece of the lifting-frame.[7]

The pots made of boards were squared, wider in one end and narrower in the other end (making them pointed at that direction) and with small holes around. They were put together with spikes. Like the baskets, the pots were of different sizes. Such pots were also used for storing lampreys alive during the winter, when they were used as bait for burbot (*Lota lota*) fishing. The pots were also placed between stones in the river, with poles around. They were mostly used during the wintertime (Juvelius 1772). Quensel and Palmstruck (1806) described the lamprey fishing gear used in similar terms as Juvelius (1772) did.

In contrast to the situation in Sweden, baskets made of willow (e.g. Fig. 28) or juniper (e.g. Fig. 33) are still frequently used in Finland, while it seems that the gear of wooden boards are not used any longer (except for using them for storage in which lampreys could be kept alive for some time). Therefore they are not presented among the Finnish types of lamprey gear in this study. Experimental gear such as reconstructed milk cans, as described from the Swedish river Rickleån, is not used here. However, similar experiments with metallic cylinders are found in the River Tjöckån/Tiukanjoki (Fig. 1:25), and in both countries cylinders from washing machines are used for keeping lampreys alive for a while (e.g. Fig. 32; Fig. 33). In Torneälven/Tornionjoki a reconstructed milk can was noted as used for this purpose.

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

These basket types can either be placed singly or together on the bottom of a rapid or attached to a weir (a *pata*). Sirelius (1906) describes that osier baskets equipped with a wreath around the mouth were used from the River Kemijoki in the north to the River Nykarlebyälven/Lapuanjoki in the Province of Ostrobothnia in the south. As mentioned, the basket gear (Fig. 2a) is still used in many of the northern Finnish lamprey rivers (although nowadays not always with the wreath) such as Simojoki, Kuivajoki, Kiiminkijoki, Siikajoki, Pyhäjoki, Kalajoki, Tjöckån/Tiukanjoki and Merikarvianjoki (number 15, 16, 18, 19, 20, 21, 25 and 26 in Fig. 1).

Back in 1978 willow baskets were frequently used also in the rivers Iijoki (Fig. 1:17; Fig. 29), Lestijoki (Fig. 1:22; Fig. 30) and Perhonjoki (Fig. 1:23), and bell-shaped baskets of juniper were still in use in the River Kokemäenjoki[8] (Fig. 1:27; Fig. 58; Fig. 59) (Sjöberg 1982). In all these rivers except the River Kokemäenjoki, the mouths of the baskets were squared and attached to lifting frames with cross-pieces above and below the basket, and with a third cross-piece that joined the pole-ends. The mouth of the basket at the River

Fig. 28. A basket type of gear, equipped with a mouth-wreath, with a wooden tap at the side which covers the exit in the top of the gear, where the lampreys are emptied. The gear is attached to a lifting frame. The River Simojoki, Northern Finland. 14 October 2010. Photo: Kjell Sjöberg.

Kokemäenjoki was round and attached to two poles without a connecting cross-piece below (Fig. 59). See also Storå (1978), who calls them shafts instead of a lifting frame. Lamprey fishing is still going on in the rivers Iijoki and Kokemäenjoki, but the use of fyke nets has now totally replaced the traditional fishing gear. In Lestijoki and Perhonjoki they still fish in the traditional way, but the material of the gear has changed from willow to lighter and more durable materials. This is clearly demonstrated in the River Lestijoki, where back in 1978 most of the gear used still was the willow basket type (Fig. 30), while in 2010 and 2011 none of that type were seen—at the same fishing site willow baskets were replaced by gear with plastic coated wire netting (Fig. 31; Fig. 32). In the River Perhonjoki the traditional gear has been replaced both with gear made of plastic netting and plastic coated wire netting (Aronsuu 2011*a*; Sjöberg 2011).

From Table 1 we can see that in many of the Finnish rivers the traditional basket type of gear constructed mainly of willow, but sometimes of juniper, has been replaced with more durable material. In Fig. 47 and Fig. 54

examples of river lamprey gear placed on *pator* are presented from the rivers Simojoki and Kalajoki. In the River Simojoki they are taken out of the water during the day for cleaning and drying, while in the River Kalajoki they are kept in the water during the day (even though the lampreys are catchable only during the night). The explanation is probably given by Valtonen (1980), who writes that the baskets made of willow shoots (*Salix* sp.) (and used in the River Simojoki) break down fairly quickly (in 3–5 years), while the baskets made of juniper (*Juniperus communis*), as in the River Kalajoki, can be used for many more years (Valtonen 1980).

However, baskets made of traditional material are still in use. In the River Simojoki (Fig. 1:15) the willow baskets look the same as they did back in 1978 (Fig. 28; Fig. 46; Fig. 47; Sjöberg 1982), and according to a picture from 1916 (Räsänen 1916: 50) either the gear or the weirs used seem to have changed. However, a few traps made of glass fibre instead of willow have been introduced (Fig. 35). In the River Kalajoki traditional baskets are also used (but here with juniper instead of willow) along with gear of plastic covered metal mesh in 2011 (Fig. 33).

How a willow basket is constructed is shown in detail from the River Nykarlebyälven/Lapuanjoki in Finland, where, however, the lamprey fishing has now ceased (Storå 1978; Storå 2008). The size of such a basket was 85

Fig. 29. Willow baskets from the River Iijoki back in 1978. Today, fyke nets of the type seen to the left have taken over. Photo: Kjell Sjöberg.

Fig. 30. Willow baskets attached to lifting frames in the River Lestijoki in 1978. On the other side of the river a lamprey trap of plastic-coated wire netting could be seen, which has outcompeted the willow baskets since then. They are about 130 centimetres long (Tuomi-Nikula 1986). Photo: Kjell Sjöberg.

Fig. 31. The same site in River Lestijoki as in Fig. 30, but in 2010. Willow baskets are not used any longer. They have been replaced with gear made of plastic-coated wire netting. Most are shown in fishing positions. 17 October 2010. Photo: Kjell Sjöberg.

Fig. 32. The traditional willow baskets in the River Lestijoki have been replaced with gear of different sizes made of metal mesh nets covered with plastic, but principally of the same shape as the old ones. Some traps are placed in fishing position along the edge of river, but because of temporary high water level most of them are left on the shore. To the right in the water a cylinder from a washing machine is seen, which is used as a corf (Swedish *fisksump*), that is. a temporary holding box for storing lampreys for some days. 29 September 2011. Photo: Kjell Sjöberg.

Fig. 33. In 2011, traditional basket gear made of juniper is still in use in the River Kalajoki, but nowadays probably more than 50 per cent of them have been replaced with gear made of plastic covered metal mesh[9] (but of traditional shape and still attached to lifting frames). Below the traps there is a cylinder from a washing machine. It is used to store lampreys alive. Such cylinders could be seen nowadays also in many other rivers, for example the River Torneälven/Tornionjoki, the River Simojoki and the River Lestijoki, where they are used for the same purpose. 1 October 2011. Photo: Kjell Sjöberg.

centimetres in length, the periphery in the middle of the basket was about 82 centimetres and the side of the squared opening was about 42 centimetres. As in Sweden the willow twigs or shoots 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 shapes of the wooden baskets are to some extent different among rivers (see for example Fig. 28; Figs. 33–34), and the materials used for the traditional baskets are also different. In the northernmost rivers like Simojoki, Kuivajoki, and Kiiminkijoki, willow is still used, while in the Rivers Kalajoki, Merikarvianjoki and earlier also in Kokemäenjoki juniper is used. The way to empty the baskets also varies among different rivers. In Fig. 34 some examples are presented. The most common way is to empty it in the narrower end of the basket, like in the rivers Simojoki, Kuivajoki, Kiiminkijoki, and Kalajoki, where the baskets are closed by a wooden tap during fishing. In the River Tjöckån/Tiukanjoki not only the shape of the basket is different compared to rivers above, but also the opening, which is placed at the side of the basket (Fig. 34e). The flap over the opening is lacking in this picture, but is seen in a picture from the River Merikarvianjoki, where similar traditional gear is used (Fig. 34f).

Another type of a basket was used in the River Kokemäenjoki (Fig. 34g), a bell shaped basket. Here the opening was placed close to the opening of the basket, and no wooden lock was used (Figs. 34g–h; Fig. 59). Instead the opening was closed with grass/hay[10] during fishing activities (Sirelius 1906).

Although there still exists traditional wooden basket type gear in many of the Finnish rivers, it is evident that the wooden material is more and more being replaced by other, lighter and more durable materials. Even in the River Simojoki, where they still stick to the tradition with willow baskets and have decided that fyke nets should not be used, new material is employed, although so far on a small scale. In Fig. 35 for example, some traps of the same shape and material (glass fibre) as in the River Torneälven/Tornionjoki are used (Fig. 42). However, the glass-fibre traps used in the River Simojoki no doubt mimic the wooden lath gear in the River Torneälven/Tornionjoki, but at the River Kuivajoki further south, the glass fibre traps used there instead mimic the wooden basket of willow (Fig. 36). In this river the fishermen apparently test different materials on a larger scale. Fig. 37 demonstrates how gear of glass fibre and plastic mesh and traditional willow baskets are used simultaneously at different weirs. Sometimes there also appear combinations of materials, such as for example at the River Siikajoki, where the traditional willow baskets are repaired or improved with plastic mesh (Fig. 38).

There also exist more comprehensive changes both in materials and

Fig. 34. The lamprey traps are normally emptied through an opening in the end of the trap, which during the catching period is closed by a wooden plug. However, there is a variation among the rivers as regards this detail too. Here are some examples of the design from different Finnish rivers: a) Simojoki, b) Kuivajoki, c) Kiiminkijoki. The traps in these rivers are made of willow. d) Kalajoki. This trap is made of juniper. South of these rivers, there exists a basket type of trap which is emptied at the side, as at e) Tjöckån/Tiukanjoki, made of willow (according to the owner of the trap). The opening was closed with a wooden flap, which is lacking on this trap. The same type of gear, but of juniper, is still used also in f) the River Merikarvianjoki further south. g) and h) basket gear from the River Kokemäenjoki, also constructed by juniper branches. Such traps were in use at least up till 1978, but have now been abandoned in favour of fyke nets. Here the gear was emptied through an opening at the edge of the entrance to the gear. The opening was closed with hay or grass.[11] See also Fig. 59. Photos: Kjell Sjöberg.

models, such as in the River Kyrönjoki, where a cylindrical trap made of metallic mesh with plastic mesh at the top of the cylinder is used, but still equipped with a lifting frame and attached to a weir (Fig. 39; Fig. 55). Another example is from the River Tjöckån/Tiukanjoki, where metallic and metallic mesh cylinders without lifting frames are used (Fig. 40) along with traditional wooden traps (Fig. 34e).

Pots of wooden laths of spruce or pine

As already mentioned (see Part I) two types of gear were frequently used in the River Torneälven/Tornionjoki back in 1978; the basket gear made of willow, and the gear made of wooden laths (Fig. 2d; Fig. 19) (from the Swedish side of the river, see Sjöberg 1982 and Sjöberg 2011). In 2010 and 2011 not a single willow basket gear was seen, while the wooden lath gear was still abundant (Fig. 41). The wooden lath type was previously also used in the River Kemijoki (Aronsuu 2011*a*), situated about 20 kilometres south of the River Torneälven/Tornionjoki. However, similar to the development on the Swedish side of the river, this traditional gear type of the River Torneälven/Tornionjoki is being replaced with a trap similar in shape, but made of other materials, in this case glass fibre (Fig. 42). In 2011 the modified type constructed by glass fibre was also found in the River Simojoki, about 45 kilometres south of the River Tornionjoki (Fig. 35).

Fig. 35. A few pieces of gear made of glass fibre have been introduced among the traditional willow baskets at the River Simojoki. They are of the same type as those used at the River Torneälven/Tornionjoki (Fig. 42). 27 September 2011. Photo: Kjell Sjöberg.

Fig. 36. Lamprey traps constructed of glass fibre material. In contrast to the glass fibre traps in the River Torneälven/Tornionjoki, which mimic the wooden lath type of gear, these are clearly related to the willow basket type. Kuivajoki, 4 October 2012. Photo: Kjell Sjöberg.

Fig. 37. New material are tested and used for lamprey fishing. On the front weir, most of the gear are made of glass fibre, on the weir in the background to the right, traditional willow baskets are used, and to the left the gear are made of plastic-covered metal mesh. Kuivajoki, 4 October 2012. Photo: Kjell Sjöberg.

Fig. 38. In the River Siikajoki the traditional willow baskets are still used, but often supported or repaired with plastic mesh. 14 October 2010. Photo: Kjell Sjöberg.

Fig. 39. Lamprey trap of metalic and plastic mesh from the River Kyrönjoki, at Voitby. 29 October 2012. Photo: Kjell Sjöberg.

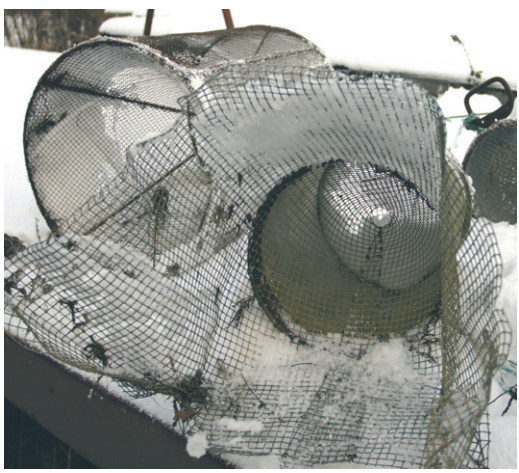

Fig. 40. Lamprey traps of metalic mesh and metal from the River Tjöckån/Tiukanjoki. 29 October 2012. Photo: Kjell Sjöberg.

Fig. 41. The traditional type of river lamprey fishing gear, constructed of wooden laths and attached to lifting-frames, is still in use in the River Torneälven/Tornionjoki. The Finnish side of the rapid Kukkolaforsen, 26 September 2011. Photo: Kjell Sjöberg.

Fig. 42. Lamprey gear of glass fibre at the Rapid Kukkolaforsen on the Finnish side of the River Torneälven/Tornionjoki. 26 September 2011. Photo: Kjell Sjöberg.

Fyke nets with wings

In Finland another type of lamprey fishing gear is also used, namely fyke nets (Fig. 2e). This kind of gear is a tightly woven long bag-shaped fishing net held open by hoops, and with wings which lead the lampreys into the gear (Fig. 43; Aronsuu 2011*a*; Sjöberg 2011). The collecting section is normally about 5–6 metres long and the wings are usually 25–35 metres long. They have five hoops and two funnels (Aronsuu 2011*a*). In contrast to baskets, stocks or wooden laths, which are placed in rapids or streaming waters, the fyke nets are placed in calmer water; they are normally placed in the sections between the river mouth and the first rapid (Aronsuu 2011*c*).

In Finland the first trials with fyke nets were performed in the River Kalajoki back in the 1940s. Then little changed until 1965, when the use of the fyke nets increased rapidly and by 1968, 52 fyke nets were used in the river. From Kalajoki the use of fyke nets spread to other rivers, first to the River Pyhäjoki, and in 1971 to the River Lestijoki, where during the autumn of 1974, 24 fyke nets were used (Tuomi-Nikula 1977; Tuomi-Nikula 1986; Tuikkala 1986). In 2010, 35 fyke nets were in use in Kalajoki and 78 per cent of the catch was caught by them (Aronsuu 2011*c*).

The use of weirs and lifting frames

In most of the Finnish lamprey rivers the fishing gear has been attached to weirs. Because of the introduction of the efficient fyke nets, the use of traditional gear and subsequently the use of weirs have decreased. It is clearly demonstrated in the Rivers Iijoki (Fig. 44) and Kokemäenjoki (Fig. 58), where back in 1978 the weirs were still in use, but at present they are totally exceeded by fyke nets. Compare also the situation in the River Kalajoki from 1978, where a view towards the church at Kalajoki shows a river with traditional gear and the situation in 2012 (Fig. 45), when many of the wooden gear and weirs have been replaced with fyke nets.

However, weirs still exist in many of the Finnish rivers, for example in the rivers Torneälven/Tornionjoki, Simojoki, Kuivajoki, Kiiminkijoki, Kalajoki, Perhonjoki and Kyrönjoki (Figs. 46–57). Their construction certainly depends upon the conditions like the river bed, the discharge rate, and the local economic importance of the lampreys. The local traditions are certainly also important. For example, the fishermen at the rivers Simojoki and Kiiminkijoki have decided to exclude fyke nets from lamprey fishing, because they want to keep the old traditional lamprey fishing, that is, with baskets attached to weirs, and also out of concern about overharvesting. Therefore, in the River Simojoki the weirs and most of the gear look the same now as in 1978 (Fig. 46; Fig. 47; Sjöberg 1982).

Fig. 43. A fyke net with wings in position in the River Lestijoki in Finland. 1 October 2011. Photo: Kjell Sjöberg.

Fig. 44. Traditional willow baskets at the River Iijoki back in 1978. Photo: Kjell Sjöberg.

Fig. 45a. The River Kalajoki back in 1978 showing many lamprey gear attached to weirs. Photo: Kjell Sjöberg.

Fig. 45b. The same view of the river, but in October 2012. Weirs are still used in the same area, but much of the lamprey fishing is now performed with fyke nets. Photo: Kjell Sjöberg.

The diversity of weir constructions is illustrated from the River Simojoki back in 1978 where at that time the weirs almost crossed the river completely (Fig. 46). Not all of them were in contact with the shore, and thus the word *strandpata* (a weir in contact with the shore, as described from the northern Swedish rivers), is not always relevant here. However, the construction is in principle the same as Ekman (1910) described as an *enryggig strandpata*, that is, with a row of trestles connected with stocks. Stones are placed on the weir to help withstand the pressure from the water. In Fig. 46

and 49, a fisherman is emptying the gear back in 1978. Many of the gear is still in fishing positions. The traps are normally emptied in the morning, dry during the day, and are put back into the water again in the evening.

Fig. 49 illustrate how gear could also be placed with just a few pieces together at small weirs, and even singly and not attached to a weir. In the foreground, two squared wooden construction can be seen at the shoreline and in the water. They are probably used as corfs where lampreys can be kept alive for some time (Swedish *fisksump*).

Fig. 46. Traditional lamprey baskets of willow attached to weirs. Many of the baskets to the left are still in fishing position, while those to the right have been taken up for drying during the day. The River Simojoki, Northern Finland 1978. Photo: Kjell Sjöberg.

Fig. 47. Traditional willow baskets equipped with lifting frames and attached to weirs are still used at the River Simojoki. 14 October 2010. Photo: Kjell Sjöberg.

Fig. 48. A *pata* at the River Kiiminkijoki where Timo Turunen is using fishing gear of traditional type constructed of willow, and with other fishing gear where the wooden material has been replaced with plastic-coated wire netting. 4 October 2012. Photo: Kjell Sjöberg.

The type of weir construction mentioned above is used today too (Fig. 47; Fig. 50). Similar weirs, *enryggiga strandpator*, could also be seen for example in the River Kuivajoki (Fig. 51; Fig. 52), as well as in the River Kiiminkijoki (Fig. 53).

As an example of diversity, also the weirs in the River Kalajoki are shown, in which the gear is attached to weirs constructed without trestles, but to poles driven into the substrate (Fig. 54).

The great variation in weir constructions in the rivers is further illustrated with a view of the River Kyrönjoki, where a weir with a more robust construction is needed in the rapid (Fig. 55).

There exist even larger and more complex weir constructions, for example in the large northern River Torneälven/Tornionjoki (Fig. 56), with an annual mean discharge of 315 m^3/sec. (Tockner *et al.* (eds.) 2009). Another complex type of construction is demonstrated in the River Kokemäenjoki (annual mean discharge of 230 m^3/sec., Kaipainen *et al.* 2007) where until about 1980 a big weir built for lamprey fishing was present at Nakkila (Fig. 58). To construct such a weir, a team of workers was needed. In the similar weir at the Ruskula village, a team of five workers did the job. The last time that weir was in use was about 1980. One reason was that it was difficult to find the right material, for example the long stocks needed to connect the different parts of the weir, but the main reason seems to be that in the end it was also difficult to hire people to do the construction work.[12]

In contrast to the situation in Sweden, in most Finnish rivers the fishing gear is attached to lifting frames, and in most rivers the gear has been at-

Fig. 49. Traditional willow baskets equipped with lifting frames and attached to weirs at the River Simojoki back in 1978. Note the boxes of wooden boards in the foreground, which probably were used for holding lampreys alive for a period of time. Photo: Kjell Sjöberg.

Fig. 50. There is a great variation in construction of the weirs. In the River Simojoki, the weir is constructed of two-legged trestles that are tied together with boards and poles, and with stones to help the construction to withstand the force of the water. 27 September 2011. Photo: Kjell Sjöberg.

Fig. 51. A weir of a single row of trestles with traps constructed of glass fibre material. Kuivajoki, 4 October 2012. Photo: Kjell Sjöberg.

Fig. 52. Another weir of a single row of trestles with traps mostly constructed of glass fibre material. Kuivajoki, 4 October 2012. Photo: Kjell Sjöberg.

Fig. 53. A more robust weir construction, like here at River Kiiminkijoki, makes it easier for the fishermen to handle the gear. 4 October 2012. Photo: Kjell Sjöberg.

Fig. 54. Basket gear from the River Kalajoki in Finland in 1978. These baskets are made of juniper, which is much more durable than willow, and that is probably the reason why they are left in the water during the day as well. This reduces the work of raising and lowering the traps, although it takes more time to clean the traps when they are emptied. They are about 70 centimetres long (Tuomi-Nikula 1986). Photo: Kjell Sjöberg.

tached to weirs of fairly advanced constructions. However, there are exceptions, for example in the River Lestijoki, where the gear is set out between stones or at prepared gates cleared of stones in front of the gear, and with support from just a pole or a wooden board (Fig. 30; Fig. 31). Similarly, for example in the big rivers with fast streaming sections of water, such as in the Kukkola rapid at the River Torneälven/Tornionjoki, it is also possible to find spots where single gear, or a few pieces together, could be placed only with support of a wooden board or pole, as in Fig. 57.

In most of the studied rivers, the openings of the gear are adjusted to a squared lifting frame with cross-section connections below and above the opening of the gear, and also with a cross-section connecting the end of the frame, as demonstrated for example in the River Simojoki (Fig. 47). The end of the frame could also be put together without a cross-section, such as in Fig. 44, from the Iijoki. A different shape of the lifting frame is demonstrated from the River Kokemäenjoki, where the opening of the gear is round, and two shafts are attached to the gear (Fig. 58; Fig. 59).

However, there are also rivers were the gear is not equipped with lifting frames and is not attached to a weir, for example the rivers Tjöckån/Tiukanjoki and Merikarvianjoki. Here the traditional traps are placed individually in the river and can be kept in place by poles and weighted down by stones to keep them in place.

Fig. 55. A weir in River Kyrönjoki with fishing gear formed as a cylinder with a metallic net and the front of plastic net. A wooden tap covers the opening in the trap where the lampreys are emptied. The River Kyrönjoki at Voitby, 29 October 2012. Photo: Kjell Sjöberg.

Fig. 56. In big rivers, like here in the River Torneälven/Tornionjoki, quite complex wooden constructions are made and the fishing gear is attached to them. The Finnish side of the River Torneälven/Tornionjoki, at the Rapid Kukkolaforsen, 26 September 2011. Photo: Kjell Sjöberg.

Fig. 57. In the big rivers too, it is possible to find stretches with calmer water flow where the gear could be attached to more simple *pata* constructions, where the gear is placed just a few together or one by one. The Finnish side of the River Torneälven/Tornionjoki, at the Rapid Kukkolaforsen, 26 September 2011. Photo: Kjell Sjöberg.

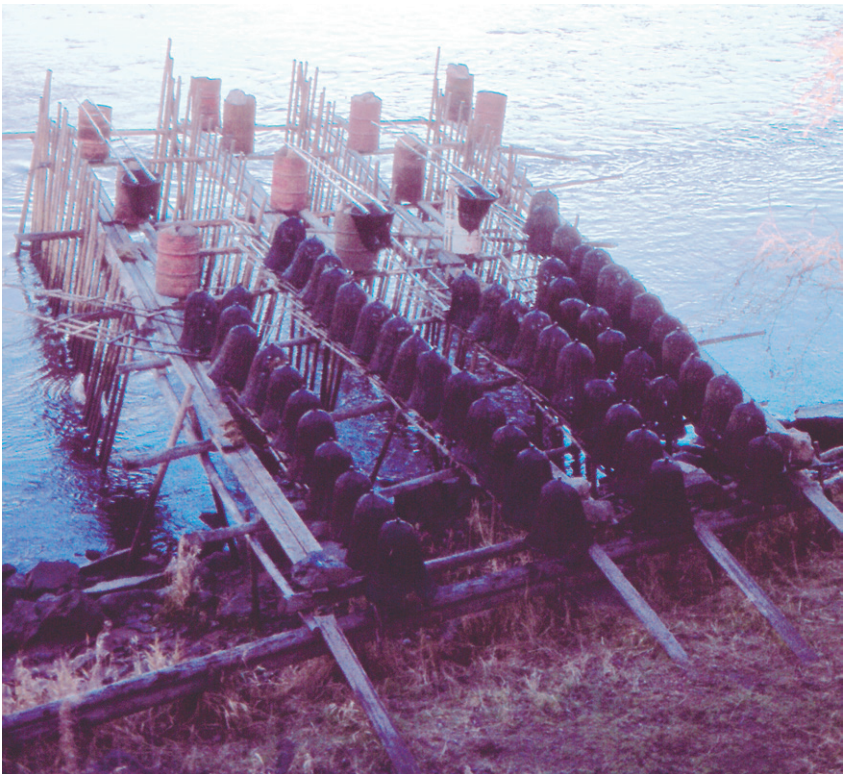

Fig. 58. A *pata* from Nikkala at River Kokemäenjoki back in 1978, with bell-shaped baskets similar to the type of gear used earlier in the rivers Salaca, Gauja and Gaudava in Latvia. Photo: Kjell Sjöberg.

Fig. 59. A basket trap from the Nakkila at the River Kokemäenjoki where this gear type was in use up to about 1980, but today has been replaced with fyke nets. This basket is very similar in shape to traps used earlier in the rivers Salaca, Gauja and Gaudava in Latvia (and attached to weirs). Here the opening of this bell-shaped gear is round, and not adjusted to a squared lifting frame as in many northern Finnish rivers. Note the opening at the edge of the entrance, where the lampreys are taken out (see also Fig. 58). Nakkila, 1978. Photo: Kjell Sjöberg.

Latvia

During the 2000s the mean catches of river lampreys in Latvia were 99 tons (Riekstiņš *et al*. (eds.) 2010), but in the period from 1960 to 1975, the overall catch even reached 400 tons (Birzaks & Abersons 2011). The river lamprey fishing is performed by enterprises on a commercial basis. No private fishing for lampreys is allowed. The number of professional lamprey fishermen is about 50–100.[13] Licences are issued by the Fishery Department of Latvia based on historical experiences gained from practising fishermen. The amount of fishing gear is also decided by the department. Then the responsibility for the fishing is delegated to the municipalities at the river, and fishermen can apply for a license to the municipality. A licence can then cover a period of for example 15 years. In 2011, 17 rivers were open for lamprey fishing. Licenses are issued for three types of lamprey fishing gear: traps with nets attached to lifting frames, fyke nets and tightly woven ordinary nets. Earlier basket types of traps were also used, as well as a combination of basket and net. Although not used today, they are described in this overview of Latvian lamprey traps types because the combined trap type is not described from Fennoscandian rivers.

Baskets of willow and their substitutes of other materials

In Latvia baskets made of willow were used in the River Daugava until about 1975, when a hydroelectric dam was built (Fig. 60; Fig. 61; Fig. 61, Fig. 77 and Fig. 80 in Cimermanis 1998). At Dole Island in the River Daugava at Riga willow baskets were attached to weirs placed at a depth of about 1.5 metres. Just below that site the depth increased to 4 metres, and with even deeper water further to the mouth. The opening of the basket was directed towards the mouth of the river. Closest to the shore a plaited construction was placed for the purpose of preventing lampreys from passing at shallow water[14] (Fig. 77 in Cimermanis 1998). A similar gear type was in use in the River Salaca in the eastern part of Latvia until approximately 50 years ago (Fig. 62; Fig. 63). In the River Gauja this gear type was also used (see Fig. 10 and Fig. 11 in Willer 1929). In all three rivers, the gear was attached to weirs (a *tača* in Latvian; lamprey weir is *nēģu tača*). At Dole Island in the River Daugava also baskets without lifting frames were used in older times (Fig. 61 in Cimermanis 1998).

A basket combined with a net

In 1992 gear constructed as a combination of a wooden basket of willow attached to a net was still in use in the River Salaca (Fig. 2g; Fig. 64). The gear was equipped with lifting frames and attached to a weir (Fig. 65; Fig. 66; see also Fig. 8 in Cimermanis 1998). Both the gear type and the weir are

unique in themselves, separately, and together represent something even more noteworthy, not being found in Sweden, Finland or Estonia. The reason is both that the gear is turned in the opposite direction compared to other gear attached to weirs, and the weirs are constructed in such a way that wooden barriers deliberately prevent the upstream migration of the lampreys. The wooden barrier also increases the water level on the upstream side of the barrier by blocking the water. There are, however, openings in the barrier where the water can pass. Below such openings the gear is placed. When a lamprey reaches the barrier, it swims sideways. When they reach the water flow from an opening in the barrier, they are flushed by the force of the water back into the gear with the mouth in upstream direction (Figs. 66–69). This trap type was in use in the River Salaca until about 12–15 years ago, when they were successively replaced by net traps only.[15]

Net gear attached to a lifting frame

The gear constructed as a combination of a basket and a net has been replaced with gear made of net only, that is, without the wooden basket, but still equipped with a lifting frame and attached to a weir (Fig. 2h; Fig. 70; Fig. 71), and otherwise used in the same way.

However, net traps with other designs are also used and they differed in size not only among rivers, but also between weirs in the River Salaca. In the first weir, the net gear used in 2010 and 2011 was the same as the gear used back in 1992 (Fig. 72). However, since then a much larger net trap has also been developed as a complement (Fig. 73). The reason why this larger gear has been developed is that the fishermen have noticed that during periods with relatively warm water in the river the upstream migrating lampreys are swimming closer to the surface compared to when the water is cold.[16] In combination with the net traps of ordinary size, lampreys could be caught at all water depths. However, to be able to empty the large traps, it is necessary to use a boat, and thus they cause more work. In total 148 traps of these types were allowed to be used in 3 rivers in 2011 (according to government rules on commercial fishing in inland waters).

A similar arrangement with barrier and the opening of the gear turned against the water flow, although in smaller scale and with net gear without lifting frames, is found in the River Venta at Kuldīga (Fig. 74).

In older times baskets were possibly used in the same way at rapids in the River Venta, like here at Kuldīga (Fig. 75). Baskets were placed under the falling water and fish trying to pass up against the water in the rapid were forced back by the water flow and into the basket gear with the mouth of the gear facing the water flow.[17] At Kuldīga seven fishermen were earlier allowed to catch salmon, vimba and river lamprey according to Cimermanis

Fig. 60. A demonstration weir with baskets made of willow shoots built at the Daugava Museum in Riga, Latvia, in 1992, showing how the baskets would look on the river bottom. The water flow would be from left to right. This type of weir and basket was in use in the River Daugava until about 1975, when a hydroelectric power plant dam was built. Photo: Kjell Sjöberg.

Fig. 61. Detail of the willow basket attached to the weir in Fig 60. The end of the basket is closed with a wooden plug. The Daugava Museum, 9 November 2011. Photo: Kjell Sjöberg.

Fig. 62. Bell shaped baskets of willow were earlier used in the River Salaca. The basket is closed with a wooden plug at the end. 15 November 2010. Photo: Kjell Sjöberg.

Fig. 63. A type of basket gear that was used in the River Salaca until about 50 years ago is shown here in the Museum of Salacgrīva. It has the same shape as the trap from the River Kokemäenjoki in Finland (Fig. 59). However, it is emptied at the end of the narrower end of the trap, not close to the entrance as in the River Kokemäenjoki. 8 November 2011. Photo: Kjell Sjöberg.

Fig. 64. Gear construced as a combination of baskets and mesh. The gear is emptied in the end of the trap, which during fishing position is closed with a wooden tap. Although the water flow was pressing against the wooden trap from inside, the tap was only very rarely flushed out of the gear, so there was no specific arrangement for keeping the tap in place.[18] The River Salaca 1992. Photo: Kjell Sjöberg.

(1998), and he has also described another old fishing method from River Venta, where bunches of twigs distributed across the river could attract migrating lampreys (Fig. 21 in Cimermanis 1998).

Fyke net without wings

Fyke nets are used in Latvia too, but in contrast to Finland the Latvian nets lack the wings that lead the lampreys into the gear (Fig. 2i). In Fig. 76 and Fig. 77 fyke nets from the River Gauja and the River Užava are demonstrated. They are often larger and with more hoops than the Finnish ones. However, in the River Daugava a shorter version with just three hoops is used. These fyke nets are set together at 8–11 metres depth. Eight to twelve nets are fixed along a 140–160 metres long rope with two large anchors at each end of the rope.[19] In total 430 net traps were allowed to be used by professional lamprey fishermen in 13 Latvian rivers in 2011 (according to government rules on commercial fishing in inland waters).

Small-mesh fish nets

Latvia also differs from both Sweden and Finland by using ordinary fish nets for lamprey fishing, apparently modified by using more tightly woven mesh (Fig. 2j). In total 31 such lamprey nets were allowed to be used by pro-

Fig. 65. In weir number 2 from the mouth of the River Salaca, baskets combined with mesh connected to lifting frames were still in use back in 1992. At the building in the background Arnis Rozenšteins is checking the weir. Photo: Kjell Sjöberg.

Fig. 66. Baskets made of willow combined with mesh, attached to lifting frames and placed in a row along a weir, but during daytime they are taken up for drying. The River Salaca in Eastern Latvia in 1992. Photo: Kjell Sjöberg.

Fig. 67. The same type of gear as in Fig. 66, but here in fishing position attached to the weir. The openings of the gear are towards the water flow. The River Salaca in Latvia, 1992. Photo: Kjell Sjöberg.

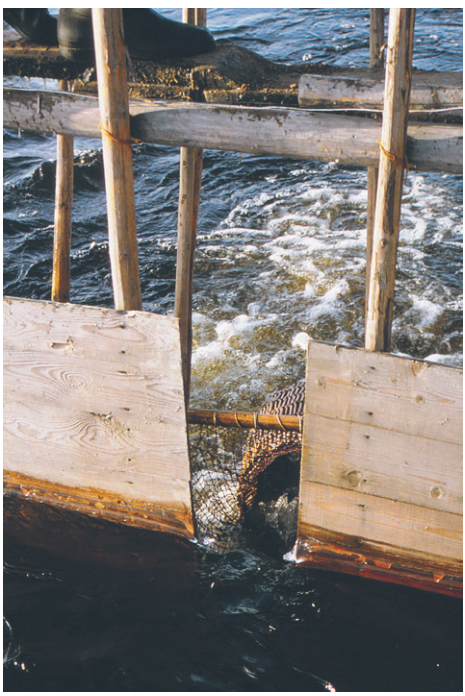

Fig. 68. A wooden barrier increases the water level against the weir. A gap in the barrier causes the water to stream into the gear and this catches the lampreys swimming upstream during their spawning migration in the river, and forces them into the gear. The River Salaca in Latvia,1992. Photo: Kjell Sjöberg.

Fig. 69. River lamprey fisherman Linde is emptying the gear attached to the second weir from the river mouth in the River Salaca in 1992. In contrast to most of the lifting frames in Finland, here they do not have a cross-piece connecting the two poles on top. The lampreys were collected and transported in a traditional box of wood back in 1992. Nowadays the box is made of aluminium. Photo: Kjell Sjöberg.

fessional lamprey fishermen in the rivers Daugava and Saka in 2011 (according to government rules on commercial fishing in inland waters).

The use of weirs and lifting frames

In the River Salaca in Eastern Latvia they still build three weirs for lamprey fishing each year, but previously there were 13.[20] A similar type of weir is also constructed in the smaller River Svêtupe (Fig. 82; Fig. 83). They cover the whole width of the river (e.g. Figs. 78–80; Fig. 82; Fig. 94), but the fishermen have to keep one third of the water free from traps. The foundations of the weir are two rows of poles of spruce driven into the bottom of the river with heavy sledges. The poles are connected to each other with horizontal poles, and crossbars connect the two lines of poles. On those crossbars gangways are placed (e.g. Fig. 73; Fig. 84). The gear can now be placed in two different ways, as described earlier, with the openings facing either downstream or upstream. In the first case the gear is placed on the upstream side of the weir (Figs. 72–73). In the second case wooden boards (Fig. 81) are attached to the weir which creates a barrier that increases the water level on the upstream side (Figs. 79–80; Figs. 82–83). There are a series of gaps in these boards, and the lamprey gear is placed on the downstream side of the barrier at these

Fig. 70. This trap type is used in the same way as the combined gear of basket and mesh used earlier (e.g. Fig. 64). The gear is emptied through the mouth by turning it upside down. This is possible because the funnel inside the gear is tied just to the base of the gear. Inside the gear it is held in place and stretched by the water flowing into it. 7 November 2011. Photo: Kjell Sjöberg.

Fig. 71. A close-up of the third weir in the River Salaca with sections of barriers. Note that this barrier has raised the water level at the upstream side to the left. 7 November 2011. Photo: Kjell Sjöberg.

Fig. 72. Maris Klêtnieks demonstrates the fishing gear used for river lampreys in the weir closest to the mouth of the River Salaca. This gear type in attached to the weir with the openings directed towards the mouth of the river. Inside the gear is a funnel that prevents the lampreys from escaping, but as the gear is directed with the end towards the direction of the water stream, the funnel is attached to the end of the gear with four strings that keep it in place. The gear is emptied from the end by loosening the string that keeps it closed. 15 November 2010. Photo: Kjell Sjöberg.

Fig. 73. A weir in the River Salaca, the first one, approximately 800 metres from the river mouth. In the first section the gear is set in fishing position, in the second section the gear is drying, and in the background a larger type of net trap is placed in fishing position. The larger gear is equipped with two funnels each. All the gear are placed with the openings towards the mouth of the river. 6 November 2011. Photo: Kjell Sjöberg.

gaps (Fig. 65; Fig. 68; Fig. 82). When a lamprey swimming upstream meets the wooden barrier, it tries to swim sideways. Then it meets the powerful water flow coming through this gap and is swept into the trap which has its

Fig. 74. Lamprey fishing in the River Venta at Kuldīga. At the shore a small-scale arrangement of a weir with openings is shown. The gear are placed with the openings facing the water flow. 16 November 2010. Photo: Kjell Sjöberg.

Fig. 75. At waterfalls like this in the River Venta at Kuldīga, baskets were earlier placed under the waterfall with the mouth of the gear facing the water flow, catching salmon and vimba that were pressed back into the gear by the strong water flow. Under such waterfalls, lamprey baskets could also be placed.[21] 16 November 2010. Photo: Kjell Sjöberg.

opening upstream (that is with its opening facing in the opposite direction from most other fishing methods which are designed to catch lampreys as they migrate upstream in the autumn).

Actually, depending on the water level situation in the river, the fishermen at the weir number 2 at the River Salaca can decide in which position they turn the gear. At low water levels and with slow flows (as can happen in the beginning of the season), the barrier is sometimes taken away, and traps are attached to the weir with the openings downstream. However, this requires much preparation work because the riverbed has to be smoothed out so the traps can be tightened to the bottom. The riverbed is overgrown with aquatic plants that have to be removed to be able to see smaller or bigger pits caused by the spring flood. Then small to medium sized stones are collected and wrapped into nylon nets, and those stone packages are placed in such pits. Otherwise there is a risk that the lampreys can pass under the traps. However, this work is seldom economically worthwhile, but is nevertheless done sometimes to avoid the risk of losing the opportunity for a good catch.[22] But normally the method with the barrier is a more efficient method at the weir number 2. The gear used when turned with the mouth in upstream direction (Fig. 70) has a funnel inside which is not attached to the end of the trap. It is kept in shape by the water flow running through the trap. For that reason the lampreys caught in the trap can be emptied by

Fig. 76. A fyke net without wings of the type used in the River Gauja (here shown on land at the town of Carnikava). About 100 pieces of this type of lamprey gear are used in the River Gauja. 9 November 2011. Photo: Kjell Sjöberg.

Fig. 77. Large fyke nets used for catches of river lamprey in the River Užava in Western Latvia. After emptying the nets in the morning, they are lifted during the day for drying. Normunds Lode is cleaning the nets. 17 November 2010. Photo: Kjell Sjöberg.

turning the trap upside down. The traps used when turned with the mouths towards the mouth of the river, that is, in downstream direction, are similar in construction to those at the weir number 1, but they are smaller in size, due to the depth and width of the river at the place. The funnel in such a trap is tied to the end of the trap with 4 strings to keep it in the right position. For that reason those traps have to be emptied through the end of the trap by loosening the string that keeps the trap end closed (Fig. 72).

At the weir number 1 (e.g. Fig. 95) just the method with the traps turned towards the mouth of the river is used (Fig. 73). The reasons are that the river is too wide there for making a barrier, the water flow is too weak for a successful result, and particularly one side of the river is very shallow, which makes it impossible to raise the water and increase the water flow.[23]

The fishing methods demonstrated at the weirs number 1 and 2 at short distance from each other at the River Salaca are good examples of how the lamprey fishermen adjust their methods to the morphological and ecological conditions in a river, as well as to the ecology of the river lamprey.

The work with constructions of the weirs starts in mid-May. The fishing season begins in mid-August and can last until 31 January, even when ice covers the river.

The fishing gear equipped with lifting frames and attached to weirs normally has cross-pieces below and above the gear, but not always at the end of the lifting frame (e.g. Fig. 69; Fig. 73). However, sometimes the two poles in the lifting frames are tied together at their ends.

Estonia

River lampreys migrate up almost all the Estonian rivers which empty into the Baltic Sea and according to Saat *et al.* (2003) about 40 of them are main spawning streams. In many of these fishing for river lampreys still occurs.[24]

There are about 200 active lamprey fishermen in the country, and they get licenses for fishing for two types of traps: cone traps (see Fig. 2k) (18,300 licenses for 2013), and lamprey fyke nets (81 licenses for 2013).[25] The state owns the fishing rights and the Ministry of Environment decides the number of licenses. The total yearly catches of lampreys have decreased over the last 60–70 years. During the period 1928–1938 the mean catch was 67 tons (Saat *et al.* 2003). At present the catches are about 50 tons per year, and 17 tons of these are caught in the River Narva (calculation based on about 15–17 lampreys per kilo in the River Narva).

Cone traps attached along a stick or a line

In Estonia cones of plastic or similar sheets (Fig. 2k) attached along a rope are used for lamprey fishing. The fishing method is described from the River Narva by Püttsepp and Järv (2010):

> The cones were earlier made of spruce bark, while cones of birch bark, thin pine planks and also of varnish-impregnated cardboard were used in the 1930ies. Sixty cones were tied to a "spine cord" (*seljanöör*), making up a cone line (*rait*).

Nowadays the same type of cones is used in the same manner, but they are mainly constructed of plastic material. In the small River Toolse (Fig. 1:35), Meelis Tambets demonstrated how the cones were attached to a pole with short ropes (Figs. 85–86) and the pole and cones were placed on the bottom of the river and kept in place by two poles driven into the river bottom.

In the River Narva (mean discharge 400 m^3/sec., Tockner *et al.* (eds.) 2009) along the Russian border, the biggest river in Estonia, the lamprey fisherman Heinard Kiik showed how his cone was used there (Figs. 87–91). Along a rope 50 cones were attached with strings at a distance of less than one metre apart. The rope was pushed down to the bottom of the river with anchors and weights of bricks. There is an anchor in one end (towards the middle of the river); on the bankside end ropes are fixed to another rope which is parallel to the river bank (anchored in both ends). The fishing season lasts from July till the end of February, and the season is closed between 1 March and 30 June for the whole of Estonia, in accordance with the Estonian fishing rules.[26] In the River Narva 15,000 lamprey cones are allowed (Püttsepp & Järv 2010). The same type of cone gear is also used in the River Pärnu (Fig. 92).

Fyke nets

Besides the cone traps, a kind of fyke net trap is also allowed for lamprey fishing in accordance with the Estonian fishing rules. They are officially

Fig. 78. The same weir as in Fig. 65, but from the other side, where the water is partially stopped by a wooden barrier with openings. The gear are placed on the other side of the weir. The River Salaca in 1992. Photo: Kjell Sjöberg.

Fig. 79. The same gear in the River Salaca as in Figs. 65 and 78, but in 2011, when the combined basket/mesh gear has been replaced with gear by mesh only. 7 November 2011. Photo: Kjell Sjöberg.

Fig. 80. The second and third weirs in the River Salaca are placed in sections of the river with faster water. Here the mesh gear has the openings facing the water flow, but catches upstream migrating lampreys. 7 November 2011. Photo: Kjell Sjöberg.

Fig. 81. Details of wooden sections of the type that built up the kind of barrier seen in Figs. 79 and 80. The River Salaca, 7 November 2011. Photo: Kjell Sjöberg.

Fig. 82. Weir in the River Svêtupe in Eastern Latvia in 2010 where the water stream is partially blocked by a wooden barrier that increases the water level. Gear is placed on this side of the weir with the mouth facing upstream. 16 November 2010. Photo: Kjell Sjöberg.

Fig. 83. The same weir as in Fig. 82, but in 2011 with lower water levels. The construction of the wooden barrier can be clearly seen, as well as the opening in the barrier where mesh gear with a lifting frame is placed on the other side of the barrier. 8 November 2011. Photo: Kjell Sjöberg.

Fig. 84. Detail of the weir in Fig. 83 showing the robust construction including cross-bracing needed to withstand the force of the water. 16 November 2010. Photo: Kjell Sjöberg.

called lamprey fyke nets (Estonian *silmumõrd*). By definition given in the fishing rules it is a trap with the height of the mouth up to 0.5 metres and with a width of the mouth up to 1 metre, and with no leading wings.[27]

Weirs and lifting frames

Püttsepp and Järv (2010) describe former fishing from two-legged weir trestles, where "wicker traps" were placed with their mouths directed towards the sea, between Narva Waterfall and the wooden bridge of Narva, where the current was particularly fast. Those traps were set in the afternoon and harvested at sunrise (Püttsepp & Järv 2010). However, a hydroelectric power plant dam has now destroyed the conditions for that type of fishing. No weir trestles are used for lamprey fishing in Estonia today.[28]

Discussion

As shown above, there is surprisingly great variation in the construction and use of river lamprey gear around the Baltic Sea. To some extent the variation is certainly dependent on the physical condition in the rivers, for example the size of the rivers, water velocity, and differences in bottom substrate. However, economic pressures and local traditions in different regions and in the different countries are clearly also involved, as are the fishing regulations issued by authorities. Otherwise there would not be such sharp differences in trapping methods when a border is crossed.

The physical conditions of many of the lamprey rivers emptying into the Baltic Sea area have been heavily influenced by the construction of hydroelectric power plant dams during the twentieth century. However, before that the rivers must have been largely unchanged. It is thus perhaps no surprise that the fishing gear used has evolved to be very well adjusted to local conditions.

To some extent the same type of gear is used today that is documented at least back to the fifteenth century (Nordberg 1977; Storå 1978). The gear used for the lamprey fishing in the River Umeälven in the middle of the sixteenth century was called wooden logs (Swedish *nättingstockar*). Back in 1732 Linnæus (Linnæus 2003 [1732]) noted two types of lamprey traps when he visited Kalix in Northern Sweden, a basket made of willow shoots, and a tree trunk, hollowed out and put together again. The fact that these types of gear were still in use in northern Swedish rivers until recent decades demonstrates how well they were adjusted to the situation in those rivers. In the River Gideälven, for example, the tree trunk traps were used till the middle of the last century and the willow basket type was used till the end of the last century in Sweden and is still used in many of the Finnish rivers

Fig. 85. Meelis Tambets is collecing cone gear for harvesting river lampreys in the River Toolse in Estonia. The cones are tied along a stick and placed on the bottom of the river in a section with gravelly/stony bottom. 7 November 2012. Photo: Kjell Sjöberg.

Fig. 86. The traps are emptied at the small end of the cone, which during fishing is closed by a plug. 7 November 2012. Photo: Kjell Sjöberg.

(Table 1). It is reasonable to assume that the present-day logs constructed of wooden boards, still used in the rivers Öreälven, Rickleån and Åbyälven in Sweden, are a substitute for the hollowed out stocks. They are used in the same way as the original hollowed out stocks.

In Northern Sweden and Finland the traditional fishing sites for lampreys are in rapids or sections with fairly fast-flowing waters and the fishing gear was developed to work in rivers with different water regimes (cf. Storå 1978; Tuomio-Nikula 1986). In the mid-sized rivers like Rickleån and Öreälven for example (mean annual discharge 16 and 35 m^3/sec., respectively; *Norrländsk uppslagsbok* 1996), the rapids are covered with stones and boulders on the bottom. Figs. 10 and 93 demonstrate how the traditional gear is placed between stones in rapids where the water level is so low that the fishermen can reach most of the rapid by wading out in the stream with waders. Gear of different sizes can be placed one by one (parallel if possible) among the stones, which are also used to lead the lampreys into the trap by filling the gaps between the traps and stones with for example spruce or alder twigs to prevent them from passing through these gaps. Part of the bottom could also be cleared of stones or arranged so that the lampreys were led towards

Fig. 87. Heinard Kiik demonstrated his lamprey fishing method in the River Narva and also the grill for lampreys in the oven behind him. Alder is used as firewood. 7 November 2012. Photo: Kjell Sjöberg.

Fig. 88. Cone-shaped gear of plastic on the River Narva in Eastern Estonia, belonging to lamprey fisherman Heinard Kiik. 7 November 2012. Photo: Kjell Sjöberg.

Fig. 89. Cone gear at the River Narva, Estonia. About 50 cones are attached less than one metre apart from each other along a rope. 7 November 2012. Photo: Kjell Sjöberg.

Fig. 90. The cones are attached to the rope, and they are emptied in the end of the cone, which during catching time is closed by a wooden plug. The cones are approximately 30 centimetres in diameter at the mouth and mostly about 60 centimetres long. 7 November 2012. Photo: Kjell Sjöberg.

Fig. 91. Fisherman Heinard Kiik emptying his plastic cone lamprey gear in the River Narva, the biggest river in Estonia, and the most important river for lamprey fishing in the country. The boat moves to the left, and after emptying each cone into a bag, it is allowed to fall back into the river on the right side of the boat. The flow of water is towards the camera. The rope and gear are weighted down to the bottom of the river with bricks. The gear is emptied during daytime. 7 November 2012. Photo: Kjell Sjöberg.

Fig. 92. River lamprey gear of plastic material is also used in the River Pärnu in Western Estonia. 6 November 2011. Photo: Kjell Sjöberg.

the traps when swimming upstream during migrating. In Finland this is described in detail by Storå (1978; 2008) from the former lamprey fishing in the River Nykarlebyälven/Lapuanjoki, and it can clearly be seen even today at the River Lestijoki (Figs. 30–31).

Naturally, the size of the river ought to be a factor in the development of fishing gear. However, for example in the big rivers Torneälven/Tornionjoki, Umeälven and Dalälven in Sweden (mean discharges of 315, 431 and 397 m^3/sec. respectively; Tockner *et al*. (eds.) 2009), the same methods were used as in smaller rivers, that is, the lampreys were caught in the rapids. This is still done in the River Torneälven/Tornionjoki, where until recently the traditional fishing gear of willow was used, that is, the same as for example in the River Lestijoki in central Ostrobothnia with a mean discharge of 11.5 m^3/sec. (Valtonen & Niemi 1979). This was possible because in the bigger rivers, the gear was attached to weirs of different constructions, which

made it possible for the fishermen to reach further out in the river from the shore than would otherwise have been possible. Also, the river lamprey is a fairly weak swimmer and probably avoids the part of the rapids with the strongest water flow. Thus, to some extent the same type of gear could be used independent of the river size.

However, when comparing Figs. 30–31 and Fig. 93 from Northern Finland and Sweden with Fig. 91 from the River Narva in Estonia and Fig. 94 from the River Salaca in Latvia, it is obvious that the fishing gear also has to be adjusted to the physical conditions of the river in the region in a more structural way. In the River Salaca in Latvia (Fig. 94) the mean discharge is 33 m^3/sec. (Birzaks 2011), and the mean depth 0.7–2.7 metres, with stony and stony-sandy as the main bottom habitat types (Grinberga & Spriņģe 2008). The River Narva in Estonia is generally 300–400 metres wide, with a mean average discharge of approximately 400 m^3/sec. The average depth of the river is four to six metres. Under such conditions it is not possible for lamprey fishermen to see the bottom and thus it is difficult to get individual traps to fit well to the bottom structure in the same way as in the northern rivers. The solution has been the cone gear in Estonia and the gear attached to weirs in Latvia, which are used also in stretches in the river with slow moving water. The gear attached to the weirs is also adjusted to the situation, with nets equipped with lifting frames. There are also weirs where the openings of the traps could be turned either in the upstream or downstream direction depending on the water velocity.

In a way, the fyke nets have nowadays to some extent neutralized the differences between the Fennoscandian and Baltic river structures as fishing sites, because the fyke nets are placed close to the river mouths and normally downstream of rapids.

An example of how water velocity influences the fishing methods is presented by Püttsepp and Järv (2010) from the River Narva with an average flow velocity of one metre per second, but increasing up to three metres per second at rapids and decreasing to 0.5 metres per second in the lower courses. They wrote: "Between Narva Waterfall and the wooden bridge of Narva, where the current was particularly fast, lamprey was fished with weirs (fish fences: *sakools*) and with wicker and cord traps. From the wooden bridge to the sea, lamprey fishers used 'pipes' or traps made of thin pine boards and birch bark."

Strong traditions of lamprey fishing in rivers for hundreds of years have certainly influenced present-day activities. Even if the economic importance of the lamprey might have decreased, the long fishing traditions along many rivers are still strong. This is seen in different ways. For example in the town of Carnikava at the River Gauja in Latvia, the river lamprey is a part

Fig. 93. A typical fishing site for river lampreys in the northern Swedish rivers with rapids with stones and boulders on the bottom. Here the fishermen can select sites for individual fishing gear between the stones and press them down to the bottom with stones on top. Arne Öberg and Jan-Erik Johansson are emptying their lamprey traps in the Rapid Långedsforsen in the River Öreälven, Sweden (Fig. 1:6). 26 September 2012. Photo: Kjell Sjöberg.

Fig. 94. A difference between Sweden and Finland vs. Latvia is how the gears are placed and constructed. In the River Salaca in Latvia with fairly calm water and a relatively low water level, weirs are used which cover the whole width of the river, and not necessarily near a rapid as is common in Sweden and Finland. 7 November 2011. Photo: Kjell Sjöberg.

of the symbol of the town, and in the town of Salacgrīva at the River Salaca there is a lamprey festival each year. Furthermore, the weirs still in use in the River Salaca attract many visitors. Tourist tours are organized to the weirs where people from different countries learn about the lamprey fishing. In Estonia, at the mouth of the River Narva, the Narva-Jõesilm Lamprey Festival is celebrated in the end of September. In the River Simojoki in Northern Finland annual lamprey festivals are also organized and there, as well as in the River Kuivajoki, the local fishermen have decided to stick to the traditional fishing methods and exclude the more efficient fyke nets.

If a type of gear has been developed and used in a river for a long time and functions well in relation to the demand of lampreys on the market, there might be limited interest in developing or accepting new methods. This may also lead to limited exchange of information, and subsequently a decline in experience. For example, not all lamprey fishermen in Sweden are aware of the similar lamprey fishing across the Bothnian Bay in Finland, and vice versa. Even when an exchange of information exists, a lack of experience on one side could be a reason why a new method is not accepted there. In fact, individual fishermen in the rivers Öreälven and Rickleån have tried to use the Finnish fyke nets, but without good results, probably because they have placed them in different habitats in the river than the Finnish fisherman would do. However, this does not mean lack of possibilities for exchange of information. For example, lampreys from the northern Swedish rivers are sent to southern rivers for processing, and thus make it possible to exchange information. Actually, the present use of cylinders from old washing machines for storing lampreys for a while can now be seen in some rivers, for example Torneälven/Tornionjoki (Fig. 24), Kuivajoki, Kalajoki (Fig. 33) and Lestijoki (Fig. 32), which might be an example of useful innovation which is accepted by the fishermen, although the different gear and methods remain intact.

Of course fishing regulations also influence the choice and development of fishing gear. For example, in both Estonia and Latvia the state authorities decide the number of licenses issued for lamprey fishing and also the type of gear allowed, as well as which rivers are open for lamprey fishing.

Even if the reasons for differences described above often seem clear, there also exist differences within the same region and also between countries with similar conditions, which are more difficult to explain. The difference between Sweden and Finland as regards use of fyke nets could again serve as an example. Why are the efficient fyke nets used in Finland but not in Sweden? One reason might be that lamprey fishing is more important in Finland than in Sweden. It is noticeable not only in the catches, but also in the interest from the authorities. For example, there still exist statistics

of the river lamprey fishing in Finland, but these are no longer collected in Sweden. There are attempts to improve the fish ways (fish ladders) in the hydroelectric power dams in Finland so that they suit the migrating lampreys (not only salmon). In Finland, lampreys are caught at dams and transported and released upstream of the dams: 100,000 adult lampreys per year in the River Kemijoki; 60,000 in the River Iijoki; 50,000 in the River Oulujoki; 10,000 in the River Perhonjoiki and 5,000 in the River Kokemäenjoki (Aronsuu 2011*b*). These activities are regulated by water courts. Also lamprey larvae are produced and released in Finnish rivers as a method for management of lamprey stock, for example 2 million larvae in the River Iijoki and 15 million larvae in the River Perhonjoki (Aronsuu 2011*b*) as ordered by the authorities. Spawning and breeding habitats are restored in some rivers, for example in the rivers Perhonjoki and Kalajoki (Aronsuu 2011*a*; Aronsuu & Tuohino 2011). No such activities to improve lamprey populations are done in Sweden, except release of adult lampreys, which is done voluntarily on a small scale in the rivers Dalälven and Ljusnan, where lampreys are transported around the dams (cf. Sjöberg 2011).

In the following sections some of the differences among and within the countries as regards gear types and the methods to use them in rivers with different conditions are discussed, as well of changes in the materials used.

Differences within and among countries in the use of gear types, materials, methods, and wooden barriers

Sweden compared to Finland

As mentioned above, in 1772 Juvelius described the trap types used in the River Nykarlebyälven (the lower part of the River Lappo å/Lapuanjoki) in Finnish Ostrobothnia, osier baskets and pots. The baskets were conical in form and constructed by osier material and small roots of spruce, that is, the same type of baskets that are still in use in the Ostrobothnian rivers, although sometimes with other materials. The pots he describes are (in my translation from Swedish) squared and narrowed towards one end and with small holes around the box. They were made of boards that were nailed together. The same description could also be used to describe the wooden logs still in use in for example the rivers Öreälven and Rickleån in Sweden. However, this wooden log is not in use in Finland today (nor in Estonia and Latvia). Thus, here we have two important differences in the recent use of lamprey gear in Sweden and Finland:

(1) Although the wooden log (Fig. 2c) once was used in both Finland and Sweden, today it is still in use in Sweden but not in Finland;

(2) The willow type of basket (Fig. 2a) has until recent decades been used in several of the northern Sweden rivers. In 1978 they were still in use for example in the rivers Rickleån and Torneälven/Tornionjoki, but in 2010, 2011 and 2012 no baskets were found used in the rivers studied in Sweden, but the basket type of gear, equipped with a lifting frame and often attached to weirs, is still frequently used for lamprey fishing in many of the Finnish rivers (Table 1).

The traditional gear is not normally equipped with lifting frames in Sweden, except those gear that are attached to weirs. The baskets and board logs were placed individually among stones in the river. In the River Dalälven, with an annual mean discharge of 379 m^3/sec. (Tockner *et al*. (eds.) 2009) the wooden pieces of lath gear used earlier (Fig. 2d) were also placed individually or a few together, attached via poles, although some kinds of weirs were used a long time ago (for details, see Ehn 1970). Thus, the size of the rivers may not be the reason for some differences among regions in the use of weirs. Furthermore, from the River Torneälven/Tornionjoki it is obvious that there could be a differentiation in use of weirs within the same section of a rapid. In the Rapid Kukkolaforsen for example, complex weir structures are used in the white water sections of the rapid, while along the shore in calm water simple weirs are used, and the gear with lifting frames could also be placed in the river with support of just a pole (e.g. Fig. 57).

There are, however, also in Finland, rivers where the gear of wooden materials, baskets of willow or juniper without lifting frames is still in use, for example the rivers Tjöckån/Tiukanjoki and Merikarvianjoki.

The distribution of weirs in connection to lamprey fishing in Sweden is interesting. They are still used in the big rivers Torneälven/Tornionjoki (mean discharge 315 m^3/sec., Tockner *et al*. (eds.) 2009) and Kalixälven (mean discharge 290 m^3/sec., but could be as high as 3,000, *Norrländsk uppslagsbok* 1994), where lamprey fishing gear equipped with wooden frames is attached to them, but not in the large rivers further south, such as in the River Umeälven (Fig. 1:8) (mean discharge 431 m^3/ sec., Tockner *et al*. (eds.) 2009) where the important lamprey fishing was going on until the beginning of the1960s when a power plant dam had been constructed. Not even in the large river Piteälven (Fig. 1:12) and in the once so important lamprey rivers Ljusnan (Fig. 1:2) and Ljungan (Fig. 1:4) was the use of weirs mentioned in the literature. In those rivers, and even in other, smaller Swedish rivers in this study south of the River Torneälven/Tornionjoki and the River Kalixälven, the lamprey traps are set out individually between stones, boulders and other obstacles on the bottom of streaming waters (e.g. Fig. 9, Fig. 93 and Sjöberg 1982).

In Finland weirs have been used in all the bigger rivers, for example in

the River Torneälven/Tornionjoki and the River Kokemäenjoki, and earlier in the rivers Kemijoki and Oulujoki as well, where, however, hydroelectric dams close to the river mouths now have changed the situation (these latter rivers are not included in this study).

It is also interesting to compare the use of weirs in smaller rivers in Finland and Sweden. On the Finnish side of the Gulf of Bothnia, weirs are found in many rivers from the River Torneälven/Tornionjoki to at least the River Kokemäenjoki (14b to 27 in Table 1), for example in the rivers Kalajoki, with a mean annual discharge of 35 m3/sec. (Eklund *et al*. 1984), Lestijoki, with a discharge of 11.5 m^3/sec. (Valtonen & Niemi 1978; Edén *et al*. 1999), and Perhonjoki, with a mean discharge of 17–21.5 m^3/sec. (Eklund *et al*. 1984; Ojutkangas *et al*. 1995). Those rivers may be compared to the Swedish River Rickleån, with a discharge of 16 m^3/sec., and with the River Öreälven with 35 m^3 sec. (*Norrländsk uppslagsbok* 1996) where they do not use weirs.

Ekman (1910) suggests an explanation: The use of weirs for lamprey fishing in Sweden is the result of influence from Finland. They are widely distributed in Finland and further east. In Sweden the Finnish influence reaches to the border region in the north, and weirs of the same type as used for whitefish catching were introduced to the rivers Torneälven/Tornionjoki and Kalixälven. According to Ekman (1910), the tradition with weirs of the kind had reached those rivers from the east, but not further south in Sweden—apparently this is still the situation today.

The difference in the use of fyke nets mentioned above is another surprising difference between Sweden and Finland. Back in the 1940s the lamprey fishermen in the River Kalajoki in Finland (Fig. 1:21) began to use fyke nets with wings for fishing lampreys on a small scale, but in the 1960s the numbers increased and spread to other rivers (Tuomi-Nikula 1986). Nowadays they are used in most lamprey rivers in Finland, with a few exceptions. However, in Sweden such fyke nets are not used at all for lamprey fishing, which is remarkable because the fyke nets are regarded as more efficient than the traditional trap types (Tuomi-Nikula 1986) and because many of the rivers on both sides of the Gulf of Bothnia are similar in size, bottom structure and water discharge. Again, the rivers Rickleån and Öreälven could be used as examples. As in the other Swedish lamprey rivers no fyke nets are used, while fyke nets are used in the Finnish River Perhonjoki, where the discharge was 17–21.5 m^3/sec. (Eklund *et al*. 1984; Ojutkangas *et al*. 1995), in Kalajoki with 35m^3/sec. (Eklund *et al*. 1984), and in the River Lestijoki with 11.5 m^3/sec. (Valtonen & Niemi 1978; Edén *et al*. 1999) (see Fig. 1 for locations of the rivers).

Sweden and Finland compared to Latvia and Estonia

It is quite obvious that the differences between rivers in Northern Sweden and Finland, compared to the situation in the Latvian and Estonian rivers have created adaptations as regards constructions of gear. For example, it is difficult to see how basket traps without lifting frames or logs of wooden boards could have been utilized efficiently in big and broad rivers such as the River Narva and the River Pärnu in Estonia, or in the rivers Salaca, Gauja and Daugava in Latvia, if they had been used in the same way as in for example the River Rickleån in Sweden. In this river, with a mean annual discharge of 16 m^3/sec. (*Norrländsk uppslagsbok* 1996), they can be placed individually among stones on the bottom. The water levels are so low that fishermen can wade out in the rapids, the water is so clear that they can see the bottom and individually adjust the gear to an efficient fishing position.

In the Estonian and Latvian rivers, which are referred to as Baltic and Eastern Continental Rivers by Tockner *et al*. (eds.) (2009), other methods have been developed. In the River Narva, with an annual water discharge of 400 m^3/sec. at the mouth, mostly 200–300 metres wide and four to six metres deep (Püttsepp & Järv 2010), the fishermen use a method where the gear could be placed out without wading into the water and without being able to see and fit individual gear to an exact position on the bottom. By using many funnel-shaped traps attached to a rope, and emptying them during the day, it is possible to catch lampreys in such habitats too.

However, why should the night active lampreys swim into small plastic traps distributed out from the riverbank when swimming upstream against the water in a broad, deep river? And why are the traps not emptied at the same time of the day as in Sweden and Finland, where normally baskets and logs placed in rapids are emptied in the morning. That was also the case at the time when baskets attached to weirs were used between Narva Waterfall and the wooden bridge of Narva. Those traps were set in the afternoon and harvested on the following day at sunrise (Püttsepp & Järv 2010). In the rapids of Sweden and Finland the migrating lampreys are sometimes led into the baskets and logs by constructions of stones (e.g. Fig. 30), and the fishermen try to prevent the fish from passing the trap by tightening around it with spruce twigs or other materials. This is not the case when the cone traps are placed in the deep and broad River Narva.

A hypothesis could be that the fishing method is adapted both to the diel (24 hours) rhythm of the lampreys and the river morphology. The lampreys are sensitive to daylight (e.g. Wikgren 1954; Claridge *et al*. 1973; and Sjöberg 1977). Already Juvelius (1772) made a comment about this. He noticed that the lamprey fishermen at River Nykarlebyälven/Lapuanjoki in Northern Finland had tried to fish for lampreys during the day, but without

success (Juvelius 1772). Actually, the lampreys are so sensitive to light in general that it is a common knowledge among lamprey fishermen both in Sweden, Finland and Latvia that the catches are smaller even when there is moonlight (e.g. Storå 1978). After migration during the night the lampreys seek shelter from the light in suitable places on the bottom, under a stone, etcetera, to attach to with their sucking discs. In a river like the River Narva they do not have access to large stones and boulders as in the northern rivers, but find the plastic funnel-shaped traps distributed on the bottom of the river, and inside the dark cones they can attach to the plastic and find shelter from the light.

The method of placing the fish gear in this way is not used in Sweden, Finland or Latvia. However, it is still a cone-formed gear of the same construction in principle as other lamprey traps, but the way to adapt it to the diel activity of the river lampreys seems to be unique within the Baltic Sea area. Instead of catching actively upstream migrating fish during the night as in Sweden, Finland and Latvia, with this method they catch the fish when they seek shelter during the light part of the day. However, it ought to be stressed that this is a hypothesis that is not proven, to my knowledge, but it should be easy to test the hypothesis.

Then the question arises why the same catching philosophy is not used in Northern Sweden, where they use the wooden board logs. The answer is certainly that in the rapids where the wooden logs are used, the lampreys can easily find shelter and attach to stones and rocks almost everywhere in such habitats, and thus few of them would have a reason to enter the logs during daytime.

Lamprey fishing in Latvia and Estonia is nowadays different from the fishing in Sweden and Finland at least in seven ways:

(1) The common wooden traps in Sweden and Finland, the wooden gear of boards or laths and the willow basket type are not in use in Latvia today;
(2) The basket type of trap attached to a lifting frame and attached to a weir, which is still common in Finland and to some extent in Sweden, is no longer used in Latvia;
(3) In Latvia large fyke nets without wings are used, and in addition
(4) different types of net traps equipped with wooden frames and attached to weirs are used, but not in Sweden or Finland;
(5) Ordinary fish nets with small mesh openings are also used to some extent in Latvia in contrast to Sweden and Finland. Furthermore,
(6) the weirs used in Latvia are different compared to those in Sweden and Finland.
(7) The use of cone traps.

First, single traps placed on the bottom of rivers and weighted down with stones (still used in Sweden) and the willow basket type (still used in Finland) are thus not used in Latvia or Estonia nowadays (Table 1). The reason could be that the bottom structure in the Latvian rivers is different. Large stones covering the bottom of the rapids or streaming sections of the rivers (typical of Swedish and Finnish rivers), does not seem to exist in Latvia to the same extent. A second explanation could be that the efficient fyke nets have taken over (as in some Finnish rivers, for example the River Kokemäenjoki).

Second, a basket type, similar to the basket gear earlier used in the Finnish River Kokemäenjoki (Järvi 1932; Soikkeli 1959; Hurme 1966) has been in use at least in the rivers Gaudava and Gauja. Pictures from 1929 of this trap type are shown by Willer from the River Kokemäenjoki in Finland and from the River Gauja in Latvia (Figs. 4, 10 and 11 in Willer 1929). They were used in the River Salaca up till about 50 years ago (Figs. 62–63) and were still in use in the River Kokemäenjoki back in 1978 (Sjöberg 1982; Fig. 58; Fig. 59). However, such gear, or basket gear in general, are no longer used in Latvia and Estonia (Table 1).

Third, fyke nets are not used in Sweden, but frequently used in Finland and Latvia (Table 1). However, at least some fyke nets used in Latvia are bigger than those in Finland (cf. Fig. 43 and Fig. 77) and the Latvian fyke nets are without leading wings. A possible explanation could be that the lamprey fishing in Finland and Latvia is of more economic importance. There still exist professional or semi-professional lamprey fishermen both in Finland and Latvia, but not in Sweden. This might have forced a development towards more efficient and less labour demanding fishing gear in Finland and Latvia (cf. Storå 1986; Tuomi-Nikula 1986).

Fourth, the type of gear constructed as a combination of basket and net and attached to a frame, which was used in the River Salaca until about 12–15 years ago, has not been documented in Swedish or Finnish rivers. Neither has its present-day replacement, that is, gear made of net only but still attached to a frame and placed at a weir been used in Sweden or Finland.

Fifth, ordinary fish nets, but tightly woven, are apparently used to some extent in Latvia. Such lamprey fishing gear is not used in Sweden, Finland or Estonia.

Sixth, the types of weir are different. In Sweden and Finland they are normally shorter and are placed in a rapid or section with streaming water. In Latvia they can cover most of a river. However, by law at least a third of the river should be free from traps to allow some fish to escape and reproduce. The model of weir with a barrier that increases the water level in the upstream direction of the weir has not been used in Sweden or Finland.

Consequently, the possibility to turn the entrance of the gear in either the upstream or downstream direction is not possible with the weirs or barriers in Sweden and Finland. A weir must be very robust to be able to increase the water level in a flowing river and it may only be in Latvia where the lamprey is so highly valued that the investment of time and energy to build and maintain such a structure is justified, and where the geomorphology of rivers makes such constructions easier.

Thus, a *pata* (weir, trestles) in Sweden and Finland is situated in a rapid or in a section with fairly fast moving water and has no barrier to increase the water level. The gear are always placed with the entrance pointing downstream to meet the upstream-swimming lampreys (e.g. Fig. 50).

In their review of fish catching methods of the world, Gabriel *et al*. (eds.) (2005) describe a very similar idea of catching upstream-migrating lampreys (*Geotria australis*) from New Zealand as has been in practise in Latvia—that is, a gear with a combination of a basket and a net, which is attached to a weir in the downstream position, but with the mouth of the gear directed towards the water stream of the river (cf. Figs. 66–68). When the upstream swimming lampreys meet the barrier of the weir, they swim sideways, and when they meet the water flowing thought narrow openings in the barrier, they are washed back into the openings of the trap.

Seventh, one fishing method dominates in Estonia, cones mainly made of plastic material attached along a rope and placed on the bottom of the river. This method stands out from all methods described earlier, because it is not used either in the neighbouring country Latvia, or in Sweden and Finland. Furthermore, this method is unique compared to those used in the other countries because it apparently utilizes the 24-hour-activity and behaviour of the lampreys in a different way. They indeed still catch upstream migrating lampreys with the cone traps, but they do not catch them during their active nocturnal migration, as all other described catching methods in the study area do. These cones evidently catch lamprey during daytime, when the night-active lampreys seek shelter on the bottom of the rivers during the light period—shelter which these cones provide.

Latvia compared to Estonia

When dealing with the rivers in Estonia and Latvia, for example the River Narva in Estonia and the rivers Salaca and Gaudava in Latvia, the differences between the counties are obvious. Although baskets attached to weirs have been used earlier, today there are just two methods in use in each of the countries. Just one of the gear types used nowadays is the same in the northern countries, and that is the fyke nets, which are used both in Finland, Estonia and Latvia, although with different sizes and shapes. Other-

wise the use of weirs is also different. However, more surprisingly, the net traps attached to weirs in Latvia are not used in Estonia, and the cone traps in Estonia are not used in Latvia (Table 1).

A possible explanation of the differences could be that the lamprey fishing is regulated by the state authorities. Both the amount of gear and the type of gear are regulated by issuing licences and the state and local authorities also decide in what rivers and where in the rivers the gear is allowed to be used. Such systems, developed differently in the two countries, might act as a conservative force, perhaps limiting changes and innovation. In Sweden and Finland the landowners along the rivers have the fishing rights, and the fishing is often organized within the framework of a fish conservation association.

Differences within countries

There are considerable differences not only among Sweden, Finland, Latvia and Estonia in the use of fishing gear, but also within countries. In Sweden, for example, the differences between the southern and northern lamprey rivers are evident. The pot of wooden laths was the traditional type of fishing gear in the rivers Dalälven, Ljusnan and Ljungan, that is, among the southern lamprey fishing rivers, and as well in the River Torneälven/Tornionjoki along the border between Sweden and Finland, but not in the rivers between (Table 1). Today, the gear type made of wooden laths is no longer used in the southern rivers, or just on a small scale, as in the River Ljungan, but it is still common in the River Torneälven/Tornionjoki. In his survey of Finno-Ugric fishing implements, Sirelius (1906) mentioned this model from the rivers Torneälven/Tornionjoki, Onega, Neva and Luga, but he also mentions analogous forms in the rivers Ljusnan and Dalälven.

Among the rivers studied in Finland, the wooden lath type of gear was found just in the northernmost River Torneälven/Tornionjoki (Table 1), where it is still common, but has earlier been used in the River Kemijoki, about 45 kilometres further south (Aronsuu 2011*c*). However, as on the Swedish side of the River Torneälven/Tornionjoki, this traditional gear has to some extent been replaced with a trap of similar form but made of glass fibre material (Fig. 22; Fig. 42).

Up till recently, baskets made of willow (*Salix* spp.) or by rattan have been in use in some Swedish rivers (to my knowledge, juniper has not been used in Swedish baskets, in contrast to Finland). Like the wooden board log, these items of fishing gear are normally put into the rapids one by one between stones, and are held down on the bottom of the river by placing stones on the top of the basket or log, as was the case in the River Umeälven. There both types were used in the same fishing site, the latter one mostly in

the end of the season, when ice began to appear in the water. The wooden board log is still used in the rivers Rickleån and Öreälven (e.g. Fig. 9; Fig. 12), that is, in the central rivers, compared to River Dalälven in the south and the River Torneälven/Tornionjoki in the north (Table 1). Baskets attached to wooden frames were in use in the River Kalixälven, and in the River Torneälven/Tornionjoki (Fig. 4) until about 15 years ago. Among the Swedish rivers studied, those two northern rivers were the only ones where the lamprey gear was attached to any kind of weir. In this respect, the situation is much the same as was described by Ekman in 1910.

In contrast to the situation in Sweden, the basket type of gear is still in use in some of the Finnish rivers, for example in the rivers Simojoki, Kuivajoki, Kiiminkijoki, Kalajoki, Tjöckån/Tiukanjoki and Merikarvianjoki. In the three northern rivers, willow twigs or shoots are used as material, while in two of the southern rivers juniper is used. There are also regional differences as regards the use of lifting frames and weirs. Among the studied Finnish rivers, lifting frames are used in all rivers from the River Torneälven/Tornionjoki in the north to the River Kyrönjoki (Fig. 1:14–24), and further south two shafts were used to lift gear in the River Kokemäenjoki (Figs. 58–59). But there are also rivers where lifting frames are not used. In the river Tjöckån/Tiukanjoki and the River Merikarvianjoki, gear without a lifting frame is still used to some extent and is placed on the bottom of the river and kept in place by stones on top.

Changes in material

Compared to a few decades ago, the most obvious change among the lamprey gear seems to be that more durable material is used, but that the fishing gear form is relatively unchanged. For example, today plastic nets, plastic coated wire netting or perforated sheet metal are used, instead of willow, or wooden boards (Fig. 14; Fig. 21; Fig. 23; Figs. 31–32; Figs. 39–40). Today there is also gear on the market constructed of fibre glass, which is perforated to let water flow through the gear (Fig. 36; Fig. 42). It is interesting to note that even when such a different material as the glass fibre is introduced, the shape of the new gear follows the traditional types—again an example of how well the trap type is adapted to the situation and tradition in a particular river. For example, there is no doubt that the glass fibre trap in the River Torneälven/Tornionjoki (Fig. 42) reflects the wooden lath type previously used in that river. Furthermore, compare the glass fibre trap in the River Kuivajoki (Fig. 36), which clearly is based on the willow basket type of trap.

The example from the River Rickleån in Sweden is typical of the situation in many rivers. Compared to the situation in 1978 for Sweden and Finland, and with Latvia in 1992, in almost all the rivers studied in 2010 and

2011, there have been changes in either the gear type used or in the material (Table 1). For example, in Sweden the basket of willow or rattan, which still was in use back in 1978, has largely disappeared and been replaced with plastic or metal mesh materials. In contrast, in Finland baskets of willow or juniper still exist in for example the rivers Simojoki and Kalajoki. In the River Simojoki the gear and the weirs it is attached to are very much the same now as back in 1978 (Fig. 46; Fig. 47; Fig 49), and also the same as in a picture from 1916 (Räsänen 1916).

The reasons for changes in materials are quite obvious as new and more sustainable materials are available nowadays, compared to birch bark, willow or juniper twigs or shoots (and spruce or pine roots as connective material). Plastic nets, metal mesh covered with plastic, glass fibre, metallic sheets with holes for water flowing by, etcetera, make the gear easier to handle and also more sustainable. For example, gear of glass fibre does not have to be dried during the day, as the willow baskets, and does not have to be replaced after a few years.

Concluding Remarks

In conclusion, there are remarkable differences in the use of lamprey fishing gear and methods for using it, as well as the use of weirs or barriers within countries as well as among countries in the Baltic Sea area. For example, it is remarkable that such a method as cone traps is used in the large Estonian rivers like Narva and Pärnu but is not used in the neighbouring country of Latvia in rivers of about the same size (the Daugava, Gauja and Salaca). Even more noteworthy, it is astonishing that such an efficient fishing gear as the fyke net is not used in Sweden for lamprey fishing, while these same nets have nearly totally replaced the traditional wooden lamprey fishing gear in some Finnish rivers. Some of the differences could be explained by specific morphological characters of the rivers in the northern and southern part of the Baltic Sea area, but also the economic importance of the lamprey fishing, local traditions and fishing regulations certainly influence lamprey fishing methods and gear.

ACKNOWLEDGEMENTS

The following persons have been very helpful in providing general information or arranging contacts with people who have information about lamprey fishing in Sweden, Finland, Latvia and Estonia or have presented information about river lamprey fishing in different rivers.

In Sweden: Jan Erik Nathansson, Stefan Stridsman, Ivar Sundvisson, Ulf Carlsson, Karl Gullberg; Kurt Niska and Helge Blomlid at the River Torneälven; Folke Karlsson, Lars-Erik Holmberg and Björn Mörk at the River Kalixälven; Henrik Renberg at the River Piteälven; Anders Öhlund at the River Åbyälven; Hans Carlstén at the River Byskeälven;

Axel Vahlström, Erik Andersson, Greger Roos, and Erling Karlsson at the River Rickleån: Rickard Danielsson, Roland Andersson and Bengt Sandgren at the River Umeälven; Hans Johansson at the River Hörneån; Sven Öberg, Karl-Gösta Forsberg, Jan-Erik Johansson, Lennart Larsson and Bo Sundqvist at the River Öreälven; Sören Johansson and Roland Eriksson at the River Gideälven; Rune Eriksson at the River Ljungan; Karl-Sivert Idén at the River Gnarpsån; Sigvard Uppman at the River Ljusnan; and Bjarne Ragnarsson and Hans Hansson at the River Dalälven. Furthermore, the staff at the Province Museum of Västernorrland provided information about the river lamprey gear in their collection, as well as Dan Lorén at the Province Museum of Gävleborg, Lars Holstein at the Province Museum of Västerbotten, Lena Öqvist at the Museum of Skellefteå, and Robert Pohjanen at the Province Museum of Norrbotten. I also want to thank John P. Ball for help with computer work, photo processing and for linguistic corrections. Gun Lövdahl helped with design and construction of earlier versions of Figs. 1 and 2 and Table 1.

In Finland: Bo-Göran Dahlgren, Kimmo Aronsuu, Esa Ojutkangas, Alpo Huhmarniemi, Risto Vikström, Fredrik Stenbacka, Malin Lönnroth, Guy Svanbäck, Kim Wennman, Risto Tolonen, Eero Hiltunen; Toni Eskola and Eero Hiltunen at the River Simojoki; Urho Vakkuri at the River Kuivajoki; Hekki and Seija Viinamäki at the River Iijoki; Timo Turunen at the River Kiiminkijoki; Matti Ukura and Penti Mekel at the River Siikajoki; Veli Hyvärien at the River Pyhäjoki; Eeva Lehtinen at Kalajoki Museum; Martti Penttila at the River Lestijoki; Håkan Bystedt and Osmo Tuominen at the River Perhonjoki; Gun-Britt Backman at the River Kyrönjoki; Yngve Rosenback at the River Tjöckån/Tiukanjoki; Heidi Toivanen, Seppo Laine, and Olavi Haanpää at the River Merikarvianjoki; Veikko, Seija and Ville Anttila, Hannu Ranne, Tuula Sarto, and Olavi Penttilä at the River Kokemäenjoki. Fredrik Stenbacka helped with guiding in some Finnish rivers in 2011 and 2012, and also made translations of Finnish literature.

In Latvia: Normunds Riekstiņš, Director of the Fishery Department, Ministry of Agriculture, Republic of Latvia, Jānis Birzaks, Head of the Inland Water Laboratory in the Fish Research Agency of Latvia; Zigrida Skaveneca in Carnikava; Ieva Zilvere at the Museum of Salacgrīva; Gundega and Hakon Kampe-Persson, Valdis Skulte, and Anita Krûmina (at the Museum of Daugava), about fishing in the River Daugava; Aleksandrs Rozenšteins, Maris Klêtnieks, Visvaldis Šrenks and Janis Krûminš at the River Salaca; Olegs Sumčenko and Nikolajs Koluškins at the River Svêtupe; Nikolajs Lode and Normunds Lode at the River Uzhava. My guides in Latvia were Maris Strazds and Agris Celmins in 1992, Maris Strazds and Valters Pranks in 2010, and Valters Pranks in 2011.

In Estonia: Ichthyologist Heli Shiplev, University of Tartu; Meelis Tambets and Heinard Kiik at the rivers Toolse and Narva; Eerik Kurs and Riho Prinz at the River Pärnu. Valters Pranks was my guide 2011, and Meelis Tambets in 2012.

Many thanks also to two anonymous referees for useful information and constructive comments.

NOTES

[7] For further descriptions and details about lamprey fishing in the River Nykarlebyälven/Lapuanjoki and about Juvelius, see Storå (1978 and 2008).

[8] Personal communication 2012 with Olavi Penttilä, who has fished for lampreys with this type of traps at Ruskula village in the River Kokemäenjoki (cf. Sirelius 1906: 170).

[9] K. Aronsuu 2011, Centre for Economic Development, Transport and the Environment in

Northern Ostrobothnia, Finland. Personal communication 2011.

[10] See note 8.

[11] See note 8.

[12] See note 8.

[13] N. Riekstiņš and J. Birzaks, Fishery Department, Ministry of Agriculture. Personal communication 2011.

[14] According to Valdis Skulte, whose father worked with lamprey fishing in the River Daugava. Personal communication via Gundega and Hakon Kampe-Persson 2013. See also Fig. 77 in Cimermanis (1998).

[15] According to fisherman Aleksandrs Rozenšteins, who works at weir number one, close to the mouth of the River Salaca at Salacgrīva. Personal communication 2010.

[16] See note 15.

[17] According to an anonymous referee of this manuscript in Latvia.

[18] According to Visvaldis Šrenks, fisherman at the River Salaca. Personal communication 2013.

[19] See note 17.

[20] See note 15.

[21] See note 17.

[22] See note 18.

[23] See note 18.

[24] Ichthyologist Meelis Tambets. Personal communication 2012.

[25] See note 24.

[26] See note 24.

[27] See note 24.

[28] See note 24.

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