

HANDBOOK FOR RIVER LAMPREY RE STOCKING METHODS



**Project: Cross-boundary evaluation and management of
lamprey stocks in Lithuania and Latvia
LAMPREY LLI-310**

**Institute of Food Safety, Animal Health and Environment "BIOR"
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FOREWORD

The river lamprey *Lampetra fluviatilis* is distributed mainly in Western Europe in coastal waters, estuaries and rivers. In Latvia, it is found in almost all rivers and streams flowing into the Baltic Sea and the Gulf of Riga.

River lamprey is included in Council Directive 92/43/EEC (21 May 1992) on the conservation of natural habitats and of wild flora and fauna, as well as in Regulation of the Cabinet of Ministers No. 396 adopted on 14 November 2000 the "List of Specially Protected Species and Species with Exploitation Limits".

The river lamprey is the most important species in the Latvian inland fishery. The largest annual catches in Latvia were registered in the late 1960s and early 1970s (more than 400 t per year). In the last ten years annual lamprey catch has decreased from 113 t in year 2007 to 52 t in 2017.

Lamprey resources are directly and indirectly affected by anthropogenic factors (river damming, overgrowing due to water pollution, poaching, etc.) and by natural factors (fluctuation of water level in spawning areas, insufficiently planned river restoration, beaver dams, etc.).

To sustain maintenance of river lamprey resources two methods are used: (1) repopulation of river sections that cannot be reached with natural migration done by translocation of spawners across barriers and (2) artificial propagation, followed by fry release.

To compensate the losses, caused to river lamprey resources, spawning river lamprey are reared in hatcheries of institute BIOR and larvae are released annually in basins of rivers Daugava, Gauja and Venta, for more than fifty years, and translocation of spawners over impasse obstacles is also periodically performed.

REARING

HISTORY OF LAMPREY REARING

In Latvia fish farmers have long-term experience in river lamprey farming and ammocoete release for restocking purposes (Eglīte, 1975; Ряполова 1972; Ряполова & Mitāns, 1991, 2012; Ряполова & Митанс 1989, 1990 a,b, 1991; Ряполова et al. 1990; Medne et al, 2019). First incubation of river lamprey eggs in Latvia was carried out already in the 1960s of the last century in the fish farm Kārļi. From 1968 until 1974 the first attempts in lamprey egg incubation proceed and in 1972 the first experimental 530 000 larvae were obtained; they were released in the River Amata – tributary of River Gauja, by 1974 the number had grown and 800 000 larvae were released (Eglīte, 1975). Annual releases continued together with development of propagation biotechnology by researchers of the Baltic Fisheries Research Institute (BaltNIIRH; now- Institute BIOR). Finding lamprey restocking solutions was necessary, as in 1970s it was planned to complete the damming with the cascade of hydroelectric power stations on the main river of Latvia – River Daugava. The maintenance and preservation of migratory fish resources in sustainable condition, including river lamprey, was a question of national importance.

In 1975 HPP cascade was completed and started operation, thus interrupting fish migration and access to spawning grounds in upper reaches of the River Daugava. To maintain lamprey population lamprey farming biotechnics continued to be developed by researchers Rjaplova and Mitans who worked out “Biotechnics of river lamprey artificial propagation” published in 1990, in Russian. Restocking of rivers was planned, following belief of that time, that lamprey follows homing instinct and returns to their native river, similarly to salmon. Rjaplova and Mitāns (1989; 2012) described their investigations of lamprey larvae growing and feeding with yeasts. Even though the fish farms in Latvia have long-term experience in obtaining lamprey eggs and spawner incubation, up until now the lamprey are released in larvae stage and there is not interest in rearing and releasing stronger and more matured ammocoetes, which would increase the survival of the lamprey.

Currently, ammocoetes are obtained and lampreys are restocked annually by the fish farm Dole located in River Daugava basin and by the fish farm Brasla located in River Gauja basin and now, after several year break, by the fish farm Pelči, located in River Venta basin, as well. Altogether, there are around 10 to 20 million of lamprey ammocoetes released in Latvia’s rivers annually (Figure 1).

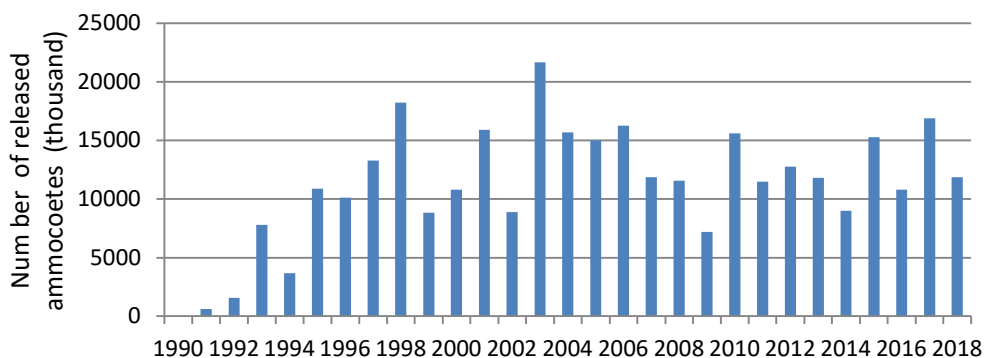


Figure 1. Number of released ammocoetes from 1990 to 2018

LAMPREY BROODSTOCK

The prerequisite for ammocoete rearing and qualitative restocking is acquisition of healthy overwintered broodstock, consisting of sexually mature lamprey males and females that will produce milt and eggs in spring.

As until now it has been impossible to ensure lamprey physiological maturation under artificial conditions, therefore, to establish broodstock in fish farms adult lampreys migrating upstream are caught in the rivers and estuaries.

Even though lampreys spawn in spring, they are entering rivers and start migration already in August of the previous year and continue to do so until spawning in May. Spawners in Latvia are 29 to 51 cm long (data of Institute BIOR).

Adults caught in autumn are usually used for stripping after overwintering in the fish farms, however they can also be caught in spring time, shortly before spawning (spring is a closed fishing season, therefore a special permit is necessary for lamprey fishing). For restocking purposes the Institute recommends the use of lamprey caught in autumn during their regular fishing time (bought from the commercial fishermen and their catches). If additional spawners must be obtained in spring, the special fishing permit must be obtained as stated in Cabinet Regulation No. 192 adopted 15 March 2005 "Procedures by which Permits for Fishing for Special Purposes and for Scientific Research Purposes shall be Issued".

Official regulations are set for permitting the fishing for special purposes, in this case for obtaining broodstock during closed fishing season:

1. One must develop a fisheries programme for lamprey restocking; the programme must state the reason for larvae release in named rivers, the number of larvae, calculations of the required broodstock, place and time and detailed description of intended catch.
2. This programme must then be coordinated with Institute BIOR and the Ministry of Environmental Protection and Regional Development. If the Institute BIOR is the applicant, its programme must be coordinated with the Ministry of Agriculture and the Ministry of Environmental Protection and Regional Development.
3. Fisherman intending to catch the spawners or the responsible person of a fishery with agreement from the fisherman submits an application for receiving a permit (licence) for fishing for special purposes. The application must state:
 - a. the given name, surname, personal identity number, telephone number and address of the permit (licence) recipient or the name, registration number, telephone number and address of a legal person;
 - b. the given name, surname and telephone number of the person responsible for fishing, in Latvia usually the manager of the fish farm is the responsible person;
 - c. the given name and surname of the fisherman (fishermen);
 - d. the time period when fishing is intended;

- e. the location where fishing is intended (the water body or the part of the water body and the local government (local governments) in the territory of which such water body is located shall be indicated);
- f. the type, number or length in metres and mesh size in millimetres of fishing gear;
- g. the registration numbers of vessels or floating means to be used in fishing.

Fishing must be carried out by commercial fishermen regardless of the season.

There is no use in catching a large number of spawners that are already travelling to spawning areas and would possibly spawn without human intervention, and then releasing a smaller or slightly larger number of larvae than the natural spawning would have produced.

The idea of restocking is: a smaller number of spawners must produce a larger number of fish. For this to be fulfilled precision must be part of each stage of rearing and all manipulations on fish, eggs and larvae must be performed with utter care.

Lamprey spawners proposed for restocking must be fished and handled with more care during catch and holding than lampreys intended for market. For commercial fishing lamprey fyke-nets, trammel-nets or weirs are used, and fishermen can choose their preferred or most economical methods. But for broodstock fishery, spawner catch must be performed carefully; as the experience shows – the lampreys caught in nets are often strained and their skin is traumatised, and their mortality rate when kept in fish farm's rearing tanks is significantly higher and can reach even 50 %. **During spawner fishing, only fyke-nets and weirs should be used.**

The bruises on their skin heal poorly and microscopic fungus infections (most commonly *Saprolegnia sp.*) can develop, that way weakening the lamprey and causing death. If lampreys look weaker or have visible bruises or disease symptoms, after removal from collection trap they were held in, they should not be incubated and used to obtain gamete.

The spawners must be transported to fish farm as soon after catching as possible. Legislative acts do not specify the exact requirements for transportation of live lampreys, nevertheless transportation has to be done in compliance with general legislative provisions for transportation of live animals including registration of vehicle and other paperwork.

Lamprey transportation should be done in dry boxes in outdoor temperature. Storage in winter conditions, in air, outside from water should be as short as possible to prevent freezing (if air temperature drops to 2 - 3 °C).

Our experience suggests that adverse impact of transportation is greatly minimised if lampreys in transportation boxes are placed in no more than two-three layers and air temperature in vehicle during transportation do not exceed air temperature outside.

1. Lamprey spawner overwintering in fish farms

In nature in winter lamprey migrate during night-time and hide during daytime, when they reach the spawning area, they enter the state of anabiosis (Docker, 2019).

The environmental conditions for spawners maintained in fish farms from their catch moment in December till spawning in end of April and beginning of May are provided as similar to natural conditions as possible to achieve maximal survival. Overwintering is carried out in standard circular flow 2 x 2 m rearing tanks (Figure 4), in low temperature and darkness (with cover), however, special tanks can also be used (Ряполова & Митанс 1989) (Figure 4). In fish farms of the institute BIOR natural flow-through river water is used (Figure 5).

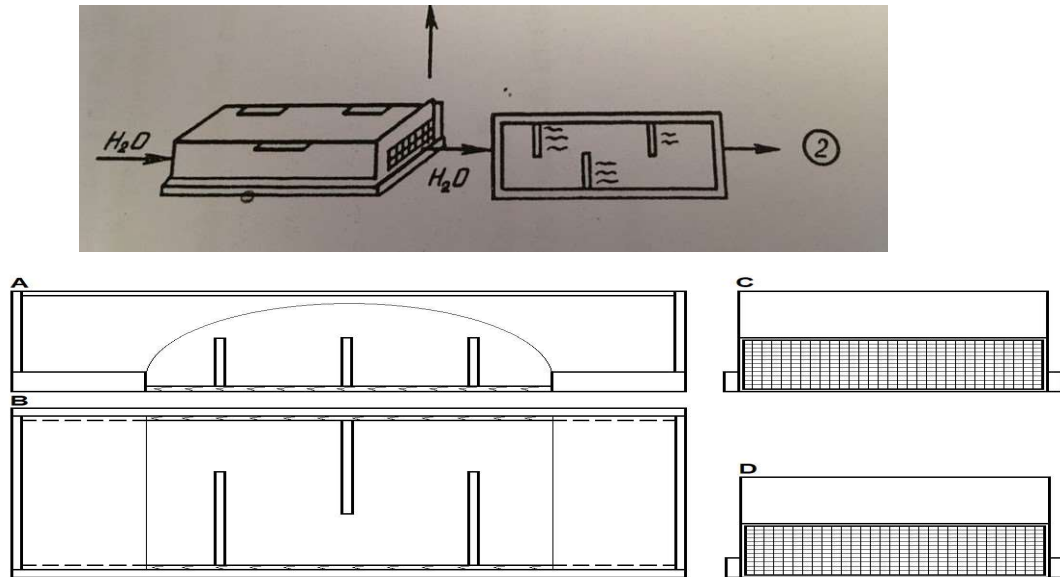


Figure 4. Tanks for lamprey holding during overwintering (Rjapolova & Mitans, 1989)



Figure 5. Lamprey stocking density during overwintering (photo: Jānis Balodis)

2. Spawners stocking density

Lamprey spawners caught in autumn are kept in basins and dark throughout the winter, it is believed that spawners can be kept in high density as long as they are supplied with sufficient amount of fresh, clean water that is rich with oxygen. In Finland lamprey density is 2700 lampreys in 1000 litres of water (Docker, 2019). In Latvia it varies from 60 to 2700 lampreys in 1000 litres of water (Table 1). During wintering they do not require additional feed as they stop feeding as they migrate into rivers and their alimentary tract atrophies.

Table 1

Adult lamprey stocking density in the fish farms

Fish farm	Stocking density		Weight of lamprey (kg)
	Kg of lamprey in 1 m ³ of water	No. individuals in 1 m ³ of water	
Brasla	40 (<i>500 in 8 tanks in total</i>)	530	0.075
Dole	200	2700	0.075
Pelči	6-10	60-100	0.100

3. Physically-chemical conditions of water during broodstock holding

Water quality is one of the most important factors affecting lamprey wintering in fish farms. They must be supplied with sufficient amount of fresh, clean water that is rich with oxygen and does not contain any harmful substances. Flow-through system supplied with water from natural water bodies is the best solution for lamprey holding in fish farms Dole, Kārļi and Pelči.

Temperature. Spawners are kept in natural water temperature. The temperature, as an environmental factor has an important role for lamprey maturation; because their body temperature follows the surrounding (water) temperature and influences metabolism and maturation, including egg and milt production. During winter, in January and February, lampreys persist periods when temperature decreases down to 0.5-1 °C and increases in spring. According to Pliškšs, Aleksejevs (1998) lamprey spawning time starts when water temperature increases to 9-15 °C.

If lampreys are intended for obtaining of larvae and their release in rivers, there is no use in artificial increase of water temperature, as conditions in nature follow the season and rushing the spawning will not be suitable for the larvae intended for release as there will not yet be sufficient amount of feed, causing higher mortality.

Oxygen. Lampreys demand water rich in oxygen. In nature they spawn in places with many rapids and which therefore are rich in oxygen. In Institute BIOR fish farms lampreys are kept in similar conditions as salmon and oxygen level is 7-9 mg/L.

Water pH level depends on organic and inorganic acids and salts dissolved in water. Water used for fish rearing must be close to neutral pH 7. The optional pH level ranges from 6.5 to 8 (Mitāns, 2020). Docker (2019) states that low pH level, in combination with high metal concentration in water during wintering has negative effect on egg quality, for instance, in

Finland during wintering the river lamprey are kept in water with pH >5.5, aluminium concentration 3 mg/L to pH 5.2–5.5 and aluminium concentration 4 mg/L (Docker, 2019). Latvia's fish farms use water from rivers where pH level ranges from 6.0 to 9.0 (LEGMC, 2019).

Water depth in tanks during incubation is maintained similar to natural, as in rivers where lamprey usually spawns, it is from 20 to 150 cm (Eglite, 1958, Ряполова, 1972).

Water flow ranges from 0.02 to 0.27 m s⁻¹, that corresponds to the average stream gradient in river stretches 0.0 to 0.9 m/s according to Institute BIOR monitoring data and to our monitoring in rivers, showing that oxygen level in rivers, where ammocoetes are founded, varies from 3.05 to 9.76 mgL⁻¹

Experience of Finland suggests for water flow to be 100 L/min/kg of lamprey (Docker, 2019). However, it should be remembered that water flow itself is not the most important factor for lamprey wintering. Experience of Latvia shows that water flow can be reduced to 3-4 L/min/kg if lampreys are kept in lower density.

LAMPREY PREPARATION FOR SPAWNING

Lampreys do not feed after entering rivers during their upstream migration, therefore it is not necessary to feed broodstock in fish farms during overwintering time. During winter males and females are kept together. They are divided in groups only shortly before spawning in spring.

The sex of lampreys can be determined only few days before spawning – males develop copulatory papilla. It must be noted that all lampreys are not ready for spawning at the same time and males, that develop slower, can be sorted with the females. In order to avoid uncontrolled spawning in basins, the readiness of spawners is determined 1 to 3 times a week. The frequency depends on the previous experience of each fish farmer. The matured lampreys are sorted for obtaining gametes.

A flow-through rearing system using natural water inflow is strongly recommended for keeping the lamprey broodstock in the fish farm as natural ambient river water with natural male and female pheromones, originating from brook lamprey, populating ambient water bodies, stimulate natural maturation without hormonal injections. In fish farms of Latvia, hormonal stimulation has never been used for lamprey maturation. Survival of lamprey adults during overwintering varies from 70% to 97%.

OBTAINING EGGS AND MILT

Recommended ratio between female and male is 1:1.2-1.5 (Ряполова & Митанс 1990). During the Project, the maturation stage was checked at least 2 times per week. The first inspection was done when the water temperature increased to 9-10 °C.

Only mature lampreys, releasing eggs or milt from gonads freely, were selected for obtaining gametes. There are two methods used to obtain eggs and milt from lampreys: stripping and surgery. There is strong recommendation to use anaesthetics for both methods. Effective and lethal doses for major chemical anaesthetics used for fish are well described in world

literature. There are no official fish anaesthetics available in Latvia (www.pvd.lv), but scientific literature does describe several medicaments: clove oil (Javahery et al, 2012), MS-222, BENZOAK, AQUI-S 20E, Aquacalm (Christiansen, et al 2013; Cho et al, 2000) etc. Clove oil is used for lamprey anaesthesia in Latvia's fish farms, because of two main factors: i) no other anaesthetics registered in Latvia for the use for fish are available and ii) clove oil is a natural product and we believe it is more nature-friendly than chemical anaesthetics.

Clove oil dose used for lamprey anaesthesia is 1-3 drops of oil (diluted 1: 9 with ethanol) per five litres of water. In few minutes lamprey become inactive; they wake up a few minutes after being placed back into clean water.

Mature female lamprey has 21 thousand matured eggs that can be obtained in fish farm and then can be fertilized. The volume method is used to calculate the total amount of eggs obtained: eggs obtained from all females are summed. The Institute BIOR scientists and fish farmers have calculated that the volume of obtained unfertilized eggs is 100 000 pcs / 100 mL.

4. Fertilization of eggs

The eggs are placed in a plastic bowl and milt is then added (1 to 5 mL of milt for 100 mL of eggs). A bird feather is used to carefully mix the milt in, to ensure that spermatozoids are close to each egg. Fish spermatozoids remain in inactive (anabiosis) state until they are placed in water. There they start moving but soon run out of energy. To ensure higher rate of fertilization than there is in nature, the eggs and milt must be mixed carefully but thoroughly. Fertilization occurs after water is added to the mix. After fertilization the eggs start absorbing water through membrane and start to swell.

The eggs have to be fertilized as soon as possible and no later than 20 minutes after their removal from the female. The shorter the time period between their removal from females and fertilization, the better the result. After successful fertilization the eggs start releasing adhesive. Some fish species have stronger adhesive than others and the eggs must be washed with counter adhesive solutions, however lamprey eggs only require thorough rinsing with water (Ряполова & Митанс, 1989, 1990 a, b, 1991; Ряполова et al. 1990);

After rinsing the eggs should be left to swell for 20 to 30 minutes. In fish farm Pelči the eggs are not rinsed and left to swell, but are instead placed in Weiss incubation system immediately after fertilization. In fish farms Dole and Brasla the eggs are rinsed and only then placed in Weiss incubation system.

Some authors suggest the use of additional chemical or biological treatment for diminishing adhesiveness after fertilization, but our experience shows that it is not necessary to apply some specific treatment, because adhesiveness decreases itself after repeated washing with clean water.

5. Egg incubation

Lamprey eggs require constant movement, therefore fertilised eggs are incubated in conical shaped tanks or jars with constant water inflow into the bottom of the container. In this type of incubator, the eggs are gently suspended and constantly tumble in the lower portion of the jar. The desired amount of eggs is 1/10th part of the volume of the Funnel-type (Weiss) incubator, the water flow rate 0.30-0.35 m / s. The preferred temperature for incubation is

14-17 °C, however as the Institute BIOR fish farms use natural river water, the water temperature is not regulated manually.

Fish farms do not measure the flow rate, but do follow the movement of eggs inside of incubator to ensure that eggs do not raise higher than ¼ of the incubator (Figure 6).



Figure 6. Lamprey eggs during incubation; water inflow from below (Photo: Ruta Medne)

10-L upwelling jars accommodated 200 000 eggs and circulated the developing embryos to prevent clumping (Docker, 2019).

6. Hatching

Hatching of lamprey occurs when 170-200 degree days are reached, i.e. at water temperature 14-17 °C incubation lasts 12-15 days (Ряполова et al., 1990; Ряполова & Митанс, 1990). Shortly before larvae hatch (usually in the moving embryonic stage), eggs are transferred from the incubator to the raceway.

7. Lamprey ammocoetes releasing

Habitats of lamprey ammocoetes are localized in shallow slow flowing reaches along river banks with soft sediment, depth of reaches varies from 0.1 to 0.5 m, oxygen saturation varies from 12 to 15 mgL⁻¹, pH- neutral from 7 to 8 (Nazarov, 2016), water velocity from - 0.10 to 0.54 ms⁻¹ (Taverny et al., 2012). According to Institute BIOR fish monitoring data lamprey ammocoetes usually are found in biotopes that consist of gravel (2-64 mm), sand (0.0-2mm) and silt (0.004-0.06mm), where water velocity is from 0.0 to 0.9 ms⁻¹, and concentration of dissolved oxygen fluctuates from 3.05 to 9.76 mg L⁻¹ in summer. To ensure maximal survival, larvae have to be released into the river sectors with the most suitable sediment type and

habitats. The releasing density of ammocoetes was calculated to be 100 ammocoetes for each m².



Figure 7. Lamprey ammocoetes releasing

SPAWNER TRANSLOCATION OVER IMPASSABLE OBSTACLES

Translocation of migratory fish spawners (breeders) is a common practice in several countries of the world. River lamprey *Lampetra fluviatilis* spawners are translocated in the Republic of Finland (Aronsoo, 2019), but pacific lamprey *Lampetra tridentata* spawners are translocated for population restoring purpose in Columbia River (Ward et.al. 2012). Detailed translocations program for different fish species is elaborated in Canada (Bruchs, et., al., 2018).

In Latvia lamprey spawners translocation was done periodically from 1960s to 1980s. However, as they were caught in the closed fishing season, therefore among the general public there were many opponents to it. The idea of spawners translocation was revived recently and in 2015 experimental programme for translocation of river lamprey spawners over River Venta waterfall in Kuldiga started again.



Figure 8. Natural waterfall Ventas Rumba, that naturally interrupts river lamprey migration to appropriate spawning grounds in upper reaches

Translocation of river lamprey spawners was performed also within the LAMPREY project where it was performed in five different small rivers of Kurzeme region. Altogether the upper reaches of River Saka and River Roja were supplemented with 3010 adult lampreys. Remarkable experience of organizing and performing of transportation of live river lamprey spawners in Latvia has been gained also in several recent mark-recapture studies and also in long-term experience gained by collection of spawners for National stocking program: “Plan for artificial reproduction of fish resources in the years 2017-2020”.

In general, this document summarizes our own experience gained within realisation of activities mentioned above. It includes short overview of possible alternative solutions and highlights what we think are the best solutions to the issues (and challenges) of the translocation of river lamprey. However, it needs to be taken into account that these guidelines are based on current information base and may be revised in a future.

OVERVIEW OF CURRENT PRACTICE AND POSSIBLE ALTERNATIVES

8. River choice for lamprey translocation

Many stakeholders, from scientists and fishermen to decision makers, are involved in translocation process. All activities must be done in highest quality for maximal efficiency and with a minimal number of spawners. It is also crucial to choose appropriate river, for lamprey spawners’ translocation.

Current practice

Rivers for translocation are chosen based on several criteria: there must be impassable obstacles on the river; river must inflow into the sea; there must be a potential spawning area above the obstacle (expert judgment); lamprey juveniles’ downstream migration must be possible; rivers for project must be differ from one another (different size of river, different anthropogenic impact etc.). Five different rivers were chosen: Alokste, Skalda, Roja, Tebra, Dubeņa (Figure 9).



Figure 9. Rivers for lamprey spawners translocation

9. Choice of release place

Habitat is the foundation for productive lamprey spawning and following abundance of ammocoetes and juveniles. During lamprey life cycle, the critical habitat requirements relate to suitable water conditions (free from pollution, appropriate dissolved oxygen), at the spawning areas, suitable hiding places and clean spawning gravels, after hatching, slower flowing nursery areas of sandy silt (Maitland, 2003).

Current practice

Before lamprey translocation, the best release place must be chosen. In the Project choice was based on expert judgment.

Possible alternatives

For lamprey spawners translocation potential spawning grounds can be analysed. Mainly two important factors are named for spawning place: water flow rate (velocity) and substrate. Eglīte (1958) noted water flows of 1–2 m/s in rivers where adult river lampreys would spawn. The high flows during spates are likely to be detrimental to populations of river lamprey, not only by making it difficult for them to access spawning grounds, but also by lowering recruitment after spawning, probably due to eggs and larvae being swept downstream into the sea (Maitland, 2003).

Most spawning of river lamprey occurs where there is some water flow through the substrate. Area where there is maximum penetration of gravels particle size is variable but is usually described as gravel with some sand (Maitland, 2003).

Institute BIOR fish monitoring data shows that lamprey ammocoetes are found in biotopes that consist of gravel (2-64 mm), sands (0.0-2mm) and silt (0.004-0.06mm) (table 2), velocity 0.0-0.9, dissolved oxygen in summer fluctuates from 3.05 to 9.76 mg/l.

Table 2

Biotopes characteristic where ammocoetes was founded.

Indicators		Values (min.-max.)
Velocity (m/s)		0.0 -0.9
Depth (m)		0.1-0.8
Substrate		
	Gravel (%)	0.0*-50.0
	Sands (%)	0.0*-95.0
	Silt (%)	0.0*- 80.0
Dissolved oxygen (mg/l)		3.05*-9.76

*in case of absence of one type of substrate other type of substrate is in large amount

Collection of spawners: methods, timing.

Only healthy and viable spawners are used for translocation. Fishermen must be educated in spawners' catches and handling.

Current practice

In all translocation events performed within the LAMPREY project as well as within other projects realized by the institute BIOR the collection of lamprey spawners (i.e., for mark-recapture studies and breeding in hatcheries) are purchased from commercial fishermen.

Obtaining of lamprey spawners is limited to fishing season which lasts from August 1 (in larger rivers) or November 1 (in smaller rivers) to January 31 (April 30 in River Daugava). In addition to that, the purchase of spawners at some extent is limited to intensity of lamprey migration and to fluctuation of market price. In most cases in Latvia lampreys for translocation and for rearing purposes are purchased during the peak of landings (usually November).

This practice has several advantages since in that case there is no necessity for the Institute to apply for a special fishing licence and organisation of fishing process itself. As collection of lampreys by commercial fisheries is restricted by fishing regulations and, due to this, it can be performed only during fishing season and in strict river sections or rivers where lamprey fishing is allowed.

In Latvia lamprey fishery is performed mostly with use of lamprey fyke-nets and in some rivers also with lamprey fishing weirs. In River Daugava, along with fyke nets, lamprey trammel nets are also used (Figure 10). Our current experience shows that both fyke nets and lamprey fishing weirs do not cause any noteworthy harm to lampreys, therefore both methods are suitable for collection of lamprey spawners. Due to spawner damage Institute avoids purchasing spawners caught by trammel nets.

Before purchase act lampreys are visually checked for health conditions. Lampreys have to be alive and show strong movement, their bodies must be intact, and without external damage or signs of blood. Slackly lampreys should be returned to fishermen and such specimens should not be used for translocation. Preferably, fishermen who sell lampreys for reproduction purposes should maintain caught specimens in special lamprey collector submerged in river water. Specimens kept in air for extended periods of time, or in dense layer without water, should not be used for restocking.

In special cases (mostly for mark-recapture surveys) lampreys are purchased during all fishing season. As mentioned before there were also a few cases when contracted fishermen performed fishing for spawners during the closed season under the special licence.



A



B



C

Figure 10. Lamprey fishing gear

A - Lamprey fyke-nets

B - Lamprey weir

C - Lamprey trammel-net

Possible alternatives

Fishing activities for collection of lamprey spawners can be performed also by institution that organizes their translocation and restocking. However, in this case several additional difficulties need to be resolved. A lamprey fishery is a specific type of fishing; it involves special type of fishing gear and usually also requires specific skillset and knowledge. So, by organising collection of lamprey spawners it must be taken into account that besides obtaining fishing licence and other legal issues there will be need for purchasing fishing gear and most probably also training for the staff involved in its operation. If organisational difficulties are overcome, catching of lamprey spawners on own efforts has several positive aspects as well. First of all,

disposition and timing of collection of spawners will not depend on fishing regulations and for cooperation with local fishermen. It is also possible that in some cases it will be less money consuming than purchase from commercial fishermen.

For restocking purposes when there is a necessity for collection of lamprey spawners during the closed season (in spring), fishing for lamprey spawners is performed under a special license and by contracting professional fishermen. The procedure for obtaining special license is described in Latvia Cabinet Regulation No. 192 of 15th March 2005 "Procedures for issuing permits (licenses) for special fishing purposes and for scientific research purposes".

In special cases (high risk of mortality, possible wintering problems, etc.) it might be relevant to perform translocation as close to spawning period as possible. Yet it needs to be taken into account that at this time most lampreys have approached their spawning grounds and fishing in traditional fishing places and by using traditional fishing gear may not be efficient and search for new methods may be needed.

Summary

If there are no special restrictions regarding timing of translocation, current practice of collection of lampreys during fishing season (mostly November) is fully appropriate.

It is possible that in special cases it might be relevant to collect lamprey spawners after the end of fishing season. Such activity may be related to a set of challenges including mitigation of possible adverse impact to natural reproduction and effort needed to perform the collection. We recommend to collect lampreys during fishing season and overwinter them in hatchery. It is common practice for spawners used in hatcheries in Latvia and for translocation of spawners of pacific lamprey.

Our current experience shows that purchase from commercial fishermen is a convenient way to obtain lamprey spawners for translocation and there is no urgent need to search for alternative solutions in Latvia.

In the future it is possible to face necessity to obtain spawners in rivers where commercial lamprey fisheries do not occur. In addition, it cannot be excluded that market price for lampreys will continue to rise and purchase of spawners will become too expensive. To prepare for mentioned scenarios purchase of lamprey fishing gears should be considered by the Institute.

TRANSLOCATION: TIMING, TRANSPORTATION AND RELEASE

Current practice

In all recent translocation events in Latvia spawners were transported and released immediately after purchase. The practice has also been similar in other activities which involve transportation of lamprey spawners. Such practice has several advantages and drawbacks. First of all, this practice is not related to any additional spendings and lampreys will have enough time for reaching suitable spawning grounds. On the other hand, translocation of spawners in autumn increases mortality risk due to possible wintering problems or excessive predation.



Figure 11. Lamprey transportation in dry boxes. Storage in winter conditions, in air, outside from water should be as short as possible to prevent freezing (air temperature from +2 to +3 °C).

Legislative acts do not specify exact requirements for transportation of live lampreys, however, transportation is performed in compliance with general legislative provisions for transportation of live animals including registration of vehicle and other paperwork.



Figure 12. Release of river lamprey in river. Some of lampreys are soaked to the walls of the box and other lampreys actively swim away. Within transportation time box is covered, however, the holes in the boxes for air penetration are left open, and box cover is opened just before release.

In all recent translocation events in Latvia spawners were transported in a dry box (Figure 11). The same method is also used for transportation of spawners for mark-recapture surveys and for short time (less than an hour) transportation of spawners for hatcheries. Suitability of this type of transportation is confirmed by the fact that transported spawners survive the winter and later are successfully used for breeding. Our experience suggests that adverse impact of transportation is greatly minimised if lampreys in transportation boxes are placed in no more than two-three layers and air temperature in vehicle during transportation does not exceed air temperature outside.

IMPORTANT: Preventing lampreys from freezing if outdoor temperature is below 0°C, as lampreys are wet and tend to freeze.

Only healthy and viable spawners are used for translocation. Fishermen must be educated in spawners catches and handling.



Figure 13. Healthy specimens turn backside up and belly down and swim away

Table 3.

Lamprey translocation in season 2018

River	Number of lamprey	Translocation date	Average air temperature/ day	Ice /snow
Alokste	310	07.12.2018	0.8	-/-
Alokste	350	14.12.2018	0.6	-/+
Skalda	250	7.12.2018	0.8	-/-
		14.12.2018	0.6	-/-
Roja	1600	17.12.2018	-1.0	-/+
Tebra	250	21.12.2018	-4.5	+/+
Dubeņa	250	21.12.2018	-4.5	-/+

Possible alternatives

Translocation alternative is to over-winter lamprey spawners in hatchery and translocate them shortly before spawning. It allows minimising the impact of predation and wintering but in a same time it involves other potential adverse factors related to transportation and holding spawners in man-made environment. It must also be taken into account that the shorter is time before spawning the shorter is distance the spawners can travel in a river and spawners need to be released in proximity of spawning grounds.

Transportation alternatives are usage of either non-oxygenated or oxygenated water tanks. Our experience shows that non-oxygenated water tanks are suitable for lamprey transportation in short, temporary distances. Oxygenated containers so far are used only for transportation of spawners to hatcheries and this type of transportation is chosen if the expected transportation time exceeds one hour. When using this type of transportation, it is important that water temperature in tank is as close to the water temperature in place of destination as possible.

Summary

Oxygenated tank is the most favourable means of transportation for lamprey spawners. However, it requires to access the roads with the vehicle used and its operation is more money and effort consuming. To speed up the translocation procedure and reduce effort, for limited number of adult lampreys, it is acceptable also to use dry boxes if the time expected for transportation does not exceed one hour.

Regardless of the means of transportation the translocation should be done in compliance with legal requirements and appropriate temperature regime must be followed.

Where there are no special restrictions regarding timing of translocation current practice of collection of lampreys during fishing season (mostly November) is fully appropriate.

SPAWNER TRANSLOCATION AND SOCIAL MEDIA

To avoid poaching, the same translocation event and release site should be performed without reflection in mass informative sources and social networks, such as, Facebook, Instagram and others. That will protect the released lamprey and prevent possible poaching.

MONITORING OF EFFICIENCY

All recent translocation activities in Latvia were followed by monitoring of their efficiency. Monitoring must be made annually at least 5 years.

Current practice

Translocations within this project were performed only a year ago and obtaining sufficient results will take several years. On other hand it is to be noted that today the results from other activities of this project indicate that precision of method used (i.e., evaluation of density of ammocoetes by using special shovel) as well as number of sampling spots may also have been insufficient.

Possible alternatives

There are two possible alternatives. First of all, reliability of results of ammocoetes monitoring can be increased by following guidelines developed during this project (for details see T.2.2. Design of released ammocoetes monitoring methodology). Evaluation of success of translocation can be realized also by using of eDNA survey (Ostberg et. al. 2018, Ostberg et. al. 2019).

Conclusion

All translocation activities should include monitoring of their efficiency. Planning of monitoring program should be done in the same time as planning of translocation itself. Monitoring program should include best available methods (including methods developed during this project) and its effort should be sufficient and in compliance with potentially affected water body.

GUIDELINES FOR TRANSLOCATION

10. General considerations

Translocation of spawners should be performed if there is a considerable probability that this activity will increase overall success of reproduction of river lamprey. Rivers stretches for translocation should be suitable for lamprey reproduction and possibility for natural migration to these stretches should be limited. It is necessary to ensure that collection of spawners will not have a detrimental effect on natural reproduction (not necessary if spawners are purchased from commercial fishermen).

11. Translocation

If there are no specific preconditions translocation should follow these guidelines:

1. Collection of spawners – spawners should be purchased from commercial fishermen operating as close to the place of release as possible.
2. Timing of translocation and release:
 - a. larger rivers/river catchments with many potential spawning places – immediately after purchase;
 - b. smaller rivers with a few potential spawning places – shortly before spawning after wintering in hatchery;
3. Transportation:
 - a. For more than one hour distance preferred means of transport is oxygenated container. Water temperature in container should be as close to water temperature in destination as possible;
 - b. For shorter time (less than one hour) the transportation in dry boxes can be used. Air temperature in vehicle should be as close to the air temperature outside as possible;
 - c. vehicle and means of transportation should be in compliance with requirements of relevant legislative acts.

12. Monitoring

Monitoring of efficiency is mandatory. Monitoring should be planned and started before translocation. Monitoring programme should include the best methods available (including the methods developed during this project) and its effort should be sufficient and in compliance of potentially affected water body.

13. Alternative solutions

There are several alternatives regarding timing, methods and equipment for collection, transportation, and release of lamprey spawners. Most probably there are more possible alternatives than described in the previous chapter. In general, it can be concluded that any alternative solution is welcomed if there are indications that using such alternative will increase efficiency of translocation or bring other significant benefits.

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