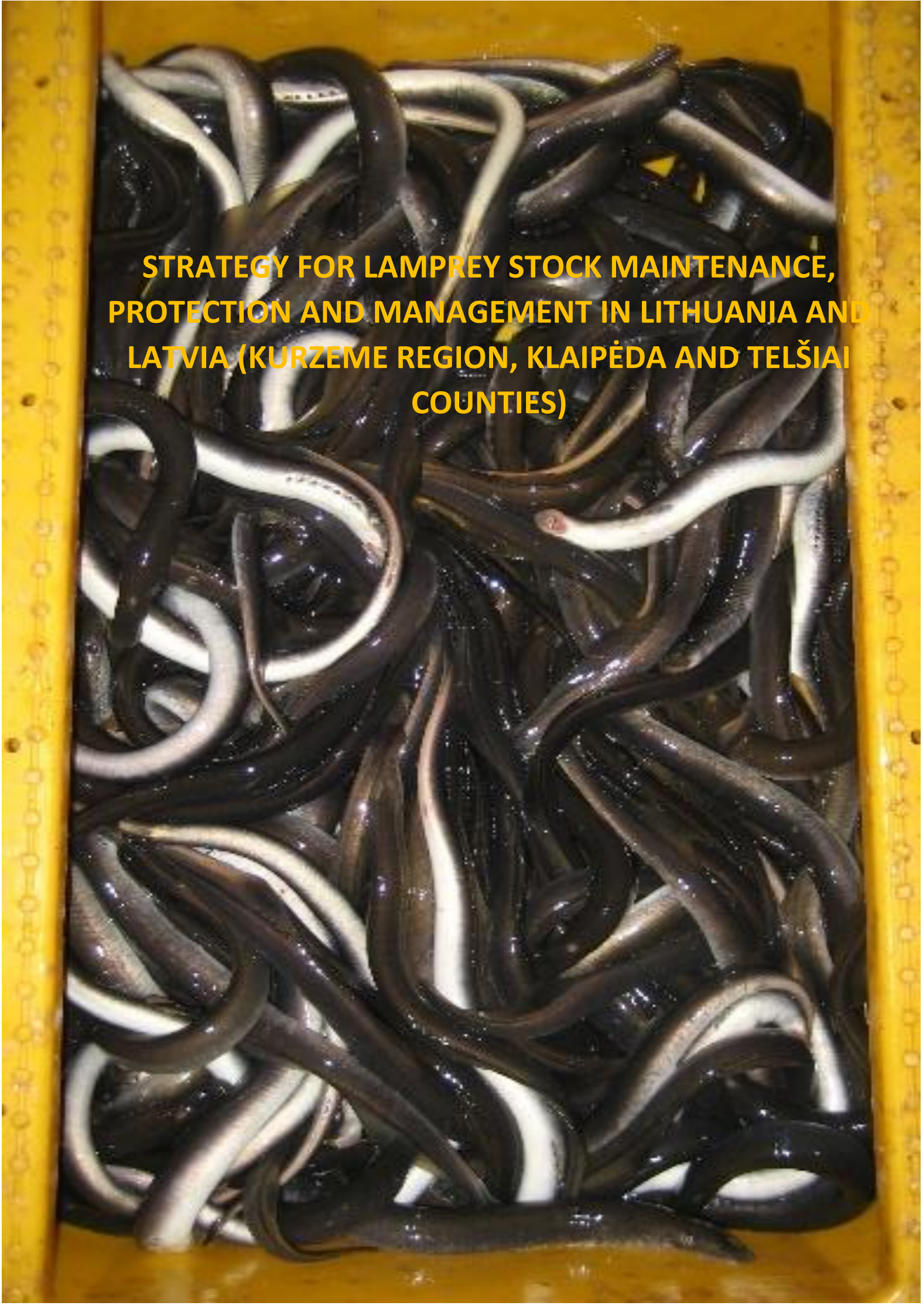
STRATEGY FOR LAMPREY STOCK MAINTENANCE, PROTECTION AND MANAGEMENT IN LITHUANIA AND LATVIA (KURZEME REGION, KLAIPĖDA AND TELŠIAI COUNTIES)

V-A Latvia – Lithuania Cross-border Cooperation Programme 2014-2020 project LLI-310 LAMPREY – Cross-boundary evaluation and management of lamprey stocks in Lithuania and Latvia



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PREFACE

Strategy for lamprey stock maintenance, protection and management in Kurzeme region, Klaipėda and Telšiai counties (further in the document it is called 'Strategy') was developed within V-A Latvia – Lithuania Cross-border Cooperation Programme 2014-2020 project "LLI-310 LAMPREY – Cross-boundary evaluation and management of lamprey stocks in Lithuania and Latvia".

This Strategy is composed of background scientific information and concrete measures for management, maintenance, conservation, monitoring and promotion of river lamprey stocks. This is recommendatory document for decision makers and related stakeholders, like ministries, fishermen SMEs and associations, nature protection agencies etc. The implemented measures of the Strategy would help to improve status of lamprey resources and would balance stock exploitation activity with conservation goals in a long-term perspective by improving integration and efficiency in environmental resource management.

Provided measures are based on scientific information collected during the LAMPREY project implementation. This information includes results of lamprey population structure genetic analysis, socio-economic analysis on importance of lamprey stocks and fishery to the region, fishing mortality evaluation by mark-recapture method; monitoring method intercalibration exercises; and specific population improvement activities like transfer or spawners above the migration barriers, stocking of rivers with larvae and river mapping.

The Strategy was developed for LAT-LIT programme area covering Kurzeme region in Latvia, Klaipėda and Telšiai counties in Lithuania (Figure 1), however it may be relevant to the rest territories of Latvia and Lithuania, or even on a broader scale within lamprey distribution range.

The important specific key words and abbreviations used in the Strategy:

- ***Spawner*** – at sea sexually maturing lamprey that starts migration to the freshwater rivers to reproduce.
- ***Ammocoete*** – blind larval stage lamprey which is spend 5-7 years buried into streambed sediments
- ***Spawning nest*** – patch of sorted gravel where females bury batch of benthic eggs
- ***Lithophilic*** – fish that requires gravel-stone substrate for their spawning
- ***MSY*** – maximum sustainable yield
- ***TAC*** – total allowable catch
- ***Fishing mortality F*** – share of population taken by commercial fishery
- ***Population genetic diversity*** – measured in two primary ways: heterozygosity and allelic diversity. Loss of genetic variation can reduce productivity of exploited populations.
- ***Management unit*** –defined as demographically independent population whose dynamic depends largely on local birth and death rates rather than on immigration.

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CONTENT

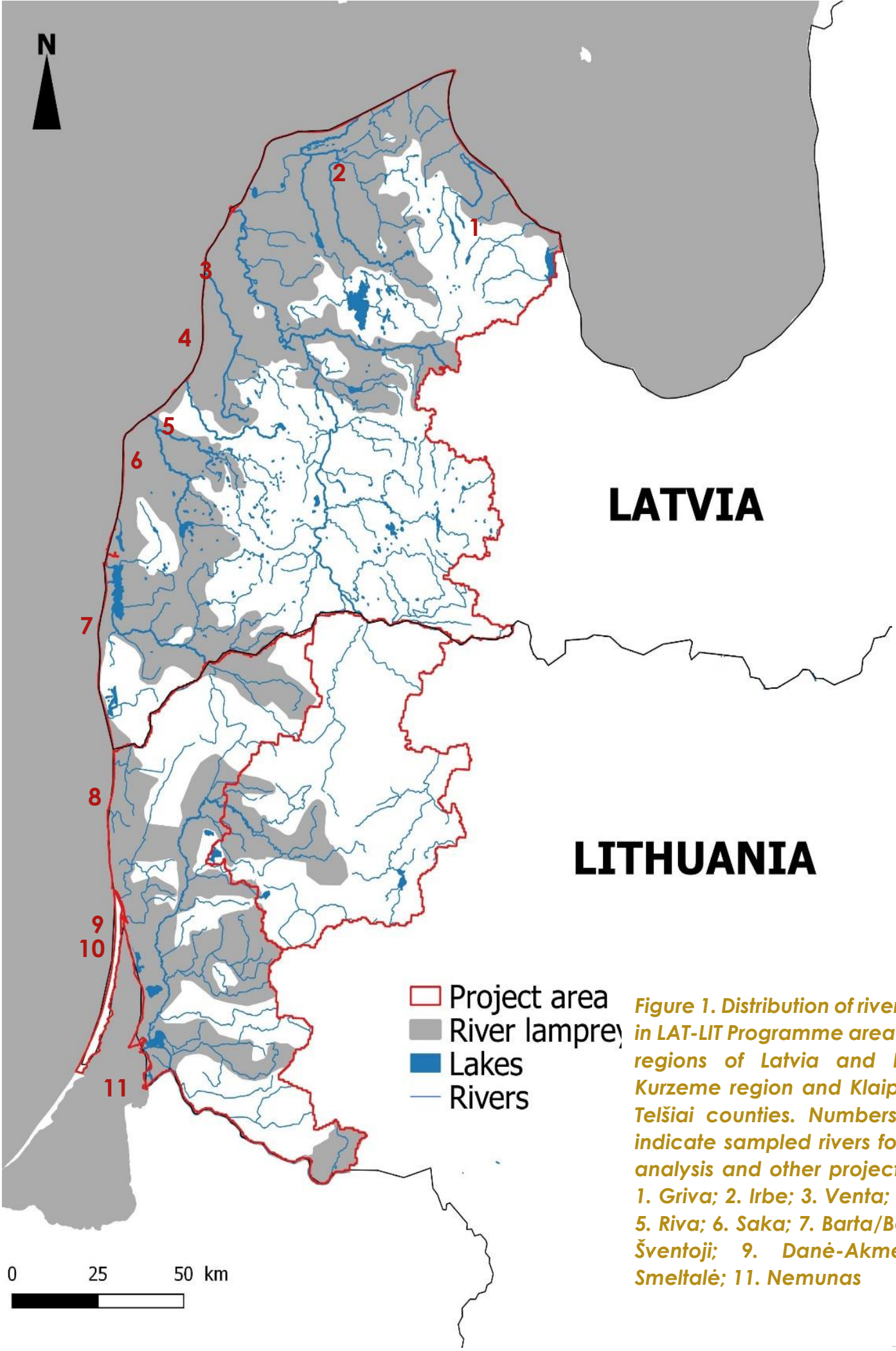


Figure 1. Distribution of river lamprey in LAT-LIT Programme area - coastal regions of Latvia and Lithuania: Kurzeme region and Klaipėda and Telšiai counties. Numbers (in red) indicate sampled rivers for genetic analysis and other project surveys: 1. Griva; 2. Irbe; 3. Venta; 4. Užava; 5. Riva; 6. Saka; 7. Barta/Bartuva; 8. Šventoji; 9. Danė-Akmena; 10. Smeltalė; 11. Nemunas

INTRODUCTION

There are about 40 lamprey species worldwide, but only few (like river lamprey, sea lamprey, Pacific lamprey, Caspian lamprey, Arctic lamprey or pouched lamprey) were or still are exploited for human consumption (Renaud, 2011). Artisanal fishery of lampreys mostly has local or regional interest, and only sea lamprey has unique worldwide fame: as delicacy in southern Europe and, as an iconic pest in Laurentian Great Lakes, where its invasion strongly affected local fishery resources having huge economic and social impact to the region and boosting evolutionary, biolological, biochemical surveys of sea and other lampreys.

Like other lampreys, river lamprey *Lampetra fluviatilis*, is of conservation concern and protected in Europe, but at the same time it is important commercial species in the Baltic Sea where it is still exploited at high intensities (in Latvia, Estonia, Finland, Russia, Sweden and Lithuania). Traditional artisanal fishery in Baltic Sea region harvests up to *xx* tons annually, while Latvia alone catch on average close to 100 ton (Abersons & Birzaks, 2014; xxxx, 2020). Therefore, their exploitation should be compatible with maintaining them in a favourable conservation status. However, stock management of river lamprey on a sustainable basis was(is?) complicated due to lack of scientific knowledge on population structure and standardized assessment methods.

The Lat-Lit LAMPREY project focused on sustainable management of stocks of river lamprey, the only commercially exploited lamprey species in the Programme area with old traditions and high importance to the local communities. LAMPREY aimed to reinforce sustainable, scientific data-based management and to balance exploitation with preservation actions of important natural resource in Programme area (Figure 1). The project activities included development of standardized monitoring methodology and stock assessment, based on classical techniques and new molecular approach (population genetic structure analysis and environmental DNA). Specific measures implemented to improve river lamprey access to spawning grounds: migration obstacle identification, enlarging lamprey distribution by transportation of several thousand spawners over obstacles, and releasing of several millions of lamprey larvae in at least five rivers of Kurzeme region. On the basis of the results, the Strategy for the river lamprey stock maintenance, conservation and management is developed.

Implementation of project provided main stakeholders with better resource exploitation, management and protection solutions, given in this Strategy. Also, it promotes conservation of local fishery traditions and regional economy, encourages cross-border cooperation which is addressed in the current Common Fisheries Policy, and increases integration and efficiency of environmental resource management capabilities in Latvia and Lithuania.

BIOLOGY AND ECOLOGY OF RIVER LAMPREY

Life cycle of all modern lampreys includes a long larval period followed by a true metamorphosis and sexual maturation of juveniles which differ dramatically from the larva (Evans et al. 2018). European river lamprey belongs to a parasitic or predatory lamprey species. During the juvenile stage these species migrate to a larger waterbody to feed on fishes and thus reach a way larger size and fecundity than their non-parasitic counterparts (Docker 2009) (Figure 2). There is no evidence on existence of land locked river lamprey populations in Latvia and Lithuania and in both countries, it can be considered as a fully anadromous species. Likewise, to other anadromous species, the life cycle of river lamprey consists of spawning and rearing in freshwater and feeding in the sea (Figure 2).

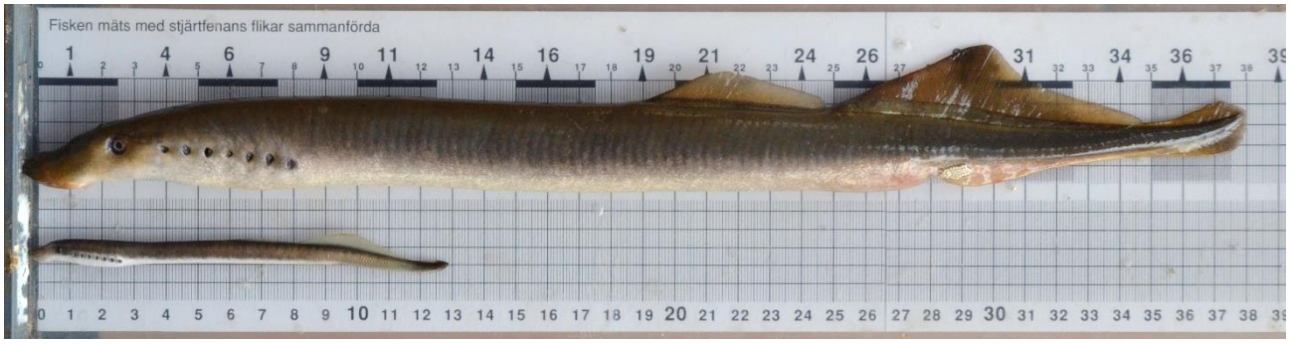


Figure 2. River lamprey Lampetra fluviatilis and brook lamprey Lampetra planeri

Spawning of river lamprey occur in swift flowing river sections with gravel bottom in specially constructed spawning nests (Jang, Lucas 2005) which often can be built in the same sites that as nests of brown trout *Salmo trutta* (Nika, Virbickas 2010). Laboratory experiments suggest that this species can spawn in variety of gravel types as long as it is possible to excavate a nest depression (Aronsuu, Tertsonen 2015). All lampreys die after spawning.

Lamprey larvae, often referred as ammocoetes, leave nests approximately one month after spawning and burrow in sediments of slower flowing sections of river. If there are enough oxygen lamprey larvae can use a large variety of habitats (steep banks, riverbank pockets, sand bars, stretches of reduced flow below wooden debris and other objects etc.) where current is slowed down and layer of silt is formed (Nazarov et al. 2016). In optimal biotopes the abundance of river lamprey ammocoetes can exceed 100 specimens in square meter (Potter et al. 1986) however average density is much lower (Kainua, Valtonen 1980) and it is suggested (Harvey, Cowx 2003) that **abundance of > 10 ind/m^2 in optimal habitats** can be used as a target value for favorable conservation status of river and brook lamprey. The larval stage ends with a true metamorphosis during which blind buried and filter-feeding larvae transforms into the free-swimming juveniles or macrophthalmia.

After completion of metamorphosis lamprey initiate downstream migration towards feeding sites in the sea. In general, downstream migration of river lamprey larvae occurs in a spring and is related to increased water level (Pavlov et al. 2017) but it can last for relatively long period (Moser *et al.* 2014).

Feeding phase for river lamprey can last for up to three years. Information on the sea period of river lamprey is rather scarce.

Spawning migration of river lamprey in Latvia and Lithuania begins already in the middle of summer and can lasts almost until beginning of spawning in next spring, however, most of upstream migrating lampreys enter rivers in October and November. Lampreys' do not have a natal homing (Waldman at al. 2008, Sipce et al. 2012), however, the mechanism of orientation during spawning migration is still poorly understood. Laboratory experiments suggest that key factor for choosing of migration route is bile acids released by conspecific lamprey larvae (Vrieze, Sorensen 2001, Gaudron, Lucas 2006).

Due to its complicated lifecycle which involves the marine environment and both swift and slow flowing sections of rivers as well as full metamorphosis and prolonged migration, the river lamprey population has several bottlenecks. The most notorious factor influencing the status of the river lamprey population is the availability and quality of spawning and rearing habitats in freshwater which is often reduced by damming and straightening of rivers or poor water quality. Spawning

success at some extent is affected also by fisheries since the river lamprey are one of few species fished exclusively during its spawning migration. Recently it is urged also to pay more attention to downstream migration and marine period (Hume *at al.* 2020)

DISTRIBUTION, STATUS AND USE OF RIVER LAMPREY STOCKS IN LATVIAN AND LITHUANIAN RIVERS

In Latvia, river lampreys enter almost all rivers and streams emptying into Baltic Sea and Gulf of Riga (Eglīte 1961), the same can be said about Lithuania. However, during the last centuries the substantial number of rivers in Latvia and Lithuania faced impoundment what resulted in significant reduction of available spawning and rearing habitat. Today migrating lampreys can reach approximately half from the project region (Figure 1). During the Soviet period situation was aggravated by massive straightening of small- and medium-sized streams and since beginning of 21st century the quality of available streams is lowered also by exploitation of small HPPs.

In the last estimation of status of Habitats Directive, the conclusions on status of river lamprey was different in Latvia and Lithuania. In Latvia the overall conservation status of river lamprey is estimated as favourable and overall trend in conservation status is stated as stable. In the same time in Lithuania the overall status of this species is estimated as inadequate-unfavourable and trend of conservation status marked as unknown. However, most probably such different conclusions were made because of dissimilarities of estimation in both countries. In Latvia there is no special methodology elaborated for evaluation of status of river lamprey population. Estimation of status of river lamprey in Latvia was based on stable distribution of this species in 1x1 km grids as well as on stable density of lamprey larvae (Abersons 2016). In the same time in Lithuania, the status of the population is assessed by approved larvae sampling methodology and set reference density value of 60 ind. m^{-2} for good population status.

Only available long-term data describing the possible changes of river lamprey population is catch statistics. According to Birzaks *et al.* 2011, changes of annual catch size or landing allow to identify three periods (Figure 3): ascending and high landings until the middle 1970s followed by period of minimal landings until beginning of 1990s and period of stable (but smaller as in 1970s) landing which continues until today. At some extent the long-term changes of catch size can be linked to the differences of fishing effort (see Abersons and Birzaks 2014) but we believe that these changes illustrate also the status of river lamprey population which was thriving until the middle of 1970s, then suffered sharp reduction and partly recovered in 1990s.

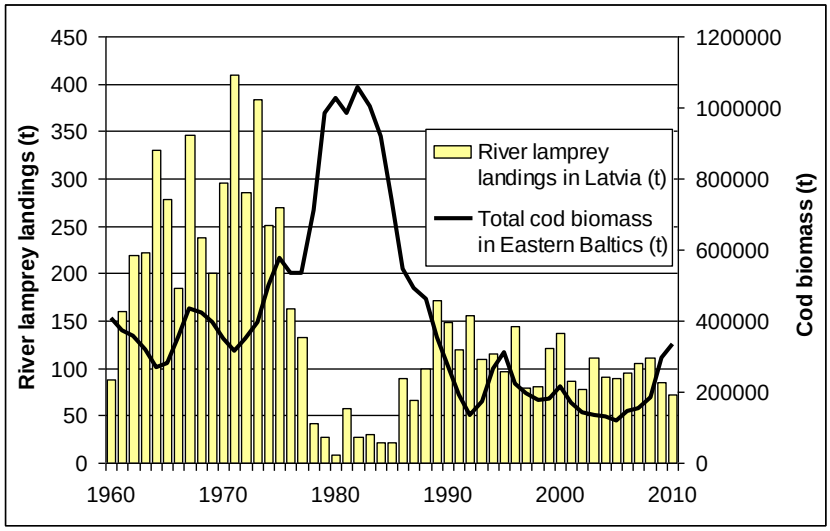


Figure 3. Landings of river lamprey in Latvia in second half of 20th century (from Birzaks et al. 2011)

Since 1990s the river lamprey fishing effort in in Latvia has not faced significant changes and the size of the annual catch depends mostly on the stock status and fishing opportunities in particular year (Abersons and Birzaks 2014). After the 2008 the size of annual landing in Latvia as a whole and in Kurzeme region particularly was tended to decline thus indirectly indicating the possible reduction of size of spawning population (Figure 4). However, in 2019 the size of annual landing raised again and reached 92.2 t in Latvia and 37.8 t in Kurzeme region. Such size of annual landing goes well in line with landings before 2008 therefore indirectly confirming that the possible decline of the river lamprey spawning population is relatively small and population status of this species is relatively good.

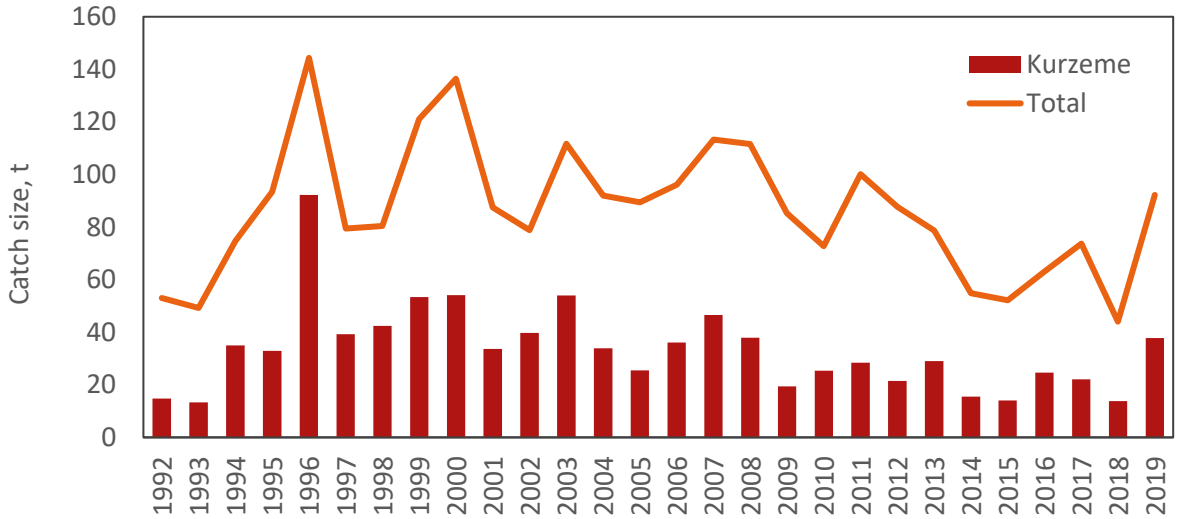


Figure 4. River lamprey landings in Latvia in period from 1992 to 2019.

In Lithuania lamprey fishery is present in three waterbodies: Curonian lagoon, Nemunas and Šventoji rivers (Figure 5). Registered river lamprey landings in Lithuania during the last decades has fluctuated from 3 to 9 tons (Figure X). However, due to applied catch limitation, the size of annual catch cannot be directly linked to status of the population.

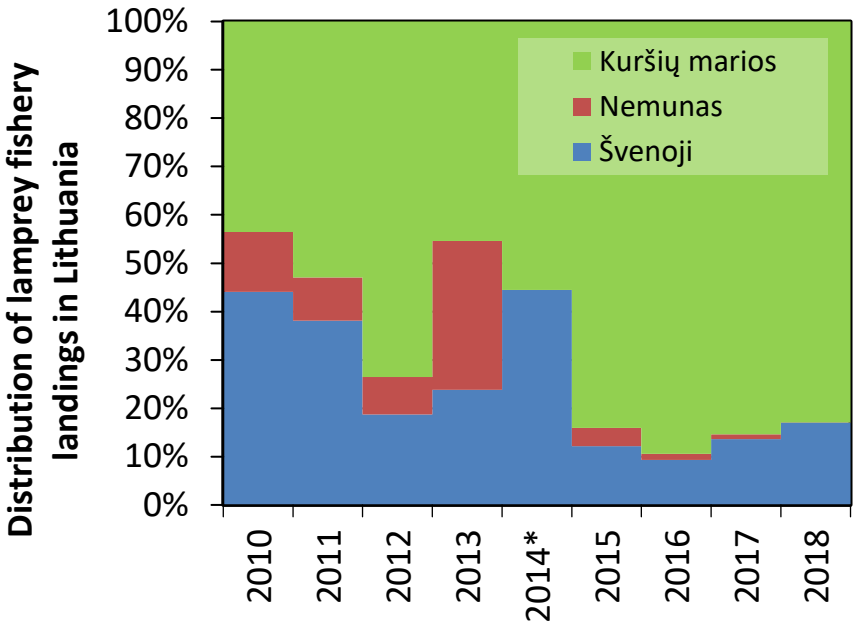


Figure 5. River lamprey landings distribution in Lithuanian fishing sites in period from 2010 to 2018.

The river lamprey is one of the most important species for inland fisheries creating economic benefit for the Region. In Latvia lampreys are consumed and perceived as a delicacy, while in Lithuania lamprey consumption traditions are nearly lost. In Latvia, in several coastal towns, takes place traditional celebrations dedicated to lamprey, there is an interest from public sector to visit lamprey-related tourism spots, participate in lamprey preparation masterclass and to attend lamprey-related cultural events. Lithuanian fishermen mainly sell all caught lamprey to Latvia, as there is higher demand.

Lamprey fishing and processing retain a large amount of hand work and maintains traditional skills specific for the Region, it has to be protected, maintained and preserved as cultural and historical heritage to sustain regional economic, develop modern cultural values and create new services in the hospitality and tourisms sector.

PRACTICE ON SUSTAINABLE AQUATIC RESOURCES MANAGEMENT

Sustainable, ecosystem-based management of fish stocks is one of crucial aspects of modern fisheries policy, while it still lacks practical application for many species (Carruthers et al., 2014). This is related to the need to have reasonable scientific information about stocks structure, distribution and status.

Modern stock assessment and management rely on biologically sound management unit approach, which itself is complicated to assess precisely. Management units are defined as demographically independent populations whose dynamic depends largely on local birth and death rates rather than on immigration. The mismatch between exploitation/management units and biological units may cause many adverse. Therefore, the exact identification of meaningful management units is central in management and conservation of natural populations.

In European Union fishery management is based on Common Fishery Policy, which encompass conservation, management and exploitation of biological resources, aquaculture and processing and trade of fishery production. The main goal of CFP is to ensure maximum possible and sustainable catch. The main principals of best practice fishery management are: long-term strategy based on multiannual management plans, ecosystem-based approach for sustainable use of resources, consideration of socio-economic development of fishery sector and the region, scientific data- and precautionary principle-based decisions.

Lamprey fishery have only local or regional importance, therefore this group of fish lacks of attention from fishery managers. The exception is the sea lamprey, which is most intensively studied and regulated lamprey species due to its enormous negative impact on Great Lakes ecosystem after invasion and region's socio-economy (Docker et al., 2014). On the other side of the world, in south Europe, sea lamprey is a delicacy with high cultural value, intensively used in a national Portuguese cuisine, therefore, this species in Portugal has management plan in Portugal. Some other North American species have local management plans on river basin scale.

Being one of river lamprey stock exploitation hot spot, the Baltic Sea region don't have nor regional, neither national management plans and strategies. Latvia and Lithuania exploit river lamprey stocks applying different fishery regulation practice and stock maintenance efforts.

LAMPREY project aimed to increase the efficiency of locally important lamprey stock management and increase integration between national bodies responsible for management and promote the development of region's economy.

RESULTS OF *LAT-LIT LAMPREY* PROJECT

Lat-Lit Lamprey project implemented many surveys for the first time in the region to have science-based background for stock management strategy. Provided Strategy measures are based on the results of:

- ***lamprey population structure genetic analysis;***
- ***socio-economic analysis of lamprey stocks and fishery importance to the region;***
- ***fishing mortality evaluation by mark-recapture method;***
- ***intercalibration exercises of monitoring methods;***
- ***implementation of specific population improvement activities like transfer or spawners above the migration barriers and stocking of rivers with larvae and its assessment;***
- ***evaluation of river potential for lamprey reproduction.***

Population genetic structure and genetic diversity

To investigate the pattern of genetic structuring and range of possible management units in Lithuania and Latvia there were analyzed river lamprey samples collected from 11 populations in distinct river catchments from the Curonian lagoon to Gulf of Riga (Figure 1). The Lithuanian rivers samples have been collected in spring 2018 from the spawning individuals or retrieved from commercial catches in Latvian rivers in 2018 autumn. There were screened 15 microsatellite primer sets using optimized protocols out of which 8 produced unambiguously determined (what???) and was further used to genotype the collected samples.

Results revealed that gene diversity within river lamprey populations did not significantly differ from the expected values reflecting the good population status except for the Venta river. Overall, the genetic diversity differences between river lamprey populations within the studied Baltic Sea region

are insignificant ($0<F_{ST}<0.03$). The STRUCTURE analyses showed that there is no significant differences among populations of spawners from 11 sampling locations in Lithuania and Latvia.

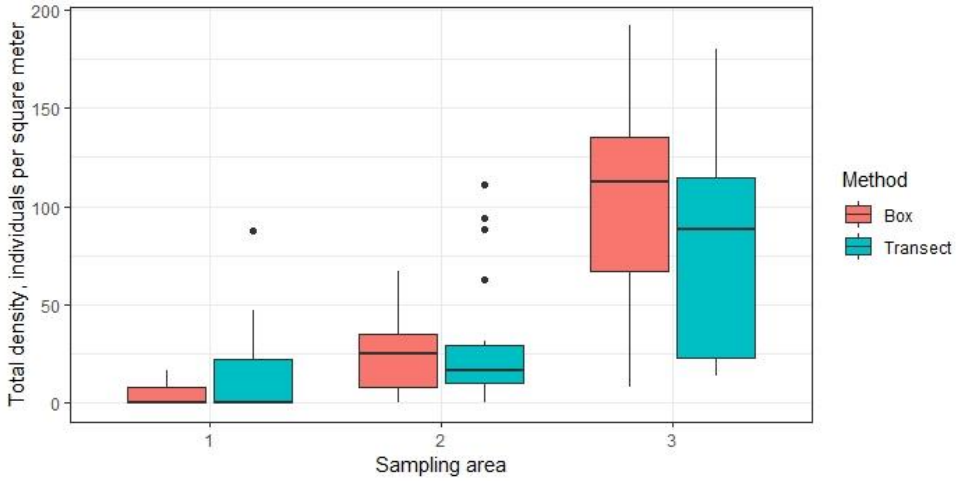
Examination of *Lampetra* spp. ammocoetes samples with mDNA marker located D-loop region as well support lack of genetic differentiation among lamprey populations in Lithuanian coastal region and Kurzeme region in Latvia. The pairwise comparison among rivers indicate that the difference among majority of populations are not existent (0 <FST <0.02) with a several exceptions of few.

Overall the result indicates, that river lamprey populations in Lithuania and Kurzeme region in Latvia form one panmictic stock and one common management unit and the status of it depends on the close regional cooperation for lamprey management and conservation. Even if a geographical distance may hinder the formation of entirely homogenous lamprey population (see Spice *et al*. 2012) we assume that genetic structure and variation or river lamprey population in Latvia and Lithuania in general is the same.

Larvae density assessment methods intercalibration

Up to day lamprey larvae in Latvia and Lithuania is collected by bottom sampling. To ensure the compatibility with the existing data, the bottom sampling should be continued. However, the sampling gear used for capture of lamprey larvae until the 2018 was different in each country. In Lithuania bottom samples were taken by sampling gear first described by Lasne *et al.* 2010. This gear is the 55 cm high and 30 x 40 cm wide box with open top and bottom and attached nylon netting with 0.5 mm mesh size at one side (Figure 1.1.). In the same time in Latvia bottom samples were taken by specially designed 8 cm high, 25 cm long and 20 cm wide shovel (Figure 1.2). Both methods have own advantages and drawbacks. Greatest advantage of the sampling box is that the precise area of each sample is known. Yet due to its relatively large size usability of this box is limited in reaches dominated by stone or wood or another large substratum. Shovel is smaller and more adjustable yet it is very hard or even impossible to measure the exact length for each sample or transect and estimate the size of sampled area.

One of activities of LAMPREY project was the intercalibration of both methods. Results of intercalibration confirmed that results obtained by both methods is compatible (Figure 1.3) yet the Lithuanian or box method demonstrates the better value distribution and theoretical concept for the monitoring data analysis. Therefore, it was concluded that further on the bottom sampling box described by Lasne *et al*. 2010 must be considered as primary method for monitoring of lamprey larvae in Latvia and Lithuania.



In accordance to the project application, the method used for further lamprey larvae monitoring should be sensitive enough to detect population change by factor 1.5 with 80% power at 95% significance. As it was concluded during the intercalibration of Latvian and Lithuanian sampling methods such accuracy can be reached if in the territory of interest there are at least 12 samples in at least 40 sampling sites taken. Since the project area include territory of both Latvia and Lithuania, at least 40 sites must be sampled in each of these countries. This will give the opportunity to follow the changes in each of country. In order to obtain monitoring results that accurately resemble changes in the lamprey population, sampling sites must remain fixed, and monitoring must be conducted at the same sites every year. Sampling sites must be located in all greatest rivers of the region, and in their tributaries in a river reaches that are suitable for lamprey larvae.

To increase the quality of gathered data samples in each sampling site must be positioned so that they cover both optimal and suboptimal biotopes for lamprey larvae. If possible, the number of samples in each of habitat type must be proportional to the amount of such biotopes in the sampling site. Analysis of existing Latvian lamprey monitoring data indicate that river biotopes can be grouped into 4 main categories

Recommended method for monitoring of lamprey larvae in Latvia and Lithuania is the bottom sampling by using of the sampling box Lasne *et al.* 2010 or Chapter 1.1 for more information).

For more information see the *Handbook of guidelines for River lamprey monitoring in Lithuania and Kurzeme Region, Latvia* at https://www.bior.....

Mark-recapture study for trap efficiency and F evaluation

In both Latvia and Lithuania lamprey fishermen are obliged to report the size of the catch after each fishing activity thus providing relevant agencies with highly detailed fisheries data. However, the size of the catch is determined not only by the status of the lamprey population. An important role is played also by meteorological and other factors which effect the intensity of spawning run as well as the fishing opportunities in such way influencing also the size of annual landing (Abersons, Birzaks, 2014). Value and usability of catch data can be greatly increased if the actual proportion of migrating lampreys that are caught by fishermen is estimated. A most suitable method for evaluation of actual fishing pressure is a mark-recapture study.

The precision of results increases significantly by the increase of sample size. At the same time increase of sample size increases the effort needed for monitoring, compromise welfare of lampreys and complicates the tagging itself to some extent. Tagging survey performed within LAMPREY project and previous surveys in Gulf of Riga suggests that current efficiency of river lamprey fishing gears is approximately 40%. Since the gear limit in Latvia has been relatively stable during the last decades it can be concluded that such exploitation rate is safe for the status of population and should not be exceeded. Therefore, it can be concluded that the sample size should be great enough to allow detect the 10% difference from 40% with 95% confidence level and 80% test power.

Calculations of sample size were carried out for proportion test following methodology by Dalgaard (2002) with software for statistical computing R (R Core Team, 2019). The larger is the difference between observed and specified proportion, the smaller sample size is needed to obtain statistically significant differences from 40%. Therefore, specific attention must be paid to proportions at the detection limit of 30 and 50%

It can be concluded that (Figure 2.1):

- to obtain a statistically significant difference for 30% from 40% at least 356 individuals must be tagged in one tagging event;
- to obtain a statistically significant difference for 50% from 40% at least 388 individuals must be tagged. in one tagging event.

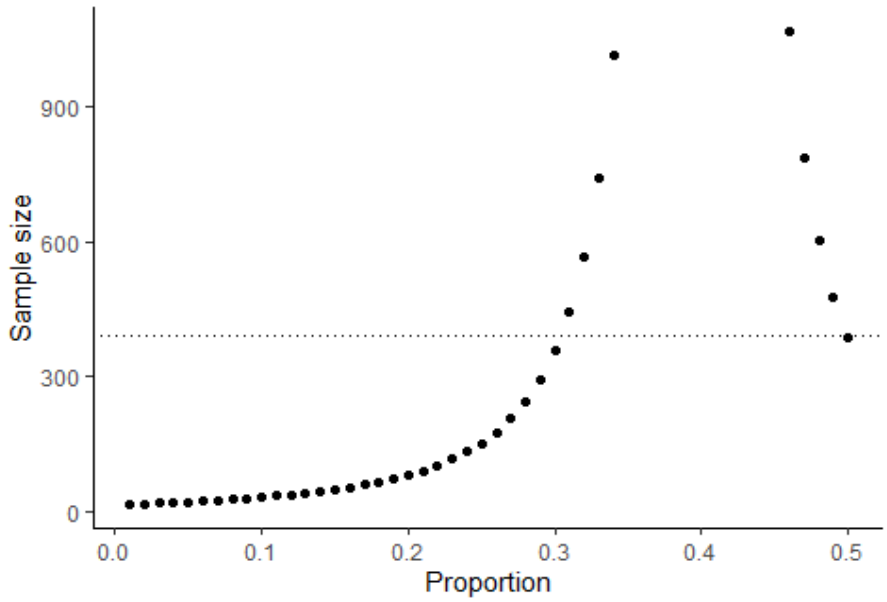


Figure 2.1 Change of sample size necessary to acquire statistically significant difference from 40% with 95% confidence and 80% power.

Decrease in sample size not only increase the detectable distance from the 40% fishing pressure but also lowers the power of the test. The results of analysis of test power to distinguish statistically significant differences at 30% and 50% from 40% with 95% confidence confirms that minimal sample size for a particular mark-recapture survey is 388 specimens (Figure 2.2). Smaller sample size will greatly decrease the power of the test and also increase the distance from 40% which can be detected.

Figure x. River lamprey tagged with a streamer tag.

For more information see the *Handbook of guidelines for River lamprey monitoring in Lithuania and Kurzeme Region, Latvia* at https://www.bior.....

River potential for lamprey reproduction assessment

TEXT, description????

Rank	River	Obstacle	Recommendations
1	Venta	Waterfall	Stocking
2	Rīva	Remains of dam	Removal/fish pass
3	Roja	Watermill	Removal/fish pass
4	Riežupe	Culvert/waterfalls/ watermill dams	Reconstruction of culvert/translocation/ stocking
5	Alokste	Powerstation/watermill	Removal/fish pass
6	Grīva	Watremill dams	Removal/fish pass
7	Vārtāja	Powerstation, pond	Removal/fish pass
8	Virga	Powerstation/remains of watermill	Removal/fish pass
9	Pāce	Powerstation/watermill	Removal/fish pass
10	Durbe	Beaver dams	Control of beaver population
11	Tebra	Beaver dam/watermill	Control of beaver population/removal of barrier/fish pass
12	Kauliņa	Powerstation/fish ponds	Removal of barrier/fish pass
13	Dzirnavupe	Watermill	Removal of barrier/fish pass
14	Dakterišķe	Watermill	Removal/fish pass
15	Rudupe	Ponds	Removal/fish pass

16	Padure	Remains of mill dam/powerstation	Removal/fish pass
17	Īvande	Waterfall/powerstation	Translocation/stocking
18	Svente	Powerstations	Removal/fish pass
19	Vanka	Powerstation/watermill	Removal/fish pass
20	Alekšupīte	Waterfall/weirs/dam	Translocation/stocking

Rank	River	Accessible	Suitable	Index value	Priority class	Reliability
1	Venta	Yes	Yes	11 260.1	-	Excellent
2	Rīva	Yes	Yes	495.6	1 (high potential)	Excellent
3	Roja	Yes	Yes	213.2	1 (high potential)	Excellent
4	Riežupe	Yes	Yes	153.3	1 (high potential)	Moderate
5	Alokste	Yes	Yes	119.3	1 (high potential)	Good
6	Grīva	Yes	Yes	62.9	2 (good potential)	Moderate
7	Vārtāja	Yes	Yes	51.6	2 (good potential)	Very low
8	Virga	Yes	Yes	51.1	2 (good potential)	Good
9	Pāce	Yes	Yes	44.4	2 (good potential)	Low
10	Durbe	Yes	Yes	41.9	2 (good potential)	Good
11	Tebra	Yes	Yes	41.4	2 (good potential)	Excellent
12	Kauliņa	Yes	Yes	30.7	3 (moderate potential)	Low
13	Dzirnavupe	Yes	Yes	29.7	3 (moderate potential)	Very low
14	Dakterišķe	Yes	Yes	29.0	3 (moderate potential)	Very low
15	Rudupe	Yes	Yes	25.8	3 (moderate potential)	Very low

16	Padure	Yes	Yes	21.1	3 (moderate potential)	Low
17	Īvande	Yes	Yes	20.3	3 (moderate potential)	Low
18	Svente	Yes	Yes	15.1	4 (low potential)	Moderate
19	Vanka	Yes	Yes	11.6	4 (low potential)	Low
20	Alekšupīte	Yes	Yes	11.6	4 (low potential)	Good

Rank	River	Accessible	Suitable	Index value	Priority class
1	Blendžiava	Yes	Yes	30.1	1 (high potential)
2	Danė-Akmena	Yes	Yes	24.4	1 (high potential)
3	Salantas	Yes	Yes	16.4	1 (high potential)
4	Šyša	Yes	Yes	16.2	1 (high potential)
5	Pragulba	Yes	Yes	8.3	2 (good potential)
6	Vieštovė	Yes	Yes	7.5	2 (good potential)
7	Eketė	Yes	Yes	3.3	3 (moderate potential)
8	Šventoji	Yes	Yes	3.1	3 (moderate potential)
9	Sausdravas	Yes	Yes	2.4	3 (moderate potential)
10	Darba	Yes	Yes	2.3	3 (moderate potential)
11	Šata	Yes	Yes	1.8	4 (low potential)
12	Vilka	Yes	Yes	1.4	4 (low potential)
13	Mišupė	Yes	Yes	1.4	4 (low potential)
14	Karkluojė	Yes	Yes	0.5	4 (low potential)
15	Agluona	Yes	Yes	0.4	4 (low potential)
16	Žvelsa	Yes	Yes	0.1	4 (low potential)
17	Aisė	Yes	Yes	0	4 (low potential)
18	Alantas	Yes	Yes	0	4 (low potential)
19	Luoba	Yes	Yes	0	4 (low potential)
20	Smeltalė	Yes	Yes	0	4 (low potential)

For more information see the *Rivers ranked according to the available potential for spawning of river lamprey and proposed improvement measures to secure river connectivity*, Kurzeme Region, at https://www.bior.....

Transfer of spawners above impassable dams

To sustain maintenance of river lamprey resources two methods are used in Latvia: (1) repopulation of river sections by translocation of spawners across barriers and (2) artificial propagation, - matured lampreys are caught during their spawning migrations, reared in hatcheries of the institute BIOR,

and larvae are released in Daugava, Gauja and Venta River basins according National Fish Resources Restocking Program.

In Latvia river lamprey spawner translocation was performed periodically from 1960s to 1980s. The spawners translocation was revived recently and in 2015 with experimental program for translocation of river lamprey spawners over Venta River waterfall in Kuldiga started again.

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

During implementation of the LAMPREY project river lamprey spawners translocation over impassable barriers was performed in late autumn in five small rivers of Kurzeme. The upper reaches of Saka River and Roja River were supplemented with 3010 adult lampreys. Guidelines for gentle river lamprey translocation, intended for people participating in spawner fisheries and release acts, were worked out during Project.

All recent translocations within LAMPREY project were performed on 2019, and will be followed by monitoring, for at least 5 years. Meaning, that release efficiency within Lamprey project will be checked from 2019 till 2023. Improved monitoring protocol will be applied, to increase procisition. First results indicates to the tendency that translocation can be effective if translocation is performed in rivers and river sections with most suitable biotops.

To contribute to the improvement of lamprey population and sustain fisheries of Kurzeme Region, it is recommended to implement stocking measures in amount to achieve at least 10% of the planned longterm increase in lamprey catches. The stocking values are set in Socio-economic evaluation of lamprey stock importance to the region Part II (Attachment XX?).

For more information see the Handbook for river lamprey restocking methods, at https://www.bior..... and Socio-economic evaluation of lamprey stock importance to the region, at https://www.bior.....

Stocking rivers with lamprey larvae

Until now the stocking of rivers with river lamprey larvae was performed following native river principle, as there was a belief that river lamprey has homing instinct that guides them back to the native rivers as for salmonids. Therefore until now in Latvia spawners for restocking purposes were fished and reared in the same river water where releases are performed. Project results verified that stocking should not strictly adhere to the native river principle, as river lamprey do not have homing instinct and there are not separate populations populating separate rivers, instead there is one common population for the whole region. Therefore, spawners can be fished by fishermen that provides the best spawner quality and released in other rivers of the region. As an example, spawners can be caught in Daugava river, and transferred for rearing to other institute BIOR fish farms located in Venta and Gauja River basins, similarly with transfer across barriers.

To sustain river lamprey spawner fisheries and farmers, rearing methodology was summarized in the Handbook for River Lamprey Restocking Methods (www.bior.....)

To sustain river lamprey population in the Region and assess efficiency more than 4.3 million of river lamprey ammocoetes were released by stocking of five Latvian small rivers - Alokste, Ālande, Ēda, Kurmale and Alekšupīte. Monitoring of restocking efficiency will last from 2019 till 2023, but first results of showed that ammocoetes abundance is influenced if stocking is performed in suitable habitats.

To contribute to the improvement of lamprey population and sustain fisheries of Kurzeme Region, it is recommended to implement stocking measures in amount to achieve at least 10% of the planned longterm increase in lamprey catches. The stocking values are set in Socio-economic evaluation of lamprey stock importance to the region Part II (Attachment XX?).

For more information see the Handbook for river lamprey restocking methods, at https://www.bior..... and Socio-economic evaluation of lamprey stock importance to the region, at https://www.bior.....

Socio-economic study on lamprey stock and fishery importance to the region

Although resource is limited, the River lamprey is one of the most important species for inland fisheries creating economic benefit for the Region. In Latvia lampreys are consumed and perceived as a delicacy, while in Lithuania lamprey consumption traditions are nearly lost. In Latvia, in several coastal towns, takes place traditional celebrations dedicated to lamprey, there is an interest from public sector to visit lamprey-related tourism spots, participate in lamprey preparation masterclass and to attend lamprey-related cultural events. Although Lithuanian fishermen mainly sell caught lamprey to Latvia, as there is higher demand, the Socio-economic survey results suggests that Lithuanian respondents would also be interested in events dedicated to lamprey, if this type of fish and its heritage would be publicly presented. It has to be noticed, that next to the consumption needs, respondents from both countries evaluate nature values of surroundings, including maintenance of biodiversity, and express support to the conservation of lamprey stocks (*Deliverable*

D.T2.4. Socio-economic evaluation of lamprey stock importance to the region, Part I Cultural and economic importance of lamprey stocks and fishery to the region).

Lamprey fishing and processing retain a large amount of hand work and maintains traditional skills specific for the Region, it has to be protected and preserved as cultural and historical heritage to sustain Regional economic, develop modern cultural values and create new services in the hospitality and tourisms sector. Socio-economic costs and socio-economic benefits arising from possible changes in lamprey stock maintenance, management and monitoring measures in Kurzeme region, Klaipeda and Telšiai counties are summarized in Deliverable D.T2.4. (*Socio-economic evaluation of lamprey stock importance to the region, Part II Evaluation of socio-economic impacts of proposed lamprey stock management strategy*).

3. IMPORTANT ASSUMPTIONS FOR PROPOSED STRATEGY MEASURES

This is important part of the Strategy – assumptions to justify proposed measures for stock management, maintenance and conservation, that they are safe, efficient and sustainable in a long-term perspective. The preconditions are based on scientific survey data (listed in the chapter above), expert opinion (gained during organized pan-Baltic expert workshop "Lamprey population status, management and assessment practices in the Baltic Sea region", 11-12 April 2019 in Klaipėda, Lithuania) and stakeholders' position.

3.1. Considering genetic analysis results revealing single lamprey stock for Latvian/Lithuanian eastern coast of Baltic Proper, there is no rationale to have different stock exploitation strategies in Latvia and Lithuania as it is now.

3.2. Stock status will depend on overall fishing pressure and integrated management strategy. In Latvia stock status is stable for XX years using gear limitation, and catches depends from stock….. By applying catch-limitation for lamprey fishery in Lithuanian rivers (Nemunas and Šventoji) and by setting reduced catch limits – we, are not helping saving Nemunas or Šventoji stocks. Opposite, catch-limited regulation distorts conditions of competition between Lithuanian and Latvian fishermen, where gear-limitation strategy is applied and catches of Latvian fishermen directly depend on the stock status. Single stock should be managed integrally and responsibly and coordinated between countries.

3.2. After analysis of long-term series of catch statistics in Latvian rivers, historically consistent fishing intensity does not affect stock status (landing size) and is considered as sustainable in a long-term perspective if the same presently applied stock maintenance and conservation efforts would be applied. Historical and present exploitation intensity is considered as a reference level, safe for the stocks and the same supporting regionally important artisanal lamprey fishery.

3.3. Maximum fishing mortality *F* in Latvia and Lithuania should not exceed 40% limit. Any changes in proposed or existing fishing intensity should comply maximum 40 % *F* limit and should be based by monitoring results and scientific advice.

3.4. For effective management, monitoring of catch statistics and larvae population status should be implemented.

3.5. Different larvae monitoring methodologies applied in both countries revealed inconsistency between accuracy of gained results. To have consistent results about population status within whole distribution range of common stock, standardized methodology should be accepted.

3.6. To reach good ecological status according to WFD, where lamprey is indicator species, specific measures should be considered to restore river connectivity.

3.7. As a first and main river lamprey population promotion action can be advised increment of natural population areas by restoring river connectivity, the second action is repopulation of suitable river areas by translocation of spawners or release of ammocoetes.

3.8. Following advises of Strategy restocking should be improved in Gauja and Daugava River Basins of Latvia.

3.7. To reach satisfactory/good status of Natura 2000 rivers according to lamprey ammocoetes parameter, the good habitat status values should be reconsidered, otherwise good habitat and population status rarely could be reached without specific maintenance measure (see section *Maintenance measures*).

3.8. The poaching in spawning areas in spring significantly deteriorate spawning biomass and these activities should be prevented.

3.9. In Lithuania there is still some importance in Curonian region, where it has historical, heritage and could be promoted as region attribute. In coastal area (Šventoji-Palanga-Klaipėda) historical heritage is lost, there is no reasons to increase catches or apply other measures.

3.10. The Baltic Sea region is the only place worldwide where lampreys are still exploited intensively and probably there locates general Baltic Sea stock and management of Baltic Sea stocks should be international. No working format is presently existing for river lamprey and this possibility should be considered.

MANAGEMENT, MAINTENANCE AND CONSERVATION OF RIVER LAMPREY IN KURZEME AND WESTERN LITHUANIA REGIONS

In this Strategy, measures, which often are considered as integral part of stock management, are given separately and grouped into 5 categories:

- ***Management***
- ***Maintenance***
- ***Conservation***
- ***Monitoring***
- ***Promotion (Dissemination)***

Management – regulation measures of lamprey stock use.
Maintenance – measures to improve stock status.
Conservation – measures to ensure favourable status of protected species.
Monitoring – actions to assess actual stock status based on multi-life stage surveys and predict future trends.
Promotion – measures to raise awareness of lamprey as a nature conservation value and local cultural heritage for fishery regions.

The presentation of measures is given after short introduction into present background situation. Measures are listed as common solution relevant for both countries, or separately for Lithuania and Latvia, considering different stock exploitation intensity, importance to the region, different practice in management and conservation and stock maintenance efforts.

Management

Background

Management of fish stocks exploitation usually consider the fishery regulation. In Latvia and Lithuania two different lamprey fishery regulation approaches are applied.

Historically and consistently, Latvian fishermen catch river lampreys in 17 rivers and 24 sites with using fyke nets or traditional unique installations – wooden weirs. Gear limitation is applied in all Latvian fishery sites, and up to xx fyke nets are used in Latvia, or xx – in Kurzeme region. The fishing season in Latvian rivers takes from… to…

Two different regulation approaches are applied in Lithuanian fishing sites: catch limitation – in rivers, gear limitation – in Curonian lagoon. In the Nemunas and Šventoji rivers low catch limits are set: presently 2 t for Nemunas river (from maximum 5 t limit in 2004-2011) and 1,5 t for Šventoji river (from maximum 3 t in 2000-2011). Traditional, low intensity lamprey fishing gears – lamprey cone traps are used in Nemunas (Figure 11), where by 3 fishing enterprises use on average 500 gears (maximum to xxx in 200x). In Šventoji river 4 local fishing SMEs use up to 5 lamprey fyke nets (mostly 4 fyke nets are used) (Figure 11). Lamprey fyke nets are also used in the Curonian Lagoon, while as for whole Curonian lagoon fishery, gear limitation is applied (maximums 32 fyke nets including ruffe

and smelt fyke nets which catch river lamprey as well). The lamprey fishing season in Lithuania is set from September 16 to December 31.

There are Individual Transferable Quotas system, total allowed catch limit parts are allocated to separate fishing enterprises. Quotas are unequal, they are set by quotas commission based on the request of enterprises who take part in auction. The involvement of scientists into this process is weak.

Lamprey fishing gears in Latvia and Lithuania: traditional lamprey weirs in Salaca river and different design fyke nets ready for use in Latvian rivers (photos from Abersons, Birzaks, 2014), fyke net in use in Šventoji river (photo: N. Nika) and traditional cone trap used in Nemunas (photo: R. Staponkus).

It is generally accepted that catch limitation is not efficient stock exploitation management strategy in small-scale fishery, like is the above described river lamprey artisanal fishery. Two different strategies applied for, as it was revealed by genetic analysis, one common mixed stock exploitation, cause many inconsistencies in sustainability of management. By applying catch-limitation for lamprey fishery in Lithuanian rivers and by setting low catch limits – we, in fact, are not saving any specific Nemunas or Šventoji rivers populations, but it restricts an access of Lithuanian fishermen to the shared lamprey resources. This, in turn, distorts competitive conditions for Lithuanian and Latvian fishermen.

The catches in gear-limited fishery directly depend on the general stock status. Shared stocks should be exploited integrally and consistently and coordinated between countries, as its status will depend on overall (possibly whole Baltic Sea basin-scale) fishing pressure and efforts in management. Therefore, some consistent collaboration platform for the Baltic Sea region lamprey experts is needed for better, more relevant river lamprey stock management.

Besides commercial fishery in Lithuania, in 12 designated rivers and in Curonian lagoon there is organized licenced amateur lamprey fishing. It is allowed to catch 50 lampreys with one license which is valid 24 hours. For different rivers there is issued different number – from 20 to 80 – licenses, what equals from 1000 to 4000 caught lamprey spawners per river. The fishing season designated in the rules of license fishery in Lithuanian inland waters, is from April 1 to April 30 and from June 1 to December 31. The first period however overlaps well with the start and the peak of lamprey spawning in the western Lithuanian rivers which usually takes from 20th of April to 10th of May. The popularity of lamprey licensed amateur fishery is low, but sometimes it may mask poaching activities. From the other hand, its not the best practice in management and conservation of stocks.

Management measures

- **Common measures**
    - ***Initiation of legal platform for international/regional expert group meetings*** to ensure sustainable region-wide assessment and management of Baltic region lamprey resources. There was a common agreement between the Baltic Sea region experts (Latvia, Lithuania, Estonia, Poland and Sweden) for the necessity of such platform.

- **Latvian measures**
    - Present fishery intensity and regulation in Latvian rivers is satisfactory and there is suggestion to ***keep existing management practice*** which was proven to be sustainable in a long-term run based on catch statistics dynamic, present genetic status and estimated fishing efficiency *F* level. These and other parameters (given in *Monitoring measures* section) giving the information on stock status should be constantly monitored to further manage lamprey fishery sustainably and safe.

- **Lithuanian measures**
    - ***Transfer lamprey fishery regulation from catch limitation to gear limitation in Lithuanian rivers*** is necessary to have common integrated stock exploitation and management practice between shared stock users
        - For Šventoji River the same presently allowed and historically used gear number should leave as the limit – up to 5 fyke nets of the same construction
        - For Nemunas River suggested gear limit is increased (on the request of fishermen association) from presently used ~500 to 800 cone traps. Cone trap is low intensity, traditional fishing gear, which have no bycatch of other species. 800 units of cone traps in Nemunas till the end of February could yield 18.5 t on average (4-33 t). About two years ago other construction fyke

nets were started to use in Nemunas. The fyke nets could yield significant bycatch and the gear performance need to be assessed initially, therefore no increase in gear number under fishermen association request could be implemented. The gear limit for this Nemunas-adapted fyke net should be not higher than presently (till the 2019 fishing season) used maximum number of gears.

- For the Curonian lagoon the same gear number for lamprey fishing (32 fyke nets) should leave as maximum allowed. The fishing mortality in Curonian lagoon is still unknown and need to be assessed for any changes in fishing intensity regulation.

- Due to climate changes and shifting hydrological patterns in rivers, prolongation of fishing season was requested by fishermen community. However, shifting from catch limitation (which low limits didn't allow to judge about migrating stock status in the rivers) to gear limitation (which can significantly increase landings) and having no data about the real stock size, we suggest to ***consider precautionary principle and not to prolong fishing season for transitionary period of 3 years***. After stock size assessment based on catch statistics, the prolongation or shortening of fishing season could be considered.

- Considering the results of socio-economic analysis and cultural and tourism potential of lamprey fishery in the Curonian lagoon region, some new fishing sites in the region could be considered. We recommend to open ***pilot lamprey fishing sites in Vilhelmas canal, Dreverna River and Akmena-Danė River*** to support local lamprey fishing tradition, to stimulate local market and consumption and develop sustainable lamprey fishery as the specifics of the region. Pilot fishery with one lamprey fyke net or 100 cone traps per site (one or another option, not both at the same time) could be allowed for two years. After the pilot fishing situation should be analysed by scientists (catch statistics, lamprey migration patterns, fishing mortality, size of the population, reproductive realization, availability to local and processers consumers etc.) for further decisions.

- Together with switched fishery regulation to gear limitation, ***catch statistics*** as raw logbook data should be ***monitored on mandatory basis by scientific institution*** (example of BIOR in Latvia) which analyse the data, jointly with Latvian BIOR institute evaluates the status of stocks and report it to regulating institution – Ministry of Environment for further decision making.

- Changes of licensed amateur fishing rules need to be implemented to avoid legal possibility to catch lampreys during the spawning season. The earliest start of river lamprey spawning in western Lithuanian rivers (Minija, Akmena-Danė and Coastal Šventoji) recorded on 20th of April, while the most common date is between 22-24 of April. Considering climate changes and warmer springs, we suggest to leave only post -spawning ***season for licensed amateur lamprey fishing in June 1 – December 31***.

- **Expected outcomes and benefits of implemented measures**
  - Better integral management of single shared stock
  - Better consistent data collection of catch statistics and stock status monitoring
  - Supports and develops lamprey fishery as specific attribute of the Curonian lagoon region where lamprey still remain cultural heritage
  - Higher catches would support local availability and consumption and could support tourism sector
  - Support of small-scale low intensity artisanal fishery using cone traps
  - Would increase awareness of fishermen and other stakeholders on the necessity for stock protection and maintenance to ensure sustainably high long-term catches (the main task of CFP)

Maintenance

Background

Latvia and Lithuania have different history and experience in lamprey stock maintenance.

In Latvia long-term maintenance and preservation of river lamprey, was a question of national importance. Fish farmers have long-term experience in farming and ammocoete releasing for restocking purposes (Rjapolova, Mitāns 2012; Medne et al, 2019). First incubation of river lamprey eggs in Latvia was carried out already since the 1960's. Lamprey farming biotechnology was created and is still developing by Latvian researchers. Currently, ammocoetes are obtained and lampreys are restocked annually in several farms located in different river catchments. Altogether, there are up 10 to 20 million of lamprey ammocoetes released in Latvia's rivers annually (Figure 3).

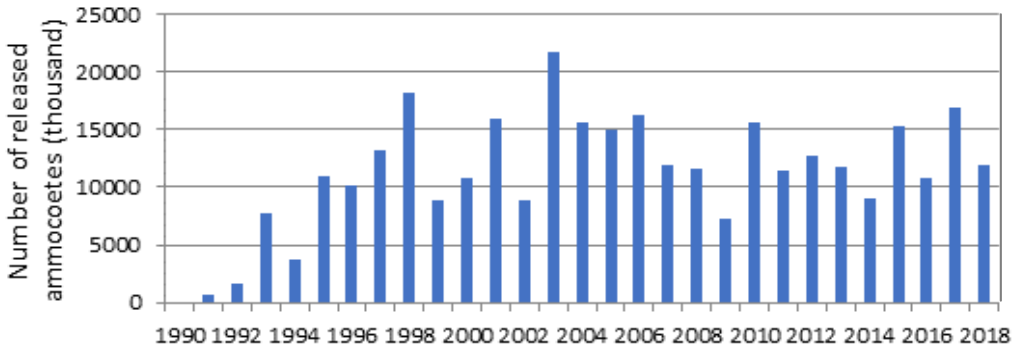


Figure x. River lamprey larvae releases to Latvian rivers in 1990-2018.

Following LAMPREY project advises releases of spawners and ammocoetes will be improved according methodology summarized in the Handbook for River Lamprey Restocking Methods (https://www.bior.lv/lv/nosledzies-latvijas-lietuvas-parrobezu-sadarbibas-programmas-projekts-parrobezu-upes-negu-krajuma-novertejums-un-parvaldiba-lietuva-un-latvija-lamprey-lli-310). In National Fish Resources Restocking Program of Latvia, for 2021-2024, annual translocation of 1250 kg of spawners and annual 5 000 000 larvae releases are planned in the Daugava River basin as well as annual 7 000 000 larvae releases are planned in Gauja and Venta River basins.

Lampreys are the indicator species in Lithuanian river ecological status evaluation under WFD, but national river status improvement programs like River basin district management plans presently don't consider lampreys. Maintenance measures like restoration of river connectivity for migratory species, water and habitat quality improvement etc. usually consider sympatric salmonid species.

Migration barriers (constructed dams and weirs and natural obstacles like Venta's waterfall or beaver dams) are the main problem affecting river lamprey distributions and stock potential in both countries. Migration of fish is facilitating by removing beaver dams at local level, while national programs focus on the building of fishpasses. These projects usually are based on salmonid approach and the design of fishpasses don't consider river lamprey as a target migrating species even though lampreys are poor swimmers.

Recently, specific river restoration activities were implemented to improve sea trout *Salmo trutta* population potential while directly considering benefit for river lamprey too. Sea trout and river lamprey are sympatric species with overlapping general distribution and habitat requirements. The use of spawning sites strikingly overlaps between these two lithophilic species (Nika and Virbickas 2010), therefore creation of spawning grounds would equally support salmonids and lamprey's reproduction potential. In Latvian Riva river new fish pass was designed and built considering migrating river lamprey. In Smeltaitė stream (Lithuania) and Raķupe (Latvia) artificial spawning habitats were created which were successively used in the first season after construction.

Maintenance measures

- **Common measures**
    - In this Strategy the common maintenance measures are understood as ***the general best-practice river ecosystem maintenance measures*** which should be considered for every national fisheries management and conservation project, and specifically, for river restoration and ecological status improvement project under WFD. Any measure should be followed by evaluation of its efficiency and post-implementation performance. These measures include:
        - **Restoration of river connectivity and improvement of lamprey migration conditions.** The central task for most recent river management programs is to secure fish migration possibilities. It is generally accepted that the most important factor for migratory species stock status is the migration barriers and lost reproductive potential. The standardized priority selection should be applied:
            1) ***the priority should be given to dam removal*** – the best solution for all aquatic species and ecosystem processes. Leftovers of old dams should be removed also if they can restrict migration, especially under low water level conditions.
            2) When removal of migratory barrier is not possible, ***the second choice should be natural-like stony bypass channel***. The lowest possible slope (not higher then 2 %), avoiding higher stone rapids and waterfalls, should be designed.
            3) The least choice should be the technical concrete fishpass. Normally they are high slope pool-and-weir type devices, mostly dedicated to good

swimmers like salmon, sea trout or vimba. We encourage the responsible stakeholder to consider ***the modification of existing technical fishpasses by applying additional structures – lamprey tiles as relatively inexpensive solution to improve performance of existing technical fishpasses and to improve lamprey migration***. Lamprey tiles proven to be efficient measure facilitating lamprey and other eel-like fish migration in ***existing technical pool-and-weir type fish passes.***

The migration barrier removal is often very difficult process, and till now there were no such experience in Latvia and Lithuania. There are only fishpass building practice: in Lithuania there were 25 fishpasses built, in Latvia – xx. When designing fishpasses, usually salmonid-approach dominates and construction of fishpass usually are still poorly accessible for poor swimmers, like lampreys. ***River lamprey should be considered as target (umbrella) species*** as the poorest swimmer ***when designing and (re)constructing fishpass***. Attention should be paid to "hanging" structures like lower end of old culverts, which often have hanging waterfall.

- **Habitat restoration and maintenance.** The crucial component for lamprey reproduction is spawning gravel availability. Lamprey require creation of spawning grounds.

- **Beaver population control**. Beaver dams in lowland rivers have many negative effects to fluvial fish: it create migration barriers, create+ unsuitable conditions for flow-preferring species (most fluvial species are absent in dammed sections), cause siltation and temporary or permanent loss of spawning gravels. To date there is no common strategy for the management of this problem, even though the negative effects are clearly demonstrated and constantly reported in national salmonid status evaluation programs. Occasional beaver dam removals are implemented to improve local situation for very short time. The problem needs long-termly sustainable and river basin district-wide strategy. This includes evaluation of the beaver population distributions and size, its impact on rivers and population control measures.

- **Water pollution control** – lamprey is intolerant species sensible to water quality. General river water quality improvement and pollution control programs are important for the lamprey populations too.
- **Hydropeaking regulation in dams**. The existing hydroelectric power plants need secure environmental discharge through the dam, which itself is not sufficient from the perspectives of fish and normal riverine ecosystem functioning in general. This minimal sanitary discharge is maintained while water is accumulating in the reservoir and then every or every few days it is flushed through turbines to generate power. This sharply pulsing water lever in 20-30 cm constantly flushes and dewaters river margin habitats, mostly used by lamprey ammocoetes. Unfortunately, the responsible operation of

HPP is the problem in both countries, and this strongly negatively affects lamprey habitats and in turn, may affect population. The current sanitary water discharge is not sufficient to ensure the needs of fish and riverine ecosystem normal functioning, therefore must be recalculated to environmentally friendly discharge (e-flow) that would maintain the natural aquatic communities

- **Ecological flow concept application.**

Figure xx. The example of hydropeaking in Tenenys river below Ramučiai HPP dam for period September 21 to October 20, 2020. Every few days the minimal sanitary water level is flushed by the accumulated water suddenly raising water to +20 cm. Data are taken from Lithuanian Hydrometeorological Service automatic water station in Tenenys River at Miestaliai village http://www.meteo.lt/lt/hidroinformacija

- **Latvian measures**
  - Maintenance of river lamprey migration conditions in 20 selected Latvian LAT-LIT programme area (Kurzeme region) rivers by implementing specific measures suggested in Table x. More comprehensive description of migration barriers, potential of the rivers and solutions for improvement of migration conditions is given in the Deliverable T.2.3. provided to relevant stakeholders.
  - If there is not possibility to implement first three actions, restocking can be advised?
  - National Fish Resources Restocking Program of Latvia, for 2021-2024, provides restocking of main Latvian Rivers, - Daugava, Gauja, Venta, besides there is a possibility for local municipalities to sustain river lamprey population and local economy by restocking of upper reaches of other small regional rivers over dams with larvae, following potential river list from (*Rivers ranked according to the available potential for spawning of river lamprey and proposed improvement measures to secure river connectivity*, Kurzeme Region, at https://www.bior.lv/lv/nosledzies-latvijas-lietuvas-parrobezu-sadarbibas-programmas-projekts-parrobezu-upes-negu-krajuma-novertejums-un-parvaldiba-lietuva-un-latvija-lamprey-lli-310), by applying foundation from Fisheries foundation of Latvia.

- **Lithuanian measures**

- Maintenance of river lamprey migration conditions in 20 selected Lithuanian LAT-LIT programme area (Klaipėda and Telšiai counties) rivers by implementing specific measures suggested in Table x. More comprehensive description of migration barriers, potential of the rivers and solutions for improvement of migration conditions is given in the Deliverable T.2.3. provided to relevant stakeholders.
- Harbour migration conditions – recommendations to consider lamprey spawners and transformers migration through Klaipeda or Šventoji harbour during dredging and other disturbing activities. Now only salmon, sea trout, vimba, twaite shad, smelt and whitefish are considered to prevent negative influence of dredging during migration.

Conservation

Background

Present status of species, conservation network (Natura 2000, Red Book, others)

Conservation values for Natura 2000 territories status evaluation

Illegal fishing and poaching

lamprey larvae monitoring in Natura2000 territories are implemented on 3-year cycle basis, but the larvae density results are not converted into stock status information, but used to evaluate conservation status of population in protected area. During the LAMPREY project different methods of larvae density were compared and intercalibrated and one common monitoring strategy /methodology will be proposed.

Šventoji. Additionally, we propose annual monitoring of recruitment and pre-migratory larval stage of river lampreys in the Šventoji River catchment. Preliminary cost in the Šventoji river 1400 EUR

We expect to have more accurate records in the logbooks after some time. Now fishermen misreport the catch in logbooks, because are afraid of new limitations. Our task is to introduce gear limitation, with no catch limit, and therefore expect some improved catch data, what in combination of fyke nets catchability results would give possibility to track spawning biomass of lamprey entering the Curonian Lagoon and the Nemunas river delta. Additionally, we propose annual monitoring of recruitment and pre-migratory larval stage of river lampreys in the Nemunas River catchment. Preliminary cost in the Nemunas catchment 6950 EUR.

Conservation measures

- **Common measures**

Market control – control of documents of legal origin of lamprey products, offered in markets. To track mismatch between official catch and sold quantities.

Encourage processors and buyers to purchase lamprey with well provable origin by raising public awareness (as example media releases encouraging not to buy fresh lamprey in spring).

Illegal (IUU) fishing control - secure adequate capacities and resources for effective control and surveillance of fishery.

Unify status evaluation criteria for Natura2000 sites.

- **Lithuanian measures**
  - Action “Nėgė” in hot spot river sections to prevent poaching on spawning individuals. This means more intensive patrolling of inspectors, national/regional park rangers, NVOs 2-3 weeks during spawning period, generally from 20 April to 10 May. Based on project results, existing monitoring programs and other surveys and others available information rivers with highest spawning intensity (density of spawning nests and spawning individuals), biggest production potential and highest poaching activities (or risk), particular rivers and river sections are identified for action “Nėgė” implementation:
    - Šventoji (Pajūrio) – section Būtingė-Laukžemė dam – 3 sections
    - Salantas – Nasrėnai-Klanalis – 3 sections
    - Blendžiava – mouth-Skaudaliai – 3 sections
    - Šustis – 2 sections
    - Šyša
    - Šata
    - Žvelsa
    - Akmena-Danė
    - Jūra
    - Smeltalė
  - Set new conservation value for good status in Natura 2000 territories
  - Suggestion for Natura 2000 network reconsideration (Švėtė, Nemmunas, other? river for lamprey completely mismatch best habitats. Also some rivers should be shifted from brook lamprey to river lamprey Natura 2000 area, or set for both species, like in Salantas and Blendžiava case).

- **Latvian measures**
  - Action “Negis” in hot spot river sections to prevent poaching on spawning individuals. This means more intensive patrolling of inspectors, national/regional park rangers, NVOs 2-3 weeks during spawning period, generally from 20 April to 10 May. Based on project results, existing monitoring programs and other surveys and others available information rivers with highest spawning intensity (density of spawning nests and spawning individuals), biggest production potential and highest poaching activities (or risk), particular rivers and river sections are identified for action “Nėgis” implementation:

Background

Currently in Latvia and Lithuania only the monitoring of lamprey larvae is carried out in the regular basis. In the project region the mark-recapture studies of mortality of ascending lamprey spawners have been done only within the framework of LAMPREY project. Before the project two mark-recapture studies was done in Vidzeme region of Latvia, yet they were single-standing studies and cannot be considered as a monitoring. There also have been several single standing studies of success of different maintenance actions in Latvia but the methodology for these studies was different and results are not always convincing.

Other long-term data source is the catch data. Even if the catch size is partly determined also by water level and other circumstances in the long-term perspective the changes of annual landing correspond to fluctuation of size of the lamprey population. In both Latvia and Lithuania, the collection of catch data is organized via individual logbooks which is filled-in by the fishermen and then collected by the State Environmental Service (in Latvia) or Ministry of Environment (in Lithuania). In Latvia logbooks is later submitted to Institute "BIOR" who is responsible for compilation of catch data. Meanwhile in Lithuania monthly catch reports are provided to Environment Protection Departament. Due to limitation of maximum annual catch size in Lithuania the informative value of the catch data in this country currently is lower than in Latvia where only the fishing effort is limited.

During developing of monitoring methods we focused on main issues – monitoring of the lamprey larvae, monitoring of the fishing effort and number of ascending spawners and monitoring of the success of the implemented monitoring measures. Monitoring of lamprey larvae and monitoring of number of ascending spawners will cover both most important parts of life-cycle of this anadromous species. Meanwhile the monitoring of the success of the implemented measures is needed for further improvement of its efficiency.

Development of monitoring methods was based on the deliverables of the LAMPREY project (Deliverable T1.5.1. Output OT1.2 "Protocol for monitoring of lamprey larvae"; Deliverable T1.5.1. "Protocol for monitoring of the number of lampreys spawners entering rivers (mark-recapture survey)" and Deliverable T1.3.1. "Methods for monitoring the stocking efficiency of lamprey larvae or translocation of lamprey spawners"). Description of the methods is compiled in Handbook of guidelines for river lamnprey monitoring in Lithuania and Kurzeme Region, Latvia which can be found in https://www.bior.lv/lv/nosledzies-latvijas-lietuvas-parrobezu-sadarbibas-programmas-projekts-parrobezu-upes-negu-krajuma-novertejums-un-parvaldiba-lietuva-un-latvija-lamprey-lli-310

- **Monitoring of lamprey larvae**

Monitoring of lamprey larvae should be performed by bottom sampling box described by Lasne *et al.* 2010 (for detailed information see Chapter 1 in Handbook of guidelines for lamprey in Lithuania and Kurzeme Region, Latvia). In each country at least 40 sampling sites should be sampled and in each site exactly 12 samples need to be taken. Captured larvae should be sedated (we recommend use of clove oil) and measured to nearest mm, later on the basis of length of lamprey larvae they

have to be devided into three age groups: subyearlings or 0+; yearlings or 1+ and older larvae, changes in each age group should be analysed individually. Location of sampling sites should be fixed during all monitoring. The location of the individual samples within the sampling site should reflect the proportion of the most important formations of the riverbed. Detailed information on the sampling procedure and collecting of the information on each sampling site and each sample can be found in the Handbook of guidelines.

In Latvia relatively, small changes is needed to meet the criteria of method of monitoring of lamprey larvae developed in LAMPREY project. Most important change (the replacement of the bottom sampling shovel with the bottom sampling box and registration of parameters of sampling sites and samples in specific way) was done already in 2019. Most important further change is increase of the sampling effort increasing the number of sampling sites in Kurzeme Region to 40.

In Lithuania, more significant changes are needed. Implementation of method developed within LAMPREY project in addition to increase of the number of sampling site will need also the implementation of form for description of samples and sampling sites and also the measurement of length of captured lamprey larvae and division of them into three age groups.

- **Monitoring of the number of upstream migrating spawners and fishing mortality rate during spawning migration**

Monitoring of lamprey larvae should be performed by mark-recapture survey (for detailed information see Chapter 2 in Handbook of guidelines for lamprey in Lithuania and Kurzeme Region, Latvia). Mark-recapture survey have to be implemented in close cooperation with commercial fishermen who can provide both the lamprey for study and information on recapture of tagged specimens. Tagged lampreys should be released in seven mandatory and one optional site, the smallest number of lampreys for one tagging event is 388. In three sites in Latvian coast of the Baltic Sea tagged lampreys should be released three times (two times in November and one time in August or September) while in other sites tagged lampreys should be released only in November. Information on location of the release sites and suggested timing of tagging is compiled in Figure X.

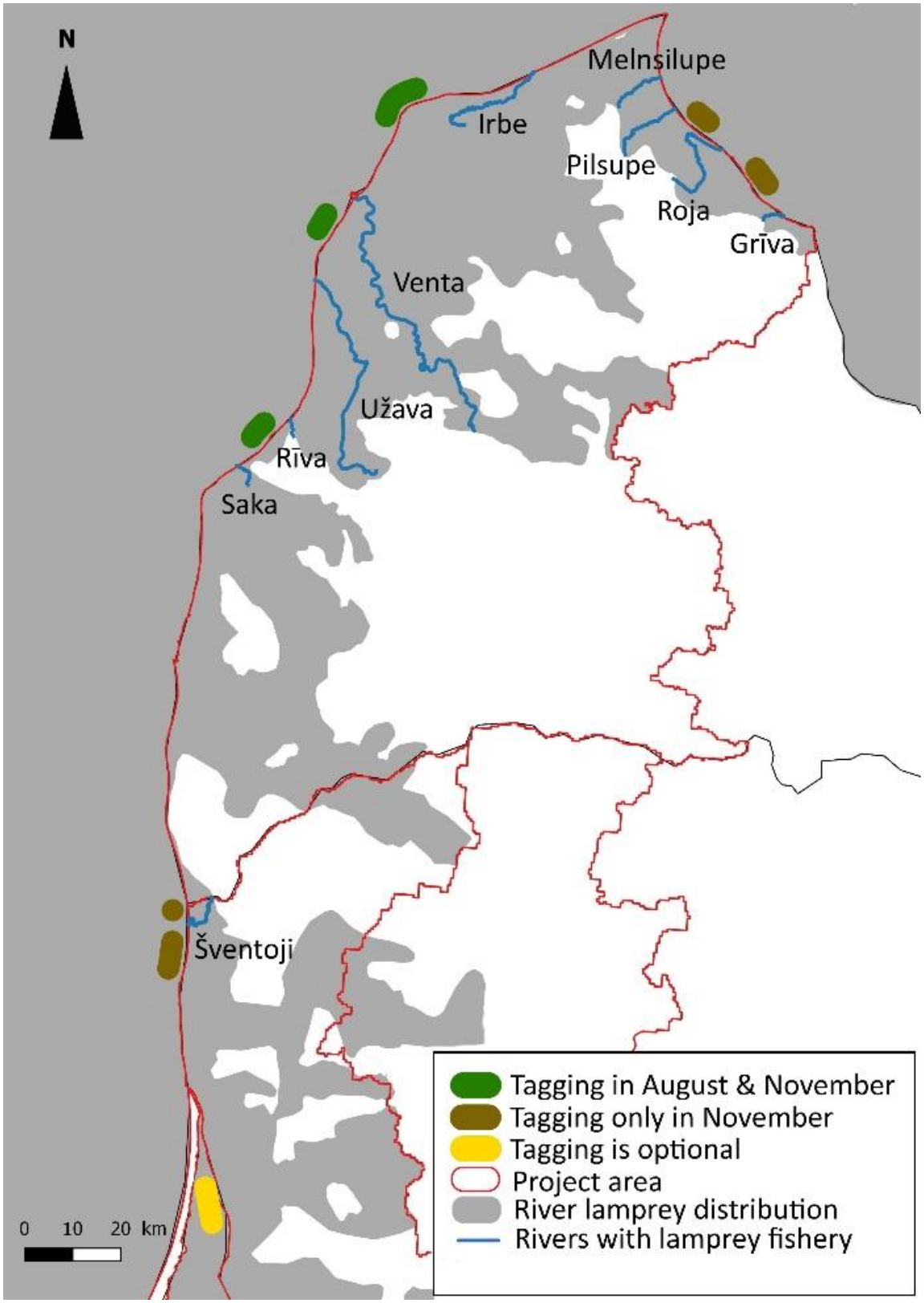


Figure 11. Recommended location of sites for release of tagged lampreys and timing for tagging

In Latvia and Lithuania mark-recapture study of ascending lamprey spawners has never been implemented as a dedicated monitoring. Therefore, in both countries establishment of special

program for the monitoring of the number of upstream migrating spawners and fishing mortality rate during spawning migration have to be developed.

- **Guidelines for monitoring of the efficiency of implemented river lamprey stock maintenance measures**

The methodology for monitoring of the efficiency of implemented stock maintenance measures in general should be performed by bottom sampling but in specific cases e-DNA monitoring or electrofishing can be also used (for detailed information see Chapter 3 in Handbook of guidelines for lamprey in Lithuania and Kurzeme Region, Latvia). Primary tool for monitoring is sampling box described by Lasne *et al.* 2010. In the river of interest at least 5 samples in 16-to 20 sampling sites have to be sampled. In monitoring of efficiency of implemented maintenance measures only optimal for river lamprey habitats should be sampled. If due to stone-dominated bottom or other factors sampling with sampling box is not possible it can be replaced by sampling with a shovel used in lamprey monitoring in Latvia until 2018. In such case at least 7 samples in one sampling site should be taken. E-DNA survey or electrofishing is recommended if the maintenance measures is implemented in river reaches with no lamprey population before these measures. Success of the implemented measures then can be proved by detection of the presence of lamprey larvae as such.

Only few maintenance measures in Latvia and Lithuania have been followed by a sophisticated monitoring of their success so far. Taking into account that such monitoring costs extra money and thus reduce the possibility of implementation of maintenance measures themselves we do not recommend to set the implementation of such monitoring as mandatory requirement also in the future. However, we suggest to perform the monitoring of efficiency in as many cases as possible and to follow the methodology developed in LAMPREY project to reach the noteworthy significance results of the obtained results.

Monitoring

Background

Present monitoring situation description (programme structure – Map (?), methods difference for amocoetes)

Catch statistics in Latvia are collected and analysed, while in Lithuania this important parameters is not considered. Also the quality of available data as monthly reports of fishing SMEs is not adequate.

Monitoring measures

- **Common measures**

Ammocoetes density evaluation methods were intercalibrated and synchronized. The box method should be used as most suitable and precise as a standard in both countries. Complementary protocol for methodology is given in the Handbook of https://www.bior.lv/lv/nosledzies-latvijas-lietuvas-parrobezu-sadarbibas-programmas-projekts-parrobezu-upes-negu-krajuma-novertejums-un-parvaldiba-lietuva-un-latvija-lamprey-lli-310

To proceed the development of new advanced monitoring methods like eDNA

To start mark-recapture survey as a standard component of stock status monitoring program. Complementary protocol for methodology is given in the Handbook of

- **Latvian measures**
  - To establish To increase station number from 20 to 40
  - To change methodology to sampling box
- **Lithuanian measures**
  - To monitor annually, not 3year basis
  - To optimise monitoring network to 20 stations (min), or desirable network of 40 stations (max)
  - Pilot mark-recapture survey for F evaluation in Lithuanian side of Nemunas and Curonian lagoon

Promotion

Background

History of resource exploitation and importance in Latvia, Memel region, info from LT media about lamprey (often very eloquent), Latvian festivals and tradition

- **LAMPREY projects results**

Socio-economic results, present perception and consumption differences in LT and LV, could consumption in LT be increased by promoting this product

Significance of resources for community, fishermen, processing and marketing, tourism sector

- **Important assumptions**

In Latvia it is very important, maybe there is no need for additional promotion and increase of awareness

In LT it is almost unknown product, except Curonian area where historically it has high value and some tradition is still alive. Therefore, it could be like regional speciality for Rusnė region (and nowhere else in LT), but to increase popularity promotion measures are needed

Promotion measures

- **Common measures**
  - Media information (to provide target topics list (?)),
  - Information about lamprey fishery and that its not threatening other migrant fish like salmon (on fishermen SMEs and associations initiative)
  - Prevention for poaching, not to buy illegal catch
- **Latvian measures**
  - None
- **Lithuanian measures**
  - Festival in Rusnė development with successful example of Stinta festival in Palanga
  - Communication between fish restaurants and Klaipėda, Klaipėda District, Palanga and Šilutė TIC for gastro tourism possibilities
  - General promotion of sea food as healthy product (WHO info)