

Interreg



Co-funded by
the European Union



Latvia – Lithuania

“Latvian and Lithuanian conjunction - Improvement of Baltic salmon and pikeperch rearing methods for more sustainable, resilient and healthy fish populations” (SPPwelfare)

Report about the salmon rearing and restocking in Latvian and Lithuanian fish farms

Deliverable D.1.1.3



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

Fisheries Service under the Ministry of Agriculture of the Republic of Lithuania,
FSLT

Latvia & Lithuania, 2024

Document is produced by the Institute of Food Safety, Animal Health and Environment (BIOR) and Fisheries Service under the Ministry of Agriculture of the Republic of Lithuania (FSLT) within INTERREG project SPPwelfare "Latvian and Lithuanian conjunction - Improvement of Baltic salmon and pikeperch rearing methods for more sustainable, resilient and healthy fish populations"

AUTHORS of the report: Olga Revina, Santa Purviņa, Kazys Vainickas, Jūratė Andriukaitienė, Vjačeslavs Revins

Other contributions (field works, management, editing, useful comments and other): Ruta Medne, Justas Poviliunas

Author of photos: Olga Revina

The project is implemented within the Interreg VI-A Latvia-Lithuania Programme 2021–2027. More information about the programme is on the www.latlit.eu and the official website of the European Union www.europa.eu.

The project implementation period is from March 1, 2024 till February 28, 2026.

The total project budget is 497 146.00 EUR. funding of the European Regional Development Fund is 397 716.80 EUR. The total eligible project budget of the scientific institute "BIOR" is EUR 293,000.00 EUR, where co-funding of European Regional Development Fund is 234 400.00 EUR and state co-financing is 20% (EUR 58,600.00 EUR).

This project is co-financed by the European Union.

This publication has been produced with the financial support of the European Union. Its contents are the sole responsibility of the Institute of Food Safety, Animal Health and Environment "BIOR" and do not necessarily reflect the views of the European Union.

Limitation of Liability and Rights

The use of third-party artistic or textual material of third parties in the description with the consent of the owner, re-use for educational or training purposes is permitted with appropriate indication of the authorship or with the prior consent of the copyright holder for further distribution.

The description and its contents may not be copied, published, modified, altered or distributed for commercial purposes.

The used logos and emblems are the registered trademarks.

The copyright holders of the description shall not assume any responsibility and liability for direct or indirect loss, damages, expenses or claims arising out of, or otherwise, related to the responsible or irresponsible use of the description or the information contained therein.

Table of Contents

Report about the salmon rearing and restocking in Latvian and Lithuanian fish farms	1
REARING AND RESTOCKING OF SALMON RESOURCES IN LATVIA	4
a. Introduction	4
b. Breeder fishery, and maintenance of breeders.....	4
a. Rearing.....	5
b. Release.....	7
c. Disease control	7
f. Biosecurity	8
g. Juvenile release strategy	8
2. Rearing and restocking of salmon resources in Lithuania.....	9
a. Introduction	9
b. Breeder fishery, and maintenance of breeders.....	9
c. Rearing.....	10
d. Release.....	11
e. Disease control	11
f. Juvenile release strategy.....	12
CONCLUSIONS AND SOLUTIONS.....	12

REARING AND RESTOCKING OF SALMON RESOURCES IN LATVIA

A. INTRODUCTION

Since 2010, the Institute of Food Safety, Animal Health, and Environment “BIOR” (Institute BIOR) has been responsible for supplementing public water bodies with juvenile fish species in Latvia. This restocking is carried out according to the National Fish Resources Restocking Program, which is updated every four years. The updates are based on scientific assessments of fish resources and the justified need for restocking to enhance valuable fish populations and compensate for losses due to economic activities, fisheries, and angling (Mitans 1972; Treigute and Mitāns, 2001; Bārtule, 2021). The main objective of the Restocking Program is to maintain the natural fish stock in a sustainable, long-term condition, preserving the salmonid homing reflex and their adaptability to natural conditions such as water, river, and weather. The program is implemented over the long term, respecting the unique characteristics of each salmon population within particular river basins (Purvina et al., 2019). Continuous restocking occurs in the Daugava River population due to the loss of access to spawning areas caused by the hydroelectric power plant cascade. In the Gauja and Venta River basins restocking is crucial because significant sections of these rivers have degraded habitats, unsuitable for salmonid spawning and parr development, leading to low natural reproduction (ICES, 2023, Purvina et al., in press).

To ensure biologically diverse, preserved and long-term fishery-useable fish resources in Latvia, a Plan for the artificial reproduction of fish resources 2021-2024 has been developed and introduced into practice. The Plan is divided in six directions. Salmon rearing in Latvia is a crucial part of the country's efforts for restocking of wild salmon populations. Restocking of salmonid resources in the Kurzeme Region is implemented under 1st direction of the Plan, devoted to restocking of migratory fish resources in the public water bodies of the Venta and Gauja River basins. Latvia has several hatcheries dedicated to this purpose, with the Institute BIOR fish hatchery “Pelči” being one of the oldest and very experienced. “Pelči” plays a significant role in Baltic salmon conservation and restocking efforts, particularly for salmon populations in the Venta River system. Through its work, “Pelči” contributes to the sustainability of salmonids in Latvia (Revina et al., 2020; 2023).

B. BREEDER FISHERY, AND MAINTENANCE OF BREEDERS

Salmon broodstock collection typically occurs in the natural rivers where the fish are born and raised. For instance, fishermen in Latvia’s Venta River, which is one

of the main rivers supporting salmon migration, capture adult salmon during their upstream migration in autumn. These captured breeders are used for controlled reproduction in hatcheries.

Once caught, the salmon are carefully transported to “Pelči” fish hatchery, where they are kept in tanks. Regular checks are conducted on the fish to monitor egg maturation. When the time is right, the salmon are manually stripped, eggs fertilized and incubated in flow-through systems.



Stripping of the salmon eggs

A. REARING

Typically, eggs are monitored once a week, with hatchery workers ensuring that no fungal infections (primarily caused by *Saprolegnia spp.*) or other diseases affect the developing embryos, also dead ones are removed.

The eggs hatch between the end of February and the beginning of March, depending on the degree days (a cumulative measure of heat exposure over time) accumulated during autumn and winter.

Eggs and larvae are kept in darkness to simulate the conditions of natural river gravel beds, which are typically dimly lit. This controlled environment helps to reduce stress and metabolic activity, improving survival rates.

As the larvae begin to swim up and deplete their yolk sacs, lighting is gradually increased to encourage the transition to active feeding. Incremental changes in light exposure are crucial, as rapid alterations can induce stress, leading to higher

mortality rates and developmental issues such as failure to thrive. Daily inspections are performed to remove dead larvae, which could otherwise become breeding grounds for bacteria or fungi, further contaminating the rearing tanks.

	
Flow-through systems for egg hatching and larvae feeding, fish hatchery "Pelči"	Flow-through tanks for salmon rearing, fish hatchery "Pelči"

The initial feeding phase is critical for the future growth, survival, and overall health of the stock. This phase marks the transition from endogenous (yolk sac) to exogenous feeding, a period of high mortality if not managed properly. The timing of first feeding must be aligned with the readiness of the larvae, typically based on their swim-up behavior and the completion of yolk sac absorption. Proper nutrition is essential during this phase to ensure adequate skeletal development, immune function, and metabolic health.

Hand feeding during this stage is often employed as it allows hatchery workers to observe feeding behavior and identify weaker groups that may require special attention. This personalized approach helps ensure that each group is feeding adequately before transitioning to automated feeding systems. In the later stages,

automated feeders are often used to deliver carefully measured portions at regular intervals to optimize feed intake and minimize waste.



The general view of the salmon farming workshop, fish hatchery “Pelči”

B. RELEASE

Salmon smolts from the “Pelči” hatchery are released into the Venta River basin as part of the restocking efforts aimed at enhancing wild populations. Smolts, the juvenile salmon that have undergone the physiological changes necessary for transitioning from freshwater to seawater (a process known as smoltification), are typically released in late spring to coincide with their natural migration timing. The number of restocked fish varies each year, influenced by several factors, including the success of broodstock collection, fertilization rates, and environmental conditions during the rearing process.

C. DISEASE CONTROL

At the fish hatchery “Pelči”, epidemiological monitoring is conducted regularly. Fish samples are routinely tested to detect the presence of pathogenic bacteria and to monitor antimicrobial resistance. This helps effectively combat potential outbreaks of infectious diseases. Additionally, on-site veterinarians conduct ongoing parasitological monitoring. Regular prophylactic treatments of the fish are carried out using salt baths.

The fish hatchery “Pelči” also researches natural immunostimulants to reduce environmental pollution.

For successful salmonid rearing and ensuring good welfare, maintaining an optimal nutritional status is essential. This can be measured by the condition factor, a key indicator of fish health. A decline in the condition factor typically signals insufficient welfare. Emaciated or malnourished fish, being smaller, are quickly outcompeted in the competition for food and struggle to feed as the

required feed size increases with their growth. Early detection of emaciated fish is crucial, as salmon can suffer from poor welfare for an extended period before eventually dying. Moreover, they can act as vectors for transmitting diseases to healthier fish.

The condition factor (K) is calculated as: $K = 100 \times \text{weight (g)} / \text{length (cm)}$

This measurement can be automated, but if done manually, it should be performed as frequently as possible, especially during high-risk periods such as smoltification, fasting, stressful conditions, and feeding deficits. The condition factor will vary with the life stage and season, but for smolts and fish up to harvest, it should generally range between 1 and 1.6. A K value below 0.9 typically indicates emaciated fish, while a very high K value may suggest vertebral deformities, which should be closely monitored.

F. BIOSECURITY

Eggs and juvenile salmon are vulnerable to various pathogens, and biosecurity consists of protocols aimed at preventing pathogens from entering the hatchery. Strict visitor procedures should be in place, limiting personnel access to the hatchery. These procedures should include changing protective clothing and footwear, as well as washing hands and sanitizing when entering or leaving each biosecure area.

Equipment should be assigned to each biosecure zone. If moving equipment is unavoidable, thorough cleaning and disinfection must be performed. Both equipment and facilities should be rigorously cleaned and disinfected between production cycles.

During the hatchery cycle, each section enters a period of inactivity, allowing time for equipment to be cleaned, repaired if needed, and disinfected before the arrival of eggs or juveniles. All equipment should be inspected for functionality and damage, cleaned, and disinfected well in advance of the new stock's arrival.

G. JUVENILE RELEASE STRATEGY

Starting from 2019, all released salmon and sea trout smolts have been adipose fin-clipped, enabling the estimation of the proportion of returning salmon originating from fish farms. The average annual release is 0.65 ± 0.17 million smolts 1+. The average weight of salmon smolts 1+ released is 18 grams in the Gauja River, 20 grams in the Venta River, and 25 grams in the Daugava River. Salmonids are released into the wild in the spring when river water temperatures reach 8 °C.

Factors such as water temperature and the salmon group's mean weight are considered to ensure that the smolts are released under optimal conditions. Additionally, the timing of the release is critical, as smolts must reach the sea within a certain timeframe to complete their development and avoid prolonged exposure to freshwater predators and suboptimal food sources.

2. Rearing and restocking of salmon resources in Lithuania

A. INTRODUCTION

In Lithuania, salmon can be observed in the Baltic Sea, the Curonian Lagoon, the River Nemunas, the Kaunas hydroelectric power station, the Neris, the River Žeimena, the Baltic Sea Sventoji. Introduced in Dubysa, Vilnia, Vokė, Siesartis, Virintai. Individual fish may be present in the Minija, Jura, Bartuva and Venta river basins. Protected in the Bartuva, Minija, Šventoji and Žeimena ichthyological reserves. The highest density of juveniles in Lithuania is found in the Žeimena River, which is 9.7 ind./100 m² (average 4.6 ind./100 m²), with lower densities in other Lithuanian rivers. It should be stressed that the Žeimena River is not subject to reproductive recovery and restocking - the river restores itself.

Since 1998, the Žeimena fish farm has been rearing salmon juveniles in closed recirculating aquaculture system (RAS), as well as grayling, rainbow trout, and whitefish. In 2003, a modern RAS complex for salmon cultivation was constructed, integrating both an egg incubator and various-sized breeder tanks. By 2006, a separate RAS facility for grayling production was established. The farm uses a deep well as its water source, consuming up to 24,000 cubic meters of water annually.

Currently, the Žeimena fish farm cultivates and releases salmon and grayling smolts into natural waters.

B. BREEDER FISHERY, AND MAINTENANCE OF BREEDERS

Breeding salmonids is one of the most effective ways to increase salmonid stocks and conserve their gene pool in natural water bodies. Salmon rearing starts with the recruitment of spawners, which in most cases begins in early October. Depending on the weather conditions, from 30 to 50 individuals are caught, which is in line with the permit issued by the Environmental Protection Agency. Broodstock are caught using electrofishing by the farm's staff. The fishing occurs

in various regions and from several rivers. For holding the breeding fish, concrete ponds located outdoors are used. Before egg stripping, the broodstock are anesthetized with 2-phenoxyethanol to reduce stress.

C. REARING

The captured salmon are overfished and matured in the Meškerinè Hatchery's overfishing field pools. The maturity of the spawners is checked every 2-3 days. The eggs of the mature spawners are fertilized with milt and placed in an incubator. To reduce the individual influence of the males, individual portions of eggs are fertilized with the milk of 2-3 males. The diameter and weight of the ovulated eggs are the main phenotypic characteristics of the eggs and are one of the main criteria for assessing the completeness of the female and her offspring. Quality salmon eggs vary in diameter from 5,6 to 6,8 mm and in weight from ~120 to 150 mg. Prior to the placement of the eggs, the incubation troughs are disinfected with a 3-5% sodium chloride salt solution. The eggs are incubated at a water temperature of 4,5 to 6,0 °C. The condition of the eggs is monitored every 4-5 days. Dead (bleached) eggs, especially those covered with saprolegnia, are removed.

The larvae usually emerge from their eggs around the beginning of February. When the yolk mass of the larvae is about 25-30% of the total body mass, they are transferred from the incubator to the pools. Once the larvae have been transferred from the incubator, the rearing process begins, during which it is necessary to pay attention to the start of feeding. Feeding is started by feeding the fish manually in small portions (3-4 days after the start of light habituation) with a starter feed (0,4 mm) and constant monitoring of the uptake of the feed. At this time and afterwards, the uptake of the feed is highly dependent on the temperature of the pool water. Care should be taken to ensure that the temperature difference between the incubator and the pools does not exceed 1,5 °C during the transfer. Our experience over the years has shown that the optimum temperature should be in the range of 11-13°C, with a decrease in temperature resulting in slower feeding. After 2-3 weeks of manual feeding, once the fish are actively feeding, they can be fed with automatic feeders. At this stage of fish rearing, it is necessary to clean the pools of fish feces and unconsumed feed at regular intervals (1-2 times a day, depending on the contamination of the pools). At the end of September, beginning of October, the fish are sorted into three fractions using special sorting equipment and the sorted fish are transferred to the larger pools of Unit II. Again, care must be taken to ensure that the temperature difference between the pools in Cell I and Cell II does not exceed 1,5 °C at the time of transfer. For each fraction of fish sorted, an average weight shall be calculated on the basis of which the fish will be fed accordingly.

The fish shall be maintained at all times. Measurements of water temperature, pH and oxygen concentration are taken several times each day and the results are recorded on a computer medium. Visual observation of the feeding behavior and appearance of the fish is also carried out. Periodic parasitological and water tests are carried out. If necessary, disinfection with 3-5% sodium chloride salt solution is carried out.



D. RELEASE

The smolts from Zeimena are released into several rivers in Lithuania. The average weight of the fish at the time of release is about 70-80 grams. Since 2022, marking of salmon and grayling was initiated, involving the amputation of the adipose fin.

E. DISEASE CONTROL

Before fish are introduced into public water bodies, bacteriological and virological tests are carried out at least once a year at the National Institute of Food and Veterinary Risk Assessment. This helps to effectively combat potential infectious disease outbreaks. Parasitological tests are carried out once a month in the laboratory of the Fisheries Service. The quality of RAS water is monitored on a regular basis by specialists in the salmon farming and rearing facilities by simple

tests, and, if necessary, for more precise data, the water is analyzed by the National Institute of Food and Veterinary Risk Assessment.

F. JUVENILE RELEASE STRATEGY

Salmon are introduced into Lithuanian salmon rivers every year in accordance with the approved Fish and Crayfish Introduction Plan. The plan is based on the recommendations of scientists - the Recommendations for the Restoration of Fish and Crustacean Stocks in State Water Bodies 2024-2028. The Ministry of Agriculture uses these guidelines as a basis for drawing up a fish breeding plan for a specific period. The plan is coordinated with the Ministry of Environment. The Fisheries Service is entitled to implement the programmes and annual plans for fish rearing in national water bodies. The plan includes the water bodies into which the approved fish species, their age groups and the quantities of fish to be released. On average, about 100 000-120 000 salmon juveniles 0+ (about -1 gram) and about 60 000 salmon smolts 1+ (about 70-80 grams) are released annually.

CONCLUSIONS AND SOLUTIONS

Hatchery Effectiveness: The Pelči fish hatchery demonstrates effective salmon rearing practices with careful monitoring of egg development, optimized rearing conditions, and strategic smolt releases in the Kurzeme Region. The hatchery's practices contribute significantly to the restocking efforts in the Venta River basin.

Disease Management: The hatchery Pelči implements comprehensive disease management protocols, including regular pathogen screening and strict biosecurity measures to safeguard fish health. Routine health monitoring and preventive treatments are key strategies to mitigate disease outbreaks and ensure a healthy stock. Additionally, the integration of probiotics or other dietary supplements, widely used in aquaculture to enhance digestion and boost immunity, could further strengthen the hatchery's disease control efforts and improve the overall health and resilience of salmonids. These supplements may offer a natural, sustainable solution for optimizing fish health and reduce reliance on medications.

Smolt Release: Release strategies in Kurzeme Region are well-managed, with smolts being released at optimal times to enhance migration success. The hatchery's focus on acclimatization and careful timing supports successful integration of released fish into their natural environment.

RAS System Utilization in Lithuania: The Žeimenai fish farm's use of closed recirculating aquaculture systems (RAS) for rearing salmon and other species allows for controlled conditions and efficient water use. The integration of modern RAS facilities enhances the farm's ability to manage fish health and production during the rearing process.

Broodstock Management: The Žeimenai farm's method of capturing broodstock through electrofishing and maintaining them in concrete ponds, coupled with the use of anesthesia before egg stripping, shows a structured approach to broodstock management.

Disease Control and Monitoring: Lithuania's hatcheries implement a robust and comprehensive disease control program, featuring regular bacteriological, virological, and parasitological testing to ensure optimal fish health and prevent potential outbreaks. Water quality in Recirculating Aquaculture Systems (RAS) is meticulously monitored to support overall fish well-being. Furthermore, the integration of probiotics—widely used in aquaculture to enhance digestion, bolster immunity, and improve resilience—can further fortify the hatchery's disease management efforts. This proactive approach not only safeguards fish health but also enhances their adaptability to natural conditions, contributing to sustainable and resilient aquaculture practices.

Literature

Bārtule I. (2021). Plāns zivju resursu atražošanai un dabisko dzīvotņu uzlabošanai [A Plan for fish resources restocking and natural habitat improvement]. Latvijas zivsaimniecības gadagrāmata, [Latvian Fisheries Yearbook], Jelgava, Latvijas lauku konsultāciju un izglītības centrs, 10-16 (in Latvian).

ICES (2023). Baltic Salmon and Trout Assessment Working Group (WGBAST). ICES Scientific Reports. 5:53. 451 pp.

Mitans A. R. (1972). Ecological bases of efficiency of natural and artificial reproduction of the Baltic salmon *Salmo salar* L. Dissertation, Univ. of Latv., Riga, 195. (In Russian).

Purvina S., Revina O., Medne O., Kondratjeva N., Lazdiņa A., Bajinskis J. (in press) Long-term Baltic salmon *Salmo salar* (L.) restocking experience in Latvia.

Purvina S., Medne, R., Bajinskis J., Kondratjeva N. (2019). Success of long-term salmonid restocking in Latvia. *Environ. Exp. Biol.* 17: 31–32.

Revina O., Avsejenko J., Revins V., Sargautis D., Cīrule D., Valdovska A. (2020). Effect of dietary supplementation with β -glucan on growth performance and skin-mucus microbiota of sea trout (*Salmo trutta*). *Archives of Polish Fisheries* 28: 155-165

Revina O., Revins V., Cīrule D., Valdovska A. (2023). TNF- α , IL-6, HSP-70, fish growth hormone, and growth performance of sea trout, *Salmo trutta* (Actinopterygii: Salmoniformes: Salmonidae) after long-term dietary administration of β -glucan and BGN-2. *Acta Ichthyologica et Piscatoria* 53, 2023, 253–Medne R., Savicka I. (2003) Promotion of salmon rearing efficiency by including yeast extract Aqualase Two in the diet. *Acta Universitatis Latviensis*, 2003, Vol. 662, pp. 45–50.

Treigute E., Mitāns A. (2001). Zivju resursu atražošanas valsts programma [National program for fish resources reproduction]. Latvijas zivsaimniecības gadagrāmata [Latvian Fisheries Yearbook], Biota, Riga, 2001. 118-124 (In Latvian).