RETROUT River Restoration Demonstration Case Reports

RETROUT project report

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Contents

Introduction

Within the RETROUT project, efficient river restoration measures and implementation methods were demonstrated as real restoration projects (whole or parts) based on national and transnational knowledge from research and dialogue. The purpose of the restoration projects was to demonstrate solutions for improving quality of sea trout river habitats with the aim to increase and secure sustainable stock production. The demonstration projects are a result of international peer learning and basin-wide research and will serve as examples that can be replicated in other countries. The specific value at impact level is improved water quality and increased fish production of rivers in the Baltic Sea region, which in turn offers better opportunities to strengthen the fish and tourism industries. This publication compiles the RETROUT river restoration case reports covering 15 restoration cases in 11 coastal rivers from Estonia, Latvia, Lithuania, Poland, and Sweden. Information from these case reports have been summarised in and used as input for the 'Baltic Sea river restoration best practices' (BSEP [*number not yet received*]).

During all stages of the restoration projects, relevant activities are documented carefully, including monitoring, causal analysis, administration, judicial circumstances, court proceedings, discussion with stakeholders, design and implementation. The process documentations of the restoration projects have generally followed and included, to the applicable parts, the below sequence of events:

1. First, a causal analysis is undertaken. Reasons for weak trout stocks or less than good ecological status are analysed. Then restoration measures are suggested based on the identified causes of environmental issues and current conditions. This results in a checklist of necessary components for a restoration knowledgebase (e.g., GIS analyses, monitoring of migration obstacles, hydro-morphological changes).
2. Cultural heritage, energy production, recreational value and other stakeholder interests are described, and possible conflicting interests are identified.
3. Compromise solutions are developed together with stakeholders that improve all relevant biological parameters, prerequisites for fishing and recreation [if applicable] as well as protect and highlight cultural heritage. Stakeholders are identified, sampled and consulted using different methods, e.g., individual discussions, focus groups, negotiations, public meetings, and opinion surveys, if needed.
4. Planning and design of chosen solutions and restoration measures.
5. Environmental impact assessment if necessary
6. Application to the competent authority. Court proceedings if necessary.
7. Implementation phase. Execution of the plans according to the design.
8. Post-implementation monitoring of restoration target indicators (e.g., sea trout parr density) for evaluation of success.

For increasing success and to gather useful experiences and lessons learned, the restoration projects were provided guidance for organising their stakeholder communication (Appendix 1), as the matter have been commonly considered important. After completion, each project has been evaluated, and the experiences and documented process stages have been compiled in the case study reports guided by general reporting instructions (Appendix 2).

Estonia

River Valgejõgi: Kotka dam

Country	Estonia
River	Valgejõgi
Site	Kotka dam
Type of sea trout populations	Mixed population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location WGS84	N 59° 32.431' E 25° 44.3145'
Total budget	Alt. 1. 390 456 € (artificial rapid) Alt 2. 72 600 € (full dam removal)

General information

The Kotka dam is located 9 km from the river mouth on the river Valgejõgi (N 59° 32.4269' E 25° 44.3151'; Figure 1). The river is 89.5 km long and has a catchment area of 451.5 km^2, elevation at the source is 107 m. Valgejõgi had poor water quality in the past; presently it is classified as very good. The river has mixed (there is natural reproduction and supplementary juvenile releases are carried out) Atlantic salmon and sea trout populations. The Atlantic salmon population is considered to be in

a precarious state and natural reproduction occurs predominantly in areas below Kotka dam. The status of trout is also poor; however resident trout occur throughout the watershed. River lamprey and vimba bream populations occur only below the Kotka dam. Resident protected species are grayling and European bullhead. Those species are absent only on the uppermost 20 km part of the river. Historically there were at least eight mills on the lower and middle part of river. All of them had a negative effect to the previously mentioned fish species. Presently most of the dams are gone and one natural like fish pass was built in 2014 to the upper part (76.8 km from the sea) of the river. The Kotka and Nõmmevski dams are the last remaining man-made migration hindrances and are primary factors affecting the abundance of migratory fish. Salmonid parr density is monitored in the most relevant parts of the river since 2016. Therefore, any change in salmonid parr densities after the dam removal would be observed and documented. There is also a 1.3 m high natural waterfall 100 m downstream of the Nõmmeveski dam, however, at least some salmon and sea trout are known to be able to pass it. Consequently, at present, salmon and sea trout need to pass three obstacles (2 dams and the waterfall) to reach the best and largest spawning areas. The long-term objective is to ease the migration past the dams so that the fish only have to strain themselves to pass the natural waterfall.

The Kotka dam is the lowermost migration obstacle. It was built in 1950 and operated as hydroelectric power station (HEP) until 1960. Later it provided water for a fish farm. Wooden parts of the dam broke in 2016 and it was not restored. The dam has no water permit, and it is not culturally valuable. Original height of the dam was 3.5 m and at present the remaining height is 1.1 m. For salmonids, the dam is considered as difficult to pass, although some salmon and trout are able to overcome it. For other species, such as European sculpin and lamprey, it is unpassable.

Planning phase

Kotka dam is a major limiting factor for Atlantic salmon and sea trout populations. Of all spawning areas in river Valgejõgi, 90 % are located upstream the dam. Therefore, Kotka dam is nationally a high priority migration obstacle that should be made passable. The dam no longer has any function and there are no plans to restore it. Negotiations to buy the dam from its private owner by the Estonian Ministry of Environment are ongoing. State ownership of the dam enables the planning for the most optimal long-term solution. Full removal of the dam is therefore realistic and technically relatively easy. The site has good access, and the dam is located on a flat landscape. Dam removal is the most certain way to enable all fish species and other aquatic fauna to move freely across the site. It also does not require any future maintenance. Through procurement, hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose two alternative solutions for the dam. Preliminary environmental impact assessment (PEIA) for all alternatives was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective is to improve the environment.

First alternative is to remove the remaining dam constructions. Upstream from the present dam location a 73 m long artificial rapid with 1.1 height would be built. The rapid would provide free passage and serve as spawning and rearing area for salmon, trout, grayling and lamprey (Figure 2). This alternative would provide free passage for all aquatic fauna. Major drawback of this alternative is the high estimated cost, 390 456 euros.

Second alternative is to remove the remaining dam construction and to enforce the riverbanks at the immediate vicinity of the dam site (Figure 3). The calculated cost of this alternative is 72 600 euros. This alternative is considerably cheaper and favoured by the future implementers (Estonian Ministry

of the Environment). It is difficult to predict how riverbank erosion will change the appearance of the river upstream of the dam and that is the biggest concern of this alternative.

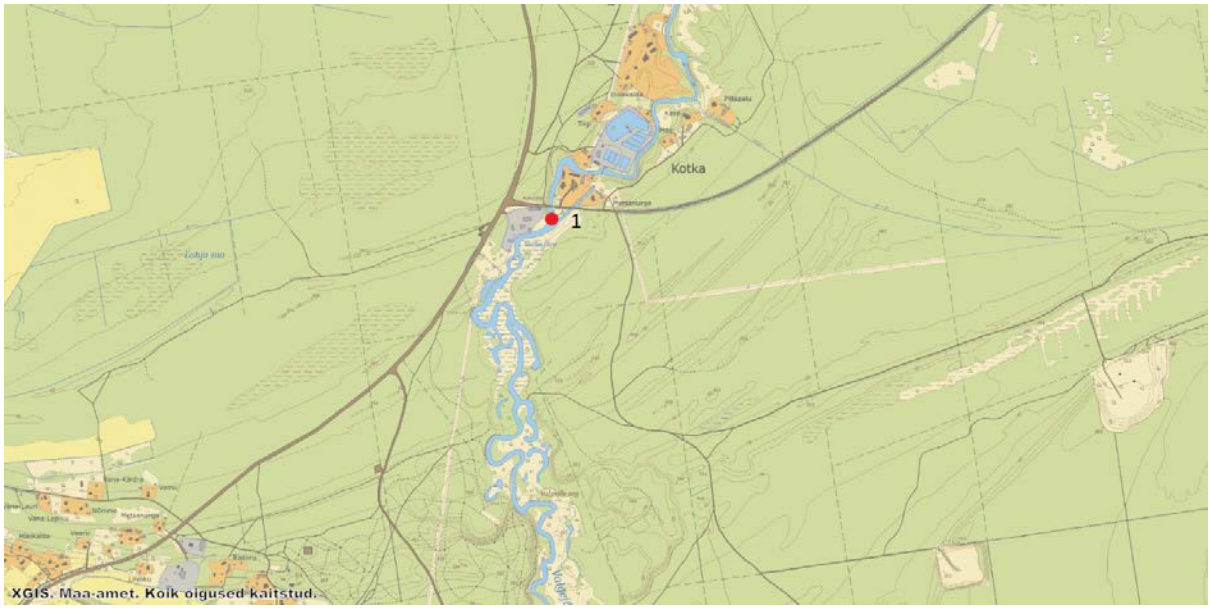


Figure 1. River Valgejõgi. 1. Kotka dam. Source: www.maaamet.ee.

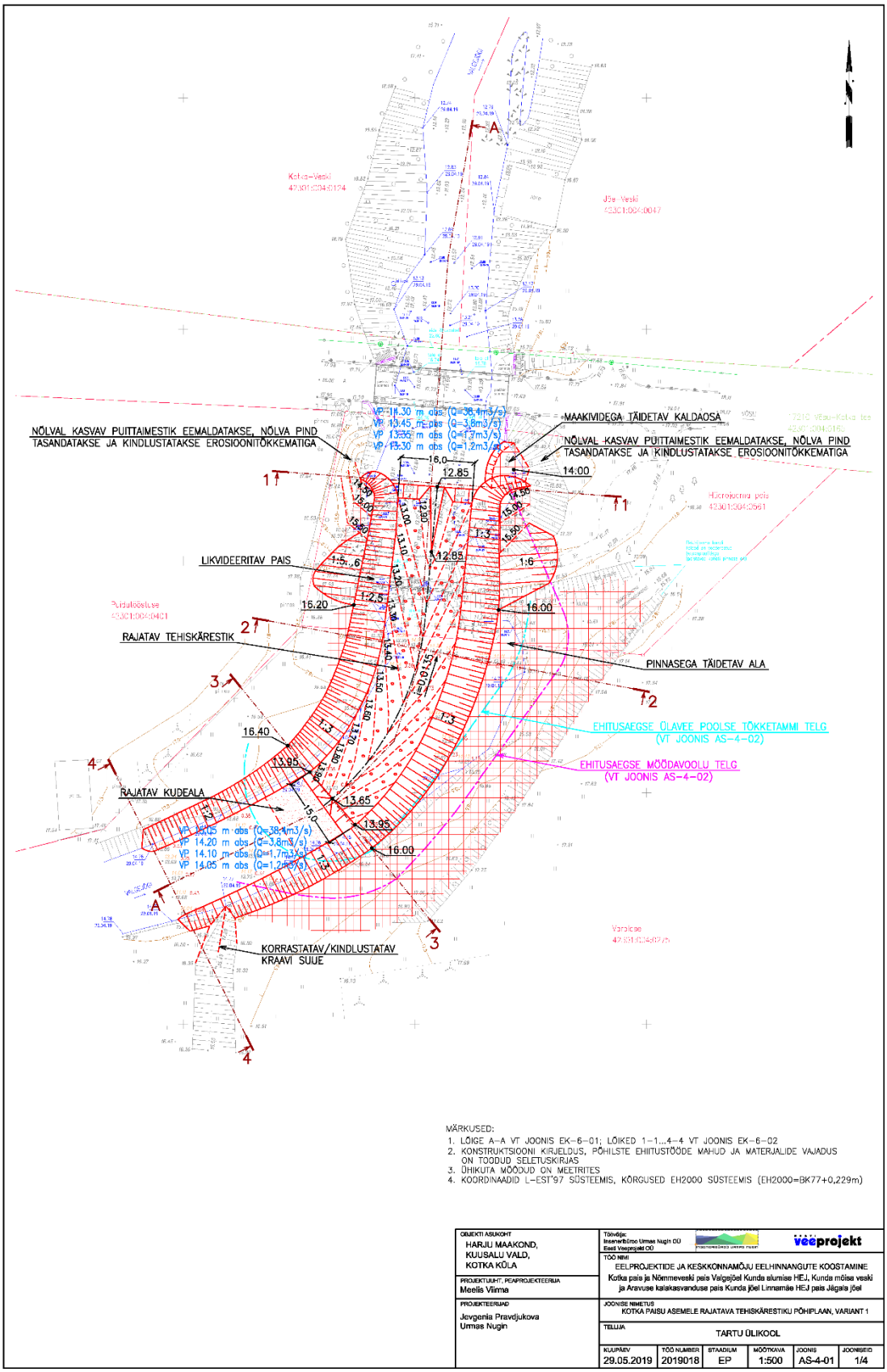


Figure 2. Design drawing (top view) of the first dam removal alternative for Kotka dam.

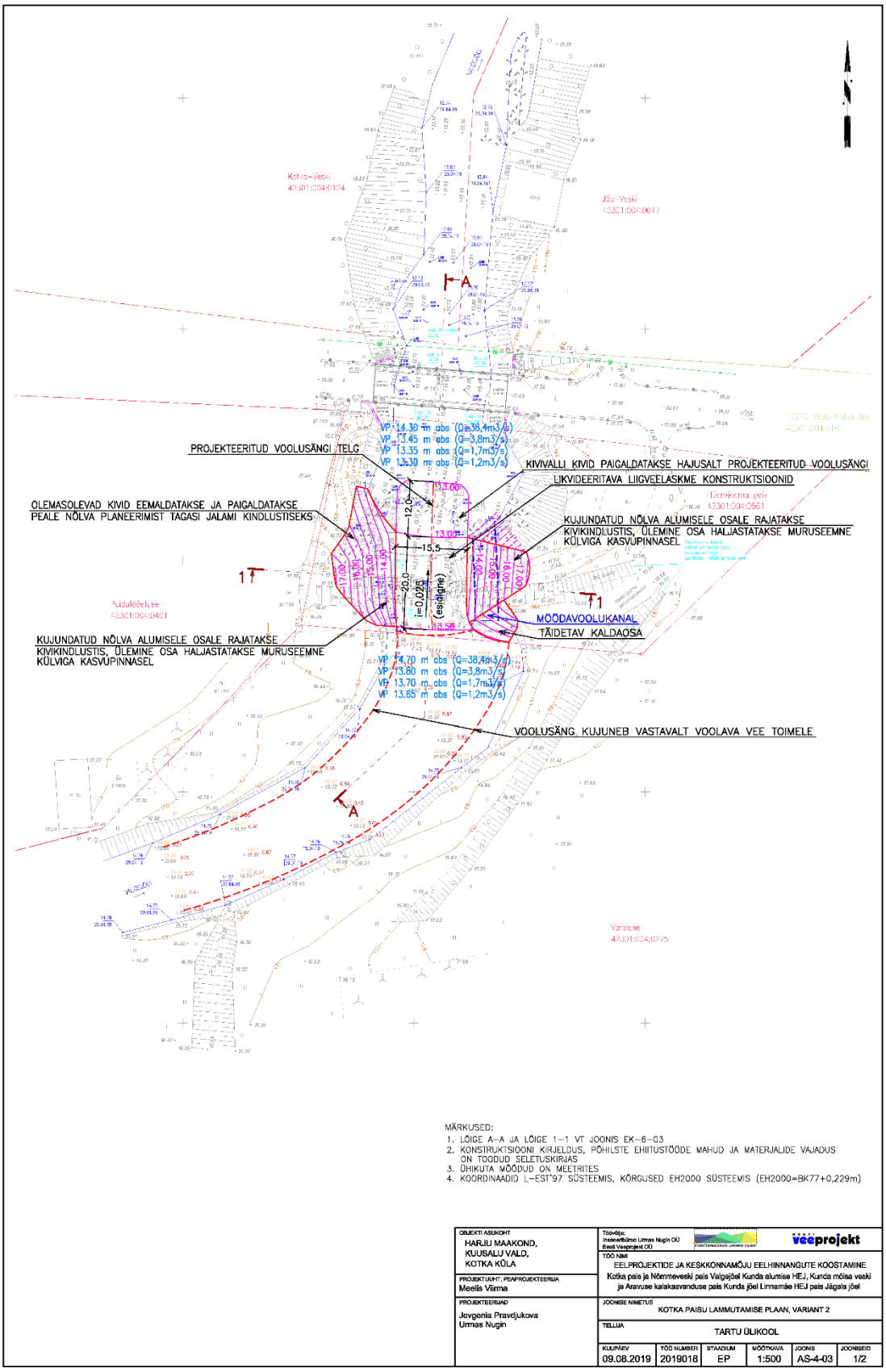


Figure 3. Design drawing (top view) of the second dam removal alternative for Kotka dam.

River Valgejõgi: Nõmmeveski dam

Country	Estonia
River	Valgejõgi
Site	Nõmmeveski dam
Type of sea trout populations	Mixed population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location	N 59° 30.4228’ E 25° 47.2926’
Total budget	Alt. 1. 223 344 € (artificial rapid)

General information

The Nõmmeveski dam is located 20.2 km from the river mouth on the river Valgejõgi (N 59° 30.4209’ E 25° 47.2936’; Figure 4). The river Valgejõgi is 89.5 km long, has a catchment area of 451.5 km^2 and elevation at the source is 107 m. The river had water quality issues in the past; however presently water quality is classified as very good. The river has mixed (there is natural reproduction and supplementary juvenile releases are carried out) Atlantic salmon and sea trout populations. River lamprey and vimba bream also ascend to the river. Resident protected species are grayling and European bullhead. Historically there were at least eight mills on the river and all of them had a negative effect to the fish fauna. Most of the dams are gone and one natural like fish pass was built in

2014 to the upper part (76.8 km from the sea) of the river. The Kotka and Nõmmevski dams are the last remaining man-made migration hindrances on river Valgejõgi. Salmonid parr density is monitored in the most relevant parts of the river since 2016. Therefore, any change in salmonid parr densities after the dam removal can be observed and documented. There is also a 1.3 m high natural waterfall downstream of the Nõmmeveski dam, however, it is known that at least some salmon and sea trout can pass it. Salmon and sea trout need to pass three difficult obstacles (2 dams and the waterfall) to reach the best and largest spawning areas. The long-term objective is to ease migration past the dams so that the fish only have to strain themselves to pass the natural fall.

Planning phase

The Nõmmeveski dam is the second man made obstacle from the river mouth and it is considered a high priority migration obstacle (Photo 2). There is a 1.3 m high natural waterfall located 100 m downstream of the dam and some salmon and sea trout can pass it. About 75 % for the potential spawning areas for Atlantic salmon and about 80 % of the potential spawning areas for sea tout are located upstream of the site. The dam was built in 1924 and it operated as a hydropower station (HEP) until 1964. The wooden parts of the dam broke in 2010 and it was not restored because it has no water permit. The original height is not known, but the present height is 1 m. The dam is considered difficult to pass for salmon and sea trout and it is considered unpassable for European sculpin and lamprey.

There are no plans to restore the dam to its original height. Side walls of the dam and the pillar in the middle of the river function as a bridge foundation. The bridge is in everyday use, and no actions are currently planned for it. Negotiations to buy the dam from its private owner by the Estonian Ministry of Environment are ongoing. State ownership of the dam would enable planning for the most optimal solution to improve fish passage.

It is not possible to lower the water level more than 0.2 m without threatening the structural stability of the side walls and the pillar. It was decided during the early planning phase that nothing would be done to the bridge. Building a new bridge would increase the cost of the project unreasonably high. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose one alternative solution for the dam. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the work is to improve the environment.

One alternative was made. Two cuttings will be made at the base of the dam openings. The new openings would lower the water level by 0.2 m. A 32 m long artificial rapid with a 4 % slope downstream of the dam base would be built. The rapid would provide free passage (Figure 5). This alternative would meet the set environment objectives. Calculated cost of this alternative is 223 344 euros.

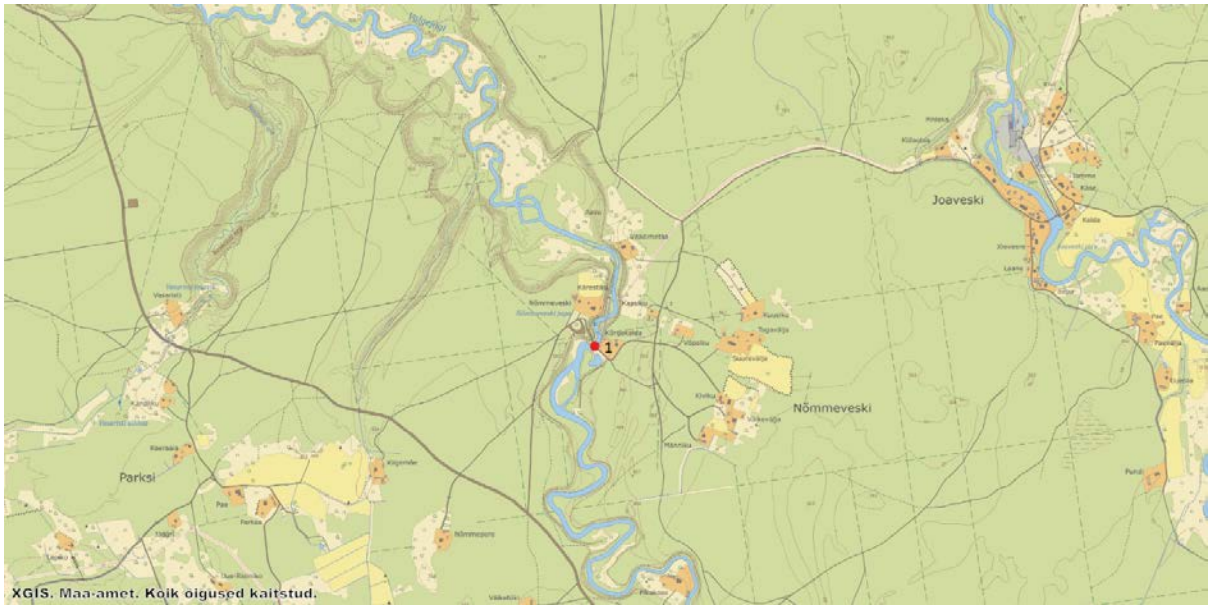


Figure 4. River Valgejõgi. 1. Nõmmeveski dam. Source: www.maaamet.ee.

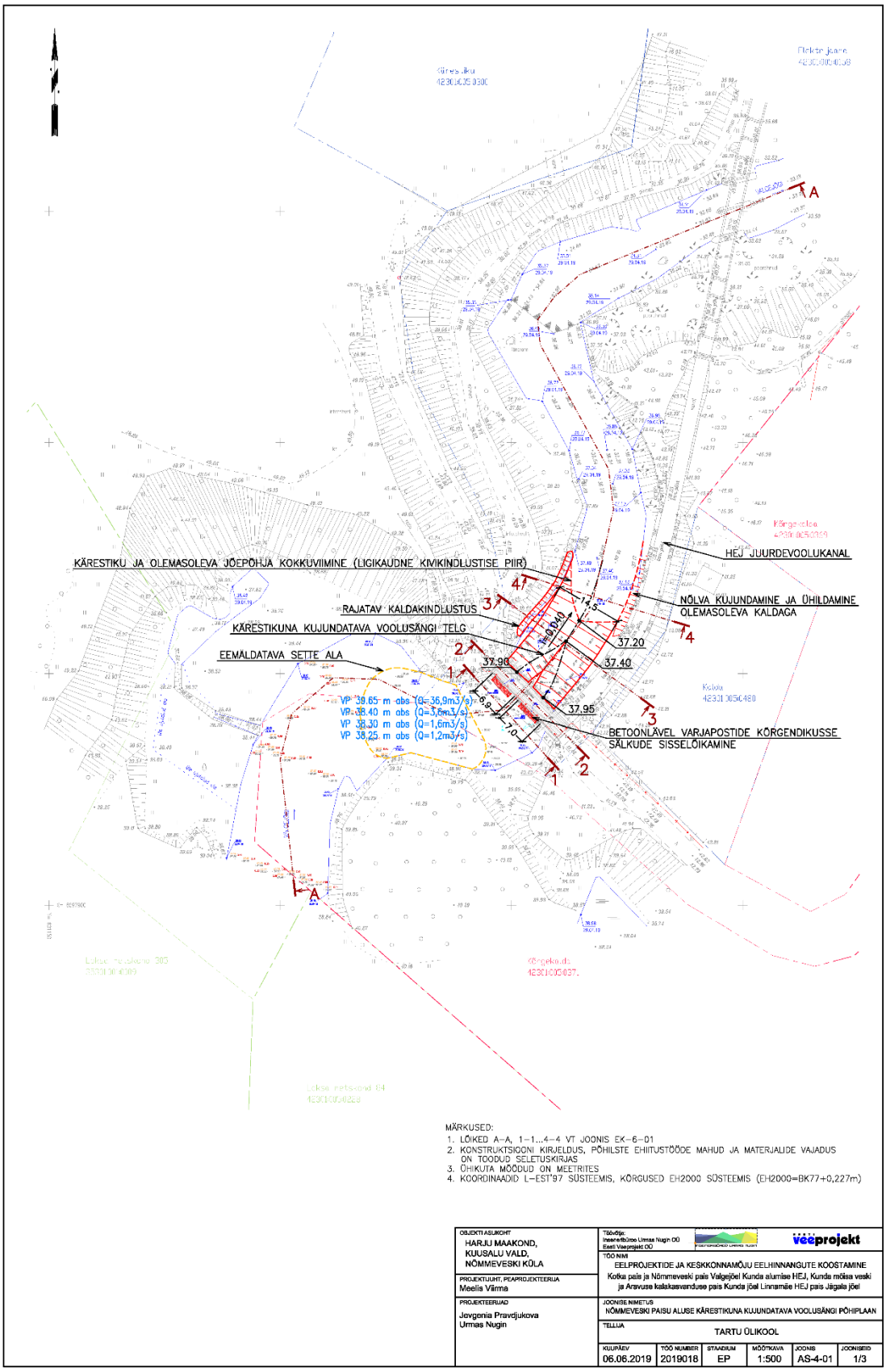


Figure 5. Design drawing (top view) of the dam hight alteration solution for Nõmmeveski dam.

River Kunda: Kunda lower hydroelectric power station (dam)

Country	Estonia
River	Kunda
Site	Kunda lower HEP
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	2 years
Geographical location	N 59° 30.1740′ E 26° 32.5186′
Total budget	Alt. 1. 2 587 667 € (bypass next to the dam)

General information

The Kunda lower hydroelectric power station (HEP) is located 2.3 km from the river mouth Kunda river (N 59° 30.1740′ E 26° 32.5186′; Figure 6). The river is 82.2 km long and has a catchment area of 535.9 km^2. The elevation at the source is 90 m. Water quality of the river is classified as good. The river has wild native Atlantic salmon population that spawns only on the lower 2.3 km long part of the river. Salmon parr density below the dam is very high, however it comprises only about 10 % of the river's total potential spawning areas. In addition, sea trout, river lamprey and vimba bream also ascend to the lower part of river. For those species over 90 % of the suitable spawning areas are also located upstream of the dam. Resident trout, grayling and European bullhead exist throughout the watershed.

Salmon and trout parr abundance is regularly monitored only on the lower accessible part of the river. There are no fish releases done in the river and all fish populations are wild and native. The Kunda HEP is one of three dams close to each other on the lower part of the river. All those dams are unpassable migration obstacles and most of the potential spawning areas for salmon and sea trout are located upstream from all three of them.

Planning phase

The Kunda lower HEP is the lowest dam on the river (Figure 7) and it is a complete migration obstacle for all fish. The planned solution must provide passage to all fish fauna, also those that are not good swimmers, e.g., sculpin. The dam was built in 1893 and operated as a hydropower station until 1971. The dam was restored and operated from 2000 to 2007. Its original height was 10.5 m, now it is 8.5 m. Wooden parts of the dam are missing and the HEP is not operational. The dam was designated as culturally valuable in 2008. Negotiations to buy the dam from private owners by the Estonian Ministry of Environment are ongoing. State ownership of the dam enables to plan for the most optimal compromise between the environment and cultural values. The dam is located in as steep valley and space for a passage solution is very limited. During early planning phase it became evident that at least partial removal of the dam is unavoidable for a viable passage solution. Through procurement a hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose 3 alternative solutions for the dam. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned works is to improve the environment.

In the **first alternative** the limestone wall on the left side on the dam would be demolished and new river channel with a 3.5 % slope would be built to left from the concrete dam. Rest of the dam remains intact. Water level will be lowered to pre-dam level. To keep the left side of the valley stable, a 110 m long and up to 10 m high concrete wall would be built (Figure 8). A 14 m long and 1.5 m wide bridge will be built across the new river channel. The bridge connects the remaining dam with the opposite river side. The calculated cost of this alternative is 2 587 667 euros. This alternative retains most of the cultural values and provides free passage to all fish and aquatic life.

Second alternative is to remove the main concrete body of the dam and lower the water level to the original height. A 100 long rapid with a 3.5% slope would replace the dam and impounded lake area (Figure 9). Only the turbine building on the right side of the river would remain. This alternative would retain cultural values only partially and would restore the river to its original state. The calculated cost of this alternative is 1 038 147 euros. The remaining turbine building needs regular maintenance.

Third alternative is to remove all parts (including the turbine building) of the dam and restore the river and the valley close to its original state (Figure 10). Riverine conditions would be similar to the second alternative. In this case cultural values would not be preserved. Calculated cost of this alternative is 1 125 234 euros.

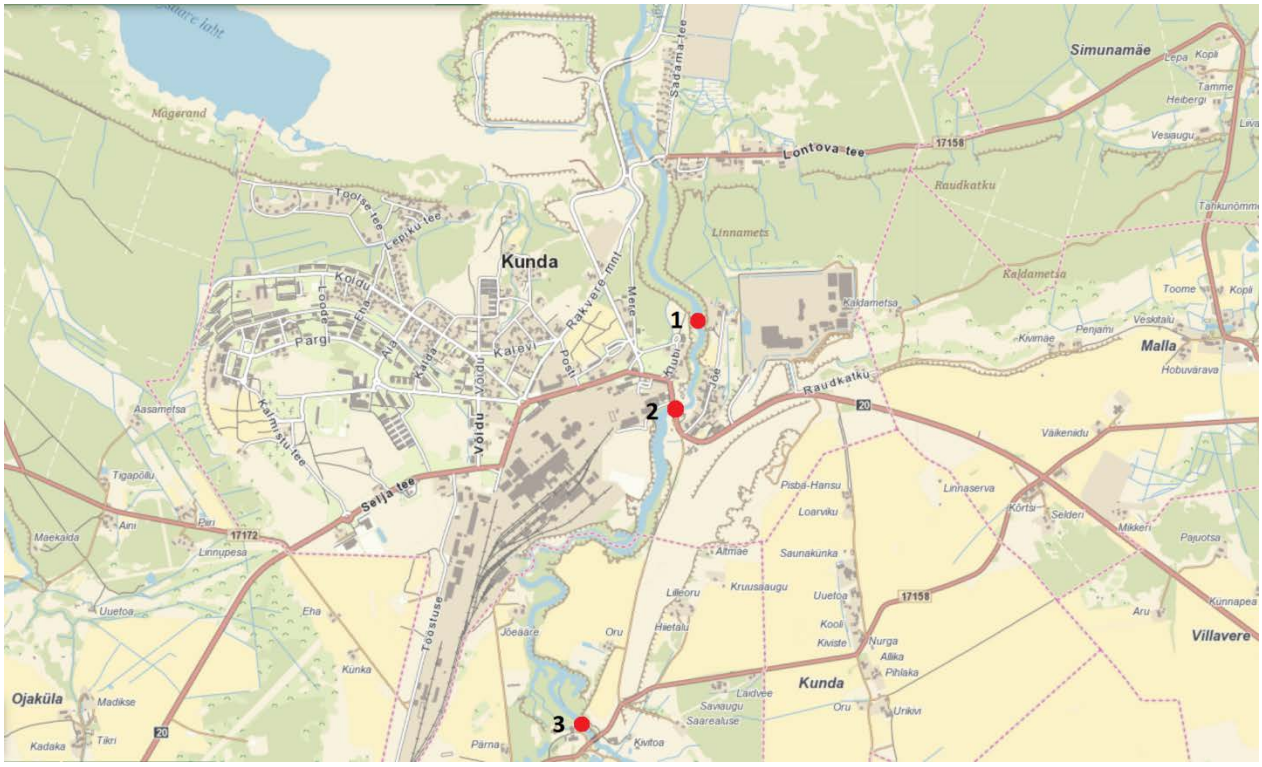


Figure 6. Migration obstacles on the lower part of river Kunda. 1. Kunda lower HEP, 2. Kunda second and 3. Kunda manor mill Source: www.maaamet.ee.

Figure 7. Kunda HEP is the lowermost migration obstacle on river Kunda. Most potential sea trout spawning areas are located upstream of the dam. Photo credit: Martin Kesler.

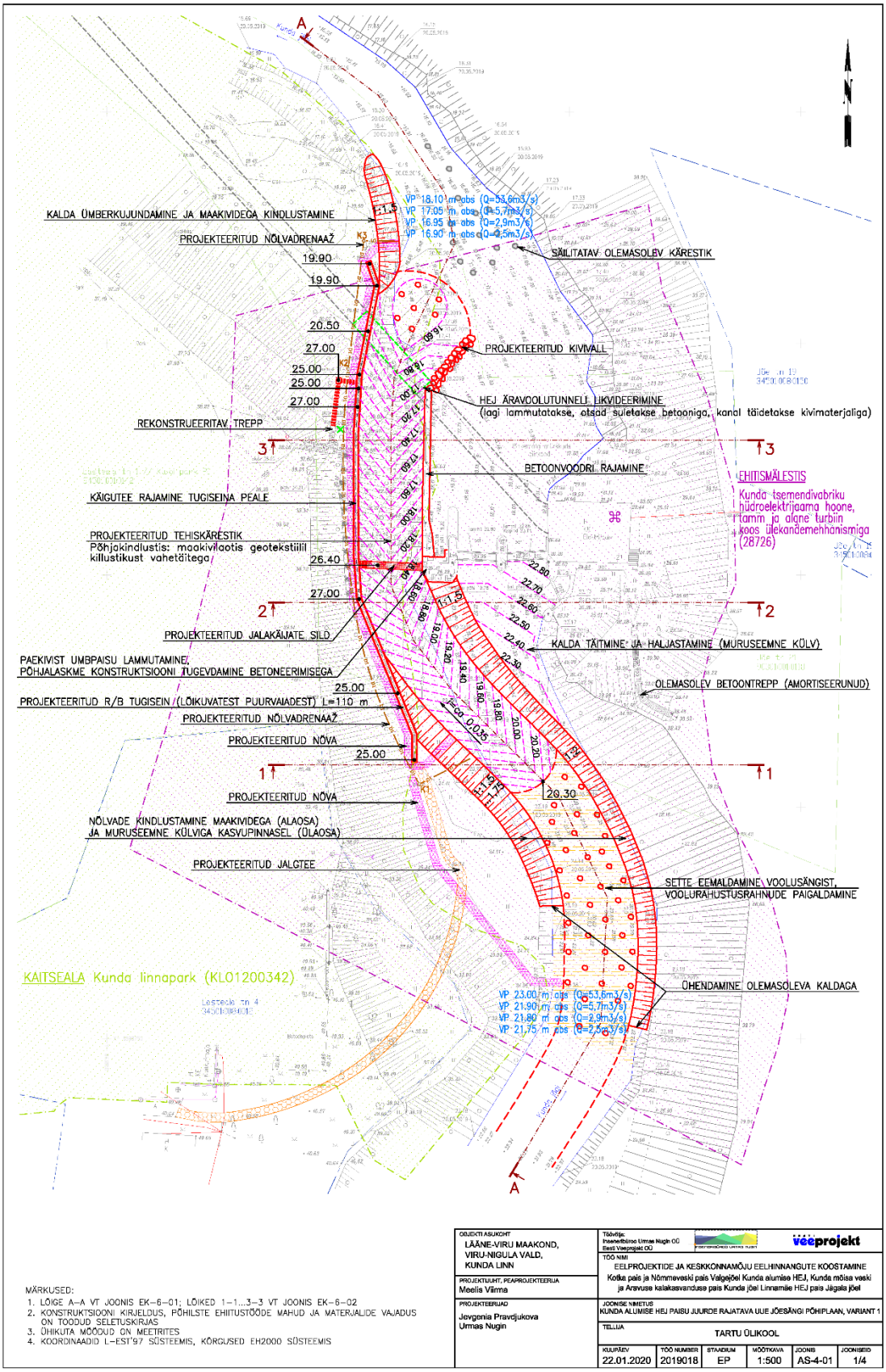


Figure 8. Design drawing (top view) of the first alternative solution for Kunda lower HEP dam.

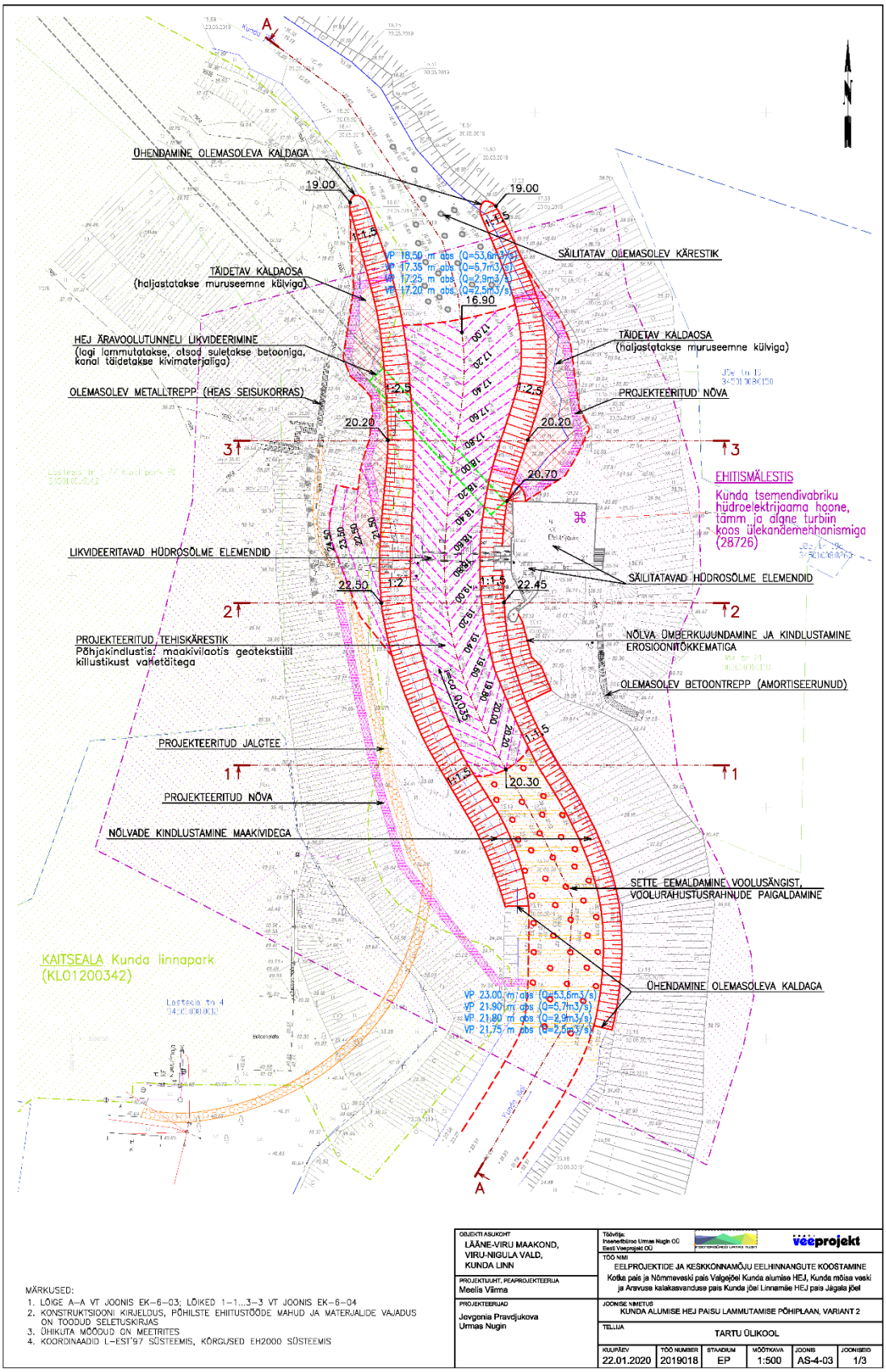


Figure 9. Design drawing (top view) of the second alternative solution for Kunda lower HEP dam.

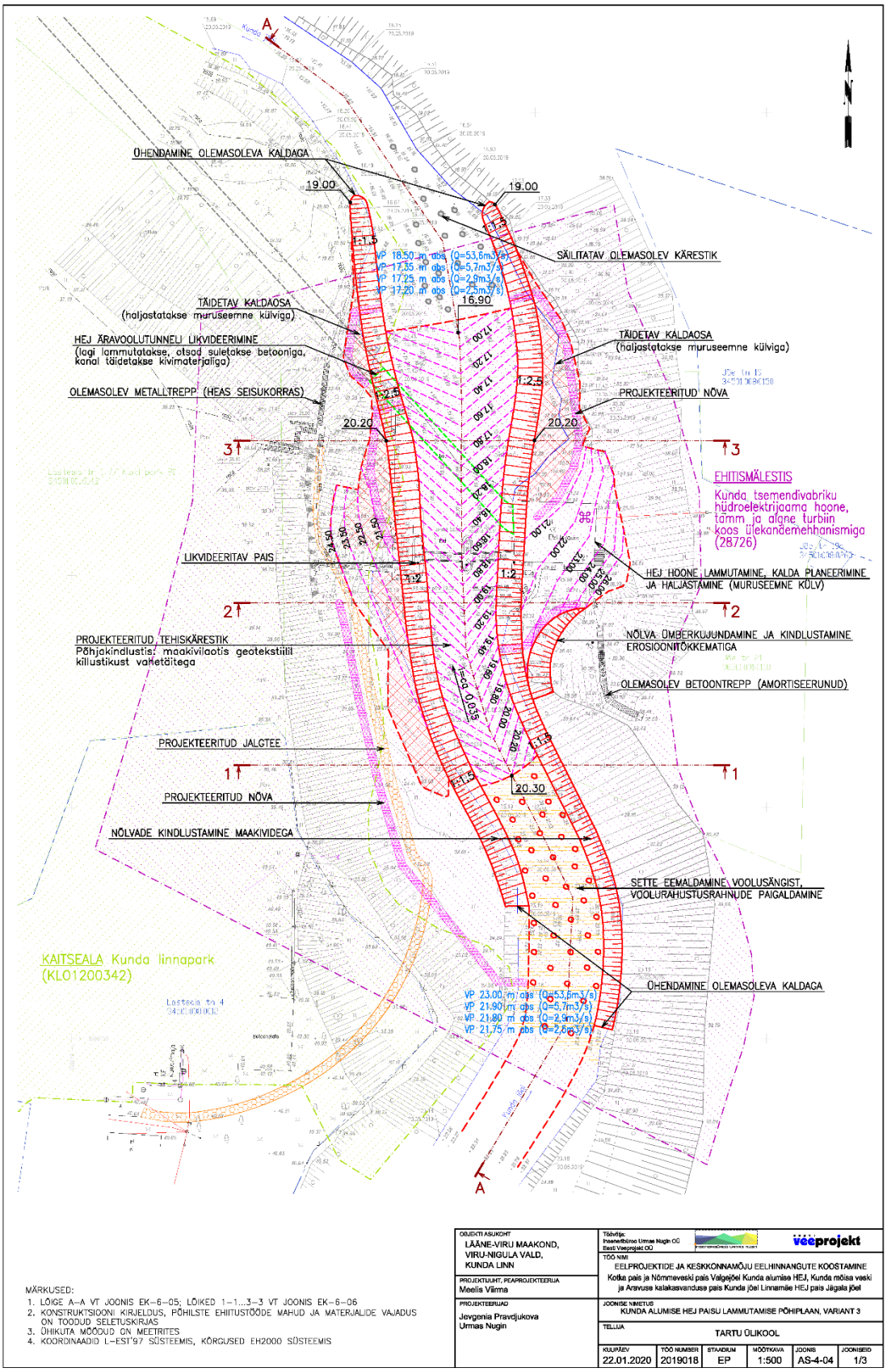


Figure 10. Design drawing (top view) of the third alternative solution for Kunda lower HEP dam.

River Kunda: Kunda manor mill dam

Country	Estonia
River	Kunda
Site	Kunda manor mill
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location	N 59° 29.1197’ E 26° 31.8685’
Total budget	104 148 € (full dam removal)

General information

The Kunda manor mill dam is the third obstacle from the sea, 5.5 km from the river mouth (N 59° 29.1191’ E 26° 31.8662’; Figure 6). Kunda river is 82.2 km long and has a catchment area of 535.9 km^2. The elevation at the source is 90 m. Water quality of the river is classified as good. The river has wild native Atlantic salmon population that spawns only on the lower 2.3 long river section. Salmon parr density on that section is high; however, it comprises only 10 % of the rivers potential spawning areas. In addition, sea trout, river lamprey and vimba bream also ascend to the lower part of river but over 90 % of the suitable spawning areas are located upstream of the dam. Resident trout, grayling and European bullhead exist throughout the watershed. There are no fish releases done in the river and all fish populations are considered wild and native.

Planning phase

The Kunda manor mill was built in 1870. Its original height was 2.7 m. The wan is in ruins and remaining height is 1.7 m. It is still a definite migration obstacle. The dam has no longer any function, does not have water permit, and it is not identified as culturally valuable. Negotiations to buy the dam from private owners by the Estonian Ministry of Environment are ongoing. State ownership of the dam enables implementation of the most optimal solution. The dam is in a steep valley and space for a passage solution around the dam is very limited. During the planning phase it became evident that removing the dam is most sensible. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose (one solution) for the dam removal plan. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned work is to improve the environment.

The only prepared solution is to remove all remaining parts of the dam, enforce the riverbanks at the immediate vicinity of the dam. The deep pool below the dam would be filled with gravel and boulders (Figure 11). Calculated cost of the dam removal is 104 148 euros.

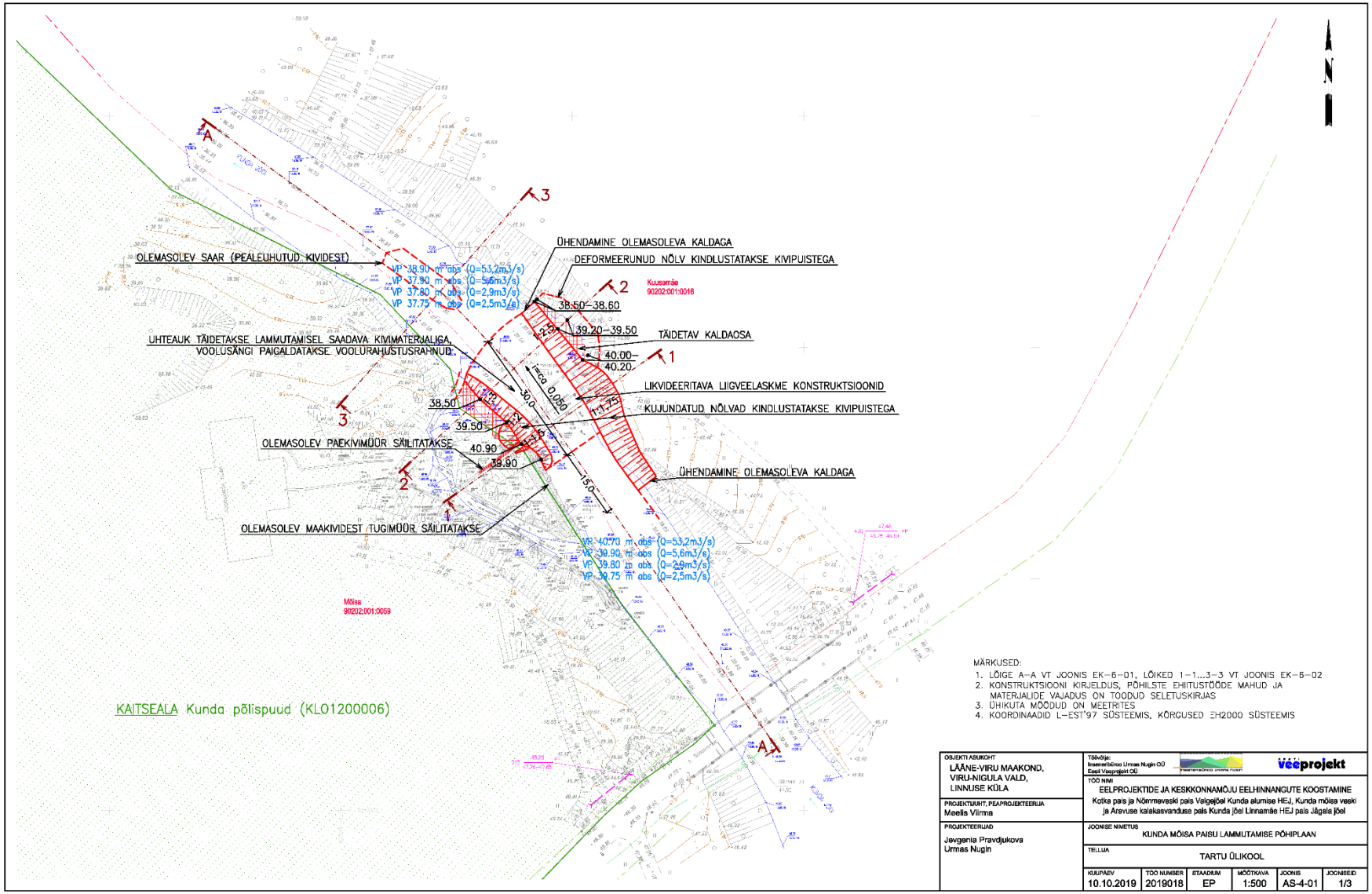


Figure 11. Design drawing (top view) of the produced solution for Kunda manor mill dam.

River Kunda: Aravuse fish farm dam

Country	Estonia
River	Kunda
Site	Aravuse dam
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	1 years
Geographical location	N 59° 14.0251’ E 26° 39.3879’
Total budget	182 820 € (natural like pass)

General information

The Kunda river is 82.2 km long, has a catchment area of 535.9 km^2. The elevation at the source is 90 m. Water quality of the river is classified as good. The river has wild native Atlantic salmon and sea trout populations. River lamprey and vimba bream also ascend to the river. Resident protected species are grayling and European bullhead. The lower part of the river has three dams and all of them had a negative effect to the previously mentioned fish species. The Aravuse dam is located on the upper part of the river. It is part the water supply system for a fish farm. It is the fourth and uppermost obstacle of the river (50 km from the sea, N 59° 14.0233’ E 26° 39.3918’; Figure 12). The precise size of the spawning areas upstream of the dam is not known, however the upper 30 km long river section

holds resident native trout population, and it has valuable spawning areas to sea trout and river lamprey. Abundance of resident trout in the upper part of the river is not regularly monitored.

Planning phase

The Aravuse dam was built in 1970 as part of water supply of a fish farm. Its height is 1.5 m high and has no fish pass. During the planning phase it became evident that it is not possible to remove the dam and a fish pass is needed. The dam has a water permit, and it requires the owner to provide fish passage in near future. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose one solution for the dam removal. Preliminary environmental impact assessment (PEIA) for one alternative was carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned work is to improve the environment.

One solution was produced. A natural-like fish pass would be built to the right side of the dam. The upper entrance is located between the bridge and the dam on the right side and the lower entrance is planned to be built as close to the base of the dam as possible. The width of the planned pass is 1.2 m, depth is 1 m, and length is 130 m (Figure 13). The pass will have two resting pools without gradient and overall slope of the pass is 1.45 %. The pass channel will be covered by geotextile which would be covered by gravel and boulders to imitate natural rapid. Calculated cost of the fish pass is 182 820 euros.

Figure 12. Location of Aravuse dam on upper river Kunda. Source: www.maaamet.ee.

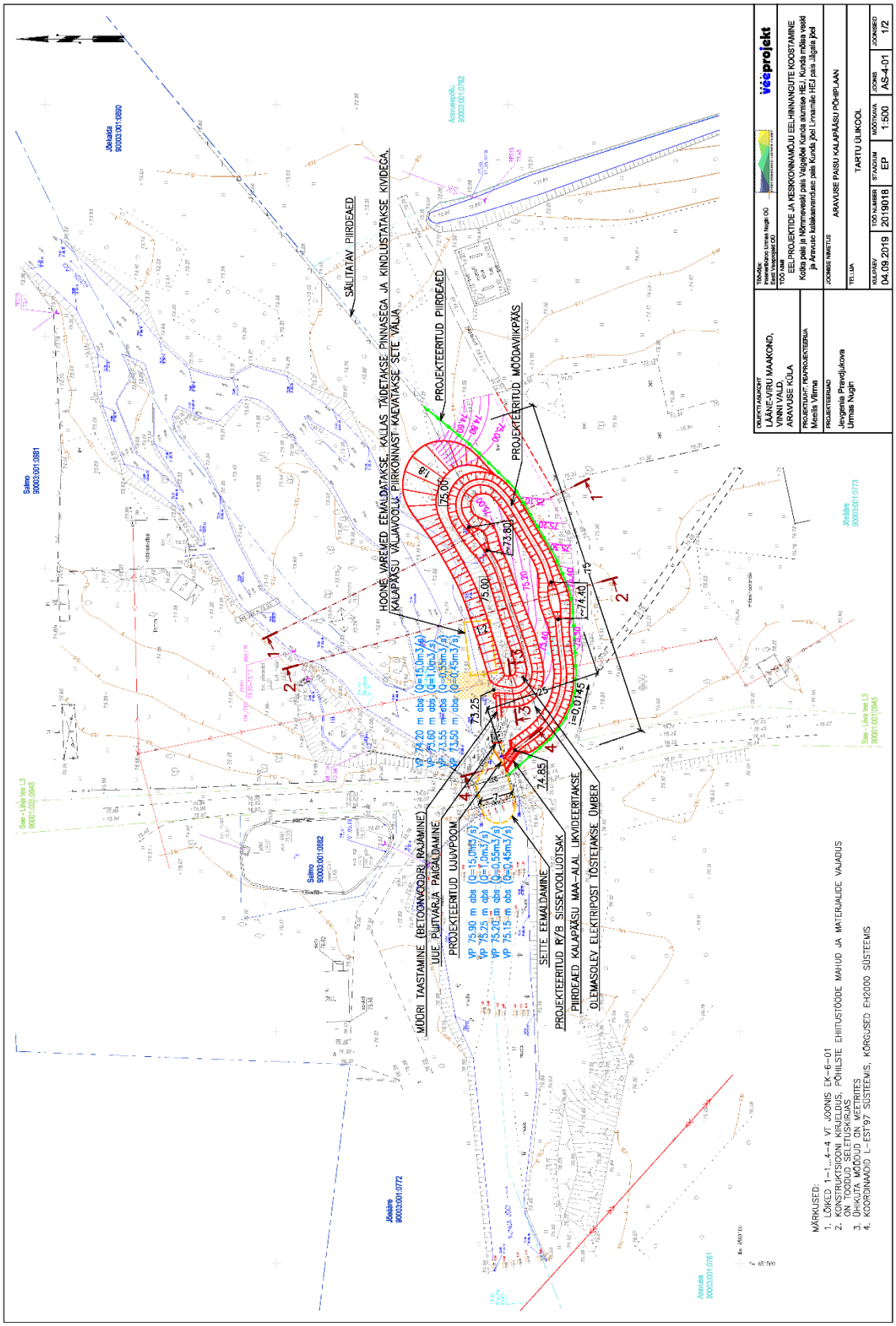


Figure 13. Design drawing (top view) of the produced solution for Kunda Aravuse fish farm dam.

River Jägala: Linnamäe hydropower station (dam)

Country	Estonia
River	Jägala
Site	Linnamäe HEP
Type of sea trout populations	Original population
Temporal scale of the restoration	Long term
Spatial scale of the restoration site	One site
Responsible organisation	NA
Duration of the project	2 years
Geographical location	N 59° 14.0251’ E 26° 39.3879’
Total budget	Alt. 1. 6 777 045 € (natural like pass)

General information

The river Jägala is 119 km long, has a catchment area of 1481 km^2 and elevation at the source is 82 m. Water quality of the river is classified as satisfactory and it has improved considerably during past two decades. The river has a natural 8 m high waterfall 4.3 km from the sea. Historically Atlantic salmon, sea trout, anadromous whitefish, vimba bream and river lamprey populations existed downstream of the fall. When Linnamäe HEP was built 1.3 km from the river mouth (N 59° 27.9322’ E 25° 9.352’; Figure 14), access to spawning areas of all mentioned anadromous species was blocked. As a result, anadromous fish populations disappeared from above the dam. Atlantic salmon smolts are regularly stocked to compensate for the loss of the natural population and some adults ascend the river. The

Linnamäe HEP was built in 1924. Its height is 11 m (Figure 15). A primitive technical fish pass was also planned but was never fully built. The dam was partially demolished in 1941 and was restored to its present state in 2002.

River Jägala from the waterfall to the sea is a Natura 2000 area, and the achievement of a good ecological status is first priority. This necessitates the restoration of the riverine habitat and fish fauna. The original parts of the Linnamäe HEP were declared as culturally valuable in 2016 and therefore a demolition of the dam became in conflict with the cultural values. The HEP has a temporary water permit. Yet the owners have an obligation to provide fish passage.

Planning phase

During the planning phase it became evident that natural and cultural values are conflicting, and a compromise is needed. Three passage solutions were compiled with the primary objective to restore the riverine habitat and ensure free fish passage with a high certainty. Cultural values were deemed secondary and may be renounced to some extent. Through procurement hydro engineering companies Eesti Veeprojekt OÜ and Inseneribüroo Urmas Nugin OÜ were hired to compose three solutions for the dam removal. Preliminary environmental impact assessments (PEIA) for the solutions were carried out by AS Maves. It was concluded that environmental impact assessment (EIA) is not necessary to prepare as the objective of the planned work is to improve the environment.

Construction of a fish pass next to the dam was deemed to be insufficient to recover fish populations. Two thirds of the historical spawning and rearing areas are destroyed by the impounded lake. The dam is located in a steep valley and available space for the fish pass is limited. Therefore, only solutions that end water impoundment would ensure the recovery of anadromous fish populations. That became the basis of all alternatives.

In the first alternative a 30 m long part of the dam on the left bank would be demolished, rest of the dam would remain intact. Water level will be lowered to pre dam level and new river channel to the left from the dam would be built. New river channel would be 200 m long and would have a slope of 1.45 %. To keep the left side of the valley stable, a 200 m long and up to 12.8 m high concrete wall would be built (Figure 16). A new bridge would connect the remaining dam with the opposite riverbank. The calculated cost of this alternative is 6 777 045 euros. This alternative retains most of the cultural values at the dam and provides free passage to all fish and aquatic life.

Second alternative is to remove the main concrete body of the dam and lower the water level to the original height. A 130 m long rapid with a 1.65 % slope would replace the dam and impounded lake area (Figure 17). Only the turbine building on the right side of the river would remain. This alternative would retain cultural values only partially and would restore the river close to its original state. The calculated cost of this alternative is 2 169 750 euros. The remaining turbine building needs maintenance and that cost is not included.

Third alternative is to remove all parts (including the turbine building) of the dam and restore the river and the valley close to its original state. Riverine conditions would be identical to the second alternative. In this case cultural values would not be preserved (Figure 18). Calculated cost of this alternative is 2 391 246 euros.

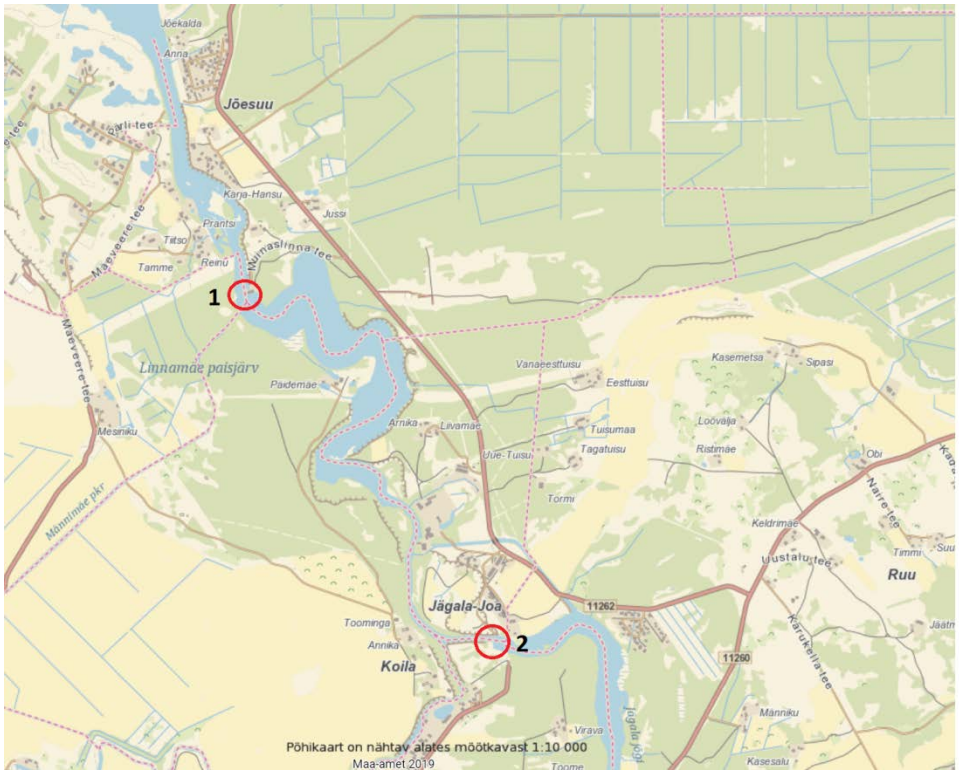


Figure 14. Indicates the location of the Linnamäe hydroelectric power station and 2 indicates the location of the Jägala-Joa waterfall. Source: www.maaamet.ee.

Figure 15. Construction of a Linnamäe HEP to river Jägala resulted is the loss of all anadromous fish populations in 1920s. Photo credit: Martin Kesler.

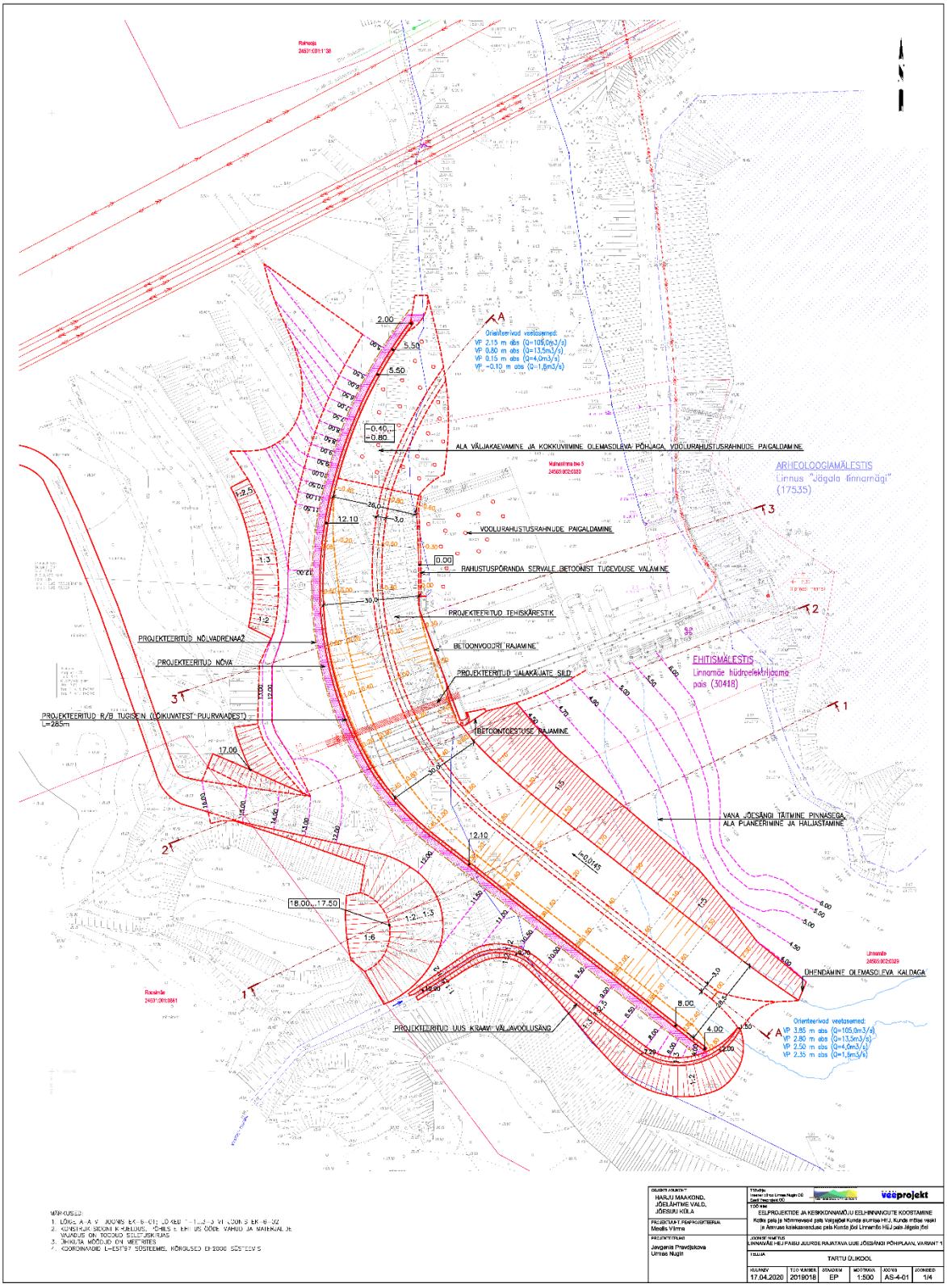


Figure 16. Design drawing (top view) of the first alternative solution for Linnamäe hydropower station dam.

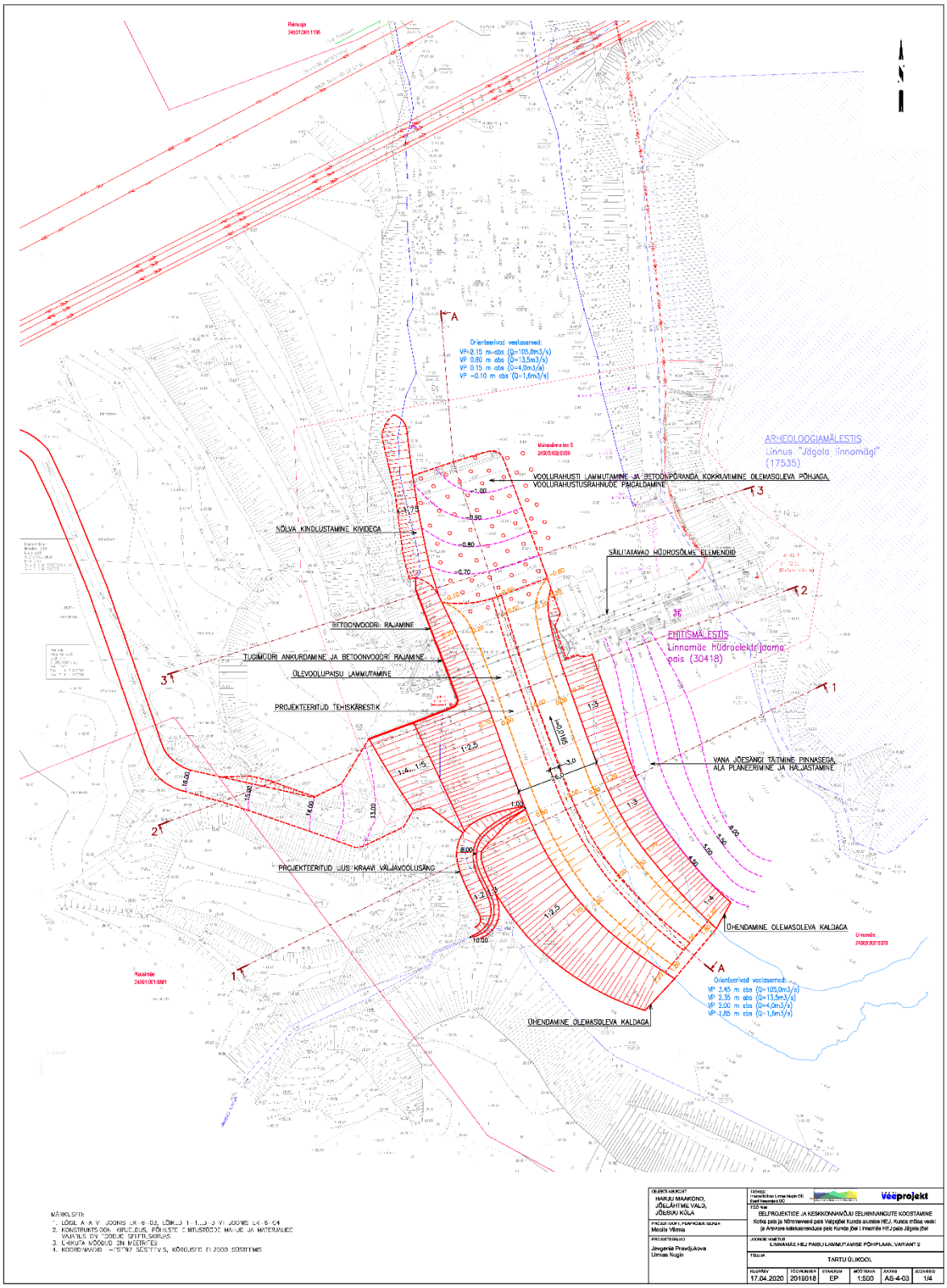


Figure 17. Design drawing (top view) of the second alternative solution for Linnamäe hydropower station dam.

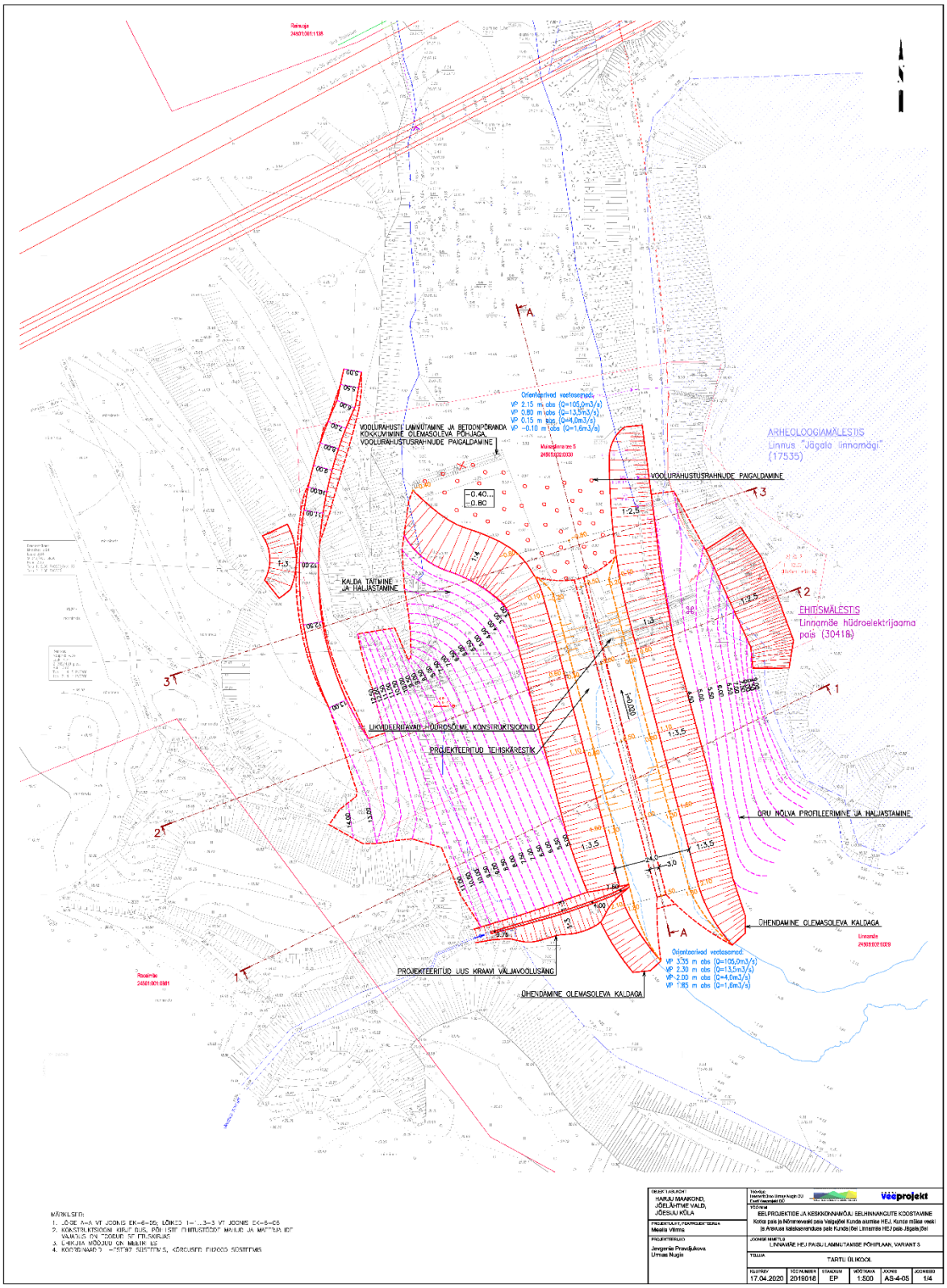


Figure 18. Design drawing (top view) of the third alternative solution for Linnamäe hydropower station dam.

Latvia

River Rīva: remains of old paper mill dam

Country	Latvia
River	Rīva
Site	Labrags
Type of sea trout population	Original population
Type of restoration	Construction of natural like fish pass across the remains of old paper mill dam to ensure the access to spawning and rearing grounds upstream this barrier
Temporal scale of the restoration	Long term
Spatial scale of the restoration	All river
Responsible organisation	Kurzeme Planning Region and Ventspils Regional Municipality
Duration of the project	2 years
Geographical location WGS84	56.973351N, 21.348703E
Total budget	220 000 €

General information

Construction of the fish pass on Rīva River in Jūrkalnes parish, Ventspils county, Latvia.

- The sea trout population in Rīva river is fully natural. No information of stocking of this species in Rīva river was found.
- The type of the restoration is 'construction of a fish pass'. Building of fish pass is a long-term solution for this particular case.
- The project aims to facilitate fish migration to the greatest part of the river. A migration barrier, in form of the remains of an old paper mill dam (Figure 19), is located approximately 1.2 km from the sea (Figures 20–21). Approximately 98 % of the riverbed is located upstream this barrier.
- Kurzeme planning region has been responsible for elaboration of the technical design documentation for the fish pass construction on Rīva river.
- Ventspils county municipality has been responsible for the construction of the fish pass on Rīva river.
- BIOR institute has provided expert support and consultation throughout the project.
- Project implementation phase: 36 months, from 01/10/2017 till 09/12/2020.
- Geographical location of the site for the fish pass in Rīva river: N 56 58.402 E 21 20.923.
- Budgetary information:
    - Kurzeme planning region: 40 000.00 EUR for elaboration of technical documentation for Rīva river restoration.
    - Ventspils county municipality: 124 365.00 EUR were planned for building works only. Fish pass installation on the River Rīva, total budget for realization of the pilot activity in the project budget (planned) EUR 164 365.00. Real costs after the purchase procedures on building, construction supervision and author supervision are 176 099.88 EUR.

Figure 19. Photos of the Rīva river restoration site before the restoration was started. Photo credit: Ventspils county municipality.

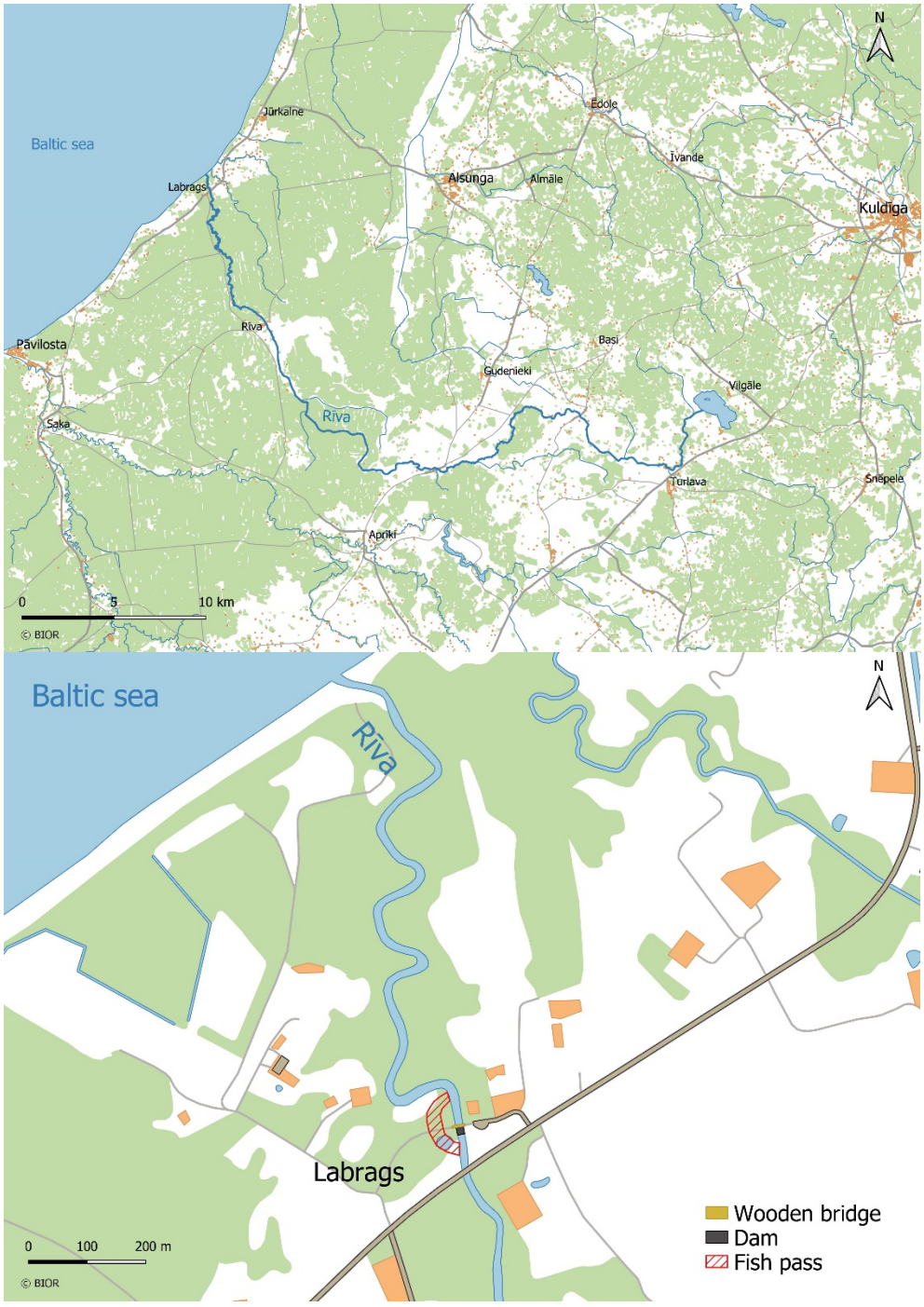


Figure 20–21. Overview and detailed location of the Rīva river restoration site.

Background for the project

Rīva is a river rich of fish species. In addition to sea trout and brown trout (*Salmo trutta*), 20 other fish species and both river and brook lampreys (*Lampetra fluviatilis* and *L. planeri*) have been found in this river. The most widespread species are stone loach (*Barbatula barbatula*), minnow (*Phoxinus phoxinus*) and gudgeon (*Gobio gobio*), often found in small fast flowing streams. These species are accompanied by roach (*Rutilus rutilus*), perch (*Perca fluviatilis*) and other species dwelling in deeper and calmer rivers. A noteworthy phenomenon is the regular occurrence of European flounder (*Platichthys flesus*) downstream the barrier. There are no records of stocking of trout or other fish species in Rīva river, and hence, the trout stock should be considered as original.

The fish fauna of Rīva river has been monitored since 2007. Regular electrofishing surveys (2007–2009 and 2016–2019) have been carried out downstream of the migration barrier. Occasionally, electrofishing has been performed also in other sites located in downstream and upstream reaches of the river. The middle section of the river has not been monitored. In 2018, two new monitoring sites were established in potential spawning sites upstream the barrier and regular monitoring every year or every second year is planned in these sites to evaluate changes in trout reproduction after the completion of the fish pass. In the monitoring downstream the barrier, sea trout parr has been caught in all years except 2019, but the parr density varied from 5 to 80 individuals per 100 m^2. Upstream the barrier, density of trout parr was much lower (usually 2 to 7 ind./100 m^2), in only one occasion reaching 31 individuals per 100 m^2.

The barrier also affects other migratory species than sea trout. Until 2009, regular reproduction of Atlantic salmon (*Salmo salar*) was found below the barrier and during recent years fish fauna monitoring have shown relatively high densities of eel in this part of the river. Rīva river is one of 17 Latvian Rivers where commercial fisheries for River lamprey takes place, which confirms that this species enters the river in noteworthy numbers.

Detailed information on hydrology and water quality was not available before the restoration project. However, general data on these issues are collected and stored by State limited liability company "Latvian Environment, Geology and Meteorology Centre". Additional data were collected and stored by State limited liability company “Meliorprojekts” that several years ago was involved in evaluation of the possibility of construction of a Hydroelectric Power Plant (HPP) next to remains of the dam.

For migratory fish species, the most significant problem was the remains of a dam of an unfinished paper mill located only 1.2 km from the river mouth. Remains of this dam block access to approximately 98 % of the riverbed of Rīva river. The most effective solution would be the complete removal of the obstacle, which, however, cannot be done due to opposition of stakeholders. Therefore, as a plausible solution, building of a natural-like fish pass, or fauna passage, was chosen. The other option was to build a technical fish pass suitable mostly for salmonids. The latter solution would have also been cheaper. However, it needs to be taken into account that in addition to sea trout and salmon, which often are able to negotiate technical fish passes, Rīva river is important also for River lamprey and other species that often fail to overcome such constructions. An important additional problem in Rīva river is the loss of habitats due to straightening of the river channel in great part of the river. Good habitats can be found in an approximately 13 km long section between the barrier and most downstream located straightened reach and in some other sections of the river. In the future after restoring the migration possibilities, further steps in restoration of this river should be considered.

Initial phase

Approximately 1.2 km from the river mouth of Rīva river is the 19th century-built ruins of a paper mill. A 3-stage concrete (masonry) barrier has been preserved along the entire width of the riverbed. As the dam does not allow migration of several fish species, a solution to overcome the barrier was needed. Therefore, the primary aim of the initiative was to ensure migration of anadromous and other fishes to the part of Rīva river and its tributaries currently blocked by the remains of a paper mill dam. A re-establishment of migration possibilities provides immediate opportunities for migratory fish, such as sea trout, to reach and utilise much larger river areas with suitable spawning and rearing habitats. In addition, opening of a migration route paves the way for future projects of restoration of sea trout and River lamprey spawning and rearing habitats upstream the dam. The project for restoring the migration possibility became possible through financial support of the EU INTERREG BSR programme project “Development, promotion and sustainable management of the Baltic Sea Region as a coastal fishing tourism destination” (RETROUT).

During the initial phase it became clear that the Municipality, the inhabitants of Jūrkalne parish and also the tourism enterprises were against the demolition and complete removal of the dam because of cultural heritage and recreational values and related economic interests. Hence, another solution, eventually as the construction of a fish pass, was required. Just beside the paper mill ruins there is a café with the views over the river and its waterfall (Figure 22). Also, the Rīva river wooden bridge across the dam site is a popular sightseeing place for tourists and locals. As one of few, if not the only of its type, this fairly large wooden bridge constructed with diagonal braces, is unique in Latvia (Figure 22). The bridge is in a convenient and easily accessed place. The existing artificial waterfall, a scenic river valley and the historic bridge create an attractive tourism destination in the Kurzeme region.

In the beginning, the project faced some legal difficulties, as the funding programme regulations allowed investments only in public properties. Part of the territory where the fish pass was planned to be placed was private owned. This problem was successfully solved by making use of a long-term lease agreement between the owner of the land and Ventspils county municipality being a public body. As a result, the concerned land area is now the property of Ventspils county municipality on which the fish pass has been allowed to be established.

Figure 22. Pictures of the restoration site in Rīva river, with the artificial waterfall and the wooden bridge. Photo credit: Ventspils county municipality.

Potential stakeholders were identified in the initial stage of the project during discussions among the project team – Kurzeme planning region, Ventspils county municipality and BIOR. It was agreed that one of the most important stakeholders are the property owners at and around the site. It was noted that the dam site is a tourism attraction object and owners of the properties are interested in development of the place, and a fish pass potentially could be a very attractive object for tourists. The identified stakeholders were then approached, and involved in the process e.g., through project meetings to discuss the possibilities of and around the fish pass and by involvement in the development of the plans.

Planning phase

Initially involved in the planning process were only the project partners, Kurzeme planning region, Ventspils county municipality and BIOR as a supervising partner (some stages of the planning), as well as the owner of property now leased on the long-term agreement to Ventspils county municipality. In later stage also the designing company was involved in the process.

There was a public procurement for the elaboration of a technical design of the fish pass in Rīva river. The winner of the tender was the State limited liability company "Meliorprojekts". Topographic surveying was performed and the necessary optimal parameters for the fish pass design were determined. The first draft solution was a technical fish pass ensuring migration only over the lowest part of the barrier. Based on experiences from other countries and after consultation among the restoration project team as well as REROUT project partners, the first alternative solution with different design variants was found to be unsuitable to provide migration opportunities to lampreys and other fish species with poorer swimming capabilities, Hence, this solution was considered insufficient in relation to the project aims and needed to be improved. The restoration project team in cooperation with the designing company agreed to look for another solution. To ensure the migration for as many species as possible, the type of the fish pass was decided to be changed from a technical fish pass to a natural-like fish pass. After agreement on building of natural like fish pass, it turned out that there is not enough land leased according to lease agreement to execute the construction of this type of passage. Therefore, an addendum to the existing agreement was discussed with the landowner, and a lease for the necessary additional land area was signed. In later stage of the final specific designing of the natural-like fish pass construction, there was some confusion in communication, leading to advancement without a full comprehension of the situation by BIOR and international RETROUT partners. This allowed a suboptimal and problematic design that was finally constructed (see section 'Implementation phase').

Important lessons learned were that the project team needs to be coherent and well-functioning, good cooperation and active supervision is needed in the relation between the project team and the designing company, all interest groups should be involved in all key stages of the planning process, and finally, all complications can be solved through transparent practices and active cooperation where all involved actors together focus on finding the overall best possible solutions.

In 2018, parallel to the planning work for the fish pass, also two new monitoring sites were established in potential spawning sites above barrier. Regular monitoring in these sites will enable assessment of changes in trout reproduction after the completion of the fish pass and can hence be used to evaluate the effect and success of restoration measure. In addition, several lamprey larvae monitoring sites were established upstream the barrier in 2020 to assess changes in river lamprey reproduction, and to evaluate restoration effect and success.

Preparation phase

Environmental impact assessment (EIA) was not applicable according to national regulations. Hence, EIA was not carried out.

In the beginning of planning phase, a request for guidelines on the technical conditions for the fish pass construction was sent to Ventspils regional environment authority. The technical conditions were received and included in the terms of reference of the design tender to be taken into account in the design by the chosen company. The produced technical design documents of the fish pass on Rīva

river were again submitted to Ventspils regional environment authority for approval that was granted on 20th March 2020.

The procurement process for the construction work was organized according to the National Law on Public procurement and regulations of INTERREG BSR programme. The winner of the tender was the applicant who offered the lowest price on conditions mentioned in terms of reference – "Venta-1" Ltd. that is a specialist in road building but also in hydraulic structures.

A price survey was carried out to get the lowest price for the construction supervision. A special requirement for the construction supervisor was a certificate for the supervision of construction works of hydraulic structures. The contract for the author supervision was signed with the State limited liability company "Meliorprojekts".

Implementation phase

Ventspils County municipality was responsible for the construction phase of the fish pass. According to the procurement procedure the contract with the building company "Venta-1" Ltd. was signed on 18th May 2020. To enable the start of the construction work and avoid delays, the building expenses in amount of 164 423.38 EUR (including VAT 21%) were first pre-financed using a loan at State Treasury, until the funding-technical issues of the regular project funding was solved.

As the planned budget for building work was much smaller than the contracted sum that was chosen after the procurement procedure, a challenge to find lacking funds for financing the project emerged. Also, additional payments for construction and author supervision services were required. The state policy stipulates that the Treasury loan can be received only to cover the eligible costs of the project, and that was not enough to cover the difference between the planned and realised costs. A solution was found when the RETROUT partnership reallocated the project budget, enabling unused financial resources of other partners to be directed to cover the construction costs of the Rīva river fish pass. By this, the municipality received an opportunity to request an additional loan from the Treasury. It is also important to emphasize the municipality's efforts to find and use financing from various sources, e.g., funds from the municipal fish fund budget were utilised to pre-finance construction costs. The construction work on the site started in June 2020 and was completed in September 2020 (Figure 23).

Figure 23. The fish pass site during construction in August 2020. Photo credit: Kaspars Abersons.

Regular meetings were held between the involved parties to control the building process and the issues connected to that. In the final stage of the construction works there were concerns brought up regarding the functionality of the fish pass during low flow conditions (Figure 24), based on some received information on potential discrepancy between the design and the realised construction. Information was received from locals that there was a risk that the fish pass would only work at high flow conditions. It was agreed that BIOR will investigate this issue further, and consecutively keep the restoration project group as well as RETROUT WP4 lead and lead coordinator informed.

Figure 24. The fish pass site after construction in September 2020 (Photo credit: Kaspars Abersons).

During further investigation it was made clear that the received alarmed signals from several parties about what is happening in the Rīva river were correct (Figure 25). So far, it had been announced with great confidence that the first natural fish pass in Latvia was being built in the Rīva river and it was to be suitable not only for sea trout but also for other fish and invertebrates. However, at this point the fish pass did not meet those expectations. It was found out that partly due to a faulty design and partly due to faulty construction work, the new fish pass had severe problems, inter alia in form of three new obstacles effectively obstructing fish migration. Also, 200 mm pipes had been laid in the channel controversially to aid fish migration. During low water conditions, there was extremely little water in the channel for the fish. It became clear that the design of fish pass in the late stage of the planning process had been changed without involvement or consultation of BIOR and RETROUT partners. The emerged concerns were expressed, and the involved parties started to search for a solution. Two meetings in the river side were held. A situation explanation and pictures were also sent to RETROUT project experts Martin Kesler (Estonia) and Robertas Staponkus (Lithuania), who also participated in a

meeting at Rīva river to provide external expert consultation. It was concluded that sufficient water in the fish pass was secured only during high flows (Figure 26); in medium and low flow conditions water flow over the obstacles is poor.

Figure 25. The fish pass site after construction in October 2020. Photo credit: Ventspils county municipality.

On 9th October 2020 a meeting was held with all Latvian restoration project partners, designers of the fish pass, constructors and local stakeholders. After long discussions, practical checking and measurements on the spot, a compromise solution that satisfied both scientists and local stakeholders was found. It was decided that the designers make the corrections in the design of the fish pass to ensure migration possibilities for different kinds of fish and at the same time secure enough water for the main channel to retain the artificial waterfall as a tourism attraction. Openings were to be made in both of the most crucial new obstacles. The dimensions of the openings were calculated so that the bottom of the opening was 10 cm lower than the bottom of pipe in the uppermost obstacle in the main river. And the width of the opening was calculated so that during the low flow the fish pass will consume approximately one half of the flow and other half will be left for the waterfall in the main river. In addition, parties agreed that the stone piles in the fish pass will be left unchanged and the upstream parts of the pipes in the stone piles will be clogged with smaller stones. The wooden shields in the uppermost part of the culvert were to be removed.

Changes in the construction were done properly and according to decided solutions and design. Additional costs caused by the situation were covered partly by the construction company within its responsibility and partly by the Ventspils County municipality. Thereafter the fish pass has been in operation. Further monitoring of the functionality of the fish pass in various conditions will be carried out during the coming seasons.

Figure 26. The fish pass during high flow conditions. Photo credit: Ventspils county municipality.

Evaluation of the project

Despite some difficulties, the project process so far can be rated as a success. During the first stage of project, potentially the most suitable solution was found, and actions were targeted towards its implementation. However, the real success depends on efficiency of fish pass which can be evaluated only after monitoring of its functionality and its impact on production of migratory fish.

To evaluate possible changes in sea trout (and salmon) production two additional electrofishing sampling sites were opened in 2018. In 2020, these sites were revisited. In addition, monitoring of lamprey larvae has started. The design of the fish pass allows also the installing of fish counter. However, due to considerable expenses of such devices it is hard to estimate if and when installing and operation of a fish counter will be possible. The results of fish monitoring in Rīva River downstream the construction site did not reveal noteworthy changes in fish fauna in 2020 if compared to previous years. However, electrofishing was conducted in July before the fish pass construction, and hence the evaluation of the effect of the fish pass can be evaluated only later based on monitoring results from the coming years.

Negative impact on fishes or another biota during the construction process was not observed. It can be expected that the existence of fish pass will not have a noteworthy impact on water level, discharge or other parameters of river itself. The only expected changes are improved river connectivity and better migration possibilities for fish and other river biota. Special monitoring for evaluation of the impact on other species is not planned but change in the fish fauna can be observed during monitoring of sea trout parr and lamprey larvae.

The restoration activity was not directly aimed towards provision of additional recreational objectives, yet it is likely that the fish pass itself will add some value to the site. The bridge over Rīva river is a replica of a wooden bridge which was included in list of national scale culture monuments. The bridge and to some extent also the ruins of unfinished paper mill and the dam itself is a popular tourism object. During planning and designing of fish pass great attention was paid to retain the value of site as much as possible, which was achieved. The fish pass will not have noteworthy impact on the bridge, ruins and dam. As it was insisted by the local landowner and other stakeholders, the remains of the dam will continue to function as an artificial waterfall. Special activities for monitoring the attractivity of the site for tourists is not planned.

Lithuania

Smeltalė river: restoration of biopond system and habitat improvement

Country	Lithuania
River	Smeltalė
Site	Švepeliai biopond and Jakų park
Type of sea trout population	Unique population, self-reproducing
Type of restoration	Restoration of biopond for nutrient reduction and habitat improvement
Temporal scale of the restoration	Long term
Spatial scale of the restoration	Biopond 500 m, park 200 m, 1 km apart
Responsible organization	Klaipėda District Municipality Administration
Duration of the project	1 year
Geographical location WGS84	55-42,2000N 21-15,2833E (Park) and 55-41,8500N 21-14,5667E (Biopond)
Total budget	

Background

The Smeltalė river flows into the Klaipėda Strait, which connects the Baltic Sea and the Curonian Lagoon and has a catchment area of 124 km^2 (Figure 27). The tributary Smiltaitė joins the Smeltalė river 15 km from the mouth. The river has a self-sustaining production of an original strain of sea trout, but the reproduction has decreased during the last years (Figure 28). Water quality is classified as poor due to eutrophication, a possible reason for the low trout production.

Two restoration demonstration cases were planned. One restoration of an overgrown biopond, ones established to reduce nutrient load on the river, and one habitat improvement activity in a meandering stretch in the same tributary (Figure 27). Responsible for the restoration activities were Klaipėda District Municipality Administration with technical/scientific supervision from Klaipeda University. A construction company was procured to carry out the activities.

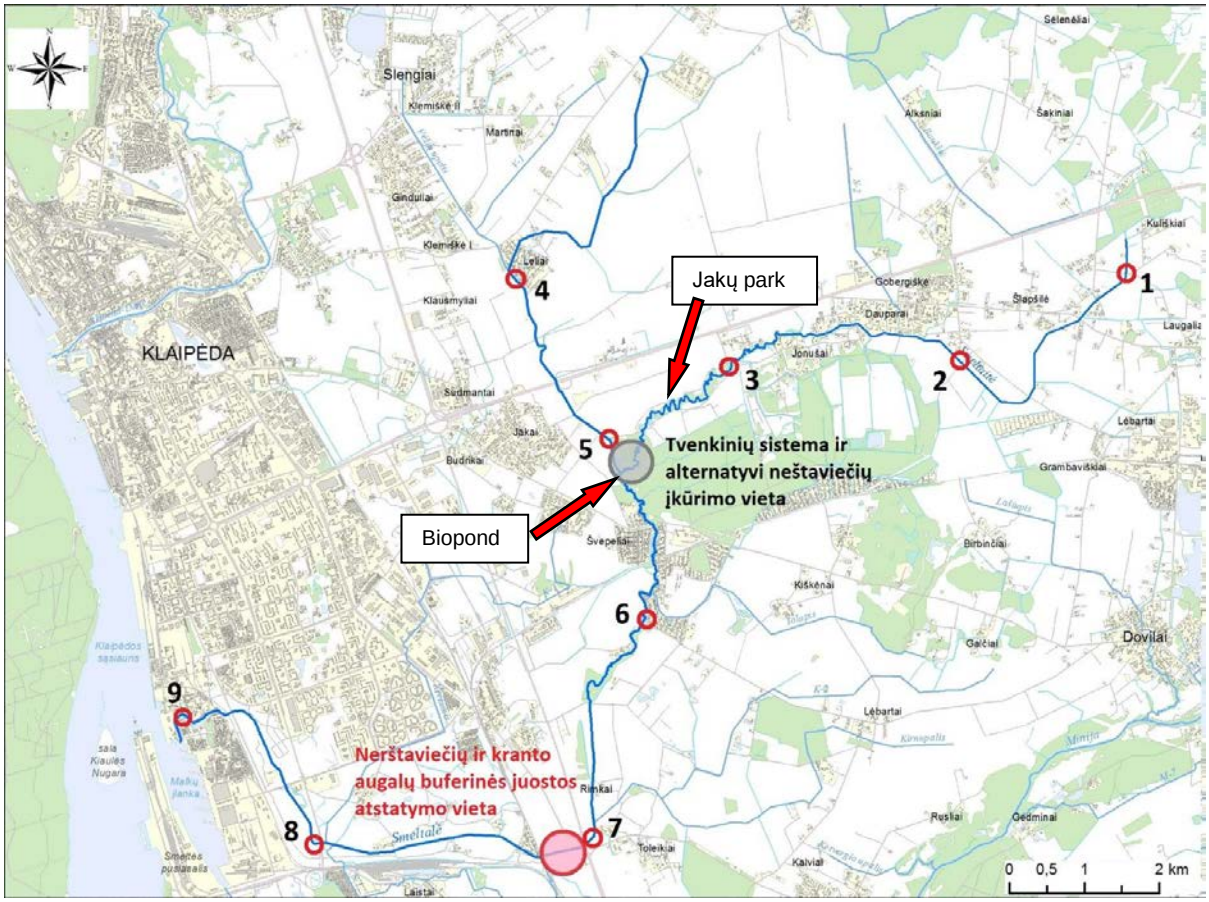


Figure 27. Smeltalė river*, overview. Indicated are the site for the biopond and the Jakų park where habitat improvement measures were implemented.*

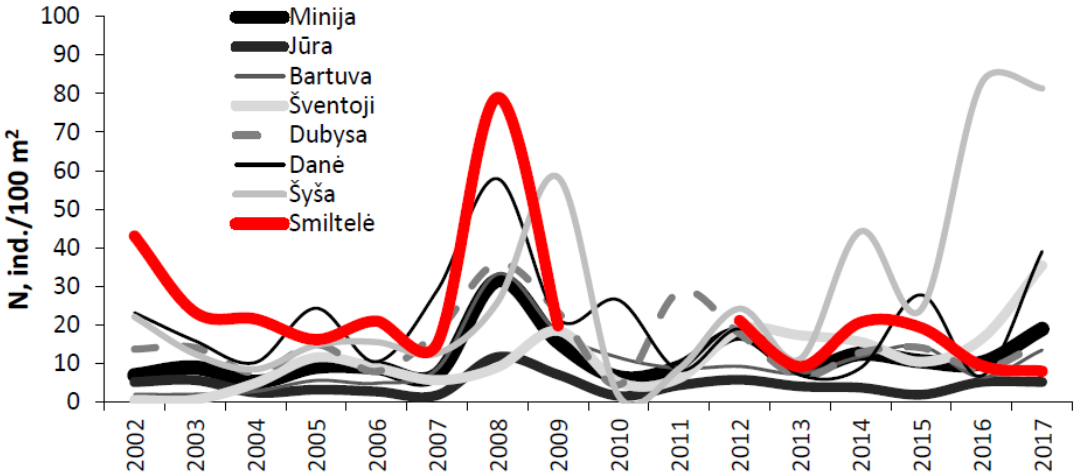


Figure 28. Salmo trutta population status dynamics in westerns Lithuanian rivers (Klaipeda University 2017).

Biopond restoration

A biopond-system was established in 1996 at the confluence of the Smiltaitė and Smeltalė rivers to improve the water quality (Figure 27). Two hectares of land was turned into a wetland for river water treatment. It consists of several sedimentation ponds, anaerobic ponds, and aerobic ponds. Since then it has not been managed properly and it was suspected that the nutrient reducing efficiency had decreased. In 2018 the pond was completely overgrown (Figure 29).

Initial phase

To evaluate the efficiency of the biopond an intensive pre-restoration survey was carried out. Nutrient flux was analysed in intact sediment cores from the biopond. Spatial and temporal distribution of nutrient load was studied by analysing water chemistry every two to four weeks for one year. Water was sampled from 13 stations in the whole Smeltalė catchment including the pond system. The study found that reduction of the total phosphorous concentration was only 1-4 % as compared with the expected 10-15%.

Planning phase

Based on the findings from the study of the nutrient reduction a plan for restoring the function of the biopond was designed. The design included removal of sediments from two first sedimentation ponds, clearing the surroundings from trees and shrubs, adaptation of area for educational purposes and restoring of an artificial weir.

Permit for the activities had to be applied for because the area is protected by the law of waterbodies protection zone.

Implementation phase

During the restoration 3300 m^3 of sediment was removed from the pond and much of the overgrowth was cleared (Figure 30) the artificial weir was restored. The area is now used for recreation and education. A follow-up study of the nutrient reduction has not yet been performed.

Figure 29. The Biopond system four years after construction (left) and 21 years after (right).

Figure 30. The Biopond system before (left) the restoration and after (right).

Habitat improvement measures

In the Smiltaitė tributary restoration measures were applied to a stretch running through a small park, Jakų (Figure 27). This part of the rivers is a 4 km long meandering stretch lined with a 100 m wide forest strip. In this stretch the river has a large potential for trout spawning and constructed habitats were judged to be able to withstand both high flows and sedimentation (Figure 31). The land is privately owned but water in Lithuania is state owned, which facilitates restoration activities. In

Smiltelė, all measures were planned to be applied in the water. The landowner was consulted and was positive to the activities. The site is easily accessible for the heavy machinery that would be used.

A possible problem with the selected site is that there are two poorly maintained road culverts in Smiltaitė tributary 1.5 km downstream the restoration site. One of the culverts is open for migratory fish only during high flow conditions, the other has a concrete block blocking passage (Figure 33).

Planning phase

To improve the suitability of the site for sea trout the riverbed has be modified because of lack of stones and gravel. A site which is known to be suitable for sea trout upstream the restoration site was used as a target (Figure 31). The planned actions included three sites, together 150 m and 600 m^2 where spawning grounds and nursery areas would be created (Figure 32). To ensure accessibility to the site, plans to remove the road culvert downstream the restoration site was made.

Figure 31. The restoration site (left) and the target site (right). The target site represents a habitat suitable for sea trout situated a few km upstream the restoration site.

Figure 32. The three restoration sites in Smiltaitė river.

Figure 33. The two culverts that constitute migration obstacles.

Implementation phase

Sea trout spawning and juvenile rearing habitats were created in the stretch by adding stones and gravel to the riverbed. Used material:

- 90 m^3gravel, a 1:1 mixture of natural gravel and washed pebble (fr. 16-70 mm)
- 24 m^3 cobble

- 5 m^3 stones (25-35 cm)
- Logs

3 x 50m sections were modified adding up to 500 m^2 productive area for salmonids and lampreys. The river before and after the restoration activities is shown in Figure 34.

The culverts forming migration obstacles were opened by removing the blocking concrete with the help of an excavator.

Figure 34. Two river stretches that flows through the Jakų park where habitat improvement activities have been implemented. Before (left) and after (right) the restoration activities.

Evaluation of the project

This was the first ever creation of spawning grounds in Lithuania and it proved to be a great success: 13 spawning reds were found in 60 m of restored habitat. Now, visitors of the park can see trout spawning in the middle of the park.

The restoration activities in Smeltalė river have already influenced restoration outside the project. The first ever dam removal in Lithuania has been carried through. This was a small dam that was not a migration obstacle, but the removal has a symbolic value by showing that dams can be removed. The second ever dam removal is planned this coming summer in Salantas river. The dam removal will also be combined with habitat improvement activities.

To conclude, the Smeltalė project has created greater knowledge among stakeholder groups about the importance of river restoration.

Poland

Reda River: Construction of the planned fish pass


Photo: Gdynia Maritime University

Country	Poland
River	Reda
Site	The town of Reda
Type of sea trout population	Stocked with fry and sea trout smolt. In some tributaries the natural production is observed.
Type of restoration	Construction of the planned fish pass and supporting infrastructure
Temporal scale of the restoration	Long term
Spatial scale of the restoration	One stretch
Responsible organisation	National Water Holding "Polish Waters" (Państowe Gospodarstwo Wodne "Wody Polskie")
Duration of the project	planned
Geographical location WGS84	54-36.6845, 18-21.6838E
Total budget	Ca. 1.05 million €

General Information

Restoration case: Construction of the planned fish pass on Reda River.

Location of restoration site: Reda river is located in the town of Reda (commune of Reda, Wejherowo County, Pomorskie Voivodeship) in Poland (Figure 35).

Sea trout population: The Reda River is stocked with fry and sea trout smolt by a Polish Angling Association in Gdańsk and under the Polish Marine Areas restocking program. But in some tributaries the natural production is observed and monitored by Department of Migratory Fish of the Inland Fisheries Institute in Olsztyn during ICES monitoring programme.

Restoration aim: The planned fish pass with the water inlet on the Mrzezino Canal and the outlet below the weir to the Reda river is intended to enable the migration of aquatic organisms between the upper and lower site of the Ciechocino weir at 7.8 km from river mouth, which will contribute to increasing the biodiversity of the Reda river and recreating the historical spawning grounds of salmonids above the weir in the Reda river and flowing watercourses.

Responsible authority/investor: The construction investor is the national authority National Water Holding "Polish Waters" (Państowe Gospodarstwo Wodne "Wody Polskie").

Documentation: According to the Polish law (Journal of Laws of 2010, No. 213, item 1397), the planned investment is qualified as a project with potential significant impact on the environment, therefore specific technical documentation and Environmental Impact Assessment (EIA) were ordered in 2017 as the "Construction of a fish pass with the implementation of accompanying infrastructure" tender. Both reports were prepared by Biuro Projektów Wodnych Melioracji i Inżynierii Środowiska BIPROWODMEL Sp. z o.o. and officially approved afterwards.

Budget: All permits have been already issued by responsible authorities and are valid until 2025, with the possibility of their extension. The only remaining issue is finding proper funds for the investment – the total estimated cost of fish pass and surrounding infrastructure is currently 4.65 million PLN (ca. 1.05 million EUR). National and international financing sources are being taken into the account, with hope of starting the construction process in 2021.

Technical parameters

Planning phase: The fish pass and its accompanying infrastructure will be constructed on the left bank of the Reda river at the weir at 7.8 km from river mouth in the town of Reda. It should be noted that the construction of the fish pass is limited to the area between the Mrzezino Canal, the Reda riverbed and the area in the immediate vicinity of the existing weir on the Reda River.

Considered options: Due to the function of damming water for the needs of rainbow trout farms with valid water permits, the weir cannot be removed. Possible variants of the fish pass project have been analysed in EIA report:

Option "0" – withdrawal from the investment. This variant is unfavourable for the environment, the Investor, residents and recreational users (anglers) of the Reda River.

Option "1" – Construction of a technical fish pass in the form of a slot fish pass. It is a type of chamber fish pass, where the partition walls are equipped with a vertical crack running through the entire height of the wall. Benefits:

- maintenance-free facility;

- structure insensitive to changes in the lower water level and works well in conditions of changing upper water level;
- vertical crevices meet the behavioural requirements of both deep and bottom fish, and if the bottom material is continuous in the crevices, also zoobenthos can utilise it;

Option "2" – The construction of a fish pass in the form of a stone half-timbered ramp along the left bank of the Reda River between the Mrzezino Canal and Reda. A fish pass limited by tight walls on both sides to prevent water filtration under a structure, with a reinforced concrete bottom, slopes and walls lined with fieldstone on a mortar and boulders fixed in the bottom with a stone-gravel embankment (structure classified as close to nature). Benefits:

- maintenance-free facility;
- construction close to natural;
- ensures free migration of all aquatic organisms.

The presented variants (apart of Option “O”) ensure the achievement of the intended goal while costs of implementation and subsequent operation are also similar. Option 2 is indicated as an investment variant, as it fully meets the Investor's requirements, and it can be assumed that its characteristics imitating natural rapids will match the surroundings and favour the migration of salmonids which spawning grounds are located above the weir at 7.8 km of the river Reda. The investment option (option 2) is the most beneficial for the environment, as it enables migration not only for fish but also for other aquatic organisms.

Construction stages: The planned work for Option 2 include the construction of a fish pass in the form of a half-timbered ramp in order to restore the continuity of the Reda river. The fish pass will be located with the upper water stand at the Mrzezino Canal and the water on the Reda river. The inlet of the Mrzezino Canal is located above the Ciechocino weir (Reda). Therefore, the investment begins with the construction of an inlet valve to the Mrzezino Canal. No reconstruction, or renovation of the early weir is planned. The subject of the investment also includes accompanying infrastructure in the form of the reconstruction of the valve on the Mrzezino Channel, construction of the PZIDD (data collection and distribution point), a wind power plant, connection to the power grid and the relocation of power cables colliding with the designed structure.

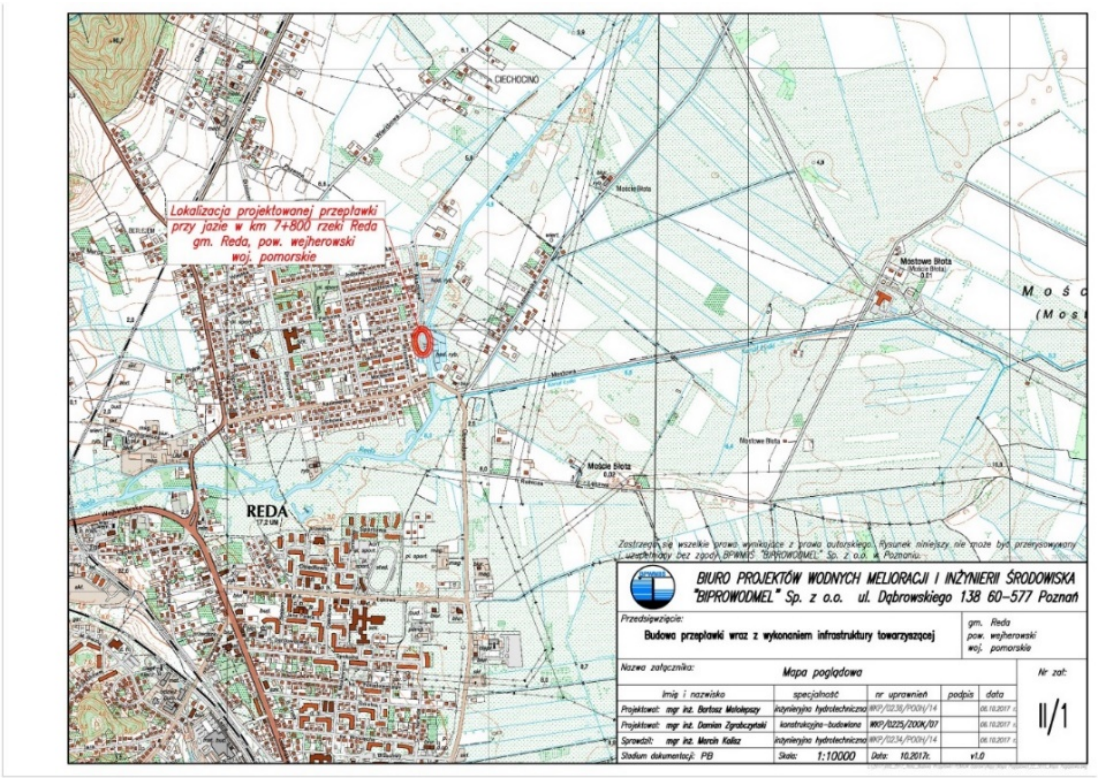


Figure 35. Detailed location of the planned fish pass in Reda. Credits: National Water Holding "Polish Waters".

The legal status of the fish pass construction area has already been regulated. The area of the planned investment covers the areas with functioning construction facilities. The area between the Reda river and the Mrzezino Canal, on which the fish pass is designed, is currently used as an access road to the weir at 7 + 800 km and the inlet with a gate on the Mrzezino (Figure 36). During the construction works at the fish pass, the weir on the Reda river will perform its function by passing water in an amount ensuring that the requirements of water permits are met.

Figure 36. Site plan of the Ciechocino weir in Reda. Credits: National Water Holding "Polish Waters".

The facility at the operational stage will not pose any threats to the environment. Its construction will enable the migration of aquatic organisms above the Ciechocino weir, which is currently practically impossible for most organisms, except for a few specimens of sea trout and salmon. It is assumed that the work of monitoring the fish pass will be automated, hence there is no need for a permanent stay of staff and the provision of social spaces.

The objects of the fish pass and gates will be marked with signs prohibiting the presence of bystanders and particularly dangerous places will be highlighted.

The actions to be executed are listed below in the expected order:

- Removal of the sheet piling and creation a circulation channel on the Mrzezino Canal
- Demolition of the existing degraded inlet with a gate to the Mrzezino Canal
- Construction of fish pass and gate facilities:
  - construction of a gate on the Mrzezino Canal with a working footbridge and steel stairs;
  - installation of protective barriers along the fish pass bed and the frame culvert from the side of the Mrzezino Canal, protecting bystanders against accidental falling into the fish pass bed;
  - structuring of the frame culvert with the joining plate;
  - structuring of fish pass segments
- Construction of a Data Collection and Distribution Point (PZiDD)
- Construction of a wind farm for supplying PZiDD
- Construction of an energy connection to supply the fish pass infrastructure
- Development of the area around the fish pass
- Strengthening of the bottom and slopes of the Mrzezino Canal at the upper position, in front of and behind the gate structure at the inlet to the fish pass

- Strengthening the Reda bottom with a gabion mattress at the bottom of the fish pass
- Profiling and strengthening the slope with a stone rip-rap between the fish pass and the Reda river bed
- Panel fencing along the left wall of the fish pass
- Leveling the area around the fish pass to the ordinate of 7.50 m above sea level
- owing with a mixture of grasses on the humus of the area between the fish pass and the Mrzezino Canal on the plot no. 406/2 (Figure 37).

Figure 37. Planned fish pass in Reda – technical drawing. Credits: National Water Holding "Polish Waters".

Fish Monitoring Systems: PZiDD (Data Collection and Distribution Point) is a fish monitoring device equipped with supply section, broadcasting section and fish monitoring section. The effectiveness of the new fish pass will be confirmed by the monitoring of the Hydroacoustic Monitoring System (HSMR). HSMR is a complete solution for monitoring fish migration without restricting their freedom of movement and introducing a stress factor. The fish monitoring system is based on the inverted side scanning sonar principle in which the acoustic head is stationary, and the fish are scanned as they pass through a narrow acoustic beam. The operation of hydroacoustic transducers is synchronized with the operation of the optical camera, which facilitates data recording and archiving.

Natural conditions

The fish pass will be located in the Reda river valley (Figure 38). It is a watercourse 44.9 km long, with a catchment area of approximately 1.546 km^2. The Reda river starts in the village of Strzebielno and continues in the ice-marginal valley shared with Łeba. From the village of Kłębłowo, the river flows in a wide and marshy valley, and the areas adjacent to the regulated watercourse are used for agriculture. Further on, the river flows through Lake Orle, which was created as a result of flooding the former excavation of the cement plant in Wejherowo. Below, the river is canalised. Before the weir of the cement plant, its greatest tributary, the Bolszewka, flows into the Reda canal. The weir

directs almost all the water to the cement plant's canal, while the old Reda riverbed is supplied mainly with exudate water. From Wejherowo it flows along the original bed. The river clearly accelerates, it flows strongly, meandering in the vicinity of the forest. It slows down near the town of Reda, where it flows into the coastal, wetland plain. The damming weir located in Ciechocino for the purposes of breeding facilities discharges part of the river's water to the Łyska Canal. Below the weir, Reda has a straight regulated riverbed. Before its estuary, the river slows down as it flows among meadows, pastures and reeds. It flows into the Puck Bay near the village of Rekowo.

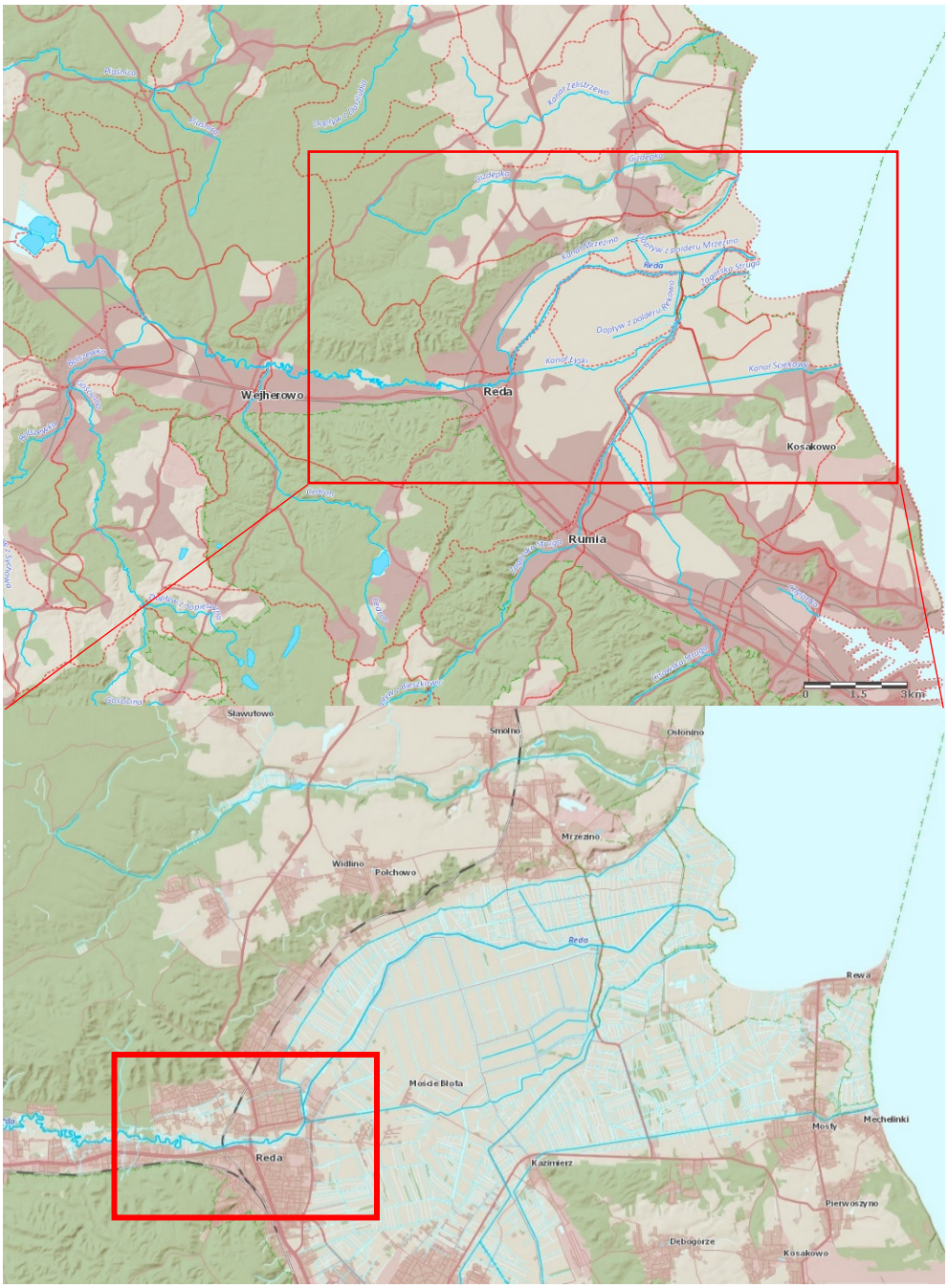


Figure 38. A map with the hydrographic system over the restoration site. Source: www.kzgw.gov.

The location of the planned fish pass is in relation to Natura 2000 areas and other forms of nature protection is illustrated in Figure 39. The investment area is beyond their reach, the border of the Darżlubski Primeval Forest is the closest.

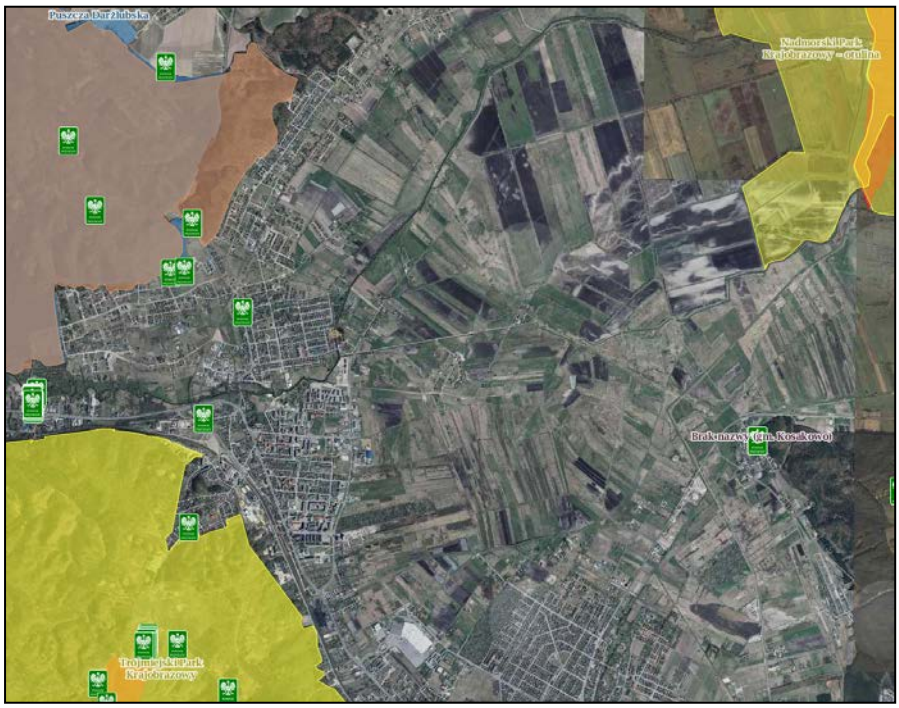


Figure 39. Location of the investment in relation to the nature protection areas. Source: General Directorate for Environmental Protection.

Flora: Environmental Impact Assessment highlight environmental conditions that shape the potential vegetation of the area, which is still being transformed as a result of human activities (settlement network, changes in water system etc.) towards the actual, present vegetation. The planned project of a fish pass will be implemented on the left bank of the Reda, between the Mrzezino Canal and the Reda River. The scope of work planned in the Reda riverbed was limited to strengthening the bottom at the mouth of the fish pass canal and cutting down trees and shrubs. The investment area is therefore a separated space, currently used for the needs of the existing Ciechocino weir. Common synanthropic vegetation (Artemisietea) is dominating in the area. It is typical for ruderal (related to settlement) and segatal (related to agriculture) grounds. Both of these functions are performed in areas adjacent to the investment area (Figure 40, 41).

Figure 40. View of the Ciechocino weir and the left bank of the Reda River. Photo credit: National Water Holding "Polish Waters".

Figure 41. View of the Mrzezino Canal, the site of the fish pass construction. Photo credit: National Water Holding "Polish Waters".

No protected plant species were found in the fish pass area. Noteworthy is the presence of an invasive species, *Echinocystis lobata* (Figure 42). An inventory of dendroflora was carried out in the area of the

planned investment. Trees and shrubs are described by species, size, diameter and length of the trunk circumference. Each specimen of a tree or shrub was given an inventory number. Tree trunk circumferences are given in cm, measured in the so-called breast height at a height of 130 cm. The area of shrubs is given in m^2. In the area covered by the investment, a total of 40 tree trunks and 7 m^2 of shrubs were inventoried and planned to be cut as part of this investment. Most of the trees were felling relatively young, healthy and not showing signs of decay. They were not inhabited by protected lichen species.

Figure 42. View of the escarpment with Echinocystis lobata, an invasive species. Credits: National Water Holding "Polish Waters".

Ichthyofauna: The ichthyofauna of the Reda basin has been studied by Inland Fisheries Institute in Olsztyn. According to the study[1], the Reda river flows from Wejherowo to Reda in its natural bed, significantly accelerating the current, which is reflected in the structure of ichthyofauna. There are numerous brown trouts and graylings, as well as single individuals of sea trout, perch, pikes, sticklebacks, stone loach and gudgeons. Further downstream of the Reda, high numbers of sea trout are noted. Brown trout, whitefish and pike had a smaller share. On the other hand, within the pre-estuary section near Mrzezino, there was a clear decrease in the number of fish. Only single individuals of brown trout, sea trout, common dace, perch, pike and three-spined stickleback were caught in the area.

Due to the existing hydrotechnical structure and an ineffective fish pass, the hydrological continuity on the Reda river is currently challenged. Efforts should be undertaken to improve this condition. When implementing new and renovating existing facilities, it is necessary to take pro-environmental solutions, i.e., those that allow for the continuity of the watercourse and free migration of aquatic organisms. Stone ramps are such a solution. The investment in question complies with the adopted parameters of the structure ensuring the continuity of migration of aquatic organisms. A slightly smaller stone diameter was adopted (for 0.5 m) to keep the fish pass width sufficient for the salmon. The adopted parameters result from the WWF guidelines in accordance with the study "Fish passes - design, dimensions and monitoring" (published 2016 by P. Nawrocki). These solutions were also consulted with local ichthyologists. From an ecological point of view, the construction of ramps with

[1] Published in the Scientific Journal of the Polish Angling Association in 2007.

a very rough bottom and a low slope is the best way to restore continuity in rivers where obstacles cannot be completely removed. Through structures of this type, all aquatic organisms can freely move, both up and down the watercourse.

Environmental Impact Assessment (EIA)

Environmental Impact Assessment was ordered in 2017 by The Board of Amelioration and Water Facilities Pomeranian Voivodeship in Gdańsk and prepared by the team of Biuro Projektów Wodnych Melioracji i Inżynierii Środowiska BIPROWODMEL Sp. z o.o., in accordance with guidelines in force[2].

EIA states that the construction of fish pass will not change the degree of use of anthropogenically used land. Completion of construction works will enable the reconstruction of the biologically active surface. Therefore, no permanent negative impact (both national and transborder) is expected and the scope of the impact will mainly cause a temporary limitation appearing only at construction stage and returning to normal afterwards. Those temporary impacts are related to construction noise, quality of water (phytobenthos, phytoplankton etc.), as well as effect on flora and fauna. In longer terms, the investment is favourable for the functioning of the natural environment, due to ensuring the hydrological continuity of the watercourse. There will be no oil, waste and noise associated with the long-term use of fish-pass.

Selected EIA conclusions regarding flora and fauna are:

- In the area of direct implementation of the task, the presence of legally protected plant species was not found [Regulation of the Minister of the Environment of 9 October 2014 on the protection of plant species (Journal of Laws of 2014, item 1409)].
- As part of the planned project, it is planned to cut trees and bushes from the immediate area of the planned works. The age structure, species structure and health condition of the trees do not indicate the necessity to qualify them as potential habitats for protected insects. There were also no bird nests or tree hollows found there.
- No plant stands or patches of plant communities listed in Annex I of Council Directive 92/43 / EEC were found in the area under the task's impact in the study area. There were no breeding species of avifauna covered by Art. 4 of Directive 2009I147IWE.
- In accordance with the Regulation of the Minister of the Environment of 9 September 2011 on the list of plants and animals of invasive species which, if released into the natural environment, may pose a threat to native species or natural habitats, the invasive plant species *Echincystis lobata* was discovered at certain sites.

This section of Reda river has been classified as significant in terms of maintaining morphological continuity, which is a necessary condition for achieving good ecological status. A representative species of fish is salmon. The assumed intact flow in the watercourse channel meets the requirements of the ordinance of the Director of the Regional Water Management Board in Gdańsk.

The stage of exploitation of the investment will not change the function of the area which is used for the weir and will remain so. The pressures from maintenance and land use will not change. In the initial period, the biological function of the surface will be restored, after completion of the works, the

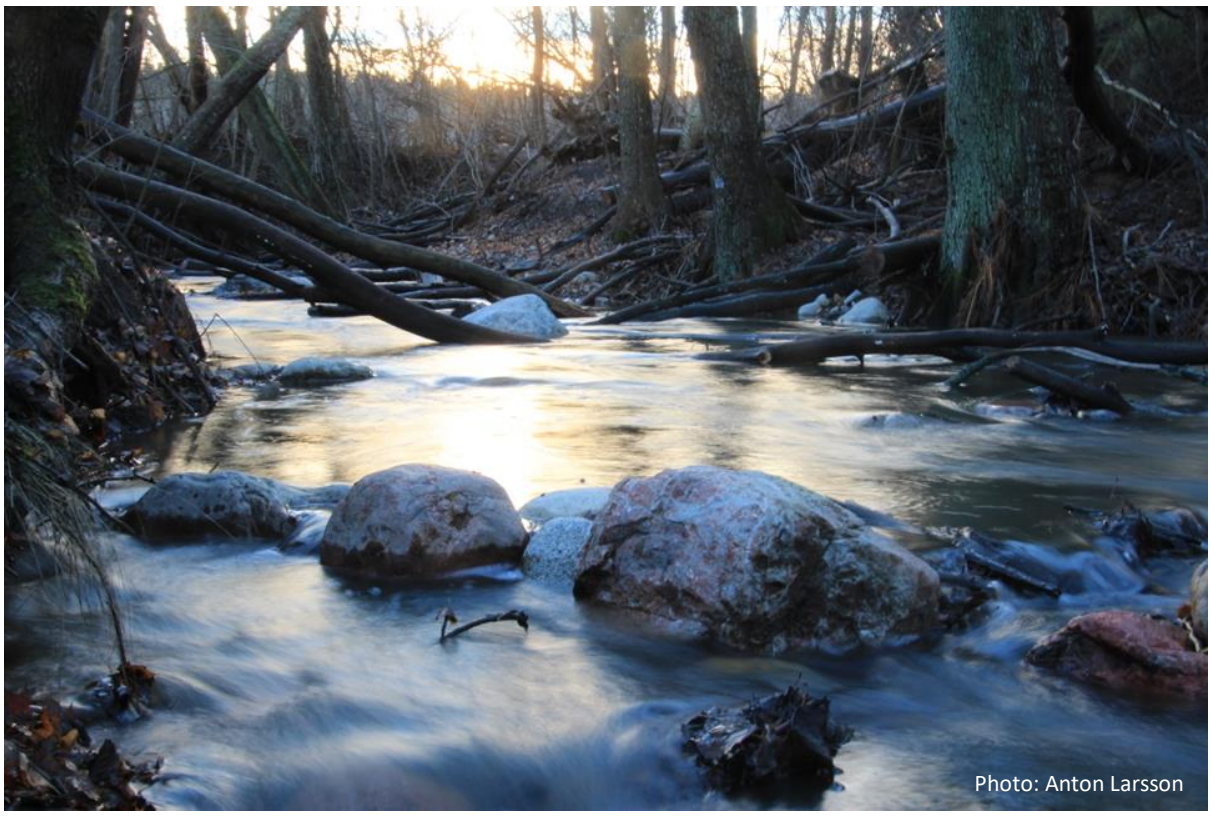
[2] "Recommendations of the Minister of Infrastructure and Development, the Minister of Environment and the General Director of Environmental Protection for investors/beneficiaries and competent institutions in the field of verification and ensuring that undertakings co-financed from EU funds in the programming period 2007-2013 and meeting the requirements of the Water Framework Directive" (February 2014).

ground surface will be tidied up and re-sown with grass. It should also be expected to have a long-term positive impact on the environment by improving the biological continuity of Reda river.

This Reda river fish pass case study report is based on an interview with PZG Wody Polskie in Gdańsk and provided documentation including Technical Report and Environmental Impact Assessment Reports (2017) conducted by Biuro Projektów Wodnych Melioracji i Inżynierii Środowiska BIPROWODMEL Sp. z o.o.

Sweden

River Bränningeån: habitat improvement



Country	Sweden
River	Bränningeån
Site	Bränninge gård
Type of sea trout population	Previously stocked, now reproducing
Type of restoration	Habitat improvement
Temporal scale of the restoration	Long term
Spatial scale of the restoration	Three stretches within 400 m
Responsible organisation	County administrative Board of Stockholm, Södertälje Municipality, Swedish Angler society
Duration of the project	6 months
Geographical location WGS84	59-8.5279N, 17-39.7874E
Total budget	20 000 €

Background

Bränningeån is one of Södertälje municipality's larger watercourses. The river has its source in an area of small lakes and wetlands in Nykvarn municipality and then flow on to lake Måsnaren, which is mostly in Södertälje municipality. From Måsnaren the watercourse flows through lake Lanaren before it flows into the Baltic Sea in Hallsfjärden bay. The water flow in Bränningeån is partly regulated by a dam at the outlet of Måsnaren which is controlled by a water-rights court ruling for the lake. The

watercourse runs through both farmland and woodland with several historical remains and ponds that are partly or completely obstacles to fish migration. Downstream of Lake Lanaren, the water flow is regulated by a larger pond at Bränninge mansion. After the dam, the Bränningeån river cuts into a wide gorge, which to a large extent is lined with deciduous forest with high nature value and biodiversity. A few hundred meters from the outlet a tributary connects which has its source in a wetland area north of Bränningeån.

The lower part of Bränningeån has high cultural heritage values. Bränninge manor dates back to the 14th century. A foundry was built by the river mouth in the middle of the 17th century and in the 1680s a bar iron hammer. Iron ore was processed from nearby mines (Utö and Skottvång). Before the land consolidation belonged to Bränninge eight farms, a watermill with a saw, a roadside tavern, and a school in addition to the ironworks. Besides the dam at Bränninge there is also a small pond and remnants of a small hydroelectric power plant downstream of the large dam.

The ecological status of the river is classified as moderate according to the Water Framework Directive, which is below the binding environmental goal for this watercourse. The poor status is due to eutrophication and physical alterations (fish migration obstacles and morphological changes). The eutrophication is likely an effect of the large share of agricultural land and urban land in the catchment area. The dams close to the mansion are definite migration obstacle for all fish. However, due to high cultural heritage values, these dams will not be removed within the project. A river habitat survey showed that the river has reduced habitat complexity due to the removal of boulders from the stream channel and lacks natural bottom substrate in many places. Furthermore, the dams have caused reduced sediment transport in the river, which has resulted in more erosion and deepening of the watercourse downstream the dams. Despite the physical impact, seatrout reproduce in the lower part of the river. Fish monitoring via electrofishing has been performed from 2002 to 2018 and show a trout parr density of 10-35 ind./100m^2 on average. The river has previously been stocked (in 2005) but is now self-reproducing.

The lower part of Bränningeån have trees shading the water which create potentially favourable conditions for sea trout. However, due to the lack of suitable gravel for spawning sea trout and of larger stones that create holding spots and pools, the potential is not fulfilled. There is also a lack of variation in flow with mostly calm water and only a few riffles and runs. By returning gravel, boulders and large logs to the stream, heterogeneity in physical structure and flow will increase, which is predicted to increase biological diversity and production of sea trout.

Previous measures

River restoration measures have been carried out several times before in Bränningeån. In 1999, the City of Stockholm implemented habitat improving measures. Gravel and large boulders were added to the river creating rapids, thresholds, spawning areas and holding spots for sea trout. Approximately 130 tonnes of gravel and stones were added to the river with aid of a helicopter. In 2016, Södertälje municipality implemented similar habitat improving measures together with Länsstyrelsen in Stockholm and The Swedish Angling Society. During this restoration effort, about 80 tonnes of spawning gravel and larger stones, 50-80 cm in diameter, were added in three sites in the lower part of the river.

Initial phase

The aim of this project was to continue the restoration of the lower part of river to the condition it had before the dams were built and the riverbed was cleared from stones and boulders. The river habitat survey indicated that river heterogeneity previously had been larger and by adding stones and gravel diversity of both physical structures and species is predicted to increase. The measures were applied upstream the previous measures.

The area surrounding Bränninge mansion has high historical value, which is important to preserve. The present landowner would like to keep the dams and the ponds in their present state. The County administrative Board have had several meetings with the landowner. After these meetings permission was given to apply restoration methods on a stretch on his property. The only other landowner is Södertälje municipality, one of the organisations performing the restoration activities. During the planning phase, the bord of the municipality was briefed about the project and decided to approve it. Early communication with all stakeholders proved to be successful to get the needed permissions to perform this project.

Preparation phase

The County Administrative Board, Södertälje municipality and the Swedish Anglers Society planned, designed and oversaw the implementation of the restoration activities. For transport of stones and placing them in the river an entrepreneur procured within a framework contract with Södertälje municipality was used. Neither an environmental impact assessment nor any other applications were necessary for the planned activities. The use of framework contract with an entrepreneur experienced in similar work simplify the process and increase the quality of the work. It is highly recommended that project management with biological and hydromorphological expertise is present during the implementation to oversee the activities.

Implementation phase

In 2018 and 2019, the restoration work in Bränningeån continued upstream of the previously restored stretches (Figures 43 and 44). The restoration activities were carried out in two stages. The actions at stretches 1 and 2 (Figure 43) were implemented from 24 to 26 September 2018. Stretch 3 was restored on January 28, 2019. The reason that stretch 3 was restored in January was due to soft and sensitive ground conditions.

A total of 280 tonnes of gravel and stone were added to the river during the restoration. Most of the material was placed on stretches 1 and 2. Adding large stones and gravel to the river created heterogeneity and structure (Figure 45). On stretches 1 and 2, logs were also placed into the watercourse to provide additional complexity (Figure 46). An estimated 50 meters were restored at stretch 1 and 80 meters at stretch 2. At stretch 3, about 18 tonnes of gravel were placed along a 35-metre stretch to create for spawning grounds for trout. This stretch consists of an old stone lined part of the river close to the old hydroelectric power construction. On the site two larger riffles were created, designed as spawning sites. Existing deep pools were preserved. In conclusion, the measures created a greater variation in the river with better conditions for sea trout and biodiversity (Figures 47 and 48).

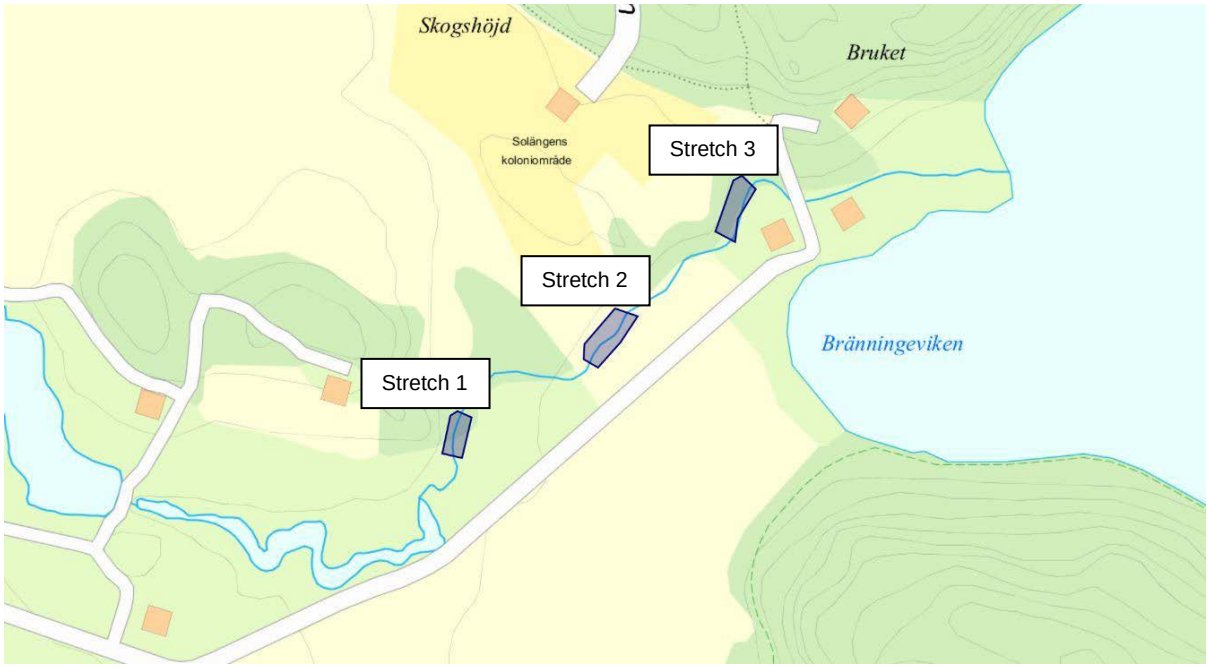


Figure 43. The three restored stretches.

Figure 44. Overview of the restoration sites.

Figure 45. A mixture of gravel, larger stones and existing logs were placed on stretch 1 and 2. Photo credit: John Kärki.

Figure 46. Logs and larger stones create hiding places, structure and holding spots. The picture is from stretch 2. Photo credit: John Kärki.

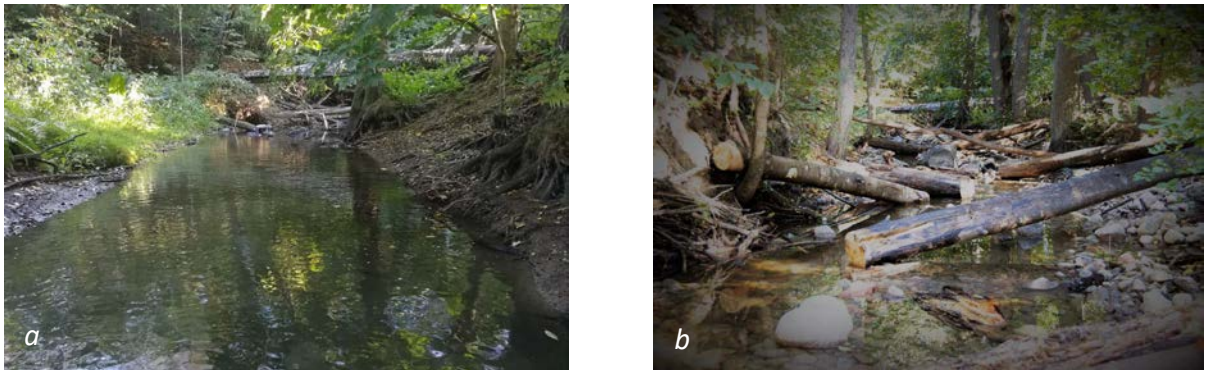


Figure 47. Stretch 1 before (a) and after (b) the activities. The cleared river stretch has been restored with stone and gravel bottom and plenty of large stone and logs. Photo credit: John Kärki.

At stretch 3, the sensitive and soft ground conditions made it impossible to get close enough with the heavy excavator to distribute stones in the river. To solve the issue, a specially designed pipe was used to get the gravel into the watercourse (Figure 48 and 49). In this way, the excavator could stand on stable ground a short distance from the watercourse and still reach into the watercourse. The pipe could easily be moved to reach new parts of the watercourse.

Figure 48. The deployment of gravel on stretch 3 was carried out with an excavator and a specially adapted pipe. Photo credit: John Kärki.

Figure 49. When the gravel had been added to the watercourse, it was distributed by hand. Photo credit: John Kärki.

Before the restoration in Bränningeån, teachers at a nearby middle school were contacted. Together with the teachers, a class was carried out on river ecology, the restoration of watercourses and sea trout biology for 4 school classes (Figure 50). The teachers prepared the students at the school and then the students themselves got to create a spawning area and roll larger stones into the river. In total, four days of restoration was carried out with the school classes. Afterwards, the teachers had follow-up activities about the activity. By linking larger nature conservation projects with activities aimed at schools and the general public, there is a good opportunity to create a better understanding of nature conservation measures. The results of the collaboration project with the school were very successful and there are already thoughts of doing similar activities in the future.

Figure 50a-c. Pictures from when students help to create a spawning ground and place larger stones in the Bränningeån river. The project with the students was carried out before the restoration with machines.

Evaluation of the project

With regard to river morphology the restoration measures in Bränningeån are at least a visual success. The heterogeneity and microhabitat diversity has increased largely. The river now has more riffles with gravel river floor and large stones creating spawning grounds and holding spots. It is, however, too early to see the long-term effects on sediment transport, meandering and other hydro-morphological processes on the river. A follow-up river habitat survey is planned for 2021.

In order to be able to follow up the effect of the restoration activities on the sea trout population, the river was electrofished prior to the work in 2018. The results will be compared with the electrofishing from the coming years and can thus be used to evaluate the effects of the restoration method with a focus on sea trout.

For stretch 2, which was restored in 2018, the trout density was very low at 4.1 individuals/100 m^2 before the measures were implemented. After the restoration work, the density was still 4.1 individuals/m^2 and only 2 individuals were found. However, the water flow was extremely low throughout autumn 2018 due to an extremely dry summer (Figure 52a), which may have had a negative impact on trout spawning in 2018 locally. It is therefore not possible to draw any firm conclusions from the results. We will have to await further electrofishing results during the coming years for safer interpretations.

In previous years the electrofishing has shown good effects from implemented habitat improvement measures in Bränningeån. In 2016, the trout density was estimated to be 7.6 individuals/100 m^2. In the first year after the restoration, 2017, the density had risen to 13.2 and in 2018 it was 30.3 individuals/100 m^2.

The communication with the primary stakeholder, the owner of Bränninge manor, has been very good throughout the project. The landowners' will of preserving the dams for the sake of high cultural

heritage values have been respected. A sign was put up inform passers-by about the project before the work started (Figure 43).

Figure 51. Two signs at Bränningeån. a) Information about the work to be done and its benefit for sea trout. b) Fishing is banned in the river and outside the river mouth.

Some additional conclusions may be drawn from the experience of the restoration work in Bränningeån.

Careful planning for the activities as well as continuous and close contact with the landowners concerned and the general public is of paramount importance for a successful project. Through good contacts, innovative mindset and prepared and experienced entrepreneurs, the project was able to be carried out with high efficiency and broad support.

It is difficult to visualise the river at different levels of flow and how it will look like at e.g., high flow conditions if the work is carried out at low flow conditions. The watercourses can often swallow more material than originally thought. The restoration sessions in September were performed during low flow due to a dry summer and autumn (Figure 52). During implementation, one could easily be led to believe that too much material was placed in the watercourse. Once the autumn rains came and water flow increased, it was clear that not too much material had been used. It is important to design the restored structures so that they have the wanted features across the full spectrum of seasonal variations.

Figure 52 a-c. During autumn 2018, the water flow in Bränningeån was extremely low due to a very dry summer. Immediately after the restoration, stones and gravel were therefore very prominent (a). Picture taken from stretch 1 on September 26, 2018. It was not until late autumn that rainfall and water flow increased. The picture was taken from stretch 1 on December 3, 2018 (b). At higher water flow, the restoration gave a completely different impression. Only the larger stones were visible in the watercourse. The picture was taken from stretch 1 on December 10, 2018 (c). Photo credits: Anton Larsson.

River Erstaviksbäcken: fish pass and habitat improvement

Country	Sweden
River	Erstaviksbäcken
Site	Erstavik manor
Type of sea trout population	Original population
Type of restoration	Replacing a not functioning fish pass with one that allows migration for other fish species, habitat improvement measures upstream the fish pass
Temporal scale of the restoration	Long term
Spatial scale of the restoration	Two stretches
Responsible organization	County administrative Board of Stockholm, City of Stockholm, Swedish Angler Society
Duration of the project	2 years
Geographical location WGS84	59-16.1582N, 18-14.9770E
Total budget	40 000 €

Background

Erstaviksbäcken is a small creek located in Nacka municipality and runs from Sandasjön down to Erstaviken (Figure 53, 54). The main channel is about 3.5 km and a tributary, which flows from Strålsjön

is about 1.5 km. The last 300 meters of the tributary are located in the Strålsjöns-Erstavik nature reserve. The river basin is 6.8 km^2 and is dominated by agricultural land, parks and gardens with mowed lawns. A river habitat survey showed that the creek is predominantly bordered by open field, often without or with only a narrow protecting tree zone along the creek. The lack of trees results in heavy growth of semi-aquatic plants such as reed and bulrush. Lately, replanting efforts have been carried through in some parts. Large parts of the creek are re-dug and straightened, and in some parts the creek is stone lined. Thus, the dominating hydromorphological type of the creek was classified as incised alluvial stream. The original hydromorphological type was assessed to be weakly meandering alluvial stream. More than 70% of the river have modified hydromorphological type. The dominating riverbed substrates are sand and clay, with clay closer to the mouth in the sea (Erstaviken) which is unsuitable for trout spawning. Somewhat better spawning grounds exists upstream the migration obstacle. The creek is calm for the most part, with only a few riffles.

There are three man-made migration obstacles in the creek. The lowermost is a poorly functioning fish pass situated close to Ersta Manor, 200 m from the river mouth. In theory it is passable for seatrout, but in reality, only a few trout are found upstream, despite better spawning grounds.

The morphology changes and the migration obstacles result in unsatisfactory morphology and connectivity status according to the Water Framework Directive.

Figure 53. Erstaviksbäcken (Erstavik creek) overview.

At present, there are only a few stretches that are good trout habitats in Erstaviksbäcken. This is due to the large changes of the creek morphology resulting in fine bottom material and lack of shading trees. The best parts are in the upper parts of the creek, which is difficult to access due to the migration obstacles. Despite the seemingly poor environment, there is a unique trout population in the creek. However, the numbers have decreased steadily since it was discovered in the late 1980-ies (Figure 55). Spawning redd counts confirm this picture. Yearly redd counts since 2014 have resulted in a total of only 4 redds, an average of 0.7 per year. Part from seatrout, pike, river lamprey and cray fish (*Pacifastacus leniusculus*) have been found in the creek. The river lampreys have been found downstream the fish pass, but not upstream.

Based on the electrofishing and river habitat survey data it is concluded that that the poor status of sea trout (and river lamprey) is at least in part caused by the migration obstacles and poor river morphology. Possible restoration activities include removal or improvement of the fish pass, tree planting in the riparian zone, habitat improving measures e.g., re-introducing gravel and large stones to create spawning grounds and holding spots. The planned restoration activities are described in Figure 56.

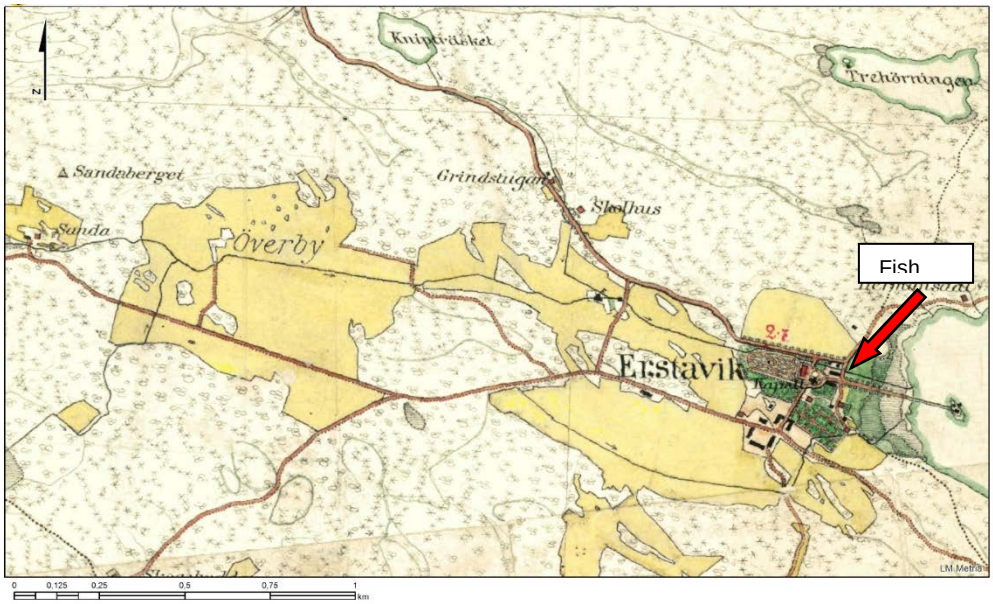


Figure 54. Erstavik manor. Present site for fish pass marked.

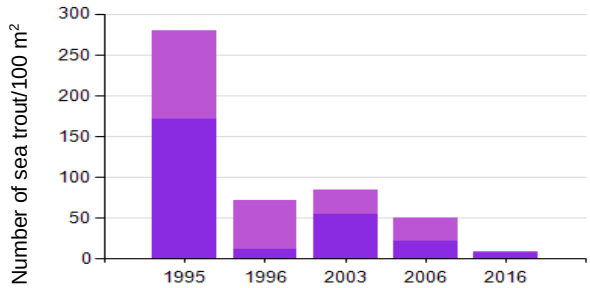


Figure 55. Electrofishing results from Erstaviksbäcken. Average of 6 sites.

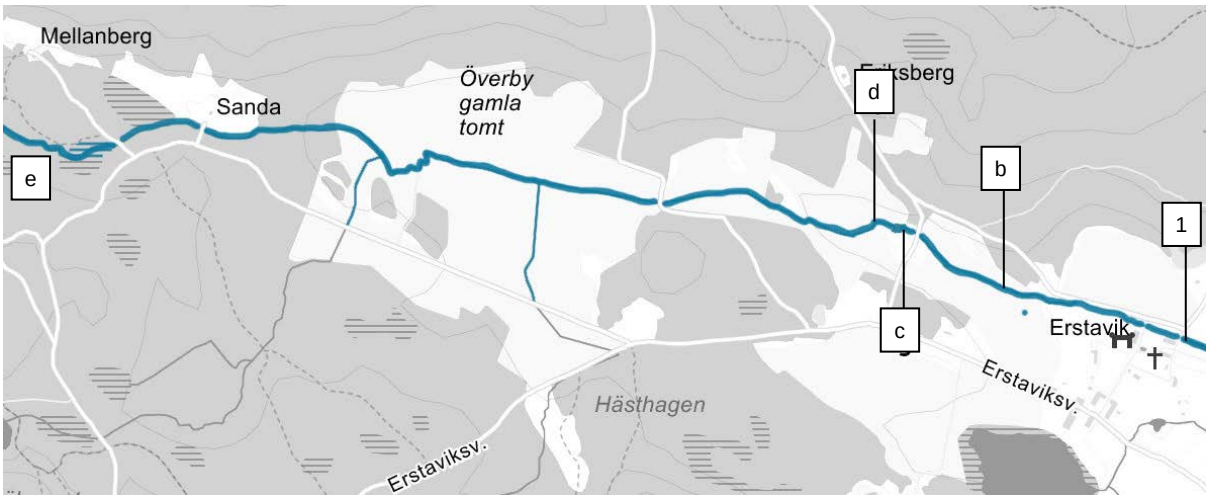


Figure 56a-e. The letters refer to comments and photos below. Photo: Oliver Karlöf.

a. The old fish pass. Migration obstacle at low flow conditions.

b. Wooden threshold downstream of the fish pass, Migration obstacle at low flow conditions.

c. Wooden weir upstream the fish pass. Migration obstacle at low flow conditions

d. Remnants of an old water driven saw. Probably not a migration obstacle

e. Potential spawning grounds close to the source lake (Sandasjön)

Initial phase

The long-term aim of the restoration activities in Erstaviksbäcken is to create conditions for a stable and growing trout population and increase biological diversity upstream the malfunctioning fish pass. The area around Ersta manor has high cultural heritage values and a park, frequently visited by the public. Any restoration activities must be planned carefully to preserve these values. A planning meeting was held with representation from the implementing authority (The County Administrative Board of Stockholm and The City of Stockholm), NGOs (Swedish Angling Society and a local fishing club, Saltsjöbadens fiskevårdsförening) Nacka municipality and the landowner (Ersta manor). The municipality was represented by a cultural heritage expert. During discussions it was clear that replacing the technical fish pass with a natural fish pass was not an option due to the sensitive settings around the manor. The suggestion to build a new fish pass with less slope to allow other fish than trout to pass was accepted by both the landowner and the cultural heritage expert. The landowner has been kept informed during the whole process from planning to implementation. Early discussions with all stakeholder groups proved to be a success factor. Later, the local fishing club (Saltsjöbadens fiskevårdsförening) volunteered during habitat improvement measures upstream the fish pass.

Planning phase

The planning involved five organisations, The County Administrative Board of Stockholm, The City of Stockholm, the Swedish Angling Society, Nacka municipality and the landowner. A design company was procured. The design was discussed with the planning group which decided to build the fish pass in wood (Figure 57). The activity will be followed-up as part of the regular electrofishing monitoring programme by the city of Stockholm. Redd counts will be performed as well.

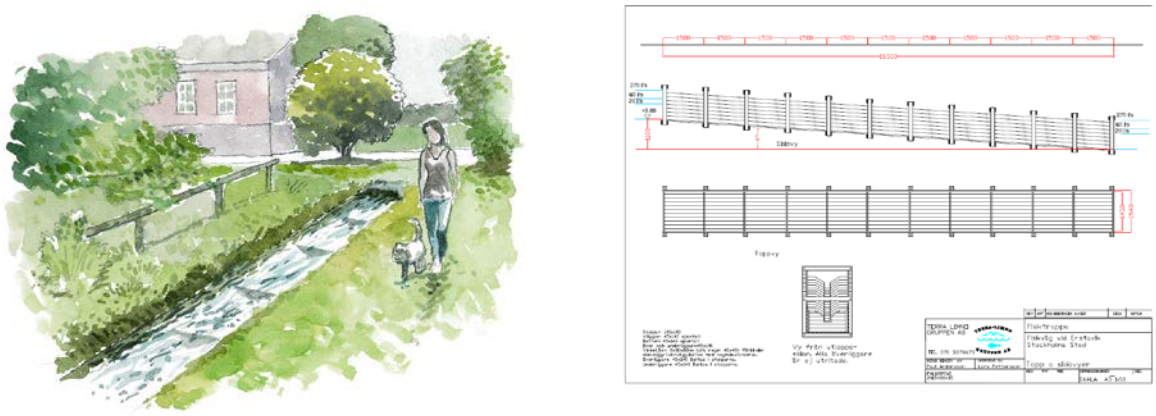


Figure 57. illustration of the fish pass in the planned setting (left). Technical sketch of the fish pass (right).

Preparation phase

The project involved an exchange of an existing fish pass, which was considered to be a minor change. Thanks to this and to the municipality being involved in the planning process there was no need for an environmental impact assessment. The approval and continuous information to the municipality officials was sufficient. When the design was accepted by all parties, a carpenter was procured to build the fish pass, to remove the old fish pass and to install the new one.

Implementation phase

Before the installation of the fish pass habitat improvement measures were implemented upstream the old fish pass. With the aid of two local fishing clubs (Saltsjöbadens fiskevårdsförening, Enskede Fiskeklubb), spawning gravel and larger stones were placed in stretches with riffles to create spawning grounds. The work was carried out over a few days and was appreciated by all who participated (Figure 58).

It took three days to remove the old fish pass and install the new one (Figure 59). The first attempt to install the fish pass did not succeed completely. There was water running besides the pass, which is not wanted. The builder had to return to seal the leak. Later that caused a disagreement about the bill, which could have been avoided had the contract been made clearer. The completed fish pass seems to work according to plan, but it is too early to judge now. The evaluation programme will later provide more information.

Evaluation of the project

It is too early to know whether the fish pass will have the wanted function or not, but the water flow through the pass as predicted. However, the fish pass is a compromise to save the cultural heritage values of the manor and park environment. A more natural fish pass would have been preferred had there been no other interests to consider. It is believed though that the resulting fish pass will have the wanted function. Trout as well as river lamprey (*Lampetra fluviatilis*) and ide (*Leuciscus idus*) are expected to be able to get through the fish pass to their spawning areas. The project will be followed up by electrofishing and redd counts during 2021. Late in 2020 sea trout and spawning redds were observed upstream the fish pass. Likewise, the habitat improvement measures will be evaluated during 2021.

Figure 58. Members of Saltsjöbadens fiskevårdsförening and Enskede Fiskeklubb volunteering to work with habitat improvement measures upstream the fish pass in Erstaviksbäcken. Photo: Oliver Karlöf.

Figure 59. The old fish pass is removed (upper left) and the new one is installed. When the leak was sealed all pools was filled as planned (lower right). Photo: Oliver Karlöf.

River Vitsån: habitat improvement

Country	Sweden
River	Vitsån with tributary Rocklösaån
Site	Vitså mill and Tungelsta park
Type of sea trout population	Mixture of wild and stocked, yearly stocked with roe and alevins
Type of restoration	Habitat improvement after dam removal, habitat improvement in a park
Temporal scale of the restoration	Long term
Spatial scale of the restoration	One stretch, 300 m
Responsible organisation	County administrative Board of Stockholm, Haninge Municipality, Swedish Angler Society
Duration of the project	12 months
Geographical location WGS84	59-4.9072N, 18-8.7943E
Total budget	15 000 €

Background

Vitsån flows from lake Öran in Haninge municipality south of Stockholm through wetlands, woodland, agricultural land, settlements, industrial areas, and culverts. It passes both straightened and meandering stretches, ponds, and near the sea a gorge lined with old growth spruce forest. The tributary Rocklösaån connects from Lake Vedasjön.

The environmental quality of the river does not fulfil the binding goals of the EU Water Framework Directive (WFD). The ecological status according to the WFD is moderate, with the hydro-morphological factors displaying poor status. The river is heavily affected by human activities such as straightening, removal of stones and logs, culverting, construction of impoundments and other structures preventing fish migration, land fill and drainage, and the use of the riparian zones for agriculture, settlements and roads. A river habitat survey confirmed these general observations. The hydro-morphological characteristics of the river have changed due to human action in more than half of the stretches. Stretches that originally were of the riffle-pool type, often good trout spawning areas, have decreased by 60 %. Clay is the dominating riverbed substrate, but there are also stretches with gravel or boulders. Calm water is dominating, but there are also stretches with runs, riffles, or glides. These results translate into suitable habitats for spawning and young sea trout in about 10 % of the river. Holding spots exist in most parts of the river, though.

Despite the generally poor environment, seatrout is reproducing in several stretches in the river. Electrofishing data show that trout have been spawning in the lower part of the river since the late 1990s. The river was stocked until 1997 but have not been stocked with trout 0+ and older since then. However, roe and newly hatched trout (alevins) have been introduced yearly at Fors, 5 km upstream one site and 6 km downstream another site where restoration work is planned. The number of trout found is generally quite low, and with the available spawning and nursery areas having decreased with perhaps as much as 60 %, the potential for increased production and biological diversity is large, provided that efficient restoration measures are applied.

To achieve good status in Vitsån there is an extensive need for measures in the whole watercourse. In large parts of the river, the possibility of implementing adequate measures is limited or hampered by urban settlements and active farming. Nevertheless, two restoration projects are planned in Vitsån (Figure 60).

One site is close to the river mouth: Vitså kvarn (Vitså mill) (Figure 61). The mill was erected in the 17th century and is visible on the map from 1784 (Figure 62) and 1901 (Figure 63). It was used until 1943 when it was demolished, but a dam building with a concrete overflow spillway and a poorly functioning concrete fish pass remained. Both the pond and the former fish pass were demolished in 2015. A stone bridge originating from the time of the mill and with high historical value is still there.

When the dam was removed a large area of thick sediments were visible. The "new" river had originally thick layers of sediment covering the river floor. The aim of this project is to try to restore the river to the state before the dam was built. It is however difficult to create a "natural" river floor from scratch and more tests are needed. This project will add important experience to the river restoration knowledgebase.

The second project concerns habitat improvement measures in the tributary Rocklösaån flowing through a park in the small community of Tungelsta (Figure 64, 65). It is a part of the municipality vision to make the values of nature more accessible to the visitors of the park. The aim is to create spawning sites and nursery areas for young trout. Due to the lack of suitable areas for trout in the Vitså river, and the difficulty of identifying sites where restoration measures are possible, the Tungelsta park is one of the few sites where this type of activities are possible.

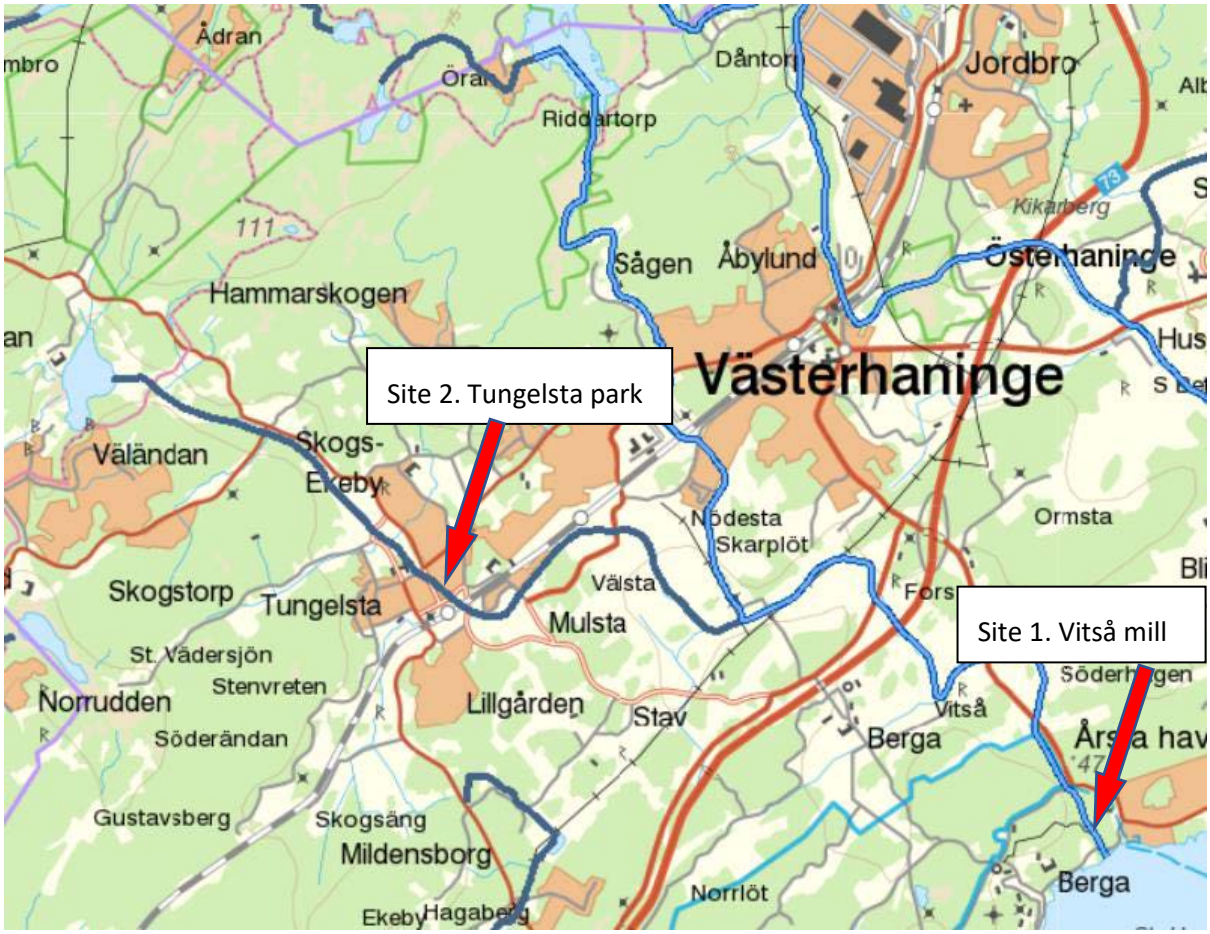


Figure 60. The two restoration sites.

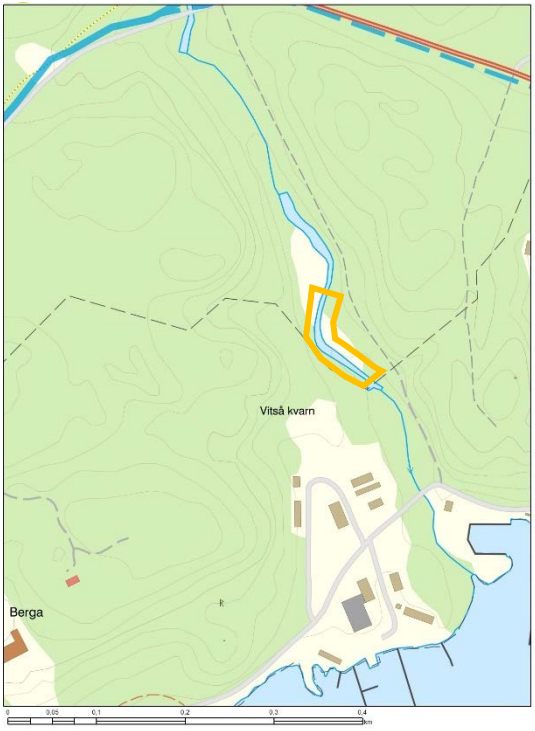


Figure 61. Restoration site at Vitså mill.

Figure 62. Vitså mill at 1901.

Figure 63. Vitså mill at 1784.

Initial phase

The activities were planned jointly between Haninge municipality, the Swedish Angler Society which performed the dam removal) and the County Administrative Board. The aim of the activities was to improve the river environment for sea trout and other aquatic organisms and to create a more heterogenous habitat with spawning and nursery sites for the trout.

Haninge municipality was the main responsible authority for the restoration activities in Vitsån. For any type of construction activity in or close to water, it is necessary to apply for a permit at the County Administrative Board, or for large projects, to the environmental court. When the dam was removed in 2015 an application for those activities was filed to the County Administrative Board of Stockholm. The application included the habitat improvement activities described in this report as well. It was referred to the two stakeholders, Södertörn's Environment and Health Protection Association which is the local environment and health authority for the municipalities Haninge, Tyresö and Nynäshamn, and to the landowner, which is the Swedish armed forces. None of these authorities had any objections to the planned activities given that sufficient precautions were taken to avoid increased turbidity of the water and leakage of hazardous oils from the machinery used. During the removal of the dam, precautions were also taken to protect the old stone bridge and other remnants of the mill, which both have high cultural heritage values. For the planned activities in 2018, only a supplement had to be filed to the deciding authority, describing the activities in more detail.

For the activities in Rocklösaån at Tungelsta park a full application was submitted to the County Administrative Board. The application was referred in writing to the identified stakeholders: Södertörn's Environment and Health Protection Association and the four landowners. Södertörn's Environment and Health Protection Association approved the application under the condition that thorough precautions were taken to avoid increased turbidity of the water and leakage of hazardous

oils from the machinery used. Of the other stakeholders, only one expressed its opinion, which was approval of the activities. No meetings were arranged.

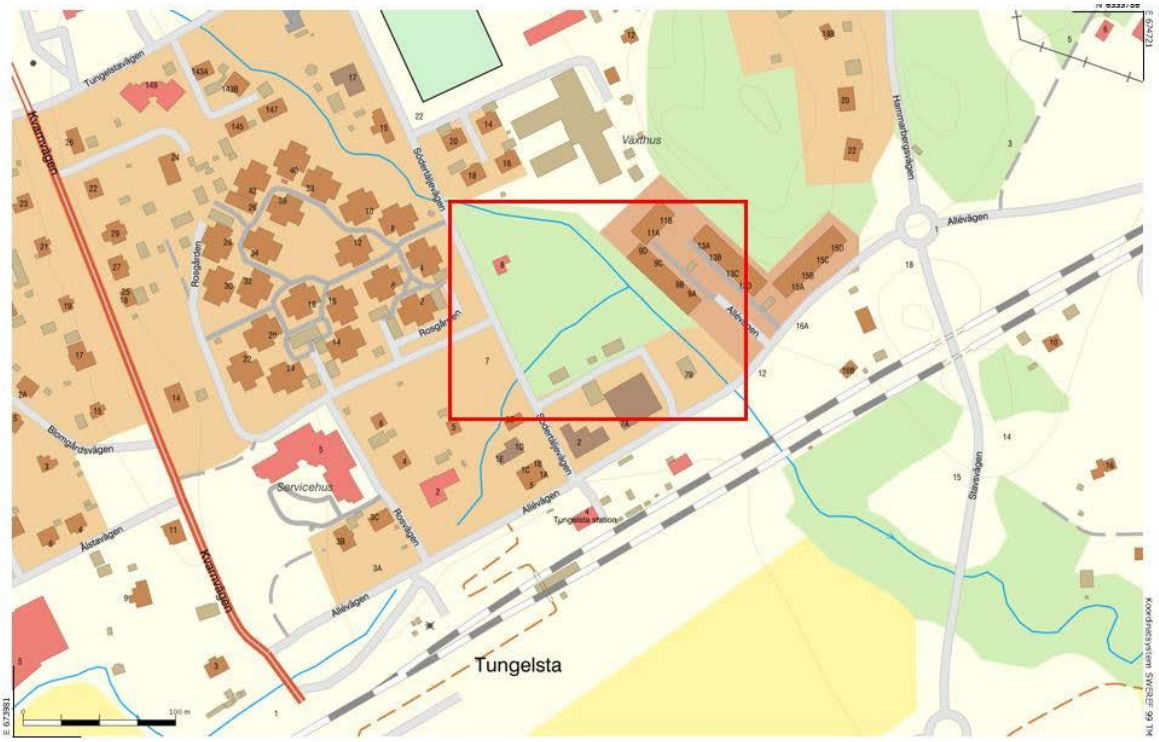


Figure 64. Tungelsta park. Part of Rocklösaån where measures took place is marked.

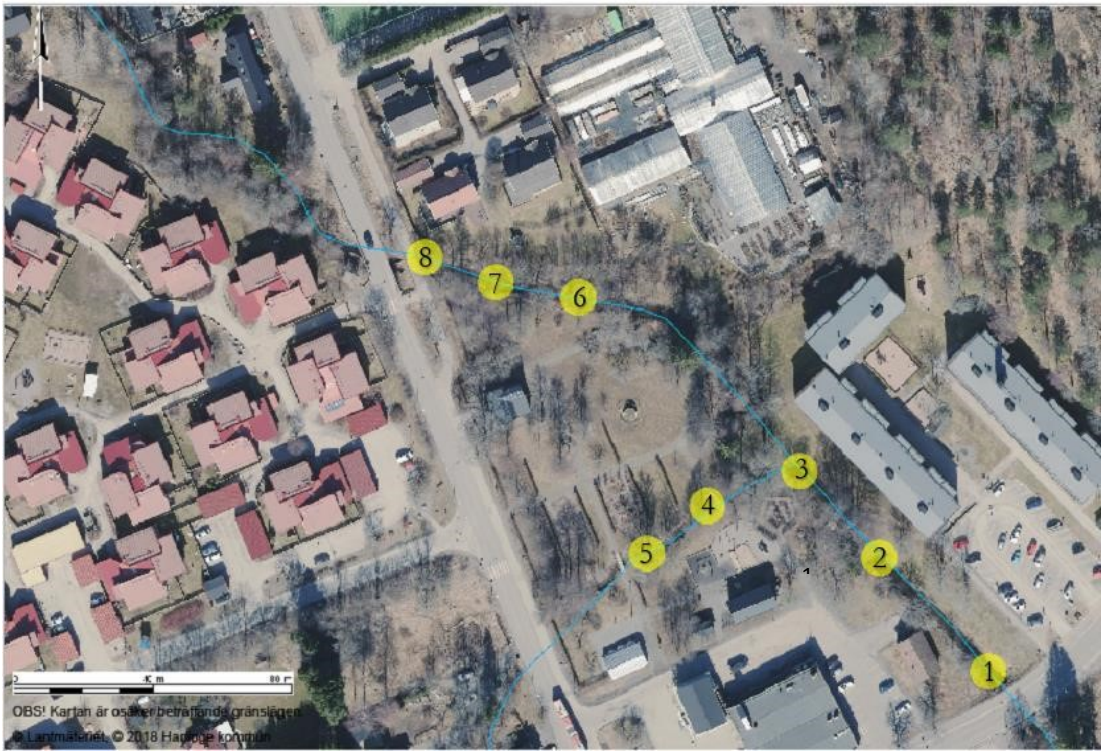


Figure 65. Tungelsta park. The 8 sites in Rocklösaån where measures took place.

Implementation phase

Vitså mill

At the Vitså mill site, stones of different sizes took were deployed on August 16-17, 2018 on an approximately 120 m long stretch upstream of the former dam building (Figure 66, 67). Coarser stones were laid at the bottom of the riverbed with smaller fractions on top. Some deeper parts were saved to create an as varied environment as possible. Several larger logs were placed in the watercourse. The water level was very low at the time of the action. The work was carried out by the Haninge Municipality's construction and works department with a track-borne 14 tonnes excavator, one wheel-borne 14 tonnes excavator and a dump truck. A transport road was built with canvas and gravel down to the river from the road at the former dam building. The transport road was then removed when the work was completed.

On December 7, 2018, plants of alder (*Alnus glutinosa*) were planted along the eastern side of the watercourse to increase shading of the water. 25 plants 200-250 cm and 40 plants 40-60 cm were planted adjacent to the watercourse on slightly different distance apart; some of these were positioned leaning over the watercourse.

Figure 66. Dumpster in action at the Vitså mill site.

Figure 67. Vitså river upstream the old mill before (left) and after (right) the activities.

Tungelsta park

In mid-September 2019, gravel and stones of different sizes were placed in Rocklösaån where the river flows through the Tungelsta park. A total of 50 tonnes of stones and gravel were distributed in about eight different locations from the railway station to just upstream the road Södertäljevägen, including in a small tributary to Rocklösaån (Figure 65). In these places, short riffles and sea trout spawning sites have been created (Figure 68, 69).

The work at Tungelsta Park was carried out by Haninge municipality's construction and works department under the leadership of the park department and with the support of the Swedish Anglers Society.

Figure 68. Site 6 in figure 6. Before activities October 2019.

Figure 69. Site 6 after activities September 2019 (left) and January 2020 (right).

Evaluation of the project

Before the habitat improvement activities began, an electrofishing survey was performed both at Vitså mill and at Tungelsta park sites by the Swedish Anglers Society. Follow-up studies in 2019 and 2020 at Vitså mill showed that the number of yearlings increased whereas the number of older fish decreased (Figure 70). The reason is that the stretch after the habitat improvement activities is shallower, has a faster flow and much larger heterogeneity, which is more suitable for young trout.

At Tungelsta park, follow-up electrofishing will be carried out in 2021. There are however already proof of trout spawning in the restored stretch. During a visit on November 22, 2019, 5 spawning pits were found (Jennifer Isaksson, Haninge municipality and John Kärki, Swedish Anglers Society). In previous years before the measure was completed, no more than one spawning pit could be identified at the site. Furthermore, the habitat improvement efforts at Tungelsta park have also been used for educational purposes for school classes through a dedicated "Sea trout day".

To conclude, both habitat improvement measures were successful with regard to hydro-morphology. The stretches are now more heterogenous, with gravel, stones and in the Vitså mill site, boulders, and large woody debris. This has shaped a more diverse river environment with larger variation in flow and river floor substrate, creating more niches and thus, in the end presumably a larger biological diversity. The activities also created a more attractive recreation environment. The park in Tungelsta is frequently visited by the local population and the County Administrative Board arrange yearly excursions the Vitså mill site during sea trout spawning time.

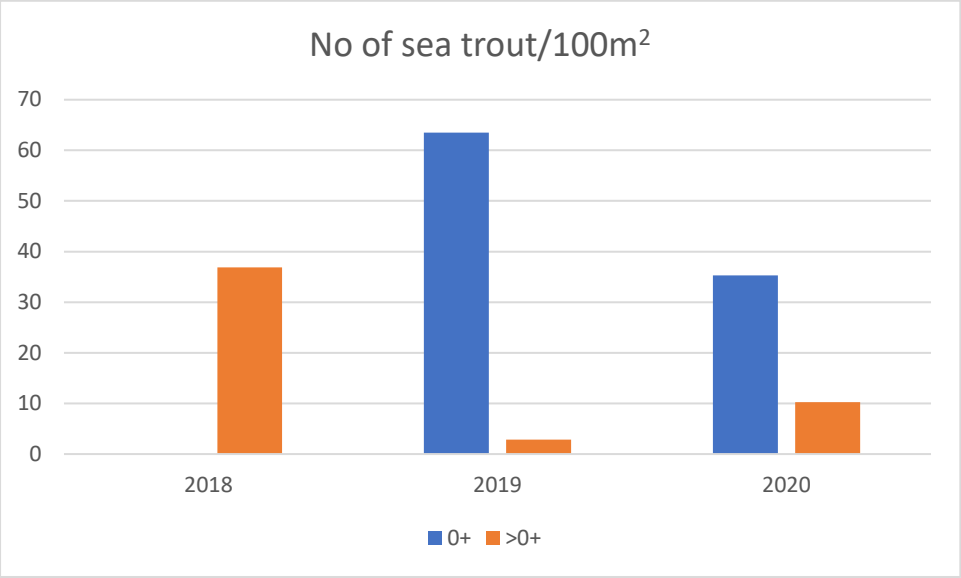


Figure 70. Number of 0+ and older sea trout per 100 m² at the Vitså Mill site.

River Skeboån: Habitat improvement and plans for fish pass

Country	Sweden
River	Skeboån
Site	Hallstavik paper pulp mill, Häverödal, Skede, Skebobruk old ironworks
Type of sea trout population	Mixed, yearly stocked, reproducing poorly
Type of restoration	Habitat improvement, plans for fish pass, hydrological investigation
Temporal scale of the restoration	Long term
Spatial scale of the restoration	Three stretches distributed over 10 km
Responsible organization	County administrative Board of Stockholm, Swedish Angler Society
Duration of the project	4 years
Geographical location WGS84	From 59°58.105'N 18°36.555'E to 60°1.895'N 18°37.433'E
Total budget	140 000 €

Background

Skeboån is situated in Norrtälje municipality 100 km north of Stockholm. The river basin is 480 km^2 and is dominated of forests with about 10 % agricultural land and just below 2 % of urban areas (Figure

71). The river flows from Lake Vällen near the border to Uppsala County and empties into Edeboviken by Hallstavik. The water quality is better in the upper parts of the river, with the lower parts having unsatisfactory ecological status according to the Water Framework Directive. The major environmental problems are eutrophication, migration obstacles and physical impact – clearing of stones and logs, straightening of the river, removal of controlling sections. However, the river has good potential as a sea trout habitat and is recognised by HELCOM as one of the Baltic Sea watercourses that need to be restored to increase the production of sea trout in the Baltic Sea[3]. The great potential is not realized today in part due to several dams that constitute migration obstacles for sea trout and other fish. At the river mouth there is a dam with a fish ladder with limited passability. 10 km upstream, in Skebobruk old ironworks, there is another dam which is a definite migration obstacle for all fish. There are sea trout between these migration obstacles, but the population is according to electrofishing results weak. The reason for the weak population is not known, but general poor habitat quality is belied to be important. Some habitat improvement measures have been implemented earlier with good results, but the work needs to continue. The project intends to design and build a fish pass at the dam at the mouth to increase the possibility for fish to pass and to work with habitat improvement measures between lake Närdingen and the river mouth. Responsible for the activities have been The County Administrative Board in Stockholm and The Swedish Angling Society.

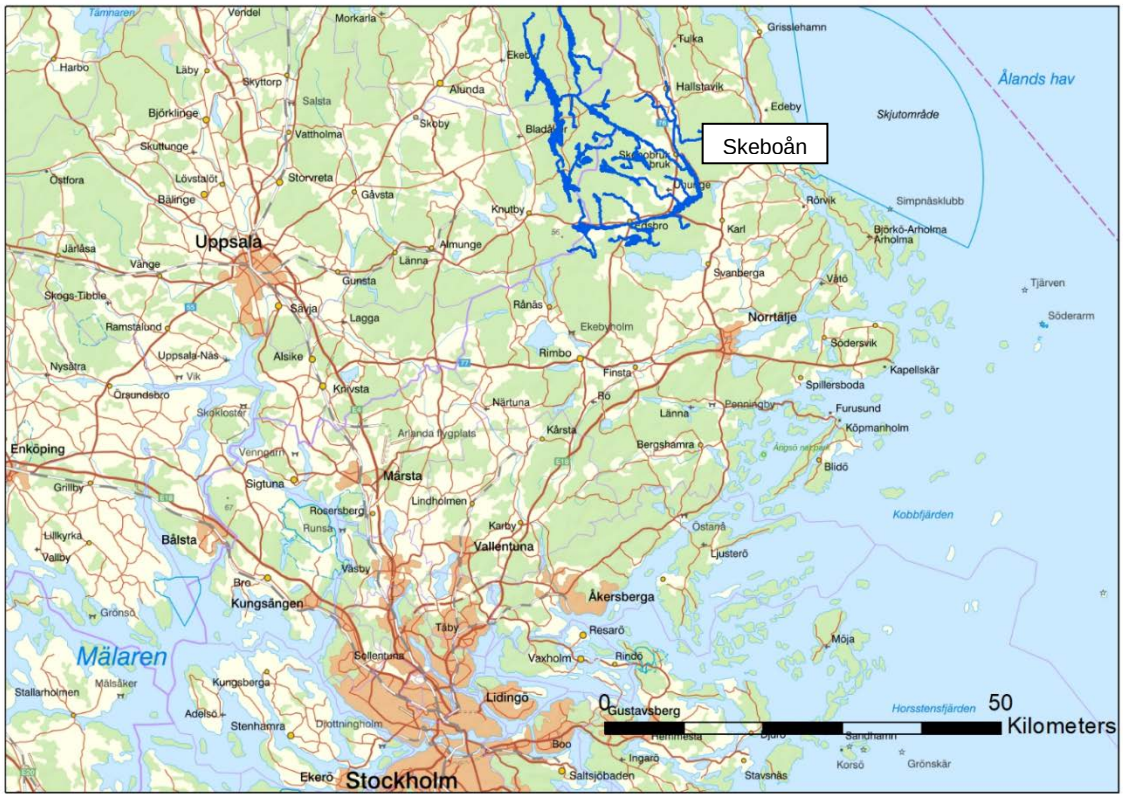


Figure 71. Skeboån, overview

[3] HELCOM Recommendation 32-33/1. Conservation of Baltic salmon (*Salmo salar*) and sea trout (*Salmo trutta*) populations by the restoration of their river habitats and management of river fisheries.

Initial phase

The Skeboå project comprise two main parts (Figure 72):

i. A fish pass past the dam close to the river mouth, Skärbrodammen
ii. Habitat improvement measures at three stretches between the dam in Skebobruk and the river mouth

The fish pass is a very complicated project, demanding several time-consuming investigations and discussions with the landowner and it will not be completed during the project implementation time. There are, however, several useful experiences to take home from the process so far. Two of the habitat improvement measures have been possible to carry out during the project lifetime. Plans for the third project are completed and ready to be implemented when time and funding is available.

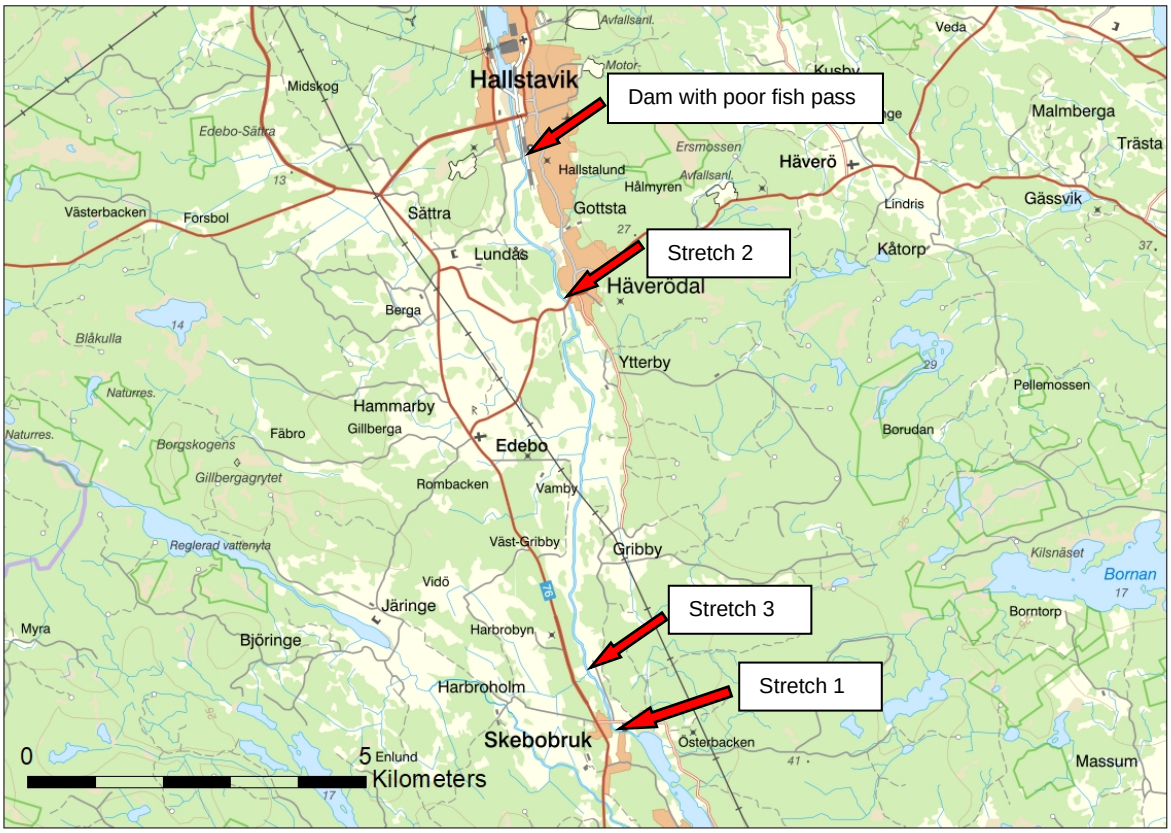


Figure 72. Skeboån, overview of the restoration sites

Fish pass

Close to the mouth in Skeboån, there is a dam with the purpose of providing a paper pulp mill with water (Figure 73). The water is led to the factory through a dug canal parallel to the river. In the end of the canal is a pond where the water intake to the factory is placed. In addition, the municipality waterworks has a water intake in the pond. The dam has a poorly functioning fish pass which is a migration obstacle for all fish except strong sea trout. In addition, it is open only 6 weeks a year and completely closed for fish migration the rest of the year. The paper pulp mill has permit to regulate water flow in all lakes in Skeboån river basin. The regulation is balanced to ensure enough water in the factory, which is operated around the clock all year round. The water flow from each lake is monitored and regulated manually. Extremely dry years (e.g., 2018) as much water as is allowed according to the permit has been drained from all lakes.

For the biological diversity of the river, the best solution would be to remove the dam completely. The factory would then loose the water regulating capacity and would during long periods have to find other sources of process water. However, there are no other water sources available, which means that the factory would have to close. The second-best solution is a fish pass that resembles a natural river, and if that is not possible, a technical fish pass could be built. The quality requirements that any type of fish passage must meet are

- The fish pass must be passable for most of the year, i.e., there should neither be too little or too strong flow in the fish pass.
- All fish, both weak and strong swimmers must be able to pass
- The fish must be able to find the entrance of the fish pass both during upstream and downstream migration
- There must be enough water in the fish pass during most of the year. Shorter time periods the pass may be closed, but in that case, there should be pools with water where the river fauna can survive. This is especially important if spawning grounds are constructed in the fish pass.

There have been several meetings with representative of the paper pulp mill, including an on-site meeting where different possibilities and solutions have been discussed. During these meetings it was clear that the paper pulp factory is positive to a fish pass under certain conditions.

- The fish pass must not in any way risk to jeopardise the production in the factory
- There must be enough water for the production
- It must be possible to close the fish pass via remote control

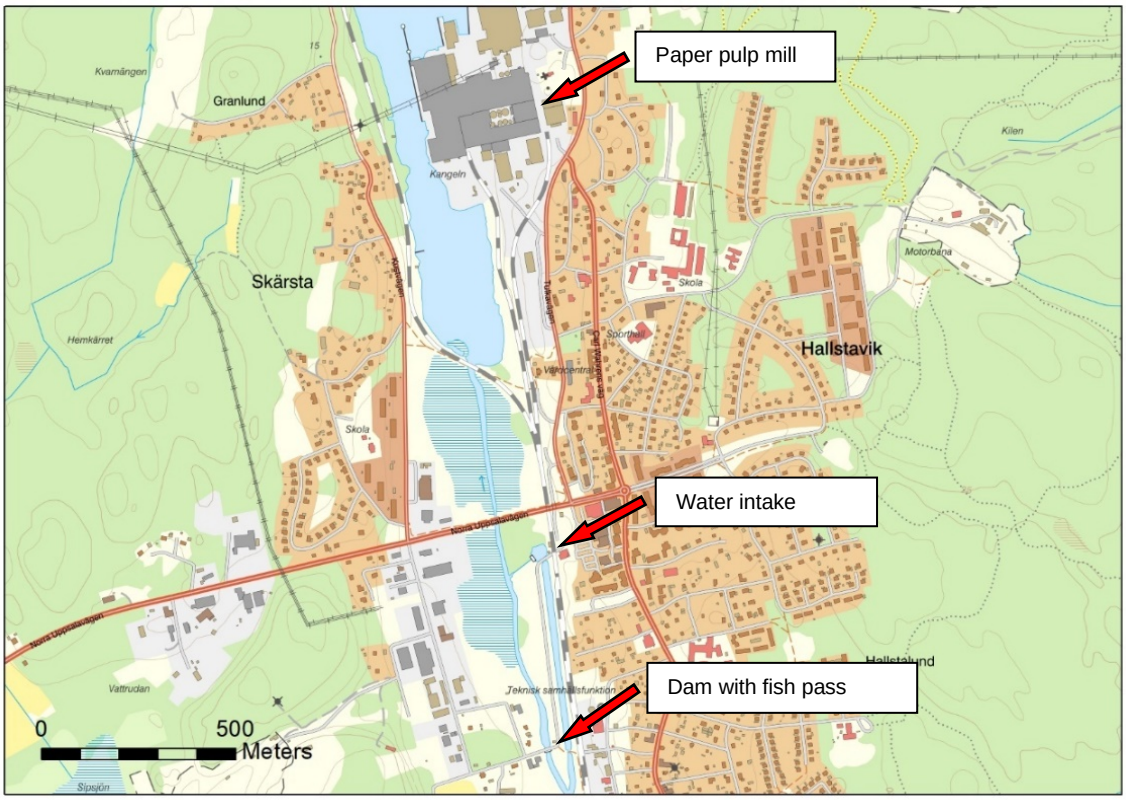


Figure 73. The dam at Hallstavik, Skärbrodammen.

The municipality of Norrtälje, which run the waterworks that provide the community of Hallstavik with drinking water, has been informed of the plans of a fish pass. The response from the municipality is positive provided that water from the treatment plant, which has its discharge in Skeboån, does not risk reaching the water intake to the waterworks.

The most important question to answer is if there is enough water for all uses; fish pass, factory and drinking water. A preliminary analysis of water flow data in the river basin based on open model data from the Swedish Meteorological and Hydrological Institute (SMHI, https://www.smhi.se/data/hydrologi/vattenwebb) reviled that there should be enough water for all purposes. However, a more detailed model study will be necessary to determine in this is the case.

Habitat improvement measures

The sea trout population in river Skeboån is mixed between stocked smolt and wild reproducing trout. The proportion of the different strands in the electrofishing catch is not known; no genetic analysis has been performed. The trout population has been monitored regularly with electrofishing from 1995. The river has been stocked yearly with approximately 3000 smolt every time. Some of them may return to spawn later; on average 30 spawning redds have been found during yearly redd counts between stretch 1 and the dam with fish pass (Figure 72, Figure 74). However, the survival seems to be low because only few yearlings are found during electrofishing surveys (Figure 75).

The reason for the low numbers of fish is not clearly understood. There are several possible reasons. The nutrient load in the river is high; the status according to the Water Framework Directive is moderate, which means that the environmental goal is not reached. On the other hand, the benthic fauna is rather divers, with some rare species, indicating that river environmental conditions are acceptable and there should be enough food for the young trout. A river habitat survey was performed to quantify the morphological changes in the river. The hydromorphological type had changed in 64% of the river in the survey area (from the mouth to lake Närdingen in Skebobruk), and 83% of stretches with large stones and boulders had disappeared. This type of stretches is often suitable for sea trout, providing holding spots and a diverse environment. In fact, suitable sea trout habitats or possibly suitable habitats, were only present on 12% of the stretch, a few hundred meters out of 10 km. At three stretches, e.g., at stretch 2 Häverödal, evidence of removed controlling sections were found. Large piles of stones and boulders were found on the riverbank. Removal of a controlling section result in a lowered base level which in turn triggers fluvial processes like erosion upstream and sedimentation downstream. The watercourse gets deeper and loses contact with the floodplain. This will in turn increase erosion during high flow conditions since the water cannot overflow the floodplain. The result is even more increased erosion, creating suboptimal conditions for aquatic organisms.

From the survey it is concluded that the large changes could at least in part be responsible for the poor status of the sea trout population. It is however also necessary to improve the water quality by other means, especially nutrient leakage from agriculture and poor single house sewage systems.

Even though an unambiguous explanation for poor survival of young trout is not at hand, the large physical changes of the river are likely to be important. Therefore, it was decided to make an attempt to improve the river habitat in part of the river. Based on the result from the river habitat survey, three stretches were chosen for habitat improvement measures. At Skebobruk, a former canal under a bridge was planned to be dug open as well as spawning ground and holding spots (Stretch 1a and b, Figure 76). At Häverödal (stretch 2, Figure 77), spawning grounds and holding spots were planned and at Skede (stretch 3, Figure 78) increased riverbed diversity and an opened parallel branch were planned.

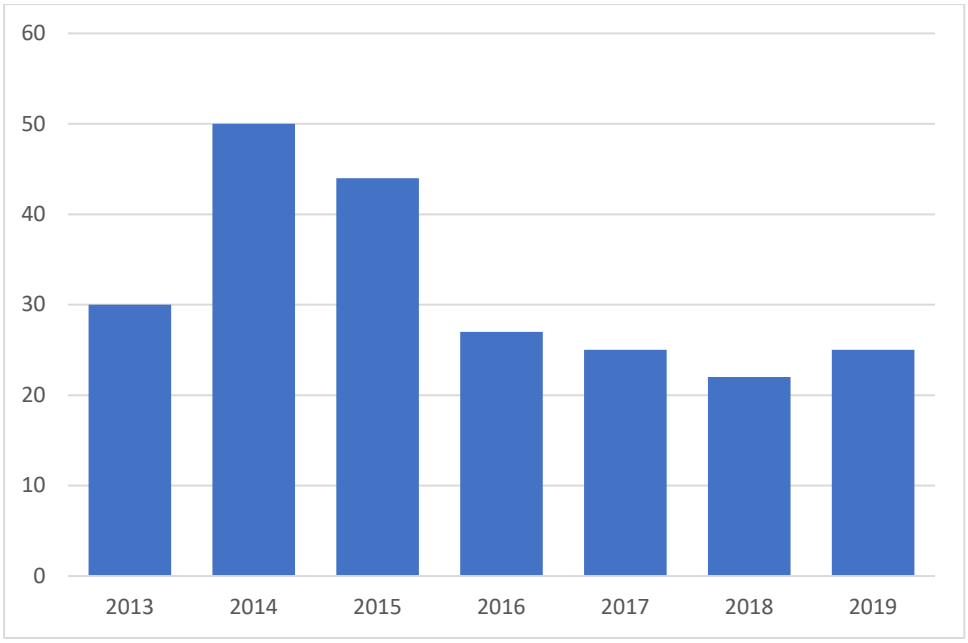


Figure 74. Spawning redd counts in Skeboån from Skebobruk to Hallstavik. Number of redds found during a one-day count.

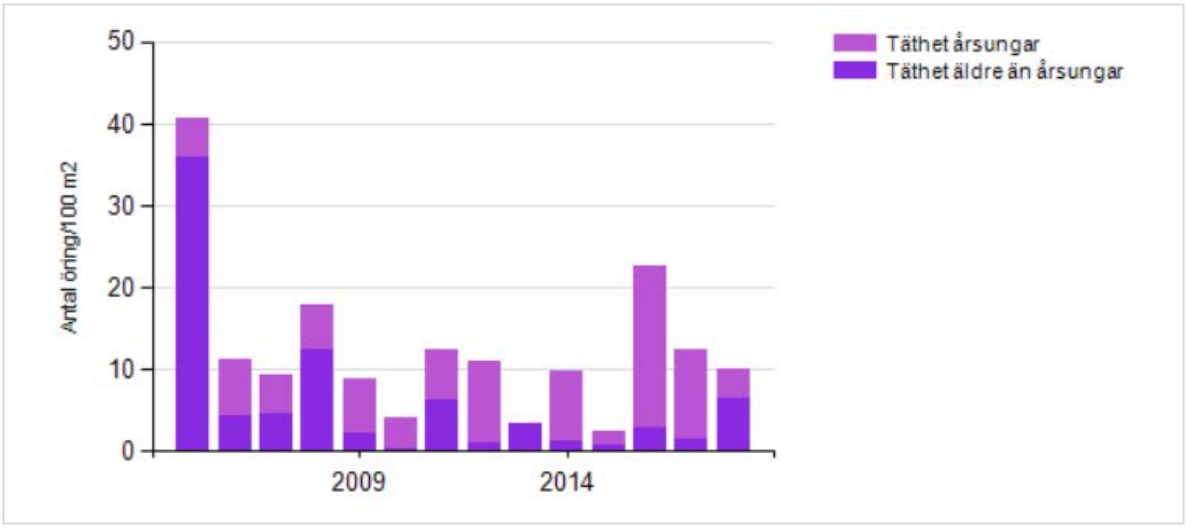


Figure 75. Electrofishing results from 4 sites in Skeboån from 1995 to 2018. Average of results from 2 or 3 sites.

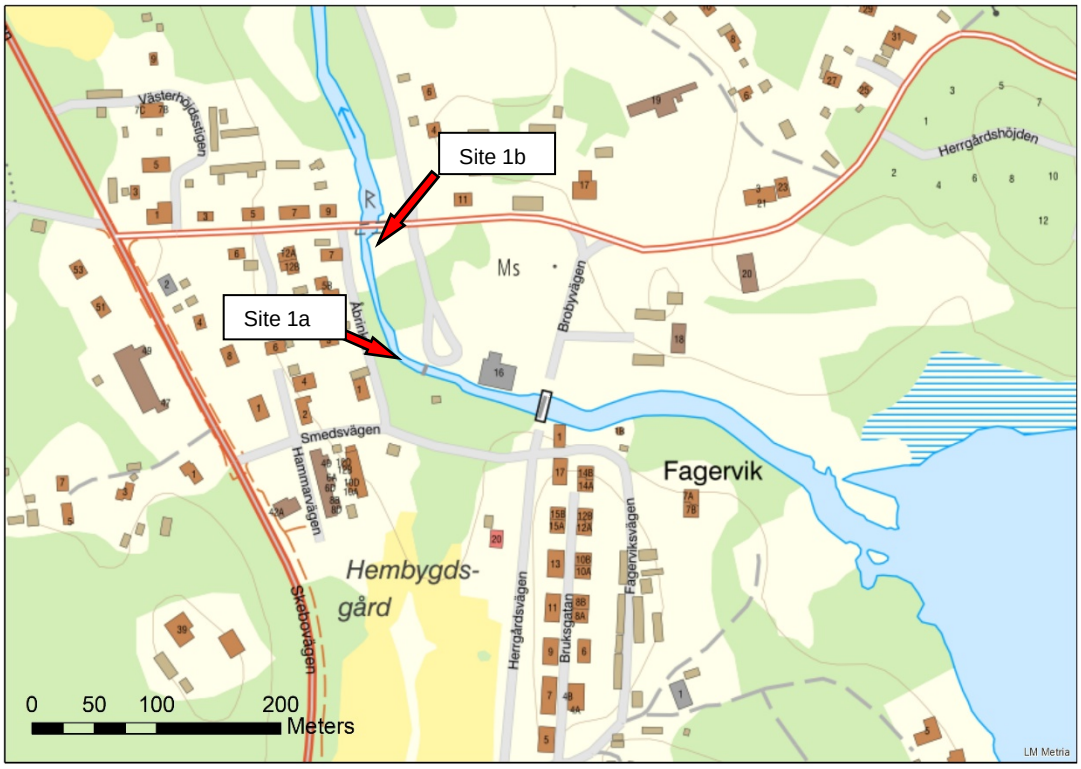


Figure 76. Stretch 1, Skebobruk old ironworks. At site 1a habitat improvement measures were applied, and at site 1b a multichannel stream was restored.

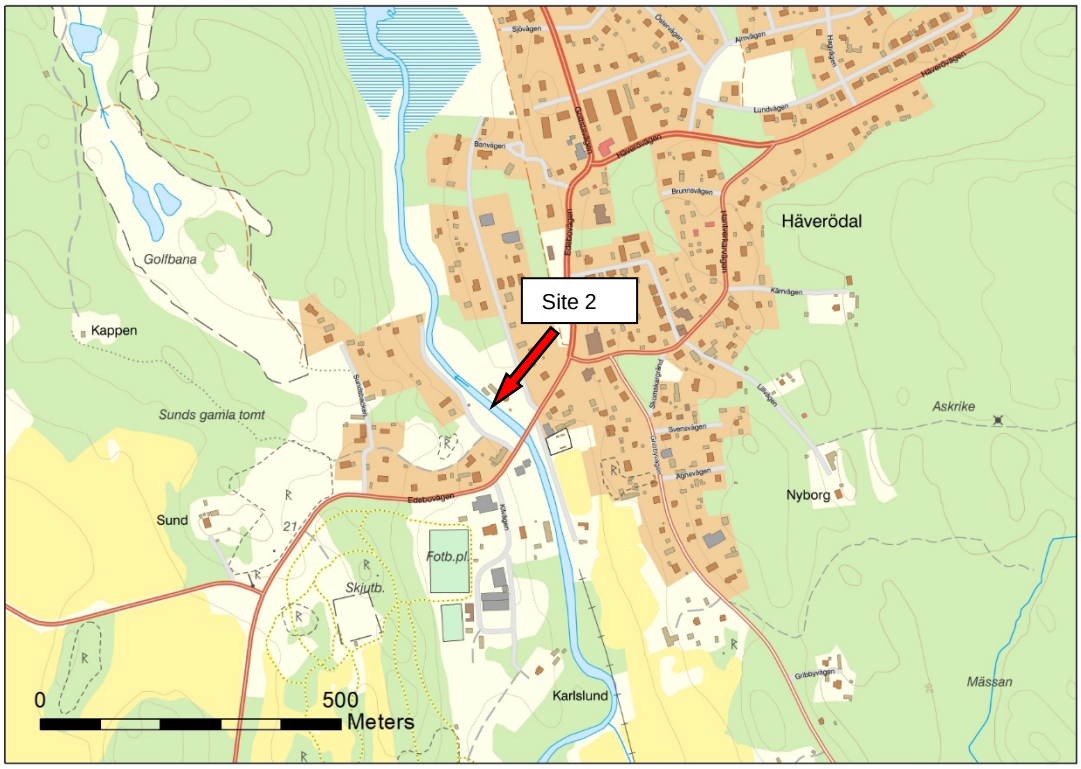


Figure 77. Stretch 2, Häverödal old mill and saw. Here habitat improvement measures were applied, and a controlling section partly restored.

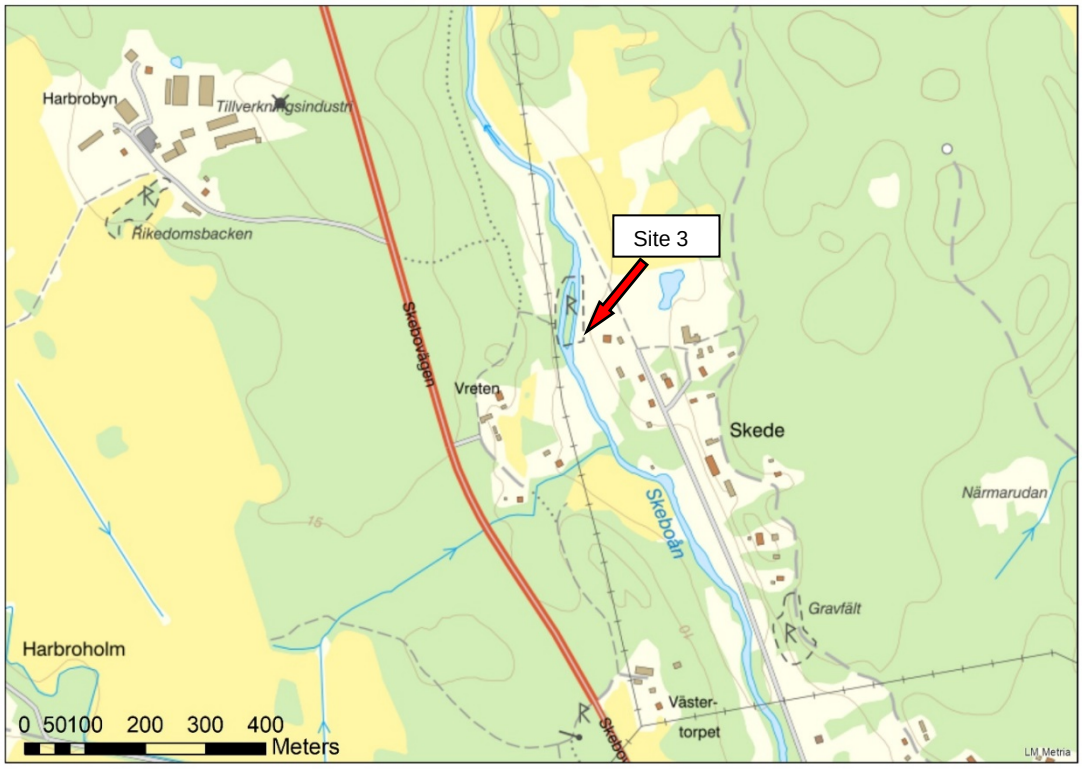


Figure 78. Stretch 3, Skede ironworks. Here, habitat improvement measures are planned. The site is a historic site protected by the Ancient Monuments Act.

Cultural heritage

The area around Skebobruk has a long history of human activity. In Skebobruk Ironworks started in the 15th century and the historical setting close to the old ironworks has very high cultural heritage values. In Skede there is also an old ironworks. The site is a historic site protected by the Ancient Monuments Act. During the initial phase, cultural and historical expertise analysed the restoration plans and discussed them at the site with the management for the activities in Skeboån. The conclusion was that different requirements applied to the three sites:

1. At stretch 1, Skebobruk, the planned measures were possible to perform, given that great precautions were taken not to create any larger changes in the visual appearance of the setting and not to damage the shore by going too close with heavy machinery. A local cultural heritage NGO was taking part during a field visit to the site and was satisfied with the plans.
2. At stretch 2, Häverödal, there were no identified cultural or historical values at the particular stretch where activities were planned.
3. At stretch 3, Skede, there are old remnants of a mill in the water which are protected by the Ancient Monument Act. For any activities here, a special permit will be necessary. Within this project, plans will be prepared, and an application filed to the competent authority, but the activities will take place at a different time.

Stakeholder involvement

An on-site meeting took place spring 2020 in which the County Administrative Board, the Swedish Angling Society, a local cultural heritage NGO and the local angling club, Skeboåns Sportfiske, took part. Skeboåns Sportfiske have been committed to improving the Skebo river environment for many years and was active in the initial planning phase. Later, they were active implementing the planned

activities. At the meeting all three sites were visited. At the Skede site, the landowners joined and together with the rest of the group discussed the possible activities. All stakeholders were positive to the planned activities. A separate meeting was held with local stakeholders at the Häverödal site. Here, the possibility to restore a removed controlling section was discussed. The stakeholders raised concerns of the consequences of an elevated water level. It was therefore decided to only restore the baselevel partly by adding less stones than originally planned. The water level will be monitored, and if possible, more stone could be added in the future.

Planning phase

Fish pass

The Swedish Angler Society was given the task to i) produce a hydrological model of the flow of water in the whole river basin, ii) with this model test if an automatic and optimised regulation of all lakes in the system could make the water use more efficient so that it would be enough for all purposes and iii) to design a fish pass that meet all process engineering and biological criteria of the fish pass.

The hydrological model showed that if the water flow is optimised by installing automatic hatches in some of the regulated lakes, water can be used more efficiently and would be enough for the factory, the fish pass and the municipality drinking water. The reason is that with automatic hatches, the water flow can be more fine-tuned compared to manual regulation[4].

The fish pass that was designed during this task connects the pond were the factory intake is and the river 600 m downstream the dam.

The suggested design and the hydrological model were discussed with representatives from the paper pulp mill and the local angling society Skeboåns Fiske, the latter having long experience of the river and its fish. The factory representatives raised concerns that the fact that the fish pass entrance was placed in the water intake pond could cause water quality problems for the factory. With more water flowing through the canal, there is a risk that the water becomes turbid which would be detrimental to the paper pulp process. There could also be difficulties for fish to find the fish pass during downstream migration due to a culvert with entrance close to the bottom of the canal. In addition, during a visit to the dam, it was noted that there seem to be some leakage through the dam. If the leakage is large, the model would overestimate the volume of available water. Therefore, for any design of fish pass to work satisfactory, the leak in the dam must be sealed.

For these reasons this design was concluded to not fulfil all criteria, neither from the point of the paper pulp factory or from the point of fish migration. It was decided that new designs should be developed together with cost estimations: i) a combination of a technical fish pass through the dam which enters into a natural fish pass on the downstream side of the dam, ii) a cost estimation of an old design suggestion which previously have been abandoned due to difficult conditions (electric cables in the ground and rocks that will have to be blasted away), and iii) a cost estimation of sealing the leaking dam.

This work is presently underway and is expected to finish in April 2020. When it is completed, a decision of which design to choose can be taken.

[4] Swedish Angling Society 2020. Skeboån. Hydrologi och faunapassage förbi Skärbrodammen (in Swedish)

Habitat improvement measures

The planning of the habitat improvement measures was done by the Swedish Angling Society in cooperation with the County Administrative Board od Stockholm and the local Angling club, '*Skeboåns Sportfiske*'. Local and regional cultural heritage expertise were consulted for approval of the measures. A large part of the planning was done during the initial phase of the project. The measures will be followed-up by electrofishing monitoring, spawning redd counts and river habitat survey during the years following the activities.

Preparation phase

Fish pass

Ones there is a decision of which design to implement permits have to be applied for at the competent authority. No Environmental Impact Assessment is needed. A smaller change that do not influence the water-rights court ruling has to be filed with the County Administrative Board. If the water-rights court ruling has to be changed, the process is more demanding of time and resources, with extensive investigations having to be performed. The process could take up to one year.

Habitat improvement measures

For the habitat improvement measures in Skeboån it was necessary to apply for a permit for water-related works at the County Administrative Board of Stockholm. The Board remitted the application to the municipality which stated that the activities were acceptable provided that great care was taken to cause as little turbidity as possible. For the activities in Skede an exemption from the Ancient Monument Act was applied from the County Administrative Board. To be able to perform the activities an archaeological expert has to be present during the implementation to make sure that no cultural values are damaged. The activities in Skede will be performed after the project implementation time.

Implementation phase

Habitat improvement measures

The Swedish Angling Society and the local fishing club, Skeboåns Sportfiske implemented the activities in end of September, early October 2020. In stretch 1, Skebobruk, a multichannel stretch was restored upstream an old bridge (Figure 76, 1a). The river was previously running through both arcs of the bridge, but one of the branches has become shallower over the centuries. It was now dug open with the aid of an excavator (Figure 79). At stretch 1b, 100 m upstream stretch 1a large stones and gravel were placed in the stream to create holding spots and spawning grounds (figure 76, 1b). About 40 tonnes of boulders and 30 tonnes of gravel were put in the stream.

At stretch 2, Häverödal, the aim was to partly restore a controlling section. Of respect to the local stakeholders that raised concerns of elevated water levels, a smaller amount of stones was put in the river than could have fitted there. 30 tonnes of boulders and 15 tonnes of gravel were put in the stream. After evaluation and consultation with the stakeholders, more stones could be put on the same spot.

At both sites a large number of people stopped by and talked about the project and asked questions. All were interested and positive to the activities. At all three site there were signs put up informing about the activities and responsible organisations.

Figure 79. Stretch 1a, Skebobruk, during implementation. A multichannel stretch is recreated. Photo credit: Patrik Bergquist.

Evaluation of the project

The fish pass project is not finished yet, so it is not possible to classify it as a success or failure yet. The habitat improvement projects were implemented autumn 2020 and no electrofishing or redd counts have been carried out yet. Concerning river morphology, a visual inspection gives at hand that we achieved the goals of the project. There is now a multichannel river under the old bridge in Skebobruk with stones and gravel on the riverbed (Figure 80 and 81). These types of habitats are often suitable trout spawning grounds, but it is too early to tell how successful it will be. Both here and at the other site in Skebobruk the diversity of structures has increased, providing more space and niches for aquatic organisms.

Figure 80. Stretch 1b, Skebobruk, before (left) and after (right), a new multichannel stretch. Photo credit: Patrik Bergquist.

Figure 81. Stretch 1b, Skebobruk, before (left) and after (right), a new multichannel stretch. Picture taken from the bridge. Photo credit: Patrik Bergquist.

At Häverödal the formerly cleared river has now a more variable structure and a partly restored controlling section. Already 32 sea trout have been observed to spawn at the newly restored stretch. The electrofishing and redd counts next and the following years will give us more information about the result of the restoration activities.

All stakeholders that we have contacted and that have contacted us during the project have been positive to the activities given certain prerequisites, for example avoiding damaging of valuable historical remnants, raising the water level too much and in the case of the paper pulp factory, jeopardising the paper pulp production. All these requirements have been possible to fulfil, with the exception of the fish pass in Hallstavik which is not built yet.

River Moraån: habitat improvement

Country	Sweden
River	Moraån
Site	Kallforsån tributary, Järna and Norrbyvälle
Type of sea trout population	Unique population, never stocked
Type of restoration	Habitat improvement
Temporal scale of the restoration	Long term
Spatial scale of the restoration	Two stetches, 200 m and 400 m 3 km apart
Responsible organisation	County administrative Board of Stockholm, Swedish Angler Society, Södertälje municipality
Duration of the project	2 years
Geographical location WGS84	59-5.5744N, 17-32.7261E (Kallforsån) and 59-5.0604N, 17-35.2722E (Norrbyvälle)
Total budget	30 000 €

Background

River Moraån in Södertälje municipality south of Stockholm has two main tributaries. Kallforsån flowing from lake Vällingen is about 20 km long and Ogaån flowing from Lake Ogan is 15 km and joins Kallforsån about 6 km from the discharge in the sea (Figure 82). The drop from source to sea is 32 m and the river basin is 92 km^2. The river flows mostly through forest (60%) but there is also some agricultural land (17%) and urban areas (8%). Most parts of the river are calm alluvial streams, (flowing though fine sediment soils), but stretches with riffle-pool systems or cascade streams exist. A

significant part of the river's stretch flows into a deep ravine, which largely consists of the Moraån nature reserve. Here the watercourse is more natural with both runs and calm parts, floodplains, meanders and plenty of blocks, rocks, gravel, and dead woody debris. Outside the nature reserve, the river is largely calm with fewer runs.

The river has been affected by human activities throughout the centuries, both in the riverbed itself and in the riparian zone. A river habitat survey showed that 18% of the river now have different hydromorphological type compared to what it originally was and that 88% of the river have been redug or cleared from stones and logs. Many of the controlling sections have been removed which have resulted in lowered base level, increased erosion and that the river loses contact with the flood plain. In Moraån there are four dams, all of which constitute migration obstacles for fish and other aquatic organisms (Figure 83). The first dam is located 6.8 km from the estuary, blocking migration to the upper parts of the river system (the Järna dam). The other dams are situated at 8 km (the Tellebro dam), at 11 km (the Kallfors dam) and at 12 km (by lake Vällen). In addition to blocking migration, the dams create sedimentation upstream of the dam itself and reduced sediment transport downstream. Due to the large morphological changes and the migration obstacles the river does not reach the environmental goals according to the Water Framework Directive.

Figure 82. Moraån, overview. Source: LM Metria ©

Despite the environmental deterioration that these changes have caused, the river still has high natural values, especially in the nature reserve, which covers a 4 km stretch below the first migration obstacle. The species-rich fish fauna and the importance of the watercourse as a reproduction area for coastal fish species, including a native sea trout population and river lampreys, is an important part of the natural value. Moraån is, among other things, one of the county's most important spawning grounds for sea-migrating trout. Yearly electrofishing monitoring below the first dam result in about

100-150 young trout per 100 m^2. At the discharge in the sea, the red-listed bird species kingfisher (VU) nests.

To restore parts of the river and compensate for the large physical changes we created spawning grounds and holding spots at two sites in the river: one in Kallforsån, 20 km upstream the river mouth, and one 1.5 km from the coast, at Norrbyvälle. The activities in Kallforsån will, for the time being, be of less value due to the dam in Järna. However, there is an ongoing process to build a fish pass past the dam. Ones this process is completed, this site will be available for migrating fish from the sea.

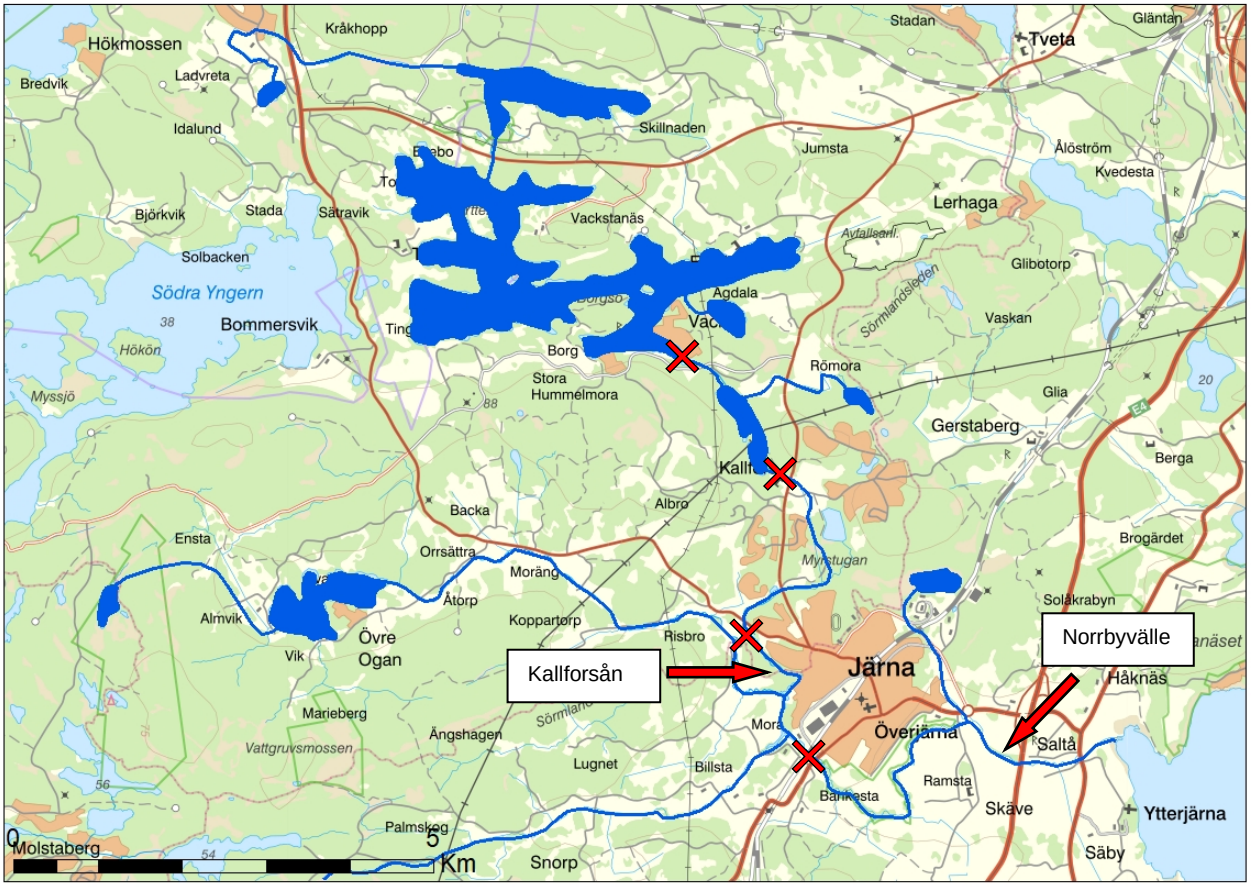


Figure 83. The two restoration sites in Moraån. The x-signs indicate migration obstacles. Source: LM Metria ©.

Initial phase

The extensive physical changes of the river have reduced its capacity to harbour a high biodiversity and strong fish populations. The river has been redug and cleared from blocks, stones, gravel, and woody debris, such as logs. These structures have an important role in shaping the river and providing a variety of niches, a prerequisite for high river biodiversity. To improve the status of the river and increase biodiversity it is suggested to add blocks, stones, gravel, and logs to the river.

Two stretches were identified which had been previously cleared from such river shaping structures (Figure 83).

Kallforsån

One and a half km upstream the dam in Järna there is a stretch which has been redug and cleared (Figure 84). Judging from a map from 1696 the river took another way at that time (Figure 88). It is not

clear why the rivers' path has changed, but on the map from 1901 it has its present path (Figure 84). The site is suitable for habitat improvement measures because the water has fast enough flow to create a riffle and pool system by adding large stones, logs, and gravel. This hydromorphological type is rare in Moraån but has most likely been more common earlier.

Stakeholder involvement

Close contacts were held with Södertälje municipality, one of the landowners; the Church of Sweden is the other. They were both positive to the activities. Information signs were put up at the site explaining the reason for the activities and responsible organisations. Despite this, part of the public reacted negatively when they saw excavators in the river and reported what they believed was an illegal action to the police. A meeting where the general public was invited and informed about the activities could have avoided the negative reactions. The lesson learned here is that early stakeholder involvement is a key to success and can help avoiding misunderstandings.

Norrbyvälle

Just downstream the nature reserve Moraåns dalgång (the Moraån valley) is a stretch which have been redug and cleared, but still has moderately fast flowing water (Figure 85). The riverbanks are tree lined but steep because of a removed controlling section downstream (Figure 86). Hence, the river has lost contact with the original flood plain and secondary flood plains have started to form. The stretch is suitable for habitat improvement measures including adding stones and gravel to the river because the water is not completely calm, and the riverbed is not too soft; added stones will not be buried in sediment. By adding large stones, logs, and gravel we hope to increase biodiversity and create holding spots and spawning grounds for sea trout.

Stakeholder involvement

Learning from the experience of the stakeholder involvement in the Kallforsån project, stakeholders were involved more actively in this part of the project. The landowners were contacted at an early stage; Södertälje municipality, being one of them, were informed at a board meeting of the city council. In addition, a NGO, Friends of Moraån, were informed about the activities. All contacted, directly involved stakeholders were positive to the planned activities. There were plans to host a public information meeting, but that had to be cancelled due to restrictions in connections with the Covid-19 pandemic. To compensate for this, information signs were put up along the pedestrian and bicycle path that runs along the river before the work was planned to start. An information leaflet was distributed to the property owners in the nearby residential area and information about the work was continuously posted on social media. A newsletter published by the municipality informed about the activities. Unfortunately, is was published after the work was finished. There were no negative opinions or criticism of the project.

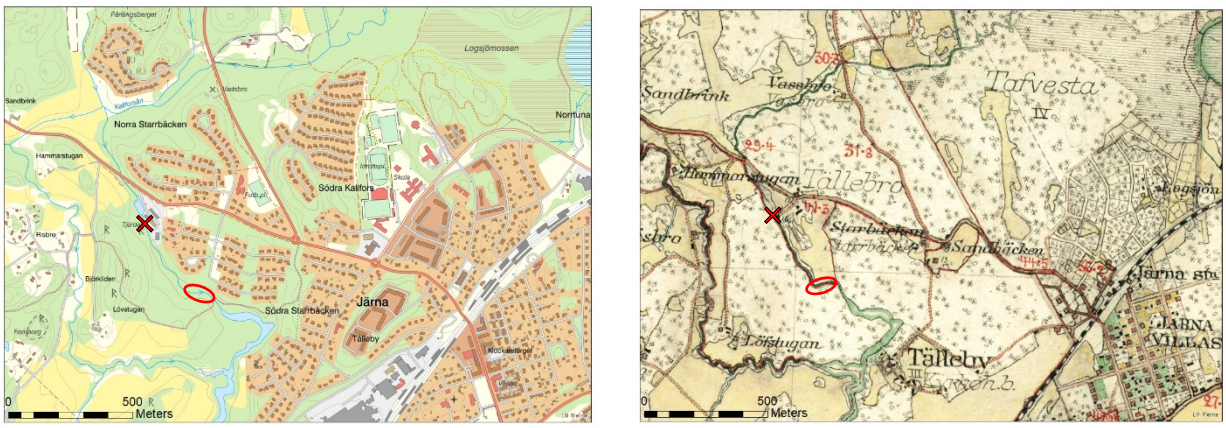


Figure 84. Restoration site in Kallforsån. Present (left) and year 1901 (right). The x-signs indicate migration obstacles. Source: LM Metria ©.

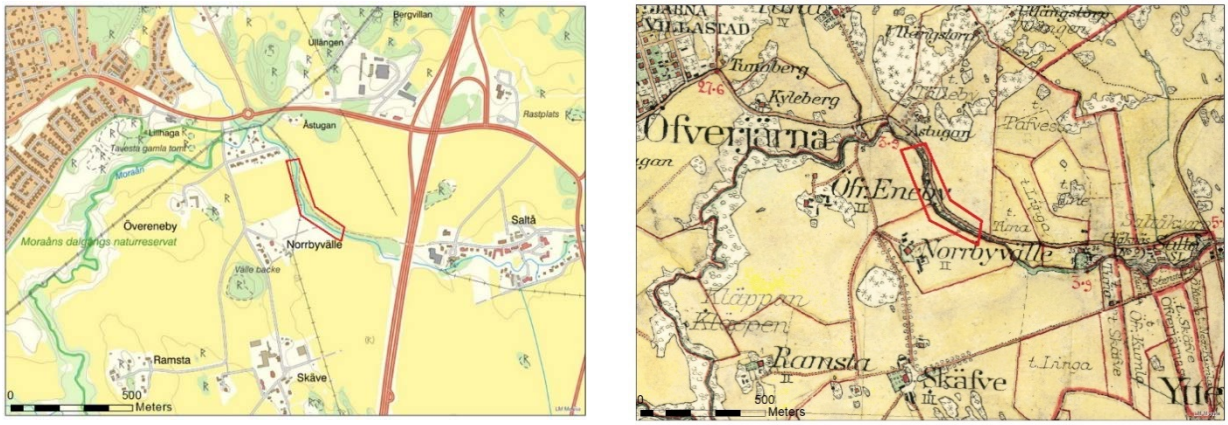


Figure 85. Restoration site at Norrbyvälle. Present (left) and year 1901 (right) The x-signs indicate migration obstacles. Source: LM Metria ©.

Figure 86. Restoration site at Norrbyvälle. Photo: Ekologigruppen AB.

Cultural heritage

The surroundings of Moraån are known to have very high cultural heritage values. To document these an archaeological analysis was made over the whole tributary of Kallforsån[5]. Several remnants of previous use of the water still exist today, in various conditions. The mill at Kallfors is known from 1506 and is very well preserved, but of the mill at Saltå only remnants of the dam wall remain today (Figure 84). The remnants of the mill at Nykvarn constitutes the migration obstacle at Järna (Figure 84). In the end of the 19th century the river was redug completely between Kallfors and the pond formed by the dam at Järna, which can be seen after careful analysis of the map in Figure 83. No structures or remnants of high cultural heritage values were found at the two sites where restoration activities were planned. Structures with high cultural values exist upstream and downstream of the two sites, but not at the direct sites. Therefore, no special consideration needs to be given to cultural heritage values during the restoration work in this project. However, the report will be used in the planning of future restoration measures in Moraån.

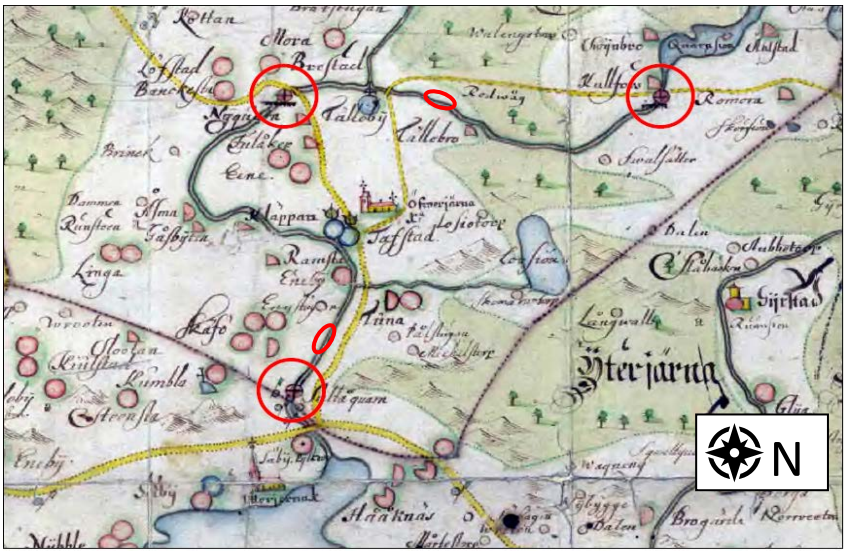


Figure 88. Map from 1696. The mills at Kallfors (on top), Järna, and Saltå are marked with circles Saltå mill is no longer a migration obstacle. The restoration sites are marked with red ovals. The map is not georeferenced, approximate N is indicated. Source: LM Metria ©.

Planning phase

Kallforsån

The activities at the Kallforsån site were planned and implemented by the Swedish Angling Society in cooperation with The County Administrative Board of Stockholm. During the planning process, Södertälje municipality was informed and consulted concerning which permits that were needed. Due to a misunderstanding in the communication between the Angling Society and the municipality, an exemption from the beach protection act was never filed. It had to be filed after the project was completed and was then accepted. This is an important lesson learned. Whenever unsure if a permit is needed or if no written exemption is given, apply the precautionary principle and file an application to the competent authority.

[5] Vattenanknutna kulturmiljöer vid Moraån. Besiktning och dokumentation av värdefulla kulturmiljöer/fornlämningar längs del av Moraån (Kallforsån), Södertälje kommun. Åsa Berger., Rapporter från Arkeologikonsult 2020:3339 (in Swedish)

Norrbyvälle

The activities at the Norrbyvälle site were planned and implemented by the Södertälje municipality in cooperation with The County Administrative Board of Stockholm. Planning meetings were held at the site. An exemption from the beach protection act was filed to the municipality and was approved before the work begun. To ensure the right competence in the working crew, a planning meeting in the field were arranged. During this meeting practicalities, such as how close to the river the crane truck could go, how far the crane could reach, and logistics for transportation of stones. Some branches had to be cut to facilitate delivery of the stones.

Implementation phase

Kallforsån

The work was carried out during winter 2018-2019. The goal was to create a more natural river stretch on a heavily cleared passage of the river by adding stones and gravel to the riverbed. By putting stones and logs, riffles and pools are created, forming holding spots and spawning grounds for sea trout, also increasing the diversity of structures enabling an increased biological diversity as well.

About 250 tonnes of large stones and gravel were put in the river with a 2-tonnes tracked dumper and a 23-tonnes tracked excavator (Figure 90). A place, most suitable for stocking of stones was chosen in consultation with the municipality (Figure 89). During the work the ground was frozen, which reduced the risk for driving damage on ground and roots. To reduce it further, excavator mats were used. Driving damage that nevertheless arose were repaired when the work was completed. The excavator was operated by a skilled person with experience from similar work. Biological expertise was present during the hole implementation phase, supervising the work. To cause as little disturbance as possible to plants and wild animals, the work was conducted during winter.

Figure 89. Stones and gravel to be used for habitat improvement activities in Kallforsån. Photo Tobias Fränstam

Figure 90. Work underway in Kallforsån. Photo Tobias Fränstam

Norrbyvälle

The work at Norrbyvälle was implemented by Södertälje municipality in collaboration with the County Administrative Board of Stockholm. The measures were implemented 2-3 June 2020. Approximately 190 tonnes of gravel and stones were placed in the river during the restoration activities. Crane trucks picked up the material about 15 km away aided by a wheel loader. The stretches were located along a pedestrian and bicycle path (Figures 91) where the trucks could stand while they lifted down both gravel and larger stones to the river (Figure 92). The material was distributed fairly evenly along the stretch. Where necessary, branches were sawn off to avoid damage to the hydraulic hoses (Figure 93). Down in the river, the material was moved with a filling hammer, skewers and by hand to create as varied stretches as possible.

Gravel was used to create spawning grounds while larger rocks were used to create holding spots and build necks that provide flowing water downstream and calmer / deeper water upstream.

Figure 91. Two crane trucks were used to deliver the stones. Photo Mikael Lindén


Figure 92. Both large and small stones were used. Photo Mikael Lindén


Figure 93. The crane releases its load in the river. The stones were then rearranged to create the wanted structures (left). Some branches had to be cut off to enable the crane to reach the river (right). Photo Mikael Lindén

Evaluation of the project

Kallforsån

No electrofishing has been done yet, but are planned to be performed during 2021. Regarding the hydromorphological properties of the stretch, the restoration activities was a success. The previously cleared stretch has now a very fine and varied stream water environment with potentially high values for aquatic fauna, especially as a spawning and rearing environment for trout (Figure 94 and 95). It may however be considered a failure that the public opinion, at least in part, was negative to the activities since they had not been reached by information about it. It is not known if this negative opinion persists.

Figure 94. Work completed. Kallforsån 2019. Photo Tobias Fränstam

Figure 95. Work completed. Kallforsån 2019. Photo Tobias Fränstam

Norrbyvälle

An attempt to electrofish the stretch at Norrbyvälle was made during October 2020 (Figure 96). Unfortunately, the equipment broke down during the work wherefore no complete results were achieved. However, some fish were caught; 10 trout yearlings, 4 older trout and one bullhead (*Cottus gobio*). A complete electrofishing monitoring will be performed during 2021.

Figure 96. Electrofishing at Norrbyvälle (left). A young sea trout (1+) (right). Photo: Mikael Lindén.

Figure 97. One site at Norrbyvälle before (left) and after (right) restoration measures. Photo: Mikael Lindén.

In 2021, new field visits will be made to the stretch during the summer months to see how the river has moved the stones and logs during the high flow periods in the fall and spring. Habitat improvement measures should continue at this site, and the site is suitable for future collaboration with schools and possibly also river conservation events for the public. Södertälje municipality have positive experience from working with schools in Bränningeån (see "Case study report – Bränningeån, SE"). The fact that students get to work practically with river habitat improvements measures and have field lessons on river ecology and its path from source to sea makes them feel proud to have contributed.

Conclusions

From the work in Kallforsån and Norrbyvälle several conclusions can be drawn.

- Early planning with checklists and timeplan formed the basis for the smooth project process
- Clear and widespread information to politicians, landowners, interest groups and the general public meant that questions could be answered early so that everyone understood why river restoration is important. Only signs by the restoration site may not be enough.
- Even if attempts are made to inform the public, some will still be surprised or upset when they discover large machinery working in the river.
- It is a good practice to continuously post information on social media about the work so that the public has the opportunity to feel involved in what is going on.

- It worked out well to pick up material centrally during the two days we worked in Norrbyvälle. Through this way of working, we could easily adapt the amount of material to the different sites and avoid risking leaving material behind on an intermediate storage.

Appendix 1.

GUIDELINES FOR ORGANIZING COMMUNICATION WITH THE STAKEHOLDERS OF YOUR DEMONSTRATION PROJECT

PART A: Purpose

In every restoration project, stakeholders have an important role to play – positive or negative – which can have immediate as well as long-term consequences for the project. Keeping this in mind, stakeholder communication was planned as a sub-activity under GoA 4.3. In the project application, it was written that "*stakeholders (be) identified, sampled and consulted*" **before** *planning and design of the measures, using different methods, e.g. individual discussions, focus groups, negotiations, public meetings, opinion surveys, etc…. Various stakeholder interests such as cultural heritage, energy production, recreational value and others, including possible conflicting interests, were to be identified in each case. Further, compromise solutions were to be developed together with stakeholders to improve all relevant biological parameters, prerequisites for fishing and recreation as well as protect and highlight cultural heritage*. In fact, according to the 'Detailed Work Plan' developed during the first project workshop in 2017, planning for stakeholder consultation under GoA 4.3 was to be supported by UCV/CR (originally KTH).

However, in the process of implementing RETROUT in general and GoA 4.3 in particular, there have been several delays and practical hindrances, and consequently, this part of GoA 4.3 never took off. However, stakeholder communication continues to remain an important dimension for the effectiveness and sustainability of the restoration measures implemented under RETROUT. Hence, what is intended now is to establish effective communication with the stakeholders of the restoration projects completed / under implementation so that both sides can draw maximal mutual benefits on a long-term basis. Also, the lessons learned from the stakeholder communication experiences will be analyzed and included in the Baltic ToolBox.

PART B: Objectives

The stakeholder communication to be organized by you will have the following objectives:

a. identifying the most important stakeholders and establishing a dialogue with them to bring them on board for sensitizing them towards the purpose of the project and sharing of responsibilities in the future for upkeep and sustenance of the measure implemented,
b. understanding stakeholders' perspectives about the measure undertaken,
c. identifying any outstanding barriers that may thwart the work, or affect its quality or completion, and
d. intervene constructively through dialogue with concerned stakeholders, where relevant.

In case, you are still in the planning phase, an objective would also be to identify any conflicting interests and develop compromise solutions.

PART C: Method

Step 1: Identify your stakeholders and set your communication goals

a) Identify the key stakeholders – agencies, organizations (NGOs), individuals, neighborhoods, businesses etc. who would be/are affected – positively or negatively – by your restoration demonstration project.

b) Also identify your major communication goals – what are the things that you need to inform them about? What are the aspects on which you need their feedback? Which are the dimensions in which you look forward to some action on their part?....

Basis of identifying your stakeholders:

- Who are/were the agencies/groups/individuals that share an interest in the project, either positive or negative?
- Which groups/individuals external to this agency have/could help in the planning and implementation of the project, or have provided support afterwards?
- Which groups/individuals external to this agency have/could obstruct the planning and implementation of the project?

Step 2: Set a date and location for a 'stakeholder workshop', decide an agenda and invite your stakeholders

You need to contact your key stakeholders & call them to a common forum – *stakeholder workshop* – where you can **share information** about your restoration project, **seek their feedback** on any questions of concern, **discuss for consensus** on issues of conflict, & **plan together with them** about better implementation and/or sustainable upkeep of the structures created etc. Decide a date and venue, finalize the agenda and send out the invitations. It could be good to restrict your participants to 10-15.

Step 3: Conduct the workshop

Conduct the workshop as a two-way discussion forum. It can have 2 parts:

a) Keep the first part for information dissemination about the project, where you do most of the talking.

b) Later switch over to question-answer session and discussions – in one large group or in smaller groups, depending on your agenda and the number of participants. (Look at the questions in Part D to guide you through the interactive sessions)

Step 4: Organizing the workshop conclusions

At the end of the workshop, you need to bring together the conclusions as a brief report, so that the lessons learned can be documented for further use. This report will also be useful at your own end. Many of the points will be in answer to the guiding questions attached here, while another important part could be a plan for ensuring sustainability of the river restoration structure and its best use for promoting fishing tourism!

PART D: List of suggested stakeholders

The following stakeholders could have interest in or be affected by your river restoration project:

1. Government agencies dealing with natural resources/water/environment/ fisheries /power/ culture/tourism/agriculture/surface transport/any others concerned
2. Local municipality and county level administration

3. Agricultural drainage association/farmers' association/ local citizens' forum etc.
4. Landowners and the 'water owners', if applicable
5. Fishing and nature protection NGOs
6. Sport fishing/Anglers' associations
7. Private actors in tourism/fishing tourism sector
8. Companies benefitting from hydropower projects, other industrial projects dependent on the river/river stretch in question
9. Local residents in the vicinity of the river stretch

PART E: Suggested questions for organizing interactive sessions

1) What was the previous state of the river/river stretch and how were the different stakeholders affected by it?
2) How has/can the restoration demonstration project brought/bring about a change in the previous state of the river? (For example, in terms of hydrology, water quality, sea trout stocks, flora and fauna diversity)
3) Are the stakeholders happy that the project will be/is undertaken? What benefits do each of these perceive to receive from the restoration project/activity?
4) What are the factors that can be seen as important by the different stakeholders in helping the project activity the most in terms of their timely completion and achievement of results? In what way have/can they facilitate?
   (Examples - law, rules and regulations, funds, local support groups, etc.)
5) Alternately, were/are there also factors that thwart(ed) the project process? Which were/are these and in what way did/can they obstruct? (Examples – lawsuits, land ownership issues, conflict of rights etc.)
6) In what ways can the different stakeholders contribute to the timely completion of the demonstration project? And/or in what ways can they contribute constructively to the future upkeep and sustenance of the project structures?
7) Alternately, in what ways could some of the stakeholders thwart the work, or affect its quality or completion, and intervene destructively?
8) Stakeholders' views on evaluation of a completed project as a success or failure – overall rating of the project/ activity as "success", "partial success", "failure", & the grounds taken for the same.

Don't do all the talking. Encourage your stakeholders to share their views in this session!

Appendix 2.

Instructions/guidelines for preparation of a case study report on the restoration demonstration projects

Case study report

Each demonstration case shall produce a dedicated demonstration project report (a concise report in English with full documentation attached/available in national language) in form of a process documentation, generally following the applicable parts of the listed sequence of events for the demonstration cases as proposed in the Work plan (see above). In general terms the case study reports will need to be informative in a processed, compressed and readily available and usable form in order to facilitate a smooth inclusion of the information and writing of the dedicated section for the 'Baltic Toolbox'.

The case study reports should not be 'raw' project documentation but instead separately prepared reports with an adequate level of relevant details, so that it is possible to present each demonstration case in a purposive way in the dedicated section of the 'Baltic sea best practice Toolbox'.

The case study reports should include at least the following information below (to the extent applicable for each project) and the format should be elaborated descriptive text (not only yes/no answers) with needed numbers/tables/figures/pictures, written in chapters/section following the sequence of the headings below:

1. **General information**
    a. Country; river name; name of the restoration location
    b. Type of target sea trout population (e.g., original, mixed re-stocked)
    c. Type of restoration case (e.g. fish pass, spawning area restoration,…)
    d. Temporal scale of the restoration
        - short-term solution of particular problem, long-term restoration project, or a combination of short- and long-term activities
    e. Spatial scale of the restoration
        - particular stretch of a river or targeted to great part of a river or it's catchment
    f. Responsible organization(s)
    g. Duration of the project
    h. Geographical location (coordinates ~WGS84 DD MM.MMM)
    i. Total budget [if this information is publishable]
    j. Pictures from the restoration site (before-during-after)
2. **Background for project**
    a. Was there a sea trout population in the river before starting the restoration project?
        - were they genetically original or introduced stocks?
    b. What was known about the sea trout population (and rest of fish community and other water biota) before the restoration project?
    c. What was known about the river hydrology and water quality before the restoration project?
    d. Was there monitoring program in place before the restoration project? (and plans for continuing the monitoring after?)

e. What was the problem in the river? Evidence for weak trout stocks or less than good ecological status
f. Identified reasons for the pre-restoration situation
g. Potential solutions with rationale and justification

3. Initial phase

a. Given the settings in hand (i.e. the feature of the river/site, the 'problem' and its reasons and the potential solutions), what were
   - the aims of the restoration project (for fish/sea trout populations and other purposes),
   - the possibilities in terms of resources and time, and
   - the potential difficulties/challenges in carrying through the project?
b. Describe different identified stakeholder interests, such as, cultural heritage, energy production, recreational value, etc., and possible conflicting interests
c. Describe how stakeholders were identified, approached and consulted using different methods, e.g. individual discussions, focus groups, negotiations, public meetings, and opinion surveys, if needed
d. How were different stakeholder interests acknowledged and in case of conflicts how were compromise solutions developed together with stakeholders?
e. Where there any obstacles/difficulties or particular successes encountered during this phase?
f. Present any lessons learned on good/bad practices during this phase?

4. Planning phase

a. Which agencies/organizations were actively involved in the planning?
b. How was the planning and design of measures done?
c. Was there a procurement process for detailed plans/design?
d. How was the follow-up on the impact of the conducted restoration measure(s) planned to be done?
e. Where there any obstacles/difficulties or particular successes encountered during this phase?
f. Present any lessons learned on good/bad practices during this phase?

5. Preparation phase

a. Environmental impact assessment (EIA)[6]:
   - Was EIA carried out?
   - If yes, why – was it mandatory by law or due to environmental concerns expressed by some stakeholders, or any other reason?
   - Who carried out the EIA?
   - Which stakeholders were identified & involved? In what way were they involved?
   - What were the findings? (attach the EIA report/statement)
b. Application to the competent authority (will differ between countries and projects)
c. Procurement process
d. Where there any obstacles/difficulties or particular successes encountered during this phase?
e. Present any lessons learned on good/bad practices during this phase?

6. Implementation phase

[6] EIA is a long process and can be carried out differently in accordance with relevant national laws. If an EIA was conducted, this phase of the project needs to be elaborated, including the dimension of related stakeholder consultation during EIA preparation.

a. What?
b. How?
c. When?
d. Who?
e. Where there any obstacles/difficulties or particular successes encountered during this phase?
f. How were the obstacles/difficulties addressed?
g. Present any lessons learned on good/bad practices during this phase?

7. Evaluation of the project

a. Success or failure all in all and for different sub-criteria (with explanations/verbal analysis)
b. Ecological objectives:
    - did this restoration project achieve its specified ecological objective(s)?
    - how has this been/will this be evaluated (present available monitoring results/plans)?
c. Other impact on river biota:
    - positive/negative impact on other fishes
    - positive/negative impact on other biota (vegetation, invertebrates, birds, etc.)
    - how has this been/will this be evaluated (present available monitoring results/plans)?
d. Secondary objectives:
    - did this restoration activity achieve any additional objectives, such as e.g., provisioning recreational value or maintaining cultural heritage value?
    - how has this been/will this be evaluated?
e. Project acceptance by stakeholders:
    - summarize what sort of stakeholder communication was carried out during the project (to whom, why, at which stages?)
    - did the project encounter any particular difficulties with certain stakeholders (explain/specify)?
    - did the project encounter particularly positive stakeholders (explain/specify)?