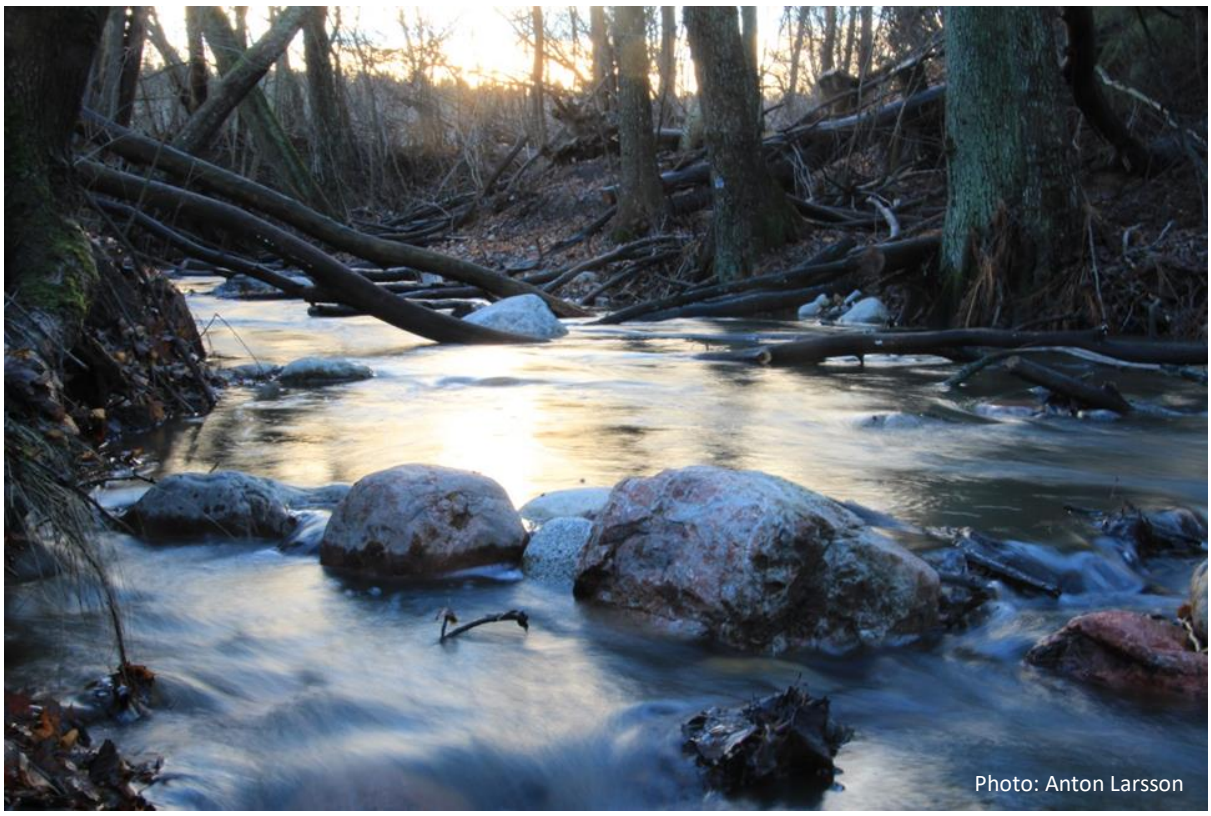
Sweden

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).

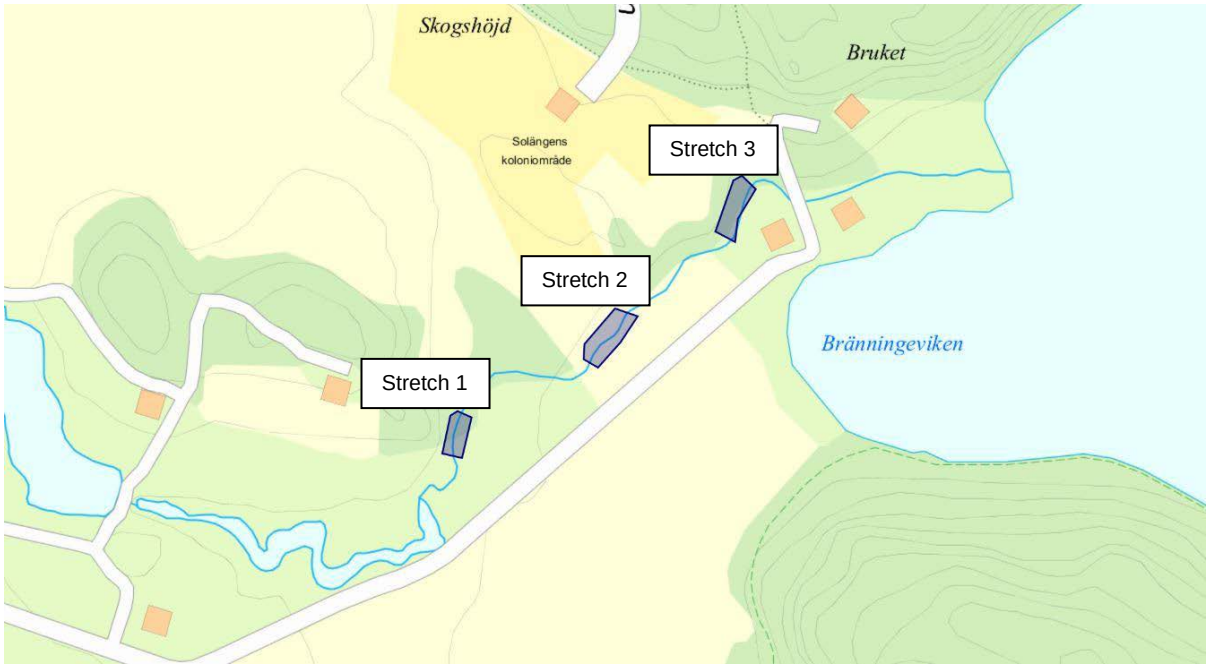


Figure 43. The three restored stretches.

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.

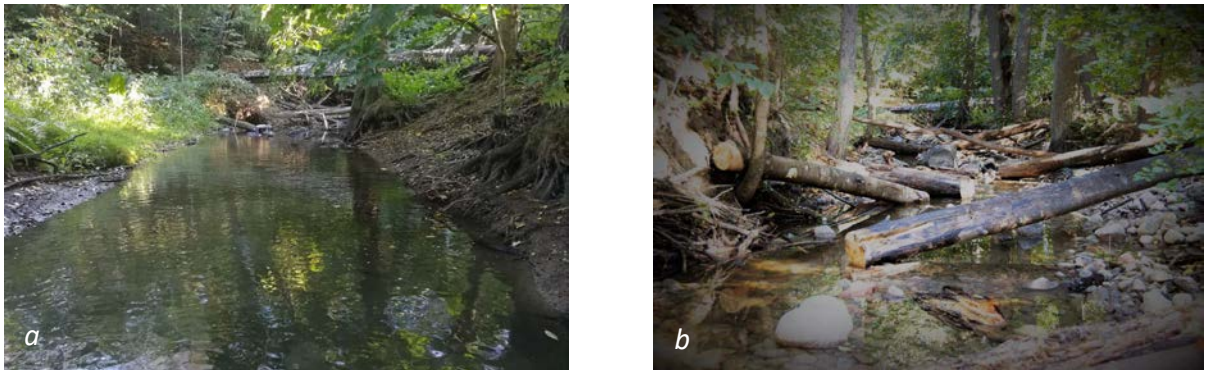


Figure 47. Stretch 1 before (a) and after (b) the activities. The cleared river stretch has been restored with stone and gravel bottom and plenty of large stone and logs. Photo credit: John Kärki.

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.

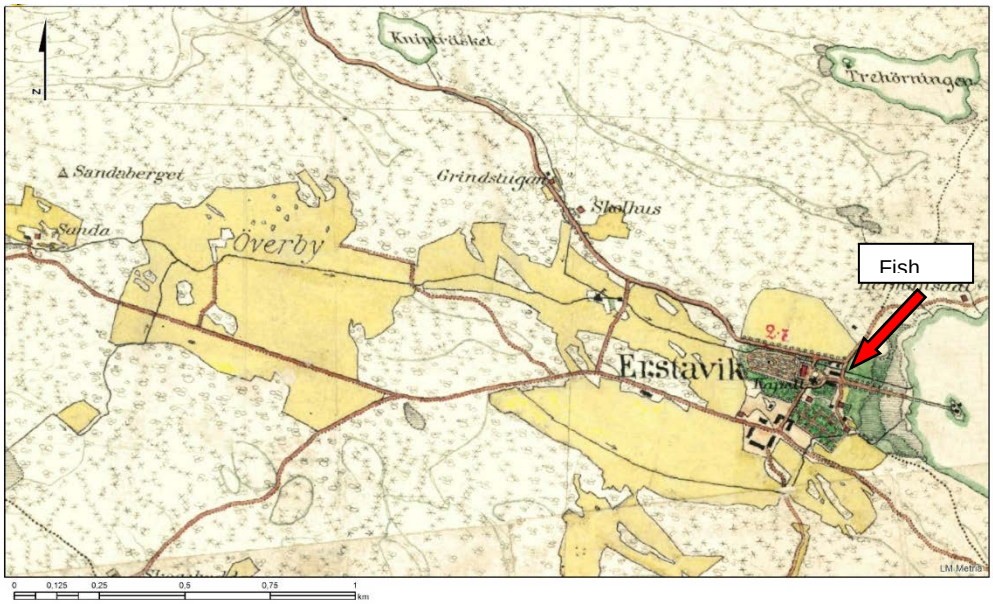


Figure 54. Erstavik manor. Present site for fish pass marked.

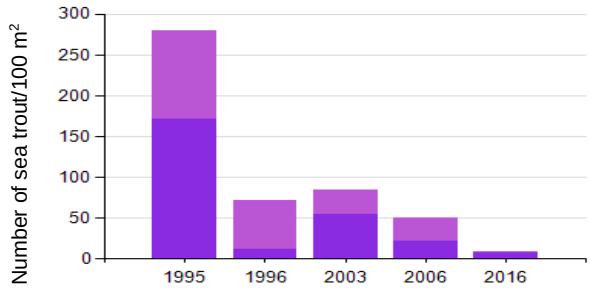


Figure 55. Electrofishing results from Erstaviksbäcken. Average of 6 sites.

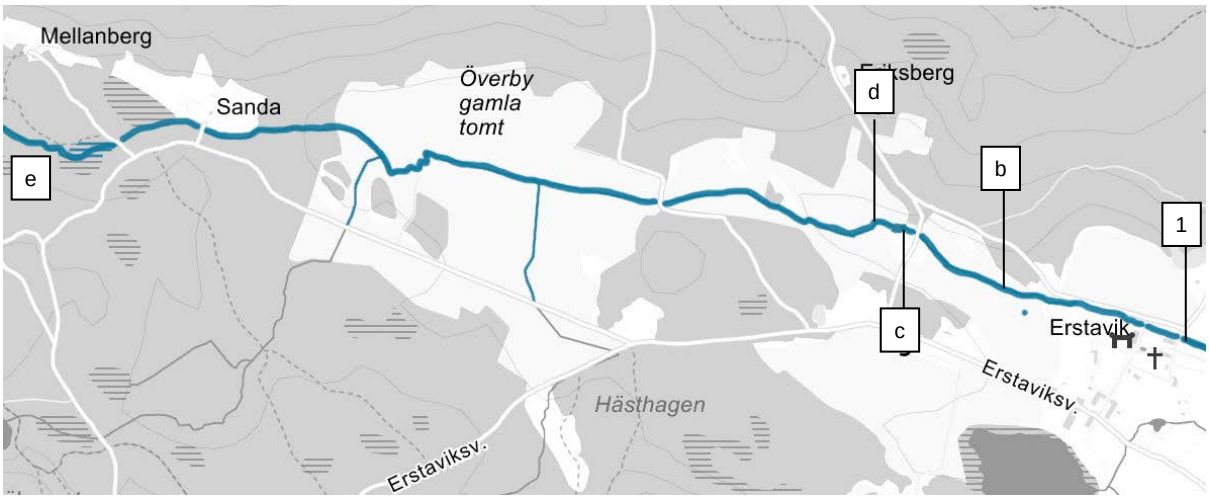


Figure 56a-e. The letters refer to comments and photos below. Photo: Oliver Karlöf.

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.

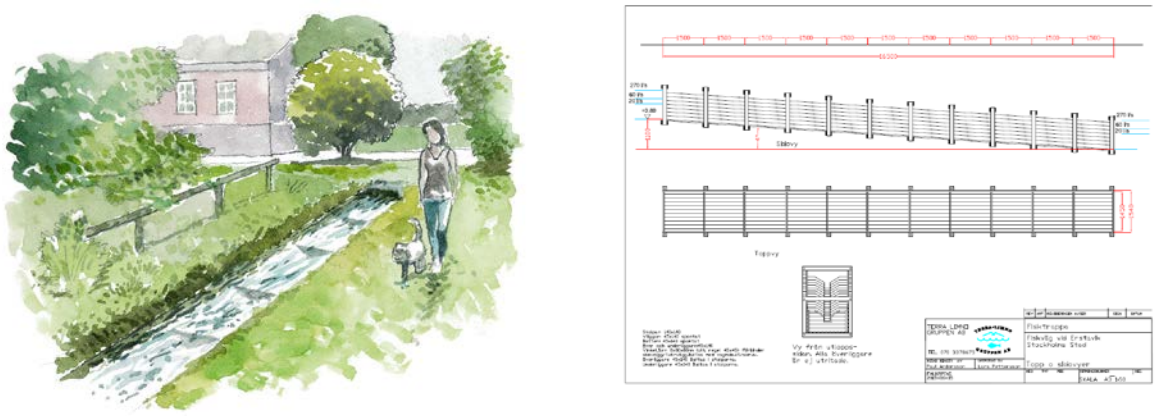


Figure 57. illustration of the fish pass in the planned setting (left). Technical sketch of the fish pass (right).

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.

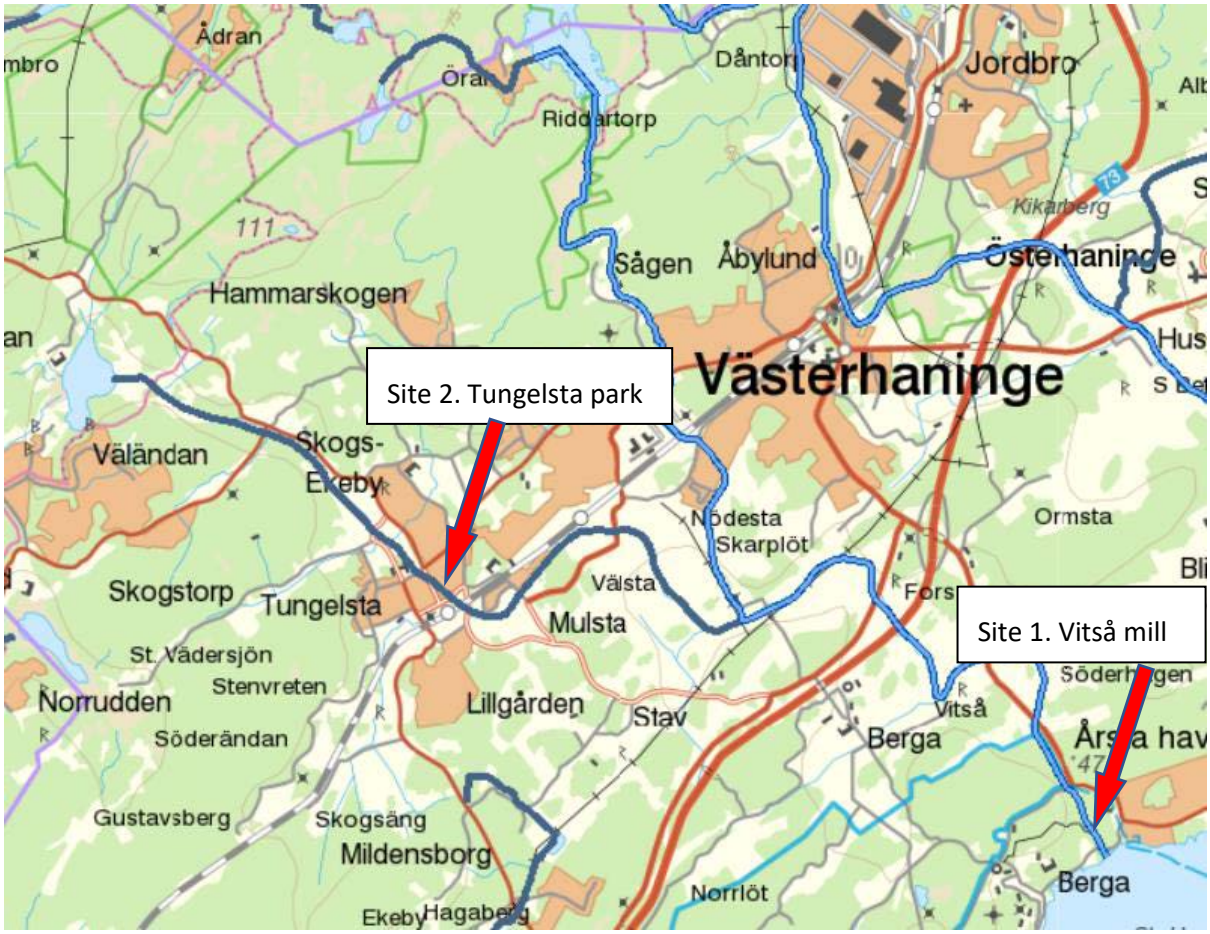


Figure 60. The two restoration sites.

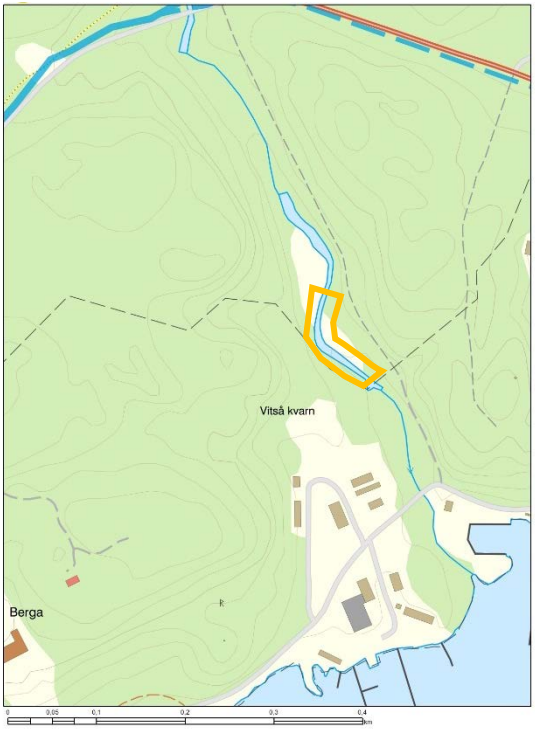


Figure 61. Restoration site at Vitså mill.

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.

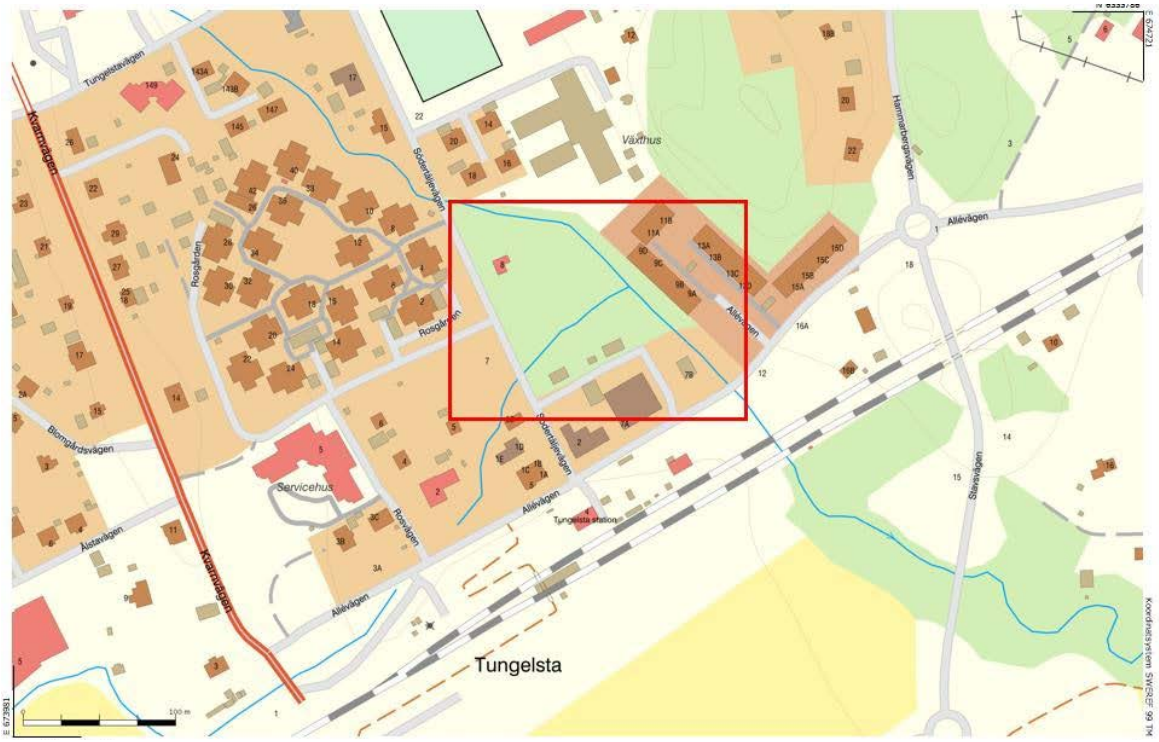


Figure 64. Tungelsta park. Part of Rocklösaån where measures took place is marked.

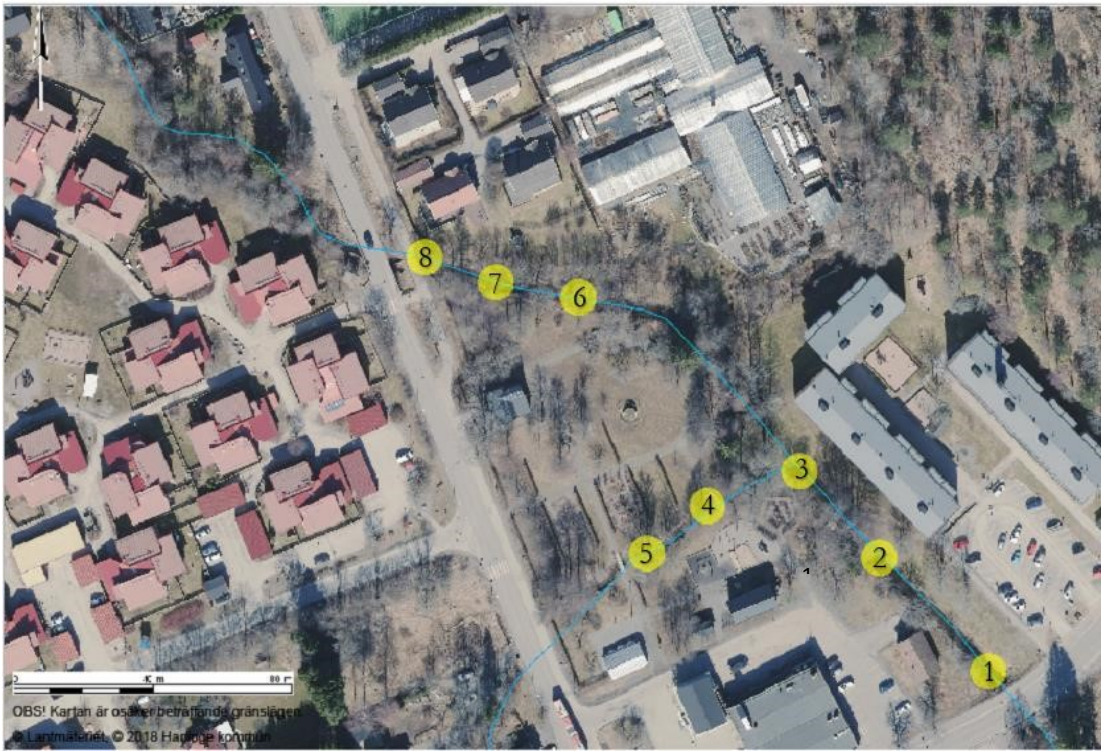


Figure 65. Tungelsta park. The 8 sites in Rocklösaån where measures took place.

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.

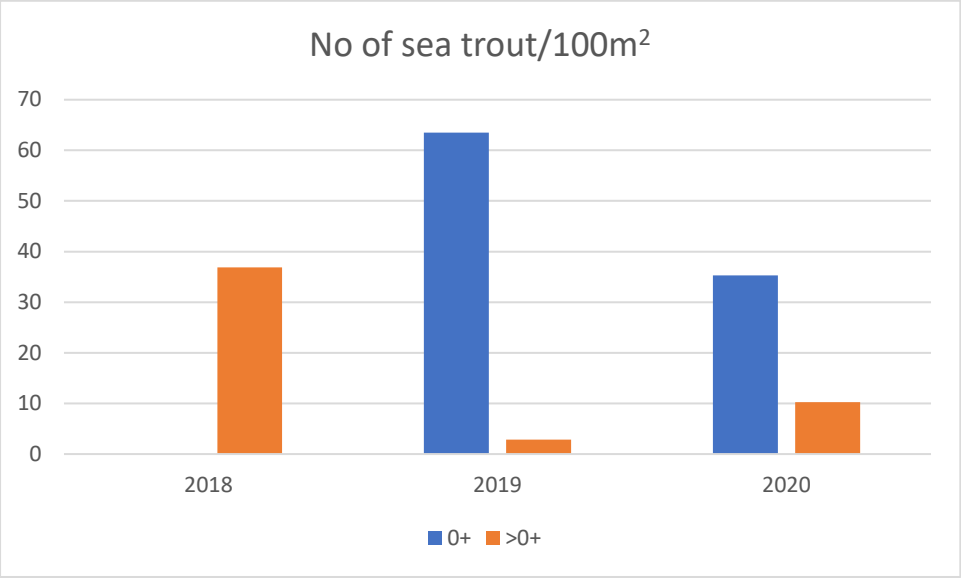


Figure 70. Number of 0+ and older sea trout per 100 m² at the Vitså Mill site.

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.

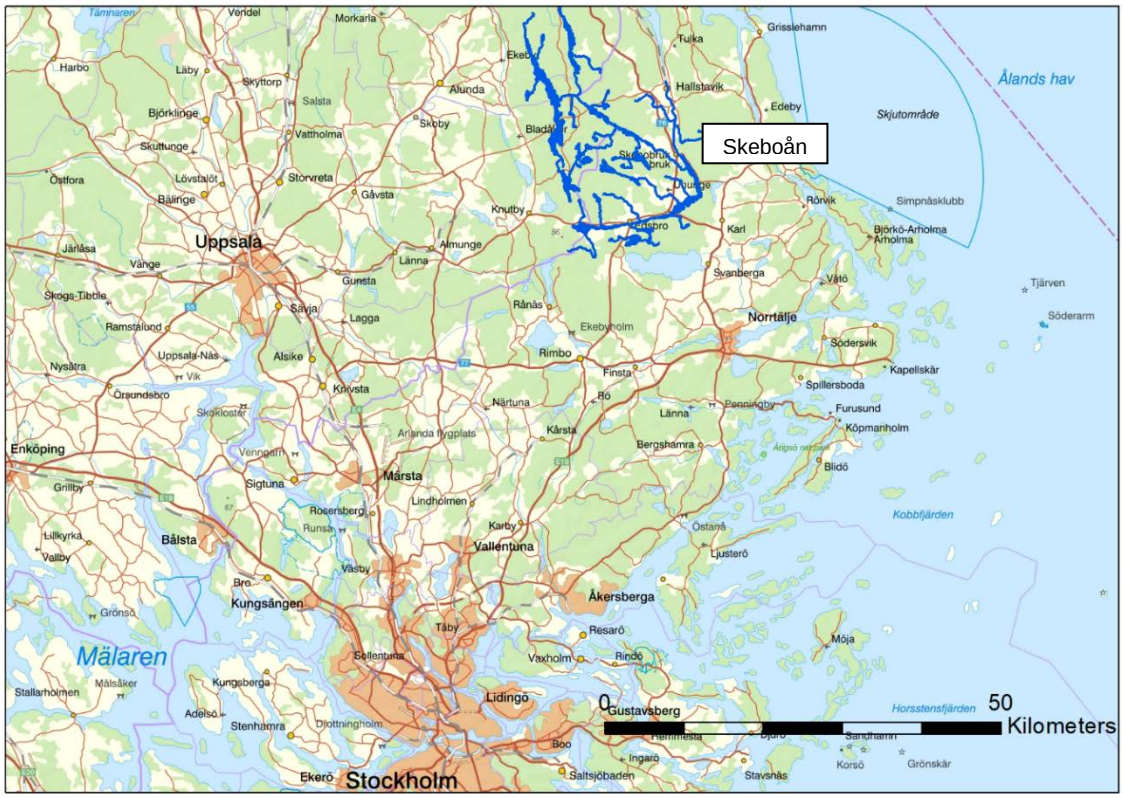


Figure 71. Skeboån, overview

[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.

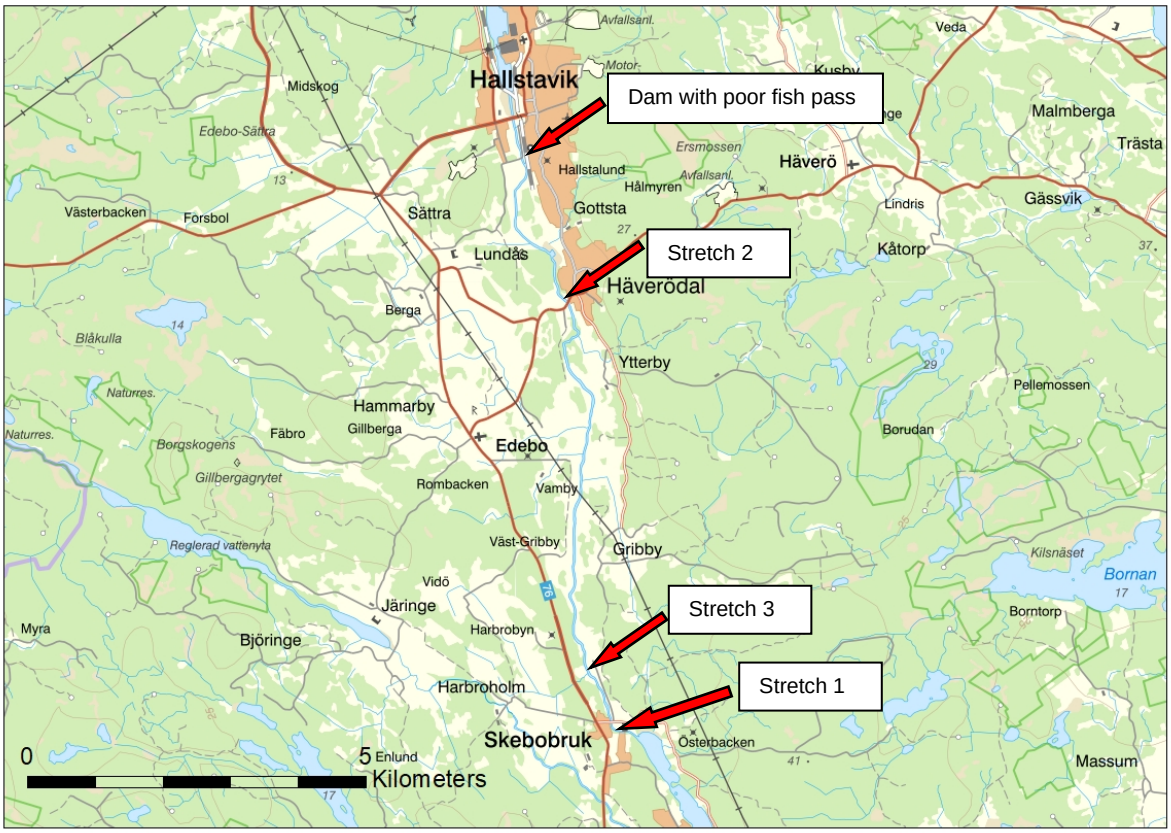


Figure 72. Skeboån, overview of the restoration sites

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

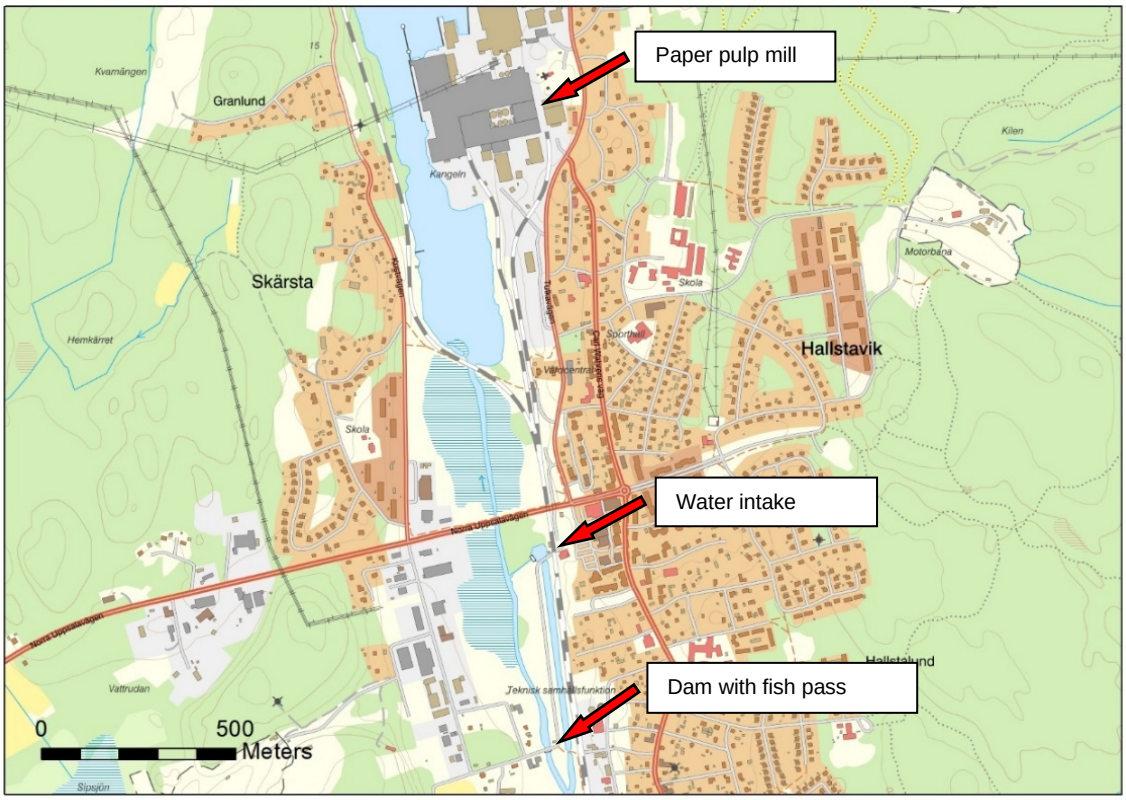


Figure 73. The dam at Hallstavik, Skärbrodammen.

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.

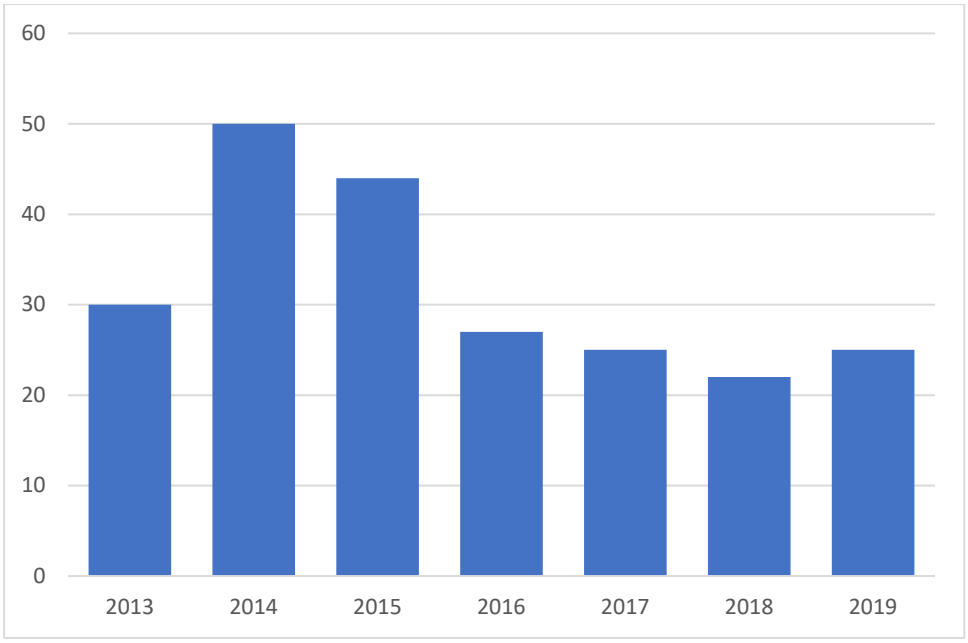


Figure 74. Spawning redd counts in Skeboån from Skebobruk to Hallstavik. Number of redds found during a one-day count.

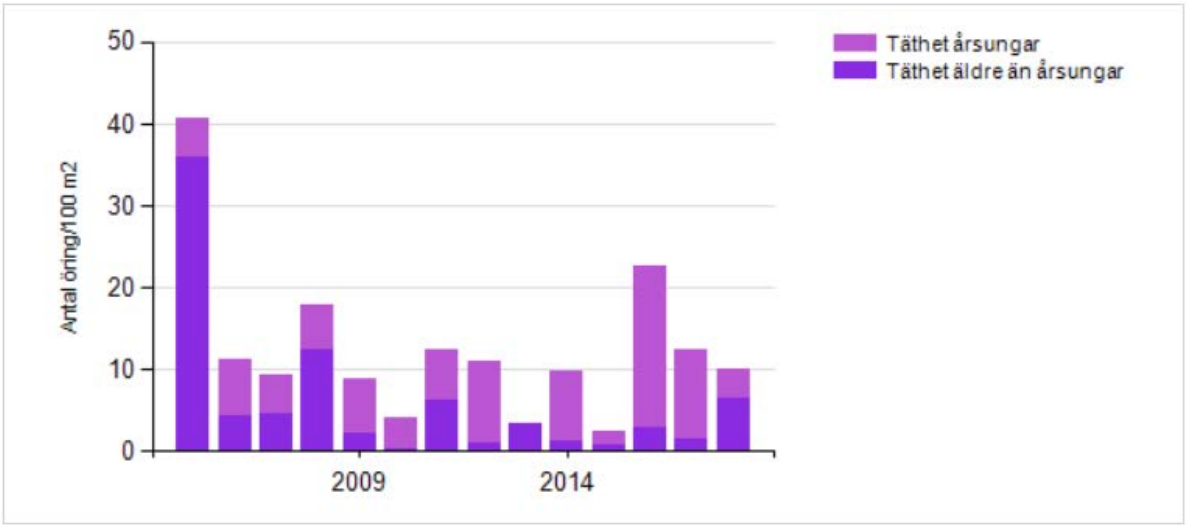


Figure 75. Electrofishing results from 4 sites in Skeboån from 1995 to 2018. Average of results from 2 or 3 sites.

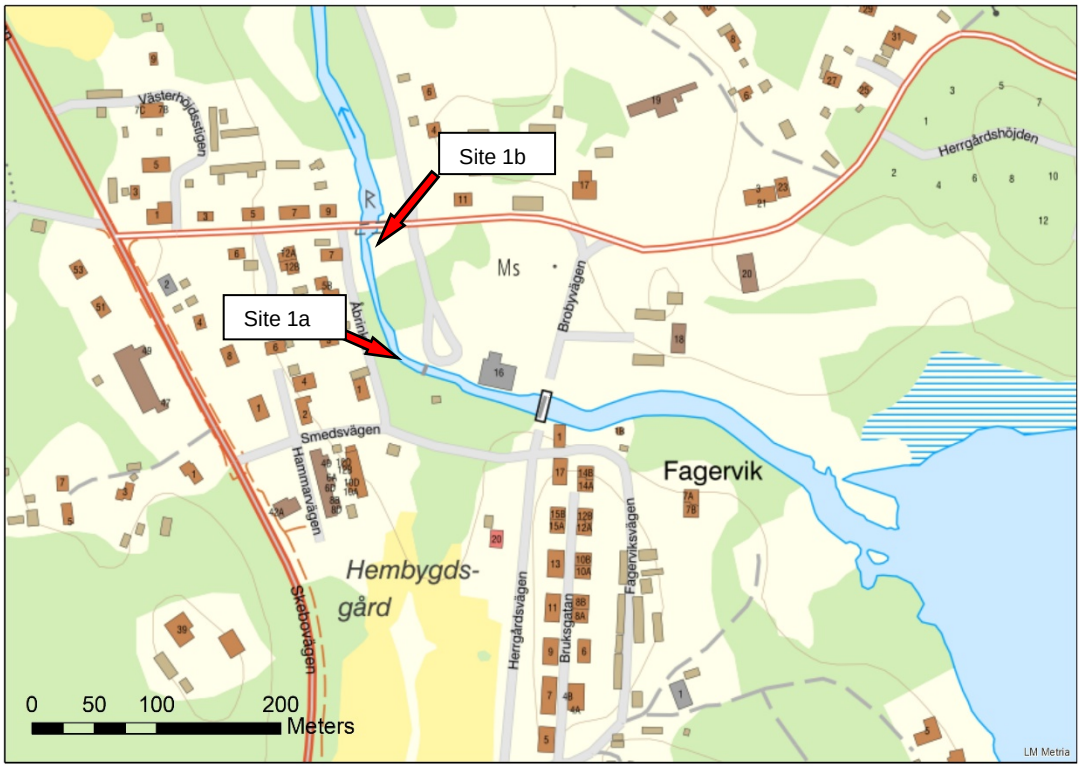


Figure 76. Stretch 1, Skebobruk old ironworks. At site 1a habitat improvement measures were applied, and at site 1b a multichannel stream was restored.

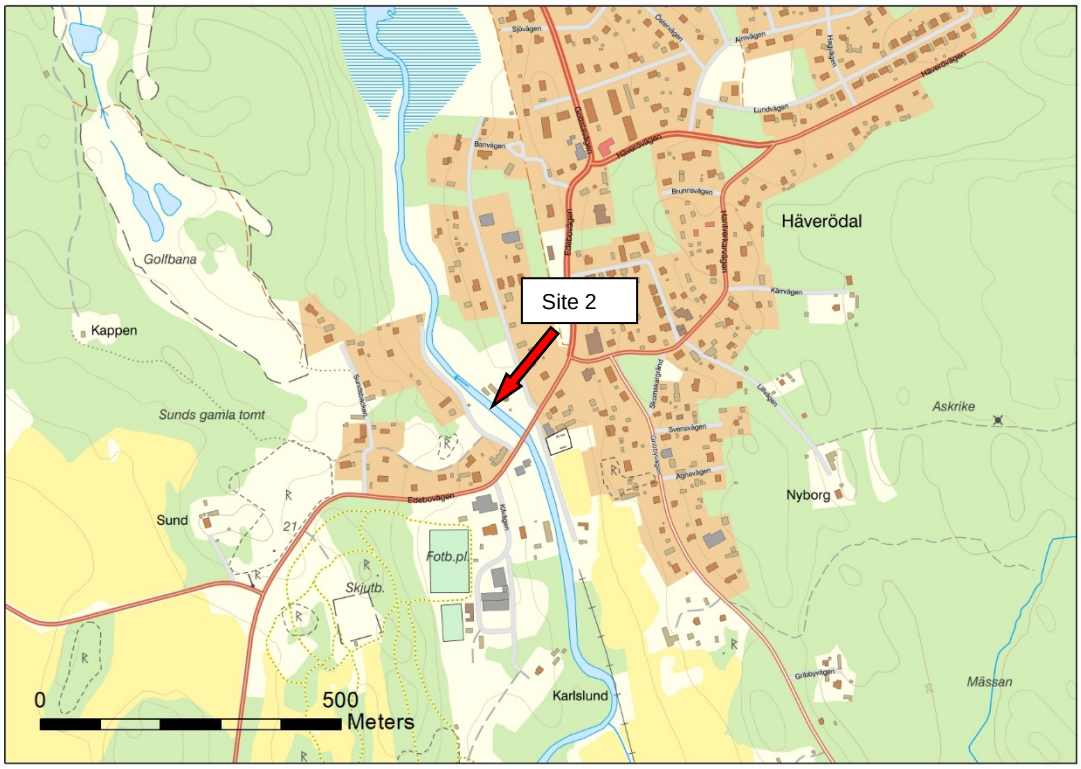


Figure 77. Stretch 2, Häverödal old mill and saw. Here habitat improvement measures were applied, and a controlling section partly restored.

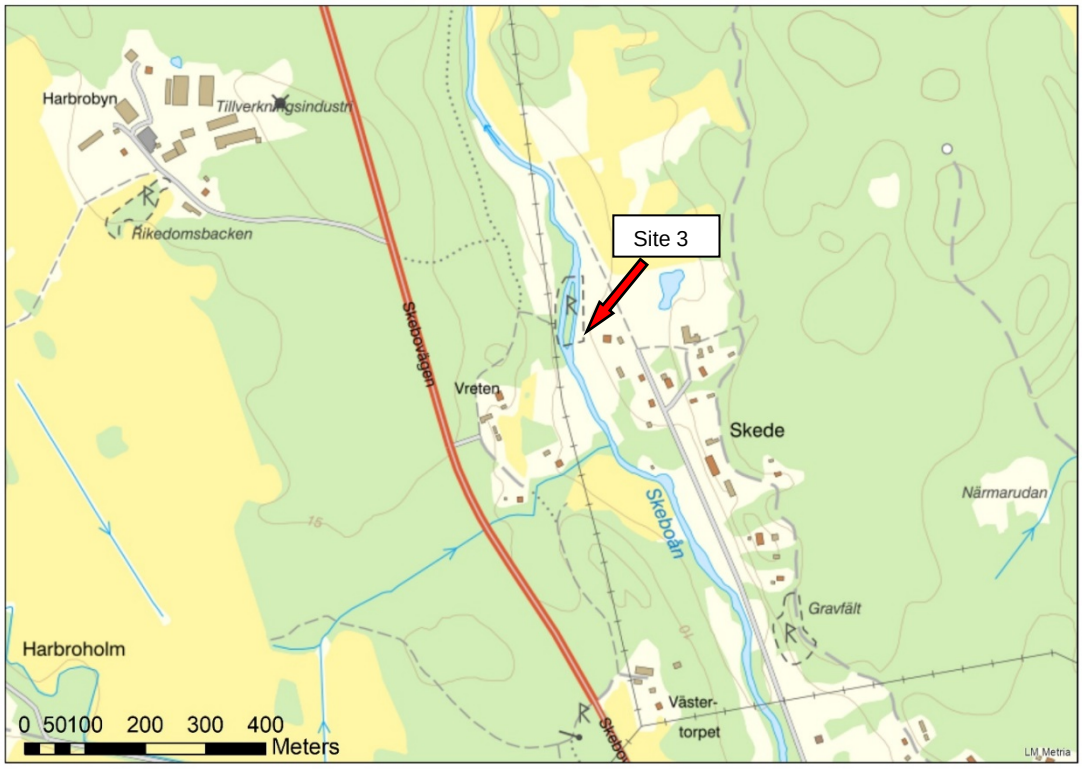


Figure 78. Stretch 3, Skede ironworks. Here, habitat improvement measures are planned. The site is a historic site protected by the Ancient Monuments Act.

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.

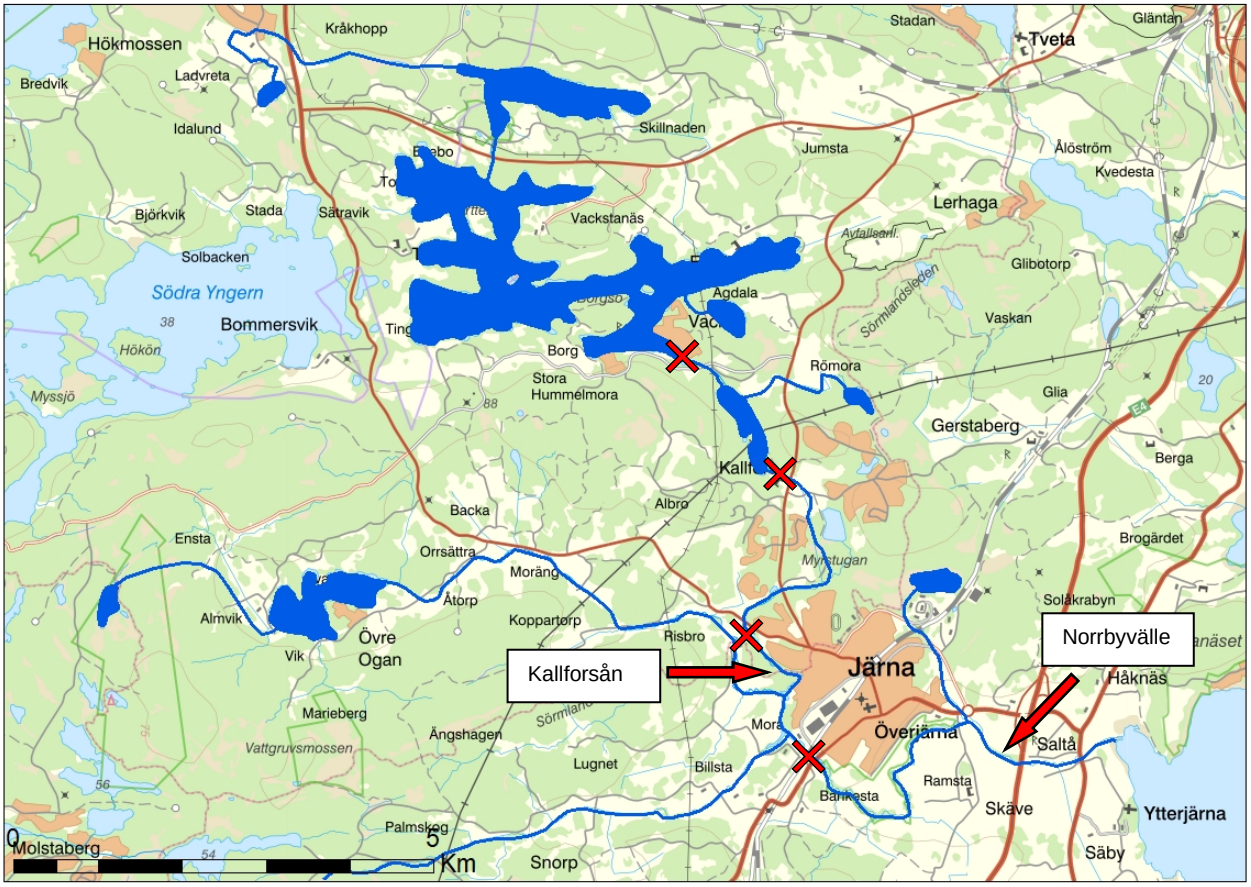


Figure 83. The two restoration sites in Moraån. The x-signs indicate migration obstacles. Source: LM Metria ©.

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.

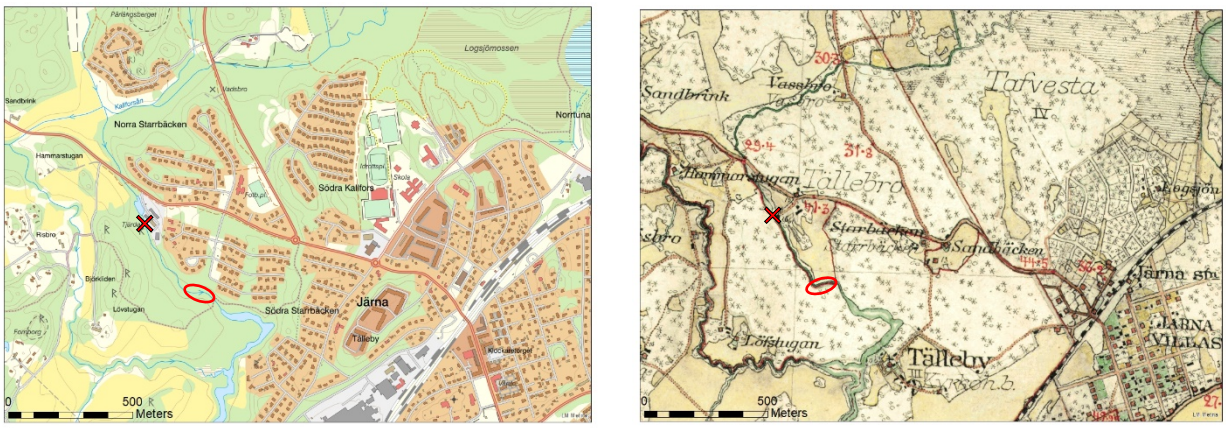


Figure 84. Restoration site in Kallforsån. Present (left) and year 1901 (right). The x-signs indicate migration obstacles. Source: LM Metria ©.

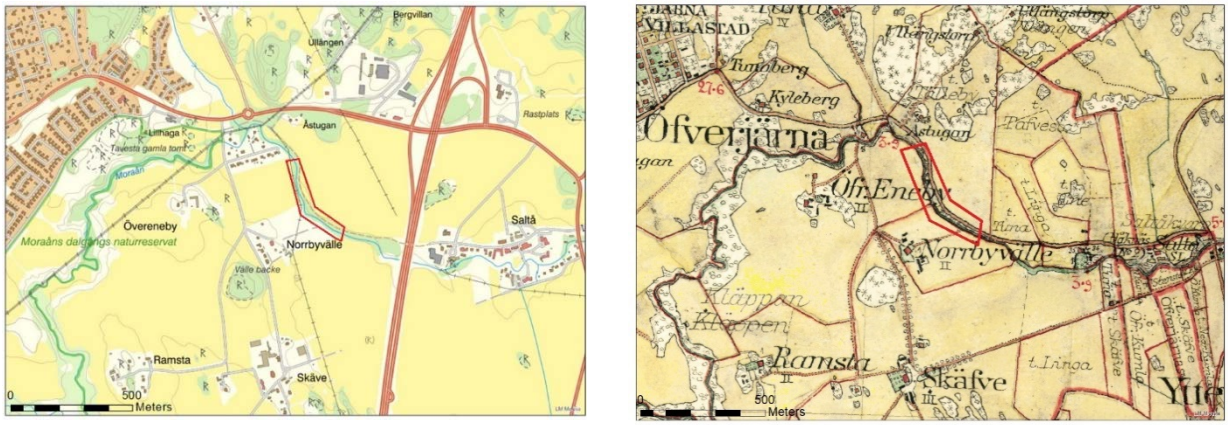


Figure 85. Restoration site at Norrbyvälle. Present (left) and year 1901 (right) The x-signs indicate migration obstacles. Source: LM Metria ©.

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.

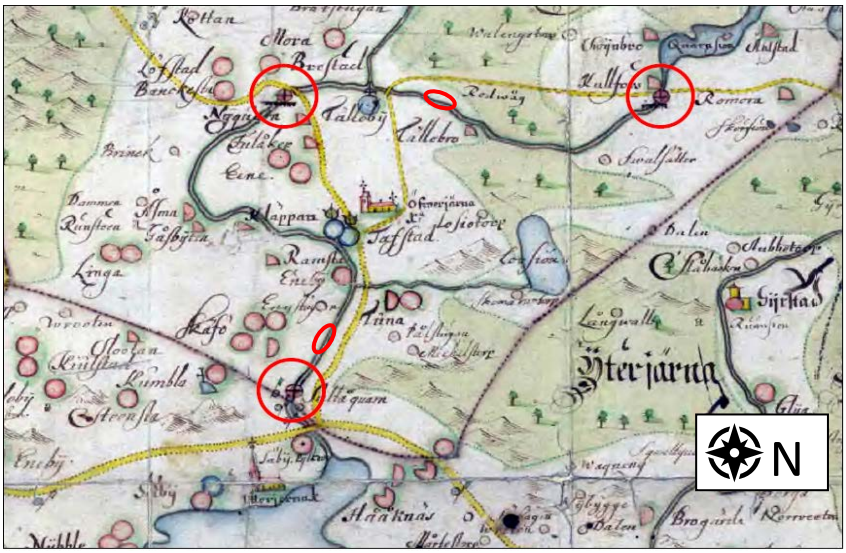


Figure 88. Map from 1696. The mills at Kallfors (on top), Järna, and Saltå are marked with circles Saltå mill is no longer a migration obstacle. The restoration sites are marked with red ovals. The map is not georeferenced, approximate N is indicated. Source: LM Metria ©.

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.