Centre for Economic Development, Transport and Environment for North Ostrobothnia

Restoration Plan for the study areas at the Syskyanjoki River and the Tulemajoki River

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CENTRE FOR ECONOMIC DEVELOPMENT, TRANSPORT AND THE ENVIRONMENT OF NORTH OSTROBOTHNIA

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Restoration plan for the study areas at the Syskya and Tulema rivers
Karelia, Russia

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1 Introduction

This survey is part of the Clean Ladoga project (KA526) (2013-2014), financed by the ENPI program. The purpose of the survey was to investigate two sites at the Syskyanjoki and Tulemajoki rivers, draw 3D models of these sites and prepare pilot restoration plans for both of them. Restoration plans are aimed to increase attractiveness of the rivers for salmonids migrating from the Ladoga Lake for spawning by restoring river beds and making it closer to the state before it was disturbed by human activities such as timber floating, dam construction, etc.

The reproduction potential of the rivers running into the Lake Ladoga was earlier evaluated by Titov et al. in 2008: "Land-locked Salmon in the Ladoga and Onego basins". Two targets were determined in such a way that they serve the needs of the Russian partners and the objectives of the project as well. Habitat requirements for landlocked salmon of the Ladoga Lake area were primarily taken into consideration.

The Land-locked Salmon in the Ladoga (*Salmo salar m. sebago*) is classified as endangered and its breeding areas have deteriorated both in quality and in quantity due to human activities (Titov et al. 2008). Some of the former spawning and nursery areas have completely disappeared. The river habitats of salmonids have been under change for a long time period. When timber floating was still in use, stones were removed manually from rapids. Construction of mills and power plants has changed flow regimes and water levels. Energy potential has been utilized by concentrating all the head at one point of the channel. Overfishing, changes in water quality and land use in the catchment area have decreased the number of salmon in the lake. Many salmon stocks in the rivers running into Lake Ladoga are almost extinct.

1.1 The location of the study areas

Restoration site 1 is situated at the **Syskyanjoki river** 2,5 km from the river mouth. It incorporates an old hydropower dam, an old hydropower station building, a bridge and the downstream territory (Figs. 1-5). The study area is 200 meters long and the mean width of the channel is about 10 meters. The gradient (slope) of the rapid section is approximately 1 - 3 %.

Figure 1. Study area 1 at the Syskyanjoki river (Source: http://maps.yandex.ru)

Figure 2. The Syskya river – study area 1 (Source: http://maps.yandex.ru)

Figure 3. The bridge and the old power house on the Syskya river (Source: Esa Laajala)

Figure 4. Destroyed dam, river Syskya
(Source: Esa Laajala)

Figure 5. Island in the Syskya river channel
(Source: Esa Laajala)

Restoration site 2 was chosen to be on the **Tulemajoki river** 1 km from the river mouth. The area is demarcated by two bridges; railway upstream and vehicular downstream (Figs. 6-9).

This study area is situated in Salmi village. It has earlier been modified for timber floating by removing stones from the channel to the riverbanks and by constructing artificial obstacles for directing timber to their required route.

This restoration area is highly significant for the project, as it will demonstrate the restoration process to the local inhabitants and in this way help to spread environmental awareness.

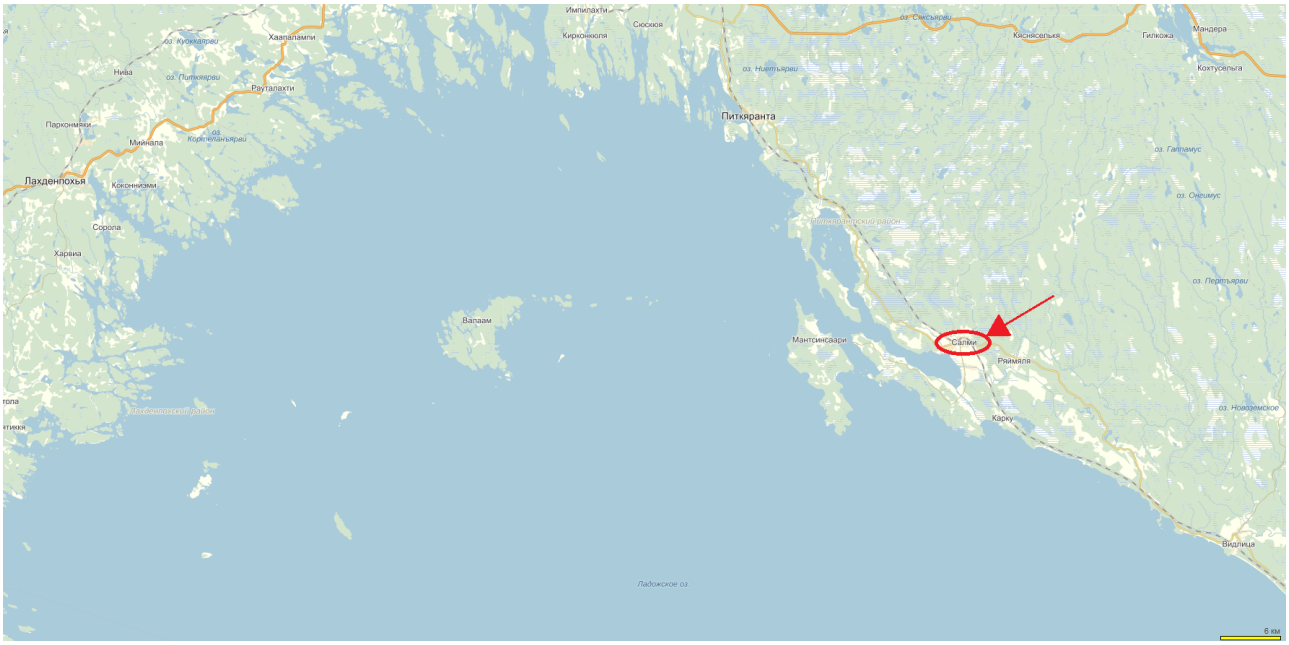

Figure 6. Salmi village – study area 2 (Source: http://maps.yandex.ru)

Figure 7. The Tulemajoki river – study area 2 (Source: http://maps.yandex.ru)

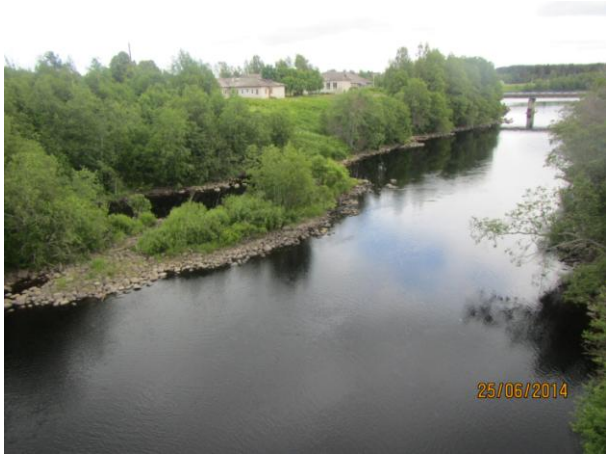

Figure 8. The view to Tulemajoki river from the railway bridge.

Figure 9. Railway bridge piles in the Tulemajoki river (Source: Esa Laajala).

1.2 The topics of the project

The project aims to restore the study areas at these two rivers in a way that they will satisfy the needs of the salmon as spawning territories. It will increase the number of salmon in the areas and the implementation will familiarize local inhabitants with methods and aims of river restoration in general. Local people can be involved in the process and learn by doing. Therefore, the Russian side can continue restoration work at other rivers without external assistance. Restoration outcomes will attract tourists and consequently can push development of the region.

The other aim of the project is to improve environmental conditions. After the restoration, the river beds should obtain more natural conditions than at the moment (modified by the human activities). This, apart from the salmonids, will affect the whole area and scenery in general.

2 The characteristics of the study cases

These two areas in the rivers Syskya and Tulema were chosen according to the main objectives and the description of acting of the Clean Ladoga project. Restoration measures will be designed as typical methods and common activities can be used on other restoration sites as well.

2.1 Description of the area

The restoration site of **the river Syskya** situated among the rapid section with a regulation dam in its upper part. The ruins of an old dam block the upstream migration of fish on lower discharges. On

the river Tulema, old timber floating structures have changed the river route so that the earlier rearing and nursery areas of salmonids now locate on the ground without any water.

2.2 The River basins and hydrology

The Syskyanjoki river originates from the Syskyanjarvi Lake and flows into the Ladoga Lake. It is 33 km long with a catchment area of 477 km^2. The height difference at the start and end of the river is 64,7 m and the average gradient of the river is 1,9 m/km. The limnetic degree of the river is 4,1 %, paludification degree is 20 % and the proportion of forest cover on the catchment is 71 % The mean annual flow is 5,3 m^3/s and runoff from territory is 10,9 $l/s/km^2$ (Ieshko 2013).

The Tulemajoki river originates from the Tulmozero Lake and flows into the Ladoga Lake 1 km downstream of the Salmi village. The river is 55 km long and has a catchment area of 1720 km^2. The height difference of this river is 72 m and the average gradient is 1,3 m/km. The river has a limnetic degree of 5 %, there are four small lakes throughout the river channel (total area 2,2 km^2). The paludification degree of the river basin is 16 % and the proportion of the forest cover on the catchment is 78 %. The average annual flow is 20,8 m^3/s and runoff from territory is 12,2 $l/s/km^2$. Soil content of the catchment is highly diverse, there are sandy moraine, teeming with boulders and gravel, glaciofluvial sand, sandy loam, light loam and peats (Ieshko 2013).

2.2.1 Anthropogenic impact on hydrology

Syskyanjoki: The River was used for timber floating only for 15 years. After floating was finished, the river channel was not cleaned of the waste timber that causes significant concentration of resinous substances in the river (Ieshko 2013).

In 1930's three dams obstructed the river channel. One dam was constructed 2 km from the river mouth (???), another 5 km and third one 23 km from the river mouth (???). They had negative impact on the population and habitats of salmon. The lowest dam was dismantled in 1989 (Ieshko 2013) but it still can be an obstacle for spawners on certain discharges and water levels.

Tulemajoki: The River was used for timber floating over 200 years and it was heavily modified due to that activity. A lot of floating timber has sinked to the river bottom which has generated clogs and floating dams.

In 1930's, there were constructed two dams, 9 and 11 km from the river mouth. They significantly affected the number of salmon in the river, as the most valuable spawning and nursery areas (SNAs) were upstream of the dams. At the moment neither of the dams are in use. Even though they are partly destroyed, they still obstruct salmon upstream migration (Ieshko 2013).

2.2.2 Hydrological factors in the restoration

In the river Syskyanjoki study area, restoration measures are typical for natural rapid sections. Because of the gradient of the site, hydraulic measures in the channel should ensure that all the stones maintain their place during flooding and freezing over.

In the river Tulemajoki study area, the main focus of the restoration is to remove old timber floating structures and to adjust the water level, discharge and route so that old salmonid rearing and nursing areas will be watered again.

2.3 Water Quality

There are no specific loading sources in the catchment area of these rivers. The river Syskyanjoki flows across swamp areas and its water chemistry and color are similar to other rivers of this kind. The river Tulemajoki has some agricultural impacts but they are significantly worse than those in the other rivers of this territory.

2.3.1 Basic description

Syskyanjoki river: The water of the river Syskya is characterized by low mineralization (15,1 to 35,7 mg/l) of bicarbonate-calcium composition, biogenic matters presented weakly. Water contains a little dose of inorganic phosphorus and iron. Turbidity varies from 13 to 18 g/m^3 and transparency from 1,4 to 2,1 m depending on seasons. Gas regime is satisfactory for salmonid habitation, although during winter and spring the carbon dioxide content is relatively high. The water has a slightly acidic character (pH varies from 6,33 to 6,78). During the open water period, dissolved organic matter and chromaticity are rather high because of the high humus concentration, runoff from fields, oil water from gas stations and livestock farms (Ieshko 2013).

Tulemajoki river: The water of the river Tulemajoki has low mineralization (15,6 to 34,5 mg/l) bicarbonate-calcium composition, contains low amounts of iron and mineral phosphorus and low quantity of biogenic matters. Turbidity is from 14 to 18 g/m^3, transparency from 1,7 to 2,3 m. Gas regime is satisfactory for habitation of salmonids, carbon dioxide content of water is relatively high in winter and spring. Lower part of the river is rich with natural humus (Ieshko 2013).

2.3.2 Antropogenic impacts on water quality

Syskyanjoki: There are settlements on the river, however few vehicular roads cross it, therefore, contaminations can be delivered by runoff.

Tulemajoki: A significant part of the catchment area is covered with agricultural areas (Ieshko 2013). Of these, livestock farms are located mostly in the lower part of the river, therefore, river in

this area is more polluted than in the upper part of the river. Contamination of the river water by oil products takes place in the village Salmi due to boating, untreated sewage outflow and car traffic (Ieshko 2013).

2.4 Structures in the river bed

Syskyanjoki: The River is crossed by a little bridge, ruins of old hydropower plant obstruct the channel, and there are also two regulation dams in the upper part of the river. Across the river in the study area 1 there is an electric line (Fig. 10). Most probably it is not in use, because it is connected to an abandoned building.

Figure 10. Electric line on the Syskyanjoki river.

Tulemajoki: Two hydroelectric dams were built in the 1930s on the Tulemajoki river (Fig. 11) at the distance of 9 km (actually HPS) and 11 km (adjusting dam) up from the river mouth. There are two bridges in the Salmi village.

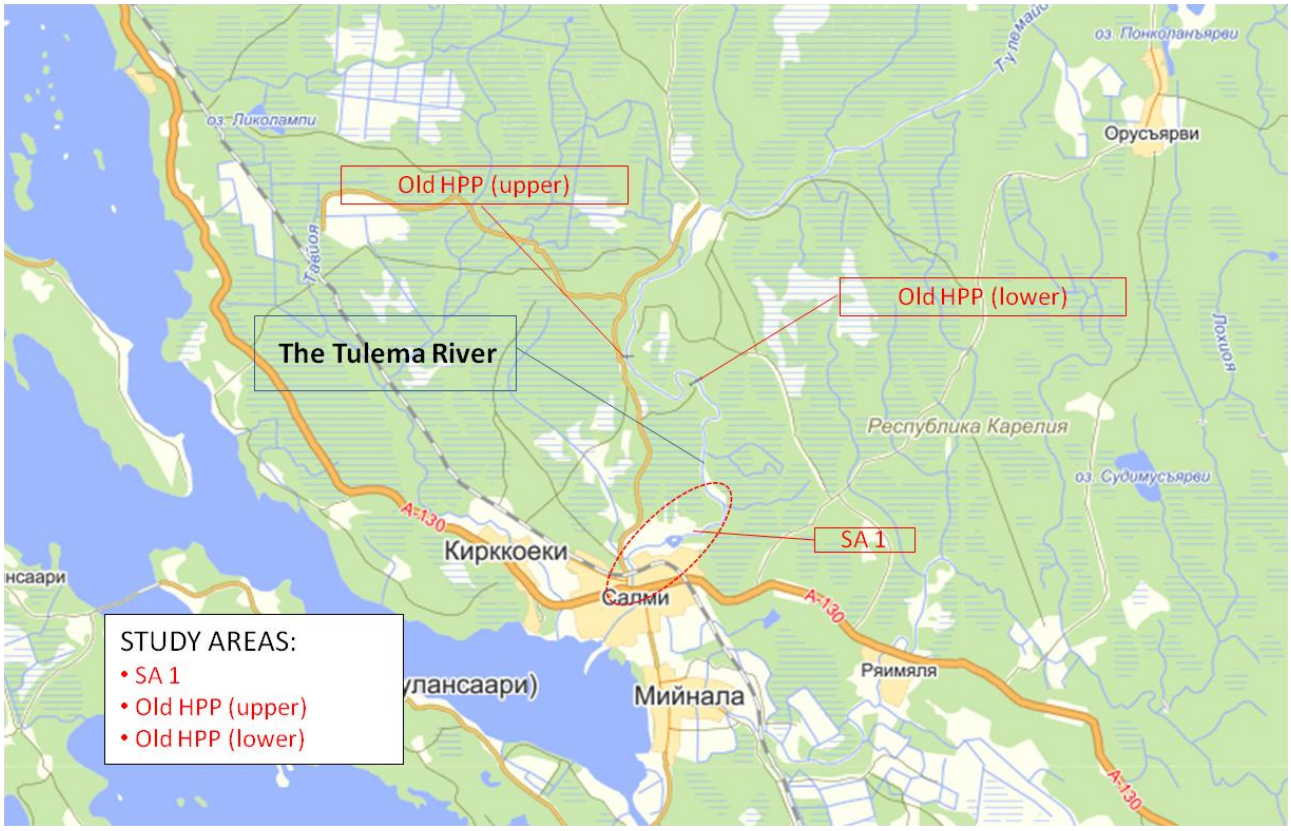

Figure 11. The location of the Tulema river, study area (SA 1) and old power plants. (http://maps.yandex.ru/, [25.9.2014]

3 Aquatic fauna

Syskyanjoki fish fauna is represented by 16 species: Atlantic salmon, lake trout, brook trout (family Salmonidae), perch, (Percidae), pike (Esocidae), burbot (Lotodae), bleak, roach, bream, silver bream, dace, ide, chub, vimba bream, stone loach (Cyprinidae), river lamprey (Petromyzontidae). In addition, grayling and whitefish come to spawn to the river in spring and autumn respectively. Competition between different species is excluded because they have small populations (Ieshko 2013).

The river Syskyanjoki is the only river running into the northern Ladoga where pearl mussels (*Margatifiera Margatifiera*) still exist).

Tulemajoki fish fauna is represented by 15 species: Atlantic salmon, lake trout, brook trout (Salmonidae), pike (Esocidae), perch, ruff (Percidae), bleak, roach, common bream, silver bream, stone loach, minnows (Cyprinidae), burbot (Gadidae), eel (Anguillidae), river lamprey (Petromyzontidae). In addition, smelt, grayling, vimba and bream enter the river for spawning in spring and a lake-river whitefish in autumn. A huge amount of crayfish were noticed in the upper part of the river.

Minnow, stone loach and juveniles of burbot and trout (brook and lake) might be competitors for juveniles of landlocked salmon. Their habitats are, however, different, which eliminates competition (Ieshko 2013).

4 Restoration guidelines

The main principle in restoring is to improve and increase the number and quality of spawning and nursery areas of salmonids, especially landlocked salmon. The restoration method should thus be chosen according to their needs and demands. In all the measures, best practices and techniques should be applied.

4.1 Common rules

Pay attention to the tracks will be removed or restored as natural as possible after the restoration work. All the trails and actions which cause damage to nature or landscape should be cleaned and finalized before departure.

4.2 Spawning and nursery areas

A general rule for designing of spawning and nursery areas is to comply the water depth of 0,3 - 0,5 m, water velocity and bottom fraction. These areas should be protected from the strong flow and velocities by using deflectors.

4.3 Spawning grounds and shelter

Adult salmon spend a lot of energy to reach spawning areas, so they need resting areas which will also serve as a shelter. For these purposes bottom landscape should be diverse with also deeper areas protected with boulders and masked with large wooden debris (LWD).

4.4 Weirs and boulders

Weirs are designed to increase water level in the upper section, as well as to provide oxygen saturation. Boulders are used to redirect the current, to strengthen weirs, to mask deeper areas and to protect some areas from a strong current. Boulders should be installed sufficiently deep into the river bed to insure their stability.

4.5 Groups of stones

Groups of stones are used to protect the spawning and nursery ground from a strong flow. They should be constructed so that deep boulders should provide the base of the structure and smaller stones should surround them.

4.6 Pools

Between the rapids on narrow areas, where the bottom level is unbalanced, the main measures for restoration is to increase diversity by digging pools and by increasing larger boulders and large wooden debris into the bottom as shelter for adult fish.

4.7 Buffering against erosion

Areas and riverbanks consist of thin soil. That is why they should be protected against flow induced erosion with gravel and stones. Preferably, local materials should be used.

4.8 Modifying the environment

Equipment for environment protection depends on the number of users such as travelers and fishermen. Additional measures and equipment should be planned when the purposes of the rivers are known.

5 Restoration plan for the study areas

5.1 Mapping and field surveys

Potential restoration sites were explored in altogether seven rivers of the northern territory of the Ladoga Lake. The restoration needs varied depending on location scope and hydro-morphological status of the rivers. Based on the results of the survey (Laajala et al. 2013) the river Syskyanjoki and the river Tulemajoki study cases were chosen for the targets of the restoration plans.

Two reports of mapping and field survey were finalized during the implementation of the Clean Ladoga project (KA526). The survey of restoration needs for rivers running into the lake Ladoga, Northwest Carelian District was finished in late October 2013 (Laajala et al.). The topography was explored in late June 2014 and the report was published in August 2014 (Laajala & Lappo). The purpose of the survey was to investigate two sites on the Syskuanjoki and Tulemajoki rivers and draw 3D models of the sites to be able to prepare pilot restoration plans for both of them.

5.2 The Syskyanjoki river: study case 1

- The site should be restored by changing the slope of the river bed to allow fish migration during low discharges;
- The old dam structures should be removed;
- Suitable bottom substrate should be increased for restoring of spawning areas;
- Material on site should be used to increase hydro-morphological diversity.

The measurement equipments can be applied without a benchmark, adjusting the local coordinate system using two points with known distance and elevation between them. It was enough for modeling purposes, as both areas were modeled separately and had no needs to be linked to each other.

The restoration measures are pointed by a pile number (PN) which starts in the upstream (the first PN 00+00) and ends in the downstream. That's why because of the restoration work is worth implementing from upstream to downstream especially working with an excavator. On the maps distances of the measures and pile numbers represents usually between 10 – 20 meters.

Syskyanjoki, study area 1 / Old HPP PN 00+00 - 00+186 length 186 m,

PN 00+00 - 00+20

- Restoration by adding big stones and boulders to the area.
- Creation of a threshold, which will raise upstream water level by about 0,2 m. It should consist of huge stones (0,5-1,5 m3). They should be partly deepened into the river bed, because water gradient is as high as 4,12% in this section, so it easily can move unstable stones.

PN 00+20 - 00+40

- Restoring by adding boulders to the channel.
- Creation of spawning areas by adding gravel and importing big stones to the channel.
- Protection of the spawning area with a deflector.
- Digging of pools to provide areas where adult salmons can rest. Masking it with big stones and LWD.

PN 00+40 - 00+60

- Creation of a threshold, which will raise upstream water level .
- Creation of a spawning area by adding gravel and importing big stones to the channel. Digging of a pool. Masking it with big stones and LWD.

PN 00+60 - 00+80

- Restoration by adding big stones and boulders to the area.
- Creation of a threshold, which will raise upstream water level .
- Digging of a pool. Masking it with big stones and LWD.
- Demolition of a wooden manmade construction.

PN 00+80 - 00+100

- Restoration by adding big stones and boulders to the area.
- Creation of a spawning area by adding gravel and moving big stones out of the area.
- Moving stones from the island to the channel.

PN 00+100 - 00+120

- Digging of pools. Masking it with big stones and LWD.
- Creation of a threshold, which will raise upstream water level.

PN 00+120 - 00+140

- Restoration by adding big stones and boulders to the area.
- Digging of a pool. Masking it with big stones and LWD.

PN 00+140 - 00+160

- Restoration by adding big stones and boulders to the area.
- Creation of a spawning area by adding gravel and moving big stones out of the area.
- Creation of a double deflector to protect spawning area and create flow diversity.

PN 00+160 - 00+180

- Restoration by adding big stones and boulders to the area.
- Digging of pools. Masking them with big stones and LWD.
- Creation of a spawning area by adding gravel and moving big stones out of the area.

PN 00+180 - 00+186

- Creation of a threshold, which will raise upstream water level.

5.3 The Tulemajoki river: study case 2.

- Riverbed should be restored, using material on site;
- Manmade obstacles in the river channel should be removed. The peninsula should be restored to the island to increase channel cross-section;
- For morphological restoration, gravel and stones should be used.
- Strict fishing regulation should be applied to avoid pouching (fishing nets);
- Conditions of two upstream hydropower plants should be investigated. Either they need fish pass facilities or not.

The used measurement equipments and principles are the same as in the study area 1, Syskyanjoki river.

Tulemajoki, study area 2 (between the bridges) PN 00+00 - 00+186 length 186 m,

PN 00+00 - 00+20

- Restoration by adding big stones and boulders to the area.

PN 00+20 - 00+40

- Restoration by adding boulders to the channel.
- Demolition of the timber floating structures and creation of the second channel for water.

PN 00+40 - 00+60

- Creation of a threshold, which will narrow the channel and raise upstream water level.
- Creation of a spawning area by adding gravel.

PN 00+60 - 00+80

- Creation of a threshold, which will raise upstream water level.
- Creation of a spawning area by adding gravel.

PN 00+80 - 00+100

- Creation of a threshold, which will raise upstream water level.

PN 00+100 - 00+120

- Demolition of the timber floating structures and using the stones from constructing for bottom restoration.

PN 00+120 - 00+140

- Demolition of the timber floating structures and using the stones from constructing for bottom restoration.

PN 00+140 - 00+160

- Demolition of the timber floating structures and using the stones from constructing for bottom restoration.

PN 00+160 - 00+186

- Demolition of the timber floating structures and using the stones from constructing for bottom restoration.

6 Implementation of the restoration

The restoration work consists of measures which will improve the structure of the river channel. Most of the restoring measures will be done by an excavator with about 20 ton capacity. The most suitable time for restoration is summer with normal or lower water levels. Gravel must be installed during a low flow period when access to the river is easiest and when it is possible to ensure that it is not introduced to areas prone to dewatering (Forseth et al. 2014). High water levels, flooding and rainy weather is not acceptable and the action should be interrupted. For the implementation work should be hired a driver with experience about restoration and a biological expert for supervising all the actions based to the plan and designing on site.

After the restoration operations all tracks and trails should be repaired and the environment restored back to a natural stage.

7 Assessment of environmental impacts

The main focus of the restoration is to improve the quality of habitat consistency and hydrology for landlocked salmon considering its whole lifecycle. After the restoration project, the hydro-morphological structure of the rivers will be gradually closer to natural. When the first measures are done, changes in biota and structures should be monitored and the observed bottlenecks removed.

7.1 Benefits

Presented restoration measures and methods are common in use in Scandinavian countries and based on monitoring experiences and results. Benefits about the restoration measures consist of physical and biological changes in bottom structure. The benefits are better habitats for aquatic fauna, increased fish reproduction and density of salmonids in these rivers and in Ladoga lake.

In these two study areas at the rivers Syskya and Tulema restoration increase the number and quality of habitats suitable for salmonids. Opening the migration route through the old regulation dam ruins more salmon distribute themselves upstream over a large area especially in the river Syskya. In the river Tulema study area restoration increase a number and quality of spawning and nursing habitat for salmonids.

Ieshko et al. (2013) estimated that the total spawning and nursery area (SNA) in the river Syskya is ca. 1,5 hectares. The potential spawning population is ca. 500 individuals (Titov et al. 2008). Nowadays the number of spawners is about 100 individuals annually. Restoration can recreate spawning and nursing areas for salmonids and take the whole existing potential in use.

In the river Tulema estimated total SNA is ca. 4,5 hectares (Ieshko et al. 2013). The potential spawning population was estimated as 800 individuals. Nowadays the number of the spawners varies 150 – 200 individuals (Titov et al. 2008).

7.2 Environmental detriments and damages

During the implementation of restoration, some brown colored water can appear because of replacing stones by excavator in the immediacy of the study areas. Some changes in the river banks and among the shoreline are to be seen after the restoration. Mostly all tracks and trails are due to the excavator, but these will be disappeared until the next season. The color of water is darkened during the restoration work because of changing the bottom substrate and structure. The impact of darkened water is short-term and harmless to aquatic fauna and plants. They will recover soon after the restoration.

8 Expenses

The total expenses are ca. 10 000 € (according to prices on 2014 level). The time for restoration is approximately 1 week / study area (Table 1). The costs of transporting material depend on distances. The estimate about expenses is composed based on experiences about the restoration projects in Finland.

Table 1. The estimated expenses.

Expenses	Unit	# of units	Unit rate (in EUR)	Costs (in EUR)
Excavator	h	76	60	4560
Spawning gravel	ton	20	25	500
Transport operation, clearance of trails		2	250	500
Supervision of work, monitoring	month	1	2000	2000
Human Resources	month	1	2000	2000
Administrational cost	7 %			510
Total all				**10 070**

9 Conclusion

The primary target of the restoration measures is to improve, re-establish or/and increase suitable fluvial habitat for spawning and nursery areas of the land-locked salmon. The purpose of the this restoration plan is to act as a model. The method and experiences can be utilized at another restoration sites and projects in the rivers running into the lake Ladoga. The study areas were chosen between seven rivers. The most effective restoration measures are to increase habitats suitable for land-locked salmon and to improve survival by constructing fish pass facilities at the dams.

By removing old timber floating structures, the diversity of the channel can be improved. This requires well prepared designing and implementation at the same time on site. This method is the most economical and also effective in practice in re-establishing salmon migration routes between the spawning and nursing areas.

The need of fish pass facilities at old and modern hydro dams was evaluated in rivers included in this survey. There are many obstacles in the rivers formed by both at old and modern HPPs for Ladoga salmon based on its lifecycle and habitat requirements. The dams block all migration between production areas (spawning and nursing grounds) and the lake Ladoga (feeding grounds). Therefore, it is important that the assessment takes into consideration the whole lifecycle and the different life stages of the land-locked salmon. The obstacles have a significant negative impact for migratory fish in the rivers of the lake Ladoga, especially for the salmon. The lack of migration routes seems to be a bottleneck in most of the explored rivers.

When choosing the restoration sites, their socioeconomic impacts were evaluated as well. The restoration site is a concrete example of active water management work. The profit from the operating will spread to other users, too. In restoration projects, many groups and stakeholders can combine their interests and collaborate. It is important to point common interests in improving salmon environments while at the same time getting positive effects on attitudes of people about their own environment. The naturally reproducing land-locked salmon stock has a very high status and along with the improvement of the stocks, the number of tourists on the area will increase. Simultaneously, the attractiveness of the environment will increase, too.

Fishery management should be undertaken into a wide range of commercial, recreational, and environmental interests. The values of existence and future options are becoming more significant in fisheries management. According to a holistic approach one of the bottlenecks is how to reorganize fishing regulations and reallocate catches between estuaries and up-river areas in Ladoga in the future.

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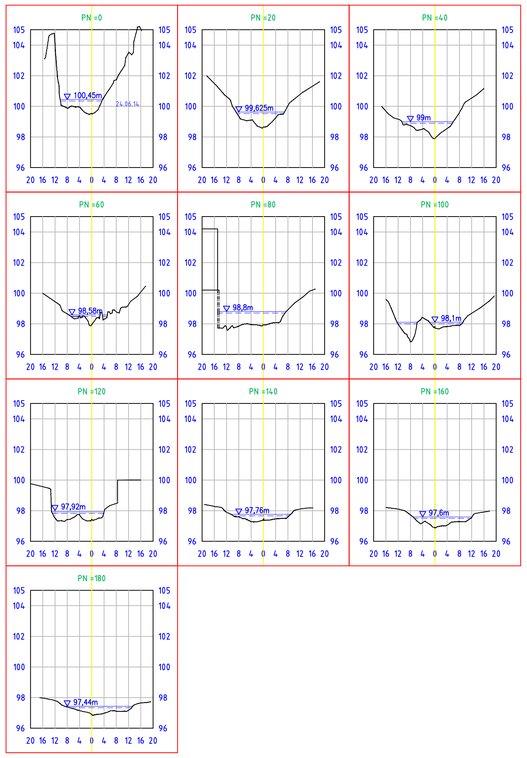
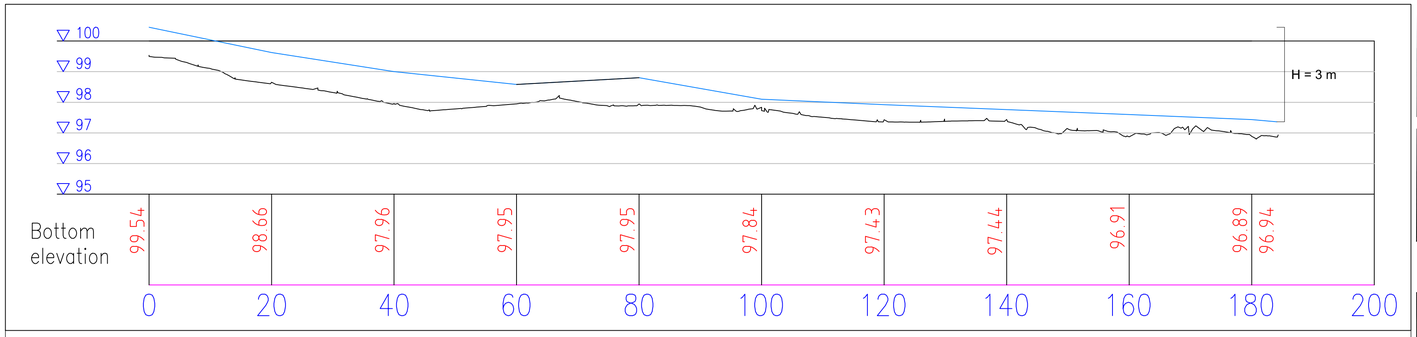
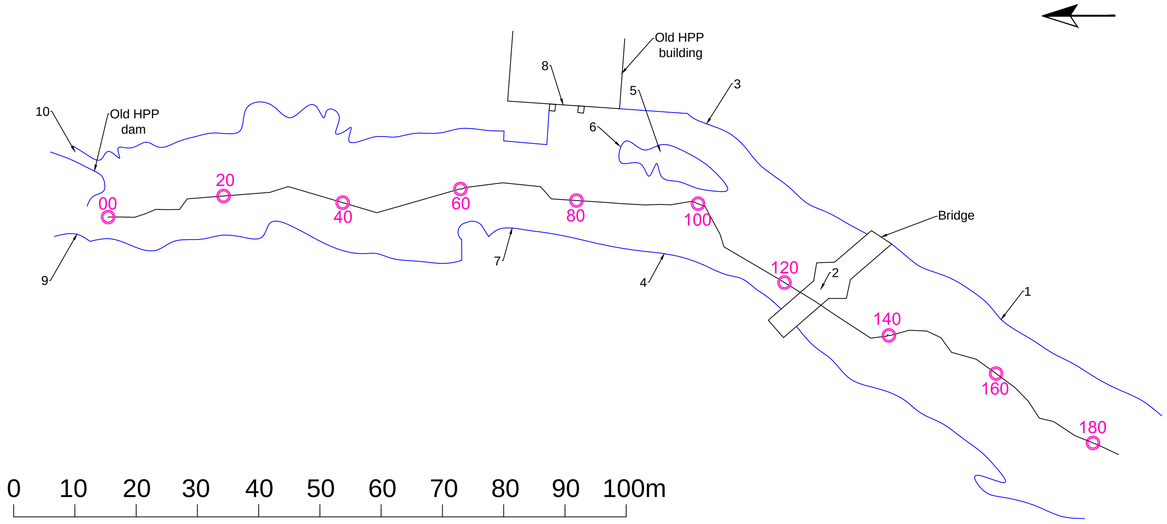






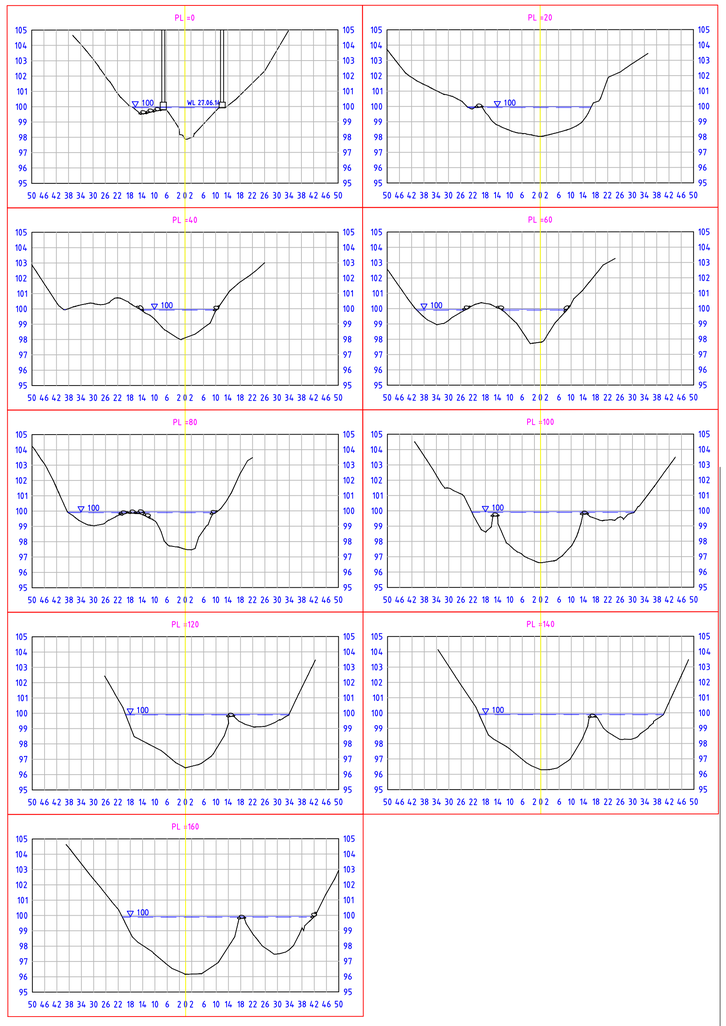
A				
Tunnus	Lukum.	Muutos	Pvm.	Tekijä

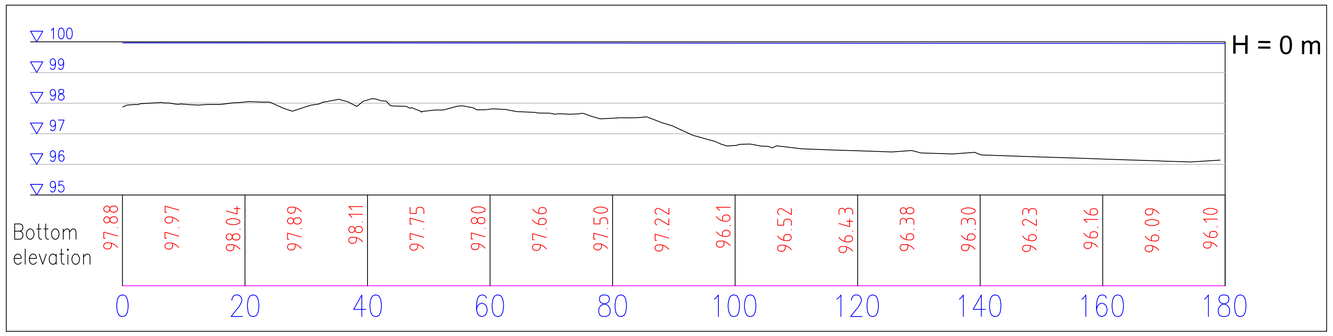
Työn nimi, kunta	Piirustuksen sisältö	Mittakaava
The study area in the Syskyajoki River	Real view before restoration	1:500 1:1000

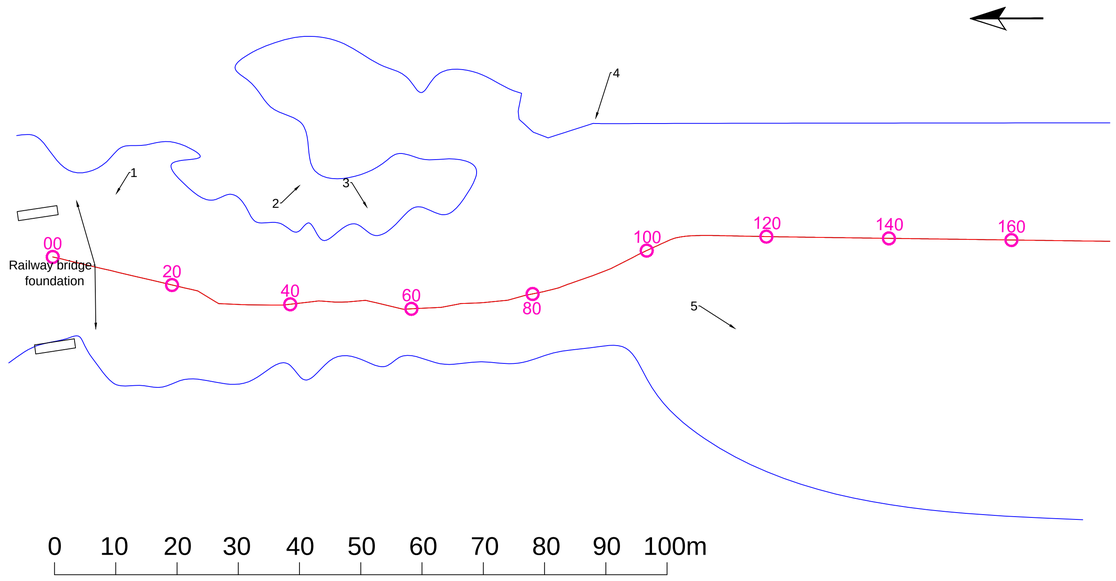
Pohjois-Pohjanmaa
Elinkeino-, liikenne- ja ympäristökeskus

Date	Suunnittelija	Piirtäjä	Drawnings number	Muutos
5.9.2014	Esa Laajala	Stepan Lappo	1	

Tnro







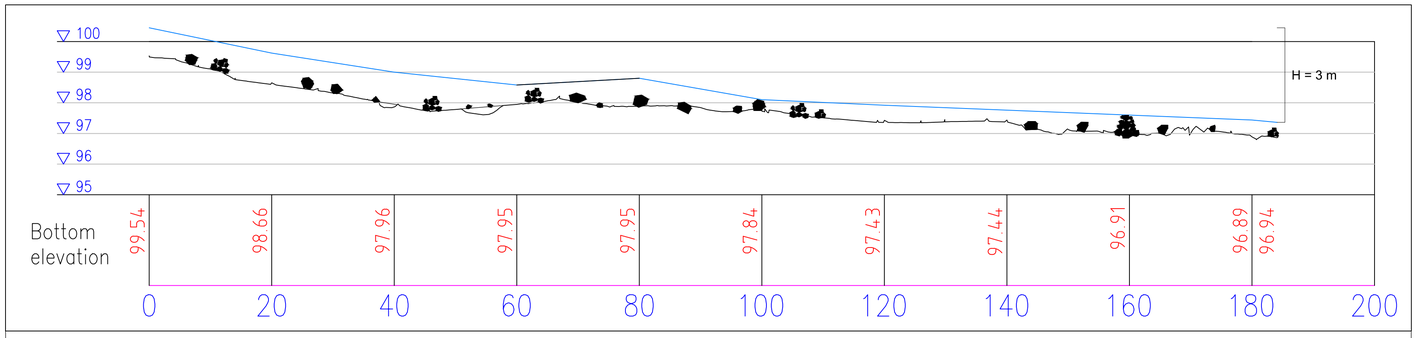
Tunnus	Lukum.	Muutos	Pvm.	Tekijä
A				

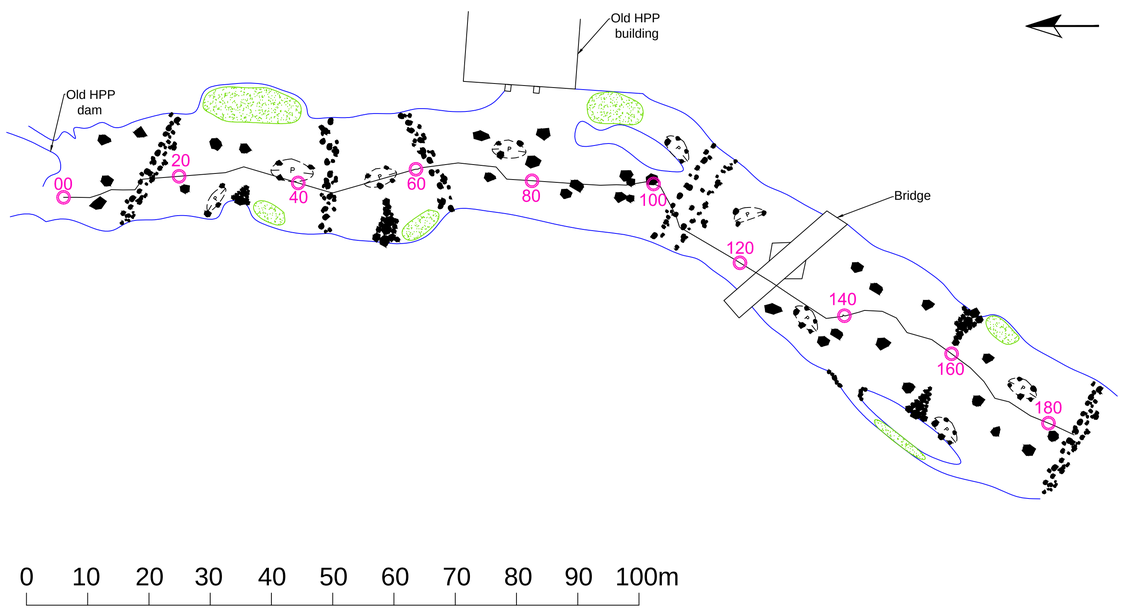
Työn nimi, kunta	Piirustuksen sisältö	Mittakaava
The study area in the Tulomajoki River	Real view before restoration	1:1000 1:500

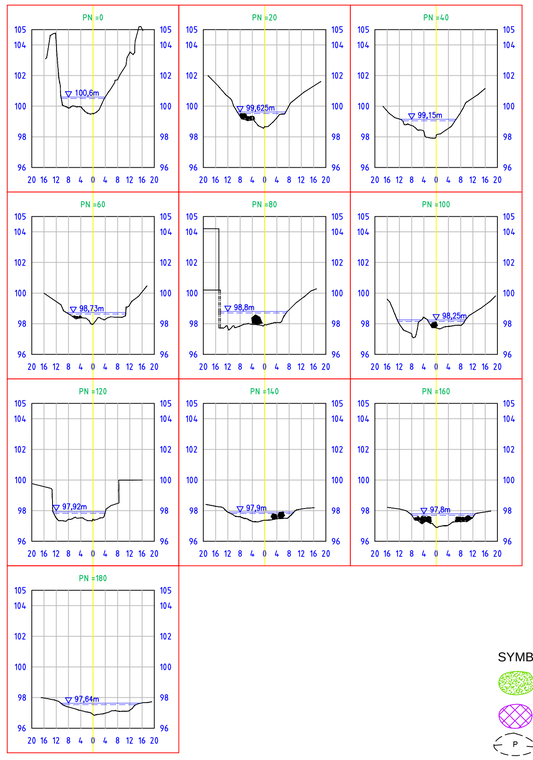
Pohjois-Pohjanmaa
Elinkeino-, liikenne- ja ympäristökeskus

Date	Suunnittelija	Piirtäjä	Drawnings number	Muutos
5.9.2014	Esa Laajala	Stepan Lappo	2	

Tnro







Svskyajoki / Old hpp PN 00+00 - 01+86 length 186 m.

PN 00+00 - 00+20
- Restoration by adding big stones and boulders to the area.
- Creation of a threshold, which will rise up water level in the upstream on about 0,2 - 0,3 m. It should consist of large stones (DIA80= 1,0 - 1,5 m) and stones should be partly deepen to the ground, because the gradient is 4,12 % in this section, so it easily can move unstable stones.

PN 00+20 - 00+40
- Restoring by adding boulders to the channel.
- Creation of spawning areas by adding gravel and moving big stones as cover to the channel.
- Protection of the spawning area with deflector.
- Increase a multiformity of the channel by digging of pools to provide areas where adult salmons can have rest. Masking it with big stones and LWD (Large Woody Debris).

PN 00+40 - 00+60
- Creation of a threshold, which will rise water level in the upstream.
- Creation of a spawning area by adding gravel and moving big stones to the channel.
- Digging of a pool. Masking it with big stones and LWD.

PN 00+60 - 00+80
- Restoration by adding big stones and boulders to the area.
- Creation of a threshold, which will rise water level in the upstream.
- Digging of a pool. Masking it with big stones and LWD.
- Demolition of a wooden manmade constructions.

PN 00+80 - 00+100
- Restoration by adding big stones and boulders to the area.
- Creation of a spawning area by adding gravel and moving big stones out of the area.
- Moving stones from the island to the channel.

PN 01+00 - 01+20
- Digging of pools. Masking it with big stones and LWD.
- Creation of a threshold, which will rise water level in the upstream.

PN 01+20 - 01+40
- Restoration by adding big stones and boulders to the area.
- Digging of a pool. Masking it with big stones and LWD.

PN 01+40 - 01+60
- Restoration by adding big stones and boulders to the area.
- Creation of a spawning area by adding gravel and moving big stones out of the area.
- Creation of a double deflector to protect spawning area and create flow diversity.

PN 01+60 - 01+80
- Restoration by adding big stones and boulders to the area.
- Digging of pools. Masking it with big stones and LWD.
- Creation of a spawning area by adding gravel and moving big stones out of the area.

PN 01+80 - 01+86
- Creation of a threshold, which will rise water level in the upstream.

SYMBOLS

- SPAWNING AREA
- TIMBER FLOATING STRUCTURES DEMOLITION
- POOL
- PROTECTIVE STONES
- STONE THRESHOLD
- SINGLE DEFLECTOR
- 00 DISTANCE
- AVERAGE SHORELINE

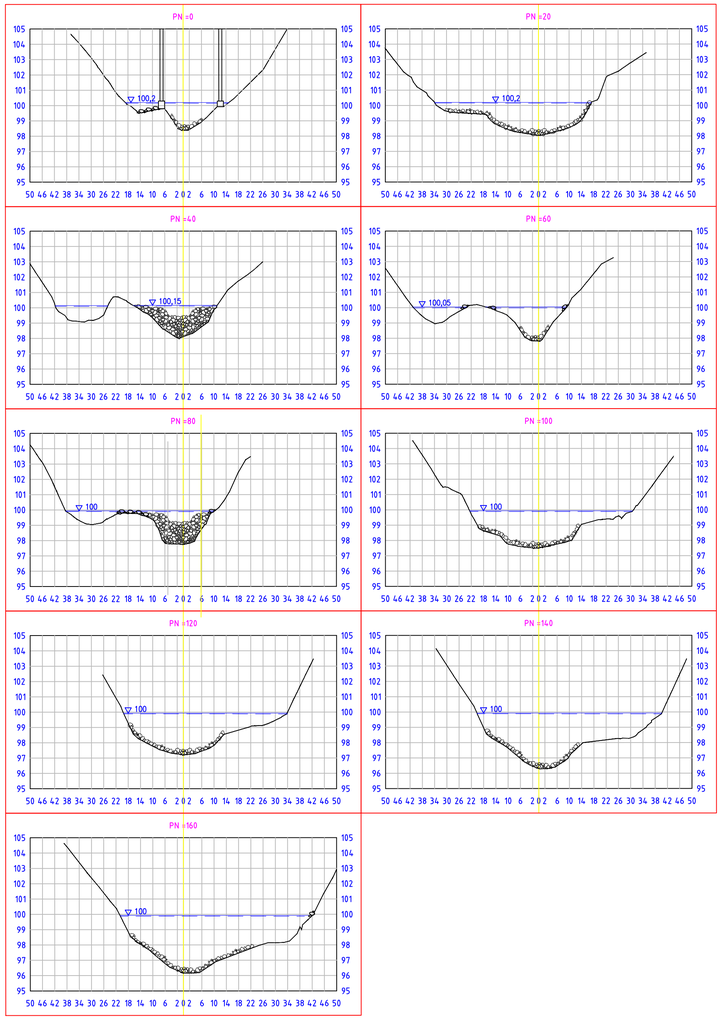
Tunnus	Lukum.	Muutos	Pvm.	Tekijä
A				

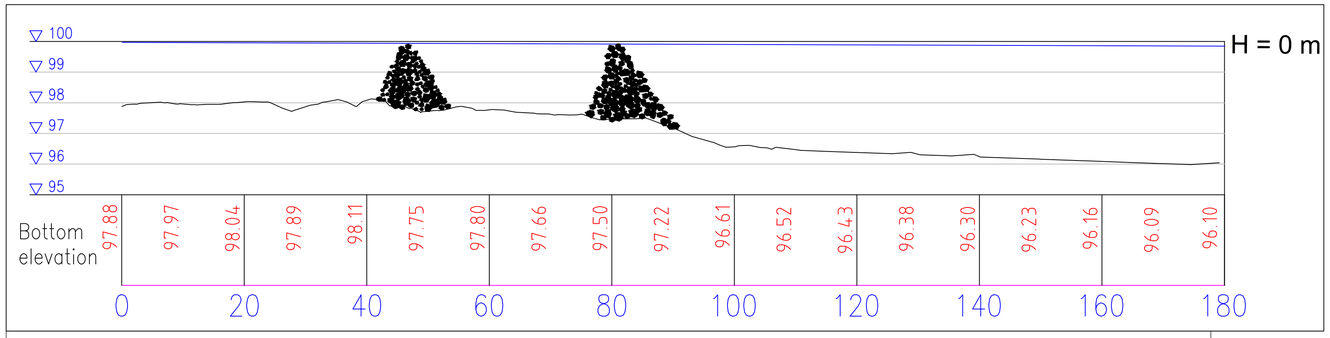
Työn nimi, kunta	Piirustuksen sisältö	Mittakaava
The river Syskyajoki study area	Restoration map	1:500 1:1000

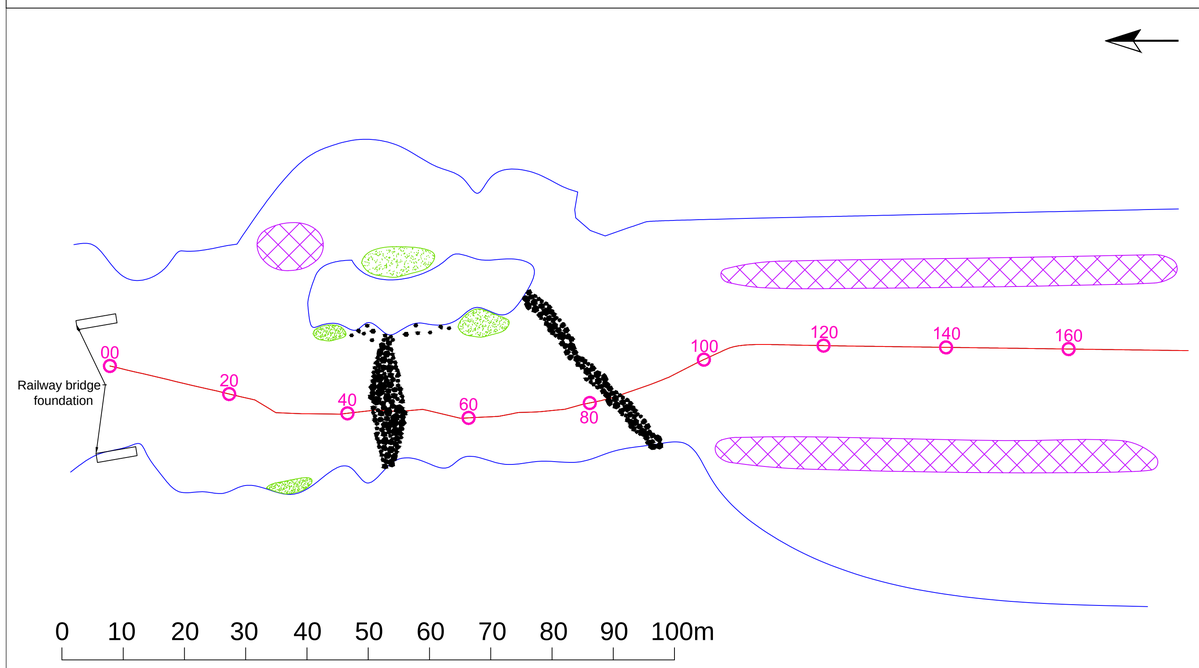
Pohjois-Pohjanmaa
Elinkeino-, liikenne- ja ympäristökeskus

Date	Suunnittelija	Piirtäjä	Drawnings number	Muutos
5.9.2014	Esa Laajala	Stepan Lappo	3	

Tnro







18. Syskyajoki PN 00+00 - 00+186 length 186 m.

PN 00+00 - 00+20
- Restoration by adding big stones and boulders to the area.

PN 00+20 - 00+40
- Restoring by adding boulders to the channel.
- Creation of spawning areas by adding gravel.
- Demolition of the timber floating constructions and creation of the second channel for water.

PN 00+40 - 00+60
- Creation of a threshold, which will narrow the channel and rise water level in the upstream.
- Creation of a spawning area by adding gravel.

PN 00+60 - 00+80
- Creation of a threshold, which will rise water level in the upstream.
- Creation of a spawning area by adding gravel.

PN 00+80 - 00+100
- Creation of a threshold, which will rise water level in the upstream.

PN 00+100 - 00+120
- Demolition of the timber floating constructions and using stones from the construction for bottom restoration.

PN 00+120 - 00+140
- Demolition of the timber floating constructions and using stones from the construction for bottom restoration.

PN 00+140 - 00+160
- Demolition of the timber floating constructions and using stones from the construction for bottom restoration.

PN 00+160 - 00+179
- Demolition of the timber floating constructions and using stones from the construction for bottom restoration.

SYMBOLS

- SPAWNING AREA
- TIMBER FLOATING STRUCTURES DEMOLITION
- POOL
- PROTECTIVE STONES
- STONE THRESHOLD
- SINGLE DEFLECTOR
- 00 DISTANCE
- AVERAGE SHORELINE

A				
Tunnus	Lukum.	Muutos	Pvm.	Tekijä

Työn nimi, kunta The River Tulemajoki study area	Piirustuksen sisältö Restoration map	Mittakaava 1:1000 1:500
Pohjois-Pohjanmaa Elinkeino-, liikenne- ja ympäristökeskus	Drawnings number 4	Muutos
Date 5.9.2014 / Suunnittelija Esa Laajala / Piirtäjä Stepan Lappo	Tnro	