BERNET CATCH

Network on the implementation of
EU Water Framework Directive
in the Baltic Sea Catchment

BERNET CATCH Regional Report:

River Kyrönjoki Water Management Plan

Provisional Management Plan Pursuant to the Water Framework Directive

2006

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LÄNSI-SUOMEN YMPÄRISTÖKESKUS
WEST FINLAND REGIONAL ENVIRONMENT CENTRE

BERNET is a network co-operation between seven regions in the Baltic Sea Region. The network was formed in 1999 as a regional contribution to improve the aquatic environment of the Baltic Sea and of the regional waters in its catchment. Right from the start, BERNET has focused especially on Eutrophication problems. Doing this, the BERNET Partners have wished to contribute to full-fi lling the aim of the Helsinki Declaration in "assuring the ecological restoration of the Baltic Sea".

The present BERNET-CATCH project that has been running for the period 2003-2006 focuses primarily on the regional implementation of the EU Water Framework Directive (WFD). Through their activities in BERNET CATCH, the partners present and evaluate different regional (and national) solutions in order to fulfi ll the objective of achieving at least "good ecological status" of all EU waters before 2015. The co-operation involves the actual water managers in the regions, and takes place through face-to-face exchange of experiences and cross regional comparisons of environmental threads to the waters within the Baltic Sea catchment, including cause-effect relations. The main activities of BERNET-CATCH is the provision of Water Management Plans within regional pilot catchments in order to distribute important knowledge and experiences that may serve as good examples to Water Managers and Stakeholders involved in the implementation of the EU-Water Framework Directive.

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- West Finland, Finland: West Finland Regional Environmental Center
- Gdansk Region, Poland: Gdansk Regional Board of Water Management
- Kaliningrad Oblast, Russia: Department of Federal Supervision Service for Natural Use for Kaliningrad Oblast - Ministery of Natural Resources of Russia and Government of Kaliningrad Oblast
- Laholm Bay Region, Sweden: Counties of Halland and Scania; Municipalities of Båstad, Laholm, and Halmstad
- Schleswig-Holstein, Germany: State Agency for Nature and Environment, Schleswig-Holstein
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The outcome of BERNET CATCH is published in an Executive Summary, one Main Report, two Cross Regional Theme reports and six regional Water Management Plans, all under the same heading, Management Strategies for the Regional Implementation of EU Water Framework Directive in the Baltic Sea Catchment:

- BERNET CATCH Executive Summary: Regional Implementation of the EU Water Framework Directive in the Baltic Sea Catchment
- BERNET CATCH Main Report: Water Quality Management in the Baltic Sea Region. Regional Implementation of the EU Water Framework Directive
- BERNET CATCH Theme Report: Public Participation and Water Management in the Baltic Sea Region. Regional Implementation of the EU Water Framework Directive in the Baltic Sea Catchment
- BERNET CATCH Theme Report: How to defi ne, assess and monitor the ecological status of rivers, lakes and coastal waters. Regional Implementation of the EU Water Framework Directive in the Baltic Sea Catchment
- BERNET CATCH Regional Report: Odense Fjord, Water Management Plan
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KYRÖNJOKI RAHASTO FONDEN FÖR KYRO ÄLV

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Regional Council of Ostrobothnia

Etelä-Pohjanmaan liitto

Pohjanmaan vesiensuojeluyhdistys ry.
Österbottens vattenskyddsförening rf.

RIVER KYRÖNJOKI WATER MANAGEMENT PLAN

Compiled by

Liisa Maria Rautio,

Eeva-Kaarina Aaltonen,

Karl-Erik Storberg

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1. INTRODUCTION

In Finland, the Water Framework Directive has been implemented with the Water Management Act in December 2004. The Water Management Act includes basic statutes on water management and the necessary procedures. The official Water Management plans according to the Water Management Act will be prepared by 2009 and it will be approved by the Council of State.

Within the Bernet Catch Project, six Baltic regions have prepared management plans for pilotcatchments as provided in the Water Framework Directive, during the years 2002-2005.

In Finland, the River Kyrönjoki was included as a pilot river in the project. This pilot area consists not only of the whole catchment area of the River Kyrönjoki, but also of a coastal sea area of the Kvarken. This preliminary management program is part of Work Package 2 of the Bernet Catch Project. The report mainly follows Appendix VII of the WFD, because national guidelines on the matter were still under preparation when the report was compiled between 2004 and 2005.

The central core actors, the Advisory Board of the River Kyrönjoki, and especially the River Kyrönjoki Work Group have taken part in the Bernet project. The Water Protection Association of Ostrobothnia and West Finland Regional Environment Centre and the River Kyrönjoki Work Group have been responsible for the making of this report. The River Kyrönjoki is part of the Kokemäenjoki-Saaristomeri-Selkämeri water management district and even information from this area has been used. This information was reported to the EU in March 2005. This report has been compiled by Liisa Maria Rautio and Karl-Erik Storberg from West Finland Regional Environment Centre and by Eeva-Kaarina Aaltonen from the water protections association of Ostrobothnia. In addition, Charlotte Haldin from the Employment and Economic Development Centre (Fisheries services) of Ostrobothnia, Yrjö Ojaniemi from the South Ostrobothnian Central Union of Agricultural Producers and Forest Owners and Stefan Nyman from West Finland Regional Environment Centre have participated in preparing the target programme. Anna Bonde has made the maps used in this report, Maarit Vuorela has made the VEPS-models and Merja Antikainen has collected the ground water data. The report was translated into English by Sami Koivuneva, Vincent Westberg and Eva Berg.

2. General characteristics of surface and ground waters in the catchment

2.1 The Catchment of the River Kyrönjoki

The River Kyrönjoki is the main river of South Ostrobothnia (catchment area 4,923 km^2). The springs of the watershed are in the Suomenselkä area. The main channel of the River Kyrönjoki starts in the confluence of the Rivers Kauhajoki and Jalasjoki in Kurikka. The river empties into Vassorfjärden north of Vaasa in the northern part of the Gulf of Bothnia. (Figures 1 and 2).

Gently sloping topography and fine-grained soil are typical physical fe on type of soil on the coast is moraine and clay and silt in the river valleys. Peat and moraine are the dominating types in other parts of the basin. Gravel, sand and fine sand occurs in the municipalities of Kauhajoki and Kurikka in the drainage divide area.

Special characteristics of the catchment are acid sulphate lands. These areas were formed during the so called Litorina Sea stage approximately 5000–1000 BC and these sediments are oxidising actively at the moment. The wide sulphate land occurrences centre in old alluvial lands and deltas of the rivers that flow into the sea. Sulphate land is not a soil class but a soil type that is found in several different soil classes. The sulphide in sulphate lands comes from the seawaters that once covered the land. Oxidizing into sulphuric acid due to the lowering of ground water, sulphide easily forms water-soluble salts or alums. This leads to the

Figure 2. The catchment area of the River Kyrönjoki and lakes bigger than 50 hectares.

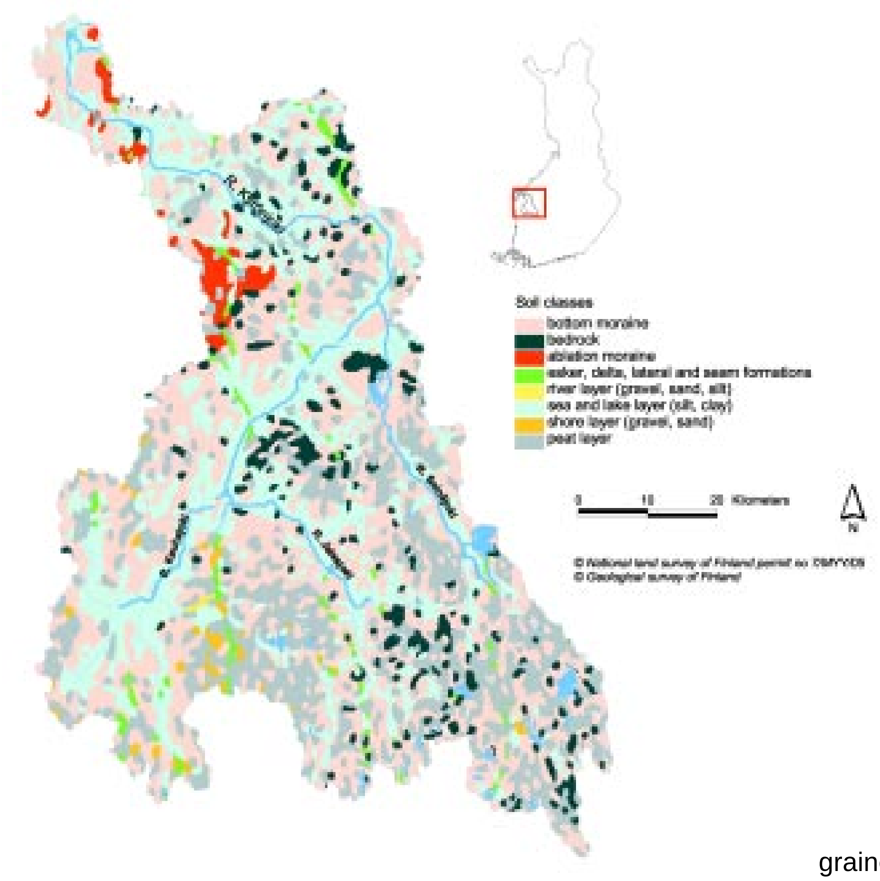

Figure 1. The soil map of the catchment of the River Kyrönjoki (GTK/ The Geological Survey of Finland).

increase of acidity and metal leaching in river water. (See chapter 3.4).

Variations in flow rate and water level are great in the River Kyrönjoki river basin that easily floods over. The slope of the streambed is small throughout; in particular in the middle part of the river. Therefore, between the Koskenkorva dam in Ilmajoki and the Malkakoski rapids in Ylistaro there is a nearly 50-kilometre-long stretch of quiet waters, where the descent is only a few centimetres per kilometre. Plenty of work, for instance, cleaning the brooks and rivers, constructing cutoffs, embankments and artificial lakes has been done in order to prevent flood damages. The mean flows of the River Kyrönjoki and its largest tributaries, as well as basic information about the largest lakes, are presented in table 1.

2.2 Land use

On the Finnish scale, the land use of the River Kyrönjoki catchment area is very intensive. On an average 25 % of the area is arable land. In some subcatchments, the proportion of arable land is even 60 %. These areas are situated on the plains of the river valley where the soil is fine-grained, and it has been easy to clear the land. The average percentage of arable land in Finland is 9 %; and in the Province of South Ostrobothnia it is 20 % (Tilastokeskus 2003).

The proportion of settlement, roads and other areas that are taken into special use is 1.2 % of the Kyrönjoki catchment and the proportion of water bodies is 1.3 %. Moraine lands that are covered with forests and bog lie farther away from the

Table 1. The mean flow (MQ), the high flow (HQ) and minimum flow (NQ) in different parts of the River Kyrönjoki and basic information about the largest lakes.

Rivers	MQ m³/s	HQ m³/s	NQ m³/s
The River Kyrönjoki	43	388	1,1
Kauhajoki	8,9	142	0,0
Jalasjoki	8,9	130	0,3
Seinäjoki	8,5	150	0,3
Lakes	Area hectare	Capacity million m³	Max depth m
Pitkämö	100	6,5	23,0
Kyrkösjärvi	640	11,0	6,0
Kalajärvi	1130	42,0	9,0
Seinäjärvi	863	11,0	3,8
Liikapuro	310	4,5	5,7
Kotilammi	104	0,6	-

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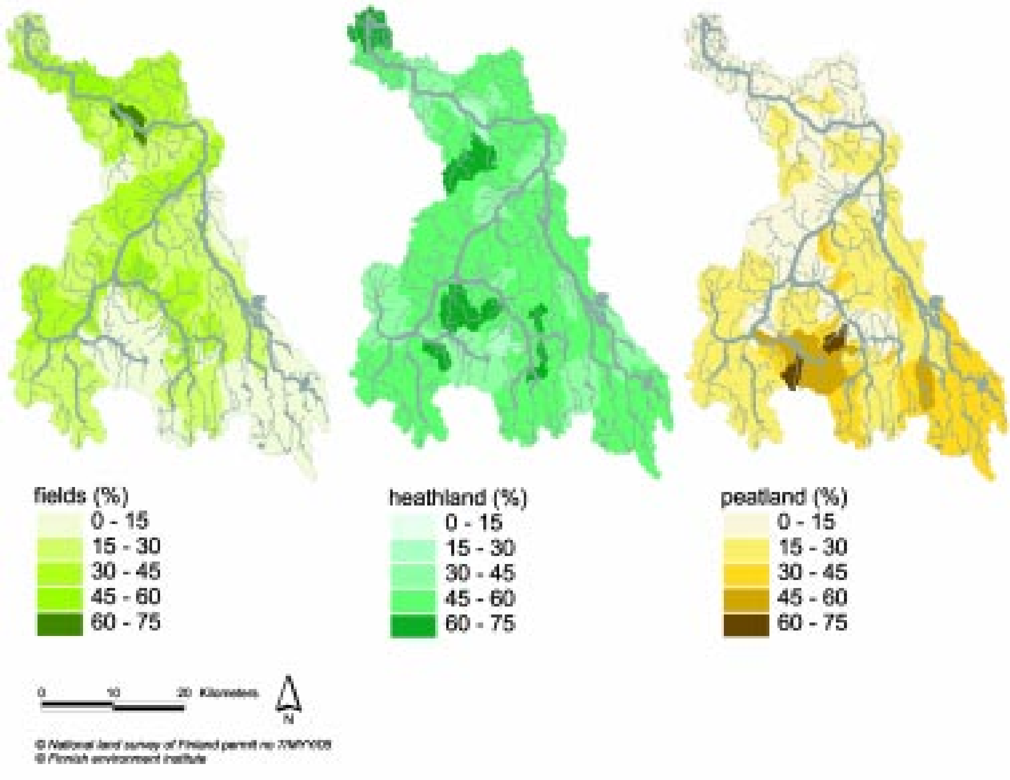


Figure 3. The proportions of fields, heath lands and peat lands in different subcatchments.

riverside. The proportion of heath lands is 50 % and peat lands 22% of the total area of the catchment. In the headwater region, the percentage of bogs is in some places over 60 %. 80 % of the bogs and wet forests have been ditched.

2.3 Ground waters

The ground water occurrences in West Finland are distributed very irregularly compared with those around the rest of Finland (Fig. 4). The most significant ground water reservoirs in the River Kyrönjoki catchment are situated in the city of Kauhajoki, where water from Pahalähde, Lumikangas (I) and Hyypänmäki is led to the municipalities of Seinäjoki, Närpes and Kaskö. Rich ground water areas can also be found in Kurikka, Ilmajoki and Ylistaro. The Areas of Salonmäki and Koskenkorva in Ilmajoki, Pitkämönkangas (A) in

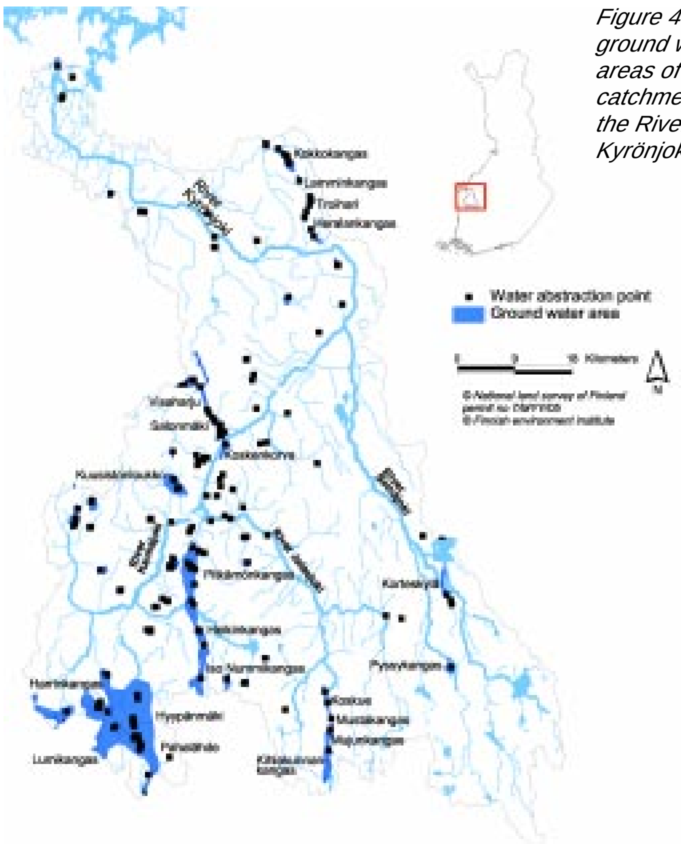


Figure 4. The ground water areas of the catchment of the River Kyrönjoki.

Kurikka and Kokkokangas in Ylistaro are worth mentioning. The smallest ground water occurrences are in the city of Seinäjoki and the Kyrönmaa region.

2.4 The Kvarken archipelago

The mouth of the River Kyrönjoki is situated in the northern part of the Kvarken archipelago. Here the river water meets the seawater in a complex archipelago area, which is strongly characterized by the land uplift. The land uplift itself is a reminiscence of the last ice age, when kilometres of inland ice pressed down the landscapes of central Fennoscandia almost 800 meters below the normal level. This land is now rising about 9 mm/year, which is particularly visible in the flat landscapes. The structure of the Kvarken landscape is rocky and stony. These elements are also found in the archipelago waters where we find more islands than elsewhere along the coast of the Gulf of Bothnia. Consequently, the waters are shallow with a mean depth under 25 m in the Kvarken archipelago. The Kvarken archipelago is proposed as an UNESCO World Nature Heritage area especially because of its geological features.

A special phenomenon in West Finland and in the estuary of the River Kyrönjoki is that the coastal waters from time to time can suffer from acidification. This is most apparent in springtime before the acid surface water, running from the rivers, is mixed with bottom water with higher salinity. The acid water occasionally causes fish kills in the delta and can disturb the reproduction of the fish species breeding in the shallow and sheltered waters of the River Kyrönjoki. The estuary sea area of the River Kyrönjoki is a very significant area for the fishing industry and there are dozens of professional fishermen in the area.

The River Kyrönjoki meets Kvarken Archipelago. Photo: Pertti Sevola.

3. PRESSURES

3.1 The nutrient load of the catchment of the River Kyrönjoki

According to flow and concentration measurements during the time 1968-2003 the mean phosphorous flow is about 150 t P/a and the mean nitrogen flow is 2,500 t/a. However, the annual variations are large.

The flow of substances from different pollution sources based on model calculations are shown in table 2. Mean phosphorus and nitrogen concentrations, as well as mean flow, from 1968 to 2004 are presented in figure 5. Phosphorous concentrations have been decreasing, but nitrogen concentrations have risen slightly. The rise stems partially from increased winter discharges, but all cause-consequence relations have not been assessed. In addition,

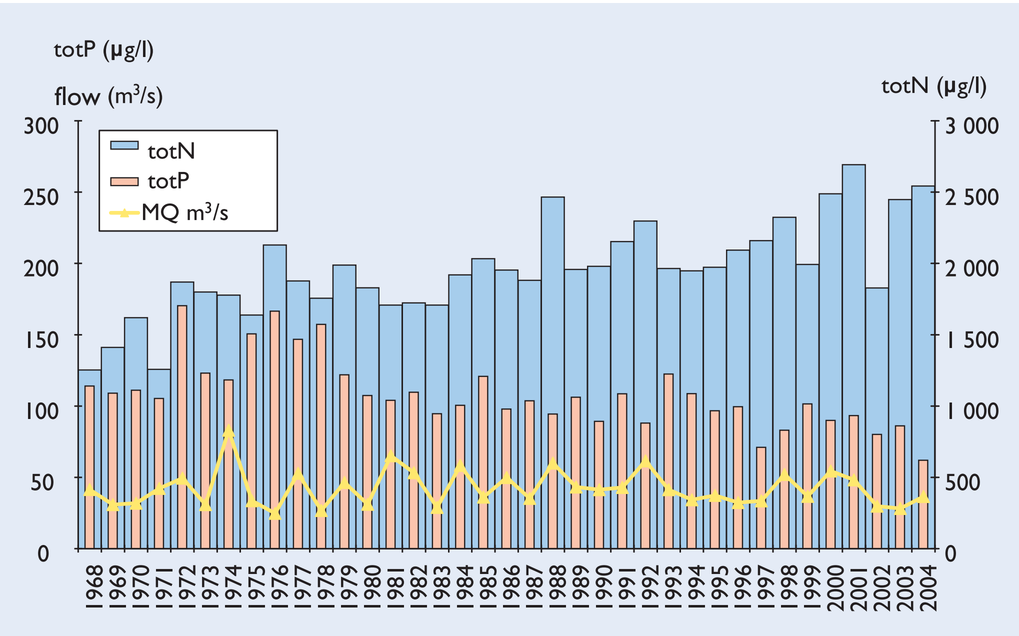


Figure 5. Concentration of phosphorous and nitrogen, as well as mean flows, in the River Kyrönjoki 1968-2003.

	Phosphorous (P)		Nitrogen (N)	
	t/a	%	t/a	%
Open field cultivation	87	58	1150	46
Animal husbandry	9	6	50	2
Forestry	5	3	75	3
Scattered settlements	14	9	100	4
Fur farming	0	0	0	0
Point source pollution	5	3	225	9
Peat production	3	2	75	3
Deposition	2	1	50	2
Natural leaching	27	18	775	31
Total	150	100	2500	100

Table 2. An estimate of the distribution of total phosphorous and nitrogen load of the River Kyrönjoki. (VEPSmodel).

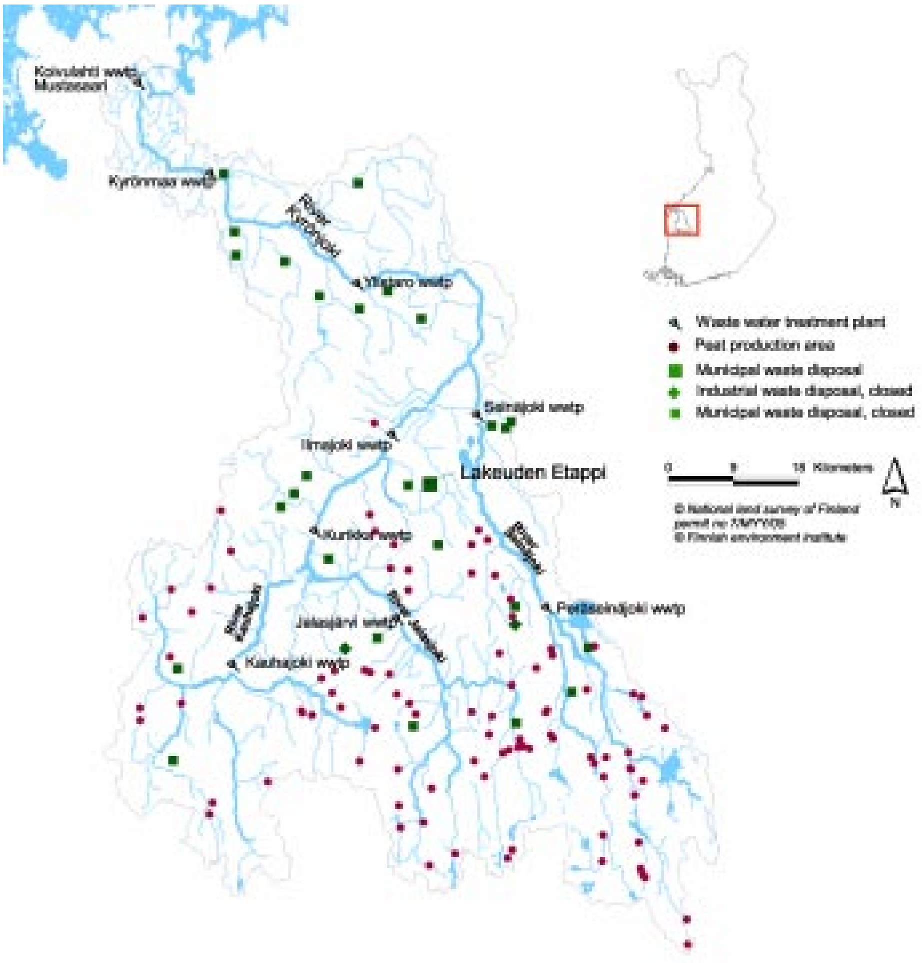


Figure 6. Point source polluters in the catchment of the River Kyrönjoki.

the acidity of the River Kyrönjoki's waters increases nitrogen washout rates and decreases phosphorus washout rates.

3.2 Point source polluters

Sewage treatment plants

The sewage of 70,000 inhabitants and 6 large industrial units is purified in the sewage treatment plants of the cities of Kauhajoki, Kurikka, and Seinäjoki, in the plants of the municipalities of Jalasjärvi, Ilmajoki, Ylistaro, and Korsholm (Kvevlax), and in the plant of Kyrönmaan Jätevesi Oy (sewage from the municipalities of Isokyrö and Vähäkyrö). In the city of Seinäjoki, the number of inhabitants connected to the sewer system is highest (97 % of the population), and in the village of Kvevlax in Korsholm the number is smallest (32 % of the population). On the average, 70 % of the inhabitants of the River Kyrönjoki region are connected to the sewage treatment plants.

Peat production

In the River Kyrönjoki catchment, there were 77 peat mining areas functioning, and their total area was about 7,900 hectares at the end of year 2003. The average area of a peat mining field was approximately 100 hectares, the smallest fields were under 10 hectares in size and the largest around 600 hectares (West Finland Regional Environment Centre). The location of peat production areas and other point source polluters are presented in figure 6.

Other point source polluters

There is only one functioning waste disposal area in the River Kyrönjoki catchment. The new Etappi of Lakeuden jätekeskus (a waste disposal centre) was opened in September 2004. In addition, there are 28 closed municipal and one closed industrial waste disposal area in the River Kyrönjoki catchment. The location of the point source polluters of the River Kyrönjoki are shown in figure 6.

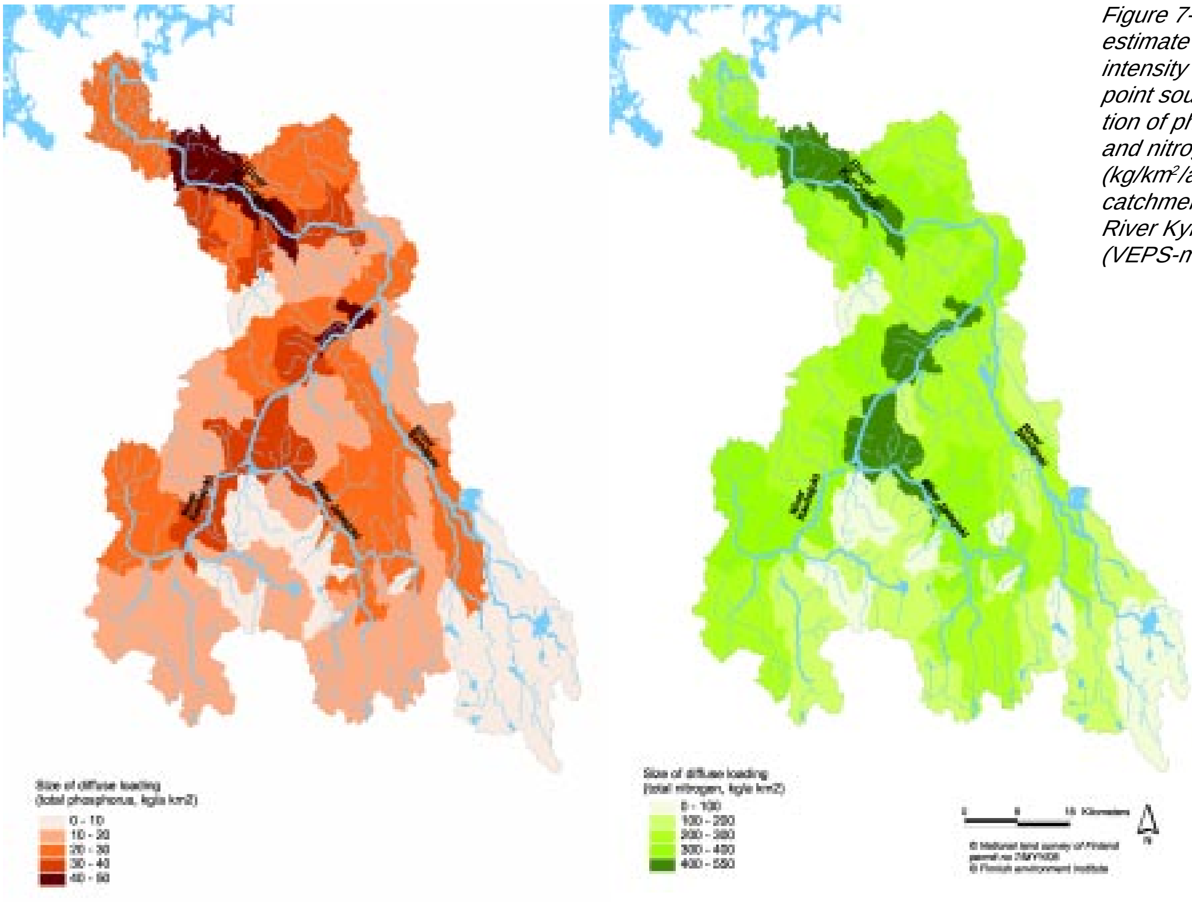


Figure 7-8. An estimate of the intensity of non-point source pollution of phosphorus and nitrogen (kg/km²/a) in the catchment of the River Kyrönjoki (VEPS-model).

3.3 Non-point source pollution

The non-point source pollution data has been calculated using the data base system VEPS developed by the Finnish Environment Institute (FEI). With VEPS, it is possible to estimate the annual nutrient load (kg/km^2/a) even in the smallest subcatchments. It also provides the proportions of agriculture, forestry, natural leaching, deposition, and scarce population in the total load. Washout rates of phosphorus and nitrogen according to the VEPS model are presented in figures 7 and 8.

Open field cultivation

There is 124,300 hectares of arable land in the catchment of the River Kyrönjoki, which is 42 % of the arable land in South Ostrobothnia. The average area of a farm is 32 hectares, which is almost 3 hectares larger than an average South Ostrobothnian farm. Farmers in the Kyrönjoki area mainly produce grass for silage, barley, oat, and fodder grain. Yields per hectare of the most common grains, grass, oat and barley, vary mostly between 3,500 and 4,000 kilograms.

The use of artificial fertilizers has become considerably less within the last

10–15 years (Figure 7). Today, South Ostrobothnian farmers spread approximately 80 kilograms of nitrogen and 11 kilograms of phosphorous onto a hectare; whereas in the late 1980s, the corresponding amounts were 120 kilograms (N) and 31 kilograms (P). Organic fertilizers are used in addition to artificial fertilizers.

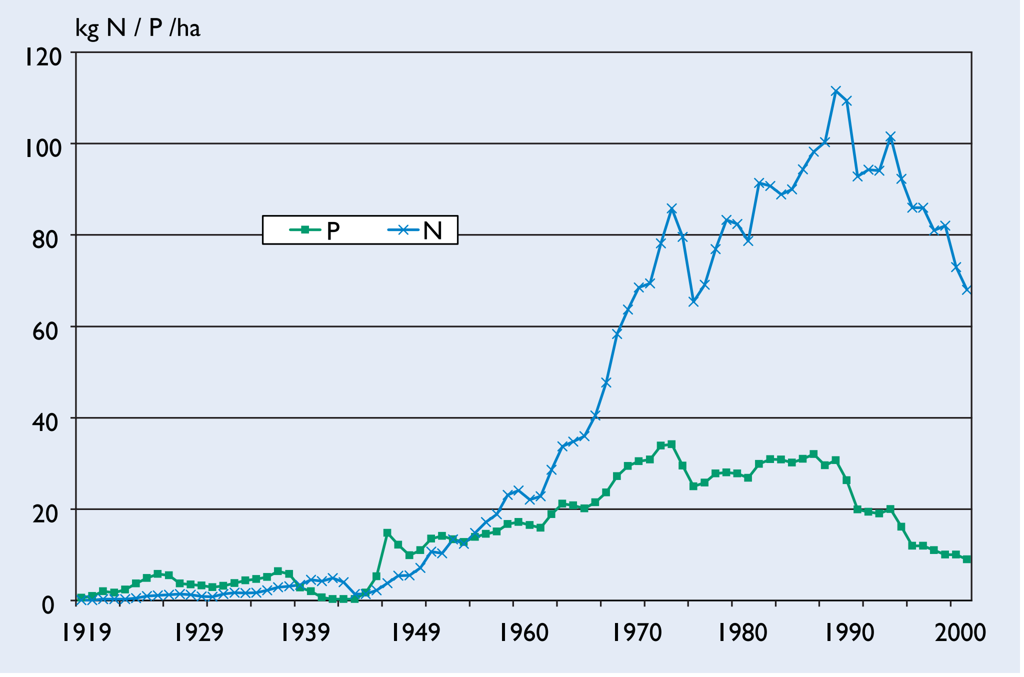
Animal husbandry and fur farming

The agriculture of South Ostrobothnia bases on a technologically advanced production and processing of milk and meat; especially developed it is in the River Kyrönjoki area. 62 % of pork (19,700 t/a), 37 % of beef (4,000 t/a), and 37 % of milk (103,200 million l/a) produced in South Ostrobothnia came from the farms in the River Kyrönjoki valley. There are about 3,600 animal husbandry farms in the Kyrönjoki river valley (Registered Association of South Ostrobothnia's agronomists 2003). Fur farming is not especially intensive in the catchment of the River Kyrönjoki. There are more than five farms in the municipalities Korsholm, Kauhajoki, Ilmajoki, Isokyrö and Ylistaro. The annual production is over 40,000 mink and fox skins.

Forestry

In the early 2000s, maintenance ditching was done in 2,760 hectares of forests in the Kyrönjoki catchment yearly. Two thirds of the maintenance work was done in the municipalities of Kauhajoki, and Jalasjärvi, in other words, maintenance ditching was concentrated on the forests around the upper parts of the basin. In South Ostrobothnia, regeneration fellings were done in the area of approximately 6,500 hectares (declining trend) and improvement cutting in the area of 17,000 hectares (rising trend). 2,000 hectares of forest in the Kyrönjoki catchment was fertilized, that is, 50 % of the area fertilized in South Ostrobothnia in 1996 (South Ostrobothnian Agronomists).

Figure 9. The use of artificial fertilizers in Finland in 1919–2001 (sales statistic of Kemira fertilizer manufacturer).



Scattered settlements and summer cottages

In the River Kyrönjoki riverside there are approximately 30,000 inhabitants in 12,000 households outside the municipal sewerage system. Most of these inhabitants live in the municipalities of Kauhajoki, Ilmajoki and Kurikka. The number of holiday residencies is rather modest, 3,500. One third of them are in Kauhajoki and in Seinäjoki the number is smallest (Väestönrekisterikeskus 2001).

3.4 Acidity from the soil

The sulphate soils of the catchment of the River Kyrönjoki are mostly situated below the old seashore line about 60 meters above the present sea level. Figure 10 shows Erviö's survey (1975) of the sulphate lands, which cover 26,400 hectares or 22 per cent of the arable land of the River Kyrönjoki catchment area. Including mire and forest areas, there are approximately 35,000–40,000 hectares of acid sulphate lands, that is, 7–8 per cent of the whole catchment area.

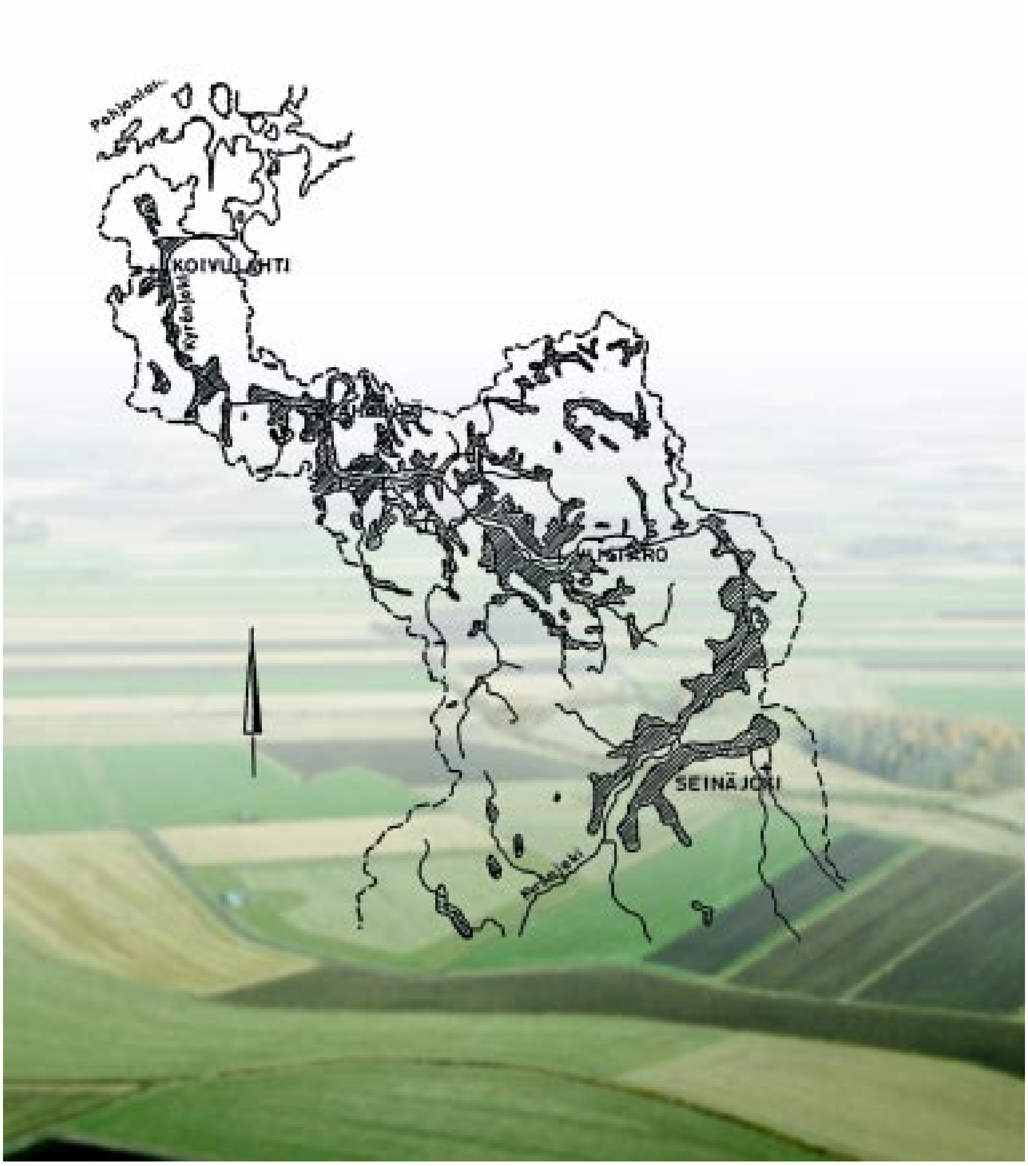
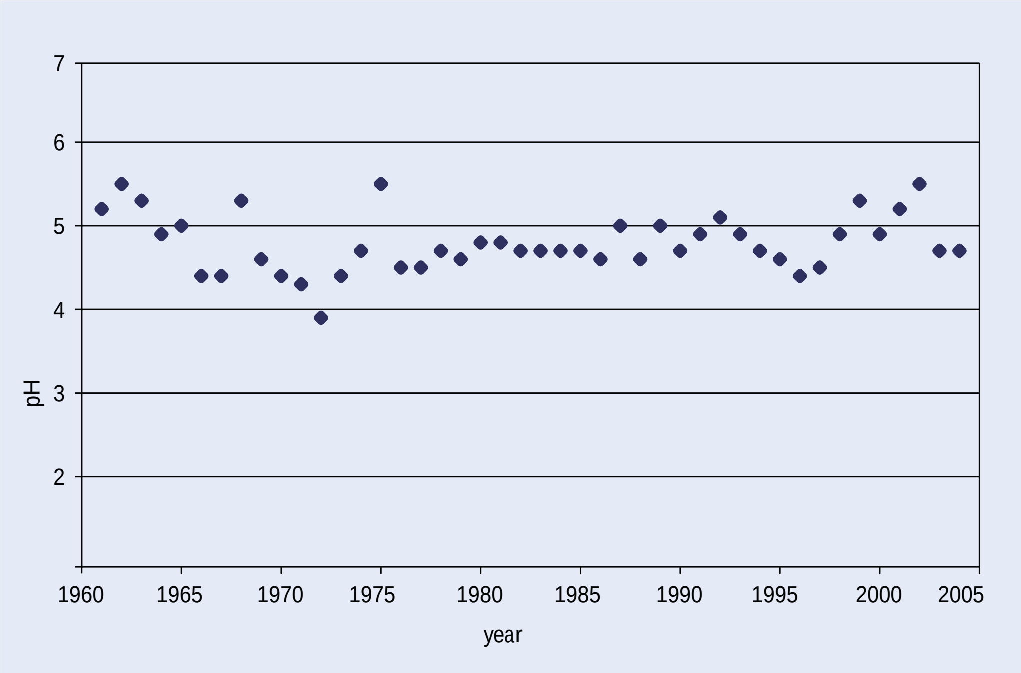


Figure 10. Sulphate lands of over 10 hectares in area in the River Kyrönjoki catchment (Erviö 1975).

Figure 11. The lowest pH of the year in the River Kyrönjoki (Skatila) between 1960 and 2004.



The origin of the acidity, its geographical distribution, the amount of leaching substances, and the processing possibilities of the runoff waters have been thoroughly studied within the investigation of the polder area of Rintala in Ilmajoki (Ramboll 2005). According to the results of a geochemical survey carried out by Åbo Akademi University, large amounts of sulphur, manganese, aluminium, zinc, nickel, cobalt, calcium, and sodium leach from the acid lands and the leaching will continue on a high level for many centuries if nothing is done. The lowest annual pH values of the River Kyrönjoki are presented in figure 11.

There are over 35.000 hectares of acid sulphate lands in the catchment of River Kyrönjoki. Photo: Unto Tapio.

3.5 Significant water abstraction

The City of Vaasa/Vaasan Vesi waterworks

There are 61,000 inhabitants in the district of Vaasan Vesi in the areas of Vaasa and Vähäkyrö. Vaasan Vesi takes all of its raw water (approximately 15,000 m^3/d) from the River Kyrönjoki. This amount of abstraction is approximately 0.3 % of the annual discharge of the River Kyrönjoki, and it does not have any impact on the water quality and quantity of the river.

Kyrönjokilaakson Vesi Oy

The water works of Kyrönjokilaakson Vesi Oy pumps groundwater from several areas in the municipalities of Kauhajoki and Kurikka: Pahalähde, Nummikangas, Iso-Nummikangas, Heikinkangas and Autionmaa. The water company must monitor the impact of the ground water abstraction on the flow rates of the Rivers Hyypänjoki and Kauhajoki and see to the sufficient water flow (100 l/s minimum) below Pahalähde in the River Hyypänjoki and reduce the abstraction if necessary according to permit decisions.

3.6 Regulation of the rivers and water construction work

The slope of the main streambed is 0.31 m/km on the average, but it is only 0.041 m/km between the rapids in Ilmajoki and Ylistaro. Because of the intensive flooding of the river, most of the construction work along the channel is connected to flood protection. After enacting Lex Kyrönjoki in 1991, the special act for abating the flooding of the River Kyrönjoki, the protection of the upper part was executed without hydroelectric power stations. Built in the 1970s, there are four hydroelectric power stations (table 3) in connection with the artificial lakes and these stations practise short-term regulation. The fall at the power station of Kyrkösjärvi is the greatest (44 m) and it is also most powerful. There are also numerous smaller mill plants used at farms along the river. These smaller plants are mostly in bad condition (Savea-Nukala et al. 1997).

The artificial lakes of the catchment of the River Kyrönjoki are Kalajärvi, Kyrkösjärvi, Pitkämö and Liikapuro. The artificial waterbodies and the considerably altered waterbodies in the river basin of the River Kyrönjoki are presented in figure 12.

The flood protection of the River Kyrönjoki is concentrated to the lower part below Voitilankoski, upper part above Malkakoski and to Seinäjoki. The largest of these flood protection projects was the upper part of the River Kyrönjoki (1964-2004), where 30 pumping stations and 100 kilometers of embankment were built. The flood protection work covered 6,300 hectares of the area.

Power station	Year of completion	Fall (m)	Power MW	Energy GWh/a	Station flow, m^3/s
Kalajärvi	1976	13,5	1,8	3,2	15
Kyrkösjärvi	1979	44	6,8	19,8	20
Pitkämö I	1970	28,3	6,3	23,9	25
Pitkämö II (Power station of Niiles)	1970	10,5	1,1	4,4	10
Hiirikoski	1921	4,2	0,3	–	10
Voitilankoski	1920s	2,9	0,05	3,5	–

Table 3. The hydroelectric power stations of the River Kyrönjoki.

Figure 12. The artificial waterbodies and the heavily modified waterbodies in the catchment of the River Kyrönjoki according to the evaluation in 2004.

Heavily modified part of River Kyrönjoki at Ylistaro. Photo: Jyrki Latvala.

4. Environmental status of water bodies

4.1 Inland waters

In the preliminary Water Framework Directive assessment in 2004 the surface waters were classified according to the intensity of the impact of human activity. The classification of surface waters is based on either ecological or chemical status, depending on which of them is worse. The classification is needed to locate the sites, where water management is required in order to attain good status by 2015. Another purpose of the assessment of impacts was to estimate which of the water bodies cannot be improved to obtain a good status by the year 2015.

The key figures of water quality between 1998-2002 from the main channel of the River Kyrönjoki (Skatila), Seinäjoki (Kiikku dam), Jalasjoki (dam) and Kauhajoki (Pitkämö), as well as from the largest lakes of the River Kyrönjoki have been presented in table 4.

In Finland, the assessment and classification of impacts is developed in a national work group, whose aim is to complete the classification principles in 2006. To facilitate the collecting of data to be reported to the Commission of the EU in 2005, the Finnish Environment Institute (FEI) developed a guide for preliminary reporting in 2004. According to the guide, the river basins shall be divided into large entities, and thus, the River Kyrönjoki has been divided into five parts (lower and middle part of the River Kyrönjoki, upper part of the River Kyrönjoki, Kauhajoki, Jalasjoki and Seinäjoki, figure 13). Usability classification of water bodies was utilized in the report and this is presented in figure 13.

Since Finland reported only the lakes larger than 40 km^2 in 2005, there were no natural, heavily modified, or artificial lakes in the catchment area of the River Kyrönjoki. Therefore, this report does not deal with the assessment of lakes. The biggest lakes in connection to the River Kyrönjoki are the artificial lakes, that were constructed in the 1970's. Nowadays they are becoming quite like naturally humic lakes.

In the preliminary assessment, a river was categorized as a water body not in good status, if human impact on water quality or biological quality elements was significant according to expert judgement

Location	pH			P(total) µg/l		N(total) µg/l		colour mgPt/l		chlo-a µg/l	
	min	max	n	mean	n	mean	n	mean	n	mean	n
Rivers											
Kyrönjoki, Skatila	4,7	7,2	106	89	98	2282	98	183	97	15	8
Seinäjoki, Kiikku	5,3	7,0	70	59	66	1340	66	224	66	22	8
Jalasjoki, dam	5,9	6,8	26	109	26	1542	26	216	26	10	8
Kauhajoki, Pitkämö	6,0	7,4	56	102	56	1419	56	166	56	12	8
Lakes											
Pitkämö	6,1	7,0	15	94	2	1550	2	225	2	32	3
Kyrkösjärvi	5,6	6,9	53	53	39	1019	39	221	39	21	63
Kalajärvi	5,4	6,4	40	34	32	774	32	186	32	28	16
Seinäjärvi	5,1	6,6	12	26	12	610	12	164	12	21	5
Liikapuro	5,0	5,9	16	28	2	860	2	225	2	49	3
Kotilammi	5,5	5,9	5	42	5	836	5	230	5	–	–

Table 4. The key figures of water quality from the largest river beds and lakes of River Kyrönjoki between 1998-2002.

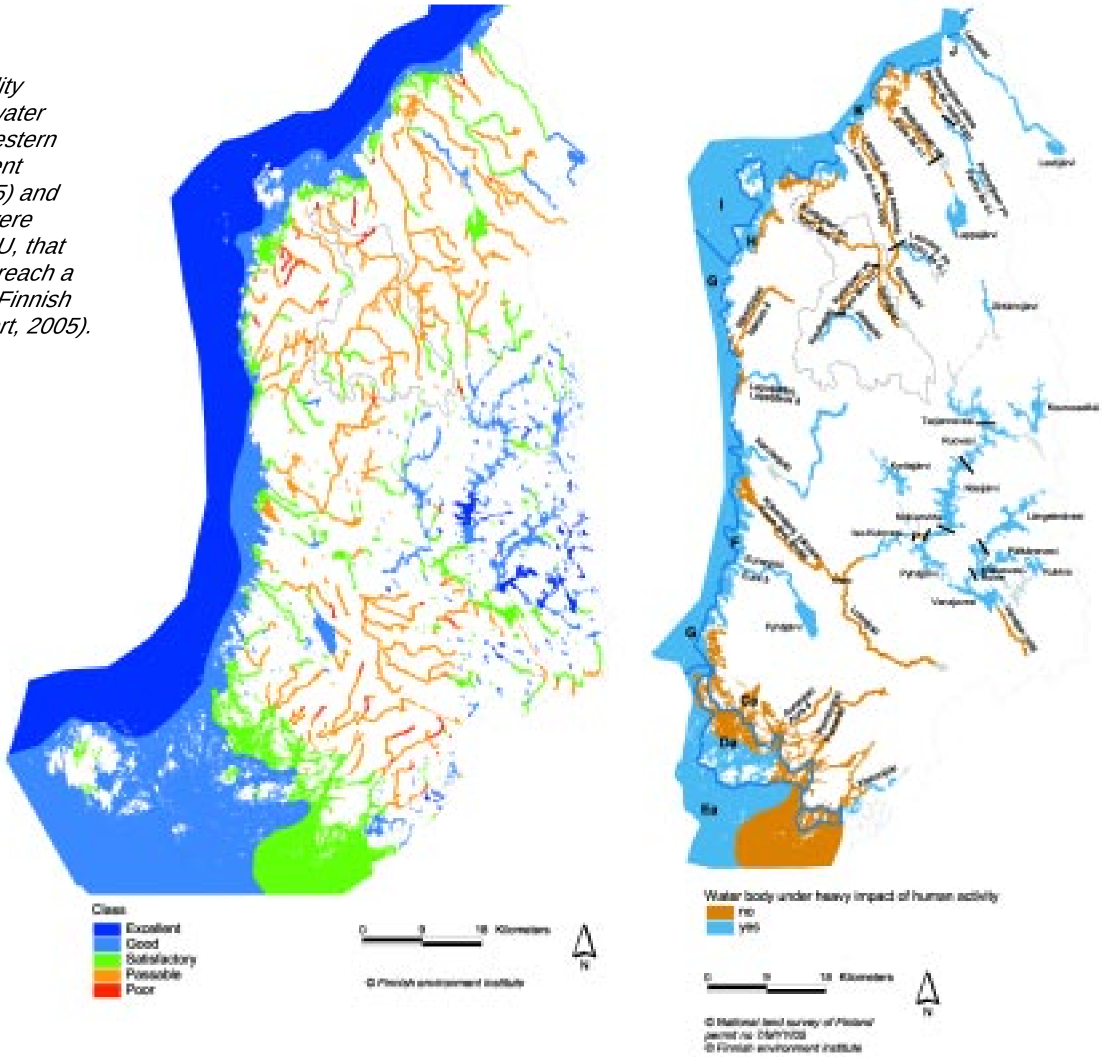


Figure 13. Usability classification of water courses of the western water management district (FEI, 2005) and the waters that were reported to the EU, that probably will not reach a good status (the Finnish Article 5 EU-report, 2005).

or research data. If the hydro morphological changes are very substantial, the part of the river is categorized as heavily modified, and also as a water body not in good status.

In the 2004 assessment, the experts assumed that substantial hydro morphological changes are noted in the upper parts of the River Kyrönjoki and in the River Seinäjoki. As far as the lower and middle part of River Kyrönjoki and the River Seinäjoki are concerned, experts have come to the conclusion that biological changes are notable. Also changes in water quality of the lower and middle part of the River Kyrönjoki are substantial especially because of the acidity problems. In the rivers Jalasjoki, Seinäjoki and Kauhajoki and the upper part of the River Kyrönjoki these changes were estimated as moderate.

On the basis of changes in hydro morphological, biological and water quality elements the experts have made an overall estimate of the River Kyrönjoki. The whole main channel of the River Kyrönjoki (lower, middle and upper part), and the River Seinäjoki are under heavy impact of human activity and the ecological status is moderate or less. The rivers Jalasjoki and Kauhajoki may partly have good status already. (Table 5 and figure 13).

Part	Length of the part, km	Arable land %	Peat land %	Catchment area, km²	Change in water quality	Biological changes	Significant hydromorphol ogical changes	In good ecological status 2015
Lower and middle part of the Kyrönjoki	86	25	22	4923	significant	significant	no	no
Upper part of the Kyrönjoki	48	25	23	2789	moderate	moderate	yes	no
Kauhajoki	25	24	27	1081	moderate	moderate	no	yes
Jalasjoki	28	22	14	1062	moderate	moderate	no	yes
Seinäjoki	45	14	32	1011	moderate	significant	yes	no

Table 5. The preliminary classification of the parts of the River Kyrönjoki according to the preliminary criteria used in 2004.

4.2 Coastal waters

The preliminary assessment of the coastal waters of the River Kyrönjoki in the year 2004 according to the WFD was based on the usability classification of surface waters. The inner parts of the coastal area and the inner archipelago were assessed as being under heavy impact of human activity i.e. have maximum moderate status. The outer part is assessed to have good status. (Figure 13).

4.3 Ground waters

Many of the activities placed on ground water areas, might be a risk to the amount and quality of ground water. Part of the pollution is diffuse pollution, and part is point source pollution. The risk factors of ground water in the River Kyrönjoki catchment have not yet been filed in national registers. Information on activities that pollute or modify ground water in the catchment area of the River Kyrönjoki is gathered in municipality-specific ground water maps.

The number of first class ground water areas per municipality and the number of areas which have one or more risk factors are presented in table 6.

The most common risk factor is traffic, but also waste disposal areas, animal husbandry, service stations, sawmills and other business activities exist on some ground water areas.

Ground water springs at Lauhanvuori National Park. Photo: Karl-Erik Storberg.

Table 6. The ground water areas of the municipalities in the River Kyrönjoki region and the number of the areas with risk factors.

Municipality	Areas	Areas with risk factors	Risk factor
Ilmajoki	6	5	Animal husbandry, service station, garage, scrapyard, sewage treatment plant, road
Isokyrö	5	–	–
Jalasjärvi	6	4	Road
Kauhajoki	19	5	Road, animal husbandry
Kurikka	19	3	Road, animal husbandry, sawmill
Korsholm	2	–	–
Seinäjoki	3	1	Track
Teuva	2	–	–
Ylistaro	9	4	Road, animal husbandry

Photo: Unto Tapio.

5. PROTECTED AREAS

In Finland there are some nature types that are preserved on the basis of national nature preservation programs. The State Council has confirmed the following national preservation programs, which are controlling the authorities responsible for preservation of the nature and also concern other national authorities:

- Program for the Development of National Parks and Nature Reserves 1978
- Mire Conservation Program 1979,1981
- Esker Conservation Program 1984
- Herbrich Forest Conservation Program 1989
- Shoreline Conservation Program 1990
- Old Forests Conservation Program 1993,1996
- Conservation Program for bird wetlands
- private protection areas
- Natura 2000 -network

Many of the conservation areas of the River Kyrönjoki catchment area are dependent on water. Typical examples of the water dependent conservation areas are Kauhaneva-Pohjankangas national park and the waterfowl habitats of Vassorfjärden (fig. 14). Natura 2000 targets are presented in figure 15. A more specific definition of conservation areas dependent on water is under preparation. In addition, there is a law called Lex Kyrönjoki, which concerns the River Kyrönjoki catchment and prevents building power plants in the lower and middle parts of the river.

There are several local beaches along the River Kyrönjoki and in its coastal sea area. The area has seven EU-beaches (Table 7).

The whole Finland has been named as nitrate vulnerable area, hence also the River Kyrönjoki and its coastal sea area is a nitrate vulnerable area. The River Kyrönjoki is also an important water supply water body.

Beach at Kyrkösjärvi. Photo: Unto Tapio.

Municipality	EU-beaches	Other swimming areas under monitoring
Maxmo	-	Finnholmen, Grusgrundet, Stråkaviken, Särkimo
Korsholm	Österhankmo	Petsmo, Köklot Furuskär
Vähäkyrö	-	Center, Merikaarto
Isokyrö	-	Orisberg Kotilampi, (Kalliojärvi), Tervajoki Kylkkälä, Pukkilansaari
Ylistaro	-	Malkakoski, Viitala beach, Ylipään ns, Kirkonkylä beach, Alapään ns
Seinäjoki	Sahalampi, Kyrkösjärvi Kalajärvi	Isosaari camp center, Törnävä
Kurikka	Pitkämö	Oppaanmäki, Luopa, Myllykylä, Center, Tuiskulankylä, Lohiluoma, Mieto
Kauhajoki	-	Ikkelänjärvi, Ikkelänjoki Asuuli camp center and Aronkylä, Hyypänjoki, Päntäneenjoki
Jalasjärvi	Lamminjärvi (center), Saarijärvi	Korvajärvi, Iso-Madesjärvi, Kolhonjärvi, Liikapuro basin, Mäntyranta, Koskutjärvi

Table 7. The beaches of the municipalities in the River Kyrönjoki area.

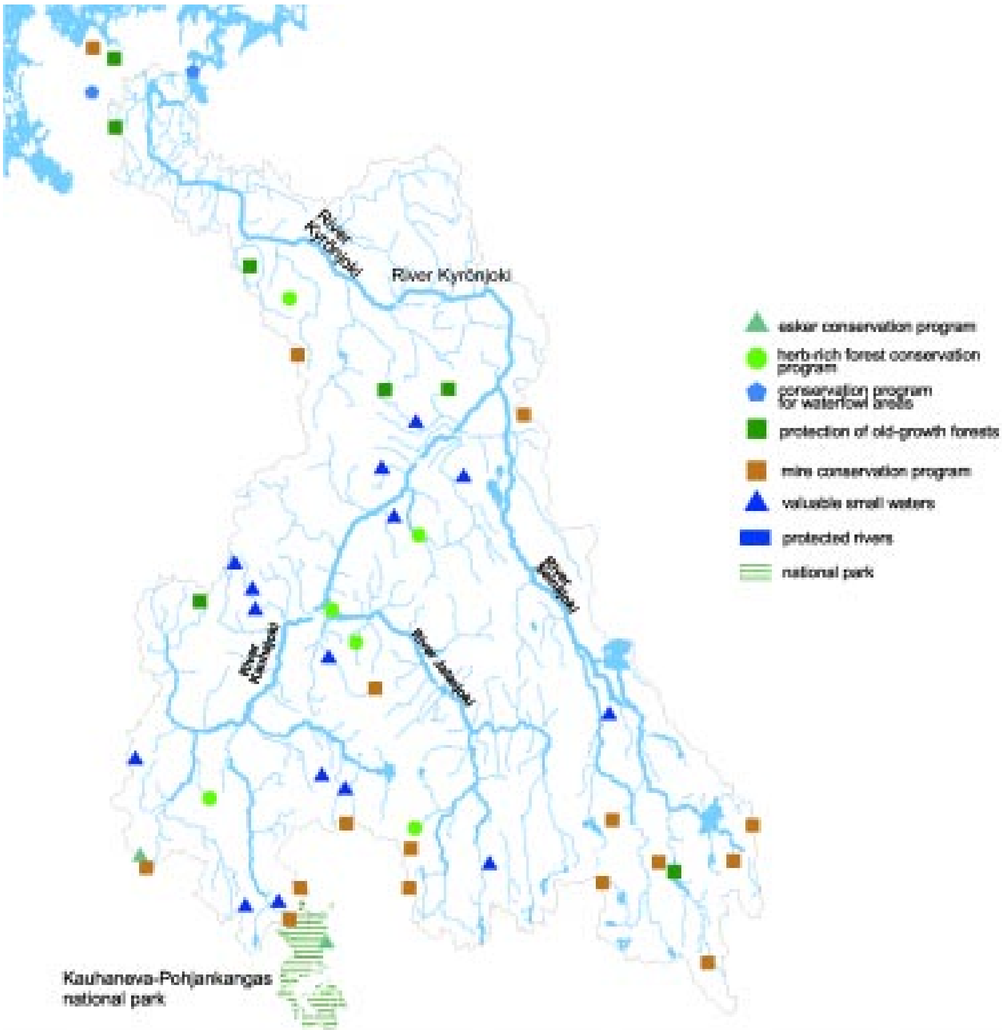


Figure 14. Protected areas in the catchment of the River Kyrönjoki.

Kauhaneva-Pohjankangas national park at the head waters of River Kyrönjoki. Photos: Liisa Maria Rautio.

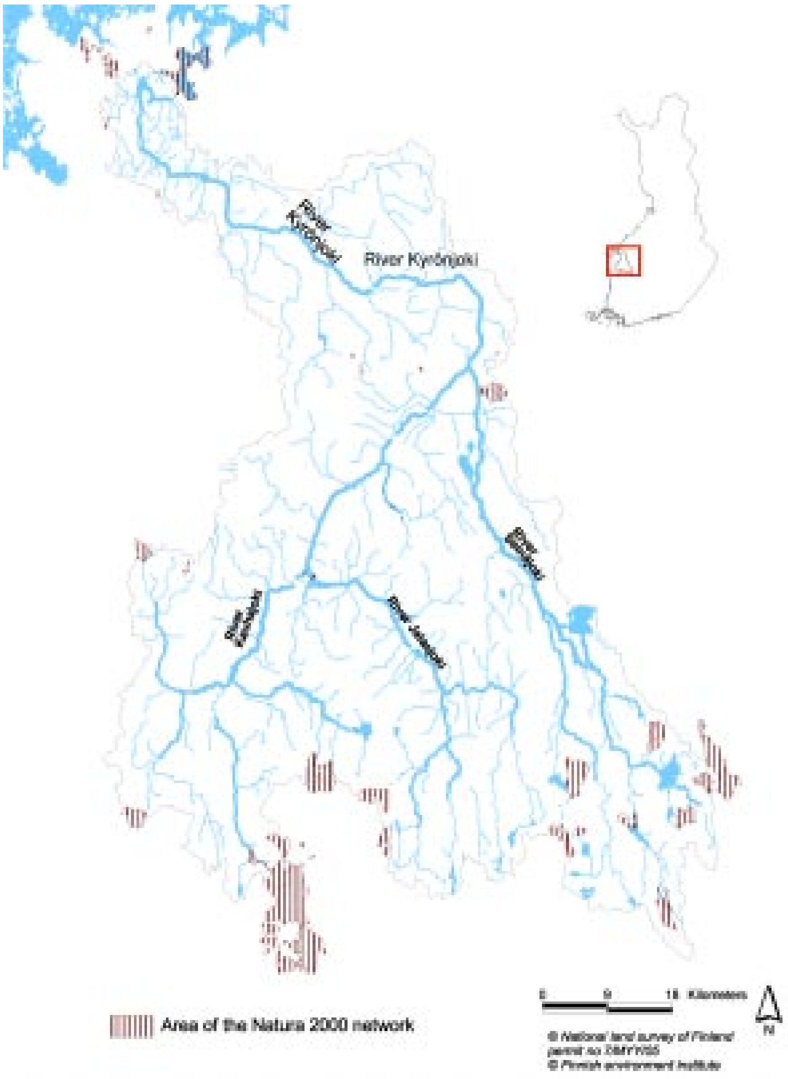


Figure 15. Areas in the Natura 2000 Network in the catchment of the River Kyrönjoki.

6. AIMS OF WATER PROTECTION

6.1 National Aims of Water Protection

Traditionally the aims of water protection in Finland have been presented on national level in the Programs of Water Protection. The Programs have been drafted since the 1970s, and the latest “The Aims of Water Protection until 2005” was accepted by the Finnish Government in 1998. The Program of Water Protection lists general and polluter-specific aims for accelerating the protection of groundwater and reducing nutrient discharge that causes eutrophication in watercourses. One of the goals was to reduce phosphorous load caused by agriculture and forestry between the early 1990s and the year 2005 with 50 %, and the load from scattered settlements with 35 %. The aim was not reached, but the program promoted water protection. New national aims until 2015 are being prepared 2006.

6.2 Aims of Water Protection set by the Advisory Board of the River Kyrönjoki

After its establishment in 1995, the broadly based Advisory Board of the River Kyrönjoki discussed the future aims concerning the improvement of the river environment. Their discussion resulted in the following goals:

Photo: Pertti Sevola

– improving the water quality (i.e. eliminating the acidity problems and reducing eutrophication)
– creating a living river valley (reconciling industrial and commercial activity with nature conservation)
– developing fishing and recreational resources in the river area
– safeguarding biodiversity
– finishing the water engineering projects, developing the use of artificial lakes and restoring watercourses

6.3 Aims of the Water Framework Directive for the River Kyrönjoki

The official aims according to the Water Framework Directive will be done when classification grounds and accordant classification is finished. Historical data of the River Kyrönjoki region, model calculations and especially expert evaluations have been utilized in setting the aims defined in this report. The needs of fishery and prevention of eutrophication have been emphasized in setting the aims of inland waters. With regard to sea area, prevention of eutrophication has been especially emphasized, and with regard to ground waters reducing risk targets was emphasized. In addition to experts of West Finland Region Environment Centre, experts on fishery, agriculture and the Water Protection Association, have participated in the preparation of aims and Program of Measures.

From the viewpoint of fishery the primary aim in the main branch of the River Kyrönjoki is to safeguard the subsistence of sea whitefish, sea trout and lamprey. The aim in Kauhajoki and Jalasjoki is to safeguard trout, grayling, and crayfish populations and the aim in Seinäjoki is to safeguard the crayfish population. These species can be considered as species that represent the state where the area is in good ecological condition, as already old historical maps indicate (Figure 16). The River Kyrönjoki is a water supply water body and this also sets distinct aims for water quality.

The nutrient and chlorophyll concentrations show signs of eutrophication in the River Kyrönjoki, the lakes and in the coastal waters of the River Kyrönjoki delta. Based on this, the present nutrient load on the river is considered to be too large. The River Kyrönjoki belongs mainly to the usability class passable. By modeling it has been estimated that, if the nutrient and sediment concentration would be decreased with 50 % from the situation of the mid 1990s, the usability classification of the River Kyrönjoki would improve from the present passable to a moderate status. This would also require an improvement of the occasional acidity and hygienic problems. (Marttunen, 1998).

The objectives of the water management are different in various parts (the main branch of the River Kyrönjoki, Jalasjoki, Kauhajoki and Seinäjoki) of the River Kyrönjoki. The most urgent needs in the main branch of the River Kyrönjoki are re-

Figure 16. A description of draught from the River Kyrönjoki 24-26 September 1854 in Merikaarto. Photo: Pertti Sevola.

ducing acidity peaks and safeguarding the migration possibilities of fish. In the branch of Kauhajoki and Jalasjoki especially nutrient and sediment loads have to be reduced. In Seinäjoki especially structural restoration is required. Considering the sea, the most significant effect comes from reducing nutrient load, but also acidity that flows out from the river has a major impact on ecological condition of coastal areas. Restoration of old gravel pits is the most important action when safeguarding the ground water areas of the River Kyrönjoki.

In this report the main objectives of the water management of the River Kyrönjoki until year 2015 are:

When decreasing the acidity peaks of the River Kyrönjoki, one goal is that the pH does not sink below 5.0 and is as often as possible above 5.5. The nutrient load will be reduced at least by 25 % and if possible by 50 % compared to the situation in the mid 1990s, so that the total phosphorous concentration of the river water would in general be below 50 µg/l. Suspended solids will be reduced as efficiently as possible. In addition migration obstacles of fish will be removed and the ecological structure of the river will be improved. The difference between central objectives and the current situation is presented in table 8.

The reduction goal of nutrient load is divided between different sources. The division is based on the results of the model calculations of Marttunen (1998). The division is based on VEPS calculations and the mean nutrient flow during the period 1969-2003 is used as the base for calculations (150 t P/a and 2 500 t N/a). These figures are also close to the nutrient flows measured in the early 1990s. Considering nutrient reduction the polluter specific objectives are presented in table 9.

Area	parameter	present state	aim in 2015
River area and delta	pH:n minimum total phosphorus migration hinders of the main channel	4,7 60-110 µg/l 8 objects	> 5,0 (5,5) < 50 µg/l 0 objects
Lakes	total phosphorus chlorophyll a mercury of fishes	30-90 µg/l 20-50 µg/l 0,2-1,0 mg/kg	< 50 µg/l < 20 µg/l < 0,5 mg/kg
Coastal area	total phosphorus total nitrogen chlorophyll a	10-30 µg/l 400-1000 µg/l 4-15 µg/l	< 20 µg/l < 500 µg/l < 4 µg/l
Outer archipelago	total phosphorus total nitrogen chlorophyll a	< 10 µg/l < 300 µg/l < 2 µg/l	< 10 µg/l < 300 µg/l < 2 µg/l

Table 8. Preliminary presentation of the aims of water management of the River Kyrönjoki by 2015.

	Phosphorus load	Lighter target level		Stricter target level	
	t /a	%	t / a	%	t /a
Open field cultivation	87	25	21,8	45	39,2
Animal husbandry	9	50	4,5	80	7,2
Forestry	4,5	25	1,1	50	2,3
Scattered settlement	13,5	30	4,1	65	8,8
Municipalities	4,5	2	1,1	40	1,8
Peat production	3	50	1,5	70	2,1
Total	121,5	28	34,1	50	61,3
	Nitrogen load	Lighter target level		Stricter target level	
	t / a	%	t / a	%	t /a
Open field cultivation	1150	25	287,5	50	575,0
Animal husbandry	50	50	25,0	80	40,0
Forestry	75	25	18,8	50	37,5
Scattered settlement	100	25	25,0	50	50,0
Municipalities	225	10	22,5	40	90,0
Peat production	75	25	18,8	70	52,5
Total	1675	24	397,5	50	845,0

Table 9. The preliminary objectives for antropogenetic nutrient reduction (the load caused by human activity) in River Kyrönjoki by 2015.

Photo: West Finland Regional Environment Centre

7. PRELIMINARY PROGRAM OF MEASURES

7.1 Basic measures according to the Water Framework Directive

7.1.1 Point source pollution

Waste water treatment plants of municipalities

The waste water treatment plants of the municipalities are the largest point source polluters of the River Kyrönjoki. They have permanent discharge permits according with the Environmental Protection Act (2000/86) or preceding water legislation. These permits are usually handled every 5 to 8 years. The permits include permit conditions for phosphorus, COD, BOD and solid substances. In areas where there are over 10,000 inhabitants the purifications plants are also obliged to oxidize ammoniacal nitrogen. The River Kyrönjoki is mainly considered as a phosphorus restricted water body and because of this the actual nitrogen removal demands are not set for the purification plants of the River Kyrönjoki region elsewhere than in Kauhajoki and Seinäjoki. Measures in accordance with discharge permits can restrict point source pollution in a way that it probably wont inhibit reaching a good general ecological status in the River Kyrönjoki. The necessity of nitrogen removal will be revised during the next permit round.

Peat production

According to the Environmental Protection Act (2000) all peat production areas with a size over 10 hectares must have an environmental permit. This also concerns old peat production areas. Peat production areas that are under 10 hectares must apply for an environmental permit if the peat production causes danger to the environment. The River Kyrönjoki area has plenty of old, rather large peat production

There are over 70 peat mining areas in the catchment of River Kyrönjoki. Photo: Pertti Sevola.

The average size of a farm is 32 hectares. Photo: Liisa Maria Rautio.

areas. These old peat production areas have filed permit applications during recent years. Permits are being processed and they will probably become valid in the nearest years. The permits include, among other things, orders about water protection and the permits restrict the area used in production. The permits are valid for the time being, but the permit terms are revised every 10 years. Peat production should not hinder reaching a good ecological status in the River Kyrönjoki when all peat production areas have received the environmental permits and follow the measures stated in them.

7.1.2 Diffuse pollution

Open field cultivation

Basic measures of open field cultivation are mainly based on the nitrate directive and on the EU:s statute about good cultivation practices and the Fertilizer Act. The nitrate directive has been implemented by a statute from the Council of State in 2000. A statute about good cultivation practices is in preparation. The statute on environmental emissions from agriculture gives the maximum amount for the use of cattle manure and prohibits fertilizing between 15 October and 15 April. The basic measures of agriculture will somewhat reduce nutrient and sediment load, but they will not have an effect on acidity coming from the fields. Basic measures will not be enough to guarantee good condition of waters of the River Kyrönjoki and its coastal sea area. Additional measures are needed in preventing acidity coming from fields and in reducing nutrient and sediment load.

Animal husbandry and fur farming

According to the Environment Protection Act (2000) animal shelter or fur farm must have an environmental permit if it is intended for at least 30 milk cows, 60 sows, 250 breeding minks or animal numbers equivalent to these. Since the year 2000 the Environmental Protection Act and permit process also concerns old animal shelters and fur farms where necessary. Licensing authority has considered when an environmental permit is necessary for old animal shelters and fur farms. Almost all animal shelters and fur farms operating in the River Kyrönjoki region are so large, that they are obliged to apply for an environmental permit. The handling of these permits is in process. Permit conditions are revised approximately every 10 years and in the River Kyrönjoki this takes place

Milk and meat production and processing is important livelyhood in Kyrönjoki valley. Photo: Liisa Maria Rautio.

mainly between 2013 and 2017. Animal shelters and fur farms should not be a hindrance for reaching a good general ecological status in the River Kyrönjoki when their conditions are in accordance with permit decisions.

Forestry

The Forest Act (1997) requires sustainable care of forests and paying attention to environmental matters in forestry. The Environmental Protection Act and Water Act relate only slightly to water protection of forestry. Forestry measures do not usually require environmental permits. Receiving government support for forest trenching requires notification procedure to the environmental authorities. Approximately twenty notifications are annually filed in the River Kyrönjoki region. Legislative means of forestry substantially improve water protection, but they will not be sufficient to guarantee reaching a good ecological status in the River Kyrönjoki. Complementary measures regarding water protection are needed.

Yearly over 2000 hectares of forest is maintenance ditched. Photo: Jyrki Latvala.

Over 30.000 inhabitants are outside the municipal sewerage system. Photo: Pertti Sevola.

Scattered settlement

The most important legislative means in waste water management of scattered settlements is a statute on the waste water management from scattered settlements, which came into effect in 2004. The statute concerns both permanent and holiday settlements. According to the statute 85% of phosphorus, 40% of nitrogen and 90% of organic matter must be removed from the waste waters by 2014. When measures accordant with the statute are carried out, the waste waters of scattered settlements will not prevent reaching a good ecological status in the River Kyrönjoki.

7.1.3 Water abstraction

According to the Water Act (1961) a permit has to be applied for water abstraction that exceeds 250 cubic meters a day. The permits include for example regulations about maximum allowed abstraction amount and monitoring. Permits are usually permanent, but in connection with new license applications permit conditions can be processed again. The significant abstractors of ground and surface waters in the catchment of the River Kyrönjoki region have appropriate permits according to the Water Act. When water abstractors follow the permit decisions that apply to them, water abstraction should not be a hindrance for a good status in the River Kyrönjoki region.

7.1.4 Operations in groundwater areas

Changing of groundwater is forbidden according to the Water Act (1961), but in some cases a permit for altering can be granted. Pollution of groundwater is forbidden according to the Environment Protection Act, and permits can not be granted for operations that will ruin groundwater. However, some groundwater areas have old activities that may cause a risk for groundwater.

According to the Water Act (2000) a protection area can be specified for an abstraction site, which will restrict the use of the area. Protection areas have been spe-

Photo: West Finland Regional Environment Centre

cified for a few abstraction sites in the catchment of the River Kyrönjoki, but they only cover a small part of the groundwater areas.

Legislative means will in principle be enough to guarantee the good chemical status of groundwater in, but complementary means are needed for old risk targets.

7.1.5 Regulation of water bodies, dams and other water construction

According to the Water Act (1961) a permit from the Environmental Permit Authorities is needed for construction projects that will affect the condition of waters. In addition, there is a separate law about hydrological construction, Lex Kyrönjoki, which prohibits the building of new power plants by lower and middle part of the River Kyrönjoki. Several dozens of permits for regulation and arrangement of water bodies, as well as building dams, power plants and artificial lakes, have been granted for the catchment of the River Kyrönjoki. Permits have been used for the River Kyrönjoki, for instance for building four artificial lakes and six power plants.

The most significant environmental permits regarding hydrological constructions in the River Kyrönjoki region have been granted between 1960 and 1990. Permits regarding hydrological construction are mainly permanent, but the arrangement permit of the River Kyrönjoki's upper part and the embankment permit of Rintala region have regulations about revising the permits. Permit decisions usually include an obligation to observe how the measures affect the condition of waters and fish fauna.

Although permits regarding the regulation of water bodies are permanent, the permits can be changed according to the new Water Act (1994), if necessary. Regulation can be eased, if it causes unreasonable disadvantages.

Current constructions (for example dams, hydropower stations and short-term regulation) and measures in accordance with the permit, partly prevent reaching a good ecological status in the River Kyrönjoki and complementary measures are needed in order to reach a good ecological status.

7.1.6 Priority and harmful substances

A statute (1994) in Finland prevents eleven substances from the black list to be discharged into waters and sewers. Other substances from the black list are prohibited to be discharged to waters, if they are used as solvents or as biocides. In addition, the Council of State has given several other decrees concerning harmful substances. A work group has prepared a report on the management of harmful substances and priority substances based on the implementation of the EU's Water Framework directive. The report was completed in June 2005. The work group suggests that, on the basis of Environmental Protection Act, a statute should be given about substances that are harmful to water environment and that the environmental norms and threshold values of certain substances should be confirmed.

There is only little activity in the River Kyrönjoki region, where substances that are harmful to the environment are handled. In this respect legislative means should be enough to guarantee the good status of waters. On the other hand, harmful substances like aluminium and nickel

Contaminated site at Ilmajoki (Kestopuu). Photo: Liisa Maria Rautio.

Artificial part of River Seinäjoki running into River Kyrönjoki at Kiikku dam. Photo: Unto Tapio.

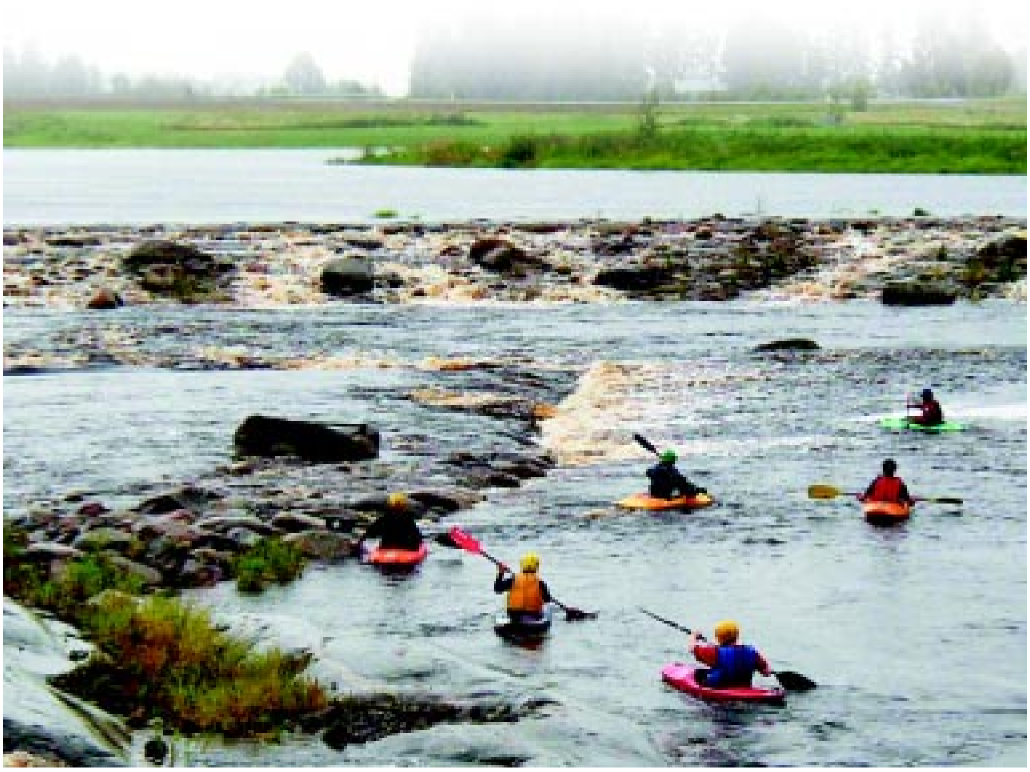
are leaching in big amounts from the sulphate soil and these problems cannot be solved by basic measures. In the artificial lakes in connection to the River Kyrönjoki the concentration of mercury in perches is 0.2-1.0 mg/kg and 0.4-1.1 mg/kg in pikes. A good ecological status cannot be achieved in artificial lakes with basic measures.

7.1.7 Estimate of the adequacy of basic measures

The basic measures will not be enough to guarantee reaching a good ecological status in the River Kyrönjoki and its coastal sea area. Acidity and structural alterations caused by hydrological constructions are the biggest obstacles for reaching a good ecological status in many parts of the River Kyrönjoki. Current basic measures can only have a small effect in solving these problems, thus complementary measures are indispensable.

Large loads of nutrients and solid substances will also prevent reaching a good ecological status in The River Kyrönjoki and its coastal sea area. Basic measures can be used to affect the loads of nutrients and solid substances. The basic measures of point source pollution, animal husbandry, fur farming and probably also scattered settlement are rather sufficient. The aims in reducing the loading can thus be achieved. However, complementary measures are needed in reducing the load of nutrients and solid substances especially in open field cultivation and forestry.

Basic measures of ground waters are probably sufficient, but certain complementary measures are needed to guarantee a good status. Especially regarding priority substances and accident situations the basic measures are probably sufficient. Additional measures are needed in dealing with harmful substances leaching from sulphate soils and the concentration of mercury in fishes in artificial lakes.



Canoeing at Malkakoski (Ylistaro). Photo: Anssi Orrenmaa.

Agri-environmental support is payed to the farmers when they change fields into wetlands. Photo: Eeva-Maija Savola.

7.2 Complementary measures

7.2.1 Financial support

Financial support is a significant complementary measure in preventing acidity from the soil and reducing the load of nutrients and suspended solids of agriculture and forestry. In this respect the most important methods are agri-environmental support and environmental support for forest management projects in accordance with the financing laws of sustainable forestry. Financial support, for instance planning small-scale waste water treatment plants, can also fundamentally complement the basic measures in waste water management of scattered settlements. Financial support is urgently needed also for research and development work, which will contribute to preventing acidity caused by soil.

Agri-environmental support has been a central measure complementing legislation in reducing acidity, nutrient, and sediment load caused by open field cultivation. Effective prevention of acidification would require support for instance for large-scale controlled drainage of sulphate land fields and possibly also for liming of acid waters in critical targets. Basic agri-environmental support, such as maximum fertilization level and buffer zones, have a central role in reducing nutrient and sediment load. Also special environmental support for agriculture (buffer zones, wetlands and controlled drainage) can be used to notably reduce environment load from agriculture.

Support in accordance with the laws on financing of sustainable forestry enables such environment protection measures, which will not happen through legislation. For instance forest ditching has been done in the catchment of the River Kyrönjoki in erosion sensitive areas, which still cause sedimentation. Nature management projects in accordance with the law on financing of sustainable forestry have been carried out in many places in the catchment of the River Kyrönjoki, but there is a need for more projects.

Efficient realization of scattered settlements waste waters treatment can be notably improved by financial support. Support is needed especially for planning and implementation of purification plants of several households.

7.2.2 Research and education

Preventing acidification from acid sulphate lands requires urgent research and development activities. Current acidity prevention methods are not at all sufficient so that a good ecological status of the River Kyrönjoki could be attained. Research is especially needed to develop new acidity prevention methods and making current methods more effective.

Research is also needed for development of the waste water treatment methods for scattered settlements. Some treatment methods on the market today do not fill the requirements of waste water statute. Technical development is also needed for treatment of waste waters from peat production, forestry and fur farms, because currently used methods are rather inefficient during heavy rains.

Waste water treatment of open field cultivation, forestry, scattered settlements, animal husbandry and fur farming can be made significantly more effective through information, education and guidance. Information and education are central complementary measures.

7.2.3 Restoration

Restoration measures are needed especially for reducing damages caused by hydromorphological construction. There are plans for removing seven central migration hinders from the lower part of the River Kyrönjoki and a fish ladder is being planned for Koskenkorva dam (Figure 17). In addition a fish ladder should be built to Hiirikoski's power plant. Carrying out these measures would secure migration of fish in middle and lower part of the River Kyrönjoki.

Small-scale habitat restoration are needed at headwaters of the River Kyrönjoki and the execution of some measures has already began. There might also be need for habitat restorations at the coast-

The old dam at Peltokoski is a migration obstacle for fish. Photo: Liisa Maria Rautio.

al sea area of the River Kyrönjoki (flads and coastal lakes). Also crayfish and lamprey restorations of Kyrönjoki should be enhanced.

Reaching a good ecological status requires revising regulation practices and some other practical measures. Detailed planning regarding the matter should be started in a hurry. The most urgent measure is the decrease of short-term regulation of Lake Kyrkösjärvi and Lake Pitkämö. At the same time the possibilities for ecological restorations of artificial lakes should be assessed.

In addition restoration measures might be needed in water bodies downstream of peat production and heavy forest drainage areas, where sedimentation has caused filling of ponds and silting of brooks. Restorations are also needed in groundwater areas; especially old soil extraction areas should be restored, if soil has been extracted below the surface of groundwater.

7.2.4 Contracts and plans

Central complementary measures are also general plans related to water protection of agriculture and scattered settlements,

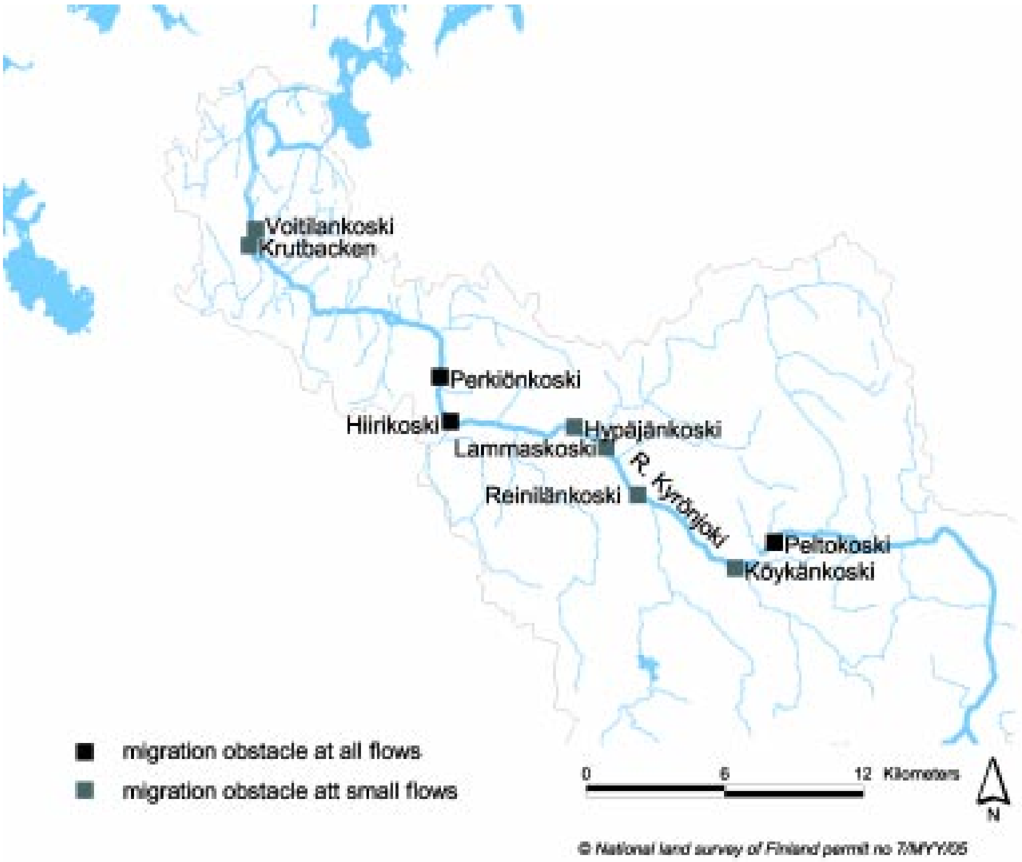


Figure 17. Central migration obstacles of the main channel of the River Kyrönjoki.

which can be used to enhance the diminution of environmental load. General plans for buffer zones have been compiled for the main channels of the River Kyrönjoki, but in future planning is needed especially for tributaries and main ditches. Attention must also be paid to general planning and mapping of wetland targets. In addition, water protection programs must be compiled for sulphate lands.

Municipality and village specific plans are needed for waste water treatment of scattered settlements. The plans can be used to promote connecting households to municipal sewer network and building purification plants. Also municipal water supply and sewerage development plans are important in expanding the sewer network.

Central complementary measures in the water protection of forestry are contracts and directions regarding the planning and implementation of forestry measures, which have notably improved the level of water protection. This procedure must be continued and developed further. Also forest certification enhances water management.

Protection plans and programs of measures are essential in ground water protection. Protection plans should be urgently compiled to all ground water areas that have risk targets.

Photo: Pertti Sevola

8. Effects of the measures

8.1 Reduction of the impacts from acidification

Reducing acidification in the River Kyrönjoki so that the lowest pH values exceed level 5.0, and possibly level 5.5, requires developing new methods for preventing acidity and combining several measures. Measures are needed in both catchment area and water body. Prompt research and development activities are primarily needed in order to find more efficient and economic acidity prevention methods. Based on current knowledge the primary measures could be a distinct increase in liming filter ditches and controlled drainage, as well as storing of water and liming of water bodies during the acidity peaks. All of these measures are so expensive that their full scale execution requires a functional support funding. Achieving distinct results requires first and foremost that the farmers of the area participate in the large-scale measures taken on arable lands and in water bodies. It is worthwhile to direct the measures to areas that are most acidic.

Currently used methods can not reduce acidity from sulphate lands so much that a good ecological status could be attained in areas which suffer most from acidity. Acidity will thus prevent reaching a good ecological status in the main channel of the River Kyrönjoki and partly also in the coastal sea area of the River Kyrönjoki. However, acidity can to some extent be reduced already by 2015.

8.2 Reduction of nutrient and sediment load

The nutrient load has to be reduced so that the eutrophication of the River Kyrönjoki and its coastal sea area would decrease. Model calculation estimates have shown

Liming filter is one of the methods to reduce the impacts from acidic fields. Photo: Eeva-Maija Savola.

that a 50 % reduction of load caused by human activity would be enough to improve the usability class of the River Kyrönjoki from passable to satisfactory (Marttunen 1998). It has been estimated that this would be enough to reach a good water quality status in the River Kyrönjoki and at its coastal sea area.

As a result of the livelihood structure in the area, which is dominated by agriculture, the part of open field cultivation in the nutrient load of the River Kyrönjoki is bigger than other operations combined. The most profitable, comprehensive reduction measures of nutrient load can be done by reducing the load of open field cultivation. Of course this fact will not remove other actor's responsibility. During low flow season the importance of scattered settlements and waste water treatment plans is larger than open field cultivation. At the river system's headwaters, where there are no fields peat production and forestry are significant load sources.

Municipalities waste water treatment plants

There are nine biological-chemical municipal waste water treatment plants in the river basin of the River Kyrönjoki. These are the most significant point source polluters of the catchment. Waste waters from the largest industrial plants of the area are also handled at these treatment plants.

The treatment plants are mainly modern and the phosphorus load cannot be reduced much more. The purification efficacy of organic matter is excellent. Reports regarding nitrogen have to be compiled in the whole catchment of the River Kyrönjoki. In order to secure a good purification level sufficient resources have to be channeled to treatment plants to secure tending, maintenance and optimal processing. In optimal circumstances it is possible to achieve a nutrient load reduction accordant to the more demanding target level.

Peat production

Sedimentation basins and ditches between two strips are the most used water protection methods in peat production. These methods are intensified for example with overland-flow. Overland-flow, however, is not suitable for all areas, because of the space and the differences in altitude that it requires. Chemical precipitation is used in demanding targets.

Water protective structures of peat production are partly outdated, but water protection measures and their combinations that fulfill current requirements can be used so that the more demanding target level for nutrient load reduction can probably be achieved.

Photo: Liisa Maria Rautio.

Open fields cover 25 % of the catchment of the River Kyrönjoki. Photo: Pertti Sevola.

Open field cultivation

The open field cultivation's significant proportion of the total nutrient load of the River Kyrönjoki stems from the catchment's agriculture and livelihood structure. The most profitable and comprehensive reduction measures of nutrient load in the whole water body can be done by reducing the load of open field cultivation. The most effective water protection measures of open field cultivation considering the catchment of the River Kyrönjoki are reducing, adjusting and specifying fertilizing, increasing controlled drainage, building buffer zones for flood vulnerable areas and in fields that slope to water bodies as well as building wetlands for example to brooks and ditches hollows. Lightened cultivation and green fallowing support these measures. In order for the measures to lead to the desired results water protection has to be rationalized in all suitable targets of the catchment.

There is not enough research data about the effects of different measures to washout rate in order to reliably estimate the effects of the measures to the load of open field cultivation. On the basis of national reports it seems that a significant reduction of load in open field cultivation is hard to achieve in the River Kyrönjoki. A target level reduction will probably not be reached with the current methods.

Animal husbandry and fur farming

The load of animal husbandry and fur farming can be decreased by reducing direct discharges and by adjusting manure use and spreading, and by treating dairies' washing waters as well as runoff waters from walking paddocks and fur farms. The largest units are within the environment permit system whereupon permit orders make measures obligatory. It is probably possible to attain a nutrient load reduction accordant to the more demanding target level.

Forestry

Reducing the load of forestry requires executing sufficient water protection measures in ditching, cutting and fertilizing targets. In addition to most common measures like sedimentation basins and – pits, overland-flow fields and wetlands should be taken into use in suitable targets. Water protection of old ditching areas can also

Photo:Pertti Sevola.

be rationalized with nature management projects. It is probably possible to attain the more demanding target level nutrient load reduction of forestry.

Scattered and holiday settlement

The statute regarding waste waters of scattered settlements is going to speed up management of waste waters also in the catchment of the River Kyrönjoki during the next 10 years. This is going to take place by expanding sewer networks and by building communal joint purification plants and property specific systems. With purification results accordant to the statute, the nutrient load of scattered settlements can be decreased according to the aims. This requires large-scale measures in 3,000 holiday residences and in over 10,000 properties that are used around the year. The target level can be reached, but it requires information, guidance, cooperation between neighbors and financial support.

Total assessment

Reducing nutrient load caused by human activity according to the stricter target level (50%) by 2015 is partly uncertain with the current methods as shown in table 10. The difficulty in achieving the target level is mainly caused by water protection methods of agriculture, which were less effective than predicted. So nutrient and sediment load might prevent reaching a good ecological status in the main channel and delta of the River Kyrönjoki. The nutrient load should not prevent reaching a good ecological status at Seinäjoki, Kauhajoki and Jalasjoki. The nutrient load will not either prevent a good ecological status of the River Kyrönjoki's estuary outer sea-area.

8.3 Restoration of water bodies

Plenty of structural modifications have been done especially for the needs of flood protection and power plants in the main channel of the River Kyrönjoki and at Seinäjoki. Restoration measures can notably improve the ecological status of the main channel of the River Kyrönjoki and the possibilities of fish migration by 2015. The condition of Seinäjoki can also partly be improved with restorations. Hydromorphological changes at Seinäjoki have been so intense that the best attainable condition will probably not be reached by 2015. It is likely that a good condition can not either be completely reached in the main channel of the River Kyrönjoki by 2015.

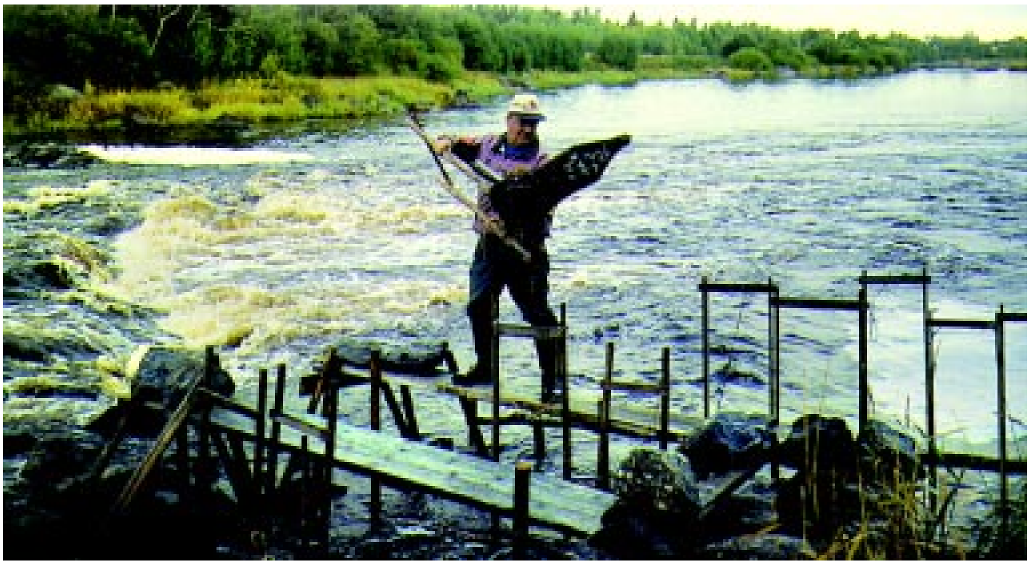
8.4 Summary of the effects of measures

The condition of the River Kyrönjoki and its coastal sea area can be fundamentally improved with the measures presented in this measures program: reducing acidity, reducing nutrient and sediment load and water body restorations (table 11). A good ecological status is probably not going to be attained in the coastal sea area and the whole region of the River Kyrönjoki by 2015.

According to preliminary assessment it is possible to reach a good ecological status in the outer sea area of the River Kyrönjoki and at Jalasjoki and Kauhajoki. Seinäjoki will probably not reach a good ecological status because of structural modifications. The biggest hindrance for good ecological status in the main channel of the River Kyrönjoki is acidity, but also nutrient load and structural matters can prevent reaching a good ecological status. Both acidity and nutrient load are the hindrances for a good ecological status in the inner archipelago and delta of the River Kyrönjoki.

	Reduction of phosphorous %		Reduction of nitrogen %	
	Basic measures	Basic and complementary measures	Basic measures	Basic and complementary measures
Open field cultivation	5-15	20-30	5-15	20-30
Animal husbandry	80	80	80	80
Forestry	25	50	25	50
Scattered settlements	30	65	25	50
Point source pollution	40	40	40	40
Peat production	70	70	70	70
Total	17-25 %	33-41 %	13-20 %	25-33 %

Table 10. Estimated reduction of phosphorous and nitrogen in the River Kyrönjoki catchment with basic and complementary measures by 2015.



Fishing of river lamprey at Voitby Rapids. Photo: Jyrki Latvala.

Table 11. The effect of water management measures to the condition of inland waters, sea area and ground waters ((++ = measure will notably improve the condition of waters, + = measure will improve the condition of waters, - = measure does not have an essential effect).

Measure	Effect	Inland waters	Sea area	Ground waters
Municipal waste water treatment plants				
Optimal management	nutrients	++	++	-
Tending and maintenance	nutrients	+	+	-
Effective handling of sludge	nutrients, harmful substances	+		
Peat Production				
Planning of land use	sediment and nutrients	++	-	++
Ditches between strips	sediment and nutrients	++	+	-
Sedimentation basin	sediment and nutrients	+	+	-
Overland-flow	sediment and nutrients	++	+	-
Chemical processing	nutrients	++	+	-
Regulation of flow	sediment	+	+	-
Open field cultivation				
Optimal fertilizing	nutrients	++	++	++
Lightened cultivation	sediment and nutrients	++	++	+
Controlled drainage	acidity and nutrients	++	+	-
Liming filter ditches	acidity and nutrients	++	+	-
Buffer zones	sediment and nutrients	++	++	++
Sedimentation basins	sediment and nutrients	+	-	-
Wetlands	acidity and nutrients	++	++	-
Using fields for noncultivating purposes	nutrients	++	++	+
Animal husbandry and fur farming				
Optimal feeding of animals	nutrients	++	++	++
Sufficient manure pits	nutrients	++	++	++
Adjusted use of manure	nutrients	++	++	++
Treatment of dairy waste waters	nutrients	++	+	+
Treatment of fur farms waste waters	nutrients	++	++	+
Guiding of location	nutrients	++	-	++
Forestry				
Light tilling methods	sediment and nutrients	++	++	+
Buffer zones	sediment and nutrients	++	++	++
Overland-flow	sediment and nutrients	++	++	-
Sedimentation basins and -pits	sediment and nutrients	+	+	-
Submerged weirs	sediment and nutrients	++	++	-
Wetlands	acidity and nutrients	++	++	-
Scattered settlement				
Guiding of location	nutrients	++	++	++
Connection to sewer network	nutrients	++	++	++
Communal purification plants of villages	nutrients	++	++	+
Land treatment	nutrients	+	+	-
Small sewage treatment plants	nutrients	++	++	-
Water abstraction				
Operation at groundwater areas	quantity of water	+	-	++
Restricting volume of abstraction				
Planning of land use at groundwater areas	nutrients, harmful substances	-	-	++
Removing old harmful targets	nutrients, harmful substances	-	-	++
Restoration of groundwater areas	nutrients, harmful substances	-	-	++
Water body structures				
Improving fish migration	structures	++	+	-
Modifying regulation	sediment and nutrients	++	-	-
Habitat restorations	structures	++	-	-
Other restorations and reconstructions	sediment and nutrients	++	+	-
Harmful substances				
Planning of land use	harmful substances	++	++	++
Restricting leaching of alum lands	harmful metals and acidity	++	++	++
Management of acid waters of alum lands	harmful metals and acidity	++	++	+
Changing the circumstances of artificial lakes	mercury	++	-	-

BERNET

9.1 The present monitoring system

The present monitoring system of the River Kyrönjoki consists of the following elements:

- monitoring of water quality, water flow and transport of substances conducted by the environmental authorities, some part of the monitoring belongs to the Eurowaternet-program
- the water quality, water flow, hydro morphological changes and biological monitoring (zoobenthos, fish, lamprey, crayfish, plants) connected to the water construction works conducted by the state
- monitoring programs connected to the point source polluters (water quality, zoobenthos, plants and fish)
- monitoring programs connected to peat production
- national monitoring of plankton algae
- monitoring of preserved areas
- monitoring of beaches

Quality element	Monitoring stations (water course+lake)	Frequency of samples	Interval of samples
National monitoring			
Water quality	5+1	4-20 x/year	every year
Heavy metals	1+0	20 x/year	every 3 years
Algal blooms	1+1	1 x /week	every summer
Monitoring of impact from water and regulation			
Water quality	9+ 5	1 x /month	every year
Water quality (automatic water sampling stations)	5+0	continuous	every year
Aquatic flora	4+ 5	1 x/year	every 2-3 years
Bentic fauna	6+ 5	1 x/year	every year
Fish	20+1	1 x/year	every 3 years
Heavy metals	6+ 4	1 x/year	every 2-3 years
Hydrology	6+0	continuous	every year
Monitoring of impact from peat production			
Water quality	20+0	4 x/year	2-3 x /5 years
Bentic fauna	8+0	1 x/year	2-3 x /5 years
Aquatic flora	8+0	1 x/year	2-3 x /5 years
Fish	7+0	1 x/year	every 5 years
Monitoring of impact from peat production			
Water quality	9+1	2 x/year	every year
Monitoring of impact from water abstraction			
Fish	6+0	1-2 x /year	every 2-3 years
Bentic fauna	0+3	3 x/year	every 3 years
Water quality	0+2	1 x/year	every year

Table 12. Current monitoring system of the River Kyrönjoki.

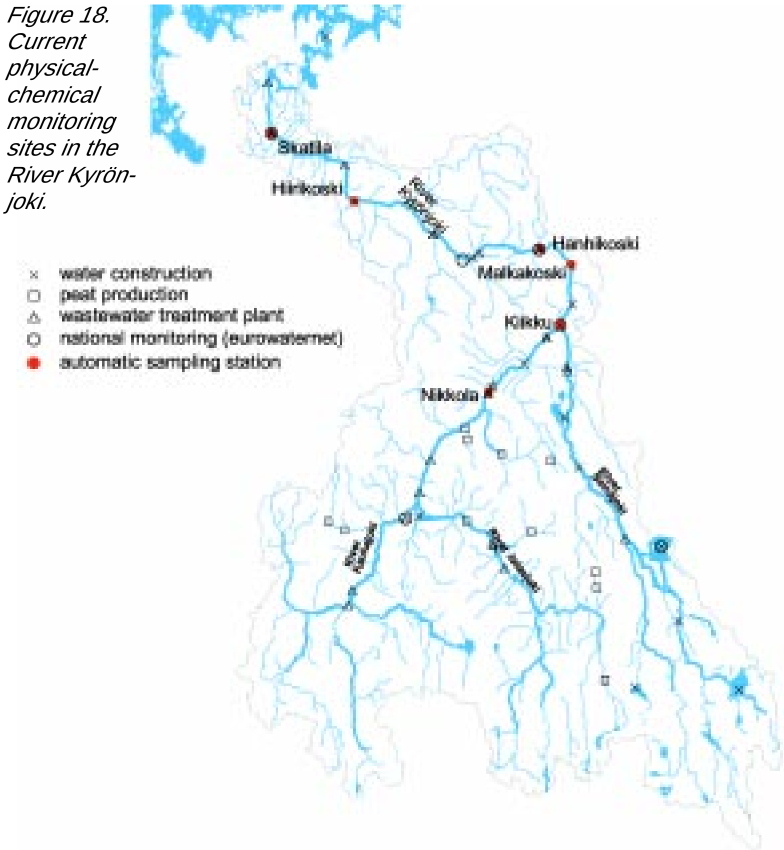


Figure 18. Current physical-chemical monitoring sites in the River Kyrönjoki.

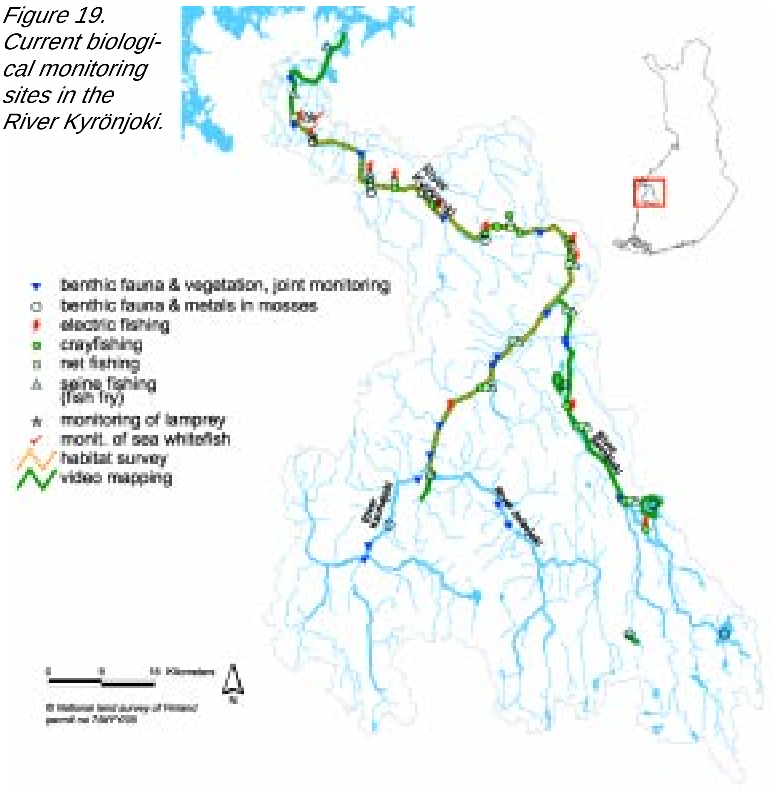


Figure 19. Current biological monitoring sites in the River Kyrönjoki.

Information about central monitoring programs is presented in table 12 and in figures 18 and 19.

9.2 Development of monitoring

According to the WFD the future monitoring will be of three types: surveillance monitoring, operational monitoring and investigative monitoring.

Monitoring of the river area

The monitoring of the River Kyrönjoki will in the future also be based on the Eurowateret-monitoring program and the hydrological monitoring program conducted by the environmental authorities. There are five monitoring sites in the River Kyrönjoki: two reference sites (Haapajyrä and Pitkämö), two sites influenced by human activities (Hanhikoski and Kiikku dam) and one station for measuring transportation (Skatila). Two of the tributaries of the River Kyrönjoki, Jalasjoki and Kauhajoki will most probably reach a good ecological status. These sites will be under surveillance monitoring. The main channel of the River Kyrönjoki and River Seinäjoki will probably not reach a good ecological status 2015. These areas will therefore be under operational monitoring. The operational monitoring will be based on the present control programs updated with monitoring on diffuse load.

Monitoring of lakes

The surveillance monitoring of the lakes in the River Kyrönjoki catchment is based on the Eurowaternet-monitoring program. There is one Eurowaternet lake in the catchment of the River Kyrönjoki: the artificial lake Kalajärvi (heavily modified water body). A large part of the lakes in the catchment are under heavy anthropogenic influence (diffuse load, regulation), and therefore the lakes will be under operational monitoring. The operational monitoring will be based on the present control programs.

Monitoring of the sea area

The coastal area of the River Kyrönjoki is under heavy anthropogenic influence and will be under operational monitoring. The outer archipelago will probably achieve a good ecological status and will therefore be under surveillance monitoring. The base for this monitoring will be the present monitoring program updated with monitoring on zoobenthos and macrophytes.

Investigative monitoring

Investigative monitoring is needed if and when the cause of an event or an accident must be investigated. The investigative monitoring must be developed and increased.

Important part of future monitoring of water quality are the five automatic monitoring stations. Photo: Liisa Maria Rautio.

Monitoring of protected areas

The present monitoring of protected areas has been based on project activities. The protected areas therefore need a new monitoring program. Both areas connected to Natura 2000 and the Habitat Directive should be included in the monitoring program.

Fish tagging is part of biological monitoring of River Kyrönjoki. Photo: Kari Saari.

10. ECONOMIC ANALYSIS

10.1 Reduction of the impacts from acidification

Liming of water bodies

The total costs of liming the River Kyrönjoki have not been estimated, because the needed quantity of lime during the acidity peaks would be so large, that liming the River Kyrönjoki is not considered as a realistic alternative. Liming the water body would create problems especially because liming would cause precipitate, which would descend to the bottom of the water body, and affect the flow of water and the status of the water body. Liming the water body would require building and maintaining a comprehensive network of liming stations, because currently there are no lime stations at the River Kyrönjoki. Pumping stations could be partly utilized in liming of water bodies. According to a very rough expert evaluation the annual costs would be 1-5 million euros, if attempts were made to control the worst acidity peaks by liming water bodies. However, the experts do not recommend this method, because of the extensive sludge problems and because of the uncertainty of the technique. In addition, liming water bodies solves acidity only partially even in the best case.

Liming fields

The additional costs of surface liming of fields have been estimated as being 200 euros/hectare/year. This is in the same magnitude as previously paid support for surface liming. If all the fields of the River Kyrönjoki that are situated on acid sulphate lands (a little over 26,000 hectares) are surface limed, then the annual costs are around 5 million euros. However, this measure would have a very insignificant effect on the acidity of the River Kyrönjoki, so the measure is not cost-effective. Deep liming of fields, in other words mixing lime into a 0.5 meter thick earth layer, would be a rather efficient method in theory, but there is no technical readiness for such an extensive operation. It has been estimated in the Orismala region, that the lime of

Controlled drainage reduces the acidity problem in River Kyrönjoki and benefits the farmers. Photo: Liisa Maria Rautio.

deep liming would cost bout 2,000 euros per hectare. Add to this the distribution costs and the rough estimation for total costs would be at least 3,000 euros per hectare. Total costs of deep liming in the whole River Kyrönjoki region would be in the magnitude of 75 million euros, but there is currently no required technique for this method.

Liming filter ditches

In some areas it has been possible to get 430 euros/hectare/year of special environmental funding for agriculture for liming filter ditches. The farmers have considered this support plainly too small and the demand for it has been low. In addition, the efficiency of liming filter ditches reduces rather quickly and they have to be renewed rather often. If, for example, the additional costs of liming filter ditches to farmers are estimated as being 900 euros/hectare/year (environmental funding doubled), then the additional costs of liming filter ditches in all sulphate land fields are 24 million euros annually. The method can be recommended, but it alone is not sufficient in solving the acidity problem.

Controlled drainage

For additional costs of controlled drainage, farmers can receive environmental funding of a little over 150 euros/hectare/year. So the additional costs of controlled drainage of sulphate land fields in the whole River Kyrönjoki region (26,000 ha) would be approximatley 4 million euros annually. This method alone is not sufficient in solving the acidity problem. This method can be recommended and its interestingness is enhanced by the fact that it also benefits the farmers.

Removing fields from cultivation

Removing sulphate land fields from cultivation has also been considered as a theoretical alternative. The price of arable land at the River Kyrönjoki is about 6,000 euros/hectare. Removing fields from cultivation would not however remove the acidification problem; in addition, blocking of ditches and building wetlands would be required. If the costs of redemption of fields and altering of drainage ditches are for example estimated as costing 7,500 euros/hectare, then the costs of this theoretical alternative would be approximately 200 million euros. This figure does not include the social and economical impacts that would be the consequences of removing fields from cultivation.

Summary

The efficiency, very rough theoretical costs and usage of the measures that were presented above are presented in table 13.

When the cost-effectiveness of available measures is compared, it can be stated that deep liming and surface liming, as well as extensive liming of water bodies, are not reasonable alternatives. On the basis of a very sketchy cost-benefit analysis it can be said that measures should be directed especially to controlled drainage, liming filter ditches and possibly to liming water bodies locally and removing fields from cultivation locally. Resources should be invested into developing new methods. Different options for preventing acidity have been assessed in pilot-scale in the region of Rintala. It was also stated in this report, that the acidity problem of the River Kyrönjoki can not be solved with currently used methods.

Preventing acidity is so expensive that its implementation requires external financing, especially through the Environmental Support Funding. From economic and efficiency standpoints, the acidity prevention measures should primarily be directed to areas that are most acidic.

Table 13. The efficiency, costs and usage of acidity prevention measures.

MEASURE	EFFICIENCY	COST	USAGE
liming of water bodies	efficient in places, sludge problem	rather expensive	precision targets
surface liming	rather inefficient	expensive	-
deep liming	efficient in theory	required technique is missing	-
liming filter ditches	rather efficient	very expensive	all alum fields
controlled drainage	rather efficient	expensive	all alum fields
removing fields from cultivation	efficient	very expensive	precision targets

10.2 Reduction of nutrient and sediment load

The costs of removing the nutrients of communities' **waste water treatment plants** consist of capital and operating costs. Removal of phosphorus is rather affordable for treatment plants because several years have passed from the building of treatment plants. Operating costs are in magnitude of 2 euros per phosphorus kilo. The current operating costs of nitrogen are slightly larger, roughly 1,5-4 euros/kg. On the other hand, the possible rationalization of nitrogen removal requires significant investment costs. For example, the investing costs of nitrogen removal plant at Kauhajoki were in magnitude of 1.0 million euros. The need of nitrogen removal at the area's treatment plants will be deliberated in connection with revising of permit conditions, mainly before 2010. Optimal management and tending and maintenance of current treatment plants are affordable and efficient methods, which are needed at all treatment plants. In addition, the handling and use of sludge requires economic investments.

The water protection measures of **peat production** are mainly rather affordable, but not necessarily very efficient. Consequently, various methods have to be combined in the production area. Usually ditches between two strips, sedimentation basins (2,000-4,000 e/a piece), and for instance overland-flow (1,000-2,000 e/ha) or regulation of flow (800-1,500 e/dam) are combined.

Overland-flow is a rather efficient method and the costs are not unthinkably large, but overland-flow requires moderately space and differences in altitude. Therefore, it is not suitable for nowhere near all targets. The most efficient method is chemical treatment, which is however significantly more expensive (70,000-100,000 e/target)

Photo: West Finland Regional Environment Centre

MEASURE	EFFICIENCY	COST	USAGE
optimal management	efficient	affordable	all plants
tending and maintenance	efficient	affordable	all plants
effecting nitrogen reduction	efficient	very expensive	large plants
management of sludge	efficient	rather expensive	all plants

Table14. The efficiency, costs, and usage of measures taken in communities waste water treatment plants.

MEASURE	EFFICIENCY	COST	USAGE
ditches between two strips	efficient	affordable	all targets
sedimentation basins	rather efficient	affordable	all targets
overland-flow	efficient	rather affordable	all suited targets
regulation of flow	rather efficient	affordable	suited targets
chemical treatment	very efficient	expensive	necessary targets

Table15. The efficiency, costs, and usage of water protection measures of peat production.

than other methods, because it requires electricity, which is usually not available in the vicinity of peat production areas. The selection of peat productions water protection methods is based on case-specific planning, where more expensive solutions are used if cheaper methods are not suitable for the target area. Peat production measures are needed especially in the catchments of Jalasjoki and Seinäjoki, where most of the peat production areas are situated.

The efficiency and costs of the water protection measures of open **field cultivation** depend substantially on the condition and location of the fields. Some water protection measures of open field cultivation belong to the basic amount of Environmental support Funding (2000-2006), which includes 95 % of the River Kyrönjoki area farmers. Environmental funding requires the following so called good cultivation methods, such as leaving buffer zones and monitoring the nutrient level of fields.

The most cost-efficient measure in water protection of open field cultivation will also in future be optimal fertilizing. Although the use of chemical fertilizers has notably reduced on average, more attention must be paid to allocation of fertilizing. Adjusted fertilizing, exact fertilizing and utilization of nutrient balance calculations are needed. Optimal fertilizing should be practiced at all cultivated fields. Lightened cultivation should also be favored, because also this widely suitable measure is both affordable and efficient.

Many of the measures are suitable only for certain targets and their efficiency and costs vary significantly depending on the target. Buffer zones, for instance, are not needed for the embanked parts of the River Kyrönjoki's main channel, but they are needed especially for steep and flood vulnerable fields of Jalasjoki and Kauhajoki. Controlled drainage and lime filter ditches are needed especially in acid fields. A rough estimate is that there are 26,000 hectares

MEASURE	EFFICIENCY	COST	USAGE
good cultivation methods	efficient	affordable	all fields
optimal fertilizing	very efficient	affordable	all fields
lightened tilling	efficient	affordable	all fields
controlled drainage	rather efficient	rather affordable	at least acid areas
liming filter ditches	rather efficient	expensive	at least acid areas
buffer zones	rather efficient	rather expensive	suited targets
rationalizing the use of manure	rather efficient	affordable	suited targets
sedimentation basins	rather inefficient	rather expensive	suited targets
wetlands	rather efficient	rather expensive	suited targets
using fields for other purposes than cultivation	efficient	rather affordable	suited targets

Table16. The efficiency, costs, and usage of water protection measures of open field cultivation.

of these fields. Distinct reports have not been compiled about wetlands, sedimentation basins or about the need of fields to be transferred to other use.

Compensations have been paid for some measures through the Environmental Support Funding (2000-2006). Their magnitude is:

- buffer zones: 450 e/ha/year
- controlled drainage: 156 e/ha
- rationalizing the use of manure: 65 e/ha
- sedimentation basins and wetlands: 450 e/ha/year

Water protection measures of open field cultivation are required in the whole catchment of the River Kyrönjoki, but the need is largest aside Kauhajoki and Jalasjoki.

The costs of the measures of **animal husbandry and fur farming** vary greatly, and currently executed external water protection measures are mainly based on the orders of environmental permits. Plenty of manure stocks have been built during the last 10 years and they fulfill mainly a whole year's storage requirements. The treatment of fur farms waste waters is also gradually progressing through environmental permits.

The building costs of manure pits for 50 milk cows farm are about 50 000 euros as dry manure pit and 25,000 euros as sludge manure pit and waste water treatment system for milk room on such a farm costs about 12,000 euros. On a medium-sized fur farm water protection measures cost about 40,000 euros.

Water protection measures of animal husbandry are needed especially in the main channel of the River Kyrönjoki and in the catchment of Jalasjoki. The municipality of Jalasjoki is one of Finland's largest milk producers, whereas Ilmajoki and Vähäkyrö have very intensive pork production.

Water protection measures of **forestry** focus on those forests, where at each time ditching, cutting and tilling is done. There is not one single cost-effective water protection method in forestry, so several methods are often used even in the same area. The required measures are planned case-specifically and the circumstances of the area influence significantly which methods are chosen.

The costs of water protection measures of forestry are in magnitude:

- sludge lagoons 10-20 e/ha
- overland-flow field 1,000-2,000 e/ha
- sedimentation basin 200-500 e a piece
- buffer zones 1,000-2,000 e/ha
- submerged weir 2,00-3,000 e a piece
- wetland 5,000-15,000 e a piece

Water protection measures of forestry

Table17. The efficiency, costs, and usage of water protection measures of animal husbandry and fur farming.

MEASURE	EFFICIENCY	COST	USAGE
optimal feeding of animals	very efficient	affordable	all targets
12 month manure pits	very efficient	rather expensive	all targets
waste water treatment of milk rooms	efficient	rather expensive	all targets
internal measures of fur farms	efficient	rather affordable	all targets
waste water treatment of fur farms	efficient	rather expensive	all targets

Table18. The efficiency, costs, and usage of water protection measures of forestry.

MEASURE	EFFICIENCY	COST	USAGE
working order	efficient	affordable	all targets
lightened tilling	efficient	affordable	all targets
overland-flow	very efficient	rather affordable	suited targets
sedimentation basins and -bins	rather efficient	ather affordable	all targets
buffer zones	very efficient	rather expensive	all targets
submerged weirs	efficient	rather expensive	suited targets
wetlands	efficient	rather expensive	suited targets

The use of dry closets in scattered settlement reduces the nutrient load to the water. Photo: West Finland Environment Centre

have largest significance in the headwaters of Kauhajoki, Seinäjoki and Jalasjoki, where water protection measures have altered water bodies.

The waste water treatment of **scattered settlements** and holiday housing requires intensifying at approximately 12,000 permanent real estates and at 3,000 summer cottages. In the choice of method the prevailing circumstances have an essential role in addition to costs. On the basis of cost-benefit analysis it is worthwhile almost always to connect to a sewer network where it is possible. The next best alternative usually is building a communal purification plant, if the neighbor areas are close enough. When a property specific method is chosen, the targets soil and slope circumstances play a significant role in choosing a method.

Waste water treatment costs of scattered settlements in a five-people-family are in magnitude:

- dry closet and treatment of washing waters 1,000-2,000 e/household
- connecting to a sewer 3,500-5,000 e/household
- communal purification plant 3,000-5,000 e/household
- land treatment 4,000-6,000 e/household
- land treatment intensified with phosphorus removal 5,000-7,000 e/household
- small sewage- and batch treatment plant 6,000-8,000 e/household

Waste water treatment of scattered settlements is emphasized to areas, which have a low sewerage rate. Areas like this are for instance Kvevlax, Ylistaro, Jalasjoki and the region of Peräseinäjoki.

MEASURE	EFFICIENCY	COST	USAGE
dry closets	very efficient	affordable	suited targets
connecting to sewer network	very efficient	rather expensive	suited targets
communal purification plants of villages	efficient	rather expensive	suited targets
land treatment	rather efficient	rather affordable	suited targets
land treatment intensified with phosphorus removal	efficient	rather expensive	suited targets
small sewage and batch treatment plants	efficient	expensive	suited targets

Table 19. The efficiency, costs, and usage of water protection measures of scattered settlements.

11. SUMMARY OF PUBLIC PARTICIPATION AND INFORMATION

This Management Plan for the River Kyrönjoki catchment has been developed in cooperation with the River Kyrönjoki Work Group working under the delegation of the River Kyrönjoki. The work was conducted during the years 2004-2005. The organization of the River Kyrönjoki co operation is presented in figure 19. The following organizations have participated in the development of the Management Program, and especially the Program of Measures:

- municipalities of the catchment
- fishery areas of the catchment
- Employment and Economic Development Centre / agricultural department
- Employment and Economic Development Centre / fisheries department
- forest authorities
- regional councils
- agricultural advisory services
- Union of Agricultural Producers and Forest Owners / South Ostrobothnia and Ostrobothnia
- associations of nature protection
- Water protection association of Ostrobothnia
- West Finland Regional Environment Centre

Some mostly technical comments have been received about the Management Program. Basic Analysis and these comments have been taken into consideration in the content of the Basic Analysis. Many comments have been received in the preparation of the Program of Measures, because the planning was a collaboration of the representatives of agriculture, fishery and point source polluters in addition to the Environment Centre. Representatives of the work group have been unanimous about the proposition.

The documentation is available for everybody at the web pages of the West Finland Environment Centre since September 2005 and these documents will be adjusted, when the actual Management Plan of Western river basin district will be prepared between 2006 and 2008.

Then official public participation and hearing concerning the planning of water management will be followed.

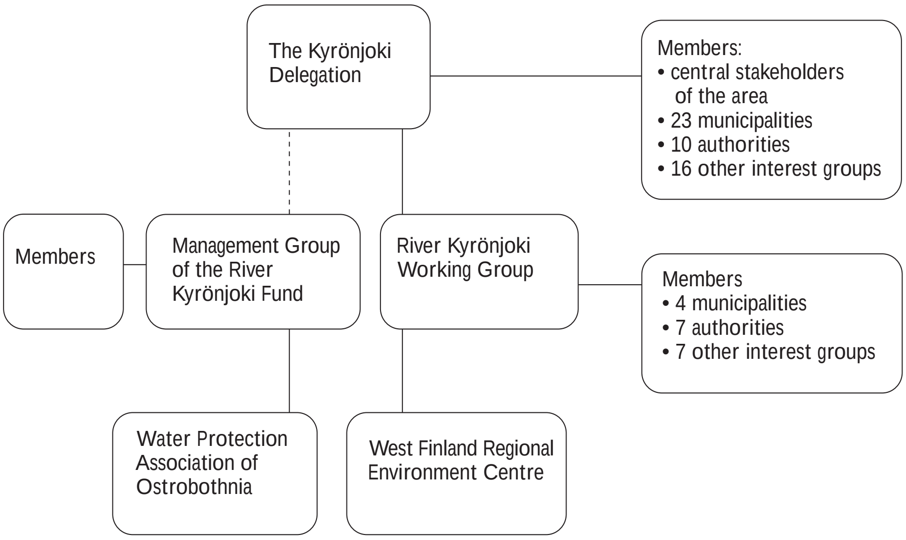


Figure 19. The organisation of Kyrönjoki co-operation.

Literature

Erviö, R. 1975: Kyrönjoen vesistön rikkipitoiset viljelysmaat. Maatal. tieteellinen aikakirja 47.

Etelä-Pohjanmaan metsäkeskus 2003: Vuosikertomus 2002.

Etelä-Pohjanmaan agronomit r.y. 2003: Etelä-Pohjanmaan maatalous 2002.

Heikkilä, R. 1999: Human influence on the sedimentation in the delta of the river Kyrönjoki, Western Finland. Monographs of the Boreal Environment Research No 15 .

Hudd,R. & Kålax P. 1999: Fiskyngelförekomst och fiskbestånd i Kyro älvs mynning 1980-1997. Miljön i Finland 293.

Lag om hållbart skogsbruk. Finlands författningssamling 1093/1996.

Lax, H-G. Julkunen, M. Koivusaari, L. Koskenniemi, E. Latvala, J. Rautio, L. M. & Teppo A. 1998: Kyrönjoen tila ja vesistötöiden tarkkailu vuosina 1986 – 1995. Suomen ympäristö nro 252. Vaasa.

Lax H-G, Axell, M-B & Tuhkanen, J. 2004: Vattendragsarbetena i Kyro älvs nedre lopp, Slutrapport för de fysikalisk-kemiska och biologiska utredningarna. Regionala miljöpublikationer nr 352.

Lähetkangas, S. & Lakso E. 1995: Kyrönjoen happamoituminen ja happamuuden vähentäminen. Vesi- ja ympäristöhallituksen monistesarja nro 630.

Marttunen,M.(toim)1998: Vesiensuojelun tavoitteet vuoteen 2005. Vaihtoehtoisten kuormitustasojen vaikutukset sisävesissä. Suomen ympäristö nro 160, Helsinki.

Metsälaki, Suomen asetuskokoelma 1093/1996.

Miljöskyddslagen, Finlands författningssamling 86/2000.

Rautio, L.M. & Ilvessalo H. (toim) 1998: Ympäristön tila Länsi-Suomessa/Miljöns tillstånd i Västra Finland. Gummerus, Jyväskylä.

Savea-Nukala, T., Rautio, L.M. & Seppälä, M. 1997: Kyrönjoen tila ja vesiensuojelun taso. Alueelliset ympäristöjulkaisut 16, Vaasa.

Sivil, M. 1997: Kyrönjoen vaellussiian lisääntymisalueet ja nousuesteet. Länsi-Suomen ympäristökeskuksen moniste 13/1997, Vaasa.

Vattenlagen, Finlands författningssamling 264/1961.

Vesilaki, Suomen asetuskokoelma 264/1961.

Ympäristöministeriö 1998: Vesiensuojelun tavoitteet vuoteen 2005/Målen för skydd av vattnen fram till år 2005, Suomen ympäristö nro 226, Helsinki.

Ympäristöministeriö/Miljöministeriet 2005: Itämeren ja sisävesien suojelun toimenpide-ohjelma/Handlingsprogram för skydd av Östersjön och inlandsvattnen-
Suomen ympäristö 771. Helsinki.

Ympäristönsuojelulaki. Suomen asetuskokoelma 86/2000.

Österholm, P & Åström, M. 2002: Spatial trends and losses of major and trace elements in agricultural acid sulphate soils distributed in the artifically drained Rintala area, W. Finland, Applied Geochemistry 17.