Foreword

This report is a part of the BERNET-Catch project where every involved partner prepares a program of measures and a subsequent provisional Water Management Plan (WMP) according to the EU Water Framework Directive (WFD). This current plan constitutes the provisional WMP for the River Stensån Basin located in South Sweden.

BERNET-Catch is a spin-off project from BERNET (Baltic Eutrophication Regional NETwork) that focuses on the integrated management of catchments and regional implementation of the WFD. BERNET was originally established to reduce eutrophication of the Baltic Sea and to support the aim of the Helsinki Convention in "assuring the ecological restoration of the Baltic Sea".

The WFD, implemented in the Swedish Environmental Code 2004, denotes the achievement of "good ecological status" for rivers, lakes and costal waters by the year 2015. Use of water must be sustainable and the protection of groundwater ensured. Measures performed within the WFD are regulated by the order SFS 2002:660.

The implementation of the WFD implies demands on a more formalized waterworks compared to what has been done in Sweden up until today. In 2004, five County Administrations were assigned to form Water Authorities to be responsible for the planning in each district. The Environmental Protection Agency and the Geological Survey of Sweden have been assigned to form statutes and official advice that will govern further work with water management in Sweden. The statutes are to be official and possible to use during 2006.

Lukas Österling, Anna Hagerberg and Lars Ohlsson, Arne Joelsson, Lars Stibe, Börje Nilsson, Marie Eriksson, Jonas Svensson and Johan Hamringe have prepared the report. It should be noted that suggested measures within this WMP for River Stensån basin do not constitute measures that are firmly anchored or decided among authorities, municipalities and stakeholders in the area.

View of the Laholm Bay. Photo L. Ohlsson

Situation of the River Stensån Basin.

Introduction

A Water Management Plan (WMP) is, a holistic document covering the water works within each water district and in which plan includes all moments incorporated in water management. It shall include a description over the district, an analysis of pressures, an economic analysis, environmental objectives within the district, results from surveillances, measures taken plus a summary of the Program of measures. The WMP is not a fixed document but rather a cyclic policy document that is reconsidered and adjusted every 6th year.

Overall, the WMP according to the WFD outlines, include a summary of the authorities' intentions and has three central functions. First, it should act as a base of knowledge for all stakeholders in work and decision making regarding water and what affects the water. Secondly, it should act as a source of information communicating the public and users of water, and thirdly, it should act as a report to the Swedish Environmental Protection Agency (SEPA) and furthermore to the commission.

In Sweden, the SEPA and the Geological Survey are still working with the national statutes that states how the Swedish Water Authorities shall report to the European commission. So far, a "Handbook chapter" is available at the SEPA but only in the form of draft. Moreover, since the River Stensån basin in this project is seen as a whole "district", the WMP simply reflects all measures taken or proposed therein. In future reporting, the River Stensån basin should be included as a part of the total Westerly Swedish water district. Suggested measures will then be described and economically analyzed in relation to the whole Westerly district.

The WMP for the River Stensån basin, as produced within BERNET-Catch, can therefore not be seen as a document that represents a general example on how a general Swedish WMP might appear in the future. Above that, this WMP has several other shortcomings , which we would like to address for the future work and commitments focusing on the regional implementation of the WFD in Sweden:

- Chemical and biological data is little in the "agricultural" part of the river. Monitoring is presently, and has earlier been, focused on the acidified area of the basin and not the eutrophicated part. This in combination with a lack of nationally stipulated reference conditions makes judgments of "ecological status" rather uncertain on a total basis.

- The report lacks risk-assessment analysis. The majority of the suggested measures aim to reducing the transportation of excess nitrogen to the Laholm Bay. It is however not estimated what the reduction of the land-based transportation of nutrients is needed to reach the proposed quality factors for "good status" in the Laholm Bay. Such estimations would have a high potential to support the future prioritizing of measures in the area.

- Due to the historical and present abundance of high quality waters, Sweden has little knowledge when it comes to "the value of waters". The economic analysis is therefore incomplete due to the uncertainty in the pricing of water services.

- The economic figures are also uncertain when it comes to the pricing of measures. Rates of subsidies for specific measures in agriculture are fixed per hectare but the net costs for the landowner in potential crop-decline are more difficult to obtain. It is also uncertainties in how much each measure is able to decrease the transportation. Regarding the costs for the measures in forest areas, there are no estimates at present. In this report, presented figures for costs and cost efficiencies should therefore be considered as very rough estimates.

- The question of how co-operation and the democratic process should be carried out, as well as river basin management on a district level, part district level and river basin level, is not yet clear as national guidelines are missing. The municipalities, existing river-based organizations as well as other actors such as The Federation of Swedish Farmers will probably play key rolls in future water basin management.

1 General characteristics

View of the Laholm Bay. Photo J. Hamringe

1.1 Laholm Bay basin

The Laholm Bay receives water from a 10 100 km^2 drainage basin. Land use in the basin is dominated by forest. Arable land accounts for 12 % of the area. The most intense agriculture takes place on the coastal plain where leakage prone soils and high precipitation result in the abundant leakage of nitrogen.
The River Stensån is the southernmost of five rivers that drain the basin and constitutes 3 % of the total area. The other four rivers are Nissan, Fylleån, Genevadsån and Lagan.

1.1.1 Laholm Bay

The Laholm Bay, in the southwest of Sweden, is fairly shallow (mean depth 12 m) with a maximum depth of 20 m. The mouth of the bay is wide and without a sill. The bay is considered a transport bottom with no continuous sedimentation of fine material. Most of the time a marked halocline prevents saltier water from mixing easily with surface water, making this an area sensitive for eutrophication. The entire bay belongs to a type called "Coastal waters south of Halland and north of Öresund".

In Sweden, the Laholm Bay has for many years been a symbol for coastal eutrophication. The effects, resulting in massive macro-algae blooms, were first observed in the 1970's. Since the 1980's the bay regularly experiences intensive phytoplankton blooms, and subsequent oxygen depletion in the bottom water. Nitrogen is regarded as the limiting nutrient for primary production in the Laholm Bay as well as in the open Kattegat.

Although there has been a massive focus on the environmental conditions of the bay, the transport of nitrogen to the bay has not decreased and problems caused by eutrophication remain unsolved.

1.2 River Stensån basin

The River Stensån basin surrounds an area of approximately 284 km^2. It stretches some 33 km from the coast and has an average breadth of 8 km. River Smedjeån bound the river basin to the north, which is a contributory to the River Lagan. In the south, the Hallandsås ridge forms a boundary to the River Rönneå basin.

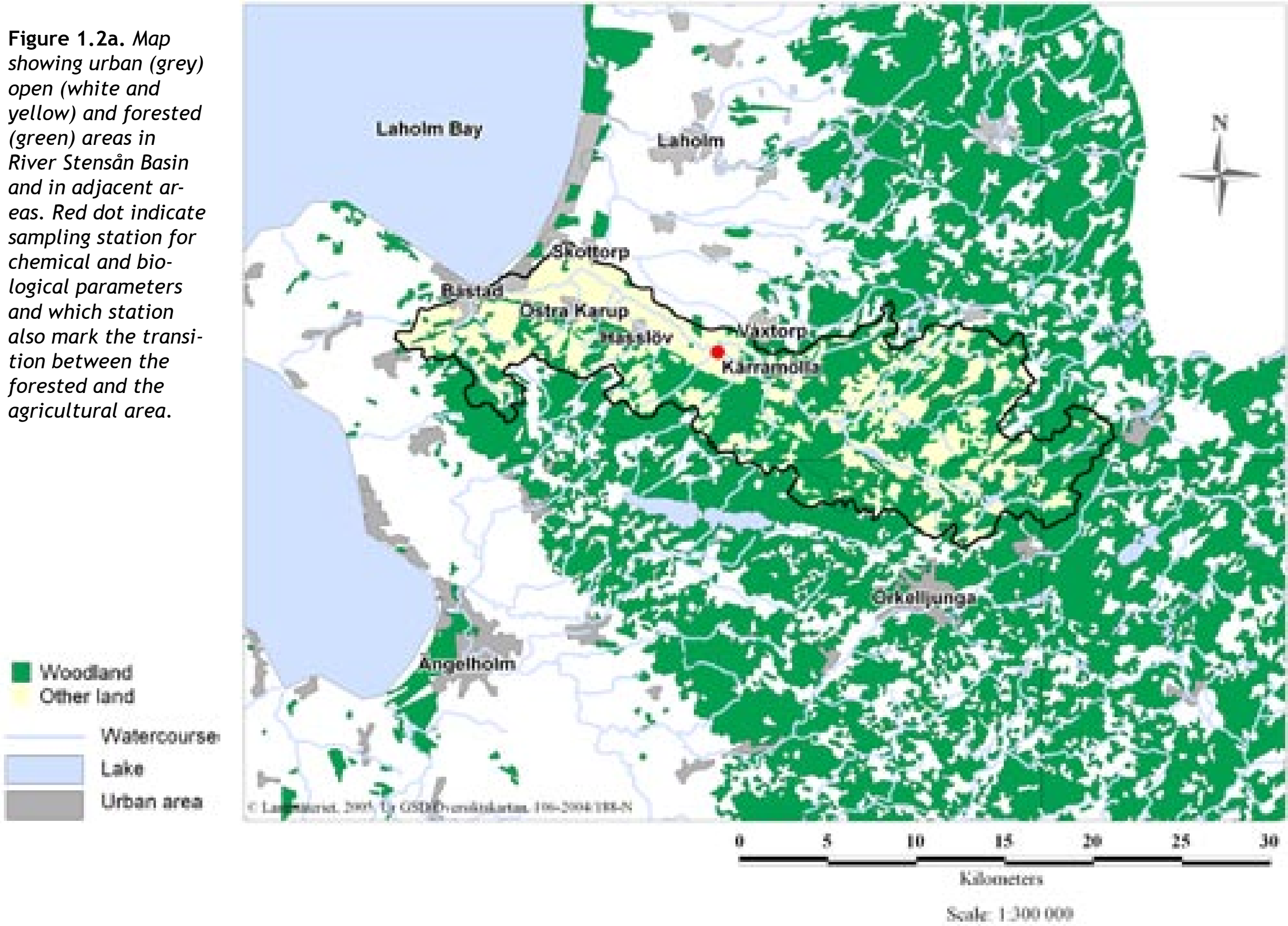
The River Stensån basin is divided between two counties, Halland and Skåne, and four municipalities,Lahol m,Båstad, Örkelljunga and Ängelholm.

1.2.1 Topography, landscape and soil types

The lower section of the basin belongs to the coastal plain. Topography is dominated here by the immediate transition to the Hallandsås ridge, a horst-formation with a mean height of 150-175 m above sea level. In the upper section of the basin, the Hallandsås ridge gradually flattens out. The terrain is more undulating, consisting of small hills and valleys as well as mires and lakes. The highest altitude is 192 m.
Moraine from the last glaciation is the dominating

Figure 1.1. *The drainage basin for the Laholm Bay divided into the five river basins.*

Figure 1.2a. *Map showing urban (grey) open (white and yellow) and forested (green) areas in River Stensån Basin and in adjacent areas. Red dot indicate sampling station for chemical and biological parameters and which station also mark the transition between the forested and the agricultural area.*



soil in the sections above the highest coastline (65 m). Fluvio-glacial gravel occurs primarily in the middle and upper sections of the basin. The coastal plain is made up of sand and coarser, which are covered by clay. In a few places, the clay comes out to the ground, but is primarily covered by a layer of sand.

Figure 1.2b. *River Stensån seen on the coastal plain, near the river mouth. In the background, Laholm Bay, Hallandsås ridge and the city Båstad can be seen.*

1.2.2 Land use, population and wastewater

Forest dominates the land use and arable land accounts for 26 % of the basin. There is a distinctive difference in land use between the upper forest dominated section and the coastal plain, which is an agricultural district. Land use on the Hallandsås ridge is mainly forest. Characteristic for the basin is a low percentage of lakes, which account for only 1 % of the area.

6 500 inhabitants populate the area, which corresponds to 23 inhabitants per km^2, of which a slight majority live in urban areas. Båstad is the largest town. However, the western part of the town is located outside the River Stensån basin.

Inhabitants of the urban areas discharge their wastewater to the Hedhuset wastewater treatment plant (WWTP). After treatment, the water is discharged via a pipe directly into the sea, therefore avoiding the River Stensån. Wastewater from sparsely built-up areas is treated in private establishments. There is no industrial discharge of any significance in the River Stensån basin. However, the E6 highway crosses in a north-south direction, approx. 4 km from the coast.

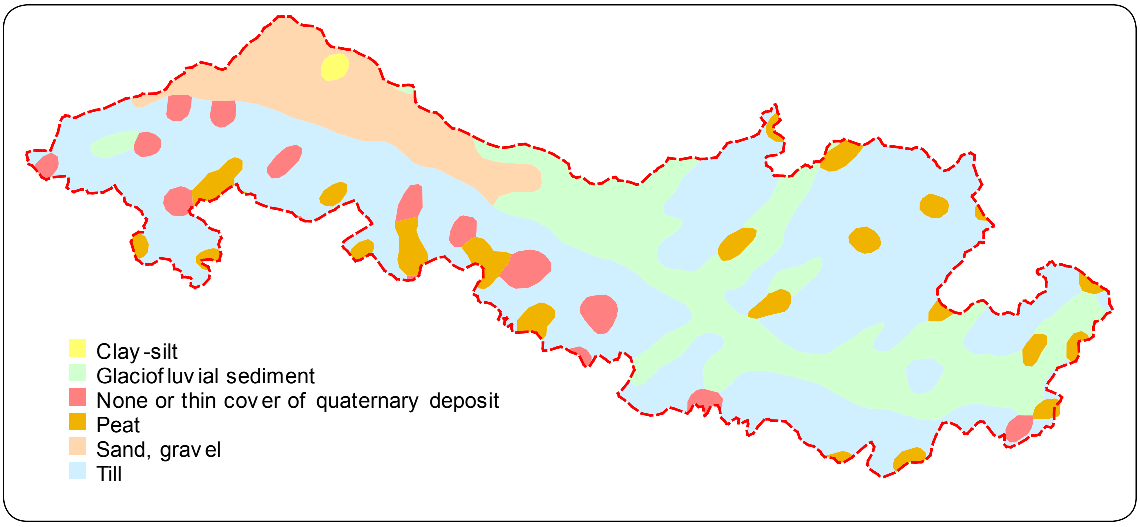


Figure 1.2.1. Simplified quaternary map over the River Stensån catchment.

1.2.3 Agriculture and forestry

Agriculture primarily focuses on fodder production and animal husbandry. Therefore, 73 % of the arable land is used for ley. This is especially evident in the transitional zone, where the coastal plain meets the upper forest dominated section. Spring cereals, accounting for 19 % of the arable land, often follow on ley. The share of catch crop is high and more than 80 % of the total arable land is winter green.

On the coastal plain, the sandy soils also provide favorable conditions for potatoes and vegetables. However, compared to other small basins within the Laholm Bay basin the total share of crops prone to leakage, e.g. potatoes, is low and the share of ley high in the River Stensån basin (Table 1.2.3a).

The trend of fewer farms that grow larger is obvious in the basin. Today there are 272 farms registered, which is half as many that existed in 1974. During the same time the total area of arable land is unchanged, 7 400 ha.

Livestock amounts to 6 200 livestock units (LU), which equals an animal density of 0.83 LU/ ha farmland. Cattle make up 71 %, pigs 15 % and other livestock 14 % of the LU. There has been a marked reduction in animal density during the last few decades (Figure 1.2.3b).

Table 1.2.2 *Key characteristics including land use for the River Stensån and Laholm Bay basin.*

Key characteristics	**River Stensån basin**	**Laholm Bay basin**
Basin area (km^2)	284	10100
Population		
Inhabitants	6500	118000
Density (inh./km^2)	23	12
Land use (%)		
Forest[1]	46	57
Arable land	26	9
Pastures	5	2
Urban areas	2	2
Inland waters	1	7
Other land use[2]	20	22
Crop distribution (%)		
Ley	72	74
Spring cereals	18	22
Winter cereals	3	4
Fallow area	2	3
Potatoes	2	1
Flow (m^3/s)		
Mean flow (MQ)[3]	4.78	130
Mean high water (MHQ)	16.0	
Mean low water (MLQ)	0.73	
Lowest water (LLQ)	0.05	
Climate		
Precipitation (mm)	700-1000	
Discharge (mm)	530[4]	
Temperature (C°)	7[5]	
River-transport (ton)[6]		
Nitrogen	415	4900
Phosphorus	7.1	113

[1] *Forest is in the statistics defined as land suitable for producing timber and wood yields.*
[2] *Includes mires and land unsuitable for producing timber and wood yields.*
[3] *Data SMHI's puls-model for river mouth (Riviera), 1974-2004*
[4] *1974-2004*
[5] *Field station north of the basin (mean from Knäred and Genevad)*
[6] *Mean 1972-2004, excluding WWTP Hedhuset*

Figure 1.2.3a. *Crop distribution in the River Stensån basin.*

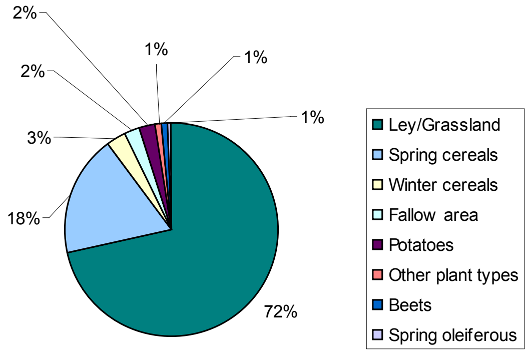


Figure 1.2.3b. *Changes in animal density between 1974, 1992 and 2000.*

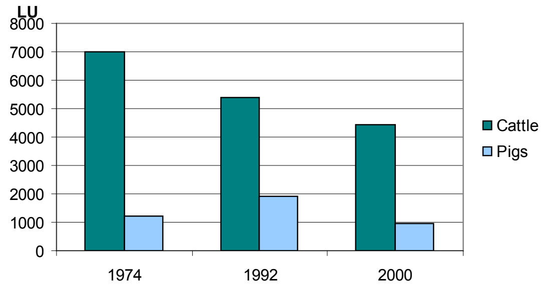
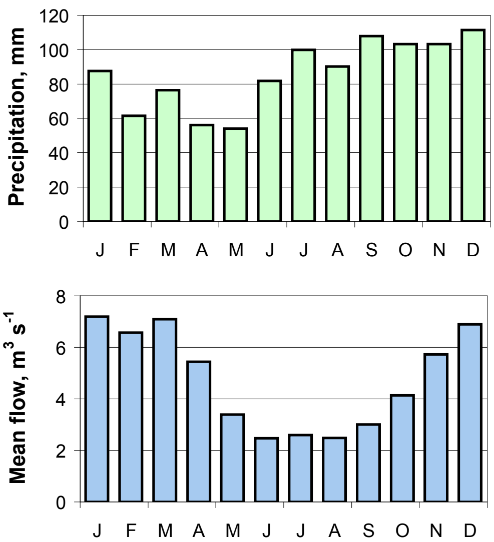


Figure 1.2.4a-b. *Monthly precipitation (upper figure) at the field station Baramosse situated at Hallandsås ridge, 9 km from the coast (1973-1980) and (below) monthly mean flow in the River Stensån at the river mouth.*



There are no specific numbers presented for the composition of forest in the basin; but noticeable is a high percentage of spruce (Table 1.2.3c). During the past decades, almost no plantation besides spruce has been made. Spruce is preferred, due to growth rate and as it is less sensitive to damage caused by wild animals. However, spruce forests in the south of Sweden create a biologically poor environment as they almost totally lack undergrowth. The Hallandsås ridge is still partly covered by deciduous forest, primarily beech.

1.2.4 Climate, discharge and flow

The climate is characterized by the maritime location and prevailing westerly winds. Mean annual air temperature is approximately 7 ˚C. The coldest month is usually January and the warmest July. The precipitation in region is among the highest in Sweden. In the upper section, the annual precipitation often exceeds 1000 mm/yr. On the coastal plain, the precipitation is lower, approximately 800 mm/yr. The discharge in the basin is approx. 530 mm/yr.

Annual mean flow is approximately 4.8 m³/s at the river mouth. Low flow often occurs in early summer and high flow in late autumn or in winter. The flow rate varies greatly in the River Stensån due to the influence of the Hallandsås ridge and the scarcity of lakes. Several floods occur annually, especially in the canalized stretch on the coastal plain, where adjacent farmland is submerged.

1.2.5 Watercourses and lakes

The River Stensåns source-area is in a forested area close to Skånes Fagerhult. Smaller source lakes are in two tributaries to the lake Vemmentorpasjön. The River Stensån then runs at the foot of the northern slope of the Hallandsås ridge, through the Lake Sjöaltesjön, via farming districts out into the Laholm Bay in Båstad. The largest tributary is the River Lilla Stensån, which flows together with the River Stensån in Stackarp. There are however an additional number of tributaries e.g., Klippebäcken that comes from the Hallandsås ridge mire- and well-forested lands.

River Stensån is preliminary split into ten river water

Table 1.2.3b. *Consumption of commercial fertilizer, manure and pesticides per hectare arable land in the Halland County compared with all of Sweden. There are no specific statistics for the River Stensån basin*

	Halland County (kg/ha)		Sweden (kg/ha)	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Commercial fertilizer only,	100	17	104	17
Commercial fertilizer + manure	135	39	135	37
Pesticides	0.75		0.79	

	River Stensån	River Genevadsån	River Smedjeån
Ley	73 %	39 %	40 %
Potatoes	2.5 %	3.3 %	7.8 %

Table 1.2.3a *Proportions of ley and potatoes out of the arable land in the River Stensån basin 2000 compared to two other small river basins within the Laholm Bay basin.*

bodies, four in the main stream and six tributaries (Figure 1.2.4c). The catchment size limit of 10 km² means that some small streams, with documented high biological values, are excluded so far. Four river types are identified based on ecoregion/altitude, geology and catchment area (Table 1.2.5a). No water body is designated as being heavily modified.

The total number of lakes and ponds is about 275. Many of the small ponds are artificial (e.g. marl ponds and fishponds). Twenty of the lakes are larger than one hectare, and only two are larger than 0.5 km². In this project, a size limit of 0.25 km² is used, reducing the number of lakes to four. We lack water chemistry data as well as information on morphometry for a vast majority of the smaller lakes and ponds in the River Stensån basin. Four lake types are identified based on ecoregion/altitude, geology, lake size and depth (Table 1.2.5b).

Table 1.2.3c. *Forest type and age distribution in the municipality of Laholm, 1991.*

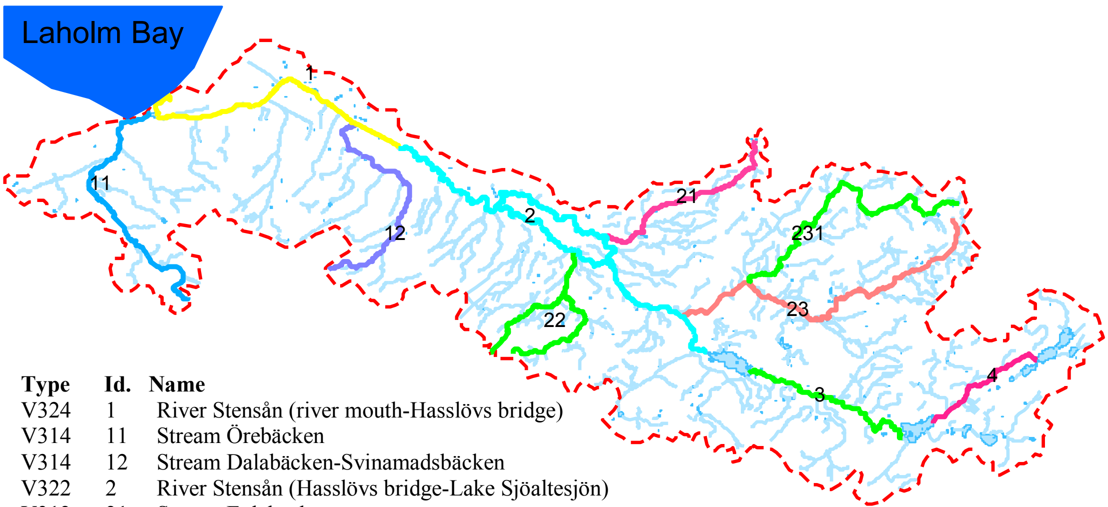
Forest type	**Age 0-30years %**	Age >30years %
Spruce	76	28
Pine	4	30
Deciduous forest - Hardwood species	0	13
Deciduous forest - Softwood species	4	11
Mixed forests	16	19

Table 1.2.5a. *Description of river types.*

River type	**Ecoregion/ altitude**	**Geology**	**Catchment (km²)**	**Number of water bodies**
1 (V312)	Central plain	Humic	10-100	6
2 (V314)	Central plain	Humic/ calcareous	10-100	2
3 (V322)	Central plain	Humic	100-1000	1
4 (V324)	Central plain	Humic/ calcareous	100-1000	1

Table 1.2.5b. *Description of lake types.*

Lake type	**Ecoregion/ altitude**	**Geology**	**Lake size (km²)**	**Depth (m)**	**Number of lakes**
1 (S3112)	Central plain	Humic	<0.5	<3	>190
2 (S3212)	Central plain	Humic	<0.5	>3	<10
3 (S3112)	Central plain	Humic	0.5-2	<3	2
4 (S3113)	Central plain	Calcareous	<0.5	<3	50-75



Type	**Id.**	**Name**
V324	1	River Stensån (river mouth-Hasslövs bridge)
V314	11	Stream Örebäcken
V314	12	Stream Dalabäcken-Svinamadsbäcken
V322	2	River Stensån (Hasslövs bridge-Lake Sjöaltesjön)
V312	21	Stream Eglabäcken
V312	22	Stream Klippebäcken
V312	23	Stream Lilla Stensån
V312	231	Stream Linghultsbäcken
V312	3	River Stensån (Sjöaltesjön-Lake Vemmentorpasjön)
V312	4	River Stensån (Lake Vemmentorpasjön-Lake Vitasjö)

Type	**Id.**	**Name**
S3112	L1	Lake Sjöaltesjön
S3112	L2	Lake Vemmentorpasjön
S3112	L3	Lake Svartasjö
S3112	L4	Lake Vitasjö

Figure 1.2.5c. *The preliminary river water bodies larger than 10 km² and lakes larger than 0.25 km² in the River Stensån basin.*

Table 1.2.5d. *Fish species caught by electro fishing in River Stensån and gillnet fishing in the four largest lakes.*

River Stensån	
Anguilla anguilla	European eel
Esox lucius	Northern pike
Lampetra fluviatilis	European river lamprey
Lampetra planeri	European brook lamprey
Leucaspius delineatus	Belica
Perca fluviatilis	European perch
Phoxinus phoxinus	Eurasian minnow
Salmo salar	Atlantic salmon
Salmo trutta	Brown trout
Lakes	
Abramis brama	Carp bream
Esox lucius	Northern pike
Gymnocephalus cernuus	Ruffe
Perca fluviatilis	European perch
Rutilus rutilus	Roach
Scardinius erythrophthalmus	Rudd
Tinca tinca	Tench

Figure 1.2.5e. *There are genuine strains of salmon and trout in the River Stensån. This salmon is one of approximately 100 salmon caught every year in the river by anglers. Photo Per Ingvarsson.*

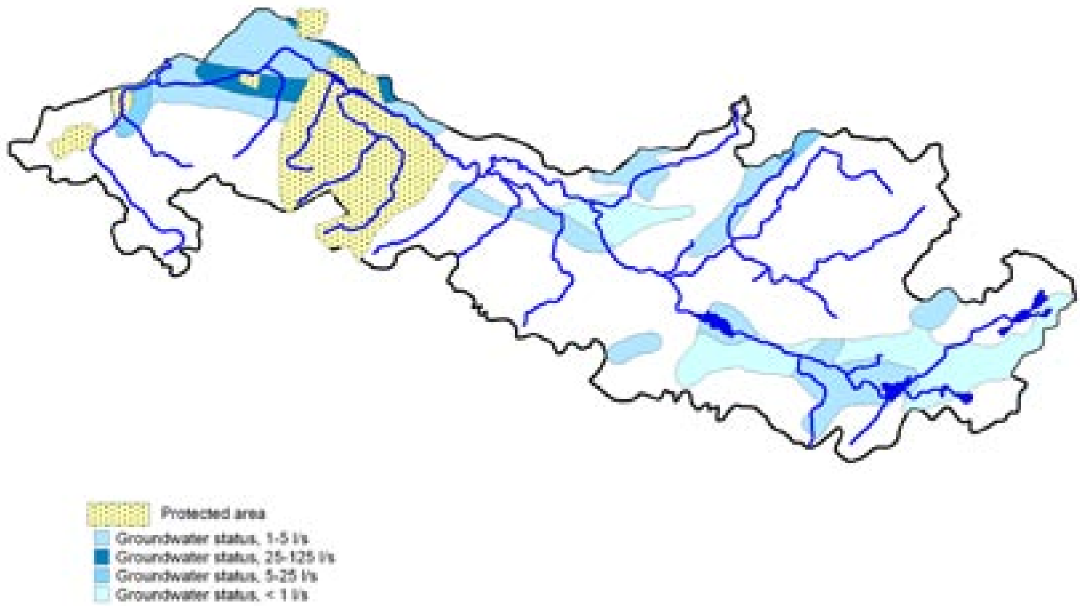
Biological values

The River Stensån holds genuine strains of salmon and trout. The salmon is infected by the parasite Gyrodactylus salaris, which probably negatively affects the abundance of parr. Besides salmon, river lamprey and belica are included on the Swedish red list of endangered species.

Based on monitoring in the River Stensån and some not acidified small tributaries, the benthic fauna is classified as rich and diverse. The total number of species/taxa varies between 45 and 55. Red listed species are normally found.

According to old observations, thick shelled river mussel, Unio crassus, and pearl mussel, Margaritifera margaritifera, was found in the main river and the Stream Lilla Stensån. During the last investigation, only one individual of pearl mussel was found. Mussels have generally been very negatively affected by acidification, eutrophication and physical modification.

Figure 1.2.6. *Potential for abstraction of groundwater and water protection areas. For Dömestorp, the area marked is the proposed outer water protection area.*



2. Pressures and environmental status

Crayfish, Astacus astacus, occur in very scarce population, mainly in the upstream parts. The population has probably suffered from acidification. Parasitic mould constitutes a potential threat to the remaining crayfish. The signal crayfish, Pasifastacus lenicussculus, which has been put out for breeding in neighboring water systems, spreads the mould.

1.2.6 Groundwater

The coastal plain is made up of fluvial deposits as wave washed sand, fine sand and coarser. An immense layer of gravel has been superposed by a layer of clay on the coastal plain of Laholm. Groundwater in this layer is greatly used for municipal water supply (Figure 1.2.6). On top of this lies sand, therefore forming separate groundwater storages, where even the top one can contain considerable amounts of groundwater. Not much is known today about the location and boundaries of the aquifers. However, the new surveys indicate that the part of the coastal plain that belongs to the River Stensån basin is part of one big aquifer underneath the layer of clay.

In sections above the highest coastline, where moraine soils are dominating, there are other types of aquifers. Hallandsås is a rock ridge with gneiss as the dominant rock type. The rock contains much groundwater, which leads to high water pressure.

2.1 Pressures

Although the River Stensån holds high biological values, there are a number of pressures that might prevent compliance with "good ecological" status in a number of water bodies (Table 2.1). The two major environmental problems in the region are the acidification of lakes and streams and the eutrophication of the coastal waters, as well as the groundwater. Land use, atmospheric deposition and physical modifications are the main pressures.

One of the largest construction sites in Sweden, the railway tunnel through the Hallandsås ridge, is partly situated in the basin.

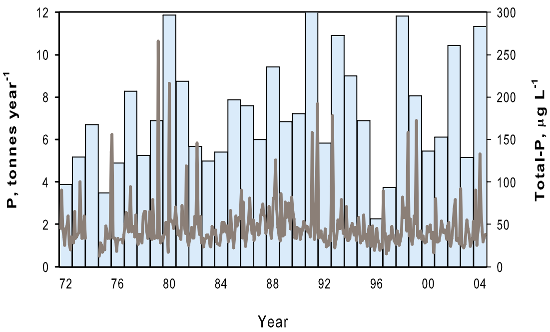
2.1.1 Eutrophication

When looking at eutrophication in the Laholm Bay and the open sea, nitrogen is the limiting substance (Fleischer 1989). Since there are little problems with eutrophication in the inland surface waters, focus will mainly be on nitrogen as opposed to phosphorus. A major difficulty is that most emissions occur from diffuse sources, which are more complicated to deal with than point sources. A comprehensive program of measures was implemented in 1988 to reduce the transport of nitrogen into the Laholm Bay (see 6.1.1). The retention of nutrients is likely to be small, especially on the coastal plain where there are no lakes and few wetlands.

	Coastal water The Laholm Bay	Lakes	River Stensån upstream Kärramölla	River Stensån downstream Kärramölla	Tributaries upstream Kärramölla	Tributaries downstream Kärramölla	Groundwater
Eutrophication	Nitrogen						Nitrogen
Acidification							
Physical pressurres			River maintenance, Obstacle for migration	River maintenance,	River maintenance	River maintenance, Migration obstacles	
Abstraction of water						Irrigation (mainly gardening purposes) Tunnel construction	
Hazardous substances							Risk of pesticides, Risk of accidents with hazardous goods

Table 2.1. *Essential threats to the water resources of the River Stensån basin and the Laholm Bay. Kärramölla marks the transition between land dominated by forest and agriculture and is marked in Figure 1.2a.*

Figure 2.1.1aa. *River-transport and average concentrations of phosphorous to the Laholm Bay basin, 1972-2004.*



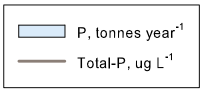
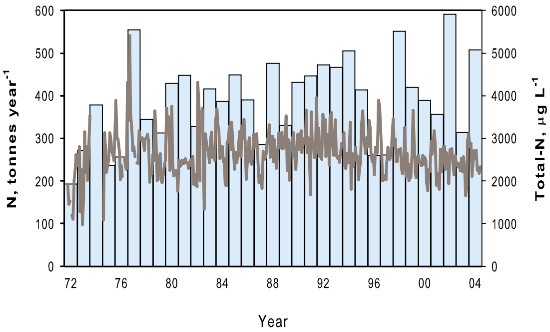


Figure 2.1.1ab. *River-transport and average concentrations of nitrogen to the Laholm Bay basin, 1972-2004.*



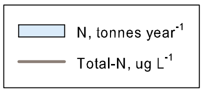
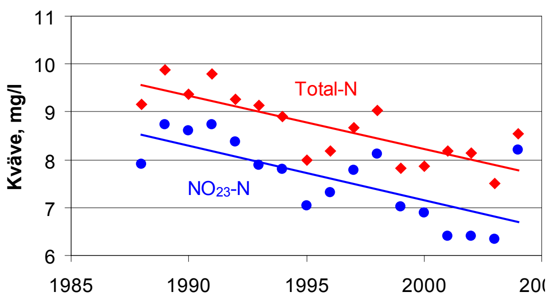


Figure 2.1.1b. *Trend in nitrogen concentration in Stream Menlösabäcken, an agricultural dominated tributary to River Smedjeån*



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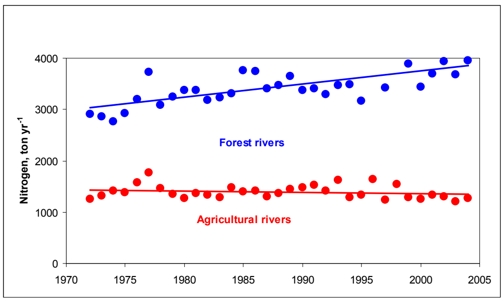
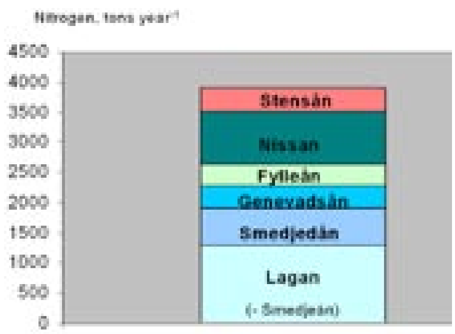


Figure 2.1.1d. *The river-transported anthropogenic nitrogen to the Laholm Bay, 1988-92, divided between rivers. The loading from the River Stensån basin (including the Hedhuset wastewater treatment plant) constitutes approximately 10 % of the total loading.*



Nitrogen loading

The total river-transport of nitrogen to the Laholm Bay varies between 2 300-7 700 tons/yr, and no decrease in transport has been observed from 1972 to 2004 (Figure 2.1.1a). In agricultural dominated sub-catchments in the region, there seem to have been a decrease in the leakage of nitrogen over the last decade (Figure 2.1.1b and c). This trend is not so obvious for phosphorus. Unfortunately, it seems like the leakage from the forest and "other lands" during the same time has increased (Figure 2.1.1c).

Anthropogenic loading from the River Stensån basin constitutes approximately 10 % of the total anthropogenic land-based loading to the bay (Figure 2.1.1d). Nutrient transports in the River Stensån show great variability, mainly depending on flow conditions. Since measurements started in 1972, the river-transport of nitrogen has varied between 200-600 tons/yr (Figure 2.1.1e). There is no obvious trend when looking at the whole period (Figure 2.1.1f). However, according to the flow adjusted nitrogen transport data, there seems to be a decreasing tendency since 1995, implying an 11 % reduction between 1995 and 2005. This trend is not statistically significant. River-transport is estimated to have decreased from 420 tons in 1995 to the actual load 370 tons.

A closer look at the matter shows that it is in the lower agricultural dominated section (downstream Kärramölla) that the reduction has taken place. In the forested section (upstream Kärramölla), the transport is unchanged during this period. Approx. 78 % of the total loading has anthropogenic origin.

Source apportionment

Diffuse sources

Agriculture is the main source of nitrogen and phosphorus, though it makes up a minor share of the land use (Figure 2.1.1f. and Table 2.1.1a). Annual leakage from arable land and pasture in the basin is approx. 281 tons of nitrogen and 7.6 tons of phosphorus. Leakage of nitrogen is 36.7 kg/ha arable land and for phosphorus 0.6 kg/ha arable land (Fritz, 1996). Since the nitrogen loading from the agricultural sector seems to be decreasing these figures might be lower today.

Annual leakage from the forest in the basin is approx. 66 tons nitrogen and 1.3 tons phosphorus. The figure 5 kg N/ha has been used to calculate the loading from forest and other lands. Directly after felling, the leakage can be ten times as high, culminating after two or three years.

Atmospheric deposition of nitrogen is included in the land-based loading. Nitrogen deposition in the region is 15-20 kg/ha. The high deposition, well above the critical load, is probably the explanation to the decreased leakage from forest and other lands. It is unknown how the accumulated nitrogen in the forest will affect the leakage in the future. Atmospheric deposition also contributes to leakage from agricultural land – but only to a minor extent. Assuming that use of manure and fertilizer is based on crop requirement, as is stipulated in the regional regulations, the deposited nitrogen will not increase the leakage during the growing season. During the rest of the year some of the deposited nitrogen will leak into the watercourses, roughly estimated 3 kg N/ha.

The deposition of nitrogen in the region well exceeds the local emissions to the atmosphere. Only 20-30 % of the nitrogen fallout in the municipality of Laholm originates from Swedish emissions (IVL 2004). Ammonia evaporation from the agriculture sector, the largest local emission to the atmosphere, has probably decreased with deceasing animal density. Nitrogen oxides from local traffic, lorries and machinery are other significant emissions in the area.

Point sources

Point sources only account for a minor share of the total nutrient load in the basin, 6 % of the nitrogen and 28 % of phosphorus (Table 2.1.1a). There are only few industries and none of them have separate discharges.

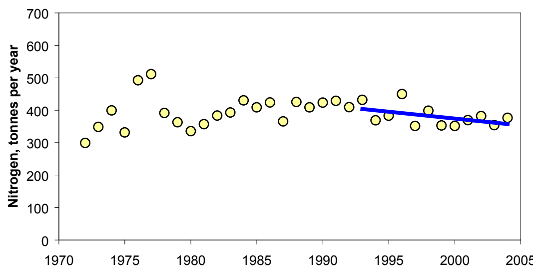


Figure 2.1.1f. *Flow adjusted transport of nitrogen in the River Stensån 1972-2004. The line indicates linear trend 1993-2004. It is in the agricultural dominated section, downstream Kärramölla that the transport of nitrogen has decreased.*

The tunnel through the Hallandsås ridge is a negligible source of nutrient substances.

An average of 15 tons N/yr and 400 kg P/yr are discharged from the Hedhuset WWTP annually. The average annual load is 10 000 PE, also including loading from outside the River Stensån basin. The outlet point for treated wastewater is situated in the Laholm Bay, 1 km from the shoreline. The level of treatment as well as the dependability of the plant is very high.

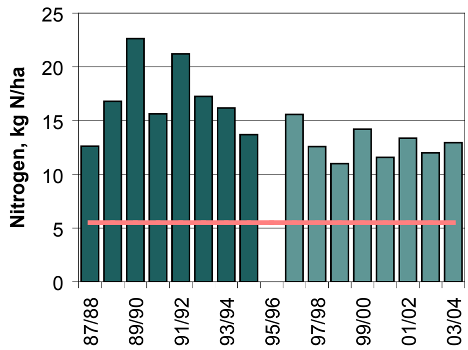


Figure 2.1.1g. *Atmospheric deposition of nitrogen (NO_x+NH_4-N) in spruce forest in the count of Halland. The red line indicates the expected deposition in 2010 if decided measures are implemented.*

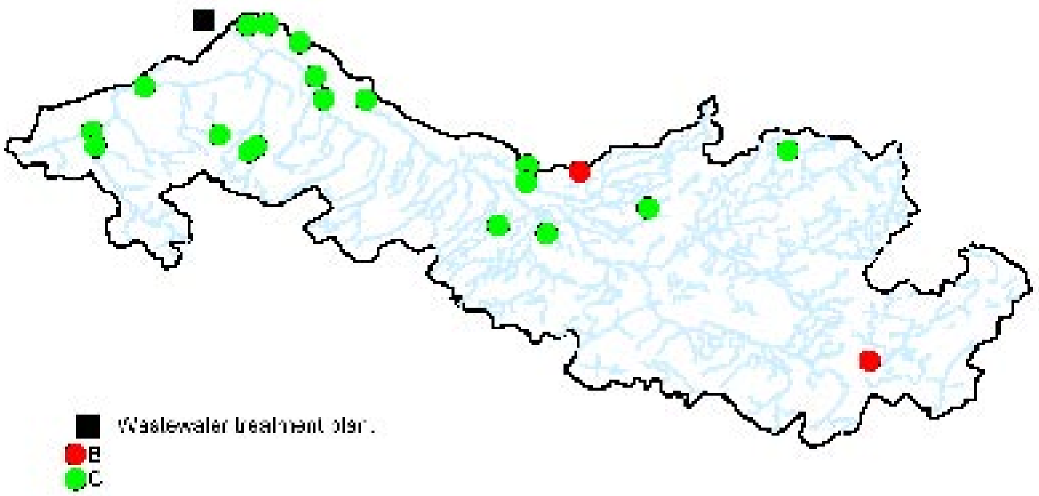
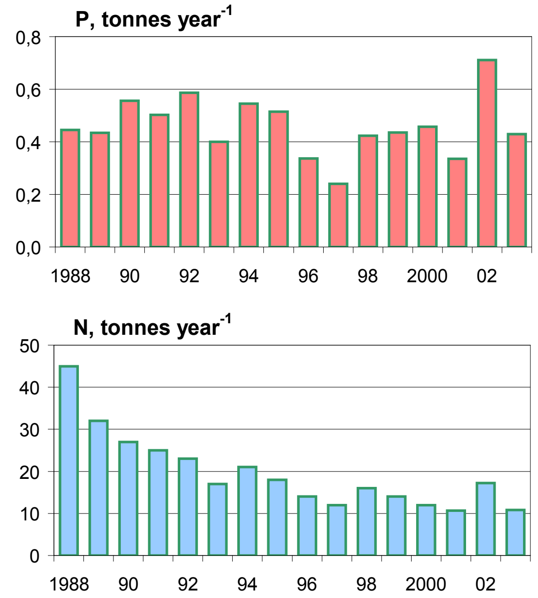


Figure 2.1.1h. Enterprises that holds B- and C-permits according to the Environmental Code.

Figure 2.1.1i. *Discharge of phosphorus and nitrogen from the Hedhuset wastewater treatment plant 1998-2003.*



Approx. 1 500 households have their own establishments for treatment of wastewater. Today the legalized requirements demands treatment of wastewater further than just sludge removal. New legislation will be implemented in Sweden during 2006 (see 5.1.1). The discharge of nitrogen within the River Stensån basin amounts to approx. 11 tons of nitrogen. There is an estimated retention of 50 % on this discharge before reaching the Laholm Bay. The discharge of phosphorus is approx. 2.5 tons, the second largest source of phosphorus. The discharges are a local problem to water status, e.g. in lakes and groundwater, rather than a pressure to the coastal water.

2.1.2 Acidification

The upper section of the basin has been severely affected by acid deposition, leading to decreased pH and increased inorganic aluminum, and damage on fish and macro fauna. To counteract the negative effects of acidification extensive liming is being carried out, see paragraph 5.3.

The deposition of sulphur is approx. 12 kg/ha, largely emanating from emissions abroad (70-80 %). Deposition has decreased due to restrictions of emissions in Europe (Figure 2.1.2) while deposition of nitrogen is still unchanged (Figure 2.1.1g). In total, acid deposition still exceeds the critical load, i.e. what is sustainable. In addition, forests have become more sensitive to acidification due to the intensity of forestry, e.g. with an increased cutting of branches and tops.

Acidification is a problem in the main river and in tributaries upstream of Kärramölla (Figure 1.2a). The lakes show stabile pH values between 6 and 7, but sometimes show weak alkalinity. pH and alkalinity in streams are generally satisfactory but they drop below critical levels at high flows. Several none-limed tributaries add to the main river downstream of Lake Sjöaltesjön, which also contribute to the unstable conditions. Despite this chemical variation, the biological values develop positively in the area.

Table 2.1.1a. *Sources of nitrogen and phosphorus in River Stensån basin including WWTP, divided on background and anthropogenic loading. No consideration ha been taken to retention on the waters way to the sea.*

	Nitrogen (tons/yr)			Phosphorus (tons/yr)		
Source	Total	Background	Anthropogenic	Total	Background	Anthropogenic
Forest	66	33	33	1.3	1.3	0
Arable land	272	37	235	4.4	0.7	3.7
Pasture	9	6	3	0.1	0.1	0
Other land use	35	15	20	0.6	0.6	0
Wastewater treatment plant	15		15	0.4		0.4
Deposition on lakes	3		3			
Private wastewater systems in sparsely populated areas	11		11	2.1		2.1
Storm water	3		3	0		0
Industries	0		0	0		0
Total	412	90	321	8.9	2.7	6.2

2.1.3 Physical pressures

Most watercourses and wetlands in the basin have at some point been subject to physical modifications, affecting the ecological status and the ability for self-purification. Straightening, deepening and damning are typical modification on watercourses.

On the coastal plain many small watercourses have also have been piped. Most wetlands have been drained to reclaim land for agriculture or forestry

The most significant physical modifications have taken place on the coastal plain, where only a fraction of the original wetlands still remains. Because of problems related to shifting-sand, the outlet-area was excavated as early as in the 16th century and in the 17th century moved south to the position of today. After continual problems with flooding, extensive physical modifications were carried out in 1925. The large shallow wetland called "Klarningen" in the riverbed, (Figure 2.1.3b.) was then replaced by a canal from Hasslöv to the rivers outlet.

In the forested section, the share of wetlands is higher. However, most of them have been subjected for some kind of human alteration.

River maintenance is still allowed in a number of watercourse stretches (Figure 2.1.3a and Annex II) to maintain the water level. Drainage societies carry out maintenance to an appointed appearance and depth given in the water rights. This can have a very negative affect on flora and fauna. During the last decades, the level of maintenance has been low in River Stensån.

Physical modification of lakes is considered negligible. The physical influence in the Laholm Bay is small and concentrated to a few harbors.

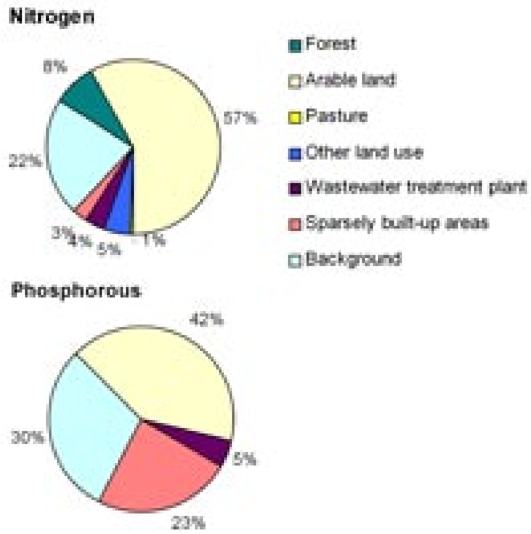


Figure 2.1.1f. *Source apportionment of the land based nitrogen (up) and phosphorus loading (down). Avvakta nya figurer från Lukas*

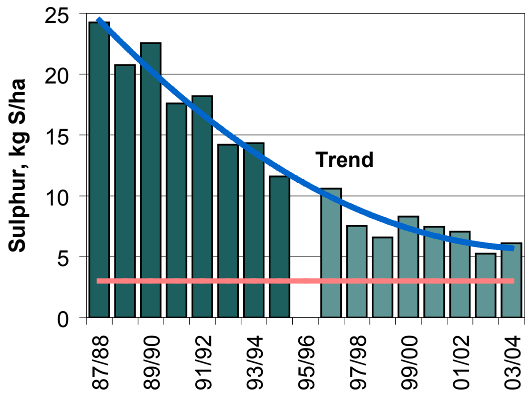


Figure 2.1.2. *Atmospheric deposition of sulphur (SO_4-S) in spruce forest in the count of Halland. The red line indicates the expected deposition in 2010 if decided measures are implemented.*

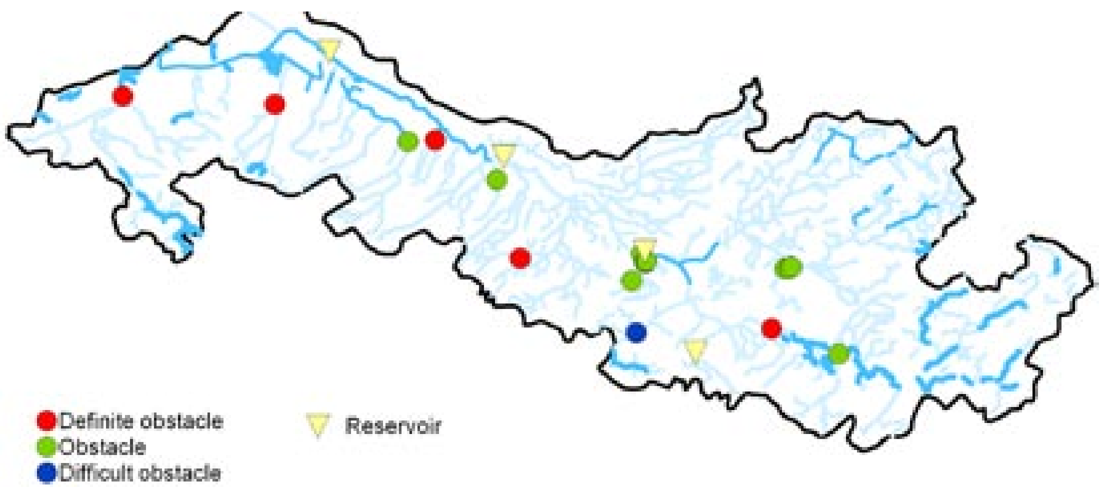


Figure 2.1.3a. *Obstacles for migrating fauna and drainage societies (marked with blue line).*

Figure 2.1.3b. *Map from 1814 showing how River Stensån on the coastal plain was a continuous system of wetlands, called Klarningen*

Figure 2.1.3c. *In the 1920´s the wetland systems were replaced by a canal.*

The river is regulated to a small extent, which is unusual in this region. Two old mills situated in the main river have turbines. These constitute partial obstructions for migrating fish. In the main river, fish can migrate upstream Lake Sjöaltesjön, where a mill constitutes a definite obstruction (Figure 2.1.3a). Several tributaries contain similar obstructions (culverts, dams). None of the mills or dams has water rights.

If the provisional master plan for Båstad Municipality is carried through, there will be extensive changes in the environment surrounding the River Stensån near the river mouth in the future (Figure 2.1.3d).

2.1.4 Abstraction of water

Water from two waterworks (Figure 1.2.6) supplies the urban areas within the basin, but also to some extent areas outside the basin, with drinking water. The potential for withdrawals of groundwater at the coastal plain is high. Annual withdrawals are presented in Table 2.1.4. The withdrawals from the waterworks are regulated in the water rights (see Annex II). The provisional master plan for Båstad Municipality estimates a population growth of 2000 people over a period of 20 years in the area surrounding the River Stensån, implying an increase in groundwater withdrawal for household consumption.

Figure 2.1.3d. *In a new, not yet decided, master plan for Båstad Municipality, land adjacent to River Stensån is suggested as industrial estate (purple) and residential area (brown).*

The population in the rural parts of the basin is supplied via separate wells. Groundwater from separate wells is also used in the agriculture sector, primarily for livestock, but also for irrigation.

The construction of the railway tunnel through the Hallandsås ridge has faced various difficulties, primarily because of the property of the rock. Above all a heavy leakage of groundwater has led to a consequently lowering of groundwater in the area around the tunnel.
According to a new water right given in 2002, the Hallandsås Railway project has the right to drain 100 l/s groundwater from the ridge during the construction period.

Groundwater was before led to the River Stensån, but now it is led directly to the Laholm Bay. Abstraction has today decreased (Table 2.1.4) and groundwater levels are fully recovered in several sections following the tunnels sealing work.

Surface water is largely used for irrigation, especially of potatoes (Table 2.1.4). Surface water is also used for the irrigation of gardens. The withdrawals cause problems, especially in the smaller watercourses during drought, since regulations (see Annex II) are not always followed

2.1.5 Hazardous substances

Hazardous substances (pesticides, heavy metals etc.) are discharged e.g. from wastewater plants, farms, industries and the transport sector. Some of the deposition is imported from sources outside the basin. Investigations carried out do not show any particular environmental effects in watercourses in the basins. Today investigations are only carried out on deposition and on groundwater at the public waterworks.

2.2 Assessment of the environmental status

In accordance with the Water Framework Directive, lakes, watercourses and coastal waters must achieve "good ecological status". This means that flora and fauna, physical-chemical and hydromorphological conditions must not appreciably deviate from what is regarded as the natural, unaffected conditions for the

relevant type of water in the given area.
Groundwater must achieve "good quality". This means that both quantitative status and chemical status needs to be at least "good".

In Sweden, work is ongoing with the adaptation of the existing quality criteria for the requirements established in the Water Framework Directive. Other, new environmental quality criteria are being derived for hydromorphological effect factors, for which there are at present none in Sweden.

To classify the status of the watercourses and lakes in this pilot project, three different approaches were tested and compared in order to establish a final assessment. System Aqua, a tool for characterization of lakes and watercourses, has been the foundation for this work.
The following biological quality factors; plankton, plants, fish and benthic fauna have been given the greatest weight in the assessment, and the worst value is decisive, pursuant to the principle of "one-out-all-out". Other quality factors, assessed to determine physical-chemical and hydro morphological conditions, are to serve a supporting role (the Swedish Environmental Protection Agency, 2003). Thus, if the status of the biological quality factors is determined to be "high" or "good", then the physical-chemical and hydro morphological conditions have also been assessed.

There are however a number of studies lacking in the current monitoring preventing a complete assessment. For a thoroughgoing description on how the assessment was done, see separate Work Package 1 BERNET-report. In chapter 6, an enhanced program, with operational and surveillance monitoring, is suggested.

Abstraction	Water volume $(10^3\ m^3/yr)$
Public waterworks	1005
Industry	10
Private wells, permanent residents	200
Private wells, summer cottages	13
Private wells, live stock	181
Irrigation	182[1]
The Hallandsås Railway Project	442

Table 2.1.4. *Calculated abstraction of groundwater and surface water. Based on statistics from 2000, except for the Hallandsås Railway Project (2003) and public waterworks (2002).*
1Based on 100 mm irrigation of the area used for growing potatoes.

2.2.1 Laholm Bay

The ecological status of the Laholm Bay is assessed as "poor" with regard to the physical-chemical parameters (Figure 2.2.1). The high content of nitrogen and phosphorus causes severe algal blooms. The intensive blooming occurs frequently and sometimes causes depletion in oxygen in the bottom waters, which in turn affect the benthic fauna. The vertical stratification with a halocline near the bottom is also escalating the problems.

The benthic fauna shows large variability, where periods with very disturbed fauna communities are followed by recovery due to temporary improvement of the oxygen conditions. Monitoring results from 2004 indicate a "poor" or "moderate status" for benthic fauna.

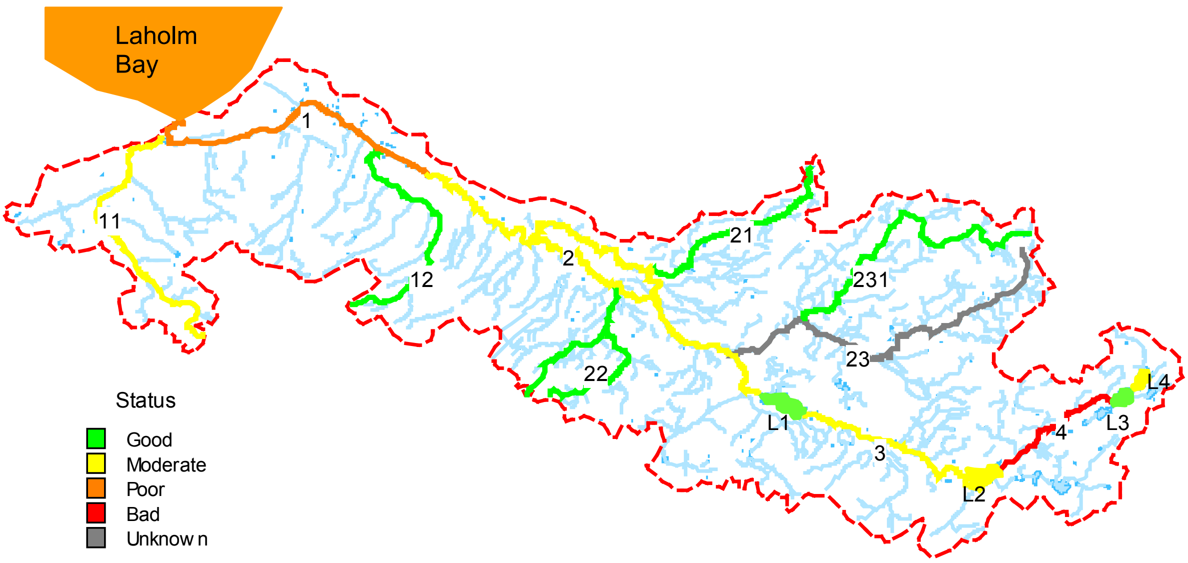


Figure 2.2. *Preliminary status classification of the surface water bodies.*

2.2.2 Watercourses and lakes

The results of the preliminary assessment of ecological status in river water bodies are presented in Table 2.2.2a. Acidification is the main pressure, apart from on the coastal plain where eutrophication and physical modification constitute the main pressures. Five of the river water bodies do not fulfill "good ecological status". For one of the river water bodies, the Stream Lilla Stensån, the status is unknown because we lack monitoring data.

The results of the preliminary assessment of ecological status in lakes are presented in Table 2.2.2b.
Two of the four lakes do not fulfill "good ecological status". Acidification is the main pressure.
identified (the main pressures are marked in bold).

2.2.3 Groundwater

An empiric assessment of status has only been carried out for the two public waterworks, Dömestorp and Eskilstorp. For other identified, not protected, groundwater bodies within the basin the Geological Survey of Sweden (SGU) has performed an overall survey that points out the groundwater bodies at risk (Figure 2.2.3). This assessment is however not based upon empiric data and actual pressure.
As regards to the two public waterworks, readings of the concentrations of nitrate and conductivity are presented in Table 2.2.3a. Both of the public waterworks have enhanced nitrate concentration, just as many other drinking water sources in the region, where the inflow-area is made up of arable lands. For station D12 in Dömestorp, the nitrogen concentration permanently exceeds 20 mg/liter, which is the suitable limit with observation given by the Swedish National Food Administration. However, the concentration is below the criteria in the Groundwater Directive for assessing "good chemical status", 50 mg /l (Table 4c. The conductivity for both waterworks show "moderate concentration" according to the limit values given by the Swedish National Food Administration. Analyses done on pesticides have shown that levels for 20 analyzed substances were under the limit of quantification.
In this preliminary assessment of the groundwater status of the public waterworks, both quantitative and chemical objectives are considered to be fulfilled.

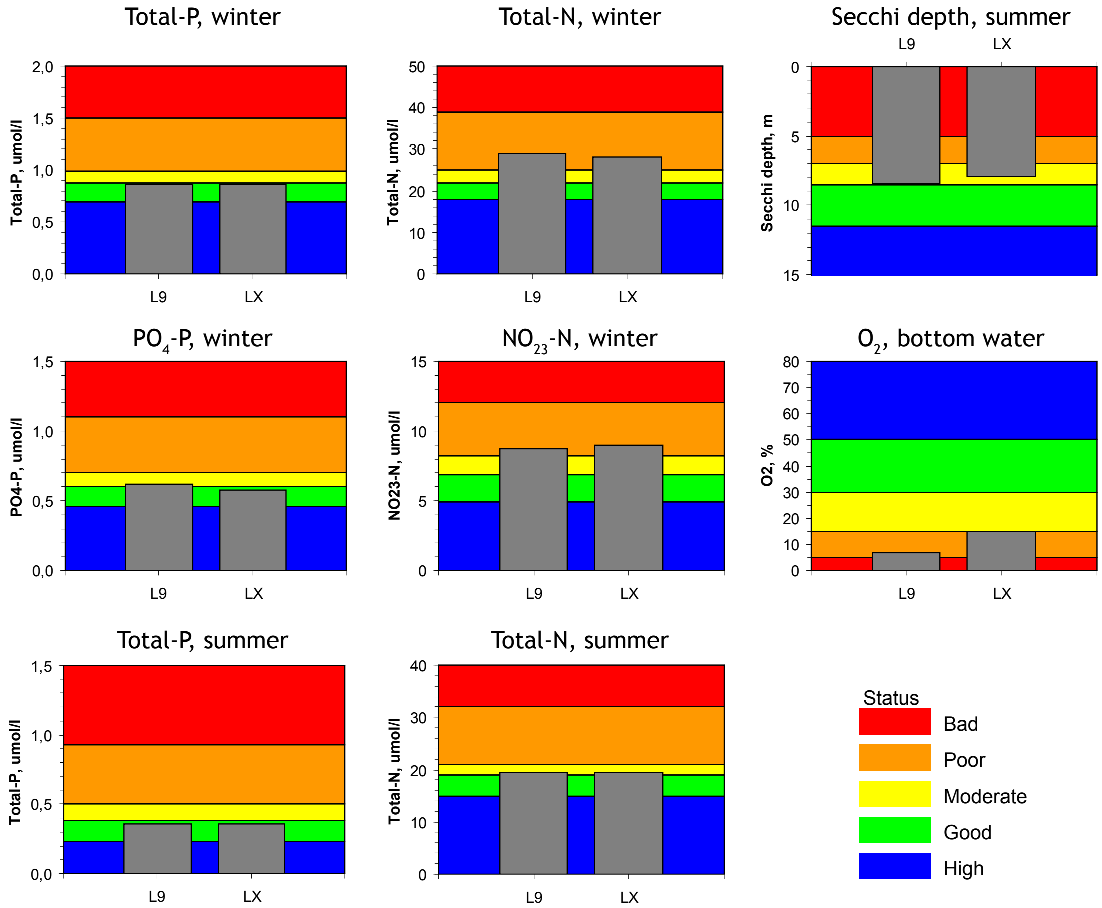


Figure 2.2.1. *Assessment of the ecological status in the Laholm Bay with regard to the physico-chemical parameters in two locations.*

Type	Number	River water body	Ecological status	Pressures
V314	1	Stensån 1[1]	Poor	**Physical modification** Eutrophication, Alien species (signal crayfish) Abstraction
V312	2	Stensån 2[1]	Moderate	**Eutrophication** **Acidification** Obstacle for migration
V312	3	Stensån 3[1]	Moderate	**Acidification** Definite obstacle for migration Physical modification Land use Short-term regulation
V312	4	Stensån 4[1,2]	Bad	**Acidification** Physical modification
V314	11	Örebäcken[1]	Moderate	Eutrophication **Physical modification** Alien species (signal crayfish) Definite obstacle for migration Abstraction
V314	12	Dalabäcken	Good	**Abstraction**
V312	21	Eglabäcken[1,2]	Good	**Physical modification** Land use
V312	22	Klippebäcken[1]	Good	Acidification
V312	23	Stream Lilla Stensån[1,2]	Unknown	**Physical modification** **Acidification**
V312	231	Stream Linghultsbäcken[1,2] (tributary to Stream Lilla Stensån)	Good	**Land use** **Physical modification** Acidification

Table 2.2.2a. *Preliminary assessment of ecological status of river water bodies in the River Stensån basin. The pressures to the ecological status have been identified (the main pressures are marked in bold).*

[1]Lack of chemical data
[2] Lack of biological data

Identified groundwater areas at risk, are located in the northwest basin area. These areas are identical to the areas dominated by sand and gravel in combination with intensive farming. The SGU points out a need for an improved data basis and deeper characterization before an assessment of the status can be made.

Type	Number	Lake	Ecological status	Pressures
S3112	1	Sjöaltesjön[1]	Good	Acidification[3] High oxygen demand, possibly due to land use or private wastewater establishments[3]
S3112	2	Vemmentorpasjön[1]	Moderate	Acidification[3] High concentration of, possibly due to acidification[3]
S3112	3	Vita sjö[1,2]	Good	**Acidification** Land use
S3112	4	Svarta sjö[1]	Moderate	**Acidification**

Table 2.2.2b. *Preliminary assessment of ecological status of lakes in the River Stensån basin.*
Lack of chemical data
[2] Lack of biological data
[3] Uncertain

Table 2.2.3a. *Groundwater status with respect to nitrate and conductivity for the two wells at each waterworks. The mean and the $CL_{(AM)}$ (mean + 95 % confidence interval) are presented. The readings go back to 1997.*

Sample station	Nitrate (mg/l)		Conductivity (mS/m)	
	Mean	$CL_{(AM)}$	Mean	$CL_{(AM)}$
Dömestorp 12	24.8	26.7	44	48
Dömestorp 13	15.6	16.4	34	38
Eskilstorp 15	15.4	16.7	46	46
Eskilstorp 20	12.4	13.2	48	49

Table 2.2.3b. *In this preliminary assessment of the groundwater status of the public waterworks, both quantitative and chemical objectives are considered to be fulfilled.*

Groundwater body	Groundwater status	Pressures
Dömestorp	Good	Eutrophication (nitrate)
Eskilstorp	Good	Eutrophication (nitrate)

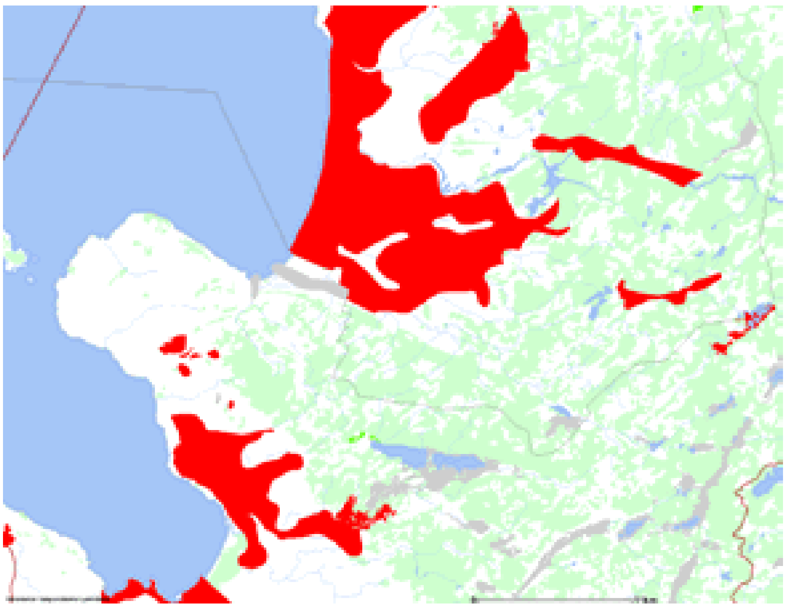


Figure 2.2.3. *Risk assessment on groundwater by SGU. Groundwater areas identified at risk are marked with red and areas at unknown risk with grey. The SGU risk assessment is to be considered more as a first model assessment of groundwater bodies that run the risk of not achieving "good status" 2015. The modeling is based on human activity within the close proximity of the bodies such as buildings, infrastructure, farming, point sources, abstractions etc.*

3 Protected areas

International protected areas

In the river basin there are twelve Natura 2000 areas designated under Directive 92/43/EEC (Figure 3 and Table 3). Even if several of these areas comprise of streams and wetlands, only two are appointed due to their aquatic values. Large parts of the main river up to Lake Sjöaltesjön, has also been suggested. Due to resistance from landowners, the Government has not yet made its final decision. The main river from the mouth up to Lake Sjöaltesjön is already designated by the Freshwater Fisheries Directive (78/659/EEG) due to its importance for reproduction of salmon.

Most of the designated Natura 2000 areas are to some extent protected as nature reserves. Some of the areas also have other forms of protection. However, certain areas lack all forms of protection. The designated Natura 2000 area on the Hallandsås ridge is one section of a larger nature reserve. As for Natura 2000 areas, almost no nature reserves have been appointed due to high aquatic values.

The counties of Halland and Skåne, and therefore the whole River Stensån basin, have been designated as nutrient-sensitive areas under the Nitrates Directive (91/676/EEC).

In the Laholm Bay, monitoring of bathing waters takes place at several sites designated as EU-bathing waters (71/160/EEC). In Båstad and Laholm municipality, monitoring is carried out at Malens havsbad, Skansenbadet by the harbor in Båstad, Birger Pers väg, Ejdervägen and Simvägen, of which some are so called "Blue flags". In the river basin, monitoring takes place at Lake Vemmentorpasjön and Sjöaltesjön, although these are not designated as EU-bathing waters.

Other protected areas

Protection areas for groundwater have been established for Båstad community, Axeltorp and Eskilstorp and are underway for Dömestorp (Figure 3).

The coastal zone from Torekov to Båstad, Hallands Väderö and the surrounding seas, plus the lower section of the River Stensån with its tributaries, are identified as sites of national interest for environmental protection. Parts of the Laholm Bay are identified as of national interest for fishery.
The northern slope of the Hallandsås ridge is identified as of national interest, both for recreation and for the protection of its landscape and scenery.

All coastal waters, watercourses and lakes are normally protected from exploitations at least 100 meters from the waters.

Natura 2000	Name	Area (ha)	Nature reserves (percentage of area)	Other protection (percentage of area)	Type of nature specific for water
SE0420292	Ledtorpet	2.0	0	2	
SE0420273	Korup	82	0	35	
SE0420283	Hallandsås ridge, northern slope	113	100		
SE0420284	Lyabäcken	12	80	20	Mixed deciduous forest together with the streaming water
SE0420179	Lya ljunghed and Älemossen	231	0	23	
SE0510122	Dömestorp	263	0	0	
SE0510103	Vallåsen DR	4.4	100		
SE0510174	Tjuvhultskärret	3.1	100		
SE0510003	Åstarpe mosse	189	100		
SE0510173	Svinamadsbäcken	83	0	0	Variable wetland complex
SE0510001	Björsåkra-Bölinge	46	100		
SE0510160	Klinta hallar	13	100		

Table 3. *Natura 2000 areas in the basin and their extent of protection.*

According to the environmental quality objective "flourishing lakes and streams", the following water bodies have been identified as in need of extra long-term protection:

- The River Stensåns main river – of considerable value nationally
- Stream Axeltorpsbäcken – of considerable value nationally
- Stream Lyabäcken – of considerable value regionally

According to the environmental quality objective "thriving wetlands" the following wetlands have been identified as in need of long-term protection:

- Långsalts mire
- Sänke moss

A general protection of certain aquatic environments of considerable value has also been suggested (SEPA 2005). No areas have been assigned by the Swedish Forest Agency for biotope protection. However, several areas with valuable nature have been assigned.

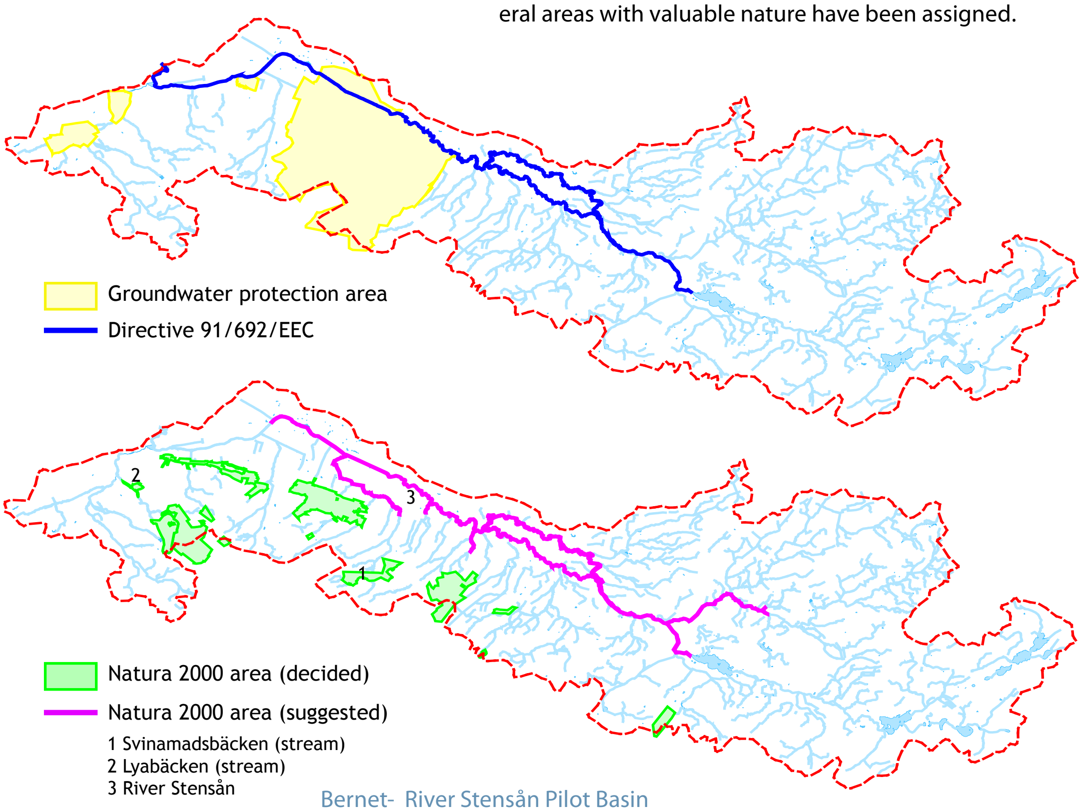


Figure 3. *Protection areas regarding groundwater and salmon breeding (above), and decided and suggested Natura 2000 areas.*

4 Provisional environmental objectives

According to the Water Framework Directive (WFD), all surface water bodies must exhibit “high” or “good ecological status” and all groundwater bodies “good groundwater status” no later than 2015. Classification of ecological status should be based on type-specific reference conditions and is described using biological quality elements, supported by physical-chemical and hydro morphological quality factors.

However, there are still no reference conditions or quality factors according to the WFD stipulated in Sweden. So far, only proposals of factors for assessment of the ecological status have been worked out for freshwaters and coastal waters in Sweden. These proposed factors have been used to preliminary assess the status of lakes, watercourses and the Laholm Bay (see paragraph 2.2.1 and 2.2.2). It is however not yet fully estimated what reduction of land-based transport of nutrients is needed to reach the proposed quality factors for “good status” in the Laholm Bay. Such estimations would have a high potential to support the futureprioritizing of measures in the area[1]. The measures suggested in this current plan, do not corroborate for compliance for certain quality factors in the bay.

Instead, for this pilot project, existing environmental objectives are still the foundation, e.g. Swedish environmental objectives, decided by the Swedish Parliament in year in year 2000 *(Table 4)

Table 4. *Swedish environmental quality objectives, decided by the Swedish Parliament in year 2000.*

Environmental quality objectives

1. Reduced Climate Impact
2. Clean Air
3. Natural Acidification Only
4. A Non-Toxic Environment
5. A Protective Ozone Layer
6. A Safe Radiation Environment
7. Zero Eutrophication
8. Flourishing Lakes and Streams
9. Good-Quality Groundwater
10. A Balanced Marine Environment ...
11. Thriving Wetlands
12. Sustainable Forests
13. A Varied Agricultural Landscape
14. A Magnificent Mountain Landscape
15. A Good Built Environment
16. A Rich Diversity of Plant and Animal Life

4.1 Objectives to counteract eutrophication

National objectives to counteract eutrophication

- By 2010 Swedish waterborne anthropogenic emissions of nitrogen into sea areas south of the Åland Sea will should be reduced by at least 30 % compared to 1995 levels.
- By 2010 Swedish waterborne anthropogenic emissions of phosphorus compounds into lakes, streams and coastal waters should be decreased by at least 20 % from 1995 levels. The largest reductions will be achieved in the most sensitive areas.

Regional objectives to counteract eutrophication

An average of 4 900 tons of nitrogen is transported annually from the entire Laholm Bay basin to the Laholm Bay, of which 25 % is considered the background loading. The aims towards a reduction of land based anthropogenic nitrogen by 30 %, corresponds to a reduction of at least 1 100 tons from the Laholm Bay basin. Assuming similar reduction of 30 % for each river within the Laholm Bay basin, the reduction for River Stensån basin needs to be at least 100 tons compared to levels of 1995 (Figure 4.1).

To counteract the leakage from land to sea, regional objectives are pointed out for the Halland region:

- Continued guidance and information in order to decrease diffuse discharges from agriculture.
- Increase efforts of education and information to the forestry sector in order to increase awareness of the significance for decreased diffusive leakage from forestland.
- Initiation of research around nitrogen dynamics in forested areas, to increase knowledge about effects of various measures that counteracts leakage.
- Building of models that prognosticate the fate of large soil nitrogen storage in forests.
- A follow up of the effects of storm felling caused by the storm event in winter 2005.

[1] *According to model estimates, it is doubtful whether Swedish environmental objectives will be enough to reach “good ecological status” according to the WFD. The modeling showed that if nitrogen transport had been reduced according to the present Swedish environmental objectives already in 1990, concentrations in the surface water might be reduced by not more than 8 %. The ecological status would then still today be classified as unsatisfactory (Marmefelt and Olsson, 2005). The reason for this is that the exchange of water between Kattegat and Laholm Bay is large which reduces the effects of local measures in the Laholm basin. The prerequisites for improved nitrate status in the Laholm Bay would be to lower the concentrations in the Kattegat, i.e. an international task. In this sense the national objectives for Laholm Bay is rather pointless. However, the model does not take into account currently taken measures in neighbor countries and the effects this has on the nutrient levels in the Kattegat.*

4.2 Objectives to counteract acidification

Regional objectives to counteract acidification (similar to national objectives)

In the Halland County, still 30 % of the lakes are acidified and efforts of liming will have to be intensified. A new program of measures for liming of soil and wetlands will be implemented in Halland in due course. To counteract acidification in the Halland region the following objectives is pointed out:

- By 2010 not more than 5 % of all lakes and 15 % of the total length of running waters in Halland County be affected by anthropogenic acidification.
- By 2010, at least 30 % of the forested area in Halland County would be of "good" or "very good status" regarding pH according to Swedish classification system for forested areas.
- By 2010, emissions of sulphur dioxide to air in Halland County will have been reduced by 25 % from the levels of 1995.
- By 2010, emissions of nitrogen oxides to air in Halland County will have been reduced by 55 % from the levels of 1995.

Current objectives for chemical water quality concerning pH and alkalinity are set in the present liming program for the River Stensån (Table 4.2).

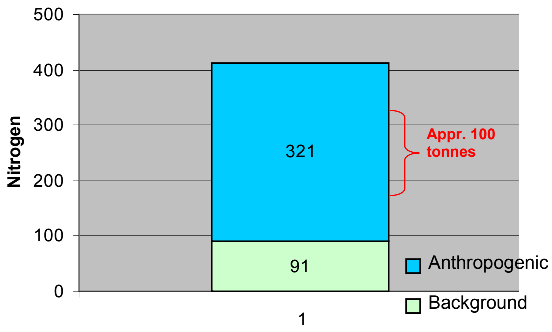


Figure 4.1. *River transported nitrogen in River Stensån basin at 1995-year level divided into anthropogenic and background loading. A 30 % reduction of the anthropogenic nitrogen according to Swedish environmental objectives corresponds to a reduction of 100 tons N/yr in the basin.*

	Lakes and watercourses Not influencing salmon reproduction areas	Lakes and watercourses influencing salmon reproduction areas
pH	6.0	6.3
Alkalinity	<0.10 meqv./l	<0.15 meqv./l

Table 4.2. *Quality objectives set in the liming program for chemical water quality at high water flow. In order to avoid excessive liming an objective is set for maximum alkalinity.*

4.3 Objectives for groundwater

Groundwater must achieve "good groundwater status". This means that both quantitative status and chemical status needs to be at least "good". An ongoing discussion of the practical implementation of the WFD in the Swedish legislations has led to adjustments and adaptations in formulations of the "Regional environmental objectives" in Halland County regarding groundwater. These objectives points out that:

- At the latest 2010, all groundwater basins for all abstractions of groundwater above a volume of 10 m³/day or that serves more than 50 persons per year should fulfill the Swedish statutes for drinking water.
- Groundwater basins for the use today or tomorrow must be long-term protected for exploitation.
- Land use and use of water should not cause change of groundwater levels that negatively causes consequences for the maintenance of water, soil stability, or for plants and animals in bordering ecosystems.
- At the latest 2009 there should be measure programs according to the WFD of how to achieve "good status"

Contaminant	**National food administration**	**Groundwater directive**
Nitrate		
Limit value	50 mg/l	50 mg/l
Suitable with remark	20 mg/l	
Pesticides and pesticide metabolites		
Limit value	0.1 ug/l	0.1 ug/l
Total content	0.5 ug/l	
Conductivity		
Suitable with remark	100 ms/m	

Table 4.3. *Quality objectives for nitrate and pesticides in groundwater according to the National food administration and the Nitrate directive.*

[2] *The Swedish environmental objectives for reduction of the anthropogenic part of the land based nitrogen transport by 30% is based on a politically bargaining from a scientifically estimate of a need of, at least, 50% reduction of the total nitrogen transport. I.e. not only the anthropogenic transport. The Marine Eutrophication project (as summarized in a special issue of AMBIO) express a need for a 50 % reduction of river transported nitrogen to the Laholm Bay would result in about 35 % reduction of the net primary production during summer and early autumn. For the Kattegat as a whole, a 50 % reduction of local sources (in Sweden and Denmark) would result in a 15-25 % reduction in spring-bloom production. Thus, to substantially improve the biological conditions in the area a minimum of 50 % reduction is needed. The present environmental objectives of a 30 % reduction is a political standpoint that does not rests on a scientific ground.*

5 Program of measures

The program of measures is based on the pressures presented in chapter 2 and is set to fulfill the objectives presented in chapter 4. The suggested measures will focus on how to counteract eutrophication, acidification, physical pressures, and how to protect groundwater.
When addressing eutrophication, focus lies on the Laholm Bay and thus, measures points at reducing the transport of excess nitrogen to coastal waters. However, the suggested measures often have more than one positive effect, which watercourses, lakes and groundwater also can benefit from, see Table 5.1b.

A number of the suggested measures are already implemented to some extent or are already decided. These are presented as "basic measures". In addition, a number of the suggested measures are not yet implemented or decided today. These are presented as "further measures".

5.1 Measures to counteract eutrophication

An extensive work has already been carried out to reduce the nitrogen transport. The means of control are legalization (Annex II), environmental subsidies and information. In 1988, special regional regulations were introduced in the municipalities of Halmstad, Laholm and Båstad to reduce nitrogen transport to the Laholm Bay, targeting agriculture (Figure 5.1a) and wastewater). These regulations have later been the foundation for similar regulations for all of the southern Sweden.

Within wastewater treatment, the regulations have led to a number of improvements, e.g. the Hedhuset WWTP was complemented in 1992 for advanced nitrogen removal. As early as 1978, the wastewater plant was equipped for chemical precipitation of phosphorus. Local authorities have carried out extensive supervision to ensure that wastewater treatment in private establishments fulfill the legalized requirements.

Since 1995, nitrogen transport is decreasing from the River Stensån basin (Figure 2.1.1d). The reduction is taken place in the agriculturally dominated section, probably due to the already implemented measures, e.g. catch crops, reduced animal density, better handling and storage of manure and construction of wetlands. This trend is representative for the Swedish agricultural sector, where leakage from arable land has decreased by 12 % from 1995 to 2003 (Swedish Board of Agriculture 2005). From Hedhuset WWTP the

Regional and local regulations

Adoption of animal density
Farmers are not allowed to have more animals than they have acreage for manure spreading. It can be land that is owned by farmers, leasehold land or land contracted for manure spreading.

Use of manure and fertilizer according to the Nitrate Directive

- Use of manure and fertilizer shall be based on soil and manure analysis.
- Nitrogen fertilization must not exceed crop requirement for the season.
- Farms bigger than 10 ha have to undergo soils being analyzed for phosphorus, potassium and pH.
- Farms bigger than 10 ha and farms with more than 30 animal-units have to have a plan for the use of fertilizer and manure.
- Fertilizer and manure must not be used during the period of 1 Dec.-15 Feb.
- Manure can during the period of 1 Aug. - 30 Nov. only be used before winter cereals and in grasslands.
- Manure must be incorporated in the soil within 4 hours after spreading on bare ground.
- In growing crops, slurry must be spread with band-spreading technique or subsurface application.

Storage of manure and sewage sludge

- The storage capacity for manure from cattle, sheep, goats and horses must be at least 8 months and for other animals 10 months.
- Tanks for urine and slurry must be covered to prevent ammonia emissions to the air.
- The storage capacity for sewage sludge must be at least at least 10 months.
- Sewage from water closets without other cleaning than silt-separation is not allowed to be discharged into water bodies.

Regulations for crop production
Farmers must during autumn and winter have growing crops on at least 60 % of their land.

Supervision
Each municipality has a supervisor to check that the regulations are fulfilled.

Economic Sanctions
In Sweden economic sanctions are used to decrease the use of fertilizer and pesticides. Special environmental fees on fertilizers were introduced in 1984. The fee for nitrogen is 1.80 SEK/kg N in fertilizers with a nitrogen content exceeding 2 %.The fees on phosphorus are based on the cadmium content. The fee is 30 SEK/g when the content of cadmium exceeds 5g/ton phosphorus.

Figure 5.1. *Example of regional and local regulations of agriculture in the Laholm Bay area.*

nitrogen loading has been halved due to the measures taken. Presumably, the loading from the private establishments has decreased as well.

The forest sector was not included in the regional regulations in 1988. Building of ditches in the forest region was however, additionally prohibited around this time. Today, the increased loading from the forest, counteract a decrease in the total nitrogen loading from the forest dominated Laholm Bay basin. The extensive felling caused by the storm in January 2005 will probably further increase the leakage from the forest. This stresses the importance to take action also within the forestry sector.

According to the national environmental objective for nitrogen, a reduction of approx. 100 tons is needed for the River Stensån (see paragraph 4.1). Table 5.1a presents how far the already implemented measure has taken us from 1995 until today and the reduction still needed – approx. 53 tons.

	River transport (Tons N/yr)	Including Hedhuset WWTP (Tons N/yr)
1995	420	436
Actual (2005)	370	384
Target load 2010	320	325
Required load reduction (1995-2010)	100	105
Required load reduction (2005-2010)	50	53

Table 5.1a. *River transport of nitrogen in the River Stensån and loading from the Hedhuset WWTP in the periods of 1995 and 2005 and required load reduction to comply with the national environmental objective in 2010. Nitrogen data for River Stensån is flow adjusted, but not statistically significant.*

5.1.1 Agriculture

In the River Stensån basin, contrary to other parts in the region, the percentage of ley and pasture is already high, which results in lower nitrogen leakage from agriculture than the average in the south west of Sweden.

EU funded environmental subsidies to decrease nitrogen loading are paid to Swedish farmers e.g. to promote spring ploughing, catch crops, buffer strips and wetlands. These and other measures already implemented are presented under “basic measures”. In table 5.1c an optimized implementation of the “basic measures” is suggested. This presupposes that the existing subsidies remain unchanged, otherwise the leaching will increase since the effect is depending on yearly undertakings. Due to the EU Midterm review of the agricultural aid the reduction of livestock production and the reduction of acreage of arable land will continue by at least 5 % until 2015.

In a project named “Focus on nutrients” (Greppa Näringen) free environmental information has been offered to farmers with more than 50 hectares of land during the past five years. This joint venture between the Swedish Board of Agriculture, the Federation of Swedish Farmers and a number of companies in the farming business, has been valuable. It is suggested that the project is continued but the size limit revised since less than half of the arable land in the basin belongs to farms larger than 50 hectare.

In addition, a number of measures that are not implemented or decided today are suggested under “further measures”, in order to reach the national environmental objective.
Highest potential for nitrogen reduction has a large-scale restoration of the riverbed on the coastal plain to its historic appearance (Figure 2.1.3b). A restoration of the riverbed can, however, be done in different ways, which explains the big variations in nitrogen reduction in Table5.1c. The simplest way to accomplish this restoration is to cease the river maintenance and farming in the river valley. Such a project is dependent upon the interest from the landowners in question and the compensation to them. Due to the frequent flooding today of the adjacent farmland the interest from the landowners for alternative land use seems to be large. Swedish legislations do however not favor large-scale restorations of wetlands and riverbeds if salmon and trout interest are threatened. Wetlands are overall considered to favor pike, which are identified as an important smolt predator. This potential conflict might be the case in the River Stensån as identified as an important spawning area for salmon and trout.

Regarding nitrogen pollution in groundwater, see paragraph 5.4.

Measures – diffuse sources	Effects					Laholm Bay	Lakes	Water-courses	Ground-water
	N-load	P-load	Org.-load	Acid-load	Flora and fauna				
Agriculture - basic measures									
Catch crops	+	(+)				+	(+)		+
Permanent buffer strips along watercourses	+	(+)			+	+	(+)	+	
Late autumn or spring ploughing, grain crops	+	(+)				+	(+)		+
Spring ploughing of ley	+	(+)				+	(+)		+
Substitution of autumn grain for spring grain after ley	+	(+)				+	(+)		+
Set aside plus decrease of acreage	+	(+)				+	(+)		+
Tuning of agricultural practices	+	(+)				+	(+)		+
Continued construction of wetlands	+	(+)			+	+	(+)	+	
Agriculture - further measures									
Regulated drainage	+					+			
Permanent fallow in proposed water protection area surrounding Dömestorp water source	+	(+)				+	(+)		+
Adjustment of crop rotation, i.e. substitution of potatoes for sugar beets. (depending on contract)	+	(+)				+	(+)		+
Production of biogas crops	+					+			
Wetlands - restoration of riverbed	+	(+)				+	(+)		
Forestry									
Leaving vegetation in the felling area	+	(+)		+	+	+	(+)		
Planting as soon as possible	+	(+)				+	(+)		
Leaving buffer strips along watercourses and ditches	+	(+)			+	+	(+)	+	
Increasing the amount of deciduous trees in the stands	+				+	+		+	
Lenient scarification	+	(+)				+	(+)		
Adherence to general prohibition of draining and minimized ditching	+	(+)			+	+	(+)	+	
Decrease deposition	+			+	+	+			+
Measures – point sources									
Wastewater - basic measures									
All private wastewater systems to comply with existing legal requirements	+	+	+			(+)	+		+
Best available technology applied to 25 % private wastewater systems	+	+	+			(+)	+		+
Wastewater - basic measures									
Post denitrification at Hedhuset WWTP	+					+			

Table 5.1b *Suggested measures to counteract eutrophication related to different effects and water types. Plus in bracket (+) means that the measure has an additional positive effect than reducing the priority substance (nitrogen).*

Table 5.1c. *Estimated potential and costs (including subsidies) for suggested measures, assuming a writing-off period of 20 years and an interest rate of 5 % for investments. The natural retention has not been considered. The table includes an estimation of the measures already implemented (after 1995).*

Measures – diffuse sources	Suggested area (ha)	Undertakings today		Reduced nitrogen leaching (Total suggested area)		Cost (Total suggested area)	
		Undertakings (permanent and yearly	Undertakings Estimated effect on leakage until 2005 (tons N/yr)	Effective-ness (kg N ha/yr)	Potential effect on a total basis (tons N/ yr)	Cost effective-ness (SEK/kg N)	Cost per year (Million SEK/yr[1])
Agriculture - basic measures							
Catch crops	815	140	1.8	11-13	8.9-10.6	71-79	0.63-0.84
Permanent buffer strips along watercourses	30-60 (more with tributaries)	n.e.		5-30	0.1-1.8	90-500	0.01-0.9
Late autumn or spring ploughing, grain crops	530	70	0.5	7	3.7	57	0.2
Spring ploughing of ley	340	45	0.5	12	4.1	33	0.13
Substitution of autumn grain for spring grain after ley	100-200	n.e.		8	0.8-1.6	37-171	0.03-0.27
Set aside plus decrease of acreage	400	150**	4.3	29	11.6	109	1.3
Tuning of agricultural practices	100-200	n.e.		8	0.8-1.6	30-40	0.02-0.07
Construction of wetlands (water surface)	26	10***	4	400	10.4	79	0.8
Total			**11**		**40-50**		**3.1-4.5**
Agriculture - further measures							
Regulated drainage	90			15-25	1.3-2.2	150-300	0.2-0.7
Permanent fallow in proposed water protection area surrounding Dömestorp water source	72			29	2.1	500-1500	1.0-3.0
Adjustment of crop rotation, i.e. substitution of potatoes for sugar beets.	20			10-44*	0.2-0.9	30-40	0.006-0.04*
Production of biogas crops	200			20*	4*		
Wetlands - restoration of riverbed	35-85			200-400	7-34	40-100	0.3-3.4
Total					**14-44**		**1.5-7.1**
Forestry - basic measures							
All measures in forestry					0.5-16.5*		
Measures – point sources	**Number**	**Number Involved today**		**Reduced nitrogen leaching**		**Cost**	
				Potential effect on a total basis (tons N/ yr)		Cost effectiveness (SEK kg/N)	Cost per year (Million SEK/yr)
Wastewater - basic measures							
All private wastewater systems to comply with existing legal requirements	100	1400		1****		500-1500	0.5-1.5
Best available technology applied to 25 % private wastewater systems	375			1.5		500-1500	0.7-2.2
Wastewater - further measures							
Post denitrification at Hedhuset WWTP				7-8		70-100	0.5-0.8
Total				**9.5-10.5**			**1.7-4.5**

[1]Costs including subsidies, n.e.= not estimate
*Uncertain figure, ** Estimated and extrapolated from statistics for Laholm municipality between the year 2000 and 2003 (SCB),
*** Wetlands constructed before 1995 (approx.30 ha) are not included, ****Effect for already performed measures is not included.

Basic measures

- Use of catch crops when growing grain.
- Spring ploughing or late autumn ploughing.
- Ploughing of ley in early spring.
- Ploughing of ley followed by the sowing of spring grain crops and catch crops, rather than autumn grain crops.
- Permanent buffer strips along the River Stensån and tributaries.
- Restrictions in nitrogen of forage to animals.
- Best use of technique (especially to reduce ammonia losses).
- Thorough management of manure (calculations of N and P balance on farm level).
- No floating manure to autumn seed.
- Wetland construction in the agricultural dominated parts of the basin.

Further measures

- Permanent fallow in frequently flooded parts of the water basin
- Conversion of grain and potato producing areas into production of biogas (grass) or energy forest
- Adjusting crop rotation, e.g. substitution of sugar beets for potatoes.
- Regulated drainage.
- Restoration of the riverbed on the coastal plain.

5.1.2 Forestry

The possibility to minimize leakage from forestry occurs primarily in connection with felling. By felling according to legislation and heeding the advice from the Swedish Forest Agency, leakage from cutting areas may be minimized without external funding. According to the Swedish Forestry Act, it is an obligation to leave buffer strips along watercourses. Nevertheless, in reality, this is not always done since it is considered to expensive by the landowner. Already today, the Swedish Forest Agency offers free information and advice in the forestry sector. However, there is a need for an intensified information campaign.

Not much is known about the effects and costs of measures within forestry compared to measures within agriculture. Thus, is difficult to say how far the suggested measures will take us; so far the leakage is not decreasing. A decrease by half may be possible in the future[3] (Table 5.1c). A decrease in the atmospheric deposition is then needed. On a local scale, deposition may be influenced through a decrease in the emissions of ammonia from the agricultural sector. Discharge of nitric oxides must be decreased through international agreements, but also through a decrease in motor traffic volume.

More research is needed to fully appreciate what will happen with the nitrogen pool in the forest, caused by long-term deposition, and the effect of the different measures.

Basic measures

- Leaving vegetation in the felling area.
- Planting as soon as possible.
- Leaving buffer strips along watercourses and ditches.
- Increasing the amount of deciduous trees in the stands.
- Lenient scarification.
- Information and advice.
- Adherence to general prohibition of draining and minimized ditching.

5.1.3 Wastewater from sparsely built-up areas

An estimated 90 % of the households with private treatment system establishments fulfill the legislated requirements today. This means further treatment of wastewater than just sludge removal. A typical private treatment establishment is today a three-compartment septic tank where the effluent is infiltrated through a drain field or an infiltration chamber.

New legislation will be implemented in Sweden during 2006. Higher demands will be set to reduce pollutants and improve the hygiene, especially in areas identified as extra vulnerable to pollution (Table 5.1.3c). This will require different treatment systems than are used today. It is not yet clear what areas will be identified as extra vulnerable. Also in areas which are not identified, the requirements will be stricter than today, e.g. there will be demands on monitoring of the treatment.

Since there is a retention of nitrogen before reaching the sea (depending on distance between source and the sea), these measures will be important locally rather than decreasing nitrogen transport to the sea in total (Table 5.1c). The reduction in phosphorus due to the basic measures is approx. 800 kg.

[3] Stefan Andersson, Swedish Forest Agency

Basic measure

- All private household wastewater systems not connected to the municipal wastewater treatment plant must comply with existing legislated.
- 25 % of the private establishments are assumed to be situated in areas designated as extra vulnerable to pollution according to the new legislation and have to upgrade their establishments.

Legalised requirement	BOD	Phosphorus	Nitrogen
Existing	No requirements (50-95 %)	No requirements (50-80 %)	No requirements (10-40 %)
June 2006	90 %	70 %	No requirements
June 2006 – Areas extra vulnerable to pollutants	90 %	90 %	50 %

Table 5.1.3. *Comparison between existing and new legislations for wastewater from scattered houses, as proposed. There are no existing requirements on removal today. Figures presented in parenthesis are what a typical establishment today removes at best.*

5.1.4 Wastewater treatment plant

The level of treatment as well as the dependability of the Hedhuset WWTP is already very high. Phosphorus and BOD removal within the plant exceed 95 % and nitrogen removal is approximately 80 %.

There is good reason for attempts towards further improvement of nitrogen removal. The average concentration of nitrogen in the outlet to the Laholm Bay is 10-12 mg N/l. If post-denitrification is added to today's existing pre-denitrification, and a source of carbon added, the amount of nitrogen in outlet could be decreased by 50 % (Table 5.1c).
No specific costs have been calculated for nitrogen removal in the Hedhuset WWTP.

An alternative measures is post-treatment in polishing ponds, which can be a cost efficient measure. Leading the effluent to a willow plantation for biomass production is yet another possible measure. Both measures require the appropriate physical conditions in the vicinity of the WWTP which have not been looked into.

Further measure
- Adding post-denitrification to existing pre-denitrification.

5.1.5 Fulfillment of objective – a decrease in nutrient transport

The suggested basic measures may decrease nitrogen transport between 43 and 64 tons (Table 5.1.5). Today 11 tones seem to be fulfilled through measures already carried out in agriculture.

Table 5.1.5 shows examples of further measures – more advanced yet possible – to enable us to achieve the objective of approx. 100 tons reduction in nitrogen transport from the levels of 1995. With these described measures, it might be possible to reach the objective. The effects of some measures, such as those suggested for forestry, have not been fully investigated but a potential for decreased forest nitrogen leakage of up to 10-15 tons annually does not seem unlikely. Especially if information efforts are intensified in the forested regions. The measures concerning further wastewater treatment needs to be better examined for Hedhuset WWTP. Also a full economic and consequence analysis is needed.

The basic measures for agriculture have, as mentioned, been carried out already to some extent, but should be possible to apply fully without essential economical consequences for the involved individuals.

The most effective measure would probably be a large-scale wetland restoration project of the riverbed of the coastal plain. This may entail conflicts with salmon and trout fishing interests as earlier commented, but is at the same time a good method of improving biotopes and the environment for other species. Restoration of the river and its surrounding areas should be possible but this is dependent upon the landowners in question.

5.2 Measures to counteract acidification

Limning efforts in the upper section of the basin started in 1985. A total of 7300 tons of lime have been distributed in the basin. Two lakes, Sjöaltesjön and Svartesjö, the wetland areas surrounding Stream Klippebäcken, and the main river upstream Sjöaltesjön are limed with various methods today (Figure 5.2a). Liming is an absolute necessity, e.g. for a viable population of salmon.

Table 5.1.5. *Summary of the effect of basic and further measure and the possibility to reach the objective.*

	Nitrogen (Tons N/yr)
Preliminary objective 30 % decrease in anthropogenic nitrogen	100-105
Basic measures, reduction	43-64
Further measures, reduction	21-55

Table 5.2. *Example of measures against acidification and their costs.*

Measures to counter act acidification	Total cost (million SEK/yr)
Basic measure Continued liming (according to program)	0.3
Further measure Extended liming, e.g. in the Stream Lilla Stensån	0.14

Liming efforts, however, needs to be intensified according to the regional environmental objectives (see paragraph 4.2). This is emphasized by the preliminary assessment of ecological status (see paragraph 2.2.2). At the moment, there is no suggestion on how liming shall be carried out in the future. Table 5.2 presents the cost of today's liming program and provides an example of what it may cost to lime the Stream Lilla Stensån (by limedoser), which is today affected by acidification.

Besides liming, measures also need to be taken to reduce the supply of acidifying substances to water bodies. A decrease in the atmospheric deposition of sulphur and nitrogen is needed, additional to the decrease already accomplished in sulphur deposition. The influence of forestry on water bodies can be minimized through wood-ash recycling and liming in forests. The Swedish Forest Agency is now working on such a program of measures (The County Administrative Boards of Halland 2005). Reduced cutting of branches and tops (GROT) and more deciduous trees in the stands are important measures as well.

Basic measures

- Liming carried out according existing liming program.
- Implementation of already decided measures to decrease the emissions of acidifying substances.
- Increasing the amount of deciduous trees in the stands.

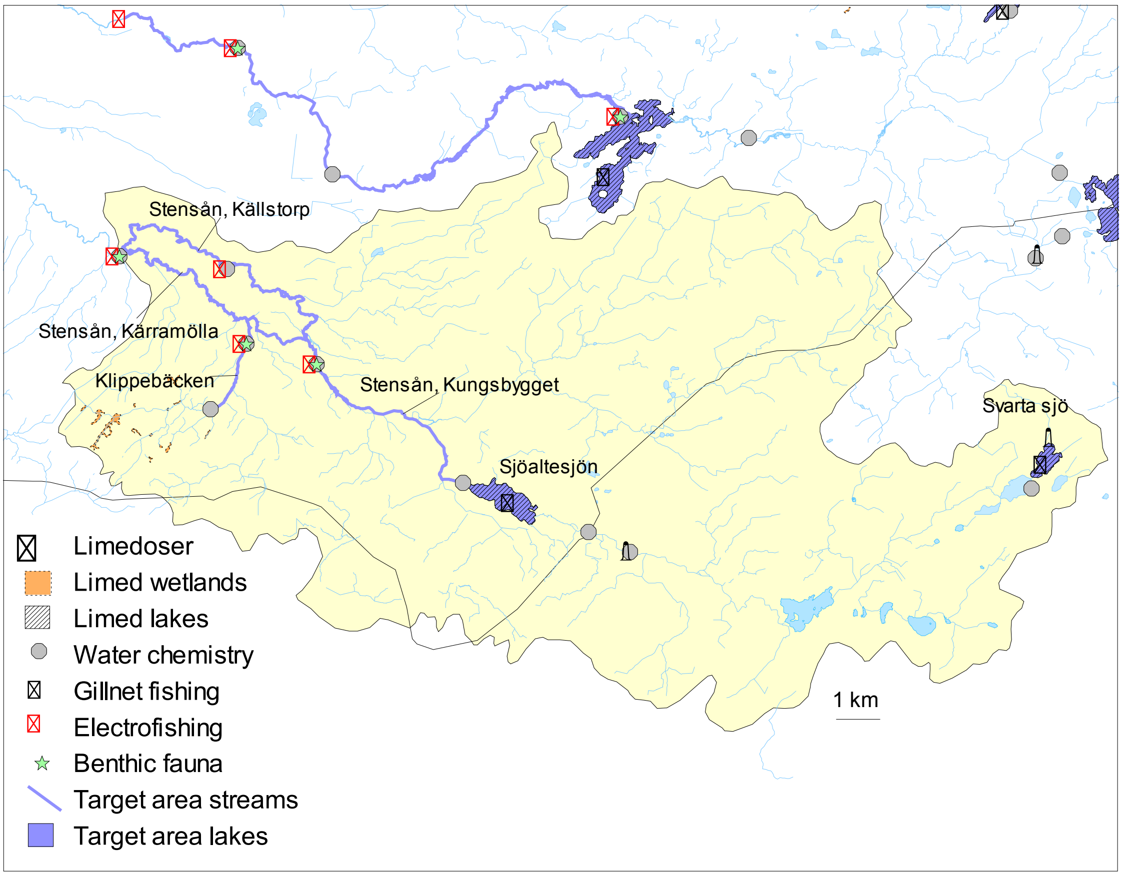


Figure 5.2a. *Liming efforts carried out in the eastern part of the River Stensån basin. Yellow area is, by the County Administrative board of Halland, identified as prioritized area of measures for liming. Lake Svarta sjö will in the future be limed from boat. Monitoring efforts in accordance to the liming program are also shown in the figure.*

Further measures

- Preparation and implementation of an increased liming program.
- Additional measures to decrease the emissions of acidifying substances.
- Wood-ash recycling and liming in forest.
- Reduced cutting of branches and tops (GROT).

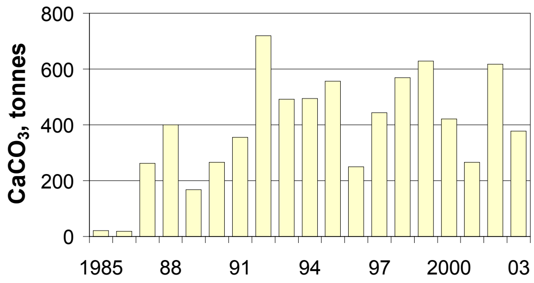


Figure 5.2b. *Liming efforts in the River Stensån 1985-2003.*

5.3 Measures to protect groundwater

Eskilstorp has been proposed as a water protection area by the municipality of Båstad, but this process has not yet been completed. In the municipality of Laholm, preparations are being made for a water protection area at Dömestorp. Future restrictions concerning land use and pesticides are likely to be implemented. The risk of infiltration of pollutants into the groundwater supply in Dömestorp is greatest in the transition between the ridge and the plain.
The proportion of crops less prone to nitrogen leakage should increase within suggested water protection areas, along with the implementation of a restrictive pesticide regime. Road 105 runs along the Hallandsåsen ridge. This should be dealt with in order to avoid future accidents resulting in polluted groundwater. Spreading of road salt within water protection areas should be carried out restrictively.

Concentrations of nitrate and pesticides are analyzed regularly at two stations within the water supply area of Dömestorp and at three stations in the water supply area. The analyzed concentrations of nitrate are acceptable (15-26 mg NO_3/l). There is a tendency however, towards increased concentrations of nitrogen in both Dömestorp and Eskilstorp. According to the WFD, water quality must not deteriorate. A water protection area surrounding Eskilstorp has been proposed by the municipality of Båstad, but this process has not yet been completed. In the municipality of Laholm, preparations are being made for a water protection area at Dömestorp.

Basic measures

- Careful and restrictive use of chemical substances within protected areas.
- Groundwater protection along Road 105 to prevent sudden pollution accidents.
- Restrictive use of salt in the way net.
- Restrictive use of manure and fertilizers.
- Access to watering of fertilized fields during dry periods in protected areas.
- Less intensive use of land in primary protection zone.
- Safety measures in tunnel building and planning of new areas around the planned railway station.

Further measures

- Permanent fallow, extensive land use within primary water protection areas.
- Restrictions in land use in primary and secondary water protection zone.
- Change of land use in protected areas. Permanent fallow in primary protection area. Less intensive use of land in secondary and tertial zone.
- Ecological farming.

5.4 Measures to improve habitats

To get a better basis on measures needed to improve habitats, a proper biotope survey is required for the River Stensån ecosystem. In the survey it is established where biotope management should be carried out, e.g. meandering, restoration of spawning grounds, creation of buffer strips and removal of migration obstacles. Such a survey has only been done in a few water bodies. Therefore, the suggested measures can not be very specific at this point. Up till now, few measures intended to improve habitats have been carried out.

Some of the already suggested measures to counteract eutrophication, e.g. wetlands and buffer strips, will not

Table 5.4a. *Example of migration obstacle removal at Drakabygget. Costs (100 % Government grant), assuming a writing-off period of 20 years and an interest rate of 5 % for investments, and effect on smolt production has been estimated. Benefits for e.g. benthic fauna or bivalves have not been considered, nor possible negative effects on crayfish. Notice that the effect of the measure while linger long after the pay-off of the investment. (The County Administration Board of Halland 2002).*

Measure to improve habitats	Total cost (SEK/yr)	Effect (smolt production/yr)	Estimated value (SEK/yr)
Further measure			
Removal of migration obstacle at Drakabygget[1]	32 000	600	27 000

only improve the chemical water quality, but the physical environment for flora and fauna as well (Table 5.1b). A large-scale restoration of wetlands in the river bed may entail a conflict between interests as described earlier (see paragraph 5.1.1).

In Table 5.4b the present production of smolt as well as the possible future production after implementation of priority measures. The value of the increased production is estimated to 350 000 SEK/yr.

Moderate and careful clearing of the riverbed by the regulation societies is an important achievement. By sparing buffer strips with trees and bushes, the amount of aquatic vegetation decreases and therefore also the need for clearing the watercourse. Buffer strips are important from several other points of view as well.

Removal of artificial migration obstacles (see Figure 2.1.3a) promotes salmon, trout, benthic fauna and bivalves. This measure must however be carried out very carefully as there is a risk of disease or of alien species (e.g. signal crayfish) being spread, presenting a further threat to threatened species in the area. In Table 5.4a the effect and cost for construction of a fish passage past the definite obstacle at Drakabygget is presented. Improvements for migrating fauna should also be made at the partial migration obstacles. Since none of the mills or dams has water rights, the owners should apply for that.

A continued supervision of withdrawal for irrigation purposes is necessary in order to avoid too great pressure on the watercourse during dry springs and summers. Irrigation ponds may compensate for water shortages.

Since no reproduction of pearl mussel has been verified, further investigations are needed to identify the pressures and dispersal. Many of the measures suggested below are beneficial to the pearl mussel.

Basic measures

- Moderate and careful clearing of watercourses.
- Buffer strips along watercourses.
- Supervision of withdrawal.
- Permanent buffer strips along the River Stensån and tributaries.
- Wetland construction.
- Considering the aquatic environment when planning new housing, industries etc.

Further measures

- Constructing fish passages.
- Removing migration obstacles.
- Re-meandering.
- Spawning and nursery habitat improvement
- Restoration of piped watercourses

Table 5.4b. *Present production of smolt and possible future production in the River Stensån after implementation of priority measures. (Almer1995).*

	Salmon (smolt/yr)	Salmon trout (smolt/yr)	Growth space (m^2)	Measure
Today	21 300	14 000	156 000	Liming as today
Potential	22 500	20 600	173 000	More buffer strips, Removal of chosen migration obstacles, Extended liming

6 Monitoring program

Swedish guidelines for monitoring according to the WFD are in progress and will be ready in 2006. The suggested monitoring frequencies within BERNET follow the WFD Annex. More information of the suggested monitoring program is presented in Annex I.

6.1 Watercourses

Surveillance monitoring will be performed in those four river water bodies where the ecological status is classified as "good" (Figure 6.1). In addition, the sampling station at the river mouth is included in order to describe the long-term development of water quality, and to calculate the nutrient supply to the Laholm Bay. Another sampling station in the middle section of the river is also included, so that the influence of forest-dominated areas can be assessed. The main pressures are acidification and eutrophication and this will reflect the design of the monitoring program. In areas affected by acidification, measurements of water quality are combined with monitoring of macro invertebrates and fish.

Operational monitoring is needed in order to validate the status classification, and to form the basis for classification of water bodies with unknown status. Efforts will focus on eutrophication and acidification. The ongoing monitoring of liming effects will be an important part of the operational monitoring program. Besides water quality, the ecological status will be assessed using macro fauna and fish. A minimum of 13 stations are suggested, of which five are part of the current liming program.

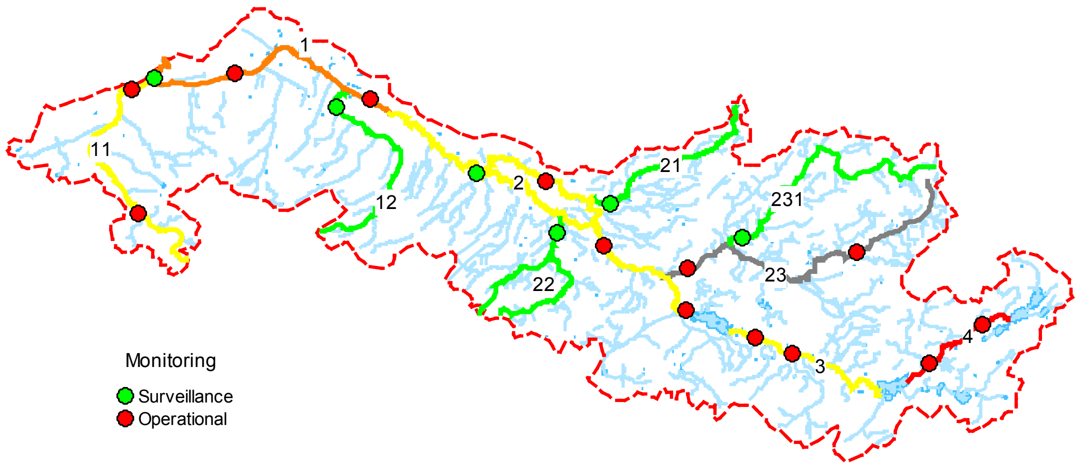


Figure 6.1. *Schematic outline for surveillance and operational monitoring stations in rivers water bodies. The colors of the river water bodies describe ecological status in accordance to the WFD.*

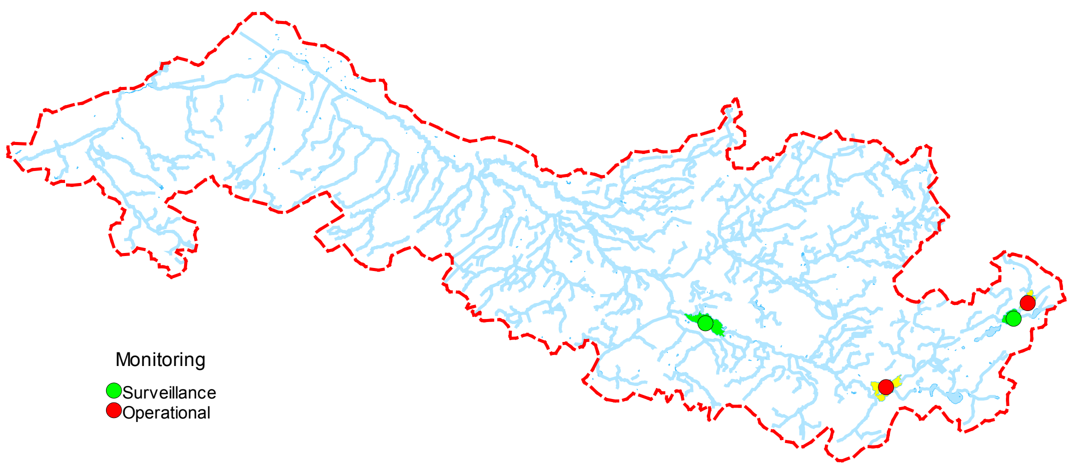


Figure 6.2. *Schematic outline for surveillance and operational monitoring stations in lake water bodies. The colors of the lakes describe ecological status in accordance with the WFD.*

6.2 Lakes

Surveillance monitoring comprises the two lakes assessed as having “good ecological status”. In the lakes in question, priority pollutants are considered not relevant based on current knowledge about the use of such substances.

Lakes Vemmentorpasjön and Svartasjö are both assessed as having “moderate ecological status”. Acidification is the main pressure and monitoring therefore focus on water quality, macro fauna and fish.

6.3 Coastal waters

The preliminary assessment of ecological status of the bay points at “poor” or “moderate status”. This might change depending on the final design of the revised environmental quality criteria (announced to 2006). For the moment, however, all monitoring in the bay will be operational (Figure 6.3). The operational monitoring is based on the currently running monitoring program.

6.4 Groundwater

Existing monitoring only compromises the public waterworks. The SGU points out a need for a deepened analyze including an improved data basis over the groundwater bodies considered to be at risk or at unknown risk in the area (Figure 2.2.3). Such a monitoring program has not been prepared yet.

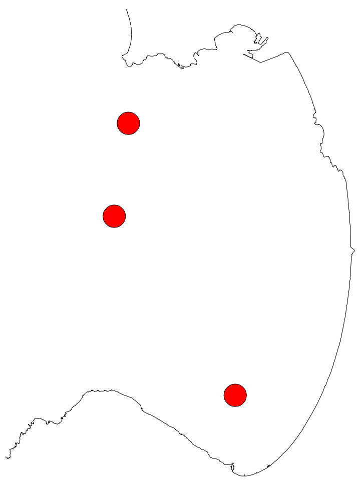


Figure 6.3. *Monitoring stations for coastal waters.*

7 Public participation

7.1 Stakeholders

In the River Stensån basin, there is currently no advisory board, working group or water management committee. The public participation in water management has to start from scratch.

Three core actors and 17 other stakeholders have been identified. The core actors are defined as authorities on regional or national level with legislative competence in the implementation process of the Water Framework Directive (WFD). Other stakeholders can be involved in the implementation process in relation to their influence on the water bodies – active involvement, consultation or information receiver.

7.1.1 Opinion among stakeholders

A short questionnaire was sent out by post in May 2004 to 38 representatives of stakeholders in the River Stensåns catchment area in order to receive information about the current public opinion of the water status. 74 % answered the questions.

The answers were distributed on the following categories:

1) Core actors from county administrations and municipalities
2) Representatives for agriculture
3) Representatives for outdoor life and nature and cultural interests
4) Operators with influence on the water status
5) Citizens in the catchment area

The stakeholders generally consider that they are well informed about the water status of River Stensån, and there is no great difference between the different categories (Table 7.1.1a). In general the stakeholders have a positive understanding of the competence of the core actors. But there is a great difference in opinion on how to combat water pollution and eutrophication. One question read: What types of measures are the most effective for improvement of the water status of River Stensån and the Laholm Bay? The answers were ranked from 1 to 5, where 1 is best effect and 5 worst effect.

The following public participation process was carried by three meetings with focusing on 1) the basic description, 2) environmental objectives and headlines in water management and 3) practical and economic prerequisites to implement the proposed measures. In connection to the meeting, a working group was supposed to be established.

Type of measure to combat eutrophication	Gov.& municip.	Agricul-ture	Nature & culture	All together
Measures in agriculture	1.0	3.2	1.4	2.6
Measures for scattered houses	3.0	3.0	3.4	2.6
Measures in sewage treatment plants	4.3	2.2	3.0	2.5
Wetland restoration	4.0	2.6	3.0	3.4
Measures in forestry	2.7	4.0	3.0	3.5

Table 7.1.1a. *Priority measures in the River Stensån basin according to different categories of stakeholders.*

About 25 stakeholders representing the municipalities, nature preservation, farmers and anglers participated in the meetings. The farmers stressed the importance of a clear basic description. The water status has improved considerably by the basic measures that have already been taken. It is important to remember that there is a time lag between implementation of a measure program and results registered in monitoring program. Such time lag for improvement should be taken into account when measures are decided for the achievement of "good status". Programs of measures must also include the resources and means for realization to be reliable.

Representatives for anglers, outdoor life and nature pointed out the need of a high biodiversity and "good ecological status "of water. Good water quality of both surface and groundwater will also contribute to a positive development of the area.

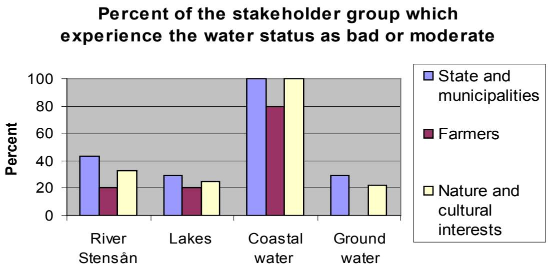


Figure 7.1.1. The *opinion on water quality among stakeholders.*

Representatives for the municipalities and the county administration focused on the atmospheric deposition as an important nitrogen source for both acidification and nitrogen transport. Together with the farmers they asked for a clear description of the present situation of water status.

Public participation process will continue with a regional conference on public participation in May 2006 (Table 7.1.1b).

Activity	Date
Identification of stakeholders by name and address.	April 04
Preparation of questionnaire to the different stakeholders.	May 04
Evaluation of the answers of the questionnaire.	June 04
International cooperation about the management plan.	Aug 04
Meeting with the stakeholders where the results of the questionnaire will be presented, the status of Stensån and the environmental objectives of the river basin management plan.	Oct 04
Identification of obstacles and the key problems in the protection and restoration of surface and ground water in Stensån catchment.	Jan 05
Invitation of the stakeholders to participate in the implementation process of the WFD and to appoint representatives to a provisional co-operative body for the WFD.	Feb 05
Remittance of the first draft of the management plan and a plan for the public participation and co-operation in the implementation of the WFD.	Feb 05
Meeting with the stakeholders to present and discus management plan.	Nov 05
Regional conference on public participation.	May 06

Table 7.1.1b. *Activities in the public participation plan in River Stensån.*

8 Economic analysis

According to stipulations in the Water Framework Directive (WFD), economic analyses of water use in different sectors are required. The aim is to assess the possibilities to reach the targets for water quality by 2015 at reasonable costs, and to develop cost effective programs for restoration and management that will be part of the management plans in 2009. By 2010 pricing of water services should give full coverage of costs.

We have, in general, here in Sweden, little knowledge when it comes to "the value of water".
Historically, we have nearly always had an abundance of water for consumption and the quality has often been extremely high. In connection with the implement of WFD, different studies have been made both at universities and colleges about what the economical consequences are expected to be.

8.1 Aim of the economic analysis

In the Swedish context the economic analysis has three main steps:

- An analysis of the characteristics and status of each River Basin District
- A review of the impacts of human activities, to assess whether the water quality objectives will be met or not
- An analysis of necessary measures and the economic consequences of guiding decisions.

8.2 Assessment of the economic significance of water use

The directive defines costs as economic costs, which are the costs to society as a whole, opposite to financial costs which are the costs to particular economic agents. Economic costs are the sum of financial costs, resources, and environmental costs. Financial costs are the costs of providing and the administrating of water services. They are usually broken down into a number of elements: operating costs, maintenance costs, capital costs, including depreciation and costs of capital, and administration costs. Resource (-alternative) costs represent the costs of foregone opportunities that other uses suffer. Environmental costs represent the costs of damage that water usage imposes on the environment and ecosystems, and to those who use the environment! The aim is to cover the costs for water services and that the price policy will stimulate an efficient usage of water resources.

The use of water resources, focusing above all on the following sectors:

- households
- industry
- agriculture
- public sector

8.2.1 Trend in water demand

It has not been possible in this report to obtain information about the development of the need of water in the four municipalities within the river Stensån drainage basin. The only information in general comes from the municipal waterworks. However a rough estimation has been done on water consumption that is prevalent for the area.
Groundwater is solely used for water supply within the river Stensån Basin and even surface water is used to a certain extent, mostly in agriculture (irrigation). Generally in Sweden, the use of water in agriculture is, 70 % for irrigation and 30 % for livestock. Solely groundwater is used with livestock. At a rough guess the need of water will somewhat decrease in the future. Energy campaigns in the municipalities are one of the main reasons. The leakage of groundwater from the construction of the railway tunnel shall in time decrease rapidly (10 % of leakage today), when the necessary sealing has been done. Irrigation of agriculture crops vary from year to year depending on climatic factors.

8.2.2 Economic significance

No information has been compiled, at the present time, of the connection of usage of water within the three main consumers: Household- Industry-Farms. Household is the only area where good and trusty information is found on the municipal handling of drinking water, treatment of waste water and the usage of water in recreation.

Urban Water Supply & Waste Water Utilities are in almost all Swedish municipalities owned and operated by the municipality council. For this management and operation Sweden has specific legislation, the Water and Waste Water Act. As water is regarded as an essential commodity, the law stipulates that water tariffs may not allow for any profit. (However you are allowed to run them at a loss!) By law, the local councils in Sweden require citizens whose properties are connected to a municipal sewerage system to pay a connection fee. The size and composition of the connection fee, which must be reasonable, is decided by local councils. Mostly, local councils set the fees dependent on the area of the property, number of apartments etc. For a normal one-family house the connection fee in Laholm, is at present, 58 500 SEK.

The costs for production and distribution of drinking water and handling of wastewater are financed by means of tariffs. The cost for each user is based on the amount of water measured at the individual property. With apartment blocks, however, no individual measuring of water consumption is done for each apartment. This results in a significant higher consumption (25%).

Two components, one part fixed annual and one part connected to the measured water consumption build up the tariff system. In Laholm municipality the predetermined annual part at present corresponds to approx. 40% of the total fee. Connection fees and tariffs are, according to law only allowed to meet the costs of the operation and maintenance of the municipal water and sewage system. It's not allowed for the local authorities, as mentioned above, to "overtaxing" the inhabitants by high water tariffs.

The supplying of industry with drinking water and the disposal of their waste water are mainly made by the municipality, and they have to pay in accordance to the fee. There are no major outlets of industrial pollution to sewers within the Stensån area. The contamination in the groundwater from the tunnel project is not lead to any waste water treatment plant, but instead led directly to a nearby watercourse, which runs into the Laholm Bay. All costs of the handling of water are taken care of by owners of the tunnel project. Included in the costs are the sealing of leaking groundwater, the diverting of leakage water, the taking of water specimens and fees for supervision from authorities. Also included in the costs is compensation to landowners for the drying out of wells in connection to the lowering of groundwater.

Agriculture uses water as a necessary input to both livestock and crop production. Mostly groundwater from private abstraction wells is used with livestock; only a small percentage comes from the public waterworks. A large part of the diffuse pollutions containing nitrogen and phosphorus, originate from farmlands.

8.2.3 Cost-effectivness

The aim is to achieve cost-effectiveness, in other words the target shall be reached with the cheapest combination of measures (Article 5, appendix III). To obtain a proper basic data for the resolutions, an analysis of the different alternatives must be carried out, so that the basis of costs and effectiveness can be placed in order of precedence. It is recommended by the Water Framework Directive (WFD) that an estimate is carried out so that the lowest price per effectiveness is found.

Many reports have been done the past few years in Sweden regarding different effective measures for cost-effectiveness. It became obvious that there is built-in uncertainty around questions to do with "reduction potential" and the costs for accomplishment. The largest uncertainty (+/- 50%) was found in effective measures within agriculture and the municipal treatment for sewage and storm water. However this was found quite the opposite in the building of private sewage treatment plants, where uncertainty was found to be considerably less (+/- 10%). Standardized solutions and known costs are considered the explanation for this.

Many effective measures since the 90´s have especially focused on the reduction of the load of nitrogen contamination from agriculture, forests and municipal sewage treatment works. Extensive work, within agriculture, has been done e.g. protection zones, better handling of manure, information and the building of wetlands. The sewage treatment works (> 10 000 PE) has been modified with advanced nitrogen removal. It was pointed out in one of the first cost-analysis that the most effective measure to reduce nitrogen loading to the sea was to build wetlands. The figure equivalent to 10 SEK/kg- removed nitrogen was often named, however in sewage treatment plants the equivalent figure named, was 100-150 SEK.

Do we know better today? By experience a more realistic figure is 35-50 SEK/kg removed nitrogen in treatment plants. The specific costs for the separating of nitrogen in the wetlands are today very difficult to give and vary greatly from wetland to wetland. The retention between different wetlands can vary between 25-1 000 kg/ha (!), which make a realistic estimation extremely difficult, especially when working with ratios and gauge levels. But, 10 SEK/kg N in wetlands is probably an understatement. Figures between 50 and 100 SEK seems with today experiences to be more realistic.

There is no available information over what the prices of effective measures will be within agriculture. A question to think about in the future is what the concept "cost-effectiveness" includes. Hopefully the concept "greatest possible benefit" will be included in our consideration. The environment has a price but what price? How long can we afford to wait to see improvements? While waiting, more environmental areas go into decline and may well never recover to its original state of condition. Despite many different efforts made to reduce the loading of nitrogen contamination in the drainage basin of the Laholm Bay, present trend graphs, show no evident reduction of emissions.

8.3 Trends in water use

There is today, all in all, no information about water usage within the river Stensån Basin. The consumption of water is a good indicator of how much water is used. A prognosis for future water usage is decided mainly on the population basis and the usage of land. The share from industry, apart from the leakage in connection with the tunnel construction is negligible. If today's land usage remains the same, in other words the same crops are cultivated and the number of livestock remains the same, then probably the consumption of water will not increase to any large extent. There is however a greater probability that consumption can somewhat reduce due to above all the reduction of pig-stock. Poor profits are the main explanation for this.

Figure 8.3 shows the consumption of drinking water over the past 10 years in the municipality of Laholm. No significant trends can be made. The variations can mainly be explained by climatic factors, e. g. increased irrigation during dry periods and the influx of tourists during the holiday period.

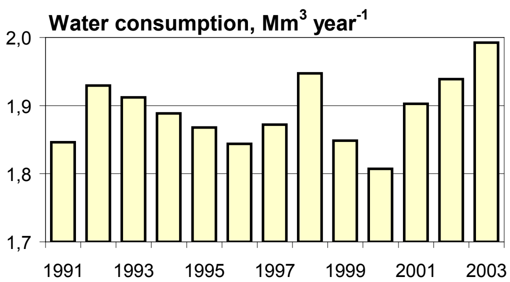


Figure 8.3 *Consumption of drinking water in the municipality of Laholm 1991-2003.*

8.4 Cost recovery

In the Water Framework Directive and in the recommendations it is stated that all members of the states shall aim for the cost recovery when it comes to water services. The Polluter Pays
Principle applies; industry, household, agriculture among others shall contribute to the financing in a satisfactory way. Price politics shall stimulate to an effective usage of water resources. Consideration shall also be taken to social, environmental and economical effects, together with geographical and climatic factors, where cost recovery is determined.

The cost for the getting and distributing water is a financial cost, to be paid by households and companies. There is generally a public water provision system in the built-up areas while inhabitants have their own water source supply in the scattered housing areas. In agriculture the water is generally used for livestock and for irrigation purposes.

When it comes to making use of watercourses as recipient the demands of payments vary. Waste water is accumulated and purified to different levels in the built-up areas depending on the stipulations given by the authorities. The costs are put together in a water and waste water fee. Householders in the country are in principle, bound to arrange the satisfactory taking care of their own waste water. Unfortunately, even today much of this sewage is still inferiorly dealt with. Sewage from sparsely built-up areas accounts for a significant part of the supplying of nutrients to the watercourses. The main culprits of pollution-outlets, foremost nitrogen, are accounted for by and large, by agriculture. The diffuse leakage is difficult to determine and obtain readings on, so therefore, also difficult to put a charge on in the future. Reliable gauge estimations are in the future a possibility.

There are few charges in the Swedish water administration. Possible means of control to
economize with the natural resources is the water and waste water fee, tax on fertilizers and
pesticides. Today the tax on trading fertilizer is 11.80 SEK/kg and 30 SEK/g Cd (over certain given levels).

It has not been possible with today's knowledge to do cost recovery estimations for water services used in the river Stensån Basin. However from experience gathered from other areas we can safely say that cost recovery for the urban households' water and waste water services are more or less 100 %. Even abstraction

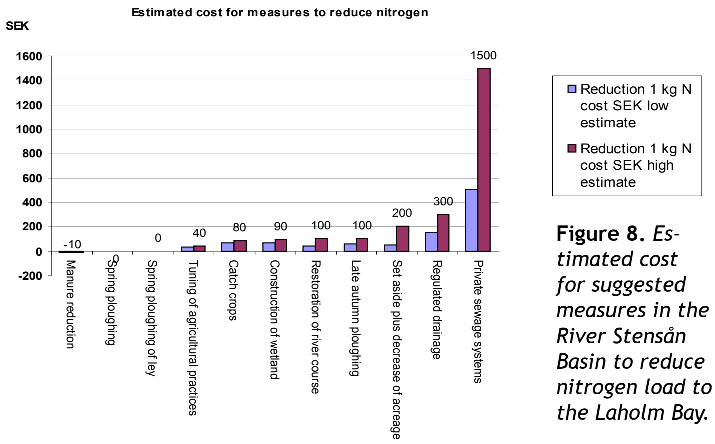


Figure 8. *Estimated cost for suggested measures in the River Stensån Basin to reduce nitrogen load to the Laholm Bay.*

of water in sparsely built areas and from farms has a high extent of cost recovery. However, when it comes to the environmental costs caused by diffuse contaminations from agriculture and private sewage, then the recovery is low.

8.5 Costs for suggested measures within the River Stensån Basin

Figure 8 presents a rough comparison between the costs for suggested measures to reduce the nitrogen load to River Stensån (see also chapter 5 this report of which figure 8 is a summary from).

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Annex I

Quality element	Frequency	Interval	Comment
Biological			
Phytoplankton	2/yr	Every year	6/yr, every 2'd year?
Phytobenthos	1/yr	Every 3´d year	
Macroalgae	1/yr	Every 3´d year	Every year?
Macro invertebrates	1/yr	Every 3´d year	
Hydromorphological			
Morphology	1/yr	Every 6´th year	
Physical-chemical			
Physical	4/yr	Every 6´th year	Not enough?
Chemical	4/yr	Every 6´th year	Not enough?
Priority pollutants	12/yr	Every 6´th year	Sediment and/or biota
Other pollutants	4/yr	Every 6´th year	Sediment and/or biota

Table a. *Monitoring frequency for surveillance of coastal waters according to the WFD.*

Suggested monitoring

Laholm Bay

Ecological status: Moderate
Pressures: Eutrophication
Type of monitoring: Operational

Quality elements — frequency — number of sites/stations:

- Macro invertebrates — 1/yr, every year — 3 stations
- Phytoplankton — 12/yr, every year — 1 (2) stations
- Macro algae — 1/yr, every 3'd year — 5 stations
- Physical-chemical — 12/yr, every year — 2 stations
- Priority pollutants — once — 1 station

River water bodies

Table b. *Frequency for surveillance and surveillance monitoring of river water bodies according to the WFD.*

Water body	Ecological status	Pressure	Type of monitoring	Quality elements frequency, number of sites/stations							
				Macro-invertebrates	Fish	Macro-phytes	Continuity	Hydrology	Morpho-logy	Physical chemical	Other pollutants pesticides
1. Stensån	Poor	Eutrophication, physical modification	Operational (and surveillance)	1/yr, every year, 1 station	1/yr, every 3'd year	1/yr, every 3'd year	-	Modelling of weekly flow, 1 station (river mouth)	1/yr, every 6'th year	12/yr, every year, 1 station*	6/yr, every 3'd year, 1 station
2. Stensån	Moderate	Eutrophication, acidification	Operational (and surveillance)	1/yr, every year or every 3'd year, 2 stations	1/yr, every year, 3 stations	1/yr, every 3'd year	-	Modelling of weekly flow, 1 station	-	12/yr, every year, 1 station** and 4-12/yr every year, 3 stations ***	-
3. Stensån	Moderate	Acidification	Operational	1/yr, every year, 1 station	1/yr, every year, 1 station	-	-	-	-	6/yr, every year, 2 stations	-
4. Stensån	Bad	Acidification	Operational	1/yr, every year, 1 station	1/yr, every year, 1 station	-	-	-	-	6/yr, every year, 2 stations	-
11. Örebäcken	Moderate	Eutrophication, physical modification	Operational	1/yr, every year, x station	1/yr, every 3'd year, x station	1/yr, every 3'd year	-	Modelling of weekly flow, x station	1/yr, every 6'th year	6/yr, every year, x station	-
12. Dalabäcken	Good	?	Surveillance	1/yr, every 3'd year, 1 station	1/yr, every 3'd year, 1 station	1/yr, every 3'd year	1/yr, every 6'th year	-	1/yr, every 6'th year	6/yr, every 3'd year, 1 station	-
21. Eglabäcken	Good	?	Surveillance	1/yr, every 3'd year, 1 station	1/yr, every 3'd year, 1 station	1/yr, every 3'd year	1/yr, every 6'th year	-	1/yr, every 6'th year	6/yr, every 3'd year, 1 station	-
22. Klippebäcken	Good	Acidification	Surveillance (will be part of the follow up of liming)	1/yr, every 3'd year, 1 station	1/yr, every year, 1 station	1/yr, every 3'd year	1/yr, every 6'th year	-	1/yr, every 6'th year	6/yr, every year, 1 station	-
23. Lilla Stensån	Unknown	?	Operational	1/yr, every 3'd year, 2 stations	1/yr, every 3'd year, 2 stations	? 1/yr, every 3'd year	1/yr, every 6'th year	-	1/yr, every 6'th year	6/yr, every year, 2 stations	-
231. Tributary to Lilla Stensån	Good	?	Surveillance	1/yr, every 3'd year, 1 station	1/yr, every 3'd year, 1 station	1/yr, every 3'd year	1/yr, every 6'th year	-	1/yr, every 6'th year	6/yr, every 3'd year, 1 station	-

**surveillance of long term trends in water quality and water transport to the coast*
***surveillance of long term trends in water quality related to forest dominated areas*
****acidification parameters*

Lake water bodies

Table b. *Frequency for surveillance and surveillance monitoring of lake water bodies according to the WFD.*

Water body/Lake	Ecological status	Pressure	Type of monitoring	Quality elements frequency, number of sites/stations							
				Macro-invertebrates	Fish	Macro-phytes	Phytoplankton	Hydrology	Morpho-logy	Physical chemical	Other pollutants pesticides
1. Sjöaltesjön	Good	Eutrophication, acidification	Surveillance*	1/year, every 3'd year, 1 station	1/year, every 3'd year*'	1/year, every 3'd year	6/year, every 3'd year	-	1/year, every 6'th year	4/year, every year***	-
2. Vemmentorpa-sjön	Moderate	Eutrophication, acidification	Operational	1/year, every 3'd year, 1 station	1/year, every 5'th	-	-	-	-	4/year, every year	-
3. Svarta sjö	Moderate	Acidification	Operational	1/year, every 3'd year, 1 station	1/year, every 5'th	-	-	-	-	4/year, every year	-
4. Vita sjö	Good	Acidification	Surveillance	1/year, every 3'd year, 1 station	1/year, every 3'd year	1/year, every 3'd year	6/year, every 3'd year	-	1/year, every 6'th year	1/year, every 3'd year	-

Annex II

Regulation and permits effecting the water and the use of water in River Stensån basin (in Swedish)
Regler och tillstånd som påverkar Stensån

Abstraction of water/Vattenuttag

Järnvägstunnel genom Hallandsås. Dom 2003-10-17 i mål M 1894-03, Svea Hovrätt. Tilltånd om bortledande av grundvtten med i medeltal 100 l/s som ett rullande 30 dygns-medel under konstruktionstiden.

Stensån, vattenbortledning för Vallåsens skidanläggning. Dom 1991-02-01. DVA 1/1991, VA69/1989, Vattendomstolen, Växjö Tingsrätt. Tillstånd till uttag om högst 252 m^3/h (motsvarande 70 l/s) under perioden 15 nov till 15 mars under förutsättning att nedströms flöde överstiger 150 l/s.

Grundvattentäkt Dömestorp. Dom 2000-07-07. M81/99, Miljödomstolen Växjö Tingsrätt. Uttag i två brunnar om 40 resp. 26 l/s. till årlig sammanlagd volym om 1095000 m^3, högst 3900m^3/dygn.

Grundvattentäkt Eskilstorp. Dom 1979-02-28. DVA 11/1979, VA 7/1978. Tillstånd till att ta ut högst 3 280 m^3 grundvatten per dygn under månaderna juni, juli och augusti, dock högst 2 160 m^3 per dygn i medeltal per år. Motsvarande 788 500 m^3/år.

Bevattningsplan Länsstyrelsen i Halland. XX-XX Vattenuttag får ej ske vid lägre vattenföring än 300 l/s i huvudfåran. Peglar för avläsning finns vid Kärramölla (Åstarps Bro) och i Båstad och får ej visa under +19 respektive +3 cm. För havsöringsbäckar i avrinningsområdet måste minimivattenföringen vara minst 25 l/s och meter bäckbredd nedströms vattenuttaget.

Drainage societies/dikningsföretag
Hallands län
Nr 685 Röhögsbäckens regleringsföretag 1933, St. Dömestorp
Nr 343+918 Lilla Dömestorp dikningsföretag 1938.
Nr 248+670 Stora Dömestorp och Hasslövs torrläggningsföretag 1926.
Nr 208+666 Lilla Dömestorp m fl torrläggningsföretag 1924.
Nr 346+919 Stora Dömestorp nr 1-4 dikningsföretag 1938
Nr 100 (77) Stora och Lilla Stensåns regleringsföretag 1957
Nr 141 Stensåns regleringsföretag 1917.
Skåne län
Dikningsföretag i Skåne län, endast redovisade i karta (Figure 2.1.3a).

Masterplans/ Översiktsplaner och detaljplaner inom avrinningsområdet
Framtidsplan 2003 – översiktsplan Laholms kommun. Antagen 2004-01-29.
Översiktsplan Båstads kommun. Antagen 2001.
Översiktsplan 2004 för Ängelholms kommun. Antagen 2005-06-20.
Översiktsplan Örkelljunga. XX-XX
Planremiss
Översiktsplan Båstads kommun. Utställd för samråd t.o.m. 2006-04-24.

Protected areas/ Särskilda regler kopplade till skydd av områden
Stensåns mellersta FVO. Beslut 1998-06-05, 11.379-2177-87, Länsstyrelsen Halland.
Nedre Stensåns FVO. Beslut XX-XX.
Mussel och fiskevattendirektiv. SFS 2001:554, NFS 2002:6.
Björsåkra – Bölinge. Bevarandeplan SE0510001, fastställt 051228.
Åstarpa mosse. Bevarandeplan SE0510003, fastställt 051228.
Vallåsen. Bevarandeplan SE0510103, fastställt 051228.
Dömestorp. Bevarandeplan SE0510122, fastställt 051228.
Tjuvhultakärret. Bevarandeplan SE0510174, fastställt 051228.
Svinamadsbäcken. Bevarandeplan SE0510173, fastställt 051228.
Ekered. Bevarandeplan SE0510002, fastställt 051228.
Klinta Hallar. Bevarandeplan SE0510160, fastställt 051228.

Föreskrifter vattenskyddsområden. NFS 2003:16 AR 2003:16.

Våtmarker i myrskyddsplan. Inge objektspecifika skydd utöver generellt förbud mot markavvattning enligt 11 kap MB §§13-14, Skogsvårdslagen om skyddsdikning.

Point sources/ Regler som styr punktkällor
Hedhusets reningsverk. Miljöprövningsdelegationen 1999-08-16, Mpd 246-9086-98, Länsstyrelsen Halland.

Enskilda avlopp. MB kap 9 §6, i övrigt enligt 12 § i förordningen (1998:899) om miljöfarlig verksamhet och hälsoskydd (FMH).
Remiss
Enskilda avlopp. Naturvårdsverkets allmänna råd [till 2 och 26 kap. miljöbalken och 12-14, 18 och 19 §§ förordningen (1998:899) om miljöfarlig verksamhet

och hälsoskydd] om små avloppsanordningar för hushållsspillvatten. Ej beslutad.

Land use/ Regler som styr markanvändning
Förordningen om miljöhänsyn i jordbruket. SFS 1998:915 och Statens jordbruksverks föreskrifter om miljöhänsyn i jordbruket vad avser växtnäring SJVFS 2004:62 (ändrad i SJVFS 2005:74).

Laholmsbuktsföreskrifterna. 13 FS 1996:84 om ändring i länsstyrelsens i Kristianstads och Hallands län föreskrifter (11FS 1988:1 och 13FS 1987:26) om åtgärder för att minska föroreningstillförseln till Laholmsbukten. Länsstyrelsen Halland

Use of pesticides/Bekämpningsmedel
Naturvårdsverkets allmänna råd 97:3.

Statens naturvårdsverks föreskrifter om spridning av kemiska bekämpningsmedel. SNFS 1997:2.

Monitoring/ Miljöövervakning
Pågående recipientkontroll Stensån
Regional miljöövervakning i Hallands län - Program för 2002-2006. Länsstyrelsen i Halland
Regional åtgärdsplan för kalkning av sjöar och vattendrag i Hallands län. Länsstyrelsen Halland
Pågående recipientkontroll Laholmsbukten
Program för samordnad kustvattenkontroll i Hallands län. Länsstyrelsen i Halland.
Kommunal kontroll vattentäkter. Ej sammanställt material
Övriga undersökningar, enskilda brunnar. Ej sammanställt material