WaterDrive
Tjust Coast Pilot
Lofta river basin - measures to reduce nutrient leakage in Vastervik Municipality, Sweden

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Background

Västervik Municipality is located in southern Sweden, in the north of Kalmar County with the Tjust archipelago and the Baltic Sea in the east. Västervik covers one of the largest municipality areas in southern Sweden. The land area covers 1 875 km² and there is almost as much water area as land area.

Agriculture and forestry are important sectors in Västervik. The tourism industry is also important for Västervik, as the municipality receives about 1.5 million visitors annually.

Västervik Municipality has a long coast and an extensive archipelago. It provides many opportunities for development, but also includes responsibility for the Baltic environment. Västervik archipelago, covered by about 5000 islands, offers a variety of outdoor activities and a rich fish selection. Most of the bays are deep with a shallow mouth. The exchange of water between the inner deeper part and the open sea is low. This makes benthic ecosystems particularly vulnerable. The poor water circulation leads to nutrient-rich water and bad oxygen conditions at the bottom. As Västervik is characterized by its proximity to the Baltic Sea, the eutrophication problem is palpable. Coastal Water sensitivity to eutrophication is higher in the inner archipelago. The symptoms of eutrophication have been obvious; including increased distribution of algae's, decreased water transparency and reduced opportunities for recreation.

Västervik has been working for many years in a holistic way to reduce the nutrient load. Sustainable work (year after year) with advising, local projects and high requirements in wastewater treatment and agriculture has been the method. Always in collaboration with stakeholders, farmers and owners of property/houses. Västervik has invested in improved sewage treatment plants. Recently the renovation of the Gamleby municipal wastewater treatment plant was completed. The plant has a modern technology with remote monitored processes and high nitrogen reduction. Västervik has set high requirements for small private wastewater treatment systems. An adviser has during several years been working with areas with summerhouses. Information and discussions about problems and solutions for sustainable wastewater has been in focus.

Since the anthropogenic nutrient load to the coastal waters is dominated by agriculture the municipality is focusing on reducing emissions from agriculture. Many different measures have been successfully developed and implemented by local farmers. Some examples are; construction of wetlands, liming to improve soil structure, and two-stage ditches, mussel farming, etc. A prerequisite for success is that measures can be done with economically sustainable methods.

Theme Water is an intersectoral body for water issues in Västervik that ties together various municipal "roles" of authority, development, wastewater treatment, etc. TW was formed in 2011 and includes the politicians in the presidiums of the Municipal Government, the Department of Environment and Planning and Västervik Energy & Environment AB together with the department managers and project leaders for municipal water projects.

Local strategy for reducing nutrient load

The Blue Vision for Västervik Municipality is to achieve Good Ecological Status in lakes, rivers and coastal water. This means that the ecosystems are healthy and in balance. The aim is to improve the water quality and at the same time increase the agricultural production. In cooperation with local stakeholders the Municipality recently has developed a Local Action Plan to decrease the nutrient load to the Baltic Sea. Three strategic objectives were set:

1. Reducing eutrophication in collaboration with stakeholders
2. Improve the coastal waters and reduce eutrophication through recycling of nutrients
3. The Citizens knowledge about the Baltic Sea and water ecology will increase by dissemination of information concerning water conservation issues

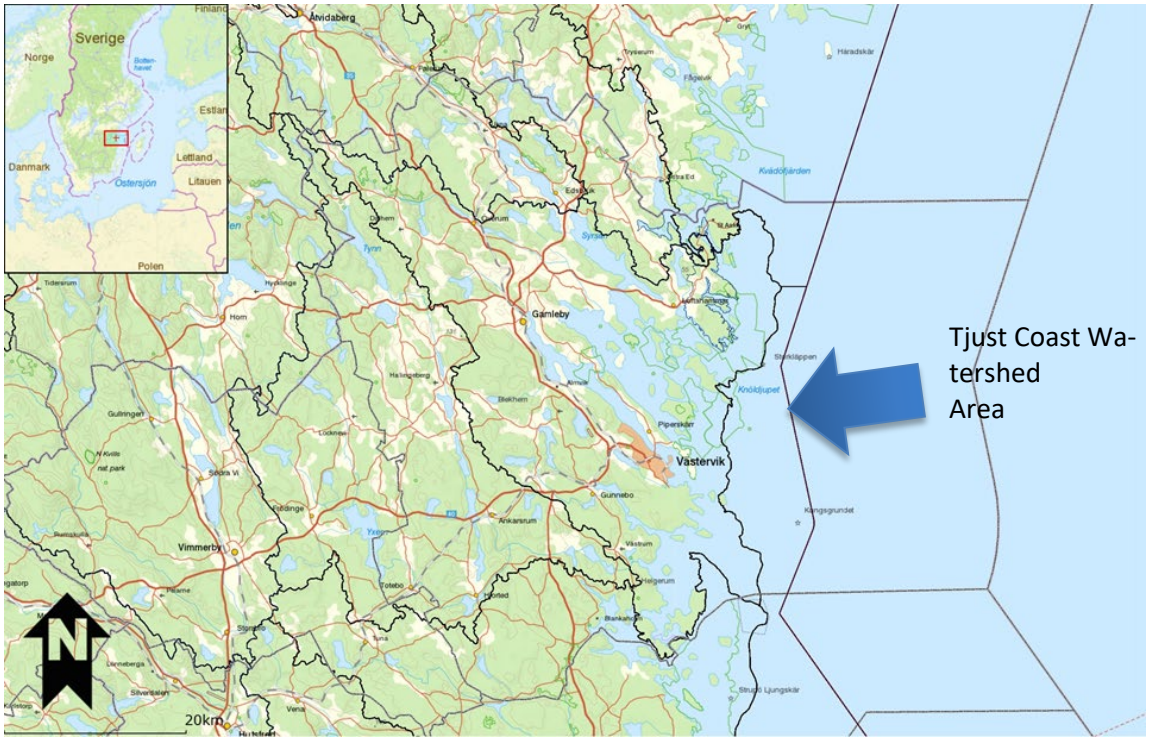
Climate changes are closely connected to the work with reducing nutrients. A local strategy for climatization, stormwater and sustainable water supply is integrated in the strategic work.

Pilot area Catchment officer

The Tjust coastal area is one of 20 pilot – areas - in Sweden with Catchment officers. In Västervik the work in this project will lead to more contact with farmers and stakeholders and much more measures in the landscape. The Västervik model will be used and developed. In Västervik an adviser is working together with a water coordinator. In that way the work with farmers can be integrated with other sectors in the community. The “Västervik method” will be able to be used in other pilot areas and by other catchment officers.

Tjust Coastal Area

Tjust Coastal Area is the largest river basin in Västervik Municipality. The whole area has problems with eutrophication but also with toxins and physical changes such as obstacles for fish. In the area between Västervik and north of Öland is a zone where the cold and nutrient-rich waters is welling up to the surface and the area is therefore of high importance for fishing. Along the inner coast there are several nature reserves and the entire archipelago is national interest for nature conservation and outdoor recreation. The landscape enters the archipelago with bays, islands and islets. The soils in the valleys are often clayey. Many of the bays, (Syrsan, Gudingen, Gamlebyviken, Vivassen and Verkebäcksviken), has a sill near the mouth that prevents a good water exchange between the inner, deeper parts of the bay and the open sea. This makes the bays, and the inner archipelago, extra sensitive to various types of contaminants.



Local demonstration Area Tjust Costal Area

The coastal area includes several smaller watersheds, such as: Loftaån, Dynestaån, Gamlebyån, Almviksån, Hörtigrumsån, Verkebäcksån, Gunneboån and has a total area of 710 km2. Agriculture is most intense along the coast and rivers. At Loftaån and Gunneboån there are old industrial environments where iron and metal processing lasted for several hundred years. Many of the rivers in the area are physically affected by dams and hydroelectric reservoirs.

Tjust WUP (Water Users Partnership) was formed officially in 2013. Much work has been done to reach out to a wide group of stakeholders. The Municipality of Västervik has the overall responsibility and the administrative services are carried out by Naturum Västervik – Natural Visitor Centre of Västervik. Water Users Partnership is a new method to implement measures through local and regional stakeholder cooperation.

Target Area - Gamlebyviken

Gamlebyviken is a deep sill bay with a limited water circulation. Already in 1923 it was classified as contaminated with large area of anoxic sea beds. The possibility to improve water quality through local action is good because a large part of the nitrogen and phosphorus load from land-based sources. Gamlebyviken is about 20 km long with an average depth of 12 meters, a maximum depth of almost 65 meters. Västervik Municipality have successfully implemented several large projects and local measures together with farmers in the area. Some examples are; construction of wetlands, liming to improve soil structure, and two-stage ditches, mussel farming, etc. The aim is to improve the water quality and at the same time increase the agricultural production. The main result is that the levels of nitrogen and phosphorus at Baggetorp river estuary have decreased. The water in the river has also become clearer. The nitrogen load from land declined by 10 tonnes a year and the load of phosphorus by 0.5 tonnes.

Link to our film about the Gamlebyviken project (in Swedish): https://www.youtube.com/watch?v=dFSIG24tO0c. The conclusion is that it is much easier and more cost effective to capture the nutrients through measures on arable land than in the sea. Actions have to be done in the right place and in the right way.

Target Area - Lofta River basin

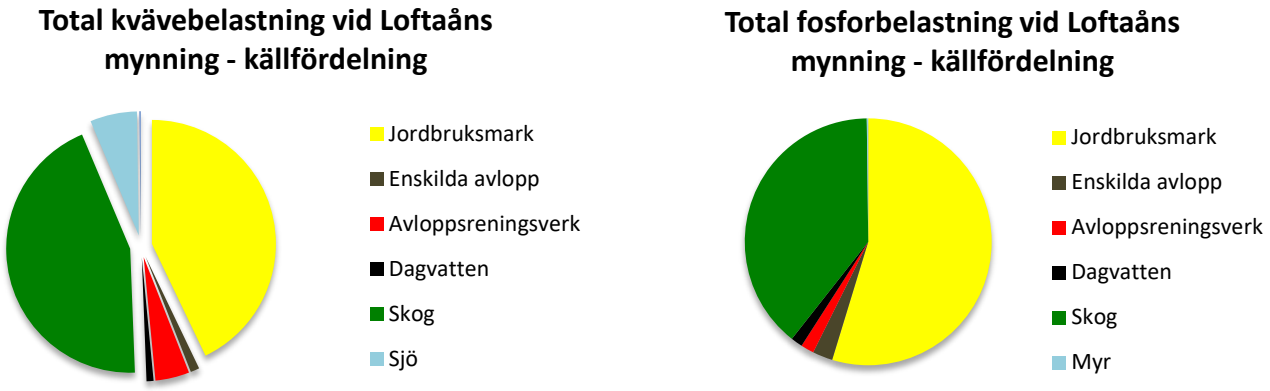
Loftaån sub basin opens into Gudingen. The ecological status is classified as moderate, poor or bad. SMHI water Webb's model for calculating the nutrient load in Loftaån estuary shows that nitrogen inputs to the sea is about 55 tonnes and phosphorus load is 2 tons per year. Agricultural land sources dominate. A local actionplan for water is etabliched. The plan is based om the national board for waterquality, HaV. It incluedes measures for decreased nutrient load but also actions for sustainable stormwater treatment, water delaying actions, and measures for biodiversity in and around the river. The plan applies from 2018 to 2021. A great amount of measures will be realised 2019-2021. The action plan was made in cooperation with Tjust Vattenråd, Wateruserpartnership in the area. The WUP concept involves stakeholders that either influences or are influenced by water in a given catchment area or by stakeholders that share an interest of the common water for different reasons, e.g. NGO:s, Water Authorities, land users and the academic sector. The stakeholders are invited to join the WUP as active members, new members can join the WUP also after it has been established. The objective for the WUPs is to gather local

knowledge and expertise. Furthermore, the WUPs implement concrete actions and innovative measures that combat negative impacts from anthropogenic activities. They also assist municipal/regional and/or national/international authorities to do the same.

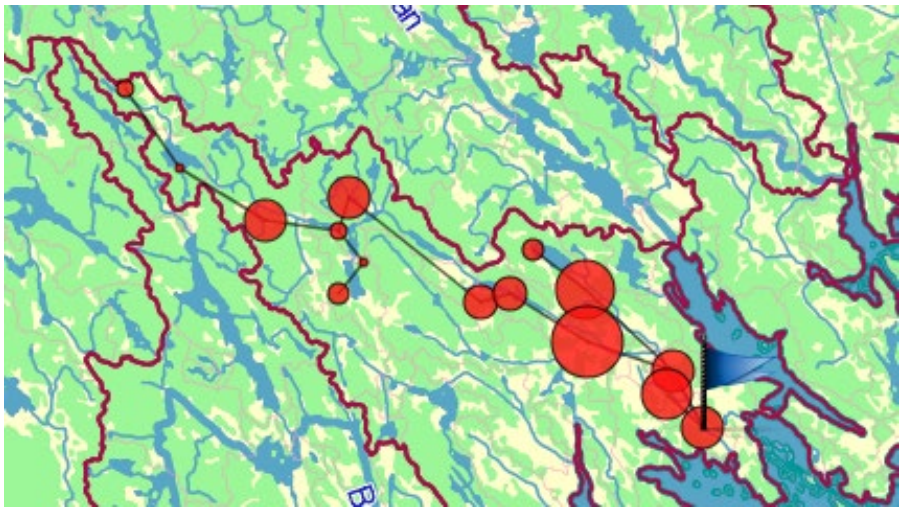
Measure	Areal	P decrease	Year
Structure lime	550 ha	85	2019-2020
Small wet-lands/ponds	10 ha	100	2019-2020
Soil map-ping	850 ha	128	2019-2020
Beveling ditches	500 meter	8	2020
Two stage ditches	500 meter	130	2020

Investmentplan from Action Plan Lofrtaån and project applications

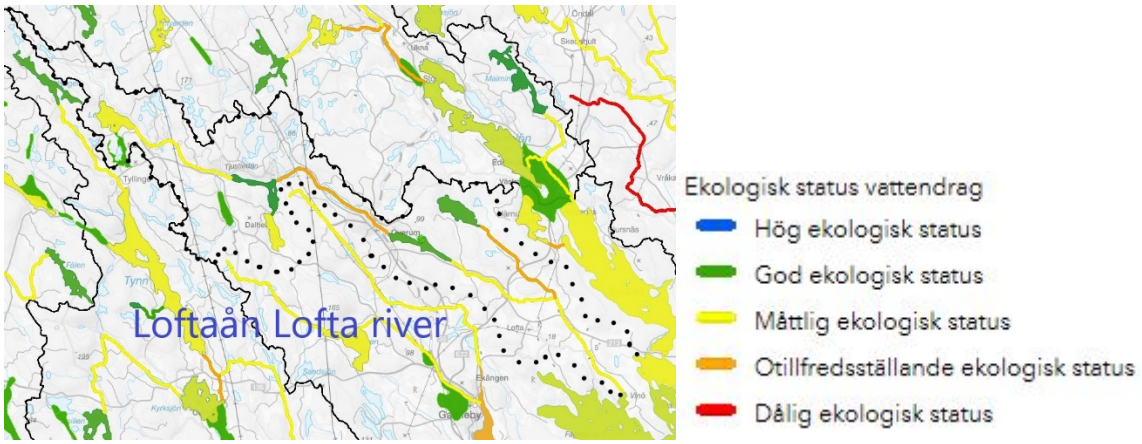
Loftaån Lofta river
55 km from the sring in the north west to Bay Gudingen in the Baltic Sea.



Nutrien load to Loftaån. To the left nitrogen and to the right phosforous
Yellow- Agricultural areas, Grey – Small waste water plants, Red Waste water plants (municipal), Black Stormwater, Forests, lakes/wetlands
Calculation by hydological method S-HYPE



Nutient load to Loftån in different parts



Ecological status Loftån.

The Västervik method – Sustainable agriculture and reduced eutrophication

Priorities to reduce nutrient leaching from agricultural land to the sea:

- Optimize the plant environment by efficient nutrients use (advice, adapted crops, increased root growth, adapted fertilization and improved soil structure)
- Keep the nutrients in the soil profile (reduces erosion, reduce soil compaction, improve soil structure, increase soil fertility)
- Stop the load of nutrients before it reaches the sea (sedimentation ponds, wetlands)
- Catch the nutrients from the sea (mussel, reed harvesting)
- Recirculate the nutrients (digestate sludge to biogas and bio fertilizer, irrigation on surrounding fields, toilet water as fertilizer)
- Consulting not only to farmers – At the same time advices to other groups as wastewater treatment, drinking water supply, forestry, stormwater treatment.

Suitable activities and measures so far;

Soil mapping, ecologically functional buffer zones, Structure Lime, Wetlands, Phosphorus dams, Bevelling ditches, Two stage ditches, Nutrient ponds for irrigation, Irrigation Dynestad.

Success factors "Västervik method"

- Act locally to create commitments between residents and farmers and other stakeholders in the area. Increased knowledge provides greater understanding of the measures.
- Make SWOT analysis on field/watercourses level with landowners and others involved.
- Develop a Local Action Plan for the watercourse in dialogue with stakeholders. Detailed priorities for the actions to be carried out.
- Simplify as much as possible with clear objectives
- Set common objectives that generate "win-win" concept both reduced eutrophication and increased harvest.
- Holistic work close to farmers, stakeholders, local and regional authorities.
- Active work with consultancy (advices) and requirements from authorities.

Conclusions and success stories

Gamlebyviken /Baggetorpsån

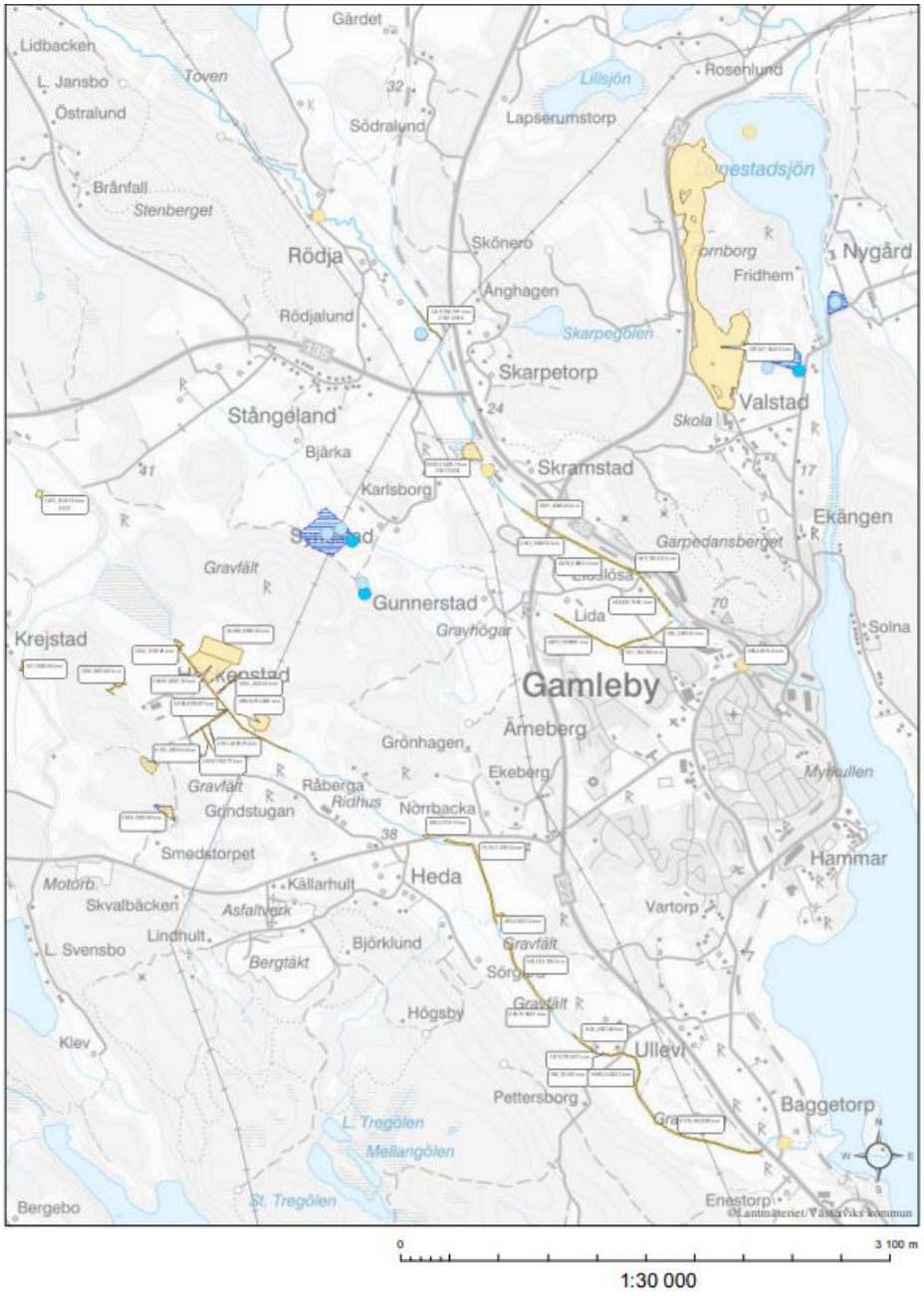
The work has received a very positive response from farmers. A holistic approach to environmental protection and agricultural production in close collaboration with landowners and local conservation organisations is required. The farmers believe that the land has become easier to cultivate, which is a result of the implementation of liming to improve soil structure. They also have fewer problems with flooded land and they have observed more even flow rates in the watercourses due to the installation of wetlands and two-stage ditches in the catchment. The farmers also indicate that yields have increased in the area. Farmers and houseowners are positive to measures when they know that their neighbour and other sectors also are working with nutrient leakage and measures. Through the project, it has become possible to get a few steps closer to the goals set up - through the use of new technology, new thinking and old experiences in the implementation of measures. The aim is to improve the water quality and at the same time increase the agricultural production. For best results it is needed to require a

holistic approach and strong local presence in close cooperation with stakeholders. We will use new, efficient technology, new thinking and old experiences. It is much easier and more cost-effective to capture the nutrients before they load into the sea. Measures should be in the right place and the right way. We know rather well what measures could be done. Monitoring shows that the nutrients in the small streams will be reduced after a couple of years. Levels of nitrogen and phosphorus at Baggetorp river estuary have decreased. The water in the river has also become clearer. Even in Bay Gamlebyviken we now start to see effects in ecological status.
The system with catchment officer from the local government seems to be a successful method. The farmers need daily contact with an adviser or coordinator to manage all the paperwork and contacts to different boards, stakeholders and authorities.

So far, a large number of local measures at farms has been realised. In an attached document our most common measures are explained.

- Soil mapping
- Ecologically functional buffer zones
- Structure Lime
- Small wetlands
- Nutrient (Phospor) ponds
- Two stage ditches and bevelling diteches
- Nutrient ponds for irrigation

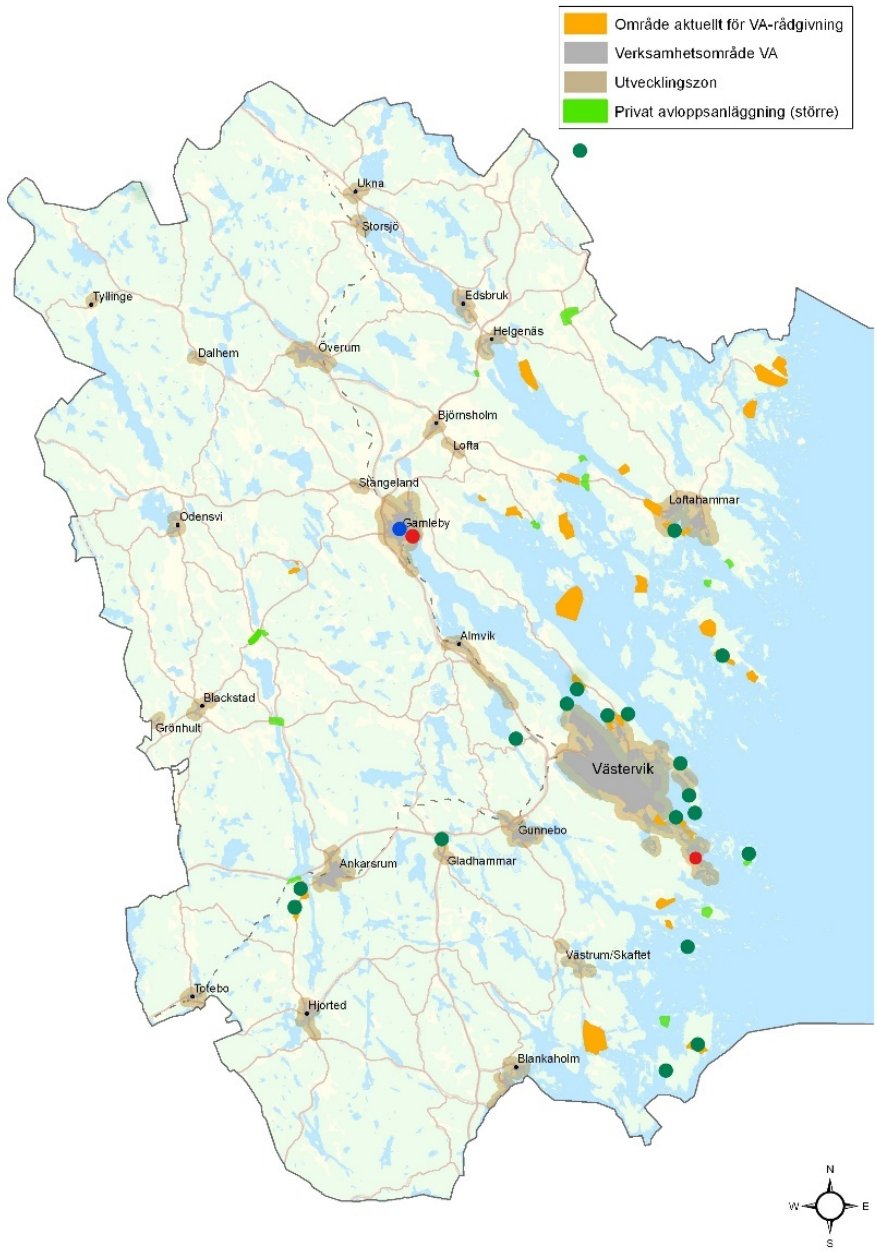
Irrigation with bottom water from Dynestad bay
The inner fjord of Gamlebyviken – Dynestad bay has been hit by several total collapses. During the collapse oxygen-free water rose to the surface and malodorous hydrogen sulphide vapours were released. The water contains extremely high concentrations of nutrients such as nitrogen and phosphorus. The average concentration from 6 meter to 16 meter is 15 mg N/l and 2 mg P/l. Moreover, the connection with the Baltic Sea results in different water layers with the salt content increases with depth. The measure to decrease eutrophication is pumping water from the Dynestad bay and use it for irrigation on surrounding arable fields. This will lead to increasing oxygen levels and reduce the nutrient content in the water. According to our calculations the possible total removal of water would be 125 000 m3 and the possible nutrient removal would be 1875 kg N and 250 kg P. So far, the studies have shown promising results, with positive yield responses and no negative impact being experienced. Forage cultivation in a non-irrigated field had a harvest of 9 tons/year and the irrigated gave a harvest of 11 tons/year. The results of forage harvest indicate a yield increase of 20%. In 2018, 60 hectares of arable land were irrigated and fertilized with 1500 kg of nitrogen and 150 kg of phosphorus from the bay. Continued fields irrigation will be implemented during 2019-2021. The plan for the future is to study the possibility of transferring the method in a larger scale in other coastal bays around the Baltic Sea. Irrigation effects on soil and groundwater will be investigated in collaboration with SLU.



Measures so far in Baggetorpsån and Gamlebyån. Blue mark - wetland. Yellow mark - other measures

Small wastewater plants

Measures for better wastewater treatment have also been realised, in the big plants as in small private wastewater plants. Measures in 2000 private houses since 2007. Several areas (20) for summerhouses now have sustainable solutions. Advising from the authorities together with strict requirements will lead to action after a couple of years. The intersectoral body for water issues, Theme Water, with political involvement is important for success. Local strategies and plans as Plan for Climatization, sustainable water supply, stormwater and local strategies for reducing nutrient load are important documents.



Measures wastewater. Green mark – Sustainable solution In area for summerhouses. Red mark – New plant in Gamleby, 450 houses to the sewage system in Västervik. Blue mark – Stormwater measures in large scale (Gamleby).

Sea Star

In 2017, Västervik Municipality won the annual national award "The Sea Star", which is awarded by the Swedish Agency for Marine and Water Management, National farmers' association and the Swedish Association of Local Authorities and Regions*." For several years, the municipality of Västervik has been at the forefront of measures to reduce eutrophication. They have been working in dialogue with local stakeholders and landowners to identify and examine specific measures to reduce the nutrient load. They have shown that it is possible to reconcile a good aquatic environment with other interests."* However, these measures are far from enough to achieve Good Environmental Status in the coast water. The work will continue.

Measures in the future

A large number of local measures are planned 2019-2021 in the target areas Loftaån and Gamleby Bay area. A local action plan for reducing nutrients in the Lofta area is established 2018. It's based on the national plan from Swedish Agency for Marine and Water Management, national board for water protection.

- Structure Liming
- Soil mapping
- Small ponds and wetlands
- Wetlands
- Ecologically functional buffer zones
- Two stage ditches and Bevelling ditches (lime)
- Buffer zones water/streams
- Irrigation Bay Dynestad (bottom water)
- Biocarbon filter ditches

Planned measures Loftaån, 2019-2021

Together with the Swedish university in agriculture, SLU, and the neighbour coastal municipalities a work for implementing delaying of water was made 2018. Focus will be in measures with multifunction as retention of nutrients and environment pollutants, decreased risk for flooding, maintained infiltration to groundwater, more diversity in the landscape and delaying of water. Delaying of water is a measure for climatization, both water scarcity as increased risk for flooding. Measures for delaying water should be distributed throughout the landscape for best effect. It can be measures on agricultural fields for increased soil infiltration rate soil water holding capacity, wider ditches that provide more space for water but also areas where the water temporarily is allowed to flood. Wetlands and ponds can be designed also to store water for irrigation. The measures should be placed as naturally as possible and so maintenance is kept simple.

Attached document with description of the most common measures

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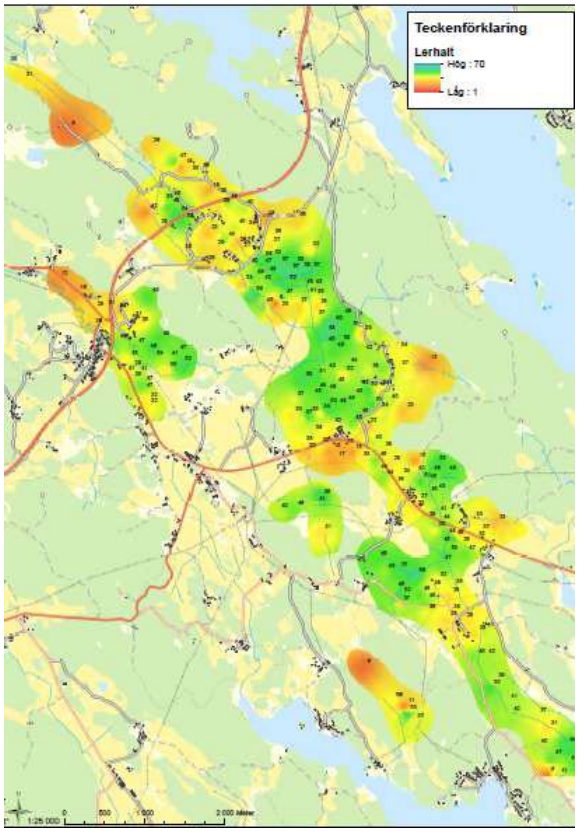
VÄSTERVIKS KOMMUN

Measures for god water status in Västervik municipality

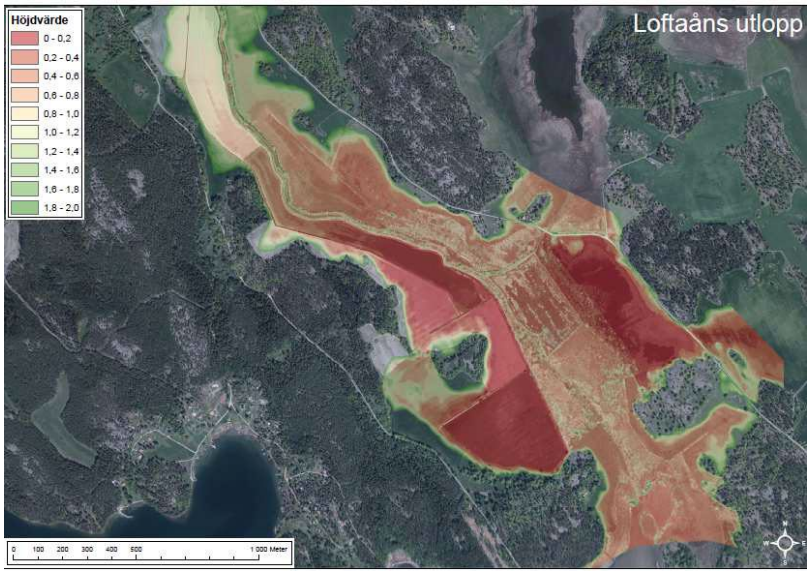
All together there are a lot of different measures for better water in lakes, streams, bays and the Baltic. In 2017 a Local Action plan for reduced nutrient leakage was approved by the Municipal Council and 2018 a Local Plan for Target area Loftaån was established. Measures needs in agriculture, wastewater, stormwater and other areas. This paper describes the most common measures to reduce nutrients leakage from arable land. .

Soil mapping

Analysis of the arable land. A tool for effective fertilization and using av the nutrients. It's also a way to find out where a certain measure is suitable - ***Find the right action on the right place***. In the figure, the green areas are soil with a high content of clay.



Soil mapping includes analysis of geographical maps to find the low areas in the landscape and critical areas in extremely wet or dry periods. In the figure the red color shows the lowest fields.



Structure liming

Using lime to receive an easily worked soil. Suitable on fields with clay. The result is; more efficient absorption of nutrients to the crops and the liming makes the field adapted for extreme weather. It´s important that the measure is performed when the weather is fine (no rain), the humidity in the soil is low and the temperature of the ground is high.

Two stage ditches

Transformation of a ditch to flatter slopes and in two levels. It can be made with one or two levels on both sides. The measure will reduce the speed of the water and will reduce the leakage of nutrients.

Bevelling ditches

Close to two stage ditches. It takes less space (from the field). Making the slopes of the ditches flatter.

Ecologically functional buffer zones

Close to two stage ditches and a kind of buffer zone. Making the slopes of the ditches flatter. Vegetation between the two levels. Great potential for increased biodiversity. Ordinary buffer zones are also used.

Filter ditches

Mixing lime (CaO) in ditches on the fields. Suitable for fields with clay. The function is like a small chemical wastewater plant and reduces the leakage of nutrients for a long time.

To reach multifunctional effects biocarbon filter ditches are planned. Biocarbon filter ditches also to reduces effects on climate, such as irregular water flow

Nutirent (Phosfor) ponds

Small ponds downstream the fields. Multifunctional possibilities as irrigation, biodiversity and fire ponds.. The figure shows construction of a two stage ditch with a deeper section, a “phosphor pond”.

Wetlands

Wetlands have many functions. Increased retention of nutrients, delaying of water, adaption to climate change, increased biodiversity. Wetlands can be constructed in forestland and in agricultural areas. The wetlands are designed in collaboration with NGO:s and authorities.

Small wetlands

Wetlands in the forestland to delay the water before it to the fields. 10 – 100 m2. Cheap and easy to construct. Increase the biodiversity.

Small wetlands close to the fields 100 till 10 000 m2. Cheap and easy to construct.