TRIPLE LAKES

A magazine on water conservation at Näkten lake, Lockne lake and Revsund lake

SPAWNING AREA
new passage brought the fish back to Billsta river

LIFE IN THE LAKES
But how are they really doing?

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EXEMPLARY
A collaborative project showcases methods and examples where plants, wildlife and water all benefit.

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TRIPLE LAKES

Many species depend on the water as a habitat.

Water you can drink, fish in and swim in

MANY ASPECTS OF WATER CONSERVATION.

Some people might think of the water supply signposts at the roadside, others don't think any further than the water they flush down the toilet. Others may think about whether the grandkids really will eat those perch they just caught, and what was it they heard about heavy metals?

The magazine 'Triple Lakes' - that you have in your hands - deals with this topic, and is published by the Triple Lakes project. Within Triple Lakes, the County Administrative Board and many others have worked with the environments in and around the waters of Näkten, Lockne and Revsund lakes. The project arose from a concern among fishing managers and local residents about overgrowing lakes, deteriorating water quality and poorer fishing. We have fantastic waters, but we also see signs that we should not take them for granted.

The idea behind Triple Lakes has been to restore the affected environments as much as possible – so that grayling, trout and other fish can return to their old spawning grounds and increase in number, but also so that they are less vulnerable to changes in our lakes and watercourses. The project has also worked to ensure that today's land use is gentle on the water, which is often about reducing nutrient leaching from households, agriculture and forestry.

Jämtland is rich in wonderful aquatic environments that we can all be proud of. This magazine showcases some of the many achievements during the five year duration of the Triple Lakes project. In this way, we want to show what water conservation can be like in practice, and how we can all help to protect it as a resource.

The fact that we can use the lake water to swim, fish and even use it to make coffee - that's something quite remarkable

Triple Lakes is based on the involvement of government authorities, companies and non-profit organisations ■

Triple Lakes is based on the commitment of government, businesses and non-profit organizations.

Big thanks to:
Jämtkraft, The municipalities of Östersund, Bräcke and Berg, The Swedish forest agency, LRF, The church of Sweden, The Härnösand diocese, SCA, The Swedish Environmental Protection Agency, Norrskog and participating fish preservation societies.

THE COUNTY ADMINISTRATIVE BOARD OF JÄMTLAND

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> We have fantastic waters, but we also see signs that we should not take them for granted.

Illustrations: Lotta Ström

Around 50% of the Triple Lakes project is financed by the EU through the LIFE fund which is the EU's economic programme for nature conservation. The aim of LIFE is to create a resource-efficient and climate-resilient society, halt the loss of biodiversity and to support the management of Natura 2000 areas. The Revsund, Näkten and Lockne lakes and their tributaries are all included in the Natura 2000 network, which consists of areas of protected nature across the EU.

3 lakes 3 characters

Lime-rich bedrock and a large inflow of groundwater makes the water in Lockne lake rich in minerals. The rare Charales algae grows here.

LOCKNESJÖN

Lockne lake is magical and beautiful with its clear green water. The lake has few tributaries; instead ground water enters the lake from sources on the lake bed. The rare Charales algae grows around the water source tributary. Taking a dip in Lockne lake requires a certain courage, as the water seldom reaches comfortable temperatures. On the other hand, the outlet flow through the Forsa river offers fine swimming in its rushing water along magnificent rocky slabs. The rock carvings there show that humans appreciated the rocks along the Forsa for several thousand years.

Jig-fishing for whitefish in Musviken is a classic fishing method in Lockne lake, which accommodates a magnificent stock of large charr, amongst other fish.

NÄKTEN

Näkten lake can be something of a bully when the wind gets up, but has a grand sense of calm when the water's surface is still. Cold and deep. There is an archipelago here with hundreds of islands and islets to explore by canoe or skating. The shoreline is barren and rocky edged, especially in the southern part. Fishing in Näkten lake has always been important. There is a tale of a priest who missed his church service because he was fishing for charr. The priest breached his duties to the extent that the Queen gave the villagers permission to stone him to death. According to legend, he was buried on the Monäset peninsula, but his remains were later moved to the Berg churchyard.

REVSUNDSSJÖN

Revsund lake is large but with a small-scale character. Its lobed shape with bays and inlets makes it feel smaller than its 73 square kilometres. A large number of flowing watercourses mean that the water in the lake changes quickly; in only a few months the whole volume of the lake is replaced. There are plenty of fish, including species such as trout, grayling, perch and whitefish. The shoreline is varied, with both cliffs and fine sandy beaches edged with pine forest. A great lake for both fishing and summer swimming ■

AMERICAN WATERWEED – NEW INVASIVE SPECIES IN ANVIK LAKE

American waterweed is an invasive species that has become a common sight in Anvik lake. It grows rapidly and prevents sunlight from penetrating the water, which can result in an excess of nutrients and a lack of oxygen when plant material is broken down. Affected water flows and problems for boat traffic and fishing can also be consequences of the spread of this waterweed.
It is important to check and clean boats and other equipment that are moved between lakes to prevent the further spread of the plant, because even small pieces of waterweed are enough to establish themselves in a new area ■

The EU's water directive

The water framework directive is a regulatory framework developed by the EU to ensure that Member States create a good ecological and chemical status in their waters. The directive entered into force in 2000 and in Sweden it has entailed the creation of five Water Authorities. The Water Authorities are working on how the quality of the waters in their districts can be increased, producing management plans and action programmes for what needs to be done in the area. The Water Authorities also collaborate with others who work with water, such as county councils and municipalities.

The County Administrative Board has, together with LRF, the Swedish Forest Agency and the forest owner association Norrskog, been invited to meetings on water conservation and the water framework directive. In these meetings we have explained the Triple Lakes project and also been able to engage in dialogue with villagers, property owners and other interested parties and stakeholders. It is planned that there will be more information meetings about the subject of water in future ■

TEXT: ELISABET AAGÅRD
ILLUSTRATIONS: VATTENMYNDIGHETERNA 2017

Skidån shows the way to careful forestry

Water is a key part of the landscape and ecosystems in our forests, and is also sensitive to heavy-handed forestry. A collaborative project at Skidån showcases methods and teaching examples where plants, wildlife and water all benefit.

ALONG A CLEAR PATH AT Skidån, just west of Revsund in Jämtland, are signposts explaining about how the felling and other measures have been carried out and the methods used. The area is a concentration of possible situations and practical solutions – a set of type examples to inspire location-adapted solutions.

There are carpets of logs and beds of twigs where large machinery can drive over, and also sediment filters made from spruce twigs and brushwood. Deciduous trees have been kept to provide food for insects. Fallen trees remain where they are in the river to create variation in the water flow and protection for insects, small animals and fish fry.

"Creating a demonstration space is not done in the blink of an eye, but it's often absolutely worth all the effort," says Bosse Magnusson, forestry consultant at the Swedish Forest Agency, who has been involved in the work creating the demo space at Skidån.

Knowledge Exchange Forum

The aim of the demo space is to show forest owners, machine operators and private landowners how they can use the forest with regard to the watercourses on their land.

Bosse Magnusson believes that the cooperation has also been very rewarding for everyone involved in the project. Skidån has become a forum for knowledge exchange and discussions on forest management and forestry for both authorities and forest owners.

"There has been clear knowledge building in this project," says Bosse Magnusson. For example, sitting in a harvester and seeing how things are done from a purely practical perspective is really important for us as well. We learn that it's not always easy moving from words to actions.

More similarities than differences

There are differing views on how forestry should be managed, but in this collaboration, different inputs to

the subject have led to a discussion and testing of theories in practice to get a consensus on water conservation in forestry. To be able to study on site and arrive at solutions in forestry is infinitely better than discussing it in theory.

"It also creates greater attention in the industry if you're united on how practical examples should be designed," says Håkan Blomkvist, nature conservation specialist at SCA.

"Awareness of water conservation in forestry has been around for a long time, and in recent years we have become better at limiting vehicle damage, although there is still a lot left to do. For example, mercury from previous emissions, which has been bound in the soil over the years, can be released through damage from vehicles.

Next generation takes its place

When autumn's first yellow leaves begin to fall, a group of students set out on the path along Skidån to get an insight into how the forest and water are connected. Teacher Daniel Svensson, at Dille Farm upper secondary school for natural resources, explains that several students are aiming to work as fishing or hunting guides, and respectful forestry is a prerequisite for them to be able to work in these water and forestry environments in the future.

"I want the students to see the whole thing," says Daniel. We are often bad at seeing the bigger perspective, but here at Skidån you really get the full picture.

Axel Roos is studying to be a forest and environmental conservationist at Torsta Gymnasium and he also appreciates the day's visit. "Water is of course the foundation of the whole ecosystem and absolutely crucial to life existing. Dried-up rivers are a bigger problem than I thought; it's about keeping them alive all year round so that fish fry and insects are not adversely affected. It's not that complicated really, just that you have to get into the mindset and look at the forest and water on a daily basis so it becomes natural to you ■

TEXT & PHOTO: HÅKAN WIKE

The forest's watercourses are often fish 'nurseries'. Here a young trout is measured before being put back in the river.

Daniel Svensson is a teacher at Dille Farm upper secondary school for natural resources, and thinks that Skidån provides an overall picture of what water and fishing conservation means in practice.

15000

Fishing licenses sold in Bräcke municipality each year. One of the most popular fishing grounds is Upper Gimån, and revenue from the fishing licences has meant that the fishing conservation area has been able to support various projects. These include keeping Stavre football pitch in top condition with a new lawnmower purchased with subsidies from the fishing conservation area.

24°C

If it is warmer than this for over a week, the trout will not survive. The fish thrive in cold water and an edge zone with shady vegetation is vital on warm days.

PATIENCE WINS OUT OVER THE REEDS

Marsh reeds are the Nordic region's largest grass and one of the most competitive water plants that multiplies rapidly. But it is responsive to mowing, so that means its growth can be limited, even if that does need a certain endurance. You do not need a permit or registration for reed cutting.

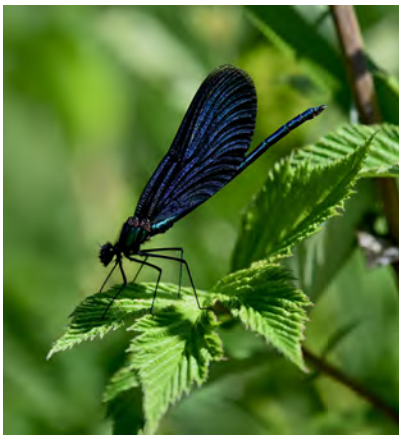
How to do it:

- Cut reeds for two to three consecutive years.
- Cut twice per season. Cut the first time early on, when the stems have grown up slightly above the water's surface so that they are properly visible; the second time when growth has stopped in autumn.
- Cut the reeds under the water's surface if possible. This allows water to flow into the stem and rots it from the inside.
- Use a pasture mower in late summer if the reeds have begun to spread up on the beach.
- It is important to clear away the cut reeds from the water so as to not return the nutrients.

DEMOISELLE DAMSELFLIES IN BRÄCKE

In Märlån in Bräcke municipality, the County Administrative Board found a total of 55 species when sampling the lake bed fauna. The finds included the Beautiful Demoiselle (Calopteryx virgo), a delicate species primarily found in clean, partially shaded and flowing water with a sandy or gravelly bottom.

Bottom fauna is insects and other small animals that live on the bed of a watercourse. The number of species and which species are found says a lot about the quality of water. In a healthy watercourse, many species can live and thrive, and conversely in a watercourse with poorer water quality and habitat, only a few species can survive.



Magnus Billqvist / Trollsländeföreningen

Mission: To save the arctic charr

Increasingly smaller fish and poorly functioning spawning areas aroused the concern of the fishing conservation association for the arctic charr in Näkten lake. It was the start of a conservation project that entailed both artificial spawning grounds and fish with radio transmitters.

An arctic charr can be up to 25 years old and the female can produce 2,500 eggs per kilogram of body weight. Anders Dahlén on the County Administrative Board is working to preserve the Red Gold of Näkten.

» **ANDERS DAHLÉN, FROM THE COUNTY ADMINISTRATIVE BOARD OF JÄMTLAND**, holds a female charr in his hands over a colander in a bowl. He is holding the tail of the charr with one hand while gently pressing the fish's characteristically red belly with the other. This makes bright orange roe flow out of the fish, into the bottom of the bowl. He is working to strengthen the living conditions of the charr in Näkten lake, and it is the fish's reproductive potential that is in focus. The work is carried out as part of the Triple Lakes project, which was created since it had become clear that everything was not right with the previously so large and healthy charr in Näkten lake.

"Those of us who've been fishing here for a long time could already see in the 90s that the fishing was becoming worse. The fish were much smaller and there were fewer spawning areas for the charr's reproduction to function properly," explains Åke Falk from the local fishing conservation association.

Sedimentation stops oxygen

We don't know why there are fewer spawning areas, but one theory is that the places previously used have been destroyed by sedimentation. The roe needs oxygen, and if the sedimentation is too strong, the oxygen supply decreases and the roe dies. One of the goals of the charr project was therefore to create new spawning areas.

First to be found were the best conditions for charr spawning. Boxes were then placed in the old spawning grounds with small amounts of fertilised roe, in order to see where it hatched best. Where the best results were obtained then became the new grounds.

"Of the twelve or thirteen piles we set out, we have five or six that we think are usable, and mainly two that we use extensively," says Anders Dahlén.

When he says 'use', he is talking about today's activities.
After the female charr is squeezed of her roe, she is measured, weighed and recorded before being released back into the water. Once the roe has been obtained, it is fertilised and allowed to swell for two hours before being put out.

One in a hundred survives

Anders Dahlén and Lars Bergwall, also from the County Administrative Board, row out to a ground where Anders then steps into with a pipe

After the milt is added to the roe, it is added into the lake to swell. Then it is carefully packaged in styrofoam containers and kept refrigerated before it is released.

and funnel. He carefully lowers the tube into the gravel while Lars fills the funnel with roe. The procedure is repeated in several locations and ends with some grids being placed over the site.

"Roe is the favourite food for several fish. I have heard it said that it is only a single roe out of 100 that survives to become fry. It's surprising that there are any new fish at all," says Åke Falk.

The idea behind putting roe in new locations is that the spot will be imprinted on the fish, and they will then return there to spawn when it is time. In this way, it is hoped the fish will reproduce in more than one place in the lake. But it will take time before we can see if the project gives good results. 2018 is the third year that the roe has been put out in the lake, but it has still not been possible to measure any level of success, as a male only returns at the age of six or seven years, and a female only after at least seven.

"So it'll only be in three years' time that we'll begin to see anything," says Anders Dahlén.

Even if it takes time to see results, their work has meant huge interest in the charr itself.

"What's best is that local residents have got involved. So there's added value both in what we do and the lake itself. That's the biggest bonus," says Anders ■

TEXT: ELISABET AAGÅRD
PHOTO: JOHANNES POIGNANT

Distinctive cold water fish

Below the mountain range, the charr is found as a large predatory fish in deep and cold lakes. It can be up to 90 cm long and can reach the age of 25. Charr is sensitive to competition from other species of fish. Many fish stocks are extinct due to the release of whitefish and burbot, other stocks are severely damaged by regulation, acidification and hard levels of net fishing.

A new threat to charr is increased temperatures. To help the charr, the Triple Lakes project has been working to ensure that the charr has a good and functional living environment, that the water is clear and that fishing does not erode stock levels.

Fish once again spawning in Billsta river

In the spring of 2017, the first graylings were once again found in Billsta river, for the first time in over 100 years. Fish passages have been built past the river's hydroelectric stations, a pond has been dug out and the bottom has been fitted out with stones and spawning gravel. One year after the restoration, the results look promising, both for the river and its inhabitants.

FISHING IN THE BILLSTA RIVER is mentioned way back in history. It is said that there were so many fish at the old sawmill upstream at the Näkten outflow, that the saw could sometimes not start up in the mornings. It was clogged with downstream migratory trout. There are testimonials on how people would simply pick up the fish by hand. When the hydroelectric power stations were built in the early 1900's, the entire width of the river was closed for migration, and the fish habitats changed dramatically.

Malin Bernhardsson, project manager for Triple Lakes, explains that human influence on the watercourse has changed many aspects. How there is hardly a single river in Jämtland where people haven't removed stones to help timber floating, at the expense of the living and reproducing conditions of the fish.

Habitats reopened

The migration routes for the fish and other species have now been opened up again. Extensive work has been done on building fish passages, bypass channels, past the river's three hydroelectric power stations and tearing out an intake pond.

"There's a lot of calculations behind the bypass. It can't be too steep if it is to suit all species. We have also 'furnished' the river for the fish - put back various sized rocks to slow down the water and which leaves behind more nutrients. This benefits the entire food chain. Smaller insects are encouraged, which then become food for larger ones, which in turn feed small fish, and finally the larger species such as trout. The stones also create quieter pockets in the water, which both fish and insects need as resting places," Malin explains.

"It is not obvious that fish will return to a watercourse that has been restored, so we are delighted that we have succeeded in achieving a way back for fish and other species," continues Malin.

Over 500 fish in the first year

Kurt Aronsson, who is involved in the Storsjön-Berg fishing conservation area, will now visit twice a day during the trout spawning period. A trap has been set up to count the number of fish that go up here to Strömbacka, Billsta river's second bypass, seen from below Storsjön. Two trout have migrated up since the fish trap was put out the day before, and before the spawning period is over there will be many more.

"Last year 14 trout made their way up here to Strömbacka and at the first bypass, closer to Storsjön, we counted 484 grayling and 58 trout in total, so the result has been beyond all expectations. It was something that none of us dared to believe," says Kurt.

The results in the Billsta river are looking good so far. Now both trout and grayling are spawning here again. And there are good hopes that the freshwater pearl mussel, a red-listed species appearing in the Billsta river basin, can be reintroduced.

Creating new fish passages in the Billsta river has been the single largest effort within the Triple Lakes project. Through this initiative, it will be possible to continue producing renewable electricity and also be considerate of the local environment and species that live there ■

TEXT: SARA STENBERG
PHOTO: SANDRA LEE PETTERSSON, SARA STENBERG

The bypass in Strömbacka was the simplest to create, even if this location also needed a lot of work. Here, the entire bypass has been dug out and the inset is being prepared to be cast in concrete.

Digging jobs for weak swimmers – in the slope of the inlet dam to the Billsta power plant, a hairpin curve was created to make the bypass sufficiently flat. Now even the burbot and perch can get past.

Pierre Samuelsson from the County Administrative Board shows how electric fishing works, to pupils from Myrviken school. The pupils also helped with the creation of new spawning beds for grayling and trout.

Good sewage treatment saves the environment

During the Triple Lakes project, the municipalities of Berg, Östersund and Bräcke have taken stock of individual sewage treatment plants. In contrast to what many people think, such as the summer cottage toilet - which may only be used a few weeks a year - can create a lot of pollution.

"MANY PEOPLE BELIEVE that as long as the water flushes everything away, everything is working as it should, but it's really not as simple as that."

These words are from Anna Lindqvist, former head of the construction and environment department at Bräcke municipality. She was part of the team and initiated the inventory of around 800 sewage treatment plants created around Revsund lake in 2016. She explains how four inventory takers travelled out to all properties with a checklist and made a visual inspection of the drainage outlet and the state it was in. The treatment plants were then graded as either green, yellow or red, depending on whether they needed improvement.

"Those which had no purification at all, for example that just went straight into a body of water, were embargoed by the Environment Committee. The property owners were then given the responsibility of replacing the old drainage outlet within two years, or facing a ban on using it entirely."

Of the just over 800 treatment plants inventoried, 116 were marked red and condemned completely. 151 had faults that were not serious enough to need immediate remedial action, and were marked yellow. A further 189 were given the colour black, which meant that the municipality didn't really know how to assess them. And the inventory takers also tried to be flexible in their assessment, by for example considering whether the treatment plant was used frequently or less often? Or by looking at what the surroundings are like, for example if the treatment plant outlet goes near a creek, a lake, above a water source or near the neighbours?

One of the reasons that many treatment plants were given remedial measures is that they had not been renovated since the house was built.

"But a sewage treatment plant is just like everything else - you have to check it regularly," says Anna Lindqvist.

"A common misconception is that it is the actual two-chamber or three-chamber septic tank that does the purification, but it isn't," explains Anna Lindqvist. The tank slows down the sludge, which then comes out into the infiltration bed where the purification actually takes place.

"It's an a-ha! moment for many people. And there isn't a function to slow down the water, so both bacteria and nutrients flow out into the water."

The biggest reason why one isn't desirable, is obviously the risk of infection. Another reason is that the nutrients that the body has not taken up, especially phosphorus, are released into the water with algal blooms as a result. The algae, which use up the nutrients, die and fall to the bottom, where a large part of the oxygen present in the water is used to break them down. This in turn leads to a lack of oxygen for the animal species that live in the lake.

"I have great respect for the fact that it can be expensive to fix your own sewage treatment, the cost can end up between 30,000 – 100,000 kronor. But the problem with the small treatment plants is that there are so many of them," says Anna Lindqvist ■

TEXT: ELISABETH AAGÅRD
ILLUSTRATION: TOBIAS FLYGAR

Life in the lakes

Clear, cold and blue. That's how we think of the water in our lakes, but how are they really doing? To find out, the Triple Lakes project has investigated the water quality in the three lakes.

THE IDEA WAS TO SEE TO what extent human activity has affected the water in the lakes – for example, traces from housing, agriculture and forestry in the immediate vicinity. By gathering information, there is now also a knowledge base to use when starting any future investigations.

All three lakes show little or no deviation from what can be considered normal. Because humans have lived on and worked with the land for several hundred years, there is a trace of these activities in the water, but no more than you would expect.

Its ground water sources means that Lockne lake has a different water quality than the other lakes, as groundwater has a different character than surface water. The differences include a higher pH and greater resistance to acidification as the groundwater is very calcareous.

Näkten lake, and primarily Revsund lake, get a significant amount of water from flowing watercourses, which gives the water more colour. For the same reason, they also have higher levels of organic matter, as rivers and streams bring a lot of material from the forest.

In terms of nutrients, all the lakes show relatively low levels in total. However, there are local variations within the lakes. Test points located in more populated parts show higher levels of phosphorus than test points located in sparsely populated areas.

The survey shows that we have good water in the lakes but that they are also influenced by human activity. This means that if we are to maintain their fantastic water in the future, we need to see our lakes as the valuable resources they are ■

Healthy factors – how the water is measured

pH and alkalinity – pH is a measure of how acidic the water is, while alkalinity indicates the water's content of substances that counteract acidification.

Conductivity describes the water's ability to conduct a current, which depends on how much salts are dissolved in the water.

Absorbance shows how well the water passes through light, which is partly due to the amount of particles in the water, and partly the amount of dissolved substances – mainly humus – in the water.

The **colour number** is a measure of how brown the water is, something that is influenced by the amount of humus substances and iron content, amongst other things.

Total organic carbon (TOC) provides a measure of the content of organic material in the water.

Nutrients in the form of nitrogen and phosphorus are naturally present in the environment, but when extra amounts are added, eutrophication can occur.

Turbidity is a measure of how cloudy the water is, i.e. the amount of particles in the water.

Chlorophyll occurs in all types of plankton algae and gives a picture of the amount of algae in the water.

The amount of **phytoplankton** reflects the amount of nutrients in the water.

A project report from Triple Lakes

THIS MAGAZINE is a report from Triple Lakes, a five year collaborative project for healthier aquatic environments and cleaner water. The project has been conducted in and around the Lockne, Näkten and Revsund lakes, all three of which are examples of Jämtland nature at its best. The lakes are also part of the Natura 2000 network, which consists of good examples of typical habitats from all EU Member States.

As part of Triple Lakes, governmental authorities, companies and other organisations have worked together to contribute to clean water and good habitats in and around the three lakes. The work has been funded by those involved in the project together with the Marine and Water Authority and LIFE, which is the EU's economic programme for nature conservation.

The work has dealt with water conservation interventions in over 40 different rivers, but has also covered information and knowledge building. Some of the project's initiatives are described in this magazine. If you would like further information, please visit **www.triplelakes.se**

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