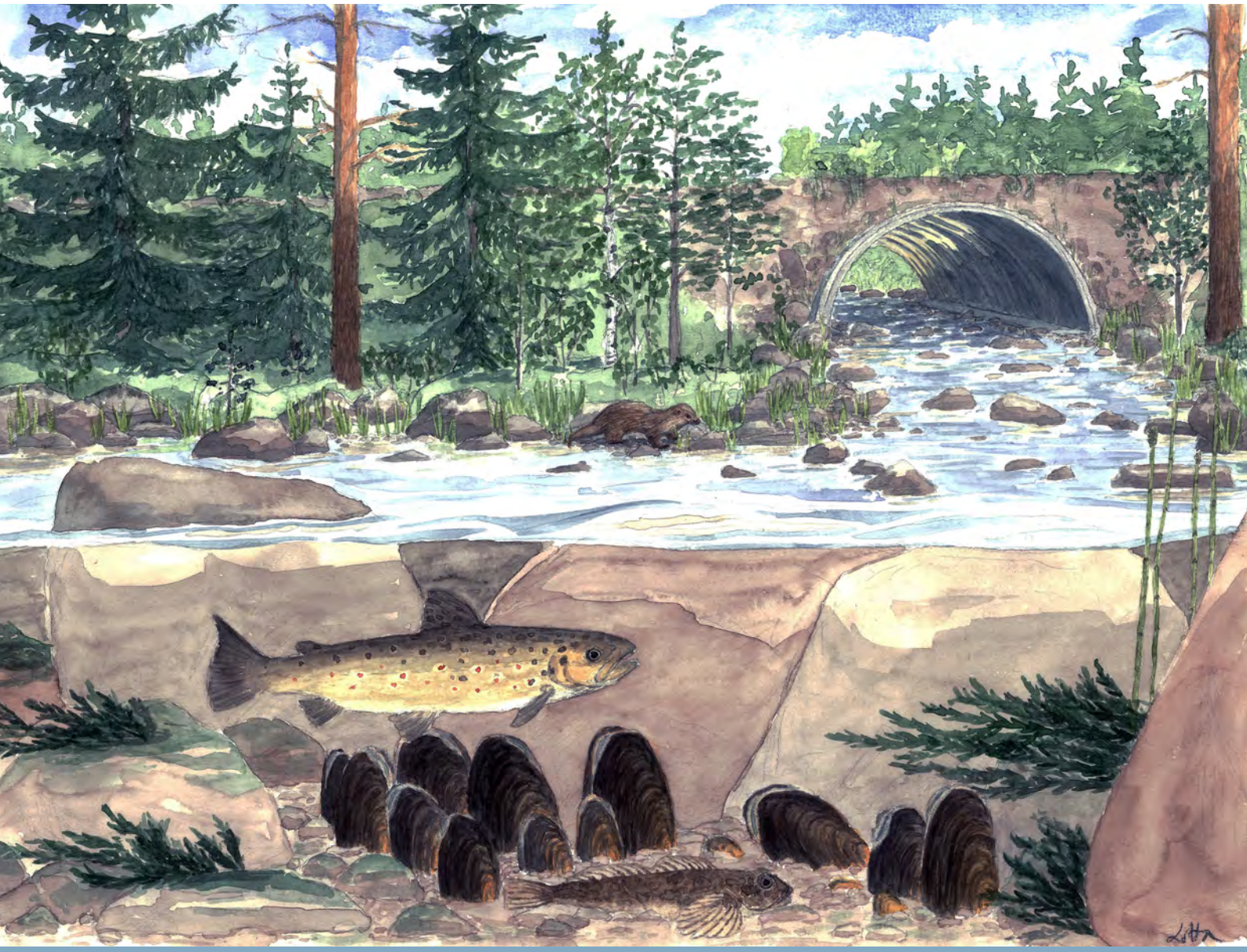
REMIBAR



REMIBAR

After LIFE-plan

EC LIFE+ programme
LIFE10 NAT/SE/045

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The freshwater pearl mussel monitoring programme is part of a national monitoring programme targeting unionids. The objective of the monitoring is to assess recruitment, the genetic variation within the populations, the threats to different populations, the conservation status of different populations, the ecological and chemical status of its habitat, and need for action.

Project description

The objective of the Remibar LIFE project (Remediation of Migratory Barriers in Streams) was to increase the connectivity in five river systems in the very north of Sweden, in the counties of Norrbotten and Västerbotten

In parts of the river systems connectivity had been lost or reduced due to the construction of culverts in road-river crossings and dams, which prevented the upstream and downstream migration of aquatic organisms, thereby blocking access to spawning, nursery and feeding areas located in rivers and creeks higher up in the river systems. Badly designed road-river crossings also resulted in a higher mortality of otters, as the otters were unable to follow the shoreline and were instead crossing the road and getting hit by traffic.

The project started in 2011 and ended in 2016. Throughout the course of the project, 304 migration barriers were removed. Eleven of these consisted of bridges lacking underpasses for otters and other medium-sized animals, while the remaining 293 consisted of dams and culverts that blocked the migration of aquatic organisms.

Included river systems and species

The project areas were the Ängesån project area (part of the Kalix River system), the Råneälven project area (most of the Råne River system), the Varjisån project area (part of the Pite River system), the Sävarån project area (all of the Sävar River system) and the Lögdeån project area (all of the Lögde River system). All five project areas are included in the Natura 2000 network. Within these river systems, the remediation efforts carried out as part of Remibar contributed to the restoration and improved status of the riverine habitat, with a particular focus on the two habitat types Fennoscandian natural rivers (3210) and Watercourses of plain to montane levels with the Ranunculion fluitans and Callitricho-Batrachion vegetation (3260), that have been identified by the EU as being particularly important to protect and conserve and are protected under the EU Habitats Directive. While a wide range of aquatic organisms are expected to benefit from the removal of the migration barriers, the project focuses in particular on the protection and conservation status of the following species: freshwater pearl mussel *(Margaritifera margaritifera)* (1029), Atlantic salmon *(Salmo salar)* (1106), otter *(Lutra lutra)* (1355) and bullhead *(Cottus gobio)* (1163).

While various species of fish and otters will benefit directly from the removal of the migration barriers by being able to access habitat that has been made available, or, for otters, through a reduction in mortality, the impact on freshwater pearl mussel populations will be indirect. This is due to the fact that the survival of mussel larvae, and consequently the long-term survival of the freshwater pearl mussel populations, depends on the successful reproduction of brown trout and Atlantic salmon as the mussel larvae live as parasites on the gills of juvenile salmon and trout during the first year of their life cycle. Hence, efforts that have a positive impact on the reproduction of salmon and trout will also have a positive impact on freshwater pearl mussel recruitment.

Results

As a result of the remediation efforts in the five river systems, connectivity increased in approximately 1 700 km of rivers and creeks, with a surface area of 67 km^2. This entire length and area was accessible to organisms migrating from the Baltic Sea, with the exception of approximately 130 km or 18 km^2 that were located upstream four remaining migration barriers. Prior to Remibar, 3100 km of rivers and creeks with a surface area of 170 km^2 were available to migrating organisms. The removal of migration barriers as part of Remibar has resulted in a nearly 40% increase in area and a more than 50% increase in length.

Although no studies have been carried out to specifically measure the impact of migration barrier removal on movement and migration behavior of different species, other than otters, that were expected to benefit from the remediation efforts, results from established monitoring programs revealed that brown trout and Atlantic salmon often began using spawning areas upstream a migration barrier within a year after the removal of the barrier. This was recorded in the Varjisån, Sävarån and Lögdeälven project areas and was indicated by an increase in the occurrence of yearlings the following spring. In these areas, electrofishing sites were located close enough to the remediated migration barriers and the newly accessible spawning areas to detect an effect on spawning success, as juvenile migrate only short distances after hatching to reach nursing areas located within a few 100 m of the spawning areas. In the Ånges River project area and the Råne River system, no monitoring using electrofishing had been carried out in the vicinity of the remediated migration barriers thereby enabling a detection of an effect. As a result, data to properly assess the impact of Remibar in these two project areas is missing.

In all five river systems, there had been a general increase in the number of Atlantic salmon and ocean-dwelling brown trout migrating up the river to spawn since the 1990s due to successful management of the salmon and trout fishery in the Baltic Sea and the estuaries. The two species are migrating higher up in the river systems as a result of the increasing competition for spawning areas of good quality. The fact that spawning areas were being used very soon after the migration barriers had been removed indicates that there is a high demand for spawning areas of good quality in the river systems.

A study of the eleven underpasses built in road-river crossings in order to prevent otters from crossing the roads and getting run over by traffic revealed that all the underpasses are functional and have been used by several species of medium-sized mammals. Animal tracking in snow revealed that otters occur in the vicinity of all the underpasses, and camera monitoring revealed that otters had used five of the underpasses. In wintertime the animals often pass under the bridge on the ice, without using the constructed underpasses.

Otter *(Lutra lutra)*.

Camera monitoring revealed that otters had used five of the underpasses.

Goals and methods for After-LIFE

Policies and collaborations on a national/regional scale

The work with removing migratory barriers will continue after the completion of Remibar in 2016. The removal of migration barriers has been identified as a priority on both a national and a regional scale – by the Swedish Agency for Marine and Water Management (SWAM) and the regional Water Authorities. The Water Authorities are regional agencies responsible for coordinating the efforts by other authorities and municipalities. In December 2016, the management plans for the two northernmost Water Districts were agreed upon (BBWA and CBNB 2016, BSWA and CBVB 2016). In these management plans, the presence of migration barriers is still recognized as one of the main reasons why the Bothnian Bay Water District has not yet reached good or excellent status in all water bodies. The management plans point out the agencies responsible for making sure that the efforts to improve connectivity are carried out to the extent necessary and also identify the water bodies where further actions are needed to improve connectivity. The responsible authorities include the County Administrative Boards (CAB), SWAM, the Swedish Transport Administration (STA), and the municipalities, among others.

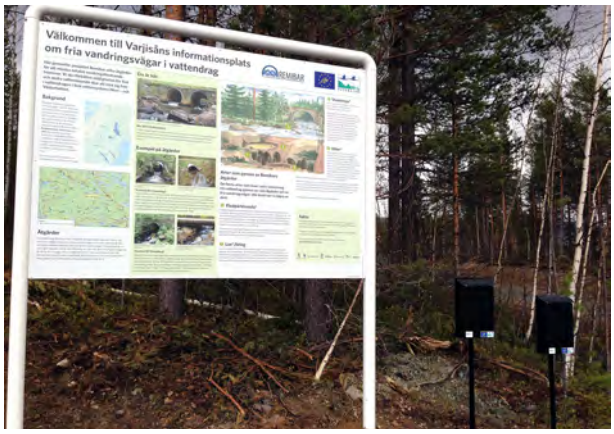
In order to promote a dialogue among different agencies, authorities and academia on issues related to connectivity, the Swedish Species Information Centre (a branch of the Swedish University of Agricultural Sciences) has established a national working group collaborating on the issue of connectivity. The working group includes representatives from a range of agencies and authorities, including CABs, the STA, the Swedish Species Information Centre, the Swedish Forest Agency (SFA), the SWAM, the Swedish Board of Agriculture, as well as academia.

Another group named the “road-water-crossing-group” has been established in the counties of Norrbotten and Västerbotten and is made up of representatives from the CABs of Norrbotten and Västerbotten, STA, SFA and some municipalities. It continues exchanging knowledge and working on the issue.

The research program TRIEKOL (TRansportInfrastrukturEKOlogi), initiated in 2009, is a research program financed by the STA and coordinated by the Swedish University of Agricultural Sciences. The main objective of the research program is to develop methods that can help the transport sector to maintain and improve the ecological functions and qualities of the landscape.

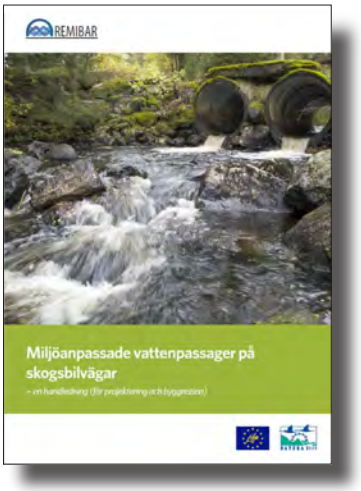
Road-river crossings – Dissemination of information regarding proper design and surveillance

Throughout the course of Remibar, in order to increase the knowledge about migration barriers, road owners and companies involved in the construction of roads were informed about the role of bridges and culverts as migration barriers and their potential negative impact on the connectivity of the aquatic environment. Information regarding different designs that would reduce the negative impact on the aquatic environment was disseminated through meetings, information material and demonstration sites. In order to make information regarding “best practices” available for a broader audience, a manual was written with the title “Ecologically adapted



Trips to demonstrations sites is often part of a visitors program.

stream crossings for forest roads – a guide for planning and construction" (Lindström-Jönsson et al., 2014). The manual was produced within the scope of Remibar as a joint project between the STA, the SWAM, the SFA, forestry agencies, and the CABs of Norrbotten and Västerbotten, among others. The manual will continue to be used by road construction companies and road owners and is available for download on the website of the STA. The STA will continue the effort to spread knowledge about best practices regarding the construction of roads in road-river crossings in their everyday work. It will also be part of other projects focusing on the restoration of river habitat and connectivity, such as ReBorN LIFE (Restoration of Boreal Nordic Rivers) which will be running from 2016 to 2021. (Further details regarding ReBorN below). The County Boards of Norrbotten and Västerbotten continue to actively promote the methods developed regarding the design and construction of road-river crossings. When receiving visitors from other agencies, from other parts of Sweden, or foreign governments, a trip to some of the demonstration sites is often part of the visitors' program.



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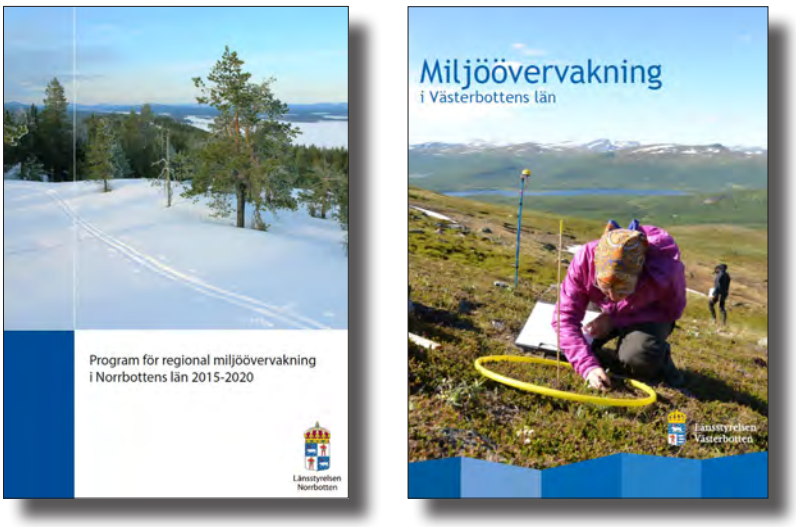
After the completion of Remibar, the STA will continue the maintenance and surveillance of the sites where migration barriers have been removed, in order to assure that the function of the structures that were built to replace the migration barriers is maintained over time. The CABs will also re-visit the sites where the migration barriers have been removed 4-5 years after the project ended in order to carry out inspections and assess whether the function is maintained and to make sure that there are no migratory barriers at the sites. The forestry companies Holmen AB, Sveaskog and the SCA are responsible for the maintenance and proper functioning of the structures built by the respective company to replace migration barriers.

Monitoring of habitat and species

The monitoring of the conservation status of species and habitats will be done by the CABs through their conservation plans for the Natura 2000 areas. For the Natura 2000 areas, one conservation plan per drainage basin has been developed. The conservation plans describe the management goals for each habitat type and species (CABNB 2005abc, and CABVB ab) and are currently in the process of being updated. The conservation plans state that no artificial migration barriers are permitted in areas with the habitat types 'Fennoscandian natural rivers' (3210) and 'Watercourses of plain to montane levels with the Ranunculion fluitans and Callitricho-Batrachion vegetation' (3260) that have been identified as having "particularly high ecological values". If it is not possible to remove a migration barrier, efforts must be made to make them passable. In these areas, newly constructed roads and culverts shall be built so that they do not constitute migration barriers for aquatic organisms. The management plans for the freshwater pearl mussel state that recruitment must be confirmed at all sites with freshwater pearl mussel populations, and that the recruitment of its host species (juvenile salmon or trout) must be ensured at sites downstream freshwater pearl mussel populations, and that no anthropogenic migration barriers are permitted in the parts of the river system that contain populations of freshwater pearl mussels. For salmon, the management plan states that no anthropogenic migration barriers are permitted along the migration routes of the species. For the otter, all new bridges in areas with otters must be equipped with an underpass that enables the otter to pass underneath the bridge instead of crossing the road. When older bridges are being renovated, they should be modified to allow otters to pass underneath safely if there is a need for it. For the bullhead, no specific management measures regarding connectivity are stated. However, many of the management efforts that are beneficial for fish in general, such as the removal of migration barriers and restoration of natural habitat from the impact of timber floating, are also beneficial for the bullhead.

The CABs are responsible for carrying out environmental monitoring in their respective jurisdictions. This monitoring is part of regional monitoring programs as well as national monitoring programs. The monitoring of freshwater includes the monitoring of surface water (lakes, rivers, and estuaries) as well as groundwater, and comprises the monitoring of water chemistry, eutrophication, acidification, and environmental contaminants, metals, in lakes and rivers. Information regarding the objectives and the structure of the environmental monitoring carried out by the CABs of Norrbotten and Västerbotten are publicly available (e.g., in CAB-NB 2014 and CABVB 2016).



The monitoring of freshwater includes the monitoring of surface water as well as groundwater, and comprises the monitoring of water chemistry, eutrophication, acidification, and environmental contaminants, metals, in lakes and rivers. Each County Administrative Board has its own regional monitoring programme.

The monitoring is done in selected streams and lakes (selected through random selection) that have been monitored for several years and are being monitored several times per year. Monitoring of animal and plant populations in lakes and rivers, include sampling of fish populations and the benthos, surveys of macrophytes, algae and plankton. Recruitment of Atlantic salmon and brown trout is monitored in all the rivers that harbour salmon populations. This is done by carrying out electrofishing at the reproductive areas as part of a monitoring programme that has been ongoing since the 1980s. In two rivers, the Kalix and the Pite Rivers, long data series from fish counters are available and they give an indication of the numbers of brown trout and Atlantic salmon that are migrating up the rivers to spawn. Fish counters were installed in the Råne River and the Lögde River 2014 and 2012, respectively, making it possible to monitor the number of adult trout and salmon migrating up these rives to spawn and potential changes in their numbers. One river, the Sävar River, is still lacking a fish counter counting adult fish.

The CAB is also responsible for carrying out the monitoring and implementation of actions to protect species that have been targeted in national action programmes for endangered species (Åtgärdsprogram för hotade arter), which is carried out in collaboration with a range of other agencies and organizations. These national action programmes have been developed in order for Sweden to meet their national and international obligations regarding the protection of biodiversity. Currently, more than 200 species (as of July, 2016) are targeted by national action programmes, including the freshwater pearl mussel and the otter (SEPA 2005 and 2006). These action programmes are renewed approximately every five years. However, the document outlining the action programme is not revised as frequently. The action plan targeting the freshwater pearl mussel is currently being revised.

The freshwater pearl mussel monitoring programme is part of a national monitoring programme targeting unionids. The objective of the monitoring is to assess recruitment, the genetic variation within the populations, the threats to different populations, the conservation status of different populations, the ecological and chemical status of its habitat, and need for action. The recruitment of the freshwater pearl mussel is used as an indicator for a natural ecosystem. The monitoring of the mussels will be expanded to include monitoring of its host populations, i.e., assessing the recruitment of brown trout and Atlantic salmon, and examinations of the conditions in the sediment and the pelagic zone. In 2017, juvenile salmon and trout at a number of sites will also be examined for the presence of mussel larvae on their gills as part of the project ReBorN LIFE.

The objective of the otter monitoring programme is to assess changes in the range and the size of the otter population, the genetic variation within the populations, the conservation status of the species, the ecological and chemical status of its habitat, and need for action. The implementation of actions to protect otters that involve the rebuilding of bridges to install functioning underpasses are done in collaboration with the STA.

In the Pite River, including the Varjisån project area, assessments of the biological and hydrological effects of the previous restorations of the Pite River system, that were carried out in 2009-2009, will be carried out until 2020. The monitoring will cover areas that were affected by the removal of migration barriers as part of Remibar and will include electrofishing to assess recruitment.

In the counties of Norrbotten and Västerbotten, new nature reserves are being established in order to protect valuable habitat in the region. The legal protection of these areas encompasses the land areas as well as the aquatic environment. The establishment of nature reserves is a continuous process.

For their survival, larvae of the freshwater pearl mussel depend on young trout and salmon that are less than one year old. Photo: Oskar Norrgrann.

Projects and partnerships

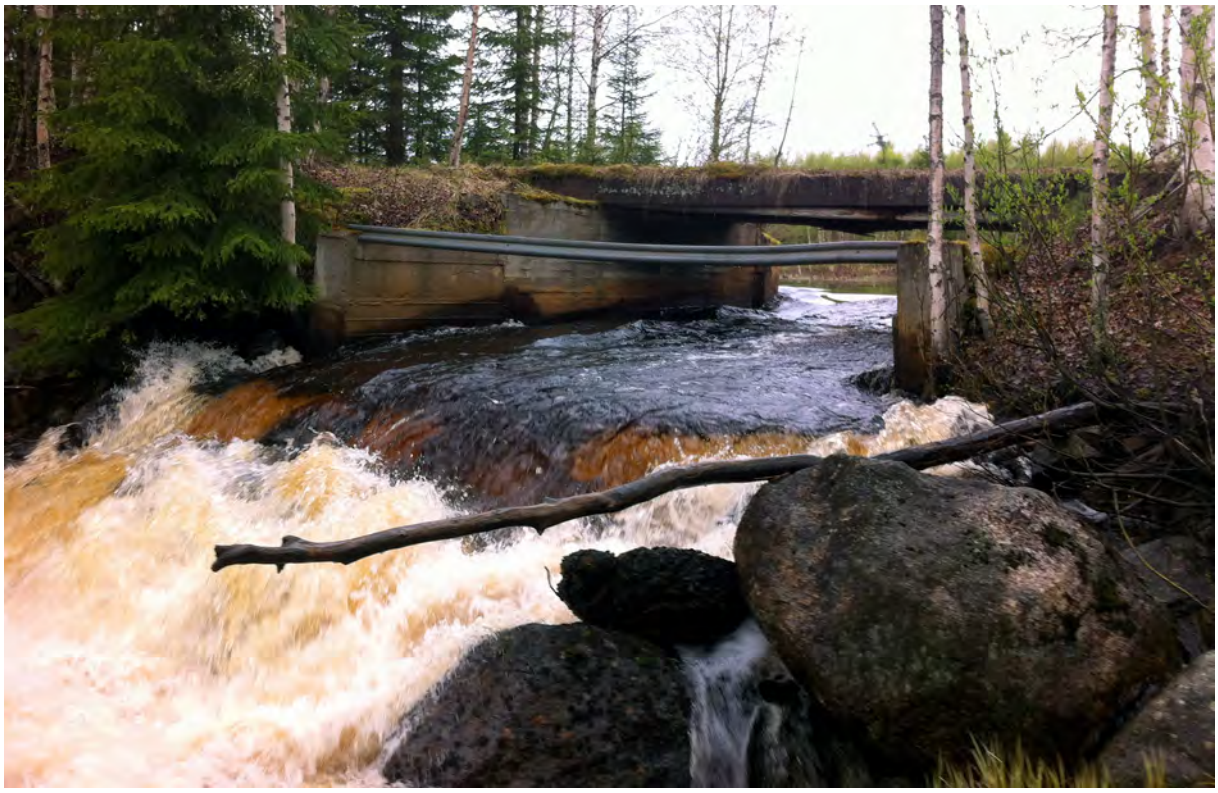
The work with removing migration barriers and improving the conservation status of the species and habitat targeted by Remibar will continue in a range of projects and partnerships.

The CAB of Norrbotten has received national funding from SWAM to restore the Kälvån River (a tributary to the Kalix River) and the Töre River from the damage done during the timber floating era. The project *Älvspecifik förvaltning av lax och havsöring samt återställning av vattenmiljöer* (River specific management of salmon and sea trout and restoration of aquatic habitat) will also include the removal of at least five migration barriers. The removal of two of these barriers has already been completed. The project started in 2015 and will end in 2018. An important part of the project is to establish a management model of salmon and trout that is efficient and firmly anchored among stakeholders, to improve the knowledge about the fish stocks and create fishing regulations based on sound scientific advice. The Råne River is a pilot river in this process.

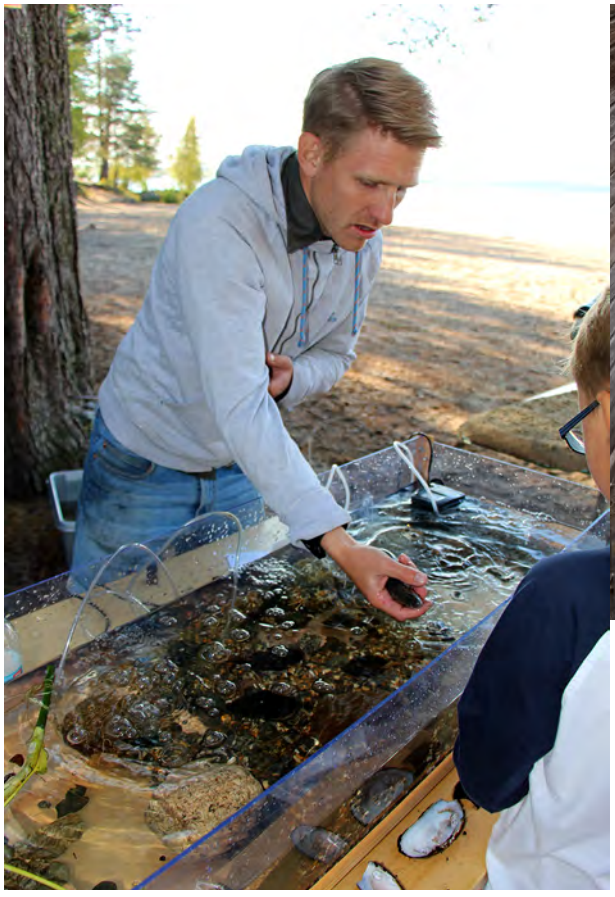
The CAB of Norrbotten is the lead partner in the project *Ecological restorations in coastal river basins in the Bothnian Bay*, which is co-financed by the Interreg North fund (Interreg Nord and the European Union 2017). The project started in 2015 and will be completed in 2018. It is run in collaboration with Finnish authorities. One objective of the project is to restore and improve the habitat for fish and other aquatic organisms in rivers that flow into the Gulf of Bothnia. Another objective is to develop new and innovative restoration methods in the rivers as and other parts of the drainage basin. The project will also contribute to increasing and sharing knowledge regarding the impact migration barrier removal has on fish behavior, spawning migration in particular. This knowledge will be used within the project and will also be valuable in future restoration projects. In addition to focusing on the requirements for successful reproduction of salmon, the project also includes studies of the requirements of whitefish and burbot (*Lota lota)*. The Swedish part of the project encompasses three rivers: the Ale River, the Ros River and the Alter River in the south of the county of Norrbotten. In addition to removing a number of migration barriers consisting mostly of dams but also of culverts, the project also involves the restoration of areas of reproduction and other measures to improve habitat. At sites where a dam cannot be removed due to its historical and cultural significance, a fish ladder is constructed so that the fish can access the areas upstream the barrier. As part of this project, a new method to construct fish ladders made of composite material that is both durable and easy to install is being developed. The method has attracted a large degree of interest internationally. In addition, the impact of the removal of migration barriers on whitefish (Coregonus) spawning migration and selection of areas of reproduction is being examined in the Alterälven River using telemetry. In 2015, when a dam the near the mouth of the Alter River was still in place, adult whitefish were observed swimming to the area just downstream the dam. The dam was remediated in 2016. Future studies will reveal whether the adult whitefish migrate past the former migration barrier during their spawning migration.

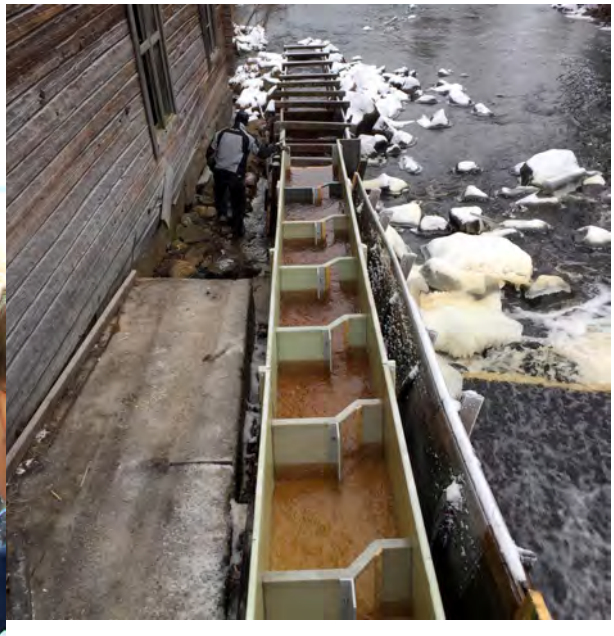
The CAB of Norrbotten is involved in another project which is part of the Kolarctic CBC Programme. The objective of the Kolarctic CBC Programme is to continue and strengthen cross-border cooperation between the countries in the North Calotte and Northwest Russia. One of the projects that are planned within the umbrella of Kolarctic involves the restoration of rivers in Sweden, Finland and Russia and would be run in collaboration with an emphasis on the sharing of knowledge between the countries regarding restoration methods. Norway would also be involved in the project to a smaller extent, as well as the Swedish energy company Vattenfall. The restoration of the rivers would involve inventories of freshwater pearl mussel populations and fish, restoration from the impact of timber floating, a reduction in the release of sediments from ditches, and a removal of migration barriers for fish. The knowledge acquired through Remibar will be used and dissipated throughout the project.

Another project that is ongoing in the County of Norrbotten includes the project that is focusing on key habitats in shallow coastal areas and is funded by the SWAM. The project started in 2014 and will be completed in 2018. The project initially focused on inventories of shallow coastal areas, and will be expanded in 2017 to include inventories of the lower parts the rivers that flow into the Gulf of Bothnia. The inventories will include the identification of migration barriers and the status of reproductive areas.



In the project River specific management of salmon and sea trout and restoration of aquatic habitat The CAB of Norrbotten has received national funding from SWAM to restore the Kälvån River (a tributary to the Kalix River) and the Töre River from the damage done during the timber floating era. The project Älvspecifik förvaltning av lax och havsöring samt återställning av vattenmiljöer (River specific management of salmon and sea trout and restoration of aquatic habitat) five migration barriers will be removed, including the dam in Kälvfors (Kalix river catchment area).





In the project *Ecological restorations in coastal river basins in the Bothnian Bay* some sites, where a dam cannot be removed due to its historical and cultural significance, a fish ladder is constructed so that the fish can access the areas upstream the barrier. A new method to construct fish ladders made of composite material is being developed.

The partners will continue to spread knowledge about migration barriers and the organisms that live in water.

The information from the inventories will be used to develop action plans and restoration projects, which may include the removal of migration barriers.

The CABs of Västerbotten and Norrbotten received funding from the European Union for the project ReBorN LIFE (Restoration of Boreal Nordic Rivers), which started in 2016 and will end in 2021. The CAB of Västerbotten is the project lead. The objective of ReBorN is to restore six rivers in the counties of Norrbotten and Västerbotten from the impact of timber floating and recreate a more natural habitat that will benefit species such as the freshwater pearl mussel, brown trout and Atlantic salmon. The rivers included are: The Lögde River (located in the county of Västerbotten), the Åby and the Byske Rivers (both rivers cross the border between the counties of Norrbotten and Västerbotten), and the Pite, Råne, and Kalix Rivers (all three located in the county of Norrbotten). Migration barriers in four of these rivers (all but the Åby and the Byske Rivers) were remediated in Remibar.

In 2014, when the Remibar project was still ongoing, another regional project, *Levande laxälvar* (Living salmon rivers) started. The project is run by the CAB of Västerbotten and will end in 2017. The project has two objectives: to restore parts of the main stem and important tributaries of the Lögde and Sävar Rivers from the damage done during the timber floating era. Another part of the project is to develop river specific salmon management plans in collaboration with fishing right owners. The project receives funding from SWAM.

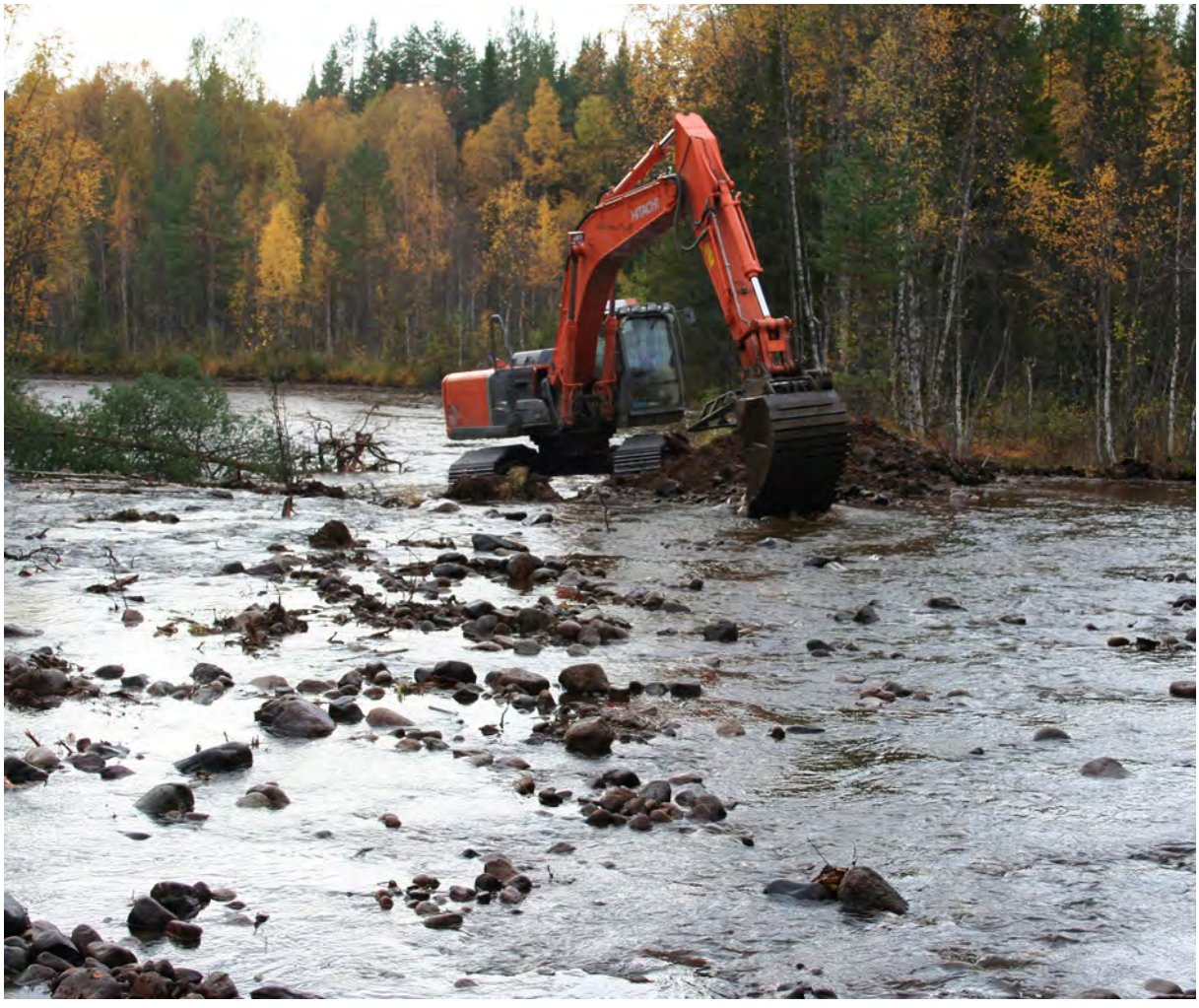
The project *Friskare skogsvatten* (Healthier forest waters), was running from 2012 to 2014 and managed by the CAB of Västerbotten (CABVB 2014). The objectives of the project were to inform forest owners about the importance of clean water, the functioning of ecological processes, and forestry practices that take the aquatic values into consideration. The project was very successful in reaching out to the community of forest owners in a series of workshops and by providing educational material including educational videos of promoted forestry practices and other material. The educational material is still available to the public.

The CAB of Norrbotten has applied for funding from the LIFE Programme to launch a project named Pearls of the North. The project would focus on improvements of the habitat of freshwater pearl mussel populations in order to increase the chances for their long term survival. The project would also include efforts to improve the recruitment of its host-species Atlantic salmon and brown trout. The measures would include efforts to restore the natural flow of water from wetlands. The drainage of wetlands (resulting from the construction of ditches and the lowering of the threshold at the outlet of the wetland) contributes to a larger release of sediments into the streams and larger fluctuations in water flow. Restoring the capacity of wetlands to retain water would reduce the release of sediments and reduce the fluctuations in water flow throughout the year. The efforts to improve recruitment of Atlantic salmon and brown trout involve efforts to increase their access to spawning areas near freshwater pearl mussel populations. This would be done through the restoration of spawning areas and the removal of migration barriers, and this part of the project would build upon the knowledge acquired through Remibar.

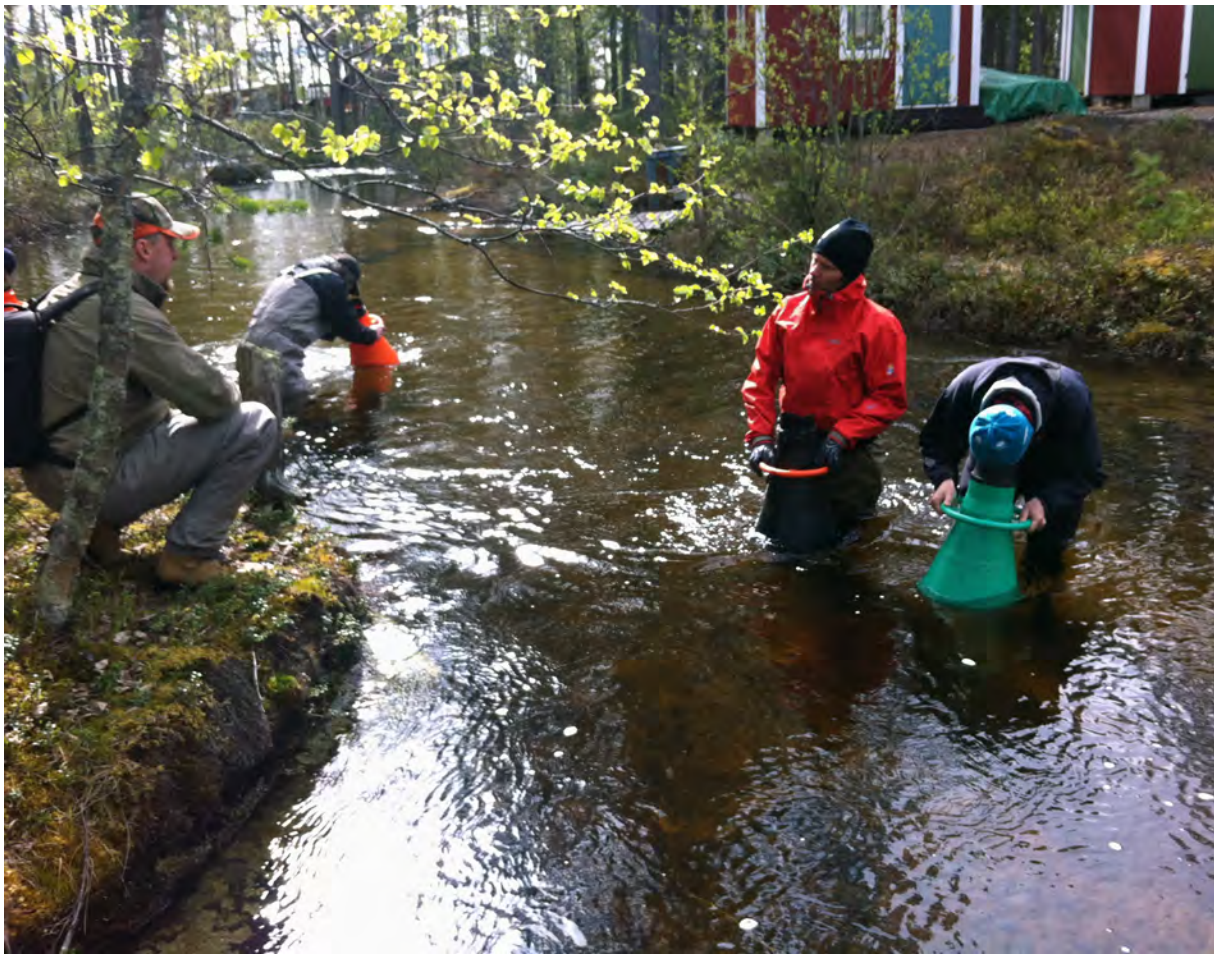
The CAB of Västerbotten has applied for funding for the project *Ecostreams*, which would be run as a LIFE project if funding is approved and would run for 6 years starting in 2018. The project would focus on the restoration of the Öre River, which is included in the Natura 2000 network, and would be carried out in collaboration with a large number of stakeholders. The project would revolve around three themes: The first theme being restoration of the lower reaches of the Öre River, i.e., the 100 km of the river downstream the Storforsen Rapids (and natural migration barrier), and its tributaries. The restoration would involve the removal of approximately 150 migration barriers (mainly culverts and dams), as well as restoration of the main stem of the river and tributaries from the damages done during the timber floating era. The removal of dams and culverts would build upon the knowledge acquired during Remibar. The second theme consists of the production of educational films with information regarding best practices for river restauration, the removal of migration barriers, and the recreation of reproductive areas. The third theme consists of the development of a management plan of the fishery specific to the Öre River, which would be carried out in collaboration with the holders of the fishing rights.

The CAB of Västerbotten has also applied for funding from the SWAM and the Swedish Board of Agriculture for a multidisciplinary project that would revolve around the restoration of the Rickle River. The project would revolve around four themes: Environmentally friendly hydropower (in collaboration with the hydropower company Skellefteå Kraft); Collaboration with the forestry and agricultural industries (with the objective to reduce leakage from forestry and agriculture by promoting a change in farming and forestry practices); Natural and cultural environment (with the objective to restore rivers and creeks to a natural state by removing migration barriers, restore the main stem of the river and tributaries from the impact of timber floating and recreate reproductive areas, and find a balance between restoration needs and the preservation of the cultural environment); and Rural development (development of sustainable industries, e.g., tourism and recreational fishery).

As shown above, the knowledge and methods acquired during the course of Remibar are being used in a range of projects within the counties of Norrbotten and Västerbotten. They are also being disseminated to stakeholders in others parts of Sweden and neighbouring countries. The work aiming at improving the status of habitat and species in the five rivers included in Remibar is also being continued within the scope of a range of other ongoing and planned projects.



The work with removing migration barriers and improving the conservation status of the species and habitat targeted by Remibar will continue in a range of projects and partnerships.



The work will continue to spread knowledge about freshwater pearl mussels to landowners.

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