WAMBAF

Action plan for Water management in Baltic forests

Version 1.0

Content

Preface

This Action plan was prepared within the project WAMBAF (Water Management in Baltic Forests), running from March 2016 to February 2019 and funded by the EU Interreg Baltic Sea Region Programme. WAMBAF focused on three main factors that significantly impact water quality: riparian forests, forest drainage and beaver activity. The main motivator for the project was to support the implementation of EU Water Framework Directive (WFD) (2000/60/EC).

The aim of this Action plan is to provide forest enterprises, forest owners' associations, hunters' associations, NGO:s, public authorities, and high-level decision makers with information about the new tools and material produced in the WAMBAF project for improving water quality and sustaining other ecosystem services when performing forestry operations. In addition, the Action plan presents ideas for further development for water protection in forestry in the Baltic Sea Region

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Summary

How can forestry contribute to good water quality?

Management of riparian forests, maintenance of forest ditch networks and management of beaver dams have high impact on the export of nutrients, suspended solids and methyl mercury to streams, lakes and the Baltic Sea. Forest enterprises, forest owners' associations, hunters' associations, NGO:s, public authorities and high-level decision makers in the Baltic Sea Region can contribute to good water quality, biodiversity and ecosystem services by implementing the new planning tools, films, guidelines with good practices and the beaver handbook produced in the WAMBAF project.

The produced material is compiled in three Tool Boxes:

Tool Box - Riparian forests

- Wet area maps - help forest machines to avoid soil disturbance and can optimize forestry on small-scale
- Blue targeting - helps to design a riparian forest buffer
- Report - Good practices for forest buffer implementation
- Film - about forest buffers

Tool Box – Forest drainage

- App for smartphones - helps to plan maintenance of ditch networks
- Report - Good practices for ditch network maintenance
- Film - about ditch cleaning

Tool Box - Beaver

- Beaver tool - classifies beaver dams as either positive or negative considering various impacts
- Beaver handbook - with information on beaver populations and management needs, country-specific legislation, good practices etc.
- Report - "Good practices for management of beavers and beaver ponds in the Baltic Sea Region"
- Film - about beavers in the Baltic Sea Region

Further development

The following ideas for development would be useful to consider by forest enterprises, forest owners' associations, hunters' associations, public authorities and high-level decision makers in the further development of water protection in forestry in the Baltic Sea Region:

- Provide open access LiDAR-data
- Develop high-quality wet area maps nationwide
- Be proactive – develop beaver management plans
- Investigate how beaver dams can reduce flooding and droughts
- Develop a manual for forest drainage
- Organize training for water protection in forestry
- Co-operate for water protection in forestry within the Baltic Sea Region
- Research on forest buffers and ditch network maintenance
- Research on how forestry affects aquatic organisms

Find out more - watch the films and download the tools, the handbook and the reports on the official WAMBAF website: www.skogsstyrelsen.se/en/wambaf

Background

Forests cover 48% of the Baltic Sea catchment. Most forests are managed for timber and energy production and have high economic value. Rivers and streams transport nutrients and hazardous substances (e.g. methyl mercury) from forests to the regional and coastal waters causing eutrophication, pollution and decrease in biodiversity. HELCOM has estimated that the natural background load from forests comprise approx. 19% of the total nitrogen and 16% of the total phosphorus load to the Baltic Sea. Research has been done mainly concerning nutrient export and water quality. However, there are gaps in the knowledge of how forestry affects aquatic organisms.

Maintenance of forest ditch networks, management of riparian forests, and the distribution of beaver dams are main drivers in the forests of the Baltic Sea Region, which affect the export of nutrients and methyl mercury, and affect biodiversity in riparian ecosystems. More specifically:

- Riparian forests cover an important part of the forest area in the Baltic Sea Region. In Sweden alone, there is >800 000 km of freshwater shoreline. Forest operations, including terrain transport, need to be carefully planned to avoid increased export of nutrients, suspended solids and methyl mercury.
- 10 million hectares of peatlands have been drained for forestry in the Baltic Sea Region. As an example, in Finland 25% of productive forests grow on peatlands. To sustain forest growth, the existing ditch networks need to be maintained. Water protection must be carefully planned and conducted to reduce export of suspended solids and nutrients to the surface waters from the ditch network maintenance areas.
- Beaver populations are considered to have reached densities causing substantial damage levels, in especially the countries in south-eastern Baltic Sea Region.

The WAMBAF project was initiated to provide forest enterprises, forest owners, hunters, authorities and NGO:s with new planning tools, film material, demonstration areas, guidelines with good practices, a beaver handbook and development ideas for improving water quality and sustaining other ecosystem services when performing forestry operations. The aim was also to train the representatives of forest enterprises, forest owners, hunters, authorities and NGO:s to use the material and to give them a chance to provide feedback for further development.

In this Action plan we have summarized information about the main materials, findings and development ideas produced in the WAMBAF project to help forest enterprises, forest owners, hunters, authorities and high-level policy makers to take them in action in their work for water protection in forestry in the Baltic Sea Region.

Important note: When applying the tools always make sure you follow national legislation and, for certified forests, also the forest certification systems.

Tool Boxes

Tool Box – Riparian forests

This tool box consists of wet area maps, the Blue targeting tool, a film and a report.

Wet area maps

The development of new high-resolution digital elevation models from Light Detection and Ranging (LiDAR) has made it possible to derive new maps that can help delineate a hydrologically-adapted riparian protection zone. By modelling the flow paths in the landscape, maps can be generated that show a variable width protection zone around stream networks, with wider protection zones where the soils are wetter and narrower where the soils are dryer, hence, giving a higher protection for areas that are more hydrologically connected. These maps are now under development in many countries. For example, Sweden and large parts of Canada now have Depth-to-water (DTW) maps available when planning forest management. As the number of high-resolution digital elevation models increases throughout the world, the potential for optimizing the water protection during forest management will increase in the future.

During WAMBAF DTW maps were developed for demo areas in Sweden, Finland, Latvia, Lithuania and Poland. A conclusive result was that the calculations of the maps had to be adjusted to local conditions due to the variability in soils, topography and climate within the Baltic Sea Region. A new method to deal with these problems was developed using machine learning. Utilizing these wet area maps is a simple way of optimizing the surface water protection (using the hydrological connectivity) especially for narrow protection zones i.e. about 5-30 m wide zones. However, the maps may provide useful information also when delineating wider protection zones. Designing buffer zones is mainly done in the field during snow-free seasons mostly by visual evaluation. With trustworthy maps delineating wet soils around streams the planning of forest buffers is facilitated and can be made more cost effective. Extraction roads could be planned in advance to avoid deep rut formations in sensitive areas. Stream crossings could be done in suitable dry areas, where the riparian zone is relatively narrow, using technical aids.

The maps can also be used for planning extraction of logging residues for energy production. On wet soils we recommend using the logging residues to reinforce the soils, by building brash mats to protect the soil from rutting and thereby avoid elevated sediment transport to adjacent surface waters. In dry areas, where soils have a higher bearing capacity, we suggest that the logging residues can be harvested for bioenergy. The new maps open future possibilities for small-scale planning such as fertilization or seedling selection can be optimized within stands by soil moisture and seasonal water availability. Hydrologically-adapted buffers are cost-efficient, because they contain wetlands and low productive forest areas with more non-commercial tree species. However, it may be more challenging to communicate the hydrologically-adapted buffers compared to fixed-width buffers. It is important that the maps presenting the hydrologically-adapted buffers are used and respected at all forestry activities.

Some examples on how depth to water maps can be used in operational forestry is descripted in the film “Traceless” (https://www.youtube.com/watch?v=xauLNORS4m0&t=302s), which is partly a WAMBAF product.

Blue Targeting

The planning tool “Blue Targeting” was initially developed by WWF Sweden (Blå målklassning). It is a forestry planning tool to help design the riparian forest buffer. In the WAMBAF project, the Blue

Targeting tool has been adapted for Finland, Latvia, Lithuania and Poland. The aim of Blue Targeting is to protect water quality and biodiversity by proposing the right *measure,* at the right *place,* to the right *extent* - to forest owners and forest planners.

About Blue Targeting and its use:

- Blue Targeting is a field checklist for evaluation of stream sections considering four aspects:
    1. Conservation values (e.g., habitats, deadwood, species)
    2. Impact (e.g., sedimentation, water quality)
    3. Sensitivity (mainly related to erosion risks and hydrological conditions on the ground nearby the stream)
    4. Added values (e.g., cultural values).
- Based on the scores of the checklist, four "Blue targets" (management goals) are identified:
    1. WG – water requiring general consideration
    2. WE – water requiring enhanced consideration
    3. WS – water requiring special action, in the stream or riparian zone
    4. WU – water that is to be left untouched. In the identification of the management goals, conservation and sensitivity criteria are the most important.
- For each management goal, best practices of forest management close to water are proposed, referring to the width and management of the buffer zone, to ensure better water ecology.
- The adapted versions of Blue Targeting take into consideration different ecological conditions and land use history of the Baltic Sea Region countries, and are currently available in English, Finnish, Latvian, Lithuanian, Polish and Russian.

Report "Good practices for forest buffer implementation to promote good surface water quality in the Baltic Sea Region"

This report has been produced within the WAMBAF project, aiming to provide recommendations and good examples from different Baltic Sea Region countries for how to manage forest buffers and riparian forests. The report has a full version and a short version in English. The short version is translated to Swedish, Finnish, Latvian, Lithuanian and Polish. Here is a short summary of the report.

Forest buffers help to protect surface waters from negative impact of forestry. A forest buffer is a zone with forest left for protection along a surface water body when carrying out forestry operations. In the Baltic Sea countries, the width of forest buffers/protection zones along surface water bodies required by legislation vary from about 5 to 500 m. Forest buffers may help to protect habitats on land and in water, supply aquatic organisms with food, provide shading and large woody debris, stabilize streambanks, protect soil adjacent to surface water, reduce transport of sediments, nutrients and mercury to surface water. Here, some recommendations are given on how forest buffers and their management can be used to protect surface water quality:

- Protect all types of surface waters. Springs, small streams and rivers may be more severely affected by forestry operations than large rivers and lakes.
- To mitigate elevated export of plant nutrients (especially nitrogen and phosphorus), suspended solids and mercury to surface water, establish forest buffers along springs, small streams, rivers and lakes.
- Prevent soil disturbance adjacent to surface water, especially in discharge areas, to avoid increased erosion and export of suspended solids, nutrients and mercury from the soil. Therefore, try to leave or create wind-resistant forest buffers, and, within the buffer, minimize off-road traffic and avoid site preparation, ditching, remedial drainage, and stump lifting.

- If a stream crossing is necessary, identify a suitable location and build a permanent logging road and bridge across the stream if possible. Otherwise, build a temporary bridge or use a portable bridge.
- Multi-layered and uneven-aged forest buffers are often considered beneficial for forest buffer functionality. Thus, if considered necessary, species composition and age and canopy structure can be modified at pre-commercial thinning and thinning to promote multi-layered and uneven-aged forest buffers.
- A larger proportion of broadleaved trees is often warranted in riparian zones[1] of conifer stands on productive forest land.
- Trees are not planted in forest buffers for commercial purposes.
- Where large woody debris in streams is sparse or lacking, single logs may be put into the streams to increase habitat diversity.
- Any harvesting of the riparian forest[2] should preferably be performed using selective cutting methods to maintain a continuous tree cover alongside the surface water. Pay attention to the risk of rutting and wind felling.
- Do not fertilize the riparian forest.
- Do not apply or handle pesticides or other chemicals within the riparian zone.
- Do not leave or store logging residue in the riparian zone, except when it has been used for ground protection associated with off-road transportation.

Note that forests and water bodies within the Baltic Sea Region show great diversity and the recommendations given must be adapted to local conditions, taking account of the characteristics of individual sites, national legislation, other regulations, and forest certification standards.

Film "Forest buffers in the Baltic Sea Region"

A forest buffer is a zone with forest left for protection along a surface water body when carrying out forestry operations. In 11 minutes, this film gives an overview of:

- Why forest buffers are important for water quality and biodiversity
- How forest buffers can be designed
- How the use of forest buffers differs between the countries in the Baltic Sea Region

Tool Box – Forest drainage

This tool box consists of a film, an app for smartphones, and a report.

App for smartphones

The main purpose of this drainage application is to support the process of detecting and managing drainage network in forests. The application assists forest owners in more effective management of infrastructure by using the latest and most detailed data about land topography, which was derived from airborne laser scanning. During the project, sets of such data for all WAMBAF demonstration areas were prepared.

[1] Riparian zone is an area adjacent to a water body, including the bank of the water body, which has an impact on the ecology, hydrology and water quality of the water body.

[2] Riparian forest is the forest that grows in the riparian zone.

Anyone may download a free of charge application (both Android and iOS version are available). After opening it, the user is asked to go through a questionnaire about issues of drainage networks and their relevant management. This phase supports the user to decide if and what activities are possibly needed for maintaining the ditch network and mitigating impact on water quality. After completion of this phase, it is possible to download topographic data (i.e. Digital Surface Model). The data is transferred to a server to be further analysed automatically. Upon the completion of this phase, the user is provided with an automatically generated drainage network and a network of streams and rivers. The user may edit the obtained layers directly in field, for example the individual ditches. The user can find suggestions on what actions may be performed to reduce the negative impacts of ditch network maintenance on water quality. All data recorded in this way may then be downloaded from the server and further analysed on desktop devices.

Report "Good Practices for Ditch Network Maintenance to Protect Water Quality in the Baltic Sea Region"

This report has been produced within the WAMBAF project, aiming to provide recommendations and good examples from different Baltic Sea Region countries for carrying out water protection in ditch network maintenance. The report has a full version and a short version in English. The short version is translated to Swedish, Finnish, Latvian, Lithuanian and Polish. Here is a short summary of the report.

There are in total 19 million hectares of peatlands in the following Baltic Sea Region countries: Estonia, Finland, Latvia, Lithuania, Poland and Sweden. 10 million hectares of these have been drained to improve forest growth. Peatlands and paludified soils are important for wood production. For example, in Finland 25% of productive forest are grown on drained peatlands. Ditch networks need to be maintained to sustain and improve forest growth. The maintenance of ditch networks increases erosion and export of suspended solids and nutrients to surface waters. That should be reduced as much as possible.

The sustainability of ditch network maintenance should be assessed by paying attention to the following factors in order to justify the economical outcome and environmental impact of the operation:

- Characteristics of the receiving water body, especially its sensitivity
- Groundwater inflow from confined aquifers
- Susceptibility to flooding
- The effect of first-time drainage
- Tree stand volume
- Tree species and understorey vegetation composition
- Ditch drainage capacity
- Soil characteristics
- Climatic conditions

After carefully considering the abovementioned factors the decision is made whether the ditch network maintenance is suitable or not in a formerly drained area.

Ditch network maintenance should be economically profitable from a forest production point of view and it should not deteriorate the quality of surface waters. Therefore, water protection is an essential part of the work and it must be planned together with the ditch network maintenance. The priority should be to avoid erosion. Different water protection structures, such as dams,

sedimentation ponds and wetland buffers, can be used to reduce sediment and nutrient transport to the surface waters.

Planning tools, monitoring, demonstration areas, education and training should be implemented to ensure good quality and continuous development of water protection in ditch network maintenance.

Film "Ditch cleaning in the Baltic Sea Region"

Over the years, considerable areas of the forests in the Baltic Sea Region have been ditched, especially in Finland. Ditch cleaning may potentially have a large impact on the receiving waters, in particular by increasing the export of sediments and nutrients. In this film, 6 minutes long, experts on ditch maintenance from Finland and Sweden discuss:

- When ditch cleaning is a suitable measure
- What are the available countermeasures for reducing sediment transport

Tool Box - Beaver

This tool box consists of the Beaver tool, the Beaver handbook, a film and a report.

Beaver Tool and Mercury

Hazardous substances (including mercury, Hg) and nutrients are an emerging environmental problem in the Baltic Sea Region. Recovering beaver populations could potentially contribute to mitigate this problem, but could, depending on the properties of the respective beaver systems, also contribute to amplification of the problem.

To evaluate the effect of beavers on mercury and its bioavailable and toxic form methyl mercury (MeHg), we removed beaver dams in Poland, Lithuania, Latvia and Sweden and sampled MeHg in sediment and biota (including fish) before and after the removal. We demonstrated that beaver dams indeed can contribute to formation of MeHg. Encouragingly, we also show that this process can be reversed by dam removal. However, dam removal is a drastic measure, and the potential beneficial effects of beaver dams related to, for example, beaver-induced increased biodiversity, flood control, and sedimentation of fine particles need to be considered for prior any potential dam removal. Importantly, our study revealed that high Hg concentrations in fish is a topical problem all over the Baltic Sea Region, not only in the Nordic countries, since Hg concentrations in all four countries exceeded the EU environmental quality standard according to the Water Framework Directive.

Due to the multiple environmental and ecological effects of beavers, there is a need to assess the value of beaver systems. We therefore developed the "Beaver tool" that serves as a decision support and/or assessment tool. As a decision support tool, it can be used to recommend to remove or keep a beaver dam, based on information on water quality, nature and/or economic values that are either gained or lost by removing or keeping the dam, respectively. As an assessment tool, it helps to identify and quantify water quality as well as nature and economic values of beaver systems.

Beaver Handbook

The beaver handbook produced within the WAMBAF project is quite extensive. The aim of the handbook is to provide background information, as well as good examples of management of dense beaver populations to balance their positive and negative impacts. The handbook covers the following information about beavers in the Baltic Sea Region:

- General biology
- Distribution

- Beavers as ecosystem engineers
- Short history of Eurasian and North American beaver species populations around the Baltic Sea
- General aspects of hunting and trapping beavers
- The processing, marketing and use of beaver products: Fur, meat and castoreum
- The beaver as a resource for tourism business and education: Hunting tourism/nature tourism/nature guiding
- Prevention of beaver damage to economic interests
- Management of beavers for water quality
- Practical tools
- Good practices for management of beavers and beaver ponds in the Baltic Sea Region

The chapter about Good practices is also provided as a separate report - "Good practices for management of beavers and beaver ponds in the Baltic Sea Region".

Report "Good practices for management of beavers and beaver ponds in the Baltic Sea Region"

The report aims at providing recommendations and good examples from different Baltic Sea Region countries on the management of beavers and beaver ponds. The report is also included in the Beaver handbook as a separate chapter. Here follows a short summary of the report.

Beaver populations are now considered to have reached densities causing substantial damage levels, e.g. in the south-eastern part of the Baltic Sea Region.

We suggest the use of an adaptive management method. This is a decision process that promotes flexible decision-making. It includes a situation analysis, setting of objectives, developing a model, and selecting and implementing management actions. Stakeholders should be involved in setting objectives for beaver management. When the system has been monitored and the actions assessed, the model may be further developed.

Management of beaver populations may include a number of actions. These include information and education of stakeholders, mitigation and prevention of beaver damage, but also relocation of beavers and removal of dams. Where permitted, hunting and trapping of beavers are the main methods for controlling beaver populations. Depending on the beaver situation (local, regional and national), current legislation and policies, and the opinion among dominating stakeholders one or several of the management actions will be selected.

Management and harvesting strategies and methods should differ between two categories of beaver sites: allowable sites and unallowable sites. The Beaver tool, which has been developed in WAMBAF, aims to classify beaver sites into these categories.

Allowable sites cause no or negligible damage. They are important for the local biodiversity, are potential centres for beaver distribution, are important to maintain the local beaver populations, and are key landscape components of woodlands, or belong to protected areas. These sites should be maintained to persist as long as possible, applying minimal harvesting within limits of annual increment.

Unallowable sites cause damage or may cause conflict situations in the near future, or contain low habitat and food supply for beavers. These sites are managed to remove beavers with subsequent prevention from repeated habituation of beavers.

In the perspective of a changing climate, the role of forest waters is important in stabilizing runoff and water tables in periods of flooding and drought. Here, management of beavers and beaver dams may be crucial.

In regions with high population density, such as large parts of the Baltic Sea Region, beavers are often perceived as a problem species when they inhabit landscapes which are either urban or dominated by forestry and agriculture. Situations of spatial overlap have a potential to develop into conflicts, and then a reaction will be to find rapid solutions to the problem. If these situations instead are predicted in advance, solutions may be found in time. In order to facilitate coexistence between society and beavers, proactive planning will, therefore, be useful. Authorities should work proactively and have a plan for the management of beaver populations, dams and damages before the animals have colonized the area.

Film "Beavers in the Baltic Sea Region"

Beavers are important landscape engineers. By damming, they often increase biodiversity and decrease water flow in the landscape. However, dams can cause conflicts, not least with forestry, since large areas are flooded particularly in the flat parts of the Baltic Sea Region. This short film gives an introduction to beaver management and shows examples how to reduce the conflict, by presenting:

- Examples of allowable beaver sites
- Technique to reduce the negative impact

Demonstration areas

Demo areas have been established in eleven places around the Baltic Sea, showing management in practice for forest buffers (riparian forests), ditch network maintenance and beaver dams (Figure 1).

In the demo areas, training courses have been organized and different measures have been carried out. Ditches have been cleaned, forest buffers have been managed and beaver dams have been removed to demonstrate the practices described in the reports "Good practices".

In addition to these physical demo areas, there are two "virtual demo areas" available to visit on the internet. The virtual demo areas are presented by using "story maps", which describes the forest and measures implemented.

The report "Overview WAMBAF demo areas" presents each demo area with coordinates, site description, photos etc.

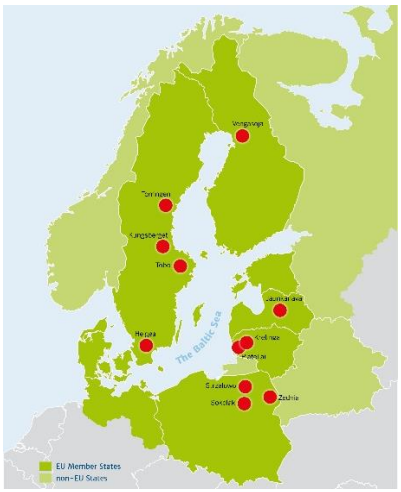

Figure 1. As part of the WAMBAF project, demonstration areas have been established in eleven places around the Baltic Sea.

Training courses and evaluation

19 training courses were carried out during 2018 with participants representing forest enterprises, forest owners, hunters, NGO:s and authorities, as well as scientists and students at some courses. The total number of participants was 628 and 23% of them were women. At the courses, planning tools and good practices were presented and tested in the demo areas. The participants were asked to fill in a questionnaire to evaluate the planning tools and other material from the WAMBAF project. The evaluation shows a great interest and need for practical tools and informative material. Among the participants, 74-78%, thought the tools and material of the riparian forest tool box would be useful in their work. Regarding the tool box for forest drainage, 66-77% considered this would be useful in their work. The respective figures for the Beaver Tool box was 33-55%.

The training courses have been highly appreciated in the project. Some new ways of implementing the training course were tested, for example by using webinars. This is a training course performed via Internet and video link, which makes the participation easier since the participant does not need to visit a certain physical place. Therefore, webinars are a way of reaching a higher number of participants. However good, the webinar cannot replace a physical meeting at a particular field site, when it comes to showing certain measures. Story maps were another way of showing the WAMBAF results. The story maps were popular since the participants can go through the material when suitable.

Need for action and further development

The following ideas for development would be useful to consider by forest enterprises, forest owners associations, hunters associations, public authorities and high-level decision makers in the further development of water protection in forestry in the Baltic Sea Region:

- **Provide LiDAR-data**
  Open access LiDAR-data is essential when developing maps and planning tools to reduce the export of nutrients and methyl mercury. LiDAR-data is not available or open access in all Baltic Sea Region countries.
- **Develop high-quality wet area maps nationwide**
  Wet area maps have a great potential. In the WAMBAF project maps were developed for WAMBAF demo areas, but to get full benefit of them high quality wet area maps should be available nationwide.

- **Be proactive – develop beaver management plan**
  Implementation of proactive management of beaver populations can avoid conflicts in the future.
- **Investigate how beaver dams can reduce flooding and droughts**
  In the perspective of a changing climate, the role of forest waters is important in stabilizing runoff and water tables in periods of flooding and drought. Here, management of beavers and beaver dams may be crucial.
- **Develop a manual for forest drainage**
  A manual for forest drainage with detailed instructions would help machine operators to perform drainage operations with suitable water protection measures.
- **Organize training for water protection in forestry.** Opportunities for training good practices and new tools should be continuously available.
- **Co-operate for water protection in forestry within the Baltic Sea Region.** It is important to learn from each other and to join efforts in research and development.
- **Research on forest buffers and ditch network maintenance**
  There is need to increase the scientific knowledge base about the effects of forest buffers and water protection measures in ditch network maintenance on the export of nutrients, suspended solids and mercury to the water bodies. There is also a need for better knowledge on the benefit of ditch network maintenance in terms of impact on tree growth.
- **Research on how forestry affects aquatic organisms**
  There is a need for better scientific knowledge concerning the aquatic organisms and their response to impacts caused by forestry.