BERNET CATCH

Network on the implementation of
EU Water Framework Directive
in the Baltic Sea Catchment

BERNET CATCH Main Report:

Water Quality Management in the Baltic Sea Region

Regional Implementation of the EU Water Framework Directive

February 2006

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Baltic Sea catchment indicating partner regions and pilot river basins

Gdansk BERNET region

RB BERNET pilot river basin

Pilot River Basin

Baltic Sea Catchment

Foreword

This report presents the main findings of the BERNET CATCH project "Integrated Management of Catchments - a Regional Cooperation on Implementation of the Water Framework Directive in the Baltic Sea Region". The main report draws the main analysis and conclusions from the BERNET CATCH Theme reports and the regional reports on water management planning in BERNET pilot river basins. Separately is made an executive summary of the project.

BERNET (Baltic Eutrophication Regional Network) is a network cooperation between water managers in seven regions of the Baltic Sea region. The network was founded in 1999 to help improve the aquatic environment in the Baltic Sea region. Since its inception, BERNET has focused on alleviating eutrophication in order to help fulfil the aim of the Helsinki Declaration "to assure the ecological restoration of the Baltic Sea".

The present BERNET CATCH project (2003–2006) primarily focuses on regional implementation of the EU Water Framework Directive (WFD) and aims to strengthen regional capacity and facilitate integration of the directive's implementation with statutory physical planning, as well as to foster public participation and stakeholder ownership. With its broad representation in the Baltic Sea region, BERNET CATCH highlights the pan-Baltic perspective and the regional interdependence of aquatic environmental quality – especially in the Baltic Sea. One of the project's main objectives is to prepare a river basin management plan for a pilot river basin (PRB) in each partner region stipulating measures aimed at improving the quality of the surface waters and groundwater. Each river basin management plan is to be accompanied by a monitoring programme designed to document the status of the water bodies, assess the pressures upon them and assess the expected beneficial effects of the programme of measures.

BERNET CATCH is thus a "trail run" of WFD implementation, although the necessary national guidelines and administrative tools may not be fully developed at this early stage in the implementation process. Through the project the BERNET partners present and evaluate different regional (and national) solutions to fulfilling the WFD environmental objective of achieving at least "good status" of all EU water bodies by 2015.

The BERNET Partners:

- Fyn County, Denmark: Fyn County, Nature Management and Water Environment Division (Lead Partner)
- West Finland, Finland: West Finland Regional Environmental Center
- Gdansk Region, Poland: Gdansk Regional Board of Water Management
- Kaliningrad Oblast, Russia: Department of Federal Supervision Service for Natural Use for Kaliningrad Oblast - Ministery of Natural Resources of Russia and Government of Kaliningrad Oblast
- Laholm Bay Region, Sweden: Counties of Halland and Scania; Municipalities of Båstad, Laholm, and Halmstad
- Schleswig-Holstein, Germany: State Agency for Nature and Environment, Schleswig-Holstein
- Viru-Peipsi, Estonia: Peipsi Center for Transboundary Cooperation (NGO).

Finally, we wish to thank the many colleagues from the BERNET partner regions who contributed their knowledge and ideas to the project. We hope that the BERNET CATCH reports will serve as a source of information and inspiration to all water managers and stakeholders involved in implementation of the WFD.

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BERNET pilot river basins

Schlei-Trave

Kyrönjoki

Stensån

Pasleka

Odense Fjord

1. Conclusion and recommendations

Conclusions

The Water Framework Directive (WFD) introduces a holistic and fully integrated sustainable approach to water management by considering groundwater, surface waters and wetlands together and by introducing the overall long-term objective of "good status" for all water bodies.

The advantage of this integrated management approach is that many measures to reduce environmental pressures affect several types of water bodies concomitantly. Moreover, some measures also benefit the terrestrial environment, e.g. the re-establishment of wetlands in river valleys. The development of management plans pursuant to the WFD and the Habitats Directive should therefore be coordinated and synchronized, i.e. a "value-for-money" approach.

Many water bodies in the BERNET partner regions are at risk of failing to meet the WFD environmental objective of at least good status by the year 2015. Even though considerable efforts have been made to combat pressures in many areas, further measures need to be taken to reduce pressure on water bodies that do not fulfil the objectives and to prevent an increase in pressure on water bodies, that already fulfil the objectives.

Integrated management strategy urgently needs to be strengthened in the BERNET partner regions in order to enable characterization of all important pressures on the aquatic environment and development of efficient and coherent strategies to deal with these pressures in a cost-effective manner.

Main recommendations

Successful and cost-effective implementation of the WFD requires several important preconditions to be met – preconditions that are inadequately met at present. These preconditions are reflected in the following recommendations.

1. *The legislative possibilities to individually regulate pressures from all sectors of society must be available at an early stage in the planning process, including the possibility to individually regulate diffuse pollution from agriculture and forestry.*

   Background:

   - A general need exists to regulate pressure on water bodies from all sectors of society (agriculture, forestry, households, industry, etc), but the range and severity of the necessary measures vary considerably from region to region depending on the magnitude of the pressure from the individual sectors.
   - *Agriculture* is presently the main source of pressure on water bodies in the BERNET partner regions, both pollutional (nutrients) and physical. Pressure is highest in the intensively farmed areas such as Fyn County and Schleswig-Holstein, where per hectare nitrogen loss to surface waters is three-fold higher than that in both Pasleka PRB and in Poland as whole, the country accounting for the highest proportion of farmland in the Baltic Sea catchment. BERNET calculations show that if per hectare nitrogen loss from all farmland in the Baltic Sea catchment increased to the present high level in Fyn County or Denmark as a whole, total nitrogen loss to surface waters in the Baltic Sea catchment might increase by more than 50%.

     Agricultural productivity is expected to expand in future, moreover, especially in the new EU countries and in Russia, thereby enhancing pressure on water bodies and increasing the need for measures to curb these pressures. In order not to conflict with the HELCOM objective of reducing nutrient loading of the Baltic Sea and the WFD objectives for water bodies it is thus necessary both to reduce nutrient loss from the intensively farmed regions and to concomitantly prevent nutrient loss increasing even further in the less intensively farmed regions such

as Pasleka PRB or Poland as a whole.
Present national legislation provides only limited possibilities to individually regulate pressure on local water bodies from agriculture and forestry. This is a major obstacle in relation to the preparation and implementation of river basin management plans aimed at ensuring attainment of the environmental objectives for individual water bodies.

- *Wastewater treatment facilities* are presently well developed in the BERNET partner regions of Sweden, Finland, Denmark and Germany, and are currently being upgraded in the partner region of Poland. Further wastewater treatment issues need to be addressed, however, including the removal of hazardous substances and improved treatment of wastewater from sparsely built-up areas in all partner regions. An urgent need remains to construct and upgrade wastewater treatment facilities in the Kaliningrad Oblast.

2. *Adequate resources must be allocated to water management, both administrative and financial*
Background:
- The financial principles governing implementation of the programmes of measures must be defined and the necessary resources allocated at an early stage of the process so as to set the framework for the planning and implementation process.
- When allocating resources for river basin management adequate resources should be earmarked for ensuring public participation from the beginning of the planning process.
- Comprehensive monitoring is vital for ensuring, that the programmes of measures are cost-effective, and for characterizing threats to water bodies of "good" or "high" status in time to hinder deterioration in their status.

3. *BERNET strongly recommend cross boundary cooperation on river basin management within the Baltic Sea area, including the river basins in Russia. A good example is the newly founded "Vistula Lagoon Water Managers Forum" which is water management cooperation between Russia and Poland regarding the transnational Vistula Lagoon.*

Recommendations

Management strategies for preparing programmes of measures

1. An important precondition for successful preparation and implementation of river basin management plans is the establishment of clear relationships between WFD objectives, operational environmental quality objectives for the water bodies and the associated maximum permitted pressures. The maximum permitted pressure is the basis for dimensioning the programmes of measures in the river basin management plans. These relationships and preconditions have to be present early in the planning process as a basis for involving the public in the choice of measures to fulfil the environmental quality objectives.

2. An urgent need remains to strengthen the integrated management strategy in the BERNET partner regions in order to characterize all important pressures on the aquatic environment and develop efficient and coherent strategies to deal with these pressures in a cost-effective manner. The advantage of this integrated management approach is that many measures to reduce environmental pressures affect several types of water body concomitantly.

3. The legislative possibilities to individually regulate pressures from all sectors of society must be available at an early stage in the planning process, including the possibility to individually regulate diffuse pollution from agriculture and forestry. A general need exists to regulate pressure on water bodies from all sectors of society (agriculture, forestry, households, industry, etc), but the range and severity of the necessary measures vary considerably from region to region depending on the magnitude of the pressure from the individual sectors.

4. The time schedule for implementation of the WFD is very tight and demands precise allocation of the resources necessary to achieve the defined aims. Early initiation of the planning process and early implementation of the programmes of measures are therefore of utmost importance as both are a matter of negotiation, ultimately entailing a formal

decision by many parties, including stakeholders, as well as several levels of authorities from state to municipal level in all the BERNET partner regions. See also the recommendations about public participation.

5. *Agriculture*: Agriculture is presently the main source of the pressure on water bodies in the BERNET partner regions, both pollutional and physical. A vital and major challenge to the entire Baltic Sea region is to ensure converging development of on one hand, increased agricultural production based on sustainable principles in the new EU countries and on the other hand, improvement of agricultural production in the old EU countries aimed at significantly reducing the present pressure on the aquatic environment while concomitantly ensuring sustainability. It is thus of utmost importance to ensure integrated implementation of the WFD and EU Common Agricultural Policy (CAP).

6. *Physical restoration and wetlands:* Wetlands and uncultivated/unregulated river valleys serve as a buffer between cultivated areas and surface waters, thereby reducing pollutional and physical pressures from agriculture and forestry. The BERNET partners strongly recommend that the new EU countries preserve their existing high proportion of wetlands and uncultivated/unregulated river valleys. They further recommend that the old EU countries re-establish wetlands and unregulated river valleys in order to enhance the natural worth of a landscape dominated by agricultural production.

7. *Wastewater:* There is a continued strong need for investments in sewerage systems and wastewater treatment facilities in all the regions – especially in the new EU countries. The issue remains important in the old EU countries, though, where wastewater from sparsely built-up areas and stormwater outfalls still poses a major problem.

8. *Linkage of biological quality elements and pressures:* The establishment of linkage between biological quality elements and pressures is necessary in order to be able to predict the effect of pressure reductions.

9. *Climate change:* As climate changes may augment/attenuate pressures, such changes should be taken into account when preparing programmes of measures.

Classification and monitoring

The WFD requires that systems for classifying water bodies be based on reference conditions and related to specific surface water type. This is not usually the case today, however.

10. Reference conditions: High priority needs to be accorded to defining reference conditions as these are a prerequisite for establishing reliable systems for classifying the ecological status of water bodies. Clearly defined reference conditions are also crucial for determining what pressure reductions are needed to achieve “good ecological status”. It is thus very important to establish “true” reference conditions that reflect pristine conditions rather than defining reference conditions in accordance with what is considered to be politically attainable. In the absence of true reference sites for certain types of surface water it is necessary to define reference conditions on the basis of:
    - Comparable sites in other countries
    - The combination of modelling and historical data to infer reference values for physical, chemical and biological variables
    - Palaeolimnological tools. The use of palaeolimnology in rivers, lakes and coastal waters must not be neglected as it may have a significant potential

11. *Intercalibration:* There seems to be a marked need for intercalibration:
    - Inter-country harmonization of typologies for directly comparable surface waters (e.g. lakes in Denmark, northern Poland and northern Germany).
    - Harmonization of definitions, e.g. a common understanding of what is meant by “reference conditions” and “good ecological status” for all types of water body.

12. *Monitoring:* Comprehensive monitoring is vital for ensuring that the programmes of measures are cost-effective and for characterizing threats to

water bodies of "good" or "high" status in time to hinder deterioration in their status.

- Monitoring programmes must focus on quality elements that reflect all significant pressures.
- Wherever possible, monitoring programmes must also include quantification of the pressures. For example, it is important to determine nutrient inputs to water bodies of reference, high, or good ecological status in order to enable them to be distinguished from water bodies of moderate, poor or bad ecological status. The programmes for monitoring pressures should be planned so as to enable the trend to be followed. In this connection the accumulation of time series is important.
- The surveillance monitoring network must be sufficiently large to enable proper general description of the environmental quality of the water bodies in a given river basin and of all relevant surface water types.
- With operational monitoring preparing the development of cost effective programmes of measures it is advisable to select a large subset of water bodies to be monitored including monitoring of presures.

Public participation

Public participation is of key importance to the preparation, implementation and success of river basin management plans. As the time schedule for implementation of the WFD is very tight, the early involvement of the public and the stakeholders in the process is vital to ensure its success.

13. Early identification of the stakeholders promotes public participation.

14. Stakeholder analysis and previous cooperation promote initiating the public participation process

15. Clear mandates and transparent management promote stakeholder participation.

16. Resources for public participation are needed by both the authorities and stakeholders. Public participation should be planned as an integral part of river basin management from the start of the planning process.

17. The authorities must be aware of different possibilities that stakeholders and the public have to participate due to differences in human and financial resources.

Lake Wulpinskie, Pasleka -River Basin, Poland
Photo: Stig E. Pedersen, Fyn County.

2. The challenges in the Baltic Sea Region

2.1 The major environmental problems

Nine countries surround the Baltic Sea, one of the largest brackish water bodies in the world. In many respects, the Baltic Sea Region is quite unique, in both its natural features and the cultural, political and socioeconomic patterns in the bordering countries. Some of the area is designated as UNESCO World Heritage Area. A large and relatively densely inhabited catchment with growing economic and an agricultural sector draining into the semi-enclosed brackish sea. The Baltic Sea and the adjacent freshwaters systems and wetlands are vulnerable ecosystems, and for decades they have been threatened by man-made impact, especially in terms of nutrient outlets, hazardous substances, acidification and physical regulation.

Excessive growth of nuisance green algae as Enteromorpha sp. *reduces growth of brown algae as Bladderwrack* (Fucus vesiculosus)*. Photo: Nanna Rask, Fyn County.*

Oxygen deficiency is a widespread phenomenon in coastal waters of the southern Baltic Sea, the deep basins of the central Baltic sea, and in deep lakes. The problem is much enhanced the last decades due to eutrophication. White sulphur bacteria and dead Starfish are a sign of severe oxygen deficiency. Photo: Nanna Rask, Fyn County.

Phytoplankton blooms may cause ban of bathing and algae foam along the shore, here at the Schlei Fjord in Schleswig-Holstein. Photo: J.Voss, LANU, Schleswig-Holstein.

Eutrophication

Excessive nutrient inputs from diffuse sources as agriculture, forestry and scattered settlements, and point sources as municipal and industrial sewage outlets, significantly influence the ecological balance of the Baltic Sea and its coastal waters. This man-made eutrophication tends to deteriorate the aquatic environment and thereby prevent the achievement of good ecological quality in surface waters not only in the Baltic Sea itself but also in many other water bodies in the total catchment to the Baltic Sea, (lakes, estuaries, near coastal waters and some river stretches) The problems with eutrophication are at present more severe in those countries in the Baltic sea region with an intensive agricultural sector and huge inputs of nutrients, causing significant losses to the environment. There is reasonable concern, however, that the future development of agriculture in countries with less intensive agriculture as Poland, and Russia in the Baltic Sea Region may reinforce

Fish kill in the Baltic Sea, due to acidification. Photo: Pertti Sevola, WFREC.

these problems if not managed properly.

Point source outlets and sewage treatment is still an important problem in many countries in the Baltic Sea region, but at present huge investments are made to ensure environmental quality goal in order to fulfill different EU directives as e.g the Urban Waste Water directive, and the directives on water protection in order to support fish and shellfish life etc, see Annex 2.1. These investments in Waste Water Treatment Plants (WWTPs) have or will lead to a significant reduction of the point source outlets in the new EU Member States as Poland and Estonia. Other countries as Russia are in the process of finding resources to a general improvement of the sewage treatment.

Acidification

Acidification is another major problem affecting rivers and lakes in terrains with insufficient buffer capacity in the ground, as is the case in large parts of Sweden and Finland. In Sweden, atmospheric precipitation of acidic substances is the most important factor. In Finland, the acidification is primarily caused by agricultural use and drainage of alum (acid sulphate) land in the flat coastal lands of West Finland. The acidification problem is not only confined to freshwater systems, but may also affect the low-saline near-coastal marine areas, especially at springtime, when the ice melts and causes flooding. Occasionally severe fish kills in marine areas are observed due to the sudden flood and acidification events.

Physical regulation

Physical regulation of rivers and streams for drainage, for flood protection, for hydropower generation, etc. is widespread in the region. In the Baltic Sea regions with intensive agriculture, drainage may cover more than 50% of the cultivated area as e.g. in the Odense pilot catchment. In this catchment, 72% of the wetlands registered in 1892 have disappeared up till now (Fyn County 2003). Regulation and piping of streams and rivers affect most rivers, leaving

Physical regulation of streams and rivers to improve drainage and to prevent flooding is widespread in the Baltic Sea Region. In many areas, flooding poses a severe problem, as e.g. in West Finland, River Kyronjoki. Photo: Pertti Sevola, WFREC.

only smaller stretches to natural meandering. Land reclamation has also lead to a significant reduction in areas of coastal lagoons, fjords and lakes. The destructions of such wetlands implies an elimination of these areas role as natural buffers between cultivated land and surface waters. One of these roles being the retention of pollutants (i.e. nutrients) from the cultivated land. In West Finland, the high rate of land upheaval (1 cm/yr) leads to continuous formation of new coastal lagoons and lakes, and to development of lakes into moors and mires. In this region, natural development is thus an important factor for physical alteration along with man-made changes. In the Baltic Sea regions with less intensive agriculture, naturally meandering water courses and associated wetlands may still be found,as e.g. in Poland and Kaliningrad.

In some lakes and coastal waters, physical pressures as dredging of shipping channels, building of harbours, dams and regulation of water exchange through sluices may be important factors which should be addressed due to the WFD. Fishery may also imply physical damage to the seabed, especially harvesting of mussels.

Forest drainage may increase the acidification problems in adjacent waters. Photo: Anssi Teppo, WFREC.

Hazardous substances

Hazardous substances also form a major problem, but are not within the scope of this report. The Helcom declaration of 1988, however, stipulates a substantial reduction of substances most harmful to the ecosystem of the Baltic Sea, especially of heavy metals and toxic or persistent organic substances. All countries in the Baltic Sea Region have signed the convention and thus are obliged to fulfill the aims of the convention. Several EU Directives also regulate the outlets of harmful substances, so those countries in the Baltic Sea Region which are members of the EU are obliged to follow these aims.

Liming of acid soil is a common measure to curb acidification in Finland. Photo: Eeva-Maija Sevola. WFREC.

2.2 The large socio-economic and political changes

Cars queuing up at the border between Poland and Kaliningrad Region, as a sign of growing economics and increasing trade. Photo: Stig Pedersen, Fyn County.

The Baltic Sea Region has faced several political changes during the last two decades. First the Perestrojka (restructuring) and Glasnost (openness) in Russia in the late eighties, which in the end lead to the foundation of the new independent democracies of Estonia, Latvia and Lithuania in the early nineties. Other changes have been in Poland with the election of a non-communist leader in 1989 and the reunion of East- and West Germany in 1990 and latest, the integration of Estonia, Latvia, Lithuania and Poland the EU in 2004.

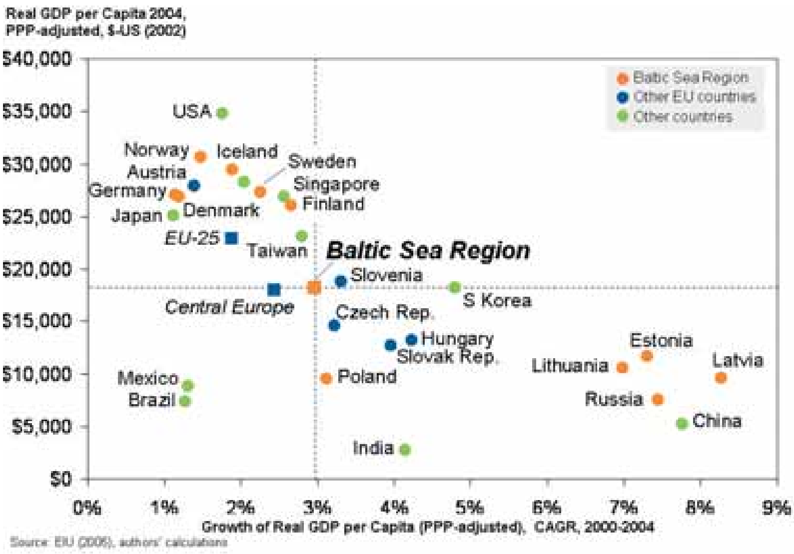


Figure 2.1
The figure show that the growth rate in the Baltic Sea Region is higher than in Central Europe and the EU-25 countries as a whole. Source: Ketels et al. *2005.*

These major events among others have all contributed to the development of new states based on market economy, introduced new ways of living and thinking and forced a development of a whole new administration. Besides, the political changes have had an enormous influence on the economic development and on the social situation in the involved countries in form of privatization and economic reforms.

In the early nineties the economic growth (measured in GDP per capita) was showing a decrease in the new market economies and stagnation in the old market economies in the Baltic Sea Region. However, from the middle of the nineties the economic growth has been increasing for all countries except Russia and since 2000 the rate of growth has increased more in the new market economies that in the old ones, see Figure 2.1 (Ketels *et al.* 2005). Entering the EU in 2004, Estonia, Latvia, Lithuania and Poland have also entered the EU Common Agriculture Policy and the possibility to receive substantial economic support to the agricultural sector. Compared to the stagnation in agricultural development in the nineties an increase in the intensity of farming is now expected.

The growing economy in the Baltic Sea Region is a common goal in order to obtain equal living standard in the countries and secure the societies in the future. However, the development also calls for a regional approach and encouragement of regional co-operative efforts to secure a sustainable development in the Baltic Sea Region in general and in the sense of an environmental sustainable development. In fast growing economies it is a special challenge to ensure that this growth will be ecologically sustainable and not lead to a deterioration of the environment.

2.3 The growing agricultural sector

The agricultural sector interacts in several ways with nature and environment. These interactions are among others related to the percentage of land used by the agricultural sector and to the intensity of farming practise and to the structure of the sector. During the past century, the agricultural sector has become much more intensive in most of Europe (and in the BERNET regions). Although the environmental impact of this general development has varied considerably in the different regions, the impact of agriculture on the environment is indisputable. In the most intensive agricultural areas of the BERNET regions (Schleswig-Holstein and Fyn) most of the land use is agricultural areas. A high productivity of the sector in these (and other) regions is driven by a high input of nutrients of which significant parts are lost to the environment. These losses being either as nutrients (Nitrogen and Phosphorus) leaked towards the aquatic environment or as emissions of ammonia to the atmosphere with later depositions on land and surface waters. Furthermore the use of pesticides in the agricultural sector will lead to some losses of these substances to the environment. National and/or regional Action Plans to reduce the damaging effects on environment in the intensive agricultural areas have been implemented. And – at least partly – succeeded in reducing the nutrient outlets and also reduced the use and loss of pesticides.

In the BERNET regions of Russia, Poland and Estonia the agricultural sector activity has dropped substantially as a result of political and economic changes during the 1990'es. Use of fertilizer and pesticides was drastically reduced and significant areas of agriculture were given up as agricultural land. This development did in many – but not all – regions/catchments lead to a minor nutrient pollution of surface waters.

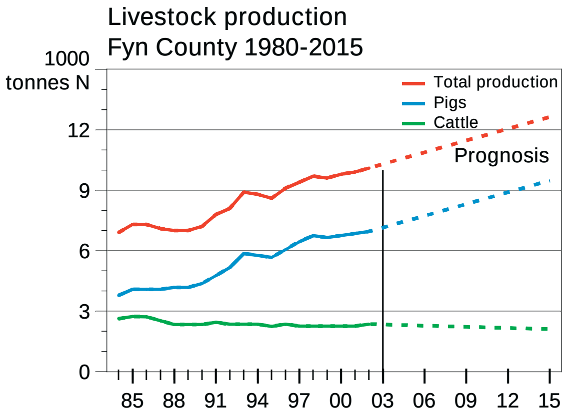


Figure 2.2
Development of the livestock production in Fyn County (around 1/3 of which is the catchment to Odense Fjord) estimated as produced products (milk, meat, eggs and hides).

Forecast of the development of agricultural production indicates a further increase in the production in 'old' EU countries as Denmark. In Figure 2.2 the development in the livestock production in Fyn County, Denmark, during the last 22 years is illustrated including a prognosis made by the agricultural sector for the development in the production the coming years. To be foreseen too is an increase in the new EU countries and probably also in Russia towards a generally higher intensity of the agricultural sector than at present leading to higher pig production, more cereals grown and the reuse of formerly grown land for agriculture.

Intensive farming increases leaching of nutrients, and decreases diversity of habitats and number of wildlife species in rural areas. Photo: Bjarne Andresen, Fyn County.

Blue Lupin, a nitrogen-fixing leguminose, flowering in the meagre soil of former farmland in the Kaliningrad Region. The decrease in agricultural production after 1989 has lead to decreased leaching of nutrients from farmland to the Baltic Sea, and the formation of new pastures. Agricultural production, however, will increase again. Photo: Stig Pedersen, Fyn County.

Impact of the harmonisation of nitrogen loss from farmland in the Baltic Sea catchment

Even though environmental actions have been taken to counteract diffuse nutrient outlets from intensively agricultural areas in i.e. Denmark, the levels of diffuse nutrient pollutions are significantly higher than in regions with less intensive agriculture (i.e. Poland, Russia, Estonia etc). Not only does the varying share of agricultural land cause variation in the agricultural derived diffuse nitrogen loading of the Baltic Sea from the different countries surrounding the Baltic, so does differences in the agricultural practice and intensity.

In view of the uncertainty as to the future level of agricultural intensity, BERNET operates with two scenarios for the impact of harmonization of nitrogen loss from farmland within the Baltic Sea catchment.

Scenario 1

If nitrogen loss from all farmland in the Baltic Sea catchment increased to the present high level in Denmark, total nitrogen loss to the Baltic Sea would probably increase by more than 50%.

Scenario 2

If nitrogen loss from all agricultural land in the Baltic Sea catchment was reduced to the present level in Poland, total nitrogen loss to the Baltic Sea would probably decrease by 10–25%.

The above scenarios show that if future nitrogen loading from the agricultural sector in the Baltic Sea catchment is solely regulated according to the rules currently applying to Danish agriculture, this would hinder fulfilment of the HELCOM goal of reducing nitrogen loading of the Baltic Sea and would conflict with the overall aim of the WFD.

Hence, a proper regulation of diffuse nutrient pollution from agriculture will be a major challenge in the years to come. Another major issue will be the proper regulation of the use of pesticides (and minimizing the loss to environment). Finally, an important issue will be the protection and ensuring of present wetlands and – in some regions - reestablishment of former wetlands and their part in the hydrological and nutrient cycle. This issue is due to the fact that many wetlands acts a significant sinks for nutrients thus in a naturally way reducing the nutrient loadings to downstream surface waters (lakes, estuaries, marine waters).

Leisure time at the beach. Protection of recreational waters as e.g bathing waters is also a Water Framework Directive task. The Baltic Sea at Sverdlogorsk, Kaliningrad region. Photo: Stig Pedersen, Fyn County.

Rivers for fishing, travelling and recreation, the Kaliningrad Region. Integrated management and protection are the main aims of the Water Framework Directive. and the environmental legislation in the Kaliningrad Region. Photo: Stig Pedersen, Fyn County.

2.4 The Water Framework Directive, other EU directives and international conventions

The Water Framework Directive

The Water Framework Directive (WFD) was issued by the European Commission in December 2000 (2000/60/EC). Three years later, i.e. 22 December 2003, Member States had to implement the WFD in the national legislation.

The WFD is the most substantial water legislation ever produced in the EU, and will provide the major driving force for achieving sustainable management of water in the Member States and other European states. The WFD encompasses all inland waters, wetlands with regard to their water needs, ground water, and all transitional and coastal waters, in general defined by the border of one nautical mile from the baseline from which the breadth of territorial waters is measured. Territorial waters (12 nautical miles) are included with respect to their chemical status (WFD, Art. 2).

The main purposes of the WFD are to:

- Establish a framework for the protection of inland surface waters, wetlands, transitional and coastal waters and groundwater.
- Prevent further deterioration and protect and enhance the status of the aquatic ecosystems, with the aim of achieving good surface water status at the latest in 2015.
- Enhance protection and improvement of the aquatic environment through progressive reduction of discharges and losses of priority substances and the phase-out of these.
- Ensure the progressive reduction of pollution of groundwater, to prevent its further pollution, and to achieve good status at the latest in 2015.
- Achieve compliance with any standards and objectives for protected areas at the latest in 2015, unless otherwise specified in the Community legislation for the protected areas.
- Contribute to achieve the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment.
- Ensure the participation of the general public.

Habitats, Bird Protection, and other directives encompassed by WFD.

The WFD is a frame work directive, aiming at integrated management and protection of water quality. It thus integrates several other directives, aimed at protecting water and water-dependent areas, e.g. recreational waters and nutrient-sensitive areas (see Annex 2.1 for a survey of EU directives encompassed by the WFD). These directives should already be implemented in the old member states, but are in many cases till now only implemented partially; e.g. in Denmark, the Shellfish Water Directive is formally implemented by the transposition of the WFD in 2003, although it was issued by EU in 1979. In the new member states, all water related directives are to be implemented within the same time schedule as the WFD.

Especially the Habitats Directive and the Birds Protection Directive, leading to designation of Natura-2000-protected areas, are important co-players with the WFD. These directives prescribe, that “good conservational status” should be obtained for the designated habitats and species. Whether this criterion can be expected to be fulfilled by attaining

One of the oldest bird watching stations in Europe, at the Curonian Spit, Kaliningrad region. Information on migrating birds is important to ensure the fulfilment of the Bird protection and Habitats directives. Photo: Stig Pedersen, Fyn County.

Main objectives of the WFD

- To prevent deterioration of the status of all bodies of surface water and groundwater
- To protect, enhance and restore all bodies of surface water and groundwater
- To achieve good surface water and groundwater status by the year 2015
- To progressively reduce pollution from priority substances and to cease or phase out emissions, discharges and losses of priority hazardous substances to surface waters
- To prevent or limit the input of pollutants in groundwater
- To reverse any significant, upward trend in the concentration of pollutants in the groundwater
- To achieve compliance with any standards and objectives for protected areas by the year 2015

Lake Wulpinskie, Pasleka -River Basin, Poland
Photo: Stig E. Pedersen, Fyn County.

WFD OBJECTIVE FOR SURFACE WATERS

"Good surface water status" means:

"The status achieved by a surface water body when both its ecological status and its chemical status are at least good"

which in more operational terms (WDF Annex 5) means:

"The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions"

Among other things this entails that:

Nutrient concentrations do not exceed the levels established as ensuring the functioning of the ecosystem and the achievement of the criteria for good status of the biological quality elements

and

hydromorphological conditions are consistent with the achievement of the criteria for good status of the biological quality elements.

WFD OBJECTIVE FOR GROUNDWATER

"Good groundwater status" means:

"The status achieved by a groundwater body when both its quantitative status and its chemical status are at least good"

Good quantitative status means:

"The available groundwater resource is not exceeded by the long-term annual average rate of abstraction"

and

"the level of groundwater is not subject to anthropogenic alterations such as would result in:

- **failure to achieve the environmental objectives for associated surface waters and any significant diminution in the status of such waters,**
- **any significant damage to terrestrial ecosystems which depend directly on the groundwater body."**

Good chemical status means:

"The chemical composition of the groundwater body is such that the concentrations of pollutants:

- **are not indicative of saline or other intrusions**
- **do not exceed the applicable quality standards**
- **are not such as would result in failure to achieve the environmental objectives for associated surface waters nor any significant diminution of the ecological or chemical quality of such bodies nor in any significant damage to terrestrial ecosystems which depend directly on the groundwater body."**

"good ecological status" in accordance with the WFD, or whether further measures of protection will be needed, is a matter of discussion in many member states. These directives also encompass marine areas beyond the coastal waters protected by the WFD.

International conventions

The WFD also focuses on fulfilling the obligations of international conventions, mentioning the OSPAR Convention on protection of the North –East Atlantic Ocean, the Helsinki Convention on protection of the Baltic Sea and the Mediterranean Sea Conventions, se Annex 2.2. The HELCOM is the strongest and most comprehensive international cooperation for the Baltic Sea area, established in 1974 and revised in 1992. All nine countries around the Baltic Sea and the EU have signed the revised convention, which came into force in 2000. By this revision, the Convention area was extended to include the internal waters as well as the open sea area. The Helsinki Convention focuses on reducing the outlets of nutrients and hazardous substances to the marine environment, and in 1988, a Ministerial Declaration was adopted with the aim of a 50% reduction from 1985 to 1995 of outlets of nutrients and hazardous substances. These aims have not yet been fulfilled, however, and the deadline has been extended to 2005, cf. chapter 3 and Annex 2.3 for an overview of the HELCOM recommendations relevant for the BERNET-Catch, concerning e.g. reduction of nutrient outlets, reduction of outlets of hazardous substances, protection of near shore areas etc.

The Marine Framework Directive

The EU is at present developing a new instrument for environmental protection, a Marine Framework Directive. This new directive will, among other things, aim at integration of the protection of the coastal waters by the WFD, the protection of the marine areas encompassed by the Habitats and Bird Protection directives, which includes marine areas to the 200 nautical mile border, and the general protection of the open sea. The directive thus should handle the major threats to the health of the sea, e.g. fishery, pollution from ship traffic, oil industry, eutrophication, and physical disturbance of the seabed. The EU Marine Framework Directive is expected to be passed by the EU commission/parliament by June 2006. Target date for completion of measuring programs is 2006, and the target date for achieving good environmental status is 2021.

The whole Baltic Sea and the Kattegat area are protected by the Helsinki Convention, signed in 1974 by all states in the Baltic Sea Region. The Water framework directive aims at achieving the objectives of international agreements to prevent and eliminate pollution of the marine environment. The Laholm Bay and Kattegat at wintertime. Photo: Stig Pedersen, Fyn County.

The Groundwater Directive

The groundwater directive, a daughter directive of the WFD, is expected to be agreed on in the nearest future. The directive establishes specific measures in order to prevent and control groundwater pollution. These measures include in particular criteria for the assessment of good groundwater chemical status, and criteria for the identification and reversal of significant and sustained upward trends and for the definition of starting points for trend reversal.

The groundwater directive also seeks to complement the provisions to prevent or limit inputs of pollutants into groundwater already contained in WFD and to prevent deterioration of the status of all groundwater bodies.

Priority substances

The WFD also points out, that all pressures should be handled, and in the indicative list of the main pollutants, listed in the WFD Annex VIII, substances contributing to eutrophication as well as several specific hazardous substances are mentioned. The WFD thus also integrates former directives regulating emission of specific hazardous substances as mercury, cadmium, and other dangerous substances, see Annex 2.1. For the time being, negotiations on the future strategy in EU concerning chemicals, REACH, are taking place, and the outcome of this is not yet clear.

Coherent management

The adoption of the WFD considerably strengthens coherent management of the aquatic environment, since a coordinated effort is required to produce a River Basin Management Plan for each river basin in 2009 at latest, and has to include aims of all former directives with relation to water protection, and to make a contribution towards meeting the obligations of the international conventions.

The time schedule of the Water Framework Directive.

2000:
- **The Water Framework Directive is adopted in EU**

2003:
- **Transposition into national laws**
- **Identification of river basin districts and competent authorities (Art. 3)**

2004:
- **Characteristation of river basin districts (Art. 5)**
- **Review of the environmental impact of human activity and risk analysis (Art. 5)**
- **Economic analysis of water use (Art. 5)**
- **Register of protected areas (Art. 6)**

2006:
- **Monitoring programmes shall be operational (Art. 8)**

2009:
- **Programme of Measures shall be established (Art. 11)**
- **River basin management plan shall be published (Art. 13)**

2012:
- **Programme of measures should be operational (Art. 11)**

2013 and every 6th year hereafter:
- **Review and update of article 5-analysis (see 2004)**

2015:
- **”good ecological status” for all surface water bodies, good ground water status and compliance with any standards and objectives for protected areas should be achieved. (Extension of the deadline of a period of 2x6 years may be accepted under specific conditions)**

2015 and every 6th year hereafter:
- **Review and update of river basin management plans including programme of measures**

The unique nature of the Baltic Sea Region needs integrated protection. The Kvarken, a UNESCO World Heritage Area, in West Finland. Photo: Vincent Westberg, WFREC.

The Curonian lagoon. A large shallow coastal lagoon, separated from the Baltic Sea by the narrow Curonian Spit. Coastal lagoons are one of the high priority types of nature protected by the Habitats directive, Photo: Stig Pedersen, Fyn County.

3. Eutrophication – a major problem

3.1 Eutrophication of surface waters

Excess nutrients in the hydrological cycle

The excess load with nutrients from land based sources constitutes a major threat to nature, freshwaters and the marine environment of the Baltic Sea. Eutrophication of the aquatic environment is a common feature of all the BERNET-Catch regions, although the degree and severity of the eutrophication effects differ from region to region. A short presentation of the general features of all the BERNET-Catch regions is given in Annex I.

Although nutrients are not alien to the environment, excess loads of nitrogen and phosphorus dramatically cause a lesser diversity of the ecological conditions. I.e. excessive algal growth, increased oxygen depletion and change in the food web structure will be the response of aquatic environments exposed to increased nutrient loadings. Furthermore, many nature areas (bogs and fens) are heavily impacted by deposition of nitrogen and many species of plants are vulnerable to excessive nitrogen deposition. However, these eutrophication problems will - on the regional scale - vary according to variations in the man made nutrient loads and the vulnerability of the different water bodies receiving the nutrient loads. The man made nutrient enrichment of the aquatic environment can be attributed to the outlets of nutrients with sewage and to the loss of nutrients from agricultural activities. Furthermore - in some areas - intensive forestry is significantly contributing to the nutrient enrichment of the aquatic environment. And finally in some intensively cultivated areas the eutrophication problem is enhanced by the massive deterioration of the retention capacity of nutrients in the hydrological cycle; a deterioration caused by land reclamation, where wetlands are destructed, river valleys intensively drained and cultivated. Wetlands have a very important role in nature as a buffer between the surface waters and the areas used for intensive agriculture or forestry – you can call wetlands "the liver" of the aquatic environment. Physical regulation and hard maintenance of rivers also diminish the recovery capacity of the aquatic environment, and thus the ability to turn over the nutrient load to the system.

The impact on the marine and freshwater environment

The Baltic Sea is a unique marine area due to its restricted water exchange with the oceans, and due to the significant fresh water input causing a wide range of salinities - from brackish water in the Botnian Bay to more marine conditions in the Kattegat. These features, together with the population of 85 million in the catchment of the Baltic Sea, makes it vulnerable to excess loads of nutrients as well as to other pollution. The catchment of the Baltic Sea is characterized by a widespread network of rivers and numerous lakes and wetland areas, due to the relatively high precipitation and the large areas of lowland in the catchment.

Today, man-made nutrient emissions by far exceed the natural nutrient cycles in the Baltic Sea catchment area, and the excess load with nitrogen and phosphorus from land based sources constitutes a major threat to the Baltic aquatic environment.

A special focus has therefore been put on the situation in the Baltic Sea and in the catchment area, especially since the 1960ies, and the first Helsinki Convention was signed in 1974, aiming at the protection of the Baltic Sea. The convention recommen-

Wetlands act as the 'liver' of the aquatic environment by nutrient retention. Karlsmosen, Fyn County, Photo: Lars Bangsgaard, Fyn County.

*(**Left**) Reconstruction of river meandering in a formerly heavily physically regulated river; Odense River, Fyn County. Photo: Stig Pedersen, Fyn County.*

*(**Right**) Lake Wysztynieckoje, Kaliningrad region. Although the point source impact from geese is evident, the nutrient concentrations in the lake are still far lower than in any lake in Fyn County. Concentrations of of nutrients and pH from lake Wysztnieckoje, Kaliningrad Oblast and lake Arreskov, Fyn County, are compared. Photo: Stig Pedersen, Fyn County.*

Water sample Lake Wysztynieckoje Kaliningrad Oblast 29 September 2005		Water sample Lake Arreskov Fyn County 20 September 2005	
Total phosphorus:	<0.010 mg/l	Total phosphorus:	0.11 mg/l
Ammonium-N:	0.0058 mg/l	Ammonium-N:	0.0014 mg/l
Nitrate-N:	<0.0050 mg/l	Nitrate-N:	0.005 mg/l
Silicon (Si):	0.51 mg/l	Silicon (Si):	7.0 mg/l
Iron (Fe):	0.021 mg/l	Iron (Fe):	0.056 mg/l
pH:	8.2	pH:	8.5
Colour (Pt):	10 mg/l	Colour (Pt):	28 mg/l

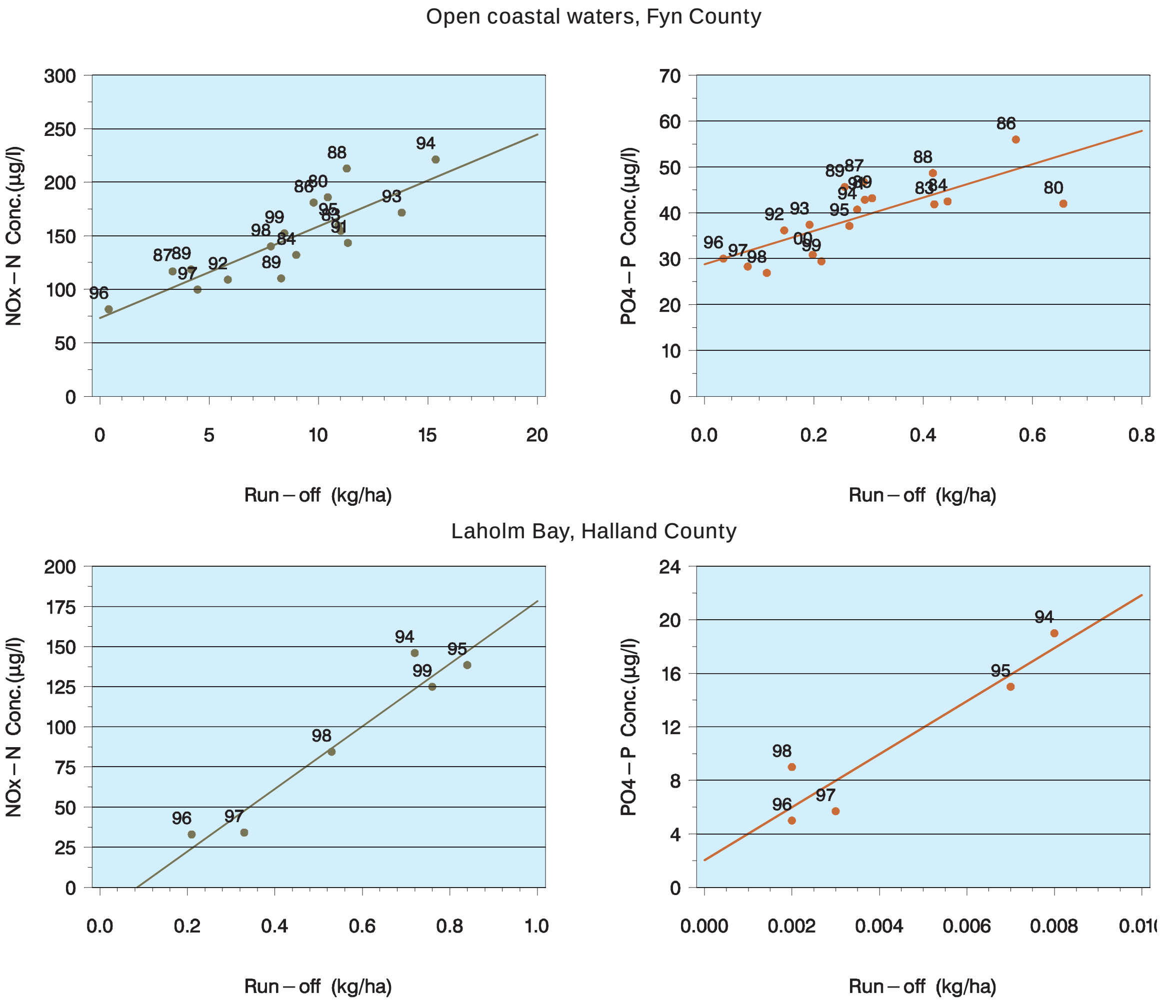


Figure 3.1
Winter load of nutrients (N and P, kg/ha) and nutrient concentration level (DIN,DIP, winter mean) in adjacent coastal waters; examples from Fyn County, open coastal waters, and Halland County, Laholm bay. See Annex I, River Stensån Catchment,Sweden and Odense Fjord Catchment, Denmark for geografic location of the areas.

dations primarily address diffuse and point source outlets to the aquatic environment, management of wetlands and freshwater ecosystems for retention of nutrients, and protection of heavily endangered or immediately threatened marine and coastal biotopes (see Annex 2.3)

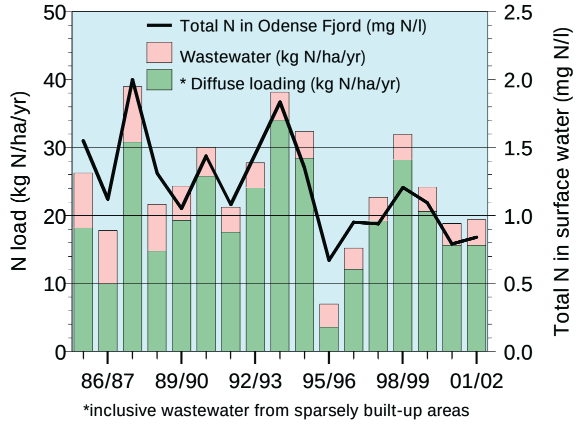
The coastal waters of the BERNET Catch Regions comprise bays, fjords and lagoons - all with restricted water exchange with the open coastal waters. On top of this, even very enclosed waters most often receive nutrients directly from larger rivers and major urban areas. These preconditions make coastal waters particularly vulnerable to eutrophication, and indeed all the coastal waters of the BERNET Catch regions show signs of eutrophication such as elevated nutrient concentrations, high phytoplankton densities and reduced water transparency. The signs of eutrophication can be assessed despite significant differences in the nutrient load, salinities, water exchange and biological structure among the regional waters.

Many of the freshwater systems in the BERNET Catch Regions also show severe signs of eutrophication. This tendency is most pronounced in the "old" EU member states, where agriculture and forestry is very intensive, and nutrient losses to the aquatic environment still large, although outlet from point sources has been reduced during the last decades. In the new member states, impact from point sources is still a widespread problem, and in the Kaliningrad region, impact from point sources constitutes a major threat to the aquatic environment. The less intensive agriculture and the lower population density in these regions, however, allow less nutrient-impacted conditions and thus a better ecological status in many freshwater systems, and in some areas, near-pristine lakes and rivers are found.

Recent changes in the aquatic environment

In general, the marked reductions in nutrient loading due to improved sewage treatment, and due to the decreased industrial and agricultural activity in some regions, have improved the heavily eutrophicated situation in some aquatic systems, although these water bodies are still significantly eutrophicated.

While the impact of nutrients may vary between the different water bodies, dependent on water exchange, degree of stratification etc, there is often a close link between nutrient load and nutrient concentrations in the same water body. Thus, a strong correlation has been demonstrated in the coastal waters of Fyn and in Laholm Bay between winter



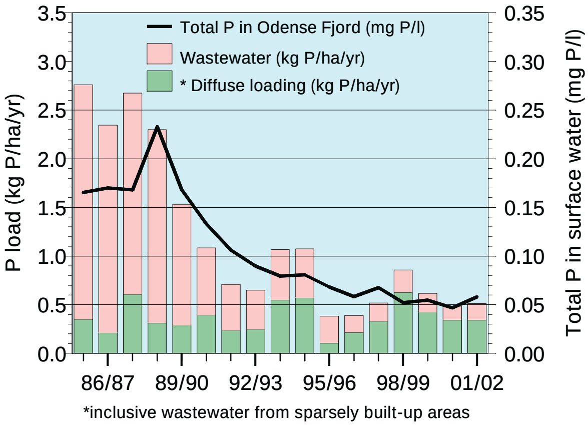
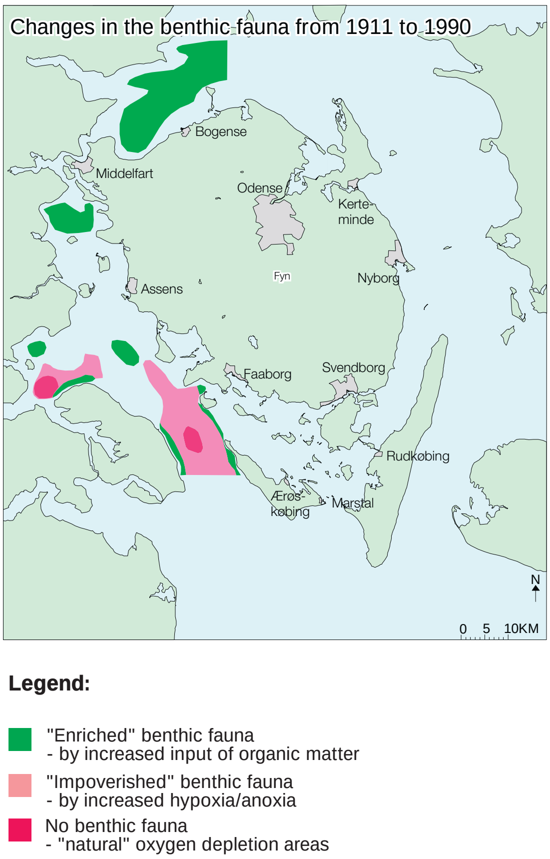


Figure 3.2
Trend in source-apportioned annual nitrogen and phosphorus load from land-based sources together with the annual mean concentration in the surface water in the outer part of Odense fjord.

Sea lettuce, (Ulva lactuca)*, a fast-growing nuisance macroalgae, is often seen in mass occurrence in eutrophicated enclosed coastal areas, as e.g. Odense Fjord in the late 1980'es. Photo: Nanna Rask, Fyn County.*

Widgeon grass (Ruppia sp.)*, a rooted macrophyte tolerant of low salinity. After reduction of nutrient impact and hence, growth of Sea lettuce, the shallow inner part of Odense Fjord was recolonized by Widgeon grass. Though improvement has taken place, the plants are still covered by filamentous nuisance algae* (Cladophora *sp.), which hamper the growth.of Widgeon grass. Photo: Nanna Rask, Fyn County.*

Figure 3.3
Developments in the marine invertebrate fauna in the Little Belt, Denmark, from the 1910-30'ies to present day.



nutrient load and nutrient concentrations (Figure 3.1).

In restricted water bodies as the enclosed Odense Fjord (Fyn), the improved sewage treatment reduced the phosphorus load to the adjacent Odense Fjord with more than 80% leading to lower phosphorus concentrations in the fjord (Figure 3.2). Concomitantly, a mass occurrence of the green algae Sea Lettuce (*Ulva lactuca*) decreased in abundance and biomass, and a submerged vegetation of sea grasses emerged.

In fjords and lakes with sedimentation basins, the release of nutrients from the sediments during periods of oxygen deficiency may exceed the nutrient load from land based sources, and the immediate response to reduced nutrient inputs from land may fail to appear. These pools of nutrients in the sediments are often accumulated through decades of excessive nutrient inputs - especially of phosphorus from former sewa-ge discharges. Such internal nutrie-nt pools -represent a "system memory" of previous nutrient loads, and may delay the response to lowered external nutrient loads in the aquatic system. In many fresh water lakes,a time span of 20-50 years from load reduction to improvement of the ecological status is often seen.

If nutrient loads are markedly reduced, however, a general improvement of the aquatic ecosystem can be expected in a short time span in water bodies with high water exchange. A 2-year-period of very low precipitation in 1996 and 1997 resulted in a more than 50% reduction in nitrogen load and more than 80% reduction in phosphorus load from Fyn. In the coastal waters around Fyn, a remarkable improvement was observed in the two following years in Secchi depth, oxygen conditions and bottom fauna diversity and biomass (Rask *et al.*, 1999). Similar observations were registered in the Laholm Bay, Sweden, during the same period. When normal precipitation and nutrient run-off returned the following years, the water quality deteriorated with numerous algal blooms and severe oxygen deficiency in 1999 and especially in 2002.

Long term changes in the aquatic environment

Although relative improvements have been recorded in some of the coastal waters, lakes and rivers during the last decade, comparisons further back show a general deterioration of the aquatic environment during the last century.

Present day monitoring programmes have only been carried out for one or two decades. We therefore only have limited information on the nutrient levels and eutrophication of the aquatic environment from before the industrialisation of the agricultural sector and other major changes in society took place during the last century. However, systematic investigations of the vegetation and macrofauna were carried out by scientists in some lakes, rivers and marine areas even back in the very beginning of the 20th century, and some data series exist from 1950'ies.

In regions where such historical data are available, a widespread deterioration of the aquatic environment

*Eelgrass (*Zostra marina*) covered by sedimented organic substances, microalgal epiphytic growth and filamentous algae in a heavily eutrophicated small fjord in Fyn County. Photo: Nanna Rask, Fyn County.*

since the 1960'ies has been documented (Schramm & Nienhuis 1996, Richardson 1996, Bonsdorff *et al.*, 1997, Rönnberg 2001, HELCOM 2001).

In the coastal waters around Fyn, the depth limit of eelgrass is reduced by 30-50% since the turn of the century (Rask *et al.,* 2000; Fyn County, 2003), due to increased phytoplankton growth and hence decreased water transparency (Richardson & Heilmann, 1995, Nielsen *et al.*, 2002). In the Little Belt, the present day species composition and abundance of the invertebrate fauna in the sediment were compared to investigations carried out in the 1910-30'ies. The comparison showed an almost 5-fold increase in bottom areas where the fauna was severely affected by regular oxygen deficiencies between the two investigation periods (Figure 3.3) (Fyn County, 2003). In Danish lakes and rivers, a profound change of the submerged macrophyte vegetation towards more pollution-tolerant species has taken place during the last 100 years (Sand-Jensen *et al.*, 2000). Historical data of macroinvertebrate fauna from Odense River and its tributaries in Fyn County, also point to dramatic changes of the species composition as a response to both pollution and physical deterioration (Riis *et al.*, 1999; Sode 2005).

Thus, the achievement of a 'good ecological status' in 2015 at the latest, as required by the Water Framework Directive, where only slight deviations from undisturbed conditions can be accepted (see chapter 4 and 5), will call for a massive further reduction in nutrient loads to the aquatic environment of the whole Baltic Sea Region.

Fish kill in the Baltic Sea may be caused by oxygen deficiency, acidification, algae blooms etc. Photo: J. Voss, LANU, Schleswig-Holstein.

3.2 Nutrient loading

To counteract the eutrophication problems of the Baltic Sea the contracting parties of the Helsinki Convention in 1988 agreed to reduce the nutrient load from land based sources by 50% for both nitrogen and phosphorus. This goal has not yet been fulfilled. Furthermore, the Water Frame Work Directive states that all surface waters of the European Community should fulfil the basic aims of "good ecological quality" at the latest by 2015. Hence, not only does the total nutrient load of the Baltic Sea have to be decreased from its present level in order to achieve an improvement in the environmental quality of the Baltic Sea, but for many local water bodies (lakes, estuaries, fjords, bogs, fens etc) a nutrient reduction is also needed. Such reductions might locally be beyond the HELCOM 50% reduction target in order to achieve the desired environmental quality.

Nutrient loadings to the Baltic Sea and the loadings from the BERNET regions

In the latest assessment (HELCOM, 2004) the total land based nutrient load to the Baltic Sea for the year 2000 was estimated to around 750.000 tonnes of nitrogen and 34.500 tonnes phosphorus including both point and diffuse nutrient sources. Related to catchment area these loads corresponds to 411 kg N/km^2 and 19 kg P/km^2 respectively or to 1,3 mg N/l and 0,06 mg P/l as mean nutrient concentrations in the total land based discharge to the Baltic Sea this year, (580*10^9 m^3/yr of water corresponding to around 350 mm/yr), (Figure 3.4).

The sources of the nitrogen load were divided by agriculture and managed forestry (60%), natural background sources (26%) and point sources of sewage (14%). The corresponding igures for the total

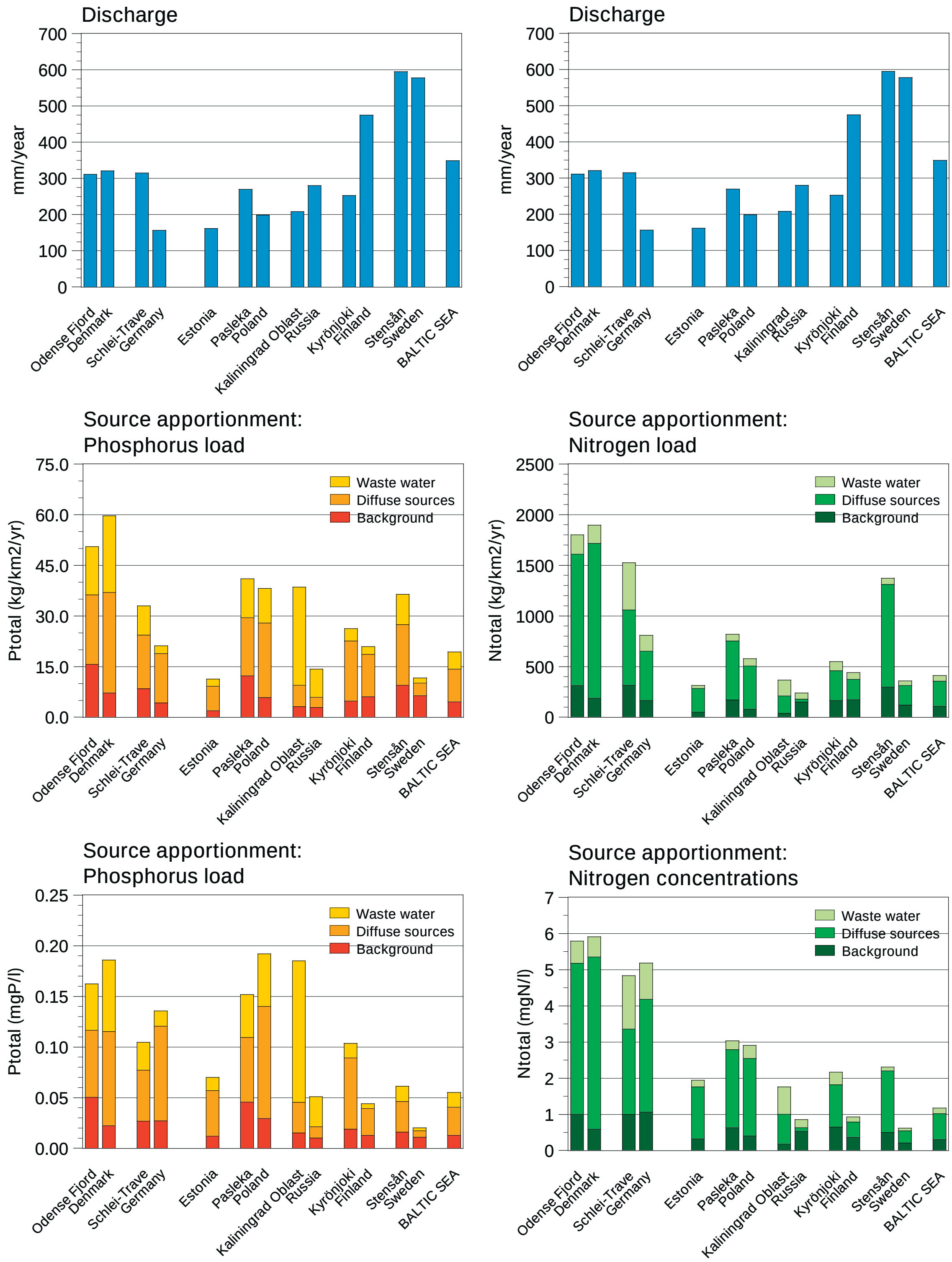


Figure 3.4
Freshwater discharge (mm) and land based area-specific total nitrogen and phosphorus loadings and concentrations from the BERNET countries and the individual BERNET-CATCH catchments. Country figures from HELCOM assessment year 2000, (HELCOM, 2004). Bernet figures: Fyn (1999-2003), Pasleka (1999-2000), Kyronjoki (1999-2003), Schlei-Trave (1990-99 (diffuse) and 2003 (sewage)), Steensån (1999-2003), Kaliningrad (1999).

land based phosphorus load were; agriculture and managed forestry (50%) natural background (24%) and point sources of sewage (26%). Compared to forestry agriculture is by far the dominant source.

There are huge differences in the area-specific nutrient loadings from the different countries round the Baltic Sea. Denmark and Germany have the highest area specific inputs of both phosphorus and nitrogen, whereas the loadings from Finland, Russia and Sweden are lower and at the same level (or slightly lesser) than the total area-specific loadings to the Baltic Sea. However, all countries contribute with man-made nutrient loads exceeding the background nutrient loadings as they have been estimated in the latest HELCOM nutrient load assessment (HELCOM, 2004).

Nutrient loadings from the BERNET regions/ catchments corresponds in general to level of the individual country specific loadings, although - when comparing the loadings in Figure 3.4 - it should be taken into account that the periods for the loading assessments differs (and so do the freshwater discharges).

Sewage water

An assessment of the general status for waste water treatment in the BERNET regions was carried out in the first BERNET project (BERNET, 2000d) showing different levels in this waste water treatment. In Schleswig-Holstein (Germany), Laholm Bay area (Sweden) Fyn (Denmark) and West Finland improved sewage treatment has lead to a huge decrease in the outlets of nutrients with sewage waters during the last decade, whereas in late 1990'ies primo 2000'ies sewage treatment in the BERNET regions of Russia and Poland was not based on 'up-to-date' technologies, (Figure 3.5). However, it was also stated in the assessment that "full treatment procedures with both phosphorus and nitrogen removal is implemented or planned to be established in all major urban areas in the BERNET regions" (BERNET, 2000d). Hence, it can be foreseen that the contributions of phosphorus and nitrogen outlets with sewage to the nutrient loadings from the BERNET-CATCH catchments of especially Russia and Poland will be reduced in the years to come in this way reducing the actual total loadings of nitrogen and phosphorus (Figure 3.4).

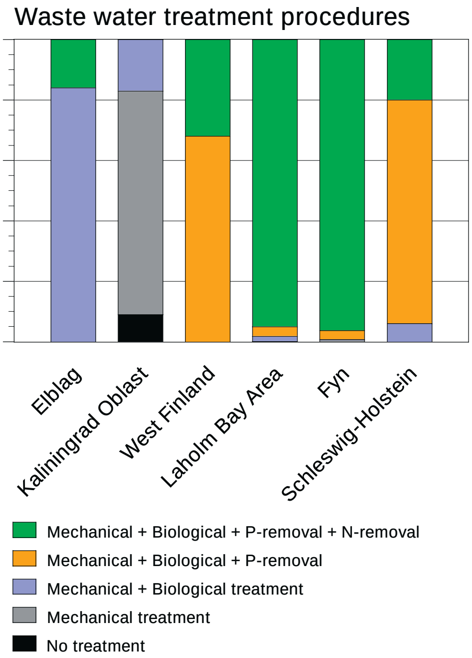


Figure 3.5. Waste water treatment procedures in treatment plants larger than 30 PE in the BERNET regions from the first BERNET project. Assessment from 1998: (Kaliningrad (RUS), Elblaq (POL), West Finland, Fyn (DK)) and 1999: (Laholm Bay area (SWE) and Schleswig-Holstein (GER)).

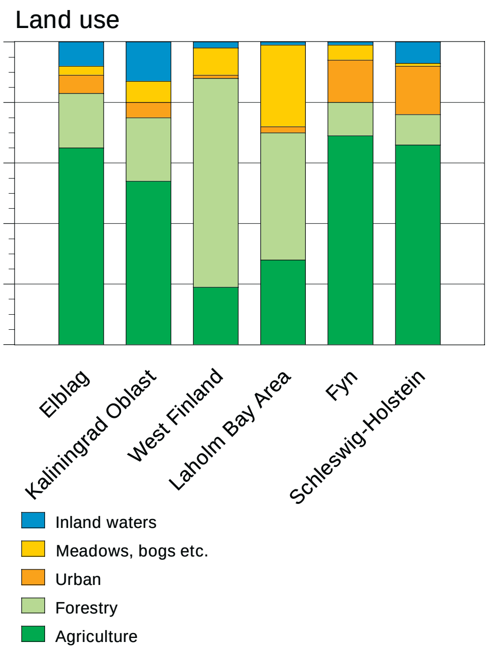


Figure 3.6 Land use in the BERNET regions. (Kaliningrad (RUS), Elblaq (POL), West Finland, Fyn (DK)), (Laholm Bay area (SWE) and Schleswig-Holstein (GER)).

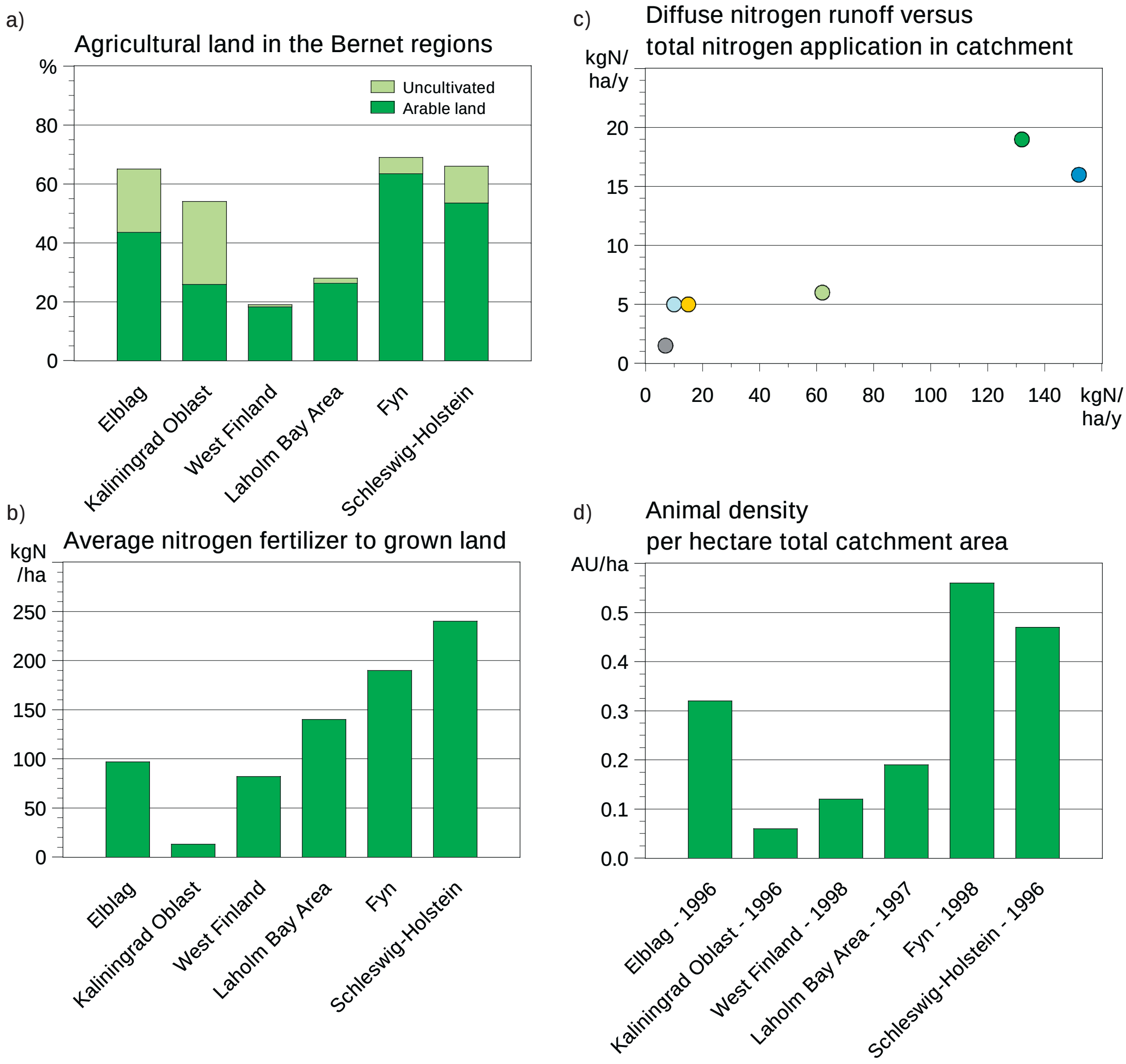


Figure 3.7a,b,c,d
a) Agricultural land in the regions of the first BERNET project in percent of total region area, and the share of this agricultural land in rotation and "set aside" in the regions. Data from (BERNET 2000a).
b) Average nitrogen fertilizer(manure+artificial) applied per hectare of agricultural area in the regions of the first BERNET project. Assesments from 1995 (Laholm Bay Area), 1996 (Schleswig-Holstein, Elblaq), 1998 (Kalinigrad, Fyn) and 1999 (West Finland).
c) Diffuse nitrogen runoff versus total nitrogen application (artificial+manure) per hectare catchment area in the regions of the first BERNET project. Atmospheric depositions not included. Elblaq: 1996, Kaliningrad: 1999, West Finland: mean 1990-94, Laholm Bay Area: mean 1990-ies, Fyn: mean 1992-1998, Schleswig-Holstein: mean 1990-99.
d) Animal livestock density (Animal Units) in the regions of the first BERNET project. Data from (BERNET, 2000a.)

Agriculture

The modern, intensive agricultural production is closely linked to a large input of nutrients by artificial fertilisers and fodder and a large surplus of nutrients lost to the environment at field level and at the production plants themselves. The supplies of nutrients from manure and chemical fertilisers to the fields are main determinators for the waterborne losses of nutrients from the fields, and the amount, storage and handling procedures of manure are main factors determining the airborne losses of nitrogen. Such intensive agriculture therefore constitutes a major source of eutrophication in catchments, where it is a major land use. In the BERNET catchments of Germany and Denmark intensive agriculture accounts for more than then 2/3 of the land use (Figure 3.6) whereas in Finland and Sweden agriculture only accounts for around 20-30% of the total land use in the BERNET catchments. Land use in the latter catchments in stead being dominated by forestry, (around 50%, Figure 3.6).

The diffuse nutrient pollution from agriculture is not solely related to the degree of land use by agriculture. In example a significant part of the land in the Kaliningrad region characterized as agriculture is for the moment not actually in rotation due to the general set back of the agricultural activities in this region these years (Figure 3.7a). Furthermore the intensity of the agriculture varies among the regions. This is illustrated in Figure 3.7b showing the different amounts of applied nitrogen fertilicer to the grown land. This application peaks in the regions of Fyn and Schleswig-Holstein with application rates of around 200 kg N/ha. In contrary the application is lowest in the Kaliningrad region. In the BERNET project it was demonstrated that the diffuse nitrogen run off in the regions was related to the total application of nitrogen with chemical fertilicer and with manure within the catchments, (Figure 3.7c). Hence the maximum annual area specific nitrogen loadings from the total areas of the BERNET regions in Fyn and Schleswig-Holstein were as high as 15-20 kg N/ha or much higher than in most of the other regions where total applied nitrogen in the catchments were significantly lower. Finally, in the first BERNET project it was shown that the animal density (Livestock Units) was much higher in the BERNET regions of Denmark and Germany compared to the other regions, (Figure 3.7d).

Nutrient retention in wetlands

Wetlands in general acts as nutrient sink were nitrogen and - to a minor degree - phosphorus is permanently retained. A significant part of nitrogen in waters passing such wetlands will be retained due to denitrification processes and thereby lost to the atmosphere as nitrogen in the form of environmentally inert gases.

In the first BERNET project it was demonstrated that the present wetland areas in the BERNET regions are far below the areas of naturally occurring wetlands. Thus in the 19th and 20th century, wetlands in the catchments to the Baltic Sea have been reclaimed for agriculture and forestry far beyond the tolerance limits for the ecosystems (Figure 3.8). In very intense agricultural regions such as Schleswig-Holstein and Fyn, only 20-25% of the original wetland areas remain. In the Elblaq and Kaliningrad regions these relative losses of wetlands are lesser than in the other BERNET regions.

Undoubtedly the losses of wetlands have reduced the natural retention of especially nitrogen in the hydrological cycle thus enhancing the eutrophication impact of diffuse nitrogen losses from agriculture.

Tentative scenarios for land based Nitrogen loading

Not only does the varying share of agricultural land cause variation in the agricultural derived diffuse nitrogen loading of the Baltic Sea from the different countries surrounding the Baltic, so does differences in the agricultural practice and intensity.

In view of the uncertainty as to the future level of

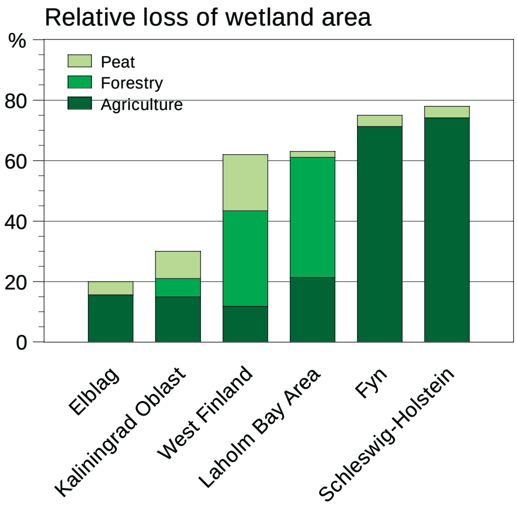


Figure 3.8
The relative loss of wetland areas in the regions from the first BERNET project due to reclamation within the last 150 years. For each region the stacked bars show the relative use of re-claimed wetlands for agriculture, forestry and peat mining. (Data from (BERNET, 2000a).

agricultural intensity, BERNET operates with two scenarios for the impact of harmonization of nitrogen loss from farmland within the Baltic Sea catchment.

Scenario 1

If nitrogen loss from all farmland in the Baltic Sea catchment increased to the present high level in Denmark, total nitrogen loss to the Baltic Sea would probably increase by more than 50%.

Scenario 2

If nitrogen loss from all agricultural land in the Baltic Sea catchment was reduced to the present level in Poland, total nitrogen loss to the Baltic Sea would probably decrease by 10–25%.

The above scenarios show that if future nitrogen loading from the agricultural sector in the Baltic Sea catchment is solely regulated according to the rules currently applying to Danish agriculture, this would hinder fulfilment of the HELCOM goal of reducing nitrogen loading of the Baltic Sea and would conflict with the overall aim of the WFD.

Hence, a proper regulation of diffuse nutrient pollution from agriculture will be a major challenge in the years to come. Another major issue will be the proper regulation of the use of pesticides (and minimizing the loss to environment). Finally, an important issue will be the protection and ensuring of present wetlands and – in some regions - reestablishment of former wetlands and their part in the hydrological and nutrient cycle. This issue is due to the fact that many wetlands acts a significant sinks for nutrients thus in a naturally way reducing the nutrient loadings to downstream surface waters (lakes, estuaries, *Oxygen deficit is another severe effect of eutrophication of lakes and coastal waters. The white shroud of sulphur bacteria on the seabed indicates that the oxygen concentration is very low. Starfish try to flee from the low oxygen level by crawling up the algae towards the surface. South Fyn Archipelago. Photos: Nanna Rask, Fyn County.*

4. Classification and assessment of surface waters

In the Water Framework Directive surface waters (running waters, lakes, and coastal waters) are differentiated according to the type and the reference conditions established for each of these types. The main purpose of such a typology is, thus, to enable type specific reference conditions to be defined which in turn are used as the template for classification systems designed to assess the ecological status in a manner that is operational from a management point of view. However, no classification or assessment can be carried out without the necessary data that must be provided by sufficient monitoring programs. This chapter therefore summarise how these items have been treated in the implementation of the WFD in the different BERNET partner regions or countries.

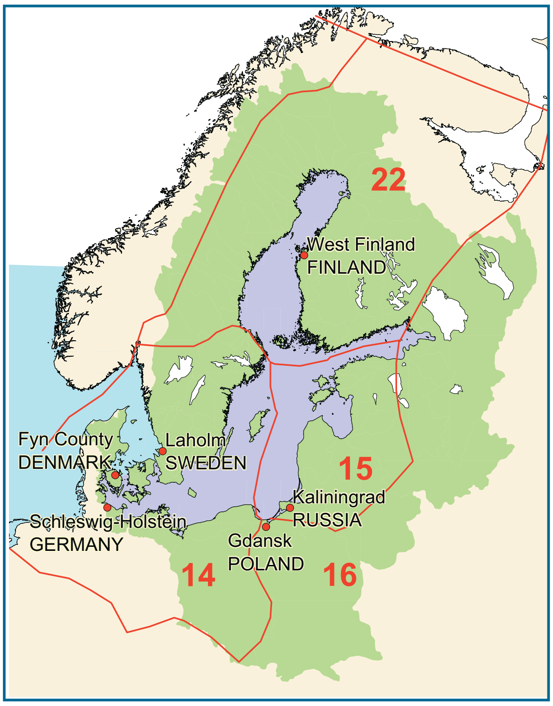


Figure 4.1 Ecoregions defined by the Water Framework Directive in the BERNET Catch area.

North Sea
Baltic Sea
14 Central Plains
15 Baltic Province
16 Eastern Plains
22 Fenno-Scandian Shield

4.1 Typology

The WFD defines two different systems – "A" and "B" - that can be used to establish a typology. The two systems are rather similar in that the same obligatory factors are to be used. These factors are geographical position, altitude, size, geology and especially for lakes, also water depth. System A, however, differs by prescribing how water bodies shall be characterised spatially (i.e. by ecoregions) and with respect to specific altitude, size and depth intervals, whereas System B besides lacking this prescription, permits the use of additional factors – the so-called optional factors. The Member States are free to decide what system to use. However, in case System B is chosen, this must not result in a greater variability in type specific reference conditions values than if System A had been used. The significance of this system B requirement is that the Member States should avoid using a too simplified typology systems (i.e. too few types) if this means that the variability in the type specific reference conditions for each type is unacceptably high (see below). Although the Directive suggests the use of several specific optional factors, the Member States are allowed to use other factors when this is appropriate. Biogeographically, BERNET partner regions and their selected pilot river basins belong to different so-called aquatic ecoregions defined by the directive (see Figure 4.1). Thus regarding inland surface waters, Fyn (and the rest of Denmark), Laholm and Schleswig-Holstein belong to ecoregion 14 ("Central Plains"), whereas Gdansk, Kaliningrad and West Finland belong to ecoregion 15 ("Baltic province"), ecoregion 16 ("Eastern Plains") and ecoregion 22 ("Fennoscandian Shield"), respectively. Regarding the coastal waters, Fyn, Laholm and partly Schleswig-Holstein belong to marine ecoregion 4 ("North Sea"), whereas Gdansk, Kaliningrad and West Finland belong to marine ecoregion 5 ("Baltic Sea").

The countries to which the BERNET partners belong are at a quite different level establishing a typology for their surface waters. Both Denmark and Germany have provided typologies for running waters, lakes and costal waters, whereas typologies are still (i.e. autumn 2005) in preparation in Finland, Poland and Sweden (except for coastal waters in the

The Danish river typology is quite simple, being based only on size characteristics (DK type 1: small stream; DK type 2; middle-sized stream; DK type3: large stream).

The forest brook Ørredbæk – a typical DK type 1 stream Photo: Frank G. Larsen, Fyn County.

River Vindinge at Hudevad that belong to DK type 2. Please note the growth of Angelica (Archangelica litoralis) that is often found along light-exposed streams in Fyn County. Photo: Bjarne Andresen, Fyn County.

Odense at Vibæk – a DK type 3 stream. It has a luxurious growth of submerged macrophytes, primarily the pondweed Potamogeton pectinatus. Photo: Bjarne Andresen, Fyn County.

latter country). Therefore, the BERNET partners of the last named three countries have either presented a preliminary typology (Finland, Sweden) or suggested a typology based on System A (Poland).

As Russia (and Kaliningrad Oblast) is neither a member of the EU, nor has adopted EU water policies, the typology of surface waters in the Russian Federation are different from the WFD typologies. Like the WFD typologies, however, the Russian typology includes both geographical and a large variety of physical descriptors, and the typology can best be compared with the EU System A. The Russian typology also considers 'ecoregions' (called hydrographical regions), but they are not directly comparable to the WFD ecoregions. Kaliningrad belongs to 'the baltic', one of the eight defined Russian ecoregions. One main difference between the Russian typology and the WFD typologies is that the Russian typology also includes elements related to the various use of surface waters. Another difference is that every descriptive element is indexed (according to defined classes) and a specific type is identified by combining the different index scores.

Running water types

The national typology is in all cases based on size, and all except Denmark also uses geology (see Table 4.1). All stream types within the partner regions are lowland streams, although on a country basis Finland, Poland and Sweden include altitude in their typology. Only Schleswig-Holstein and Finland includes geomorphologic factors. Despite the fact that the Weschlian ice border separates both Schleswig-Holstein and Jutland into western sandy soils and eastern moraine soils, the typology of Sleswig-

Table 4.1 Summary of the typology of streams in the BERNETcatch partner regions.

Typology of running waters					
Country	System A or B	Obligatory factors		Optional factors	No. types in BERNET partner regions
		Size parameters	Geology	Geomorphology	
Sweden	B?	X[2]	X		2
Denmark	A	X[1]			3
Germany	B	X[2]	X	X	7
Poland	A	X[2]	X		4
Russia	-	X	X		(1)
Finalnd	A	X[2]	X	X	5

[1] Catchment size classes: <10, 10-100, >100 km^2
[2] Catchment size classes: 10-100, 100-1000, >1000 km^2

At its lower course the River Schwentine (Schleswig-Holstein) forms a flushed lake (DE (Germany) type 12) with a retention time of about only 10 days. Photo: Gudrun Plambeck, LANU.

Lake Sehlendorfer Binnensee is one of the very few brackish coastal lakes in Schleswig-Holstein that naturally exchange water with the Baltic Sea. Photo: Mandy Bahnwart, LANU.

Holstein includes geological factors, whereas the Danish typology surprisingly does not. It is very probable that the Danish typology is too simplified to permit a proper description of the type specific reference conditions (e.g. the assemblages of both macrophytes and fish show significant differences between the two geologically different areas.

Lake types

Most BERNET countries have decided to use system B, except Poland and Russia (see Table 4.2). However regarding system B, the choice of typology factors differs considerably, although all countries include 'depth' (an indicator of stratification of the water column). Most striking is the difference between the Schleswig-Holstein and Denmark that must have comparable lakes types. One obvious reason is that only Denmark considers saline or humic lakes. However for alkaline, non-saline lakes, the catchment size and retention time are regarded important for the typology in Germany, whereas this is not the case in the Danish typology. All lakes within the BERNET regions are lowland lakes. However, the national typology of Germany, Finland, Poland and Sweden also include altitude, as mountainous areas occur in other parts of these countries.

Coastal waters

Twelve types of coastal waters are defined by the BERNET partners in their PRB's. In addition, the Polish part of Vistula Lagoon is defined as a transitional water (i.e. estuary with a significant gradient between fresh and saline water). All partners have used typology system B. Important typology factors are salinity, mixing conditions, residence time and to some extent ice coverage (in Finland), whereas other possible factors like tidal range, intertidal area, depth, and substratum are not regarded so important that they are included in the typology. Among the nine types located in the western and southern coastal waters of the BERNET area three main groups of types may be identified: *meso- to polyhaline open*

Typology of lakes									
Country	System A or B	Optional factors							No. types in BERNET partner regions
		Altitude	Depth /stratification	Colour	Salinity	Alkalinity	Lake size	Retention time	
Sweden	B	X	X	X		X			4
Denmark	B		X	X	X	X			5
Germany	A/B	X	X			X	X	X	5 (7)
Poland	A	X	X						?
Russia	-		X					X	(8)
Finland	B	X	X	X		X	X		4

Table 4.2
Summary of the typology of lakes in the BERNETcatch partner regions.

coastal waters (5-30 PSU (Practical Salinity Unit), stratified, short residence time), m*esohaline open coastal waters* (5-18 PSU, fully mixed and residence time short), and *mesohaline inner coastal waters* (5-18 PSU, fully or partly seasonally mixed, residence time generally medium). The three remaining types (all Finnish types) are different due to their remote geographical position far from the saline water inflow area at the Danish Straits. They are also ice covered for either 90-150 days or more than 150 days, and the salinity is generally < 5 PSU.

4.2 Reference conditions

According to WFD reference conditions - i.e. the condition that would be found without or with only minor human influences - must be defined for each specific type of surface water. Such types might for example be small, medium-sized, and large sandy lowland streams. Establishment of the reference conditions for such types of surface waters is one of the most essential tasks in carrying out the WFD because the general aim that all water bodies should achieve 'good ecological status' (or at least 'good ecological potential) strongly depends on how reference conditions are defined. Generally however, the provision of reference conditions in the partner regions (and countries) is very much behind. One reason is that streams, lakes and coastal waters in most parts of the countries involved are so impacted by human activities that it may be difficult to identify true reference sites. This is most pronounced in e.g. Denmark and Germany. Another reason is that surface waters which are near a "natural state" are seldom included in the monitoring programmes that mainly focus on the effect of pollution and other kind of human impact. Further, current monitoring does not include all types or some of them are only very sparsely studied. Sweden and to some extent Denmark seems to have launched a national inventory programme in order to define reference conditions, although Denmark – as mentioned - have great difficulties in finding suitable reference sites.

When present-day data on reference conditions are not available, other possibilities are the use of historical data, paleolimnological data (plant and animal remains in sediments), predictive (numerical or statistical) modelling, or expert judgement (that of course must be based on data in some way). Historical fish data are often available to some extent due to the economical importance of fish in the past. Other biological elements may be available, like information of historical distributions and depth limits of Eelgrass and macroalgae in coastal waters of Den-

Reference streams may be difficult to find – also in West Finland. One example is Katikanluoma, a small humic stream located in the uppermost part of the River Kyrönjoki catchment. Photo: Anna Swanljung, West Finland Environmental Reseach Centre).

Reference streams that may be comparable to present-day physically deteriorated streams in Fyn and Schleswig-Holstein is still found in Lithuania, as e.g. the lowland middle-sized River Savaca. Photo: Brian Kronvang, NERI.

The Kvarken Archipelago in West Finland is not only a coastal marine area of great beauty; it also represents "near reference" conditions. Photo: Peter Wiberg-Larsen, Fyn County.

mark. However, historical information is often poorly quantitatively supported. Models are both recommended and widely used for current assessment systems. The predictive models are often designed to handle large datasets. And they may sometimes be used to predict reference condition alongside a general ecological classification. Expert judgement is already used in many countries, and is an important approach when more precise and concrete data is absent, sparse or inadequate. Thus, in most analyses of reference conditions an element of expert judgement is involved, often in a combination with other approaches. It is, however, important that the procedures used are carefully documented.

The current status in the provision of type specific reference conditions in the partner countries is summarized in Table 4.3. The status clearly shows several major gaps, and that more co-operations are needed in the future to harmonize the use of the approaches and to allow the wider, cross-regional use of the methods. Although reference condition are not provided nationally, some partner regions do have presented lists of macroinvertebrates indicating reference conditions in running waters (Schleswig-Holstein and Fyn).

It should be noted here that EU is carrying out a intercalibration process (2004-2006) that aim at establishing boundaries between the high-good and good-moderate quality classes (see e.g. WFD guidance document no. 14 and EU-CIS, Ecostat, 2005). This process is as previously stated based on definition of reference conditions.

Running waters

Rivers are generally the best studied surface water category in the BERNET partner countries. Available data on macrozoobenthos and fish is available especially from Denmark, Sweden, Germany and Finland, although data from true reference sites are scarce, whereas Gdansk and Kaliningrad have so far very little biological information on their pilot area rivers. Water physical-chemical data have not been presented by the partners in detail. However, such data provided by HELCOM are presented in Figure 4.2 (page 39).

Lakes

Available monitoring programmes and models show the most promising approaches for reference conditions for phytoplankton and physical-chemical data (Denmark, Germany, Sweden and Finland). In Denmark paleolimnological data is used as a supporting tool (aquatic plants, diatom-inferred phosphorus concentrations). There is a great need for new data describing reference conditions, and it may be difficult to include all the possible bioelements in the future work.

Coastal waters

The use of a combined modelling and historical data approach is successfully used in Denmark to infer nutrient levels, physical parameters and vegetation metrics. Finland uses monitoring data to describe reference conditions for phytoplankton and macrozoobenthos, whereas Germany is planning to use historical data, modelling and expert judgement in the absence of present-day reference sites. In Sweden monitoring data on phytoplankton and water quality is used in models completed by expert judgement, a method that may be adopted by Poland and Kaliningrad in co-operation due to the absence of reference sites in their coastal waters.

Tabel 4.3
Summary of the use of different quality elements establishing reference conditions in surface waters of the BERNETcatch partner countries. The different surface categories: Rivers, lakes and coastal waters. X: quality element in current use; XF: quality element in future proposed.

	Partner	Denmark						Finland						Germany					
	Element/ Method	Phytoplankton	Other aquatic flora	Benthic invertebrates	Fish	Hydromorphology	Water physico-chemistry	Phytoplankton	Other aquatic flora	Benthic invertebrates	Fish	Hydromorphology	Water physico-chemistry	Phytoplankton	Other aquatic flora	Benthic invertebrates	Fish	Hydromorphology	Water physico-chemistry
Rivers	Present-day data		-	XF	XF	XF	XF		x	x	x	x	x	x	x	x	x	x	-
	Pred. model.		-	-	-	-	-		-	x	-	-	-		-	-	-	-	-
	Paleo, historical		-	XF	XF	-	-		-	x	x	-	-	x	x	-	-	-	-
	ExpertJu		-	XF	XF	-	-		XF	-	XF	XF	-	x	x	x	x	-	-
Lakes	Present-day data	XF	-	XF	XF	-	x	x	-	x	x	x	x	x	x	-	-	-	XF
	Pred. model.	-	-	-	-	-	-	XF	-	-	-	-	-	-	-	XF	XF	-	XF
	Paleo, historical	-	XF	-	-	-	XF	XF	-	XF	XF	x	XF	x	x	XF	-	-	-
	ExpertJu	-	-	-	-	-	-	XF	XF	XF	XF	-	-	x	x	XF	XF	XF	XF
Coast	Present-day data	-	-	XF		-	XF	x	x	XF		-	XF	XF	XF	XF		-	XF
	Pred. model.	XF	x	XF		-	x	XF	-	x		-	x	XF	XF	XF		-	XF
	Paleo, historical	XF	x	XF		-	XF	-	-	-		-	-	-	XF	-		-	-
	ExpertJu	-	-	XF		-	XF	XF	XF	XF		-	-	XF	XF	-		-	-

	Partner	Kaliningrad						Sweden						Poland					
	Element/ Method	Phytoplankton	Other aquatic flora	Benthic invertebrates	Fish	Hydromorphology	Water physico-chemistry	Phytoplankton	Other aquatic flora	Benthic invertebrates	Fish	Hydromorphology	Water physico-chemistry	Phytoplankton	Other aquatic flora	Benthic invertebrates	Fish	Hydromorphology	Water physico-chemistry
Rivers	Present-day data		-	-	-	XF	XF		-	-	-	XF	-		-	-	-	XF	-
	Pred. model.		-	-	-	-	XF		-	x	x	-	x		-	-	-	-	-
	Paleo, historical		-	-	-	-	-		-	-	-	-	-		-	-	-	-	-
	ExpertJu		-	-	-	-	-		-	-	x	-	-		-	-	-	-	-
Lakes	Present-day data	-	-	XF	XF	-	XF	-	-	-	-	-	-	-	-	-	-	-	-
	Pred. model.	-	-	-	-	-	-	-	-	XF	XF	-	XF	-	-	XF	XF	XF	XF
	Paleo, historical	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ExpertJu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coast	Present-day data	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-
	Pred. model.	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-
	Paleo, historical	-	-	XF		-	-	-	-	-		-	-	-	-	x		-	x
	ExpertJu	-	-	-		-	-	-	-	-		-	-	-	-	-		-	-

4.3 Classification

Following the definition of different surface water types and identification of the corresponding type-specific reference condition, the next step in carrying out the WFD process is to provide different kinds of classification systems that enable the water district authorities to describe (or assess) the ecological quality of water bodies in running waters, in lakes, and in coastal waters – dependent of their respective type. Thus for each type of classification system – representing different biological quality elements, hydromorphological quality elements, or physical-chemical quality elements - an Ecological Quality Ratio (EQR) must be established for each of the five pre-defined ecological status classes (high, good, moderate, poor, and bad). Thus, the classification systems must describe deviations from the type-specific reference condition.

The description of the ecological quality is essential for an assessment of whether or not a given water body comply with “good ecological status” – i.e. the main objective in the directive - or even “high ecological status”. For those water bodies that are designated as ‘heavily physical modified’ or ‘artificial’, an ‘ecological potential’ must be identified. This means that the objective in these cases – at least for some quality elements - is set somewhat ‘lower’ than for ‘normal’ water bodies. Ecological potential is also defined by comparison with reference conditions, in this case the high ecological potential. High ecological potential fulfils the high demands on the biocoenoses of a water body achievable under the presently existing heavily physical modified or artificial conditions. This is compared to the high quality found at water body types which are most closely comparable to this water body.

All BERNET partners have described available national classification systems – related to WFD or not - and they have primarily used these in the WFD risk assessment process carried out in their respective pilot area (see chapter 5). Provision of WFD related classification systems is in progress in all regions, although the outcome at present differs considerably. Generally, Germany has taken the absolute lead and seems to have put a great effort attempting to produce indices for many of the biological, physical-chemical, and hydromorphological quality elements. However, in the other partner countries the work seems to proceed with different speed.

No region besides Schleswig-Holstein has attempted to provide true locally adapted classification systems in order to carry out the present project – i.e. playing the WFD process in their respective pilot area. Thus, Schleswig-Holstein has provided a classification of lake quality using different phytoplankton metrics, and in addition presented a proposal for a macroinvertebrate-based classification of lake outlets that is a special type of running waters. Fyn County has, however, generated an assessment procedure, essentially a ‘preliminary’ classification system, based on site-specific historical eelgrass depth limits for Odense Fjord and empirical relations between this and total nitrogen (and Secchi depth).

As already described, WFD classification systems must be related to reference conditions of the respective aquatic types in rivers, lakes, and coastal waters. This is surely not an easy task as sites with reference quality are few in the countries most impacted by agriculture and other human activities, especially regarding certain types of surface waters. Another thing is that it – as an example - may be easier to find reference sites among small streams that are relatively abundant than among the naturally fewer large rivers that also have a greater risk of being heavily impacted. Consequently, some classification systems are not truly founded on reference conditions, and they may for that reason be regarded as only preliminary. An interesting question that may be asked in connection with a project as the present is, whether it is possible to use reference sites from one country in a classification exercise in another country. No attempts of this kind were made in the present project, mainly due to the linkage to national initiatives, to limited BERNET resources, but also because the partner regions include several ecoregions and therefore very different types of surface waters.

Although classification should be founded on the reference condition of a specific type of surface water, some classification systems in reality covers several types. Obvious examples are the Danish Stream Fauna Index and the Danish Physical Stream Index that are used in all three Danish running water types despite the fact that both indices may have a bias between small and large streams. Further, these indices are not truly founded in any reference condition.

For coastal systems, site-specific classification systems may be preferred over type-specific systems. Thus, analyses have shown that for rooted macrophytes (Eelgrass) in Danish coastal waters the

Table 4.4
Current status establishing systems for classification of surface waters according to their ecological status in the BERNETcatch partner countries. The term 'WFD system' means that the system reflects the five quality classes, and that it is also related to and reflect certain pressures and therefore are operational from a management point of view. DK: Denmark; DE: Germany; FI: Finland; PL: Poland; RU: Russia; SE: Sweden.

Status for establishing WFD classification systems in the BERNET countries			
Status shown as: x: WFD systems provided and ready for implementation (x): WFD systems in preparation {x}: non-WFD systems in use	**Watercourses**	**Lakes**	**Coastal waters**
Phytoplankton	none (DE) {PL[1],RU}	none (DK,DE,FI,SE) {RU}	none (DK,DE,FI,SE) {RU}
Macrophytes/ phytobenthos	DE[2] (SE) {PL[1]}	DE[2] (DK,FI,SE) {RU}	DK[7] (DK,DE,FI,SE) {none}
Macroinvertebrates	none (DE[3],FI,SE) {DK,PL,SE,RU}	none (DE,FI,SE) {PL,RU}	none (DK,DE,FI,SE) {none}
Fish	none (DK,DE,FI,SE) {SE,RU}	none (DK,SE) {none}	Not considered in WFD
Hydromorphology	DK[4],DE (none) {SE,FI,RU}	none (none) {FI}	none (DE) {none}
Physical-chemical elements	none (SE) {DK, SE,RU,DE,FI}	DK[5] (SE) {DE,FI,PL,RU[6]}	DK[8] (DK,DE,RU,SE) {FI}

1 Saprobic system
2 Both macrophytes and phytobenthos, 2 & 3 modules in rivers and lakes, respectively
3 Several indices or metrics
4 Not related to reference conditions
5 Only phosphorus
6 Only for lakes used for water supply or recreational purposes
7 Regional classification using depth limits for Eelgrass (*Zostera marina*)
8 Regional classification using N, P and Secchi depth

ecological status in many water bodies is overestimated, compared to the present ecological condition, when using type-specific classification even in a very restrictive way (Dahl *et al.*, 2005).

There are great differences in the classification systems and metrics that have been provided so far in the BERNET partner countries involved. An overview of the current efforts to provide systems to classify the ecological status of surface waters is presented in table 4.4. The classifications systems for biological, hydromorphological, and physical-chemical quality elements are treated in more detail in the following text.

Biological quality elements

Macroinvertebrates

Indices in any form were only available for ***running waters***. Further, new indices especially designed for the WFD are only provided in Finland, whereas already existing biotic indices are used in Denmark and Sweden (Danish Stream Fauna Index, the British ASPT Index, and the Swedish Acidity Index) and the traditional saprobic system is still in use in Germany and Poland. And some of these pre-WFD indices are certainly not sufficient to fulfil the requirements of the WFD because they are based only on qualitative data. Germany has a multimetric index in preparation for running waters that aim at complying with WFD requirements. For ***lakes***, Germany attempts to produce indices, although macroinvertebrates may generally be difficult to use as reliable quality elements in lakes located in this part of Europe. In this context, it is interesting to note that in Poland and Kaliningrad (Russia) the use of biotic indices (Chandler Score, modified Trent Index, DSFI, ASPT Index) has been suggested for lakes, although they are originally developed for use in running waters and especially for riffle sites. From a scientific point of view it is more than questionable if the use of most of these indices has any relevance in lakes. For Danish ***coastal*** *waters*, various diversity- and sensitivity-based indices (e.g. Margalef's richness, Shannon's H, AMBI) have been tested and compared. In Finnish waters, the environmental typology seems to reflect the depth-dependent assemblage of soft bottom macrozoobenthos reasonably well. As in Denmark, various diversity – and sensitivity – based indices have been tested and will be used (e.g. BQI, BBI). So, in these two countries, a well-founded basis for the development of classification systems now seems available. New indices for both running waters, lakes and coastal water are in, preparation in Sweden.

Macroinvertebrates is excellent bioindicators, not at least in rivers. Examples are (right) the river mussel Unio crassus, here burrowed in the sediment of River Odense, Fyn County, and (left) the caddis larva Agapetus ochripes hidden in their small "bean-like" cases made of sandgrains. They both demand good water quality and unregulated streams. Photos: Michael Jensen, Biofoto/Scanpix and Jørn Knudsen, Fyn County.

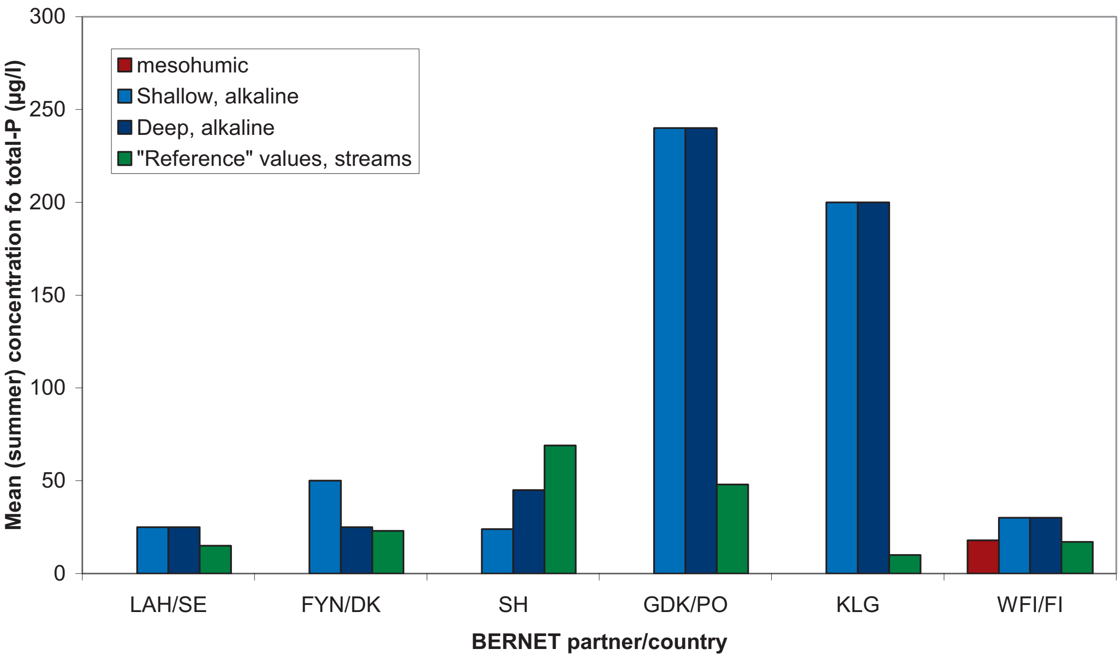


Figure 4.2
Assessment of "good" ecological quality in lakes in the BERNETcatch partner countries described by summer mean concentration of total phosphorus. Values from Sweden are "translated" from a present (non-WFD) classification system, whereas Polish values are recalculated from maximum values using a highly significant relationship between maximum values and summer mean values established for Danish lakes (that may be comparable to the Polish ones). For comparison are also shown "reference" values for streams (according to the HELCOM 2005).

Dead woody debris is the ultimate criteria for good morphology of streams and rivers, offering habitats and strongly fosters the overall heterogeneity that is the basis of biodiversity. Photo: Matthias Brunke, LANU.

Fish

Indices based on fish assemblages are considered in both Denmark and Germany – for ***running waters*** as well as ***lakes***. It is already documented that the composition of fish nicely reflects the ecological quality of the most dominant lakes types in Denmark, whereas there is doubt whether indices using fish are appropriate reflecting the ecological quality of the running waters and lakes in Northern Germany. In Sweden at least two fish-based indices are in use for running waters, although they are not truly based on the principles of WFD (i.e. not based on any reference condition). However, Sweden prepare fish indices for both rivers and lakes.

Macrophytes and microphytobenthos

Germany is unique among the BERNET partner countries as it has provided complete classification systems based on macrophytes and microphytobenthos that are founded on reference conditions of respective surface water types. Thus, a multimetric index is developed for *running waters* and a rather similar one for *lakes*. Both these multimetric indices include a so-called *Reference Index* based on macrophytes (using type-specific occurrences and varying ecological status of submerged species, and including both number of species and their abundance) and for benthic diatoms a *Trophic index* and a *Quotient of Reference species*. The Trophic index is related to the effect of nutrients (phosphorus) on species composition, whereas the Quotient of Reference species is related to the type specific occurrence and the varying ecological status of the species. In addition, the multimetric index adapted for running waters also include an *Assessment Index* which weight the occurrence and number of taxa assigned to different categories according to their ability to tolerate high nutrient concentrations. In Denmark and Sweden, the use of macrophytes in classification of ***lakes*** has been considered, although no index or metrics has been developed so far, whereas in Poland the saprobic system using epiphytic algae has been suggested as a preliminary classification tool. For Danish ***coastal waters***, various scenarios of classification systems based specifically on the depth limits of eelgrass (*Zostera marina*), for which a large body of historical data provides well-documented reference conditions, have been presented. Based on similar data, but somewhat independent of this, a concrete suggestion of how to use eelgrass depth limit to distinguish between 'good' and 'moderate' ecological status in a risk assessment of Odense Fjord has been suggested by Fyn County. Classification systems based on depth limits of eelgrass and of *Fucus vesiculosus* is considered in Germany, the latter also in Finland. Also Sweden has macroalgae indices in preparation. For macroalgae, classification systems using (total) coverage are currently in preparation in Denmark, both for near-coastal areas and for stone reefs in more open, deeper areas.

Phytoplankton

In Germany, multimetric classification systems using phytoplankton are in preparation, being based on reference conditions of various types of ***running waters*** and ***lakes***, respectively. In Denmark and Sweden some phytoplankton metrics have been considered for lakes but not in terms of a true multimetric index. Phytoplankton is not regarded as an important and, thus, relevant quality element in Danish running waters due to their small size, and the development of related classification systems are therefore not considered. In Danish ***coastal waters***, a preliminary description of reference conditions using chlorophyll ***a*** has been suggested for a number of WFD intercalibration sites, being the first step in the process of generating a classification system. The reference chlorophyll ***a*** data has been generated from historical Secchi depth data using present chlorophyll ***a*** - Secchi depth relations. In Germany, indicators like abundance (including algal blooms), species composition, and biomass are all likely candidates as metrics in a future classification system.

Hydromorphology

Classification systems describing the physical and/or the structural characteristics of ***running waters*** are only developed in Denmark and Germany, and to some extent in Finland, Sweden and Russia. However, at least the Danish Physical Index is not founded on true reference conditions or is differentiated for each or the three defined running water types. The Danish index incorporates both reach-linked variables (occurrence of riffles and pools, degree of meandering, occurrence of a natural stream profile, width of the uncultivated zone along the stream) and site specific variables (occurrence of fast current, dead wood and macrophytes, coverage of stones, gravel, sand or mud). For ***lakes*** and ***coastal waters***, only Germany has so far considered using hydromorphological elements in their classification. Sweden prepare hydromorphological indices for both running waters and lakes.

Physical-chemical indicators

A classification using indicators from within this WFD quality element is used in ***running waters*** of Germany, Poland, and Kaliningrad, although it was provided several years before the WFD was adopted in the European Community. For ***lakes***, Denmark has provided a classification system for the two most dominant lakes according to the WFD, whereas pre-WFD classification systems (or quality criteria) for lakes exist in Germany, Kaliningrad (i.e. Russia), Poland, and Sweden. While the systems in Germany, Kaliningrad, Poland, and Sweden include several variables, the Danish classification of lakes only includes total phosphorus.

For both *running waters* and *lakes* the quality criteria for chemical substances, including nutrients, seem to vary significantly among the partner countries, also for surface water types that may be comparable. As an example, good ecological quality in lakes described using mean summer concentration of total phosphorus seems to vary considerably (with a magnitude of five) (Figure 4.2). Thus, the values from Poland and Kaliningrad are exceptional high. From a management point of view the Polish values are so high that it may be relatively easy to comply with good ecological quality.

For ***coastal waters***, only a few concrete suggestions for classification systems are available. One is in Sweden where classification systems have been elaborated for nutrients, oxygen (seen together with effects of oxygen stress on macroinvertebrates) and Secchi depth. The other example, which is more an assessment system to distinguish between 'good' and 'moderate' ecological status rather than a fully developed classification system, has been worked out by Fyn County for Odense Fjord; it involves indicators like total nitrogen, and phosphorus as well as Secchi depth.

The maximum depth at which eelgrass (Zostera marina) is able to grow is a useful "metric" when classifying ecological quality in coastal areas. Photo: Nanna Rask, Fyn County.

Weighing several quality elements at the same time

When classification systems are available for each type of surface water (e.g. coastal waters), and assessments using all these systems are carried for a certain water body, it is essential to weigh the assessment results together to obtain a common assessment. This can of course be done in different ways. However, according to the WFD one should use the "one out- all out principle". The meaning of this is that the common assessment is dependent on the quality element that shows the poorest result. Under the HELCOM auspices, HEAT (HELCOM Eutrophication Assessment Tool), an assessment tool has been streamlined to meet the requirements of the WFD mentioned above. This tool has now been tested on data from 15 Danish coastal waters, comprising open, near-coastal and estuarine areas (among them Odense Fjord) (Andersen *et al., 2005*). Its uses available site-specific data for reference conditions and for current conditions for different indicators within each of the quality elements: plankton, submerged aquatic vegetation, benthic invertebrates and the group of physical-chemical indicators (3, 6, 10 and 11 different indicators, respectively). Each indicator within a quality element is assigned a weight based on the response to pressures, importance, reliability of reference conditions, etc. Thus, an EQR for each quality element can be calculated after weighting of the indicators. Finally, the "one out- all out" principle using the lowest EQR among the QE's can be applied, and for that purpose HEAT has tested different distributional patterns of the WFD quality classes, Good, Moderate, etc., where especially the breakpoint between the Good and Moderate status is important (in HEAT 15, 25 and 50% deviations from the reference conditions have been tested), but still an unresolved issue in the implementation of WFD.

4.4 Monitoring

No classification or assessment of the ecological status of water bodies can be carried out without sufficient and reliable monitoring data. The WFD considers three different types of monitoring: surveillance monitoring, operational monitoring, and investigative monitoring.

Surveillance monitoring is used to describe the development of the ecological and chemical quality in a river basin (Figure 4.3). This means that besides covering all three kinds of surface waters this monitoring must also include all types of water bodies within each category. It may be carried out using permanent measuring sites relatively far apart, as far as the monitoring network is reasonably representative. The aim is mainly to: (1) assess long-term natural changes, (2) assess long-term changes from extensive human use, (3) supplement and validate the status assessments, and (4) plan efficient future monitoring programs. The monitoring program includes the biological quality elements according to the WFD as well as physical-chemical elements, relevant and priority harmful substances and hydrological elements. If surveillance monitoring results in the assessment good or high ecological status for some water bodies, monitoring is continued with a higher interval (e.g. every 6 years), because changes from human activity cannot be ruled out in most areas throughout Europe (WFD, Annex V, No. 1.3.1.).

If the assessment from surveillance monitoring indicates moderate or worse status for water bodies, the quality of those water bodies has to be improved by measures and the water bodies will be included into the operational or investigative monitoring.

The aim of ***operational monitoring*** is to validate the results of the water bodies' status and to assess the effects of the measures carried out to improve ecological status (Figure 4.4). Operational monitoring will therefore include water bodies, which probably have moderate or worse status, where measures are being initiated, which are part of a Natura 2000-area, and which do not comply with the environmental objectives for protected areas according to WFD (art. 4). The monitoring stations may change depending on the development of a water body and the implementation of measures. It is not necessary to monitor each water body, but to monitor representatives of designated water body groups. The first phase of the operational monitoring (till 2008) will be used to validate the results of the status reports by using indicative quality elements. If this outcome reveals good status for water bodies, further quality elements will be assessed. If the status of a given water body is assessed as good using all quality elements, operational will change to surveillance monitoring. If the water body is assessed to be in a moderate or poor status, additional measures need to be taken to enable the development towards good status

The **investigative monitoring** is applied, when the ecological status of a water body is assessed as moderate or worse and the causes are not readily found in one or more pressure sources, or alternatively, if the impact of a specific event, be it natural or man-made, is to be established. Further biological quality elements, hydromorphology and physical-chemical parameters can be included. Investigative monitoring is meant as an addition to operational monitoring. The measuring program must be adapted to the special questions arising from the individual ecological and pressure situation of a water body in regard to the frequency and the choice of elements to be

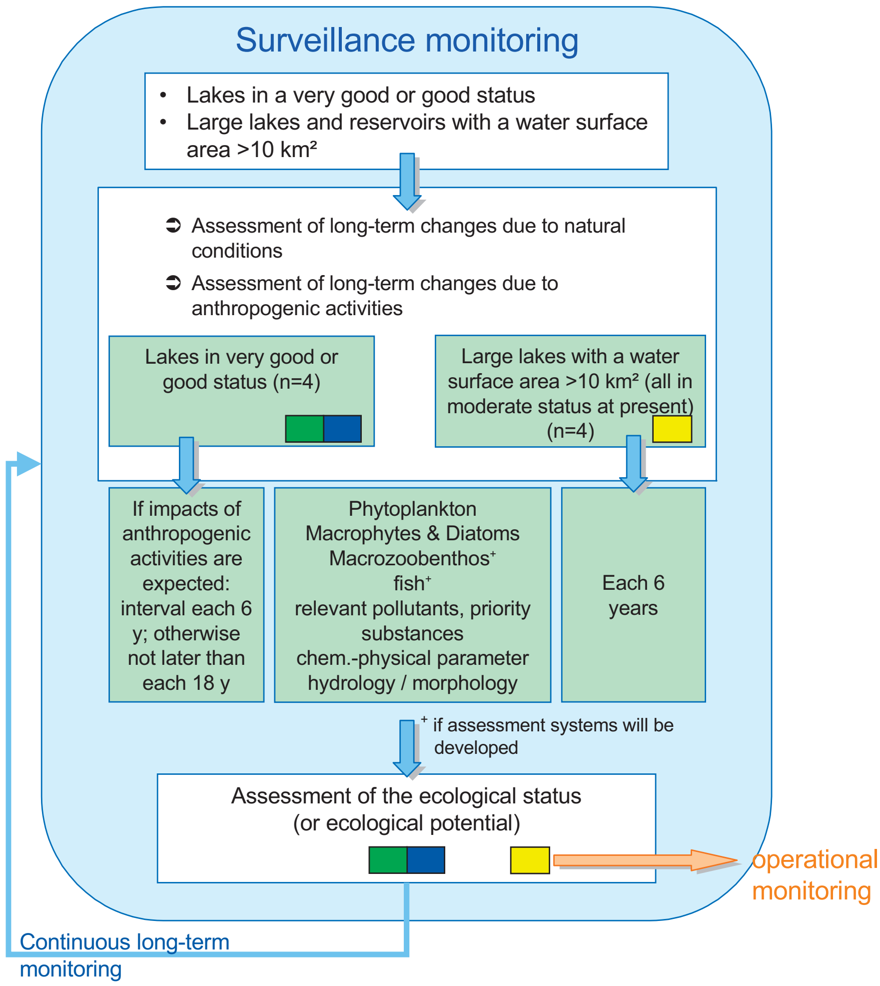
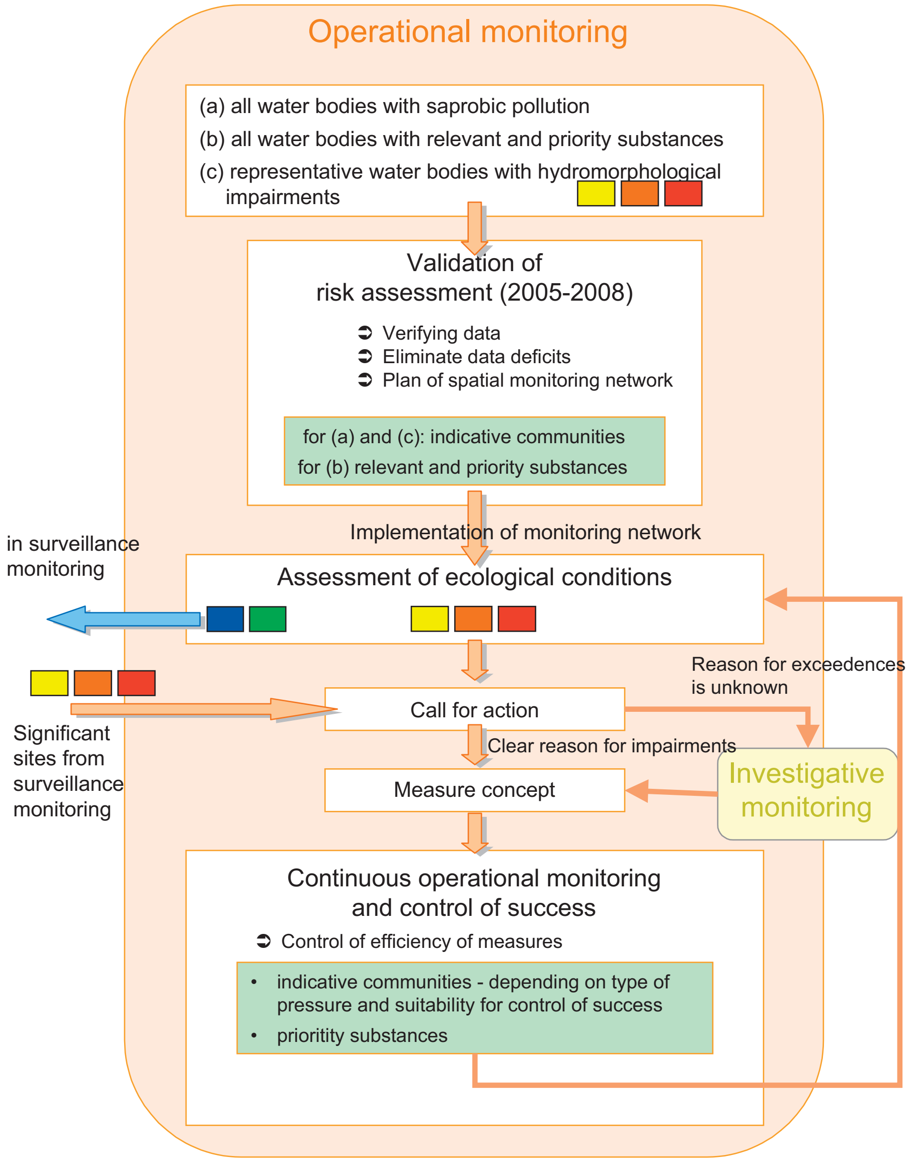


Figure 4.3
The principles of surveillance monitoring exemplified for lakes.

Figure 4.4
The principles of operational monitoring exemplified for rivers.



measured.

Although the WFD predominantly focuses on monitoring quality elements that may be indicative for specific pressures, **monitoring of the pressures** themselves is certainly important. This is especially important in operational monitoring. Otherwise it may be impossible to link pressures properly with their effects in the water bodies, and thus to be able to adjust plans for obtaining good ecological quality. Monitoring possible pressures or at least "background" levels of these pressures (e.g. run-off of nitrogen from catchments) is even important in surveillance monitoring. Thus, such monitoring may be able to detect the reasons for future negative changes in the water bodies that at present have good ecological quality because these negative changes would otherwise be unexplained. And monitoring the "back ground" levels of pressures at water bodies with good or even high ecological quality is important in comparison with monitoring levels of pressures that induce moderate and worse ecological quality in other water bodies.

In the following text we focus on how the implementation of the three types of WFD monitoring is planned in the BERNET partner countries or regions. At the moment concrete plans for monitoring in either countries or BERNET regions are few. There are plans for monitoring in Schleswig-Holstein, and the Danish national monitoring program may cover a certain part of the required WFD monitoring. Consequently, some partners have made suggestions for monitoring programs only in order to carry out the present project.

Rivers

The rationale of the WFD is principally adopted by the partner regions (see Table 4.5), and much of the differences in approach are due to differences in the pressures in consideration. For instance, the monitoring of the rivers Stensån (Laholm) and Kyrönjoki (W.Finland) focus on acidification, which is not an issue in the other areas. Other differences consist in omitting biological quality elements, e.g. phytoplankton and phytobenthos/diatoms in Fyn, West Finland and Laholm, because they may not be relevant in their types of water bodies. Some partner regions have chosen shorter monitoring frequencies for particular biological quality elements. Fyn and Schleswig-Holstein expect to monitor some water bodies which are smaller than the given system of the WFD (e.g. macrozoobenthos of small high quality streams). The monitoring of aquatic Natura 2000 areas and species is integrated in the operational monitoring by Fyn, West Finland and Schleswig-Holstein. For investigative monitoring, West Finland uses automatic sampling stations and biotests. The monitoring of Gdansk is divided into three levels, namely a national, regional and local programme, since 2004

Surveillance monitoring in rivers in the BERNET partner regions							
Quality element	WFD	Laholm	Fyn	Schleswig-Holstein	Gdansk	Kaliningrad	West Finland
Biological elements							
Phytoplanton	6 months	-	-	2 months	n	o	-
Macrophytes	3 years	+	+	+	n	o	>+
Phyto-benthos/Diatoms	3 years	-	-	+	n	o	-
Macrozoo-benthos	3 years	+	+	+	n	o	>+
Fish	3 years	+	+	+	n	o	>+
Hydromorphological elements							
Continuity	6 years	+	+	+	+	o	+
Hydrological regime	Continu-ously	+	+	+	n	o	+
Morphology	6 years	+	+	+	n	o	+
Physical-chemical elements							
Thermal conditions	3 months	>+	+	>+	n	o	2-4 months
Oxygen content	3 months	>+	+	>+	n	o	2-4 months
Salinity	3 months	>+	+	>+	n	o	2-4 months
Nutrient status	3 months	>+	+	>+	n	o	2-4 months
Acidification status	3 months	>+	+	>+	n	o	2-4 months
Other pollutants	3 months	>+	+	>+	n	o	2-4 months
Priority pollutants	1 months	-	+	>+	n	o	2-4 months

Table 4.5 Surveillance monitoring in rivers: Intervals between sampling/ measurement "events" (e.g. 2 years between sampling in a river) for different quality elements as stipulated in the WFD, and as suggested/planned by the BERNET partner regions. +: same frequency as demanded by the WFD; >+: more frequently than demanded by WFD; -: no monitoring of quality element, o: no comparison possible, n: no information available.

The number and size of migrating spawning seatrout (Salmo trutta) may be estimated using a fishcounter – here placed in River Brende. A passing trout is detected by diodes and the resulting electric signals stored automatically on a computer. Photo: Tom Rugaard, Fyn County.

harmonised with the requirements of the WFD.

The Kaliningrad region differs strongly from the WFD approach and is therefore difficult to compare. Main differences arise from the temporal organisation of monitoring (carried out during spates and low-flow) and the chosen parameters, with a strong emphasis on abiotic variables, though also biological parameters are investigated. A long-term monitoring is carried out on the basis of a national-wide program. Furthermore, specific programmes are implemented for chlorine-organic pesticides, at reclamation areas or sites of anthropogenic eutrophication.

Lakes

Whereas the lake monitoring programs of Fyn and Schleswig-Holstein are in a final developing stage, the programs in West Finland and Laholm will not be finished before the end of 2006. However, these regions/countries have a similar concept of monitoring lakes in the three categories of surveillance, operational and investigative monitoring according to the WFD. Although they follow the same basic guidelines, there are national differences concerning the kind of monitored quality elements and the frequencies of measurements. In the surveillance monitoring program most countries investigate the complete set of all five biological quality elements as prescribed by the WFD (see Table 4.6). Fyn and Laholm has decided not to include phytobenthos, because this biota has not been monitored in the national routine programmes and an assessment system is not yet available, whereas West Finland has not planned to monitor phytoplankton so far. Further, there are deviations from the WFD guidelines regarding the intervals and frequencies and intervals. Fyn, Laholm and Schleswig-Holstein suggest enhanced frequencies to overcome the high natural variability of phyto-

Sampling phytoplankton in the eutrophicated Lake Arreskov, Fyn County. Note the extremely high abundance of the bluegreen alga Aphanizomenon flos-aquae. Photo: Jette Christiansen, Fyn County.

The “Secchi depth” is one of the easiest ways to characterize ecological quality in lakes. A white disc is simply lowered to the depth where it can no longer be seen. High biomasses of phytoplankton due to excess of nutrients result in low Secchi depth values and thus turbid water; low biomasses result in clear water and high Secchi depth, permitting the growth of submerged macrophytes. Photo: Jette Christiansen, Fyn County.

Surveillance monitoring in lakes in the BERNET partner regions							
Quality element	**WFD**	**Laholm**	**Fyn**	**Schleswig-Holstein**	**Gdansk**	**Kalinin-grad**	**West Finland**
Biological elements							
Phytoplankton	every year (2)	3 years (6)	3 years (7)	3 years (6)	n	o	3 years (1)
Macrophytes	3 years (1)	+	+	+	n	o	4 years (+.)
Phyto-benthos/Diatoms	3 years (1)	-	-	+	n	o	n.d.
Macrozoo-benthos	3 years (1)	+	+	+	n	o	6 years (+.)
Fish	3 years (1)	+	6 years (+)	6 years (+)	n	o	6 years (+.)
Hydromorphological elements							
Hydrology	every year (12)	n	3 years (+)	6 years (+)	n	o	n.d.
Morphology	6 years	+	+	once at all	n	o	n.d.
Physical-chemical elements							
Thermal conditions	every year (4)	3 years (+)	3 years (7)	3 years (6)	n	o	+ (4-6)
Oxygen content	every year (4)	3 years (+)	3 years (7)	3 years (6)	n	o	+ (4-6)
Salinity	every year (4)	3 years (+)	3 years (7)	3 years (6)	n	o	+ (4-6)
Nutrient status	every year (4)	3 years (+)	3 years (7)	3 years (6)	n	o	+ (4-6)
Acidification status	every year (4)	3 years (+)	3 years (7)	3 years (6)	n	o	+ (4-6)
Other pollutants	every year (4)	-	on demand	on demand (6)	n	o	n
Priority pollutants	every year (3)	-	on demand	on demand (6)	n	o	n

Table 4.6 Surveillance monitoring in lakes showing both intervals between sampling/measurement "events" (e.g. 2 years between sampling in a lake), and frequencies (the number of samplings within a sampling events, e.g. 7 samplings within a given sampling year) for different quality elements as stipulated in the WFD, and as suggested/planned by the BERNETcatch partner regions. Intervals are shown in red colour, frequencies in green colour and in brackets. +: same as demanded by the WFD; -: no monitoring of quality element, o: no comparison possible, n: no information available; n.d.: not decided. Black colour is used, when both intervals and frequencies correspond with WFD demands, and for "-", "0", "n", and "n.d.".

plankton and some chemical elements, because the WFD-frequencies are too small to assess long-term natural changes as well as long-term anthropogenic changes. For quality elements exhibiting very small variability, e.g. lake morphology, the monitoring frequency may be reduced.

The operational monitoring programs are organized country-specific in a very different way.

National programs may be used to support the WFD monitoring program. Denmark, for instance, has developed a very ambitious national program (called NOVANA) that differentiates between three size-groups of lakes regarding quality elements, frequencies and intervals. Hence, large lakes are monitored more frequently to evaluate the effect of measures, whereas for the small lakes and ponds (0.1-5 ha, 0.01-0.1ha) a reduced monitoring program has been adopted.

That not all occurring lakes in a catchment can be monitored continuously, due to economic considerations among other things, is solved by selecting lakes that are thought to be representative. This strategy is followed by Fyn but also by Schleswig-Holstein, who has selected representative lakes according to lake type, hydrological interrelationships (river-lake-systems), kind and strength of pressure(s), degree of degradation (lakes with high regeneration potential) and conducting measures.

In the operational monitoring not all biological quality elements have to be investigated. Therefore most regions have decided to choose biota which are (1) most sensitive for the specific pressures and (2) which are suitable to control the success of the taken measures. Lakes, situated in the agricultural characterized lowlands of Fyn and Schleswig-Holstein suffer mainly from diffuse nutrient input. So

Offshore platform used for collecting sediment cores. This equipment is produced by "Aquased", Rostock, Germany. Photo: Mandy Bahnwart, LANU.

phytoplankton and/or macrophytes/ phytobenthos will be monitored as these are very indicative of eutrophication. In contrast, in the Scandinavian lakes acidification may be the main pressure and the operational monitoring therefore focus on water chemistry, macroinvertebrates and fish.

The design of an investigative monitoring program is important, e.g. in case of accidental pollution or when the operational monitoring have not already been established. The analysis of the given regional information shows, that this program is in all BERNET regions of less importance compared to the other two categories and will be attributed only to a very small number of lakes.

The monitoring programs of the Gdansk and Kaliningrad regions are difficult to compare to the others, because they do not use the three categories of surveillance, operational and investigative monitoring. The Polish lake monitoring is designed as a rotating network that includes most of the lakes once per 5 or 6 years, but otherwise very little is known about the future program.

In contrast, the Kaliningrad region has developed a really intensive approach for monitoring lakes that differs substantially from the WFD monitoring. The obligatory monitoring program is strongly related to the corresponding hydrological regime. This means that water level and ice cover determine the time and frequency of monitoring. This means that monitoring is rather flexible, which is also necessary for the detection of pesticides that are intensively investigated in this region. As well as for the rivers, the monitoring focuses mainly on abiotic variables, though also biological parameters are investigated.

Table 4.7
Surveillance monitoring in coastal waters showing both intervals between sampling/ measurement "events" (e.g. 2 years between sampling in a given coastal area), and frequencies (the number of samplings within a sampling event, e.g. 7 samplings within a given sampling year) for different quality elements as stipulated in the WFD, and as suggested/planned by the BERNETcatch partner regions. Intervals are shown in red colour, frequencies in green colour and in brackets. +: same as demanded by the WFD; o: no comparison possible, n: no information available; n.d.: not decided. Black colour is used, when both intervals and frequencies correspond with WFD demands, and for "n" and "n.d.". o.d.: "on demand" - i.e. if there are indications that priority pollutants and other pollutants are emitted to the aquatic environment.

Surveillance monitoring in coastal waters in the BERNET partner regions							
Quality element	**WFD**	**Laholm**	**Fyn**	**Schleswig-Holstein**	**Gdansk**	**Kaliningrad**	**West Finland**
Biological elements							
Phytoplankton	every year (2)	+	+ (26)	+	n[a]	o[b]	+
Macrophytes	3 years (1)	+	2 years (2)	+	n[a]	o	+
Macrozoobenthos	3 years (1)	+	2 years (1)	+	n[a]	o	+
Hydromorphological elements							
Hydrology	every year (12)	n.d.	n.d.	Continuously	n[a]	o[b]	n.d.
Morphology	6 years	+	+	+	n[a]	o	n.d.
Physical-chemical elements							
Thermal conditions	every year (4)	6 years (+)	+ (26)	+	n[a]	o[b]	+ (2-20)
Oxygen content	every year (4)	6 years (+)	+ (26)	+	n[a]	o[b]	+ (2-20)
Salinity	every year (4)	6 years (+)	+ (26)	+	n[a]	o[b]	+ (2-20)
Nutrient status	every year (4)	6 years (+)	+ (26)	+	n[a]	o[b]	+ (2-20)
Other pollutants	every year (4)	6 years (+)	o.d. 3 years (3)	o.d. (+)	n[a]	o[b]	3 years[c] (3)
Priority pollutants	every year (12)	6 years (+)	o.d. 3 years (3)	o.d. (+)	n[a]	o[b]	3 years[c] (3)

[a] No information available yet for the Polish WFD Coastal Monitoring Programme (in preparation)
[b] For information on the Kaliningrad Coastal Monitoring Programme please consult the BERNETcatch Work Package 1 report.
[c] Only sediment sampling

Coastal waters

In most countries the development of WFD monitoring schemes profit from the experience gained from many years of practical coastal water monitoring on regional or national scale. This applies in particular to the methods used. The design of the programs is determined mainly by the demands of the various classification systems, which in some cases are still under development. Therefore the monitoring programs presented by the regions are still in a draft stage, and minor or bigger changes in near future are most probable. No information was available from Gdansk, where near-coastal monitoring has not been performed during the last years; hence, a new program is under development.

Table 4.7 shows the frequencies used/planned in surveillance monitoring in the partner regions. Biological quality elements are measured by all "old" EU regions, and apart from Fyn these also follow the minimum frequencies given in Annex V. The deviation in Fyn is especially evident in pelagic variables like phytoplankton and nutrients, where 26 samplings per year are taken in contrast to a minimum frequency of every 6 months as requested by the WFD. This elevated frequency is chosen due to the pronounced temporal and spatial variation of these variables in the Western Baltic Sea. The same conditions also prevail in Schleswig-Holstein. However, here the needed information for a proper assessment will be taken from the more frequent operative monitoring (see below). Pollutants and priority substances are analysed in Fyn and Schleswig-Holstein only if there is a suspicion of discharge, whereas Laholm runs a screening every 6 years and West Finland monitors every 3 years.

For the coastal operational monitoring, the biological quality elements (and the supporting chemical and physical quality elements) are generally monitored more frequently than in the surveillance monitoring. Thus, phytoplankton (together with hydrography and nutrients) is measured 10-52 times per year in the westerly located regions. In West Finland phytoplankton and macrophytes are not part of the program, whereas fish is only monitored in this region (once a year). Macrozoobenthos is sampled in all "old" EU countries once every year as well as every 2nd (Fyn) or 3rd (West Finland) years. Compared to the clear picture in the surveillance monitoring (see above), the status of the operative monitoring for pollutants and priority substances is unclear in some regions. Whereas Fyn County intend to sample every 2 years, the monitoring in Schleswig-Holstein is carried out only if reduction measures are taken in the associated catchment. In Laholm a base study of priority substances in sediments will be carried out and the results will determine the outline of a possible monitoring program, whereas in West Finland the sediment quality will be investigated every 3rd year.

Investigative monitoring is supposed to be carried out only if operational monitoring results point at an unexplained deterioration of the ecological status. No such monitoring programs have, however, been presented by the regions as the operational monitoring has not started yet and, thus, no results are available.

The coastal monitoring in Kaliningrad deviates considerable from that presupposed in the WFD. It is therefore difficult to make proper comparisons. However, hydrography, water chemistry and pollutants (like chlorinated hydrocarbons, phenols, and heavy metals) are main elements of the program. Biological variables include pelagic parameters like phytoplankton, zooplankton, and microbial indices, whereas neither macrofauna nor macrophytes are considered. The sampling frequency varies from twice a month to 2-4 times a year.

The sampling vessel Liv II on a monitoring cruise in The South Fyn Archipelago Photo: Fyns Amt.

4.5 Conclusions

The analyses of Work Package 1 have lead to a number of conclusive statements. These are expressed and presented in the following box.

- The provision of typologies for rivers, lakes and costal waters must be speeded up in several of the BERNET partner countries
- The typologies must be established using more than just one criteria (e.g. size for running waters in Denmark)
- There seems to be a great need for intercalibration and harmonisation of typologies between countries regarding directly comparable surface waters (e.g. lakes in Denmark, Northern Poland and Northern Germany)
- The definition of reference conditions must have the highest priority, as this is a the necessary template for establishing systems suitable for classifying water bodies in "good" and "not good" ecological quality.
- In the absence of true reference sites for several surface water types, alternative solutions must be used including the use of (i) comparable sites in other countries, (ii) combining modelling and historical data to infer nutrient level, physical parameters and biological variables, or (iii) paleolimnological tools. The use of paleolimnology in running waters must not be neglected as it may have a significant potential.
- The provision of WFD based classification systems for running waters, lakes and coastal waters must be speeded up in most of the BERNET countries
- Classifications systems must be founded on reference conditions and related to specific surface water types
- Although some biological quality elements seem to have been neglected in some countries due to the lack of tradition and experience, they may be important supplying other biological quality elements in respect to describing the effect of specific pressures (e.g. diatoms as indicators for eutrophication of running waters)

- Classification systems especially designed for one surface water category must not uncritically be used to in assessment of other surface water categories (e.g. macroinvertebrate indices developed for streams that do not "work" in lakes).
- Classification and assessment must be founded on several biological and other elements, and for a specific biological quality element even on more than just one quality criteria or metric (e.g. the Danish Stream Fauna Index is too rigid to reflect ecological quality regarding different types of pressures)
- It is important that monitoring programmes focus on quality elements that reflect all significant pressures
- And it is important that monitoring also include quantification of the pressures themselves - if possible. It is further important that e.g. the input of nutrients to water bodies of reference, high, or good ecological quality is measured – in order to make comparisons possible with the input that results in moderate or worse ecological quality.
- Establish time series of this kind is very important in order to follow possible developments in e.g. land use.
- The surveillance monitoring network must have a size that makes it possible properly to describe the actual status of environmental quality in the water bodies in a given catchment, and for all relevant surface water types.
- In operational monitoring it is advisable to select a subset of water bodies to be monitored if the total number in consideration is very high. This selection must, however, be representative.

5. Aims and risk assessment

5.1 Designation of water bodies

An important part of the WFD process is to designate water bodies to be classified according to their ecological status. The water bodies are the basic units for which the risk assessment is carried out which again forms the basis for developing the subsequent management plans and monitoring programmes.

The partner regions (except Kaliningrad that does not need to carry out this part of the project) have designated a considerably varying number of water bodies within their respective pilot areas (see Table 5.1). Of course a major part of the difference is due to the size of the pilot areas that varies with a magnitude of almost twenty (284 to 5303 km^2). Correcting for differences in size, however, Fyn County have designated 0.302 water bodies/km^2 in running waters of River Odense, whereas 0.041, 0.035 and 0.012 water bodies/km^2 are designated in the pilot areas of Schleswig-Holstein, Laholm, and Gdansk, respectively, and only 0.001 water bodies/km^2 in River Kyrönjoki (West Finland). Accordingly, although with a slightly less variation, the number of lake water bodies (per km^2 pilot area) ranges with a magnitude of about four and coastal water bodies about six. Therefore, the main reason for the difference in water body number is that some partner countries like Poland and Finland have decided only to include relatively large water bodies in their Article 5 reporting (e.g. lakes with an area > 50 ha and rivers with a catchment > 1000 km^2), whereas e.g. Denmark (and Fyn County in particular) also includes relatively small water bodies (lakes > 5 ha and streams with a catchments < 5 km^2 in some cases).

All partner regions seem to aim at designating water bodies of the same type and overall status as presupposed in the directive. This is quite straightforward in lakes, where each lake may be designated as only one water body if the lake is not too big and heterogeneous. However, in running waters and open costal water it may not be so straightforward. Thus in running waters, it is obvious that the number of potential water bodies depends on the heterogeneity of the stream reaches and not at least of the degree of detailed knowledge (i.e. the number of monitoring sites). Despite the relatively small size of streams included in the designation process, the mean length of water bodies in the pilot area of Fyn

Summary of the designation of water bodies in the BERNET Pilot Basins

	Category	River Stensån (Laholm)	River Odense (Fyn)	Schlei-Trave (Schleswig-Holstein)	River Pasleka (Gdansk)	River Ma-monovska (Kaliningrad)	River Kyrönjoki (West Finland)
Number of Water bodies	Rivers	10	316	217	28		5
	Lakes	4	14	46	14		0[1]
	Coasts	1	3	24	2[4]		1
WB's/km^2	Rivers	0.04	0.30	0.04	0.01		<0.01
	Lakes	0.014	0.013	0.009	0.006		0
	Coasts	0.035	0.029	0.045	0.0009		0.0006
Heavily modified WB's (%)	Rivers	0	57	6	0		40
	Lakes	0	1	5[2]	0		0
	Coasts	0	0	13	0		0
Artificial WB's (%)	Rivers	0	11	1	0		0
	Lakes	0	0[3]	0	1		0
	Coasts	0	0	0	0		0

Notes
1 Only lakes > 0.40 km^2 considered
2 Coastal lakes created by modification of former fjords etc. (by dams, sluices)
3 Lakes created by excavation of stones, gravel and sand, or peat, are not regarded artificial, as they may 'behave' like natural lakes
4 One of these – the "Vistula Lagoon" – is identified as a transitional water body

Table 5.1
Summary of the designation of water bodies (WB), the identification of heavily modified water bodies (HMWB), and the identification of artificial water bodies (AWB), respectively, carried out for rivers, lakes and coastal waters within the Pilot River Basins of the BERNETcatch partner regions – except Kaliningrad that does not have to carry out a risk assessment.

The lower reach of River Stavis may initially be identified as heavily modified due to a regulation carried out during the1950s. However, after a restoration it may be regarded as "natural" and must therefore achieve "good ecological" status. Photo: Bjarne Andresen, Fyn County.

County is about 3 km, which is more than the lower limit recommended in the WFD guidelines. In open coastal areas it may be difficult to designate water bodies because the boundary between two potential water bodies may not be sufficiently sharp.

5.2 Heavily modified and artificial water bodies

Some partner regions have provided criteria for a preliminary identification of heavily modified water bodies (HMWB's). However, these criteria vary considerably. Among the running waters of the pilot areas, Schleswig-Holstein only identifies water bodies impacted by shipping lanes (only 6 % of all water bodies) and awaits further studies before designating other possible HMWB's (Table 5.1). Fyn County, on the contrary, has identified 57 % of the water bodies within the pilot area as heavily modified using a large variety of physical criteria (degree of piping/culverting, other kinds of modification of the stream morphology, impoundments, water abstraction, stormwater outlets, and general physical properties according to the Danish Physical Index). In River Kyrönjoki (West Finland) two out of five water bodies are identified as heavily modified (due to impoundments and regulations of the flow), whereas no HMWB's are identified in the pilot areas of Gdansk and Laholm.

Regulation of the water level does occur in several lakes – at least in the pilot areas of Fyn County and Schleswig-Holstein. However, the fluctuations in water level are in general regarded as relatively insignificant. Thus as an example, only one lake is identified as a HMWB in the pilot area of Fyn County (one example due to a significant regulation of the water level). In the pilot area of Schleswig-Holstein, five coastal lakes may be identified as HMWB's being former fjords now transformed into lakes by damming, sluices etc.

The current speed is significantly reduced upstream old watermills. If the impoundment is preserved due to its cultural or economic importance, the upstream reach may be classified as heavily physically modified. Photo: Bjarne Andresen, Fyn County.

Fyn County has designated 14 artificial water bodies in running waters, all being watercourses made for draining of reclaimed land where coastal waters or freshwater wetland formerly existed. Among the other partners, none except Schleswig-Holstein recognises artificial water bodies, mainly due to the relatively large size of the water bodies considered (it is easiest to create small artificial water bodies).

No lakes are identified as artificial water bodies in any of the partner regions, except for one lake by Gdansk. This is either due to the fact that only large lakes are generally regarded in the WFD process by the partner regions (such large lakes are unlikely to be artificial), or in Fyn County because man-made lakes in practice behave quite like natural lakes.

For coastal waters, criteria like navigation and upkeep of shipping routes, coastal defence measures with a strong hydrologic or morphodynamic influence, and strongly modified coastal strips with ports, industry, sheet piling, boardwalks reaching out from the coast, etc, may be used in Germany to define heavily modified water bodies. In addition to those, Danish criteria may further include land reclamation, that often involve damming, draining and sluicing activities, fairways and channels, and areas with former extraction of raw materials (e.g. stone fishing or other activities).

5.3 Aims and risk assessment

In all partner regions (except Kaliningrad), the risk assessment was carried out in order to assess whether or not the water bodies considered may achieve at least 'good' ecological status by 2015, i.e. thereby taking into account if already planned measures to improve the ecological status (i.e. measures that are independent of the WFD) are expected to have the desired effect by 2015.

The metrics or criteria used in these assessments were generally rather simple, often being based on 'old' classification systems (e.g. the saprobic system in running waters) and not necessarily ideal in the WFD process. Preliminary, but newly developed classification systems using physical-chemical metrics have, however, been used in the assessment of the Laholm Bay in Sweden.

The metrics were in general of biological and/or chemical nature. In running waters macroinvertebrate indices were used in combination with a chemical (including specific pollutants) and physical assessments. In lakes chemical assessment prevailed; in Schleswig-Holstein supplemented by an assessment using metrics for phytoplankton and submerged macrophytes. Pressures like land use (liming, intensive farming) and significant wastewater point sources were also included as an element in the assessment of lakes in Schleswig-Holstein and for running waters in Gdansk.

The risk assessment carried out for running waters and lakes in the pilot area of Laholm differed considerable from that carried out in the other pilot areas. Thus, a wide variety of quality elements and criteria, including several metrics reflecting the degree of 'naturalness' (according to an assessment system called 'System Aqua'), were used for both watercourses and lakes. The System Aqua metrics includes present physical changes, flood control and/or regulation of water level, land use in surface water areas (incl. riparian areas), water quality, alien species, change in flora and fauna, and fragmentation. Three different approaches were tested in the assessment. In one of these, only System Aqua was used and a mean value of the different metrics calculated and used in the assessment, although different results could be obtained if the 'worst' value (the "one out – all out principle") among the different metrics was used instead. In both the other two approaches, the lowest scoring quality criteria for fish and macroinvertebrates were used as the determining criteria in the overall assessment, whereas physical-chemical quality criteria and the worst hydromorphological indicator value (according to System Aqua) were used only to support the distinction between good/moderate and high/good ecological status, respectively. The two last-mentioned approaches only differed from each other by their choice of biological criteria: either the 'official' national criteria or those of System Aqua.

A regional procedure was developed for the assessment of the coastal part of the Odense Fjord pilot area. Besides the assessment, the procedure

Use of objectives different from those of the WFD – a special Danish case

By an executive order announced 16 October 2005, Denmark has officially decided not to use "good ecological quality" as the common objective carrying out the risk assessment. Thus instead, the aims of the risk assessment are full-filling the objectives that are stipulated in the current County Regional Plans using principles dating back to the 1970s. This certainly makes a difference. First of all, the objectives stipulated in these plans are reflections of weighing many different interests and considerations. Secondly, the objectives of the different surface water categories are grouped as "stringent", "basal" or "eased", and whereas only the first two mentioned groups of objectives are comparable to "good ecological quality" (*sensu* WFD), eased objectives are only equivalent to "moderate" or worse ecological quality. Furthermore, the requirements that are necessary to full-fill the objectives differ considerably dependent on the regional plan in consideration. In practice, the "official" risk analysis may inevitably lead to significantly fewer water bodies being in risk of not complying with the objectives in 2015 than if the assessment had been carried out applying the WFD-objective of "good ecological quality".

During a period of oxygen depletion hydrogen sulphide is released from the sediment in an eelgrass (Zostera marina) meadow at 4 meters depth. The hydrogen sulphide is oxidised to free sulphur by the oxygen in the water – the sulphur is seen as grey clouds above the seabed. This process may cause severe death of eelgrass, as seen in the South Fyn Archipelago in the summer 1994. Oxygen depletion is a result of eutrophication and the respective area is at risk of not complying with good ecological status in 2015. Photo: Nanna Rask, Fyn County.

also provided a specific quantitative measure of the upper limit of an impacting factor (the nitrogen load) that should be met in order to reach at least 'good' ecological status. It was based on the use of (site-specific) historical data of eelgrass depth limits from the beginning of the last century and empirical modelling of relationships between eelgrass depth limits and total nitrogen (and Secchi depth) from numerous Danish coastal areas. When combined with a dynamic 3-dimensional fjord modelling running a range of scenarios with different nutrient loads (including an anticipated anthropogenic reference load), which established relationships between nitrogen load and fjord concentration, the combined result was a necessary functional relationship between cause (nitrogen load) and effect/response (eelgrass depth limit). It was for instance calculated that the nitrogen load should be about halved in order to meet the objectives.

It should be noted that such an assessment based on eelgrass depth limit and derived nitrogen concentrations and Secchi depths obviously cannot stand alone, i.e. the assessment should preferably be based on all WFD quality elements in order to make the assessment more robust. Such a procedure has been tested in Odense Fjord using the HELCOM eutrophication assessment tool HEAT on several indicators (for further explanation see chapter 4.3). The assessment gave the result that the ecological status of both water bodies in Odense fjord, the inner and outer part, was below acceptable (Moderate or lower) irrespective of whether the boundary between Good and Moderate status were set at 15, 25 or

Table 5.2
Summary of the risk assessment carried out in the Pilot River Basins of the BERNETcatch partner regions – except Kaliningrad that does not have to carry out the assessment. The importance of physical impoverishment and insufficient water quality, respectively, are described semi-quantitatively by: ++ (very important), + (important), and – (not important). The table also shows the present ecological status of the water bodies.

Summary of the risk assessment carried out in the BERNET Pilot River Basins

	Category	River Stensån (Laholm)	River Odense (Fyn)	Schlei-Trave (Schleswig-Holstein)	River Pasleka (Gdansk)	River Mamonovska (Kaliningrad)	River Kyrönjoki (West Finland)
Present status: water bodies with moderate – bad ecological status (%)	Rivers[1]	64	96	>96	79		79
	Lakes	50	71[2]	74[3]	50		-[4]
	Coasts	100	100	100	nd[7]		100
Water bodies at risk of not achieving at least good ecological status by 2015 (%)	Rivers[1]	64	96	96	0		56
	Lakes	50	71[2]	74[3]	7[6]		-[4]
	Coasts	100	100	100	100		100
At risk due to physical impoverishment	Rivers	++	++	++	-		++
	Lakes	-	-	-	-		-[4]
	Coasts	-	-	-	nd[7]		-
At risk due to insufficient water quality	Rivers	++	++	+	-		+
	Lakes	++	++	++	+[5]		-[4]
	Coasts	++	++	++	nd[7]		++

Notes
1 %'s calculated on basis of water body length.
2 Additionally 15 % of the lakes are potentially at risk
3 Additionally 17 % of the lakes are potentially at risk
4 No lakes > 40 ha within the pilot area
5 Only one lake that is impacted by wastewater (point source)
6 Additionally 64 % are potentially at risk due to insufficient data
7 nd: not determined. The two water bodies are considered to be potentially at risk due to lack of data

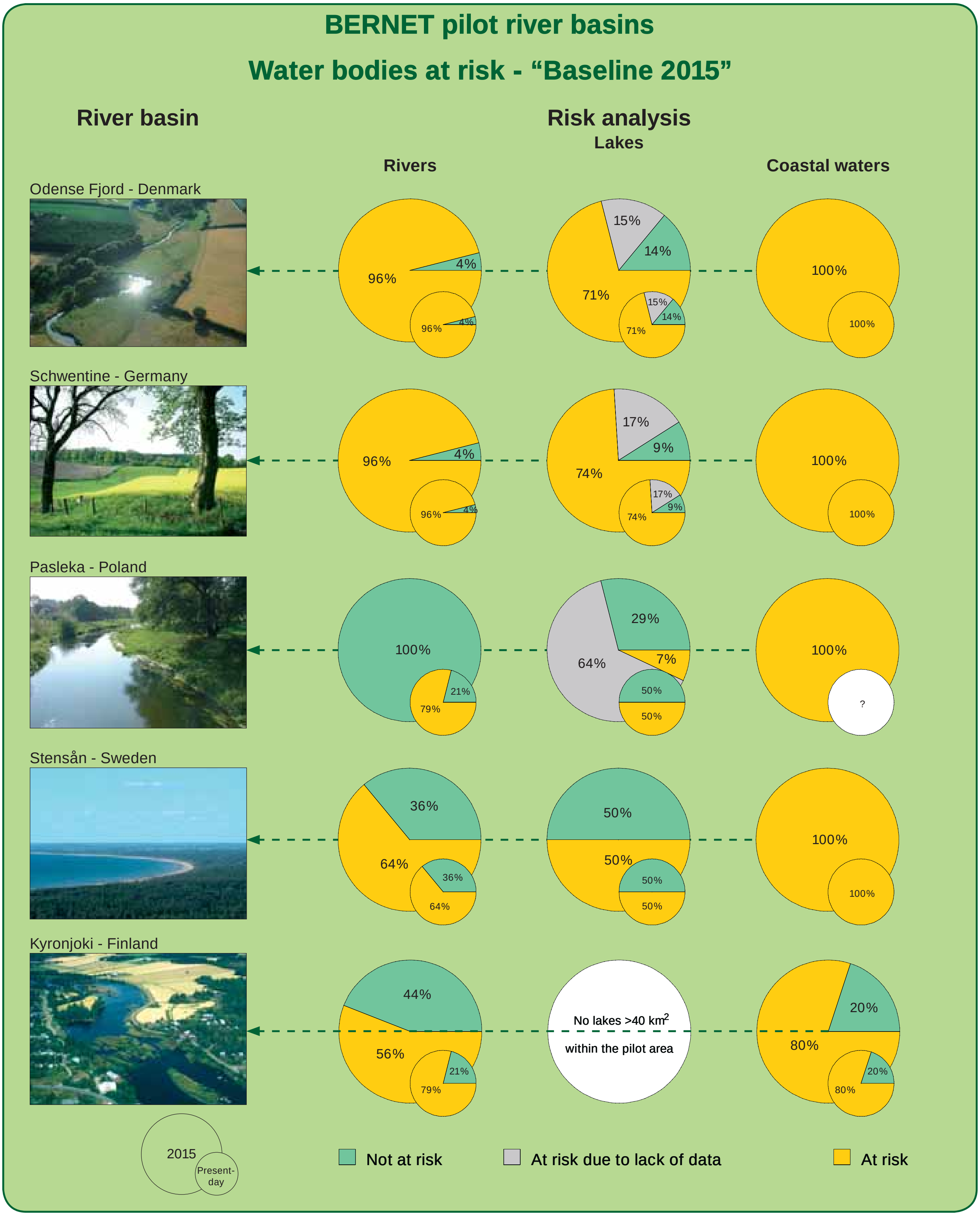


Figure 5.1
Summary of the risk assessment according to "baseline 2015" in the BERNETcatch pilot catchments – except Kaliningrad that does not have to carry out the assessment. For comparison (inserted circle) is also shown the present ecological status of the water bodies.

50% deviation from the reference condition. Setting the latter boundary is still an unresolved issue in the WFD.

If data were not available for a reliable assessment in the BERNET regions, the respective water bodies were either identified as being at risk of failing good ecological status ('the precaution principle') or potentially at risk (lakes and coastal water bodies of the Gdansk pilot area). In the absence of an assessment system, the West Finland and Schleswig-Holstein coastal water bodies were considered to be at risk of not attaining good status due of the pressure and impact from acidic loads (the West Finland pilot area) and nutrient loads (pilot areas of both West Finland and Schleswig-Holstein).

An overview of the present status of the ecological quality of different types of water bodies and risk assessment for the same water bodies carried out in the pilot areas of the partner regions is shown in Table 5.2 and Figure 5.1.

The overall risk assessment showed major differences regarding running waters, lakes, and coastal waters.

Thus in the pilot areas of Laholm, Fyn County, Schleswig-Holstein, and West Finland 56–96 % of the water bodies in running waters were assessed as being at risk of failing good ecological status in 2015, whereas none of the water bodies in the Gdansk pilot area were regarded as being at risk. The main reason for this difference is that the running waters in the pilot areas of Laholm, Fyn and Schleswig-Holstein are in general heavily physical deteriorated and that this deficit must be overcome by WFD initiatives, whereas the watercourses of the Gdansk pilot area are primarily impacted by pollution (primarily due to insufficiently treated waste water) which may be significantly reduced due to already planned measures. However, it must also be stated that the Polish definition of good ecological quality in both rivers and lakes are highly eased compared to most other BERNET countries (see Figure 4.1). Therefore by proper waste water treatment, it may be quite easy to reduce the high content of phosphorus (that is the main reason for the present day "not-good" status in about 80% of the water bodies, see Table 5.2) of the rivers in the Gdansk area to level that do not exceed the relative high limit value for this parameter.

Accordingly, 50-74 % of the lakes were assessed as being at risk in the pilot areas of Laholm, Fyn County and Schleswig-Holstein, compared with only 7 % in the Gdansk pilot catchment. Apart for the explanations mentioned above, this remarkable difference is also due the lack of data in several Gdansk lakes, and because these lakes only are regarded as being potentially at risk. An obvious alternative to this "classification" would have been to place them among those at risk.

All coastal water bodies in the partner regions were considered to be at risk or potentially at risk of failing to attain good ecological status in 2015.

5.4 Conclusions

The analyses of Work Package 1 have lead to a number of conclusive statements. These are expressed and presented in the following box.

- **The designation of water bodies should be carried out in order to obtain operational units.**
- **It is important that the small streams and lakes/ponds are not forgotten when designating water bodies. Thus, although the WFD expects the authorities to concentrate on the relative large streams/rivers and lakes, "good" ecological status should ultimately be achieved in all surface waters**
- **Lakes should only be designated as heavily modified if their water level is significantly fluctuating**
- **Man-made lakes should by regarded as natural lakes – and not artificial ones - if they created by extraction of raw materials, and if they function as natural lake ecosystems**
- **Risk-analyses must be carried out on the basis of aims that reflect "good" ecological status, not on more eased objectives (e.g. on basis of already existing water quality planning that do not comply with WFD guidelines)**
- **It is important that "good" ecological status is defined in relation to some kind of reference condition, also in the preliminary risk assessment**
- **If "old" classifications systems is used in the risk assessment, they must be appropriate in relation to water bodies in consideration**
- **Ideally, more than just one quality element should be regarded when carrying out the risk assessment**
- **If no data are available, water bodies must be classified as being at risk – not at least if the existence of significant pressures are recognised**
- **"Good" ecological status represented by e.g. the phosphorus content of water must not vary several magnitudes between comparable surface waters types of the different countries. This calls for international co-operation.**

6. Program of Measures in the pilot catchments

The programmes of measures is the heart of a water management plan, expressing the management activities and strategies which are political decided to fulfil the objective of the Water Framework Directive on at least “good ecological status” of all waters in the year 2015. In most cases there are a lot of different management solutions giving the same result, and the chosen solution is a result of a planning process evaluating different solutions. The chosen solution are supposed to be the most cost effective, but a more expensive solution may be chosen for political reasons i.e. to secure a wish on recreating more nature and recreational areas close to larger populations of people in cities.

This chapter describes cost effective measures identified by BERNET to fulfil the WFD objectives of the waters within the BERNET pilot catchments. First is given an overview of the significant pressures that impact the different types of waters (watercourses, lakes, coastal waters). Afterwards is given an overview of the proposed measures to reduce the pressures fulfilling the WFD objectives in all types of waters within the BERNET catchments. Finally is given a description of selected measures targeted the main types of pressures including a description of costs and effects of the individual measures.

Annex 1 presents each of the BERNET pilot catchments, the environmental status of the waters and identified measures to fulfil the WFD objectives.

Table 6.1
The significant pressures to watercourses, lakes and coastal waters identified in the BERNET pilot catchments.

Major environmental pressures on water bodies in BERNET Catchments		
	Pollutional pressures	**Physical pressures**
Rivers	● Nutrient (N,P) ● Organic matter ● Oxygen-consuming substances (BOD) ● Acidification ● Sediment load ● Hazardous substances ● Pathogenic bacteria and viruses	● Regulation of rivers and river maintenance, mainly in connection with intensive agricultural cultivation of river valleys ● Dammed rivers (hydropower and irrigation) ● Water abstraction (reduced flow) ● Flood protection ● Navigation ● Fishery
Lakes	● Nutrients (N,P) ● Hazardous substances ● Acidification ● Pathogenic bacteria and viruses ● Internal load from sediment	● Dammed (hydropower production) ● Land reclamation for agricultural production ● Fishery
Coastal waters	● Nutrient (N,P) ● Hazardous substances ● Acidification ● Pathogenic bacteria and viruses ● Internal load from sediment ● Thermal pressure from cooling water	● Navigation ● Excavation of shipping fairways ● Sand, gravel and stone fishery ● Disposal of excavated material ● Land reclamation for agricultural production ● Fishery
Groundwater	● Nitrate leaching ● Hazardous substances ● Pathogenic bacteria and viruses	● Water abstraction ● Raw material / soil extraction

6.1 Major environmental pressures

The risk assessment (table 5.2) shows the waters which are at risk not fulfilling the WFD objectives. The reasons for not fulfilling the objectives are a result of many different manmade pressures. These pressures can be divided in the following 2 main types:

- Pollutional pressures
  - Diffuse airborne and waterborne pollutants
  - Point source pollutants
- Physical pressures

The significant pressures related each type of waters are listed in table 6.1

Watercourses

The BERNET risk assessment shows that fulfilling the WFD objectives imply both measures related physical pressures and pollutional pressures.

Lake with poor status. Lake Arreskov, Fyn County. Photo: Fyns County.

The main pollutants of watercourses are oxygen consuming substances, and outlets causing acidification. Oxygen consuming substances, expressed as the BOD content, originating outlets of sewage from households and industries. Acidification outlets origins typically soils leaching acid load because of land reclamation (i.e West Finland) or because of airborne deposition of acid substances in areas where soils have low buffer capacity (i.e. Laholm Bay catchment). In some local areas outlets of toxic and hazardous substances (i.e. pesticides and heavy metals) also have significant impact.

The physical pressures of the watercourses are in all BERNET catchments typical a result of land reclamation intended intensive cultivation in river valleys. Also damming of rivers with the purpose of hydropower production and irrigation are major physical pressures, hindering the fish migration. In some areas waterworks influences the water flow in watercourses significantly and with that also influence the ecological status. Outlets of sediments to the waters typical originate erosion from cultivated fields and storm water outlets from paved areas also influence the ecological status significantly.

Lakes and coastal waters

Fulfilling the WFD objectives in lakes and coastal waters imply first of all reduction of outlets of nitrogen and phosphorus. These nutrients originate mainly from agricultural production and sewage outlets from households and industries. In lakes (and some coastal waters) nutrients pressures also originate internal load of phosphorus from the sediments, caused by accumulation of former time manmade outlets. In areas where soils have low buffer capacity (i.e. Laholm Bay area), acid loads also cause acidification. In some areas loads of hazardous substances influence the ecological status significantly (i.e. Odense Fjord).

Physical pressures are mainly caused damming (lakes), land reclamation and navigation. Sewage outlets of pathogenic bacteria and viruses influence the bathing areas.

THE MAKING OF PROGRAMMES OF MEASURES

HOW TO MAKE THE WFD OBJECTIVES OPERATIONAL SEEN FROM A WATER MANAGEMENT POINT OF VIEW?

The making of programmes of measures aims to fulfil the Water Framework Directive's (WFD) environmental objectives on at least "Good surface water status" by the year 2015.

Management strategy

Step 1:
Identification of operational quality elements of the water bodies (i.e. algae biomass and nutrient concentration) that could be linked to the significant pressures (i.e. nutrient loads) giving an answer on the maximum acceptable pressure to fulfil the WFD objective.

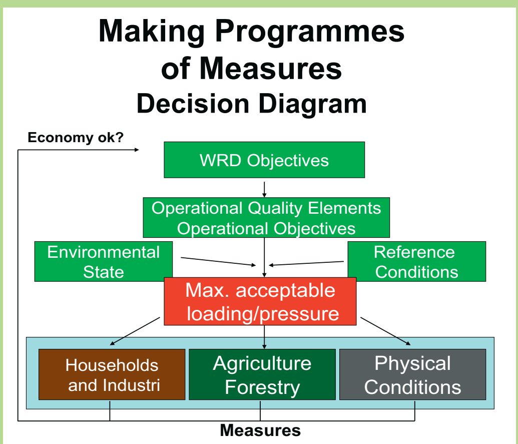
Step2:
Identification of reference values of the quality elements; which means the undisturbed situation.

Step3:
Defining "threshold values" of the quality elements setting values on "only slightly deviation from undisturbed conditions", i.e. 10%, 25% or perhaps even 50% deviation of reference values; setting the operational WFD objective.

Step 4:
Defining max acceptable pressures (i.e. nitrogen load) corresponding the operational WFD objective. Ecological modelling founded on monitoring results could be a valuable tool to give answers on max acceptable pressures (see figure).

Step 5:
Find measures (i.e. measures reducing diffuse pressures from agriculture) that match the maximum acceptable pressures to fulfil the WFD objective.

The making of programmes of measures is an iterative process involving stakeholders and political decisions.



WFD environmental objective

All surface waters shall by the year 2015 at minimum achieve

"Good surface water status"
meaning
"the status achieved by a surface water body when both its ecological status and its chemical status are at least good"

which in more operational terms means (WFD Annex 5) that

"The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions"

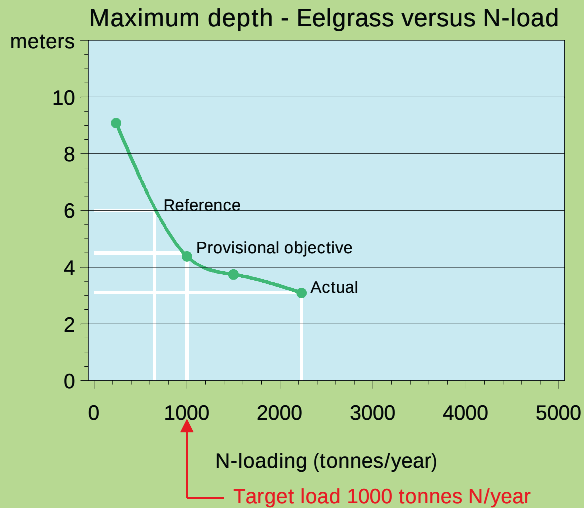
and

"Nutrient concentrations do not exceed the levels established so as to ensure the functioning of the ecosystem and the achievement of the values specified above for the biological quality elements"

and concerning hydromorphological quality elements

"Conditions consistent with the achievement of the values specified above for the biological quality elements"

Defining relations between operational objectives and nitrogen loading



6.2 Baseline 2015

Prognosis for the trend in pressures

The risk assessment is based on knowledge of the present environmental state of the water bodies and the pressures upon them, as well as on knowledge of the effect of the already adopted and planned measures to reduce pressure on the water bodies before 2015 (Baseline 2015). The risk assessment has to include the effect of the already planned or implemented initiatives to reduce the pressures, e.g. initiatives to improve wastewater treatment, initiatives to reduce the environmental impact of agriculture or planned initiatives to reduce physical pressure on the water bodies, e.g. the removal of watercourse obstructions that hinder the migration of fish.

The effect of the environmental measures implemented so far

In the BERNET pilot catchments of Schleswig-Holstein, Laholm Bay area, Fyn County and West Finland, improved wastewater treatment has lead to a marked decrease in wastewater discharges of nutrients and oxygen-consuming substances over the last decade. In the BERNET regions of Kaliningrad, Gdansk and Estonia in contrast, wastewater treatment in the late 1990s and early 2000s was not based on 'up-to-date' technologies. The BERNET regions of Poland and Estonia are presently constructing, modernizing and upgrading the municipal wastewater treatment plants.

Agricultural activities are the main source of nitrogen loading of water bodies and a major source of phosphorus loading. In the old EU countries in particular, highly intensified agricultural production involving intensive livestock production and high fertilizer consumption has considerably increased nitrogen loss to the surroundings, especially in the period 1950–1990. That large amounts of excess fertilizer from agriculture in the BERNET catchments is lost to the water bodies is partly attributable to reclamation and drainage of up to 80% of the wetlands over the past century as wetlands naturally retain nutrients.

The largest nitrogen loss from agricultural activities comes from the BERNET catchments with the most intensive agricultural production (Odense Fjord, Stensån and Schwentine catchments), although environmental initiatives in the past decade have reduced the diffuse loss of nitrogen from agricultural land in these catchments by up to 30%. The BERNET catchments in which loss of nitrogen from livestock farming is least per hectare (Gdansk and Kaliningrad) are also the catchments in which fertilizer consumption and livestock production are least and in which the reclamation of wetlands for agricultural use is least.

Economical growth affects waters

The risk assessment also has to incorporate assessment of the future pressure on the water bodies, for example as a result of urbanization and growth in agricultural and industrial production – activities that can alter the present environmental state. In the agricultural area international analysis agencies expect continued growth in livestock production in the EU, especially in the new EU countries including Poland, which is the EU country with the greatest area of agricultural land. All things being equal, such growth in livestock production will entail enhanced pressure on the environment unless special environmental measures are implemented concomitantly.

BERNET has estimated that if the nitrogen losses from all agriculture land in the Baltic Sea Catchments were rised to the high level in Denmark and Fyn County, then the total nitrogen loss to the Baltic sea would increase by probably more than 50%.

Table 6.2

Measures to fulfil the WFD objectives in BERNET pilot river basins						
Pressures and measures to reduce them	**Target pressure or aim of measure**	**Affected water bodies/habitats**				
		Coastal waters	Lakes	Rivers	Ground -water	Terrestrial natural habitats
Diffuse pressures – agriculture						
Improved utilization of nutrients in manure ○ Improved utilization of animal fodder ○ Storage requirements (min. 6–12 months capacity) ○ Requirements as to manure application systems and max. amount of manure applied.	N and P loads	+	+	+	+	(+)
Improved utilization of nutrients in manure ○ Reduced ammonia volatilization (livestock housing, manure storage and application)	N load (airborne)	(+)	+	(+)	(+)	+
Enclosed storage facilities for manure and silage, including facilities to eliminate ammonia volatilization and odour pollution	N, P and BOD loads	+	+	+	+	+
Reduced livestock production/density	N and P loads	+	+	+	+	+
Catch crops: Optimized and increased use	N load	+	+	+	+	
Spring ploughing instead of autumn ploughing	N load	+	+	+	+	
Set-aside for: ○ Wetlands, natural habitats and permanent grassland in river valleys ○ New natural habitats, forests and permanent grassland	N and P loads Sediment load Improved/natural hydromorph. structure Restore natural habitats	+ +	+ +	+ + +	+	 + +
Fertilization requirements (N, P): ○ Reduced N and P fertilization quotas	N and P loads	+	+	+	+	
Fertilization demands (P): ○ Phosphorus balance at field level ○ Reduced P fertilization quota in soils with high P content	P load	+	+	+		
Cultivation restrictions on potentially erosive areas	P and sediment loads	+	+	+		
Buffer zones (uncultivated) alongside surface waters (rivers, lakes, etc.)	P and sediment loads	+	+	+		
Reduced or regulated drainage	Hydrology, N and P loads	+	+	+		+
Diffuse pressures – forestry						
○ Leaving vegetation in the felling area ○ Planting as soon as possible ○ Leaving buffer strips alongside rivers ○ Increasing the amount of deciduous trees ○ Reducing emissions to the atmosphere from traffic, industry and livestock	N and P loads, acid load	+	+	+		+
Point-source pressures						
Wastewater treatment facilities ○ Sparsely built-up areas – improved wastewater treatment ○ Municipal treatment plants – improved wastewater treatment ○ Stormwater outfalls – basins ○ Renewal/renovation of sewerage systems	N, P and BOD loads Hazardous substance load Pathogenic bacteria and virus load	+ + +	+ + +	+ + +	 +	
○ Former waste disposal sites – measures to reduce leaching	N, P and BOD loads Hazardous substance load	+ +	+ +	++ ++	++ ++	
Peat production ○ Ditches between two strips of cultivated land ○ Sedimentation basins and overland flow ○ Chemical processing (nutrients) ○ Regulation of flow (sediment)	N, P and sediment loads	+	+	+		
Reducing physical pressures						
Reintroducing and protecting migratory fish ○ Removal of obstructions for fish migration ○ Restrictions on angling and fishery and at potential spawning grounds, etc.	Improved/natural hydromorphological structure Reintroduction of migratory fish	+	+	+		
Re-establishment of natural rivers and river valleys ○ Re-meandering of regulated rivers and reopening of culverted streams ○ Restoration of gravel and stones in river beds ○ Cessation or minimization of river maintenance ○ Extensification of cultivation	Improved/natural hydromorphological structure N and P loads Sediment load	+	+	++		++
Cessation/reduction of groundwater and surface water abstraction	Improved/natural hydromorphological structure			+	+	+
Others						
Biomanipulation of lakes	Increased water transparency and greater plant and animal diversity		+			
Removal of contaminated sediments and soils	P load, hazardous substance load	+	+	(+)	+	
Reducing emissions to the atmosphere from traffic, industries and livestock	N load, acid load	+	+	+		+
Prevention of acidification due to leaching from acidic soils ○ Liming (rivers, etc.) ○ Controlled drainage ○ Liming filter ditches in connection with existing drainage systems	Acid load, hazardous substance load	+	+	+		

6.3 Program of measures

BERNET has identified a lot of different measures to reduce the pressures fulfilling the WFD objectives in all types of waters within the BERNET pilot catchments (table 6.2). These measures address reduction of different types of pressures. Some measures are multifunctional, addressing at the same time more types of pressures and protection of more types of waters, i.e. "Set aside for recreating wetlands in river valleys", which at the same time both reduce the nutrient pressures on lakes, running waters and coastal areas, reduce physical pressure on watercourses and create new nature. Some measures are specific regionally due to especial local conditions, i.e. measures in West Finland targeted peat production, and measures targeted acid loads from reclaimed lands rich of sulphate soils.

The choice of measure depends on effects and economy, which differs from region to region and between water bodies and sub-catchments. The potential for using a specific measure in a specific area are varying. In some areas you may not have possibilities recreating wetlands because of the shape of landscape or because it is very expensive recreating wetlands due to of high prise on set aside caused by the existing use of the farmland.

Nutrient loss from agriculture is a main pressure which has to be adressed accordingly to the WFD. Photo: Bjarne Andresen, Fyn County.

Reducing diffuse pressures - agriculture

In BERNET regions where agricultural production is not intensive as Poland, Kaliningrad and Estonia; the losses of nutrients to the waters are not so high (Figure 3.1). Here the measures to fulfil the WFD objective focus the building of adequate storage facilities to animal manure, giving a better utilisation of the manure and decreasing the losses of nutrients. An expected intensification of agricultural production in these areas may lead to higher losses of nutrients like in Denmark and Schlesvig Holstein. The challenge here is to manage this development, securing that the loss of pollutants will not increase with the growing agricultural sector in these areas.

In the BERNET regions where agricultural production is intensive (Denmark, Schlesvig Holstein and Sweden) and the losses of nutrients to the waters is biggest, the fulfilment of the WFD objectives call for bigger doses of measures related agriculture, compared to the BERNET regions in Poland, Kaliningrad and Estonia. Efforts have already been done to reduce the losses of nutrients from farmland, i.e. demands on manure storage capacity, manure handling, fertilizer quota and catch crops. But still the losses of Nitrogen and Phosphorus from farmland in Denmark, Schlesvig Holstein and Sweden, are high and more measures are needed to fulfil WFD-objectives. Intensive use of catch crops, recreation of wetlands and reduced fertilizer quota are some of the proposed supplementary measures to fulfil the WFD objectives.

A detailed description of agricultural practice and management in the BERNET regions can be found in BERNET (2000c).

Reducing diffuse pressures - forestry

The forestry legislation in the forest dominated pilot areas (Sweden, Finland) requires a sustainable care of forest areas by paying special attention to environmental matters in forest management. However, measures in forest management do not usually require environmental permits. In Finland a notification procedure to the environmental authorities are expected for forest trenching. The legislative frames of forest management in Sweden and Finland can substantially improve the water protection, but probably will not be sufficient enough to guarantee reaching a good ecological status in the pilot water bodies where forestry is dominant. Complementary measures regarding water protection are further needed.

Reducing the nutrient and sediment load of forestry requires an implementation of sufficient water protection measures in ditching, cutting and fertilizing. In addition to these, the most common measures like sedimentation basins, overland flow fields and wetlands should be taken into use in suitable targets.

Measures to curb acidification

Lakes, rivers and even near coastal waters suffer from acidification due to acid atmospheric deposition. But also leaching of acid substances from sulphur and ferruginous soils often enhanced by drainage of these soils for land reclamation increase acidification.

Acid atmospheric deposition originates primarily from power plants, traffic and agriculture (ammonia). These emissions are long distance and transboundary transported. By example in southern Sweden acid deposition mainly originates foreign emissions as Denmark, Poland, Germany, and Great Britain. In Sweden (the year 2000) 93% of the sulfur deposition, 92% of the nitrogenoxide deposition and 79% of the ammonia deposition was origin foreign emissions (Naturvårdsverket, 2005).

Airborne acid pollutants deposited on soils with low buffer capacity will be leached to the waters. Leaching of acid substances are often also a result of land reclamation and drainage of acidic soils for agricultural use. As an example acidification mainly originates from atmospheric deposition in Stensåen pilot basin, while in Kyronjoki pilot basin acidification is primarily caused by leaching from acid soils.

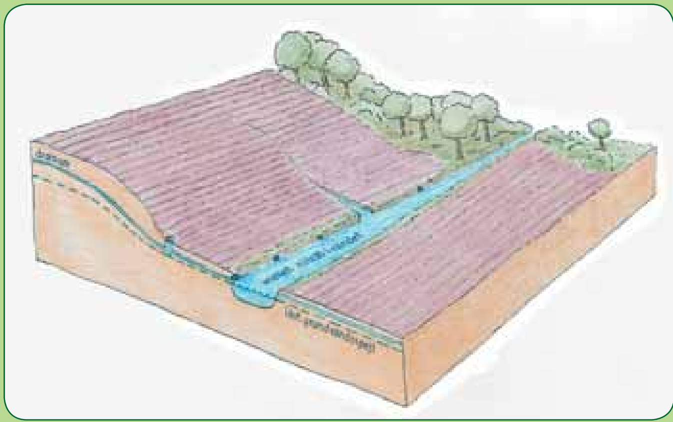
To reduce the acidification of water bodies, some measures already has been introduced i.e. liming of rivers and some measures reducing the emissions to atmosphere are also implemented nationally in many countries. As an example the cost of liming Swedish waters is 3 billion SEK in the period 1983-2003 (Naturvårdsverket, 2005).

Nevertheless more measures are needed targeted the main sources of pressures, especially reducing emissions to atmosphere from traffic, power plants and agriculture and reducing leaching from acid soils. Measures targeted to atmospherics emissions have to be addressed internationally.

Regarding measures to reduce the leaching from acid soils, development of new methods as well as

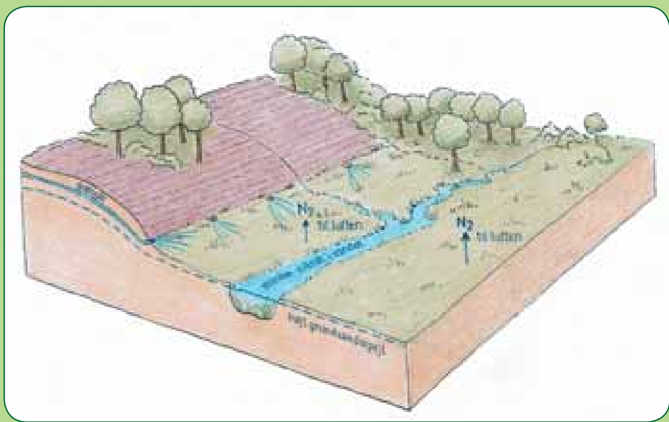
RECREATION OF WETLANDS

Before



Where River Valleys are used for intensive agriculture or forestry no natural buffer between the intensive used areas and the surface waters exist. The rentation of lost nutrients from the cultivated areas is very low in these intensively used river valleys.

After

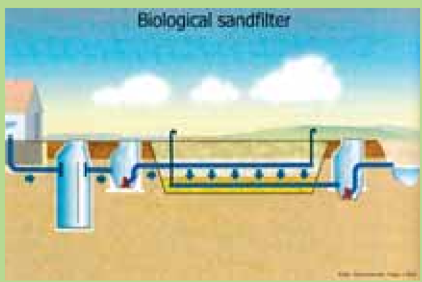


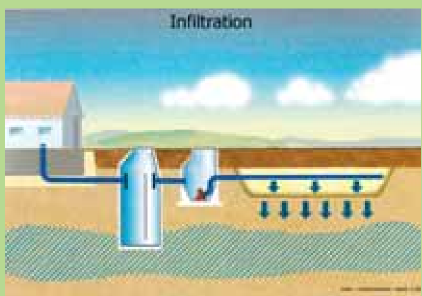
Wetlands in river valleys functions as a buffer between the surface waters and the areas used for intensive agriculture or forestry Wetlands act as nutrient sinks and are valuable nature areas. The Nutrient retention is typically 200-400 kg N/ha and 1-5 kg P/ha

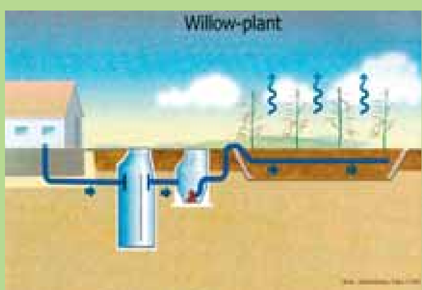
Costs
Typically 8,000 € per hectare
recreated wetland (Denmark)

Scattered settlements

Measures to improve sewage treatment







Costs of improved sewage treatment: Typically 4.000-10.000 €
per household/settlement

combining several traditional measures, are needed. Based on current knowledge the primary measures for reducing the acidity from soil could be a distinct increase in liming filter ditches and controlled drainage in the catchment, as well as storing and liming of water in artificial water bodies during acidity peaks. However, these measures are very expensive and their full scale implementation require a functional support funding. Prompt research and development activities are primary needed in order to find more efficient and economical acidity prevention methods. The currently used methods can not properly reduce acid leaching originated acid soils to achieve a good ecological status in the water bodies.

Reducing Point Source Pressures

Municipal Sewage treatment Plants

Municipal sewage treatment facilities are already well developed in the BERNET regions in Sweden, Finland, Denmark and Schleswig Holstein. The efficiency of BOD-removal and removal of nutrients are high, and only minor improvements are needed. A very large share (70-90%) of private houses and industries are connected to municipal sewage treatment plants. Further measures related outlets of hazardous substances and pathogenic bacteria and viruses are in some cases needed to fulfil the WFD-objectives.

For the moment the BERNET regions of Poland and Estonia are doing construction, modernizing and upgrading of the municipal sewage treatment plants according to requirements of EEC Directive 91/271 concerning urban waste water treatment. This work is supposed to fulfil the WFD objectives regarding outlets from municipal sewage treatment plants.

In Kaliningrad the planning and construction on upgrading municipal treatment plants has started, but economic/financial resources are lacking.

Some BERNET regions (Poland and Kaliningrad) also point out the importance of renovate old sewer systems.

Scattered settlements

All BERNET regions address measures to improve sewage treatment at scattered settlements not connected to a municipal waste water treatment plant. The improvements are necessary to fulfil WFD-objectives especially regarding lakes and watercourses. Measures can either be a connecting of the settlements to public sewer systems or individual improvement of sewage treatment facilities (see fact box oppesite).

Storm Water Outlets

Some BERNET regions (Denmark) address supplementary measures to reduce storm water outlets to fulfil the WFD objectives. The measures are typical building of basins on the sewer systems to retain pollutants, reducing outlets of nutrients and oxygen consuming substances and reducing pressures from high peaks of waters. The building of separate sewer systems instead of combined sewer systems for both sewage and storm water is also a measure to reduce outlets of pollutants caused by storm water.

Reducing physical pressures

In watercourses the reduction of physical pressures are one of the main tasks to fulfil the WFD-objectives.

All BERNET region addresses measure on "Removal of obstructions for fish migration" as an important task. Many locations in the watercourses have obstructions for fish migration typically caused by damming for hydropower production or irrigation purpose. The measures can be removal of the obstruction or building of fish ladders/passages. Also culverting/piping of sections of the stream hinders the fish migration. In this situation the measure to enhance fish migration is to reopen the watercourse. BERNET has already a lot of good examples of the building of fish passages to enhance fish migration (Figure 6.1).

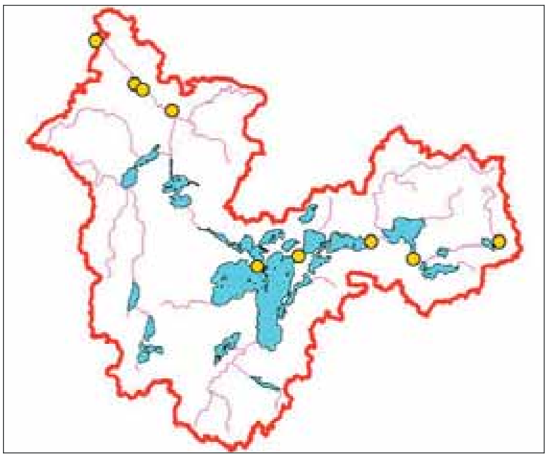


Figure 6.1: Obstacles for fish migration in the Schwentine Catchment.

Fish ramp with canoe path in Malente, Schlesvig Holstein.

Fishramp, Brende River, Fyn County.

Measures to fulfil objectives of Water Framework Directive BERNET Pilot Catchments Scenarios COSTS					
Measures to reduce pressures	**Costs of scenarios million EURO**				
	Odense Fjord *1 1046 km2	**Pasleka** 2295 km2	**Stensån** 284 km2	**Kyronjoki** **4920 km2**	**Schwentine**
Reducing Diffuse Pressures – Agriculture	3,8/yr	24	0,65/yr		
Higher utilization of nutrients in animal manure 1. Better utilization of animal fodder 2. Demands on storage facilities (min. 6-12 month capacity) 3. Demands on manure: spread. systems and max. amount spread	0 + 0,32/yr	- 24 -		Cheap + +	
Catch-crops: Increased use	0,17/yr		0,05/yr	Cheap	
Spring ploughing instead of autumn ploughing	-		0,03/yr	Cheap	
Set aside 1. Wetlands, nature and permanent grassland in river valleys 2. New nature, forests and permanent grassland	2,1/yr -		0,32/yr -	quite expensive -	
Fertilization demands (N,P): 1. Reduced N- and P-fertilizer Quota	1,2/yr				
Fertilization demands (P): 1. Phosphorus balance at field level 2. Reduced P-fertilizer quota in soils with high P-content	? ?			Cheap Cheap	
Buffer zones (uncultivated) along surface waters			0,2/yr	quite expensive	
Reduced or regulated drainage			0,05/yr	quite expensive	
Reducing Diffuse Pressures – Forestry	0	0			
1. Leaving vegetation in the felling area, planting as soon as possible 2. Leaving buffer strips along watercourses 3. Increasing the amount of deciduous trees and lenient scarification 4. Decrease deposition by decrease emissions to the atmosphere from traffic and livestock				quite Cheap quite expensive - -	
Reducing Point Source Pressures	25 (93)	17			
Sewage treatment facilities 1. Scattered settlements – improved sewage treatment 2. Municipal treatment plants - improved sewage treatment 3. Storm Water Outlets – basins 4. Renewal/renovation of sewer systems	13 13 67 *2 -	9,2 2,4 - 5,1	0,25-0,56/yr 0,05-0,08/yr - -	quite expensive quite expensive -	
Former waste disposal sites – measures to reduce leaching	+			+	
Peat production facilities 1. Ditches between two strips of cultivated land 2. Sedimentation basins and overland flow 3. Chemical processing (nutrients) 4. Regulation of flow (sediment)				Cheap Cheap expensive Cheap	
Reducing Physical Pressures and recreation of natural physical and hydromorphologic structures	+?	3			
Re-introduce and protection of migrating fish 1. Removal of obstructions for fish migration 2. Restrict. on angling, fishery at river stretches pot. for spawning etc.	+?	3		quite expensive 0	
Recreate natural rivers and river-valleys 1. Re-meandering of regulated rivers and Re-open culverted streams 2. Restore gravel and stones into riverbed 3. Stop or minimize river maintenance 4. Extensivate cultivation	+? *2		0,09/yr	quite expensive quite expensive - -	
Others	0 *1*	0			
Bio – manipulation LAKES					
Removal of contaminated sediments in lakes					
Prevention of acidification occurring leakage from soil. 1. Liming (watercourses etc) 2. Controlled drainage 3. Liming filter ditches in connection with existing drainage systems			>0,045/yr	expensive quite expensive very expensive	
TOTAL COSTS "WDF-Measures"	3,8/yr + 25 + ?	44	1,5/yr		
Basic Measures (Existing measures)	40/yr				

Table 6.3
Costs of measures to fulfil objectives of Water Framework Directive in the BERNET Pilot Catchments. Scenarios based on the BERNET water management plans.
+: Type of measure already implemented
**1: Cost of measures are primary related fulfillment of objectives in Odense Fjord*
**2: Measure targeted fullfilment of objectives in watercourses*

Caused intensive cultivation of river valleys, the rivers are often regulated by straightening and dredging the river trace. Moreover the river valley is drained and regularly river maintenance takes place several times a year. These actions and activities may often create bad hydro morphologic conditions in watercourses hindering the fulfilment of the WFD objectives. Measures to reduce these physical pressures can be extensification of the agricultural cultivation in the river valley giving basis to stop the river maintenance. The building of new riverbeds by re-meandering of the river and restoring of gravel and stones in the river bed may also be necessary to reduce physical pressures giving back the natural vitality of the watercourse (good hydro morphologic conditions). BERNET has good examples using these measures.

The extensification of cultivation in river valley also give the possibility to use the river valley as nutrient sink by creating wetlands. This shows the multifunction of river valleys doing measures to reduce pressures of several types of water bodies (watercourses, lakes and coastal waters) at the same time.

6.4 BERNET scenarios on WFD measures

In most of the BERNET pilot catchments are given examples of supplementary measures (scenarios) to fulfil the WFD objectives of selected types of water bodies within the pilot catchments. The scenarios on measures, included the costs of measures, are listed in table 6.3. The scenarios are typically preliminary estimations on measures not taking into account all measures needed to fulfil WFD objectives of all types of waters within the pilot catchment. If available the costs of already implemented measures so far are listed too.

Ejby Mølle Waste Water Treatment Plant, situated in the city of Odense, Odense Fjord catchment. Fyn County's biggest plant with a total capacity of 268.000 person equivalents. Photo: Jan Kofod Winther.

7. Public participation in Water Management

7.1 Water Framework Directive and Public Participation

The Article 14 of the WFD requires the Member States to encourage the active involvement of all interested stakeholders in the implementation. Especially public consultation and participation is essential during the production and updating of the water management plans which form the central theme of the Directive. For the public consultation to be meaningful, people will need a basic understanding of the principal features of the Directive and how these relate to the situation in their own local river basin.

Public Participation, particularly in environmental issues, has long traditions in some of the Baltic Sea areas. Public participation in the WFD spirit is to ensure that all inhabitants affected by water management planning have the possibility to participate in the process and the plan itself. During this project, there have been numerous meetings, contacts and consultation from stakeholders and their groups around the Baltic Sea.

The focus has been on how to involve the stakeholders and the general public in water management and the development of Water District Plans. The successful implementation of the EU Water Framework Directive (WFD) relies upon a close cooperation and coherent action at all administrative levels in the member states. However, the implementation is also most reliable on the general public to participate in the planning process at several stages during the preparation of a Water Management Plan. Information, consultation and involvement of all stakeholders including the land owners, farmers associations, non-governmental organizations and the public in general is a central issue of the implementation. Co-operation between different parties (authorities, associations, etc) is also needed for a full understanding of the environmental and socioeconomic problems connected to the eutrophication of the regional waters.

The objective was to bring together the stakeholders who are affected by the WFD on the regional and local level, to prepare a participation plan for the preliminary Water Management Plan of the Pilot River and to identify the central obstacles and problems in the implementation of the directive.

The focus was also to compare the legislation connected to the WFD public participation, different national or regional strategies of public participation of the implementation process as such in the different BERNET-regions.

The Water Framework Directive and Public Information and consultation
Article 14 states:

That the Member States shall encourage the active involvement of all interested parties in the implementation of the WFD, in particular in the production, review and updating of the river basin management plans. Each river basin district shall ensure that the following is put available and published:

- **a timetable and work programme for the production of the plan at least three years before the beginning of the planning period**
- **an interim overview of the significant water management issues in the river basin district at least two years before the beginning of the planning period**
- **draft copies of the river basin management plan at least one year before the beginning of the planning period**

7.2 Activities and work topics

The activities were divided under three topics: Identification, Networking and Acceptance.

Identification

To start the participation with the general public in the planning processes, the partners made a **stakeholder analysis** based on the Guidance Document on Public Participation prepared by the EU Water Directors. The making of a stakeholder analysis implies going through a series of steps of questioning and interaction based on the knowledge available on the stakeholders at catchment level. It gives an opportunity to make a thorough analysis of the stakeholder structure from an initial phase, but also to re-analyze the stakeholder structure in a quite well known catchment and identify the central stakeholders concerning water management planning. The stakeholders of all regional catchments were named, identified and listed with full contact details. The stakeholders were furthermore divided on the basis of their role in the preparation of a water management plan into experts, decision makers, users or implementers. A schematic structure of the stakeholder analysis is presented in Figure 7.1.

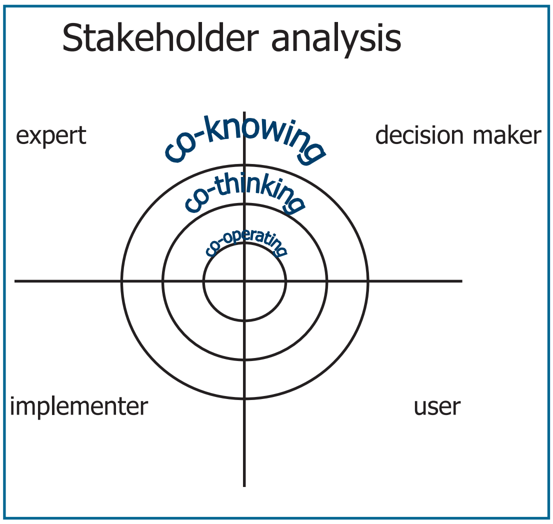


Figure 7.1 Schematic structure of the stakeholder analysis model.

The Identification-phase was finished by preparing a **participation plan** on how to reach the different categories and groups of stakeholders during the water management planning process.

Networking

Networking was the phase of the stakeholder-cooperation that was characterized by active involvement of selected stakeholders or key actors in the water management planning process. The process included the involvement of the public in seminars or information meetings to promote the content of the Basic Analysis or the first part of the Water Management Plan. This phase included also for example the establishment of the contacts to the identified stakeholders if not yet included in the planning process from before.

Acceptance

The Acceptance phase moved the stakeholder involvement in the Networking-phase to the next level. This phase aimed to work out an acceptance of the environmental problems. During this process the environmental objectives in the Water Management Plan were defined. However, the main issue of this phase was to get acceptance from the stakeholders on the Program of Measures and the needed actions to reach the environmental goals in the catchment.

7.3 Identification

In the beginning of the "Identification"-phase nearly all partners made a stakeholder analysis or re-analyzed the stakeholder structure in their case study areas. When evaluating the identification processes between the BERNET-regions it was found that long term collaboration with stakeholders is often a traditional way to manage water issues in Germany and Nordic countries. In Danish, Finnish and German pilot river catchments public participation has been built on previous experience. On the contrary public participation was a quite new approach in water management issues in the case study areas of Estonia, Poland, Russia and Sweden.

In the Estonian case study the public participating process was promoted by interdisciplinary research. Together with the sociological studies in Viru-Peipsi region Peipsi CTC (a regional NGO) used organization's databases in the identification of the stakeholders in the region. Parallel with the identification of stakeholders, Peipsi CTC carried out a study to determine the type of information and the channels of communication needed in order to meet the requirements of a large range of stakeholders. It was evident, that a variety of different channels and tools of communication and information packages were needed to reach the large audience.

Like in the Estonian cases study, a large range of stakeholders was engaged in the Russian and Polish cases. In the Russian case study the identification was done on the basis of legislation, existing water management, environmental systems and practical experience. The public participation plan was initially prepared including several activities e.g. meetings with the key stakeholders (authorities of federal, regional and municipal level), and later with other stakeholders. The number of stakeholders was quite flexible and differed from the number set in the beginning of the project. In the Polish case study, it was decided to work only with the stakeholders from the regional and local level. The Swedish case started from an empty table by identifying stakeholders and sending out a questionnaire to the different stakeholders.

The water authorities of Danish, Finnish and German case studies made a re-analysis of the already known stakeholders from previous cooperation and found some new cooperation models for water management. The Danish legislation demands less public participation than was used in the Odense Fjord Project. Cooperation was carried out through the establishment a *National Scientific Board, a Regional Political Board and a Local Technical Advisory Board.* In Schleswig-Holstein (GER), stakeholders have been identified by the water authorities in general. The re-analysis was done within the regional working groups lead by *the water boards* to ensure that no stakeholder organization was forgotten. In the Finnish case study, the re-analysis of stakeholder structures deepened the collaboration with the stakeholders in *the Kyrönjoki Working Group*. At the same time, some new organizations were included in the co-operation and *a new task* group was founded for preparing the preliminary program of measures.

CONCLUSIONS OF IDENTIFICATION:

A) Stakeholder Analysis

- **a stakeholder analysis or a re-analysis of the stakeholder groups can be an useful method**
- **dividing the stakeholders into different categories and levels might be difficult**
- **the number of stakeholders and their roles can vary during the co-operation process**

B) Participation Plan

- **a written participation plan was an useful tool**
- **the public participation strategies need to be flexible to get all stakeholders involved several channels, tools and information packages are needed**

Some general conclusions can be drawn from the identification process. A stakeholder analysis is a very useful method to identify stakeholders at the very beginning of the process if there is no earlier co-operation with stakeholders. This method was used in the Polish and the Swedish case studies. On the other hand a re-analysis can be valuable if the stakeholders are already known. A conclusion from the Danish, Finnish and German case studies is that public participation should be built on previous experience whenever it is possible. According to the Estonian case study it is useful to use existing stakeholder databases.

It must be kept in mind that the number of stakeholders is flexible and that their roles may vary from the ones set at the beginning of the project and may vary regionally. The stakeholder analysis is still not unproblematic. In all case studies there were some problems, especially with the categorisation of the stakeholders according to their role and involvement. Through the identification process the water authority has striven to offer equal opportunities to all stakeholders.

A written and well-prepared participation plan was an essential tool for organizing the networking at regional and local level. There is a need for flexible public participation strategies due of the differences in the national traditions in administrative backgrounds and practices. It is necessary to get all stakeholders involved from the beginning of the process. According to all case studies different channels and tools of communication and different information packages are needed to reach stakeholders in especially and public in generally. In the Estonian case study local newspapers were an effective information tools at the local level. In the Schleswig-Holstein case study all available tools of information fulfilled the duties of water authorities on public participation.

7.4 Networking

Public participation and especially networking is an important element in the preparation of a water management plan. For example, in the Polish and Estonian cases a lot of experience was gained during the networking processes, although there were different ways to involve stakeholders. In the Estonian case, *seminars* were a very useful way to change information and give feedback between local stakeholders and co-ordinators due to interaction. It was considered important that the public and interest groups were involved from the beginning of the process. Involving pupils and students promoted effectively the networking phase. In the Polish case, *an open water* forum was an opportunity to create an informal body for stakeholders. Polish state authorities have prepared national strategic guidelines for public participation and the national strategy will support the implementation work of water authorities at regional and local level. Participation plan can also be changed if necessary during the networking process.

In Sweden the authorities in the case study area were rather skeptical in the beginning of the process because the reactions of the stakeholders were not yet known. The experience showed that stakeholders were afraid of the requirements of new directives and legislation. As in many of the cases, the networking process gave a broader view of water management but the process itself took time. A warming up period is often needed to get public involved in the process. On the other hand, there is also the risk of public participation burning out when there are too many participation processes going on. A cure for this is that the stakeholders are given true power to influence the process and the case. The experience showed that the networking process must be addressed to both brain and heart. To get a deeper understanding and motivation to the process, the stakeholders can be invited to excursions and field studies to the area in question. The process will fail if stakeholders have no possibility to influence the environmental objectives and program of measures. *Dialogue groups* and the *Formation of A Working Group* will be organized in the end of 2005 on the Swedish case study area.

During the Finnish case study, the degree of involvement of the stakeholders has changed from loose cooperation towards more active involvement and shared decision making in the *Advisory board of Kyrönjoki* and the *Kyrönjoki Working Group. The Task Group for the Program of Measures* was established and it was a new way to commit stakeholders to the participation process. According to the Finnish experience, public participation strategies require flexibility and combination of several participation techniques. For example NGOs are often interested in environmental issues but their possibilities to participate in meetings are limited due to limited resources.

The water authority in the Danish case used new co-operation methods by creating *three advisory boards.* The Odense Fjord pilot project can be seen as a training ground for the future participation processes in water management in Denmark. Experience showed that competence and mandate of the stakeholders and objectives of a working group should be clear from the beginning of networking process. Stakeholder meetings give an opportunity to create an understanding of others' views and opinions on important environmental issues. According to the Danish experience, stakeholders have very different possibilities in the participation process. Some strong stakeholder organisations influenced the networking process strongly, whereas (economically) weaker stakeholders must make alliances in order to ensure their common interests. The networking process reflected a battle of right of use the catchment amongst the stakeholders.

The participation process of the Schleswig-Holstein case was implemented during the early phase of the Basic Description. The positive feedback from the stakeholders and from all the political parties has indicated that the networking methods and tools were right in German circumstances. The system had not too many problems with the process of integration and co-operation within the working groups. The round table system that was used allowed a discussion of problems with the right persons involved at the right level and at the right time. In Schleswig-Holstein case, *the water boards* are playing a key role in the implementation process. Participation in water management has been established on the ideas of open planning process and the bottom up approach has given the stakeholders a real feeling that each of them is a real partner in the process.

Conclusions of Networking

- clear mandates and work methods make the process easier for all partners
- using of existing groups is useful
- usually state authorities are core actors but NGO's can also have a central role
- mutual trust and networking is promoted by joint meeting with all stakeholders involved
- public participation and networking requires resources from all parties involved
- different stakeholders and interest groups have different opportunities to participate

Several conclusions can be drawn up from the case studies concerning networking process. The case studies agreed on the prerequisites that competence and work methods were clear in the beginning of the process. In the networking processes, there is a need for several participation techniques because local practices in management issues vary due to the historical and cultural factors. EU legislation on Public participation states the guidelines, but let the case studies find their own solutions getting stakeholders involved in the water management process. Working with already existing groups seemed to make networking easier and promoting mutual trust and commitment. However, NGO's had important roles in region where old co-operation structures are lacking. From the Estonian experience it seemed useful to involve the organizations of the third sector in promoting public participation in areas where there are no previous co-operation structures.

According to almost all case studies the problematic issue in water management is that resources are insufficient. According to the Nordic case studies there is lack of mainly financial resources, whereas according to the Estonian and Polish case studies there are lack of both financial and human resources. Resources are needed both from authorities and other participants. For example lack of experienced specialists and authorities and shortage of financial resources usually hinder consultation with public and the implementation process. The Schleswig-Holstein case study was an exception because the water boards are supported and funded by the state authorities. There are several systems to finance water boards with a contract between River Basin Authority and each River Basin Water Board. From the experience of the several case studies the stakeholders have the same opportunities to participate in the meetings. The degree of participation depends on human and financial resources of each stakeholder, and therefore not all stakeholder groups have had the opportunity to participate equally. Nevertheless the different stakeholders groups are interested in water management and have indicated a wish to influence the work.

7. 5 Acceptance

Acceptance is the most important and challenging part of public participation processes. Acceptance of i.e. environmental objectives is not always achieved or even expected. In the case studies the preparation of the Water Management Plan took more time than expected, which led to the fact that the time for the acceptance process was quite limited. Therefore not all possible problems may yet have shown themselves within the project time in the BERNET case studies. Experience still show that an open dialogue between the conflicting parties can broaden the understanding of different views among stakeholders.

According to experiences from Fyn County a political decision from the authorities is necessary at some point since you can't expect complete acceptance to proposals. Although consensus amongst stakeholders could not be expected, it was possible to achieve acceptance of opinions through an open dialogue and participation. The Danish water authority evaluated that the work within the advisory boards proceeded well although consensus was not achieved to a satisfactory degree. The reason for this was that it took more time and resources than reserved to reach consensus in central issues. For this reason it is necessary to define objectives and standards for the meetings in order to succeed in the process. The experiences from the project will be used in future planning in Denmark although the project will not be continued.

According to Finnish legislation the Water Management Plan is a political paper accepted by the State Council. This document is binding the authorities but not the stakeholders. According to the West Finland Regional Environment Centre, there were not a lot of conflicts in the acceptance process in the Finnish case study. Environmental objectives were accepted among stakeholders but an open dialogue was needed. The discussion on the program of measures will continue after the pilot project. The need for economical resources and a slow impact of measures are challenges of the acceptance phase even in the future. According to the water authorities in the case study the broad cooperation with the interest groups prolonged the process but at the same time it increased the possibility of participation for the central stakeholders and the communication between the partners.

In the Schleswig-Holstein case study the acceptance process has dealt only with parts of the Water Management Plan. So far the acceptance process has been successful. The main interests have been to gain a broad understanding for water management in general and the implementation of the WFD in particular. The Water Management plan is concentrated on morphological changes and problems of the water district. According to the responsible water authorities their system seemed to meet the optimum with respect to costs, efforts and profit at this stage of the process. The working climate was described as constructive and fair.

Also Swedish, Polish and Russian case studies indicate that there is a need for clear and understandable environmental objectives that are possible to obtain in the foreseeable future. Otherwise there is a danger that goals will only remain on paper and that public participation may become formal informative events without actual impact. For example Polish experience emphasises that the goals and the possible influence of the stakeholders should be clear. Swedish experience emphasises also that the public participation process makes the stakeholders aware of their influence and responsibility in the process.

According to Estonian case study the transmission of information to local organizations and stakeholders prolonged the networking and acceptance process but at the same time, it was a good opportunity to make stakeholders aware that "it is my plan". This awareness is very important for the acceptance. In the networking process the role of the coordinating NGO (Peipsi CTC) has been important in the Estonian case study. When the WFD implementation in Estonia proceeds the state authorities will get more experience and the official role of Peipsi CTC will diminish.

Conclusions of Acceptance

- defined and reachable aims promote the acceptance process
- an open dialogue is a prerequisite for an acceptance
- the impact of measures and the economical consequences influence the process
- if acceptance is not reached by negotiations a political decision is needed

There are several conclusions of the acceptance process in the case studies. First of all, it is important to present clear and understandable environmental objectives which are possible to obtain in the near future. This point of view was important to the Swedish and Polish case studies there are in the beginning of the networking process. According to the other case studies the reachable aims make the acceptance process easier, but final goals must be presented. An open dialogue during the stakeholders meetings is necessary to achieve acceptance of opinions but sometimes there is a need for political decisions to support proposals from the authorities. For example according to the Danish experience the Local Technical Board supported the political decisions.

Historically economical consequences seemed to influence acceptance process in all cases. For example the consequences of the measures and their impacts influence the acceptance process. According to the Finnish experience measures with slow impact on the environmental state affects the acceptance processes. Negative results often decrease the participation activity among stakeholders.

The experiences of the case studies are valuable for future water management planning processes although only some problems were met during the project due to the limited timetable. The participants are conscious of the fact that enough time and resources are needed for preparing water management plans and receiving consensus.

However, the case studies have shown that the acceptance process is a significant mutual learning process. The authorities learn to prepare information for target groups, and stakeholder groups learn about the work of authorities during the process. This interaction is essential for the whole process, and it is also a good starting point for further planning. The three stages of the process with the identification of the stakeholders, networking and the acceptance process are the key factors to a successful water management plan in future.

7.6 Conclusions

The first step of public participation was headlined "Identification". A stakeholder analysis was a good starting point in areas with little previous experience in cooperation with local stakeholders. Even in areas with long cooperation traditions with local stakeholders the re-analysis of the stakeholders gave some valuable information. In all stakeholder analyses there were some practical problems with the roles of the stakeholders due to their multiple roles throughout the water management process.

A public participation plan in written form was a useful tool for organising the "Networking"-phase. Existing groups or cooperation structures accelerated the networking between the parties involved because of commitment and mutual trust. One stimulating factor in the cooperation seemed to be that the participants have learned each others working methods from previous cooperation. This was especially the case in the Danish, Finnish and Schleswig-Holstein case studies. The authorities had also learned to prepare the information to different target groups, and the stakeholder groups had experience from water management processes from before.

Active participation of stakeholders is a prerequisite for a good implementation of the WFD but even a more important factor is to improve the decision-making so that the decisions are made together by all actors involved and all stakeholders equally. In the case studies there were differences in the stakeholders´ power to influence. In the Schleswig-Holstein case and in the Nordic countries the stakeholders had a more powerful position in the participation process, or at least they were more visible throughout the water planning process. Strong stakeholders with economical resources had more possibilities to participate and influence the process, than smaller stakeholder groups with limited resources.

In the networking process the objective and the competence of the cooperation groups should be clearly defined from the beginning. In the case studies it was also evident, that there can be problems with the implementation as the participation work need more time and resources than is often allocated. Lack of experience and a shortage of both financial and human resource reduce the possibilities for both stakeholders and authorities to consult and cooperate. A weak interest in environmental issues also hampers the consultation and cooperation. In areas with serious environmental problems and with clear conflict between stakeholder groups these issues are of outmost importance.

"Acceptance" is the most important and challenging part of public participation processes. Not in all cases acceptance is achieved or even expected. Experience has shown that an open dialogue between the conflicting parties can broaden the understanding of different views among stakeholders. Consensus is a valuable factor in proceeding water management and helps finding solutions in complicated issues. A way to increase the commitment between the stakeholders and authorities is to include the main stakeholders in the preparing of the program. The case studies have verified that the successful cooperation and participation requires involvement of all main stakeholders and that they are offered equal possibilities to influence the process and its results. When acceptance is not achieved a political decision is needed. In the end responsibility for a final decision lies with the water authority.

A timetable and planning are very important factors in public participation. Different methods can and should be used in involving stakeholders to active networking in water management. Different channels and information tools are needed to reach the large range of stakeholders and to meet their special needs and interests. In the case studies, the information was delivered in various ways to the public in general, and to the stakeholders especially. The broad package of tools gave usually a good result.

National strategies to support on public participation and governing practices varied between the BERNET-countries from quite centralised to decentralised management strategies. For example in Poland the Ministry of Environment has done national strategies and practical action plans for the involvement of the public. In Estonian case the local NGO produced a strategic document on public participation to coordinate their activities in the process of public involvement. In the absence of national guidelines, other acts and previous experience were used as a guide in the planning processes e.g. Denmark, Sweden, Russia and Finland. The cases showed that it is important to have flexible public participation strategies due to the differences in historical and cultural backgrounds of the countries. The main factors influencing public participation during the case studies are shown in Figure 7.2.

Figure 7.2
Main factors influencing public participation of water management

Generally, dialogue is necessary between authorities, stakeholders and the general public from the very beginning of the participation process. Experiences from the project shows that public participation will not succeed if only article 14 of the WDF is implemented in national legislation. Authorities have several duties in implementation of the WFD e.g. to create open discussion forums, to answer the questions of stakeholders and to receive feedback and critics from the participants. Instead of a traditional informative role from top to down, the authorities within the WFD should have a more participatory way of action with stakeholders and general public.

Conclusions of public participation are shown in the Factbox.

Members of the Bernet Catch Project dealing with Public Participation. Photo: Vincent Westberg.

Conclusions of public participation

1) Identification

1.a Stakeholder Analysis

- **a Stakeholder Analysis is a useful method in to identify the stakeholders**
- **a Re-analysis of the Stakeholder Groups can be useful in areas with long term co-operation**
- **the number of stakeholders and their roles vary during the co-operation process**

1.b Participation Plan

- **a written participation plan is an useful tool for organising the networking**
- **the participation strategy needs to be flexible due to the differences in local practices**
- **several channels, tools and information packages are needed to reach the stakeholders**

2) Networking

- **clear mandates and work methods make the networking easier for all partners**
- **it is necessary to get stakeholders involved from the beginning of the process**
- **networking requires resources from all parties involved**
- **mutual trust and networking is promoted by joint meetings**

3) Acceptance

- **an open dialogue is a prerequisite for an acceptance process**
- **reachable aims makes the acceptance process easier**
- **the consequences of the program of measures influences the acceptance**
- **if acceptance is not reached by negotiations a political decision is needed**

As shown there is no exact way of involving the public in water managing planning. The exchange of experience between regions has broadened the horizon as how to approach public participation.

After some years it would be of interest to see how the preliminary Water Management Plans and acceptance policies has proceeded in the case study areas and how the cooperation process is working in practice.

8. Water management planning in the partner regions and the states

8.1 The principles of the WFD

In the EU, problems associated to deterioration and eutrophication of both fresh and marine waters, have caused increasing concern for many years. Legally binding directives have been issued to be implemented in the member countries since 1976. Through the last decade, decreases in discharges, resulting from improved waste water treatment, is reflected in generally improving conditions in rivers, lakes and coastal water quality, in terms of organic matter and phosphorus, while nitrate levels have remained relatively constant. The nitrate levels are significantly lower in the new EU member states, reflecting the less intensive agricultural production compared to the old member states (European Environmental Agency, 2003).

The purpose of the EU Water Framework Directive (WFD), approved in December 2000, and transposed into national legislation in 2003, is to protect all types of water - streams, lakes, brackish (estuaries) and coastal waters and ground water - as well as terrestrial ecosystems (regarding the demand for water) that are directly dependent on aquatic ecosystems from further deterioration, and to improve the quality of these ecosystems. The directive aims at a sustainable use of water resources, and at an extensive protection and improvement of the aquatic environment through specified reductions of emissions, including prioritised substances and prioritised, hazardous substances. Further, it should contribute to diminish the effects of spates and drought.

The quality of aquatic systems (streams, lakes, brackish and marine waters) is described by biological variables supplemented by hydrological and chemical characteristics. The definition of reference conditions and of the 'good ecological quality' that all water bodies should attain before the end of 2015, is a crucial theme. Based on the experiences and input from the member states, the EU Commission will issue a general guidance in 2006 on how to set reference conditions and define borders of ecological status classes, in order to assure a common standard and understanding of "good ecological quality" to be set EU-wide.

The directive presuppose planning for aquatic districts, each defined as a land and marine area including one or more catchments and the matching ground and coastal water. Each member state is committed to analyse the characteristics of each aquatic district, including the human impact on the aquatic environment, and to register all areas that needs protection and that are dependent on water. Further, the state is committed to provide an action programme - an 'Aquatic District Plan' - for its own aquatic districts. This plan must contain certain minimum measures on the protection of water, according to the EU legislation, but also more extensive ones where needed to attain "good ecological status" in 2015. The plan may be supplemented by more detailed programmes for catchments, sectors, problems or type of water, but must be provided within 9 years and fully implemented within 12 years from the year 2000.

The directive especially stresses the importance of the public taking part in the preparation, revision and in carrying out the aquatic district plans.

The directive especially focuses on:

- Integrated management of river basin districts, including surface waters, groundwater and wetlands.
- All pressures have to be addressed, whether physical, nutritional or hazardous substances.
- Establishing reference conditions; the reference conditions correspond to the "high ecological status" which must show no, or only very minor, evidence of distortion from undisturbed conditions for the type.
- Definition of the ecological status of surface waters based on biological variables, as benthic algae and macrophytes, phytoplankton, and bentic macroinvertebrates, and for fresh waters and transitional waters also fish.
- The aims of attaining Good Ecological Status (GES) for surface waters and good status for ground

water should be fulfilled before the end of 2015, unless special circumstances are documented.
- to ensure the participation of the general public

These new principles deviate from the former water management planning systems in most of the BERNET catch partner regions, and from the former principles of water protection of the EU, where specific pollutants and certain problems have been addressed 'one by one'. Thus, the implementation of the WFD requires new ways of planning in all the Bernet Partner regions. The need of integrated management is further emphasized, because several directives aiming at protecting specific areas, as e.g the Habitats- and Bird protection directives, are encompassed by the WFD, see Annex 2.1.

8.2 Strategies in the partner regions

Integrated management

The important Water Framework Directive principle of integrated management of river basin districts is a challenge for many of the Baltic Sea regions, where focus till now has been on specific environmental problems, and on addressing specific pressures or sectors, often leaving other important pressures out of the management plans. In Denmark, e.g, the regional water planning was designed to handle point sources and, thus, primarily planning for wastewater treatments plants, while diffuse sources including leakage of nutrients from agricultural practices till now have been regulated by the state. In West Finland, e.g., the regulation has been focussed on acidification and phosphorus outlets, while reduction of nitrogen is not included in the management plans. Cost-efficient measures to reduce the total nutrient outlet to the aquatic environment were thus often hampered by the non-integrative nature of the water management planning.

A main recommendation of the first BERNET project was to develop and implement Regional Action Plans at catchment level, in order to implement a sustainable nutrient management in the Baltic Sea Region. This recommendation thus formed a pre-strategy for implementation of the EU Water Framework Directive in the Baltic Sea Region, and at the same time it was a regional approach on fulfilment of the Helsinki Convention. By the transposition of the Water Framework Directive into national legislation, focus was set even more on the development of integrated management in all member states. The experiences gained through the first BERNET project thus pointed to this integration, thereby facilitating the implementation of the Water Framework Directive in the BERNET Catch regions.

There is still an urgent need, however, to strengthen the integrated management strategy in the BERNET Catch regions, in order to elucidate all important pressures on the aquatic environment, and develop efficient and coherent strategies to handle these pressures in a cost-efficient way.

Development of an integrated approach to achieve compliance with any standard or objectives for areas protected by other directives, especially the habitats and Bird Protection directives, is also an important challenge to the future management.

Integrated protection of water and nature is an essential part of the Water Framework DirectiveFD. Large parts of the Kvarken area in West Finland are encompassed by both the Water Framework Directive and Natura-2000-protection. Photo: Stig Pedersen, Fyn County.

A fixed time schedule

The "good ecological quality" as defined in the WFD has to be fulfilled in 2015 at the latest, unless special circumstances are documented by the member state to the EU commission. If documentation is sufficient, a prolongation of maximum 2 x 6 years may be allowed. The programme of measures necessary to reach this goal should be established by 2009, and all the measures should be made operational in 2012 (WFD art.11).

Although many of the BERNET regions since the 1970ies have developed planning systems using quality criteria for the aquatic environment, the principle of fixed time schedules has not been commonly in use.

It is thus a new challenge to actually reach the defined goals in due time before the end of 2015. The focus is hereby set on the time schedule for implementation of actions to reduce the man-made pressures of the aquatic environment, by 2009 at latest. All experiences from the former planning systems point to the importance of an early planning process and onset of the programmes of measures, as this is a matter of negotiation and in the end formal decision between many partners, including stakeholders as well as several levels of authorities, from state level to municipal levels in all BERNET regions. Three years later, all the measures should be made operational, which is a matter of large investments in wastewater treatment plants, construction of wetlands, reconstruction of natural river courses, and changing of agricultural practices in due time to reach the necessary reductions of pressures and subsequently the GES in the water bodies. The time schedule of the WFD is thus quite tight, and demands a precise allocation of the resources necessary to reach the defined aims of the WFD.

Removal of physical obstructions in rivers, in order to allow undisturbed migration of aquatic organisms will be an important and expensive task to solve before 2015. Laahema National Park, Estonia. Photo: Stig Pedersen, Fyn County.

Reference conditions and classification

Defining reference conditions and matching classification systems, and subsequently performing a risk analysis based on this template has been a matter of thorough discussion, not only in the Baltic Sea regions, but in all EU Member States. The EU Common Implementation Strategy for the Water framework directive thus includes development of a boundary setting protocol for the intercalibration of reference conditions and class boundaries (EU-CIS 2005).

As human impact on the aquatic environment is so widespread and severe in the EU, only few water systems may show true reference conditions, and construction of reference conditions based on modelling, historical data and expert judgement is difficult. The classification of the water bodies in high, good or moderate ecological status is based on the reference conditions. Thus, the level of reference conditions is crucial to the later analysis of how much the pressures will have to be reduced to fulfil “Good Ecological Status. In most Baltic Sea regions, there has been a tendency to define reference conditions and the subsequent classification in the light of what is judged to be politically possible, and not as true, naturally based reference conditions, see e.g chapter 5, where the Danish principles for risk assessment is described.

The marine areas in the Baltic Sea region may still show a very diverse submerged vegetation in less polluted areas, as in the central part of the South Fyn Archipelago in Denmark. Characeans, rooted macrophytes, and Bladderwrack are all represented in the same area. The archipelago is designated as a Natura 2000-area under the Habitats- and Bird protection directives. Photo: Nanna Rask, Fyn County.

Treatment of sewage from scattered houses is an important issue in many of the BERNET- Catch regions. Development of small treatment plants for the single houses in the countryside is going on. Photo: Stig Pedersen, Fyn County.

Quantitative quality criteria

The quantitative definition of ecological status and the focus on biological quality elements (plant- and animal life) is another quite new and challenging issue for at least some of the surface water types. The hydro-morphological and physic-chemical quality elements (water regime, nutrient and oxygen content etc) are defined as supporting quality elements, and their main role is to ensure the functioning of the ecosystem.

Biologically based indices have been used only in watercourses and streams in most Baltic Sea regions, and the chemical water quality has been the base of defining whether the aims were fulfilled or not for the other kinds of surface waters. Development of quantitative evaluation systems for all surface water categories based on biological quality elements is thus a challenging task for all the Baltic Sea regions.

Linkages between pressures and biological variables

Linkages between the biological variables and the pressures are necessary to establish so that the effect of pressure reduction can be prejudiced. Linkages have to some extent been developed between pressures and chemical water quality, but have only been developed for very few biological variables; e.g the relation developed for Odense Fjord between N-load and biomass of sea lettuce and depth limit of eelgrass (chapter 6). Development of such instruments are crucial to fulfil the aim of the WFD, where the ecological quality of the water body, as defined primarily by biological quality elements and quantitative class boundaries, should be the basic of calculating the necessary reduction of man-made pressures.

Waste water treatment

Waste water from households constitutes a major nutrient source, and biological waste water treatment with subsequent nutrient removal is indispensable in order to reduce eutrophication problems and achieve a good water quality of the adjacent waters. Thus, a significant improvement of the water quality has been achieved in both fresh water bodies and coastal waters with a major impact from urban waste water after the establishment of waste water treatment with nutrient removal. Waste water treatment is carried out at different levels in the BERNET Catch Regions leading to highly different loading from waste water in the aquatic environment. Although there are significant differences in the waste water treatment at present, full treatment procedures with both phosphorus and nitrogen removal is implemented or planned to be established in all major urban areas in the BERNET Catch regions.

Analysis carried out by the BERNET Catch regions have demonstrated a continued strong need for investments in sewer systems and treatment facilities in all the Regions - most pronounced in the new EU regions, but also an important issue in the old EU-regions, where waste water from scattered settlements and storm water outfall is still a challenging problem.

Scenarios of nutrient loss

The agricultural sector handles a major part of the nutrients used in our regions, and the high environmental costs of an intensive agricultural production are seen today particularly in Schleswig-Holstein, Fyn County, and the coastal farmland of Laholm Bay and West Finland. The agricultural production is less intensive in the new EU regions at present, but is expected to develop towards a more intensive production in the coming years. Adapting the Western European farming practices in these regions will significantly increase the nutrient load to the Baltic Sea, and lead to escalating eutrophication problems in wetlands, as well as in fresh waters and the marine environment.

In view of the uncertainty as to the future level of agricultural intensity, BERNET operates with two scenarios for the impact of harmonization of nitrogen loss from farmland within the Baltic Sea catchment.

Scenario 1

If nitrogen loss from all farmland in the Baltic Sea catchment increased to the present high level in Denmark, total nitrogen loss to the Baltic Sea would probably increase by more than 50%.

Scenario 2

If nitrogen loss from all agricultural land in the Baltic Sea catchment was reduced to the present level in Poland, total nitrogen loss to the Baltic Sea would probably decrease by 10–25%.

The above scenarios show that if future nitrogen loading from the agricultural sector in the Baltic Sea catchment is solely regulated according to the rules currently applying to Danish agriculture, this would hinder fulfilment of the HELCOM goal of reducing nitrogen loading of the Baltic Sea and would conflict with the overall aim of the WFD.

It is therefore mandatory and a major challenge to the entire Baltic society to ensure converging development of on the one hand an increased agricultural production in the new EU regions based on sustainable principles in their best sense, and on the other hand a less intensified agricultural production in the old EU regions, likewise to a sustainable level. Along with this the BERNET Partners strongly recommend the new EU regions to preserve their wetlands and undisturbed physical conditions of streams and rivers, and the old EU regions to restore their aquatic environments and improve their natural assets.

Another major issue will be the proper regulation of the use of pesticides (and minimizing the loss to environment).

The BERNET-Catch-members visit a Danish pig farm. Protection suits are needed to avoid infections of the pigs. Photo: Stig Pedersen, Fyn County.

Linkage between WFD and the EU agricultural policy (CAP)

As agriculture is more and more recognized as a major pressure factor for the aquatic environment, the coordination between the implementation of the WFD and the common agricultural policy is a very important issue. Several initiatives have been taken to elucidate the coherence and antagonism of these two policy areas, and projects to explore this subject have been granted from the LIFE foundations.

Public participation

National strategies to support on public participation and governing practices varied between the Bernet-countries from quite centralised to decentralised management strategies. Timetable and planning are very important factors in public participation, and is

Public participation and stakeholder involvement is an essential part of the implementation process of the WFD, not least when negotiating how to restore wetlands. Photo: Stig Pedersen, Fyn County.

more resource- and time-consuming for the water authorities than often expected. Public consultation and participation is essential especially during the writing, review and updating of the water management plans which form the central theme of the Directive. For the public consultation to be meaningful people will need a basic understanding of the principal features of the Directive and how these relate to the situation in their own local river basin.

Consensus is a valuable factor in proceeding water management and helps finding solutions in complicated issues. A way to increase the commitment between the stakeholders and authorities is to include the main stakeholders in the preparing of the program. The case studies in the Bernet regions have verified that a successful cooperation and participation requires involvement of all main stakeholders and that they are offered equal possibilities to influence the process and its results. When acceptance is not achieved a political decision is needed. In the end responsibility for a final decision lies within the water authority.

The implementation of a sustainable water management in the Baltic Sea Region in accordance with the requirements of the Water Framework Directive, is thus a tremendous challenge. It will require that the entire society is fully informed on the causal relations and the necessary regulations and investments needed to assure a sound Baltic Sea Region environment to be passed on to future generations.

8.3. Conclusions

Management strategies

A main recommendation of the first BERNET project was to develop and implement Regional Action Plans at catchment level, in order to implement a sustainable nutrient management in the Baltic Sea Region. This recommendation thus formed a pre-strategy for implementation of the EU Water Framework Directive in the Baltic Sea Region, and at the same time it was a regional approach on fulfilment of the Helsinki Convention. By the transposition of the Water Framework Directive into national legislation, focus was set even more on the development of integrated management in all member states. The experiences gained through the first BERNET project thus pointed to this integration and thereby facilitating the implementation of the Water Framework Directive in the BERNET Catch regions.

Integration

- There is still an urgent need to strengthen the integrated management strategy in the BERNET Catch regions, in order to elucidate all important pressures on the aquatic environment, and develop efficient and coherent strategies to handle these pressures in a cost-efficient way.

Time schedule

- The time schedule of the WFD is very tight, and

The overall aim of the WFD is to protect and re-establish a well-functioning ecosystem in all categories of water bodies in the aquatic environment; e.g in the coastal zones of the Baltic Sea. Photo: Michael BoRasmussen, Bio/consult.

demands a precise allocation of the resources necessary to reach the defined aims of the WFD. An early planning process and onset of the programmes of measures is therefore of utmost importance, as this is a matter of negotiation and in the end formal decision between many partners, including stakeholders as well as several levels of authorities, from state level to municipal levels in all BERNET regions

Reference conditions

- The level of reference conditions is crucial to the later analysis of how much the pressures will have to be reduced to fulfil “Good Ecological Status. It is thus very important to establish ‘true’ reference conditions, reflecting pristine conditions, and not to define reference conditions with regard to what is judged to be politically possible.

Linkage of biological quality elements and pressures

- Linkages between the biological quality elements and the pressures are necessary to establish so that the effect of pressure reduction can be prejudiced.

Sewage

- Analysis carried out by the BERNET Catch regions have demonstrated a continued strong need for investments in sewer systems and treatment facilities in all the Regions - most pronounced in the new EU regions, but also an important issue in the old EU-regions, where waste water from scattered settlements and storm water outfall is still a challenging problem.

Physical restoration and wetlands

- The BERNET Partners strongly recommend the new EU regions to preserve their wetlands and undisturbed physical conditions of streams and rivers, and the old EU regions to restore their aquatic environments and improve their natural assets.

WFD and CAP (EU Agriculture Policy)

- It is mandatory and a major challenge to the entire Baltic society to ensure converging development of on the one hand an increased agricultural production in the new EU regions based on sustainable principles in their best sense, and on the other hand a less intensified agricultural production in the old EU regions, likewise to a sustainable level. Integration of WFD-implementation and CAP is thus very important.

Public Participation

A successfull paticipation and cooperation of stakeholders is a time - and resource consumming task, that reguires a high level of information on all issue related to Water Management planning and the offering of equal possibilities to influence the process and its results to all key stakeholders

More specifically the BERNET Catch – in order to combat the eutrophication problems – highlight the needs to:

- Ensure that all waste water from new developments as well as existing built up areas should be collected in sewer systems connected to treatment facilities
- Improve the sewage treatment facilities and sewer systems in the three eastern BERNET Regions (most pronounced in the Kaliningrad Region)
- Regulate agricultural activities on both catchment and farm level in order to reduce nutrient leaching and ammonia evaporation
- In areas – where relevant – to reduce nutrient emissions from forestry
- Protect existing wetlands by law and to restore reclaimed wetlands in order to decrease the nutrient load on coastal waters
- Combat acidification
- Restore streams and lakes from physical regulation wherever possible
- Secure enough resources for a successful paticipation and cooperation of main stakeholders

BERNET Work packages at work

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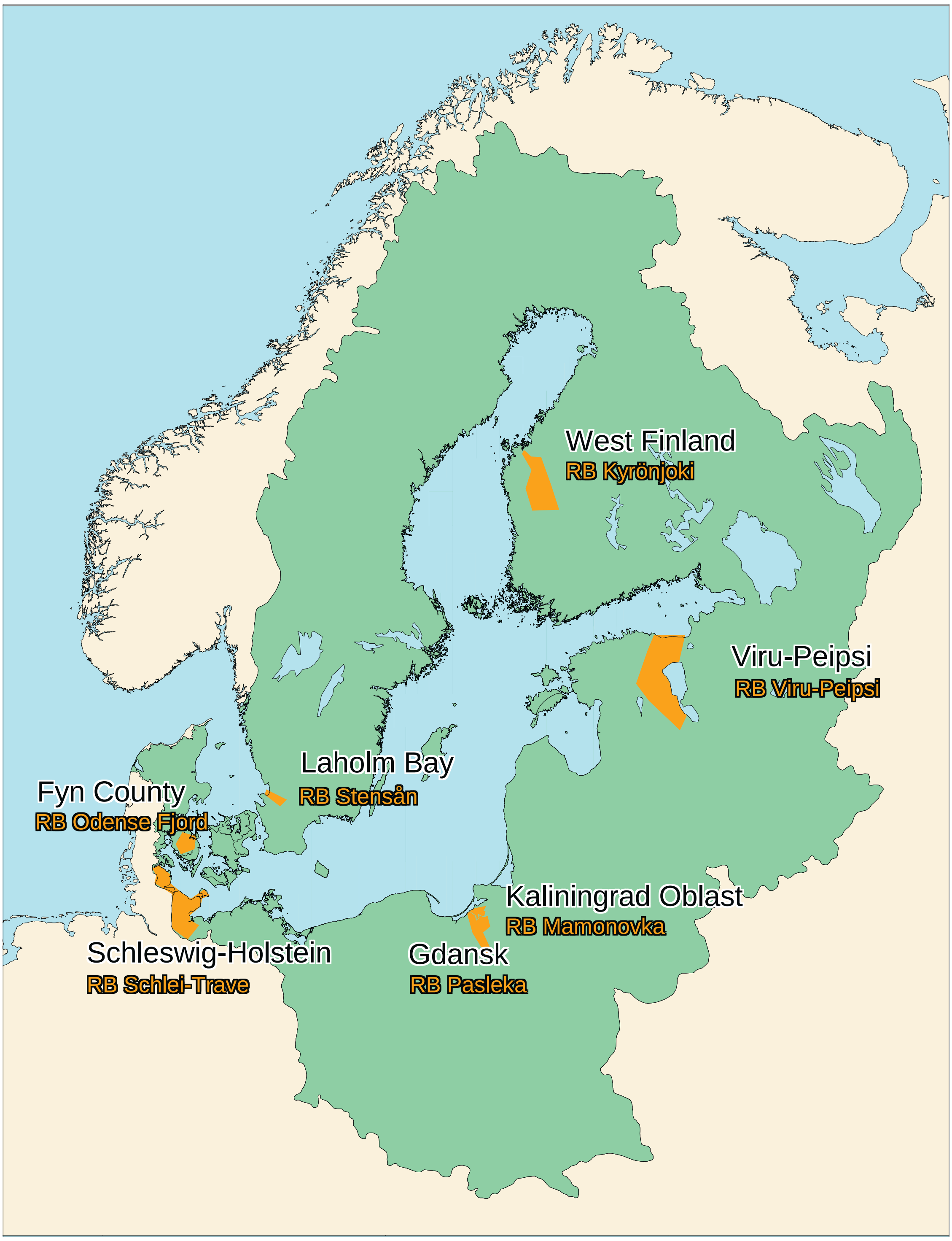
Annex I


West Finland
RB Kyrönjoki
Viru-Peipsi
RB Viru-Peipsi
Laholm Bay
RB Stensån
Fyn County
RB Odense Fjord
Kaliningrad Oblast
RB Mamonovka
Gdansk
RB Pasleka
Schleswig-Holstein
RB Schlei-Trave

BERNET pilot river basins


Schlei-Trave


Kyrönjoki


Stensån


Pasleka

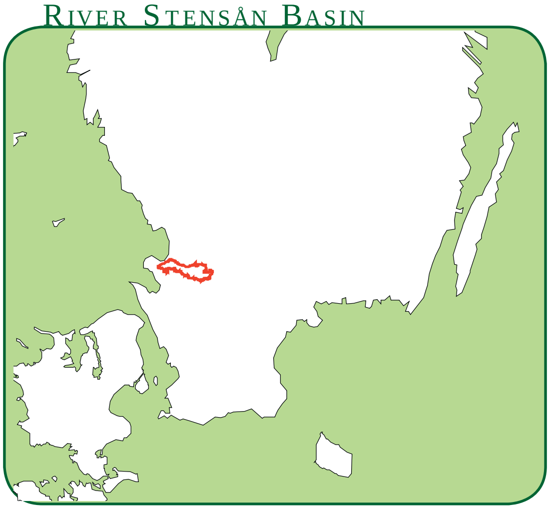

Odense Fjord

The Laholm Bay

The Laholm Bay, in the southwest of Sweden, is fairly shallow with a mean depth of only 12 meters. A well-defined halocline prevents saltier water from mixing easily with surface water, which makes this an area sensitive for eutrophication.

Eutrophication effects, resulting in massive macro-algae blooms were first observed in the 1970's. Since the 1980's the bay regularly experiences intensive phytoplankton blooms, and subsequent oxygen depletion in the bottom water. Nitrogen is regarded as the limiting nutrient for primary production in the Laholm Bay as well as in the open Kattegat. Although there has been a massive focus on the bay, many problems remain unsolved.

River Stensån Basin



The River Stensån basin

The River Stensån is the southernmost of the five rivers that drain the Laholm Bay basin. The river catchment area is approximately 284 km². Forest covers most of the basin (Figure V), except for the coastal plain where agriculture dominates. Fodder grain and grassland makes up 70 % of the arable land. Spring cereal is the dominating cop. Livestock amounts to 6.200 LU.

Characteristics	River Stensån basin	Laholm Bay basin
Basin area (km^2)	284	10 100
Population (inh.)	6500	118 000
Population density (inh./km^2)	23	12
Flow average (m^3/s)	4.5	130
Share of arable land (%)	26	12
Transport Nitrogen (ton)*	415**	4900
Phosphorus (ton)*	7.1**	113

*1972-2004
**Excluding WWTP

Nearly half of the population of 6.500 lives in rural areas.

The share of lakes is low, 1 % and only four lakes are larger than 25 ha.

The River Stensån holds genuine strains of salmon and trout, threatened species of large freshwater bivalves and a rich and diverse benthic fauna. The river is regulated only to a small extent, which is unusual in the region. Acidification of lakes and streams,

Land Use

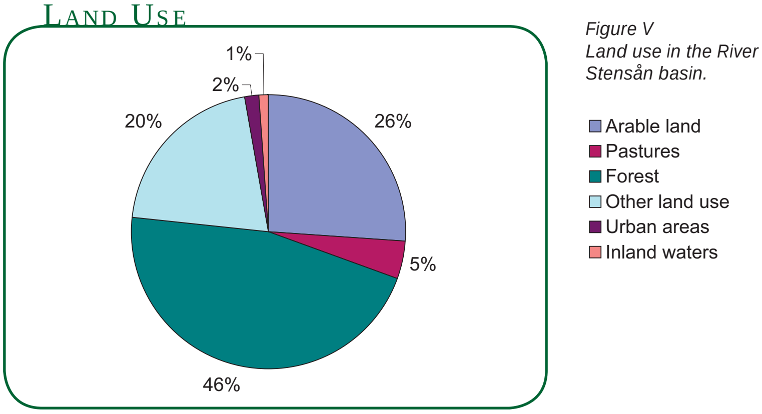
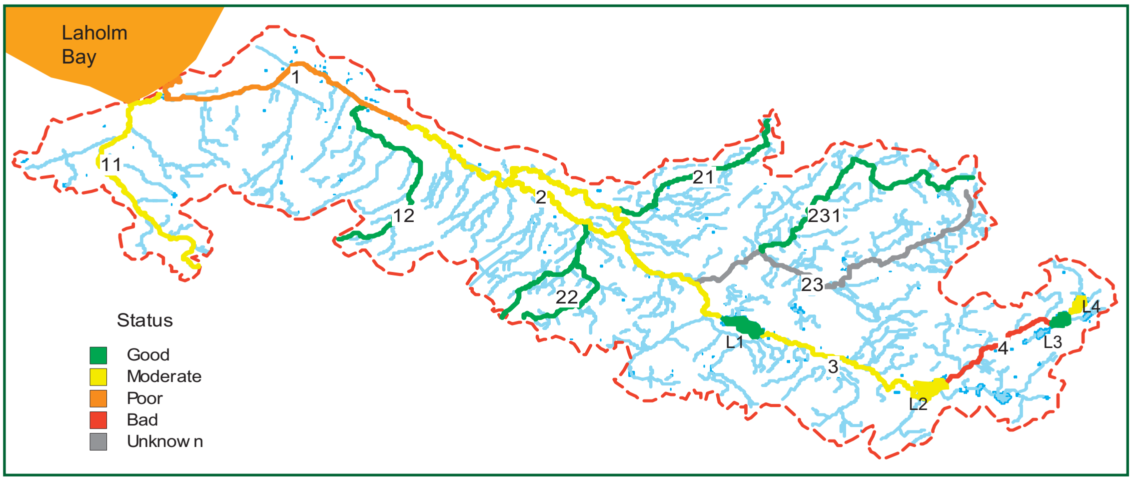


Figure V
Land use in the River Stensån basin.

Figure X
Preliminary status classification of the surface water bodies.



and eutrophication of the coastal waters are the two major environmental problems to deal with.

Environmental state of surface waters

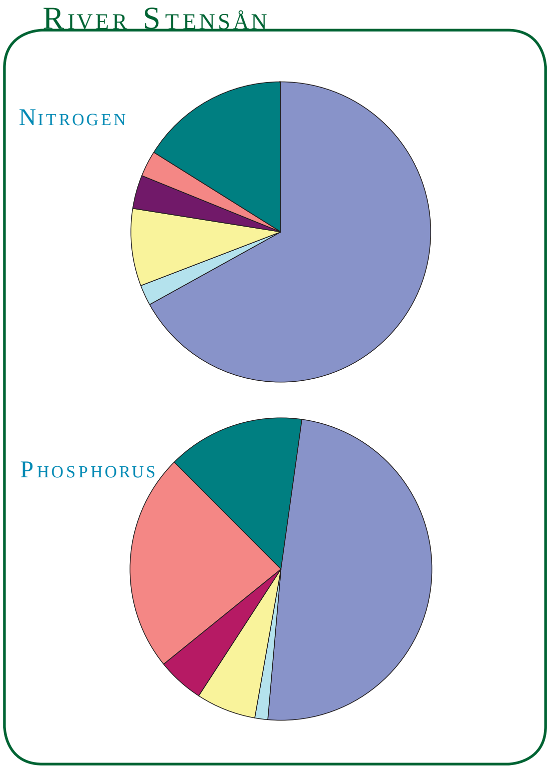
The preliminary assessment of ecological status (Figure X). indicate that four out of ten designated river water bodies fulfill Good Ecological Status (GES). However, all four river bodies of the main river course fail to fulfill GES. For one tributary stream, the status is unknown .The main pressures are eutrophication and physical modification in the lower section and acidification in the upper section.

Two out of four designated lakes fulfill GES. Acidification is the main pressure.

Eutrophication, caused by riverine nitrogen input, prevents the coastal waters from fulfilling GES.

Figure A
Sources of nitrogen and phosphorus in River Stensån basin (including natural background).

- Woodland
- Arable land
- Pasture
- Other land use
- Wastewater treatment plant
- Sparsely built-up areas



Sources of nutrients

Most of the nutrients derive from diffuse sources (Fig A). Agriculture is the main source, although it constitutes a minor part of the land use. The leakage is appox. 36 kg nitrogen per hectare arable land and 0.6 kg for phosphorus. Corresponding numbers for the forest is 5 kg N and 0.1 kg P.

There are no separate industrial discharges. Point sources contribute only to a minor part of the nutrient load.

Much effort has already been taken to reduce the losses of nutrients. The only wastewater treatment plant (WWTP) in the basin today removes 95 % of the phosphorus and 80 % of the nitrogen. Wastewater from the rural areas is treated in private establishments. An estimated 90 % of the establishments fulfill the legislated requirements.

Within agriculture numerous measures have been taken, e.g. regulation of crops, adoption of animal density, and use and storage of manure.

Despite all measures taken, there is still no decrease in the total nitrogen transport from the

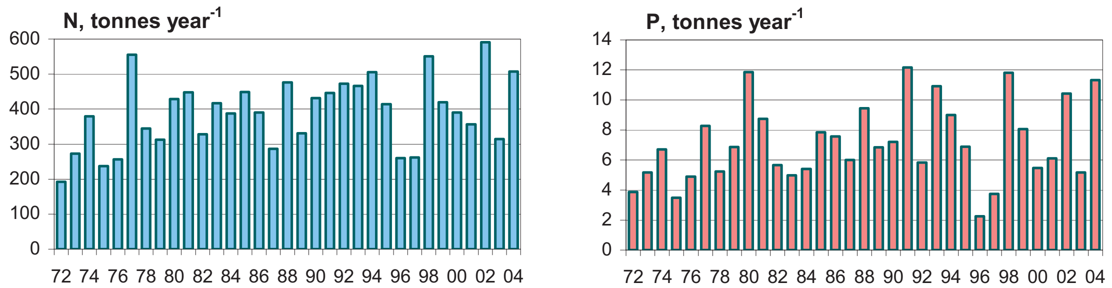


Figure B
Transport of nitrogen and phosphorus in the River Stensån 1972-2004.

Laholm Bay drainage basin as a whole. The main reason seems to be an increasing transport from forest areas (Figure Y).

Nutrient transports in River Stensån show great variability, mainly depending on flow conditions, and there is no obvious trend (Fig. B). According to flow adjusted nitrogen transport data, however, there seems to be a decreasing tendency since 1995, implying an 11 % reduction between 1995 and 2005 (Fig. C). The trend is not statistically significant.

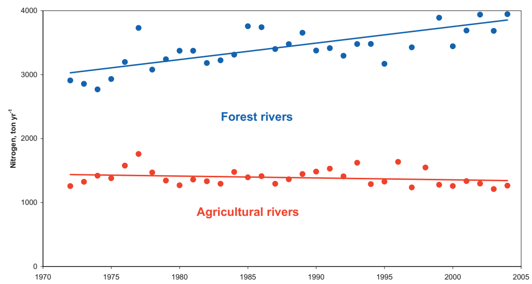


Figure Y
Flow adjusted nitrogen transport to the Laholm Bay divided on rivers dominated by forest and agriculture.

Acidification

Atmospheric deposition of sulphur and nitrogen is the main cause of the acidification problem. Deposition of sulphur has decreased markedly, while deposition of nitrogen is still at the same high level.

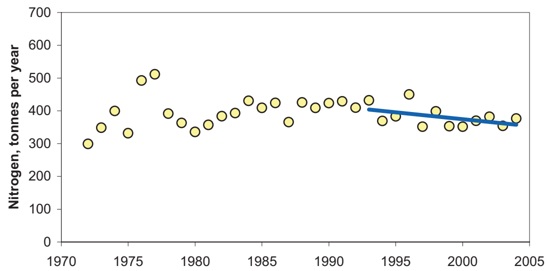


Figure C
Flow adjusted transport of nitrogen in the River Stensån 1972-2004. The line indicates linear trend 1993-2004.

Groundwater

Drinking water is supplied by two public waterworks in the basin. This groundwater is protected by a layer of clay. Although the nitrate level is somewhat enhanced, both the quantitative and chemical status has preliminary been regarded as good.

The population in the rural areas often abstracts their water from the top layers. Limit values for drinking water is here often exceeded.

Program of measures

The program of measures addresses:

- Reduction of nutrients (focus on nitrogen)
- Acidification
- Physical pressures

In this pilot project, the objective for nitrogen reduction has been based on existing national environmental objectives, which entail at least 30 % reduction of anthropogenic nitrogen compared with 1995 levels. Applied on River Stensån basin this means a reduction of 100 ton N.

The suggested measures to reduce nitrogen comprise existing measures, which should be possible to apply in a larger scale without essential economic consequences for the individual. There are also more advanced measures – yet possible – to enable us to reach the objective (Fig Z).

Cost calculations points out measures in the agriculture sector, e.g. catch crops, more effective use of manure, spring ploughing and wetland restoration, as the most cost-efficient. The single most efficient measure would be a large-scale restoration of the riverbed. Measures concerning wastewater, especially in sparsely built-up areas, are much more expansive.

The increased leakage from the forest areas stresses the importance of minimizing losses in connection with felling. A decreased deposition of nitrogen is also needed. Only a minor part stems from local discharges. We are therefore dependent on other regions to lower the emission to the atmosphere.

To counteract acidification, liming is carried out at three locations in the basin. Liming is an absolute condition e.g. for a viable salmon population. Watercourses not included in the liming program are left to recover on their own accord.

Measures to reduce the effect of physical pressures include removing barriers for migration, creation of buffer strips and minimizing the clearing in the watercourses. To avoid future problems, it is very important to carefully consider the aquatic environment in the local and regional planning process.

Figure Z.
Priority measure to reduce nitrogen pollution.

PRIORITY MEASURE TO REDUCE NITROGEN POLLUTION

Agriculture
- **Existing measures**
- **Catch crops**
- **Permanent buffer strips**
- **Spring ploughing of ley and grain crops**
- **Wetlands**
- **Tuning of agriculture practices**

More advanced measure
- **Regulated drainage**
- **Permanent fallow**
- **Adjustment of crop rotation**
- **Production of crops for biogas**
- **Wetlands – large-scale restoration of riverbed**

Forest
- **Leaving vegetation in the felling area**
- **Planting as soon as possible**
- **Leaving buffer strips along watercourses**
- **Increasing the amount of deciduous trees**
- **Lenient scarification**
- **Information and advice**
- **Decrease emissions to the atmosphere from traffic and livestock – decrease deposition**

Wastewater treatment plant
- **Post denitrification**

Wastewater from sparsely built-up areas
- **Compliance with legal requirements**

Pasleka Pilot River Basin – Poland

Characteristics of Pasleka river sub-basin

Pasleka is discharging into the Vistula Lagoon. It is the most significant river in the Vistula Lagoon basin district located in the eastern part of the Polish part of the basin district.

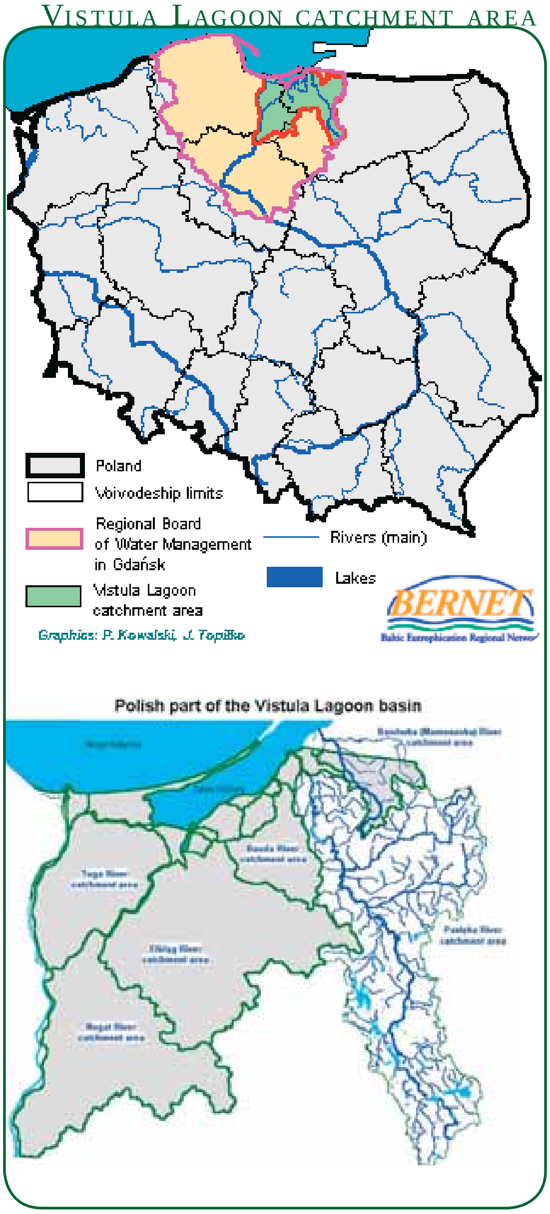
Vistula Lagoon is located in the southeastern part of the Baltic Sea, east of the Bay of Gdansk. It is separated by the Vistula Peninsula from the sea.

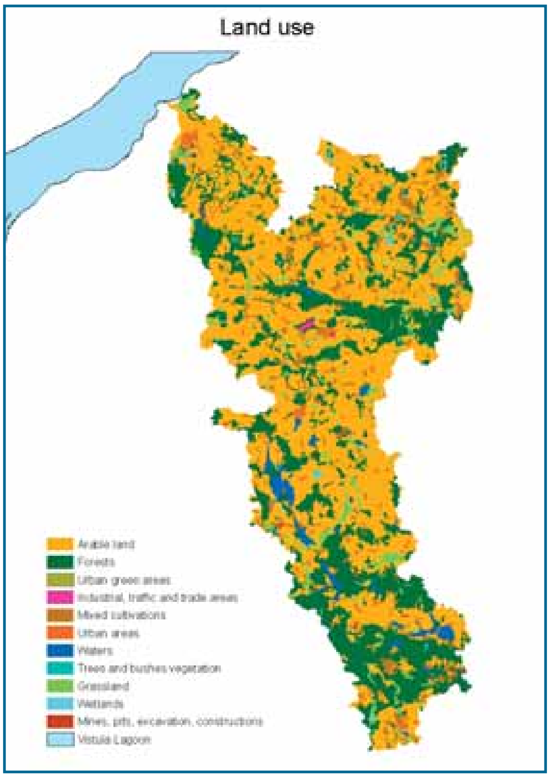
There are 170 lakes in the region with an area above 0.01 km^2. Most of lakes are located in the Pasleka and south part of Nogat sub-basins.

The total length of Pasleka river is 169 km and the area of the river basin is 2 294,5 km^2. It springs out from the Paslek lake located in the western part of the Masurian region at the altitude of 157 m. There are two main right-side tributaries: Walsza river and Drweca Warminska river. The river mouth is located in the middle of the Vistula Lagoon southern coast.

The whole Pasleka river and Pasleka river valley is designated as Natura 2000 bird and habitat protection sites.

VISTULA LAGOON CATCHMENT AREA





Population

The population of Pasleka river basin is some 78 000 inhabitants. The biggest town in the basin is Braniewo with nearly 18 900 people, then Orneta about 9 700 inhabitants and Olsztynek with some 7 800 inhabitants. The average population density is 34 persons per square km, and excluding the biggest municipalities from the considerations then the population in the countryside is 10/km^2 in the sub-basin.

Land use and activities in Pasleka river sub-basin

Most of the catchment is covered by arable land and forest. Some 55% of the total area is used for agricultural purposes, 31% for forest and 14% for other purposes. Grassland and forest dominate in the southern part of the catchment. The southern part of the basin is covered in 80% by forest located on sand formations.

Pasleka river sub-basin is not much intensively exploited or industrialised. This results from several reasons such as: the basin area belongs to the least inhabited ones in Poland; no specific heavy industry was developed there and the land is mainly used not intensively by farmers. There is also no heavy nor paper industry in the area. The only industrial activities are food production and farming.

Quality and environmental state of surface waters

On the basis of water quality monitoring in the Pasleka sub-basin in 2001 and 2002 it was established that the II class (related to the good ecological quality) is presented by the Pasleka river in two up-stream cross-sections and in one up-stream cross-section of Milakowka river. It is characteristic that the class threshold was mainly exceeded by concentration of total phosphorous - regarding the physico-chemical parameters. The sanitary status of rivers is very poor. The biological index of seston saprobity usually is located within II class except for cross-sections situated below Olsztynek (Jemiolowka river), Gietrzwałd (Gilwa river) and Milakowo (Milakowka river).

An overall assessment of the nutrient load, expressed in total nitrogen and total phosphorus, of the Pasleka river was presented in the final report of a project "Controlling Non-Point Pollution in Polish Catchments" (August 2003). The results are given in a table below.

In the Pasleka sub-basin the most of water bodies is not at risk (32 out of 41 water bodies). There are water bodies potentially at risk with lacking appropriate data to assess the risk (9 out of 41 water bodies - 9 due to point pressures and 4 due to water intakes).

Nov.1999 - Oct.2000	Total Nitrogen		Total phosphorus	
	Tons	mg/l	tons	mg/l
Total load*	1878	3,08	94	0,15
Point sources	161	0,26	27	0,04
Retention	250	0,41	2	0,00
Diffuse load	1967	3,23	69	0,11

*Total load out of catchment = Diffuse load + Point sources - Retention

Table 1
Overall result of the rough load assessment

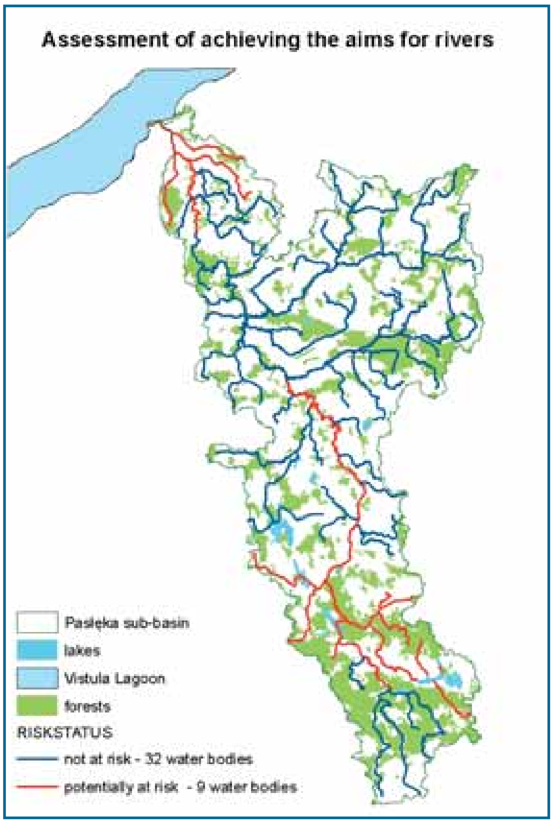
In the Pasleka sub-basin there are 14 lakes of an area over 50 ha:

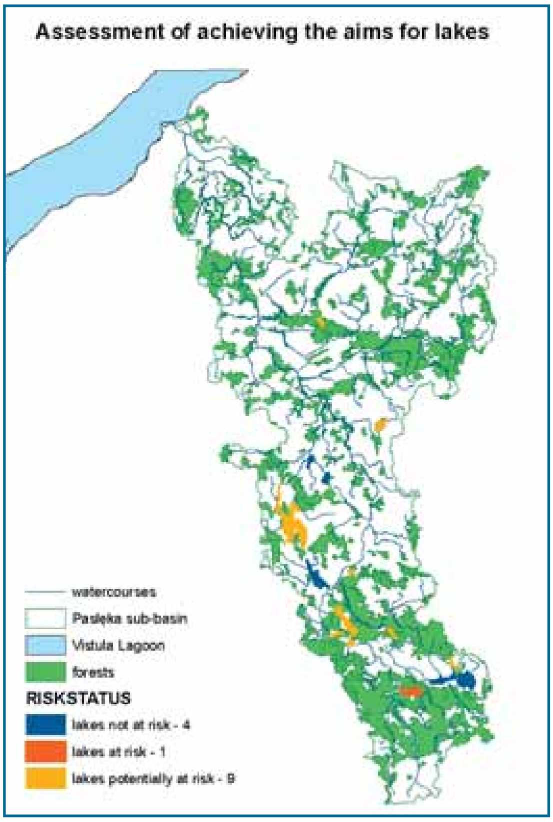
- 1 lake at risk of failing environmental objectives,
- 4 lakes meeting the environmental objectives by 2015,
- 9 lakes being at risk – because of insufficient data for the final risk assessment of failing the environmental objectives.

Sources of pollution

The present animal density calculated as Animal Unit per 1 ha of agricultural land (AU- an animal of 500 kg) is about 0,34 AU/ha. Most of the farms in the catchment are not equipped with manure pits nor urine or slurry tanks. Point sources from the farms lacking manure pits and storage tanks for natural fertilizers are serious sources of pollution to the water quality.

About 40-50% of the population in the Pasleka catchment is not connected to any sewage system. Most of the farms using the community water supply system have no sewage system.





PROGRAM OF MEASURES

POINT SOURCE POLLUTION

- Modernization and development until 2015 of wastewater treatment plants and sewerage systems in six agglomerations located in Pasleka river sub-basin of more than 2000 PE.
- Modernization and improvement of exploitation conditions of existing WWTPs in municipalities with population less than 2000 PE with simultaneous extension of sewerage systems.
- Individual wastewater treatment facilities in the rural scattered houses and farms where no common sewerage systems are cost effective due to long distances and difficult conditions.
- Proper handling of natural fertilizers by construction of manure pits and storage tanks.

NON-POINT POLLUTION

Agriculture

The most important actions must focus on the implementation of good agricultural practices – GAP and to make the basic rules obligatory for the farmers:

- Optimisation of manure and slurry utilisation according to distribution plans.
- Rules on fertilization periods for manure etc.
- Compulsory fertilisation planning.
- Green cover on agricultural land and intensive straw incorporation after spring crops.
- Restrictions on animal density.

***Moreover*:**

- Introduction of the biogeochemical protection zones - the zones of permanent vegetation - along the edges of open Pasleka river banks.
- Introduction of absolute restriction of mineral fertilisation of meadows and pastures along the Pasleka valley.
- Start to re-naturalise the floodplains of the Pasleka valley by the use of daming technique in the existing irrigation system.

RIVER CONTINUITY FOR AQUATIC SPECIES MIGRATION

- Absolute restriction on localisation and construction of new or reconstruction of the old facilities impounding water.
- Restoration of the Pasleka river and its tributaries continuity by an elimination of the existing obstructions or their reconstruction that would support free migration through the fish passages.

REINTRODUCTION OF MIGRATING FISH

- Introduction of obligatory grating of hydropower inlets aiming at protection of fish, especially protecting small forms of sea-trout or salmon against great losses but also outlets for protecting the spawning fish heading for upstream stretches.
- Establishing the protection stretches for the potential areas of spawning and young form growth.
- Proper fishery and angling management concerning limitation of fishing in the mouth of the rivers and most downstream river stretches during spawning season for stock reconstruction.

Pasleka river below Braniewo

The catchment of Kyrönjoki

The River Kyrönjoki is the main river of South Ostrobothnia, and the River empties into to the Gulf of Bothnia north of the city of Vaasa. The catchment area is 4,900 km² and the largest headwaters are Kauhajoki, Jalasjoki and Seinäjoki. The river landscape is flat and sensitive for flooding during high runoff peaks. Four artificial lakes have been built in the catchment for flood protection. There are several lakes of over 50 ha, mainly at the head waters (figure 1).

The ground waters of the Kyrönjoki region are distributed very erratically and the most significant ground water reservoirs in the Kyrönjoki catchment are in the municipality of Kauhajoki (figure 2).

The catchment of River Kyrönjoki has also several specially protected targets like Natura 2000-areas and beaches.

On the Finnish scale the land use of the Kyrönjoki catchment area is very intensive. Around 25 % of the area is arable land. Farmers in the Kyrönjoki area produce mainly grass, barley and oat. The proportion of heath lands is 50 % and peat lands 22% of the total area of the catchment (Figure 3).

A significant part of the lower part of River Kyrönjoki (over 35,000 ha) are acid sulphate lands. Large amounts of acidity and metals leach from the acid lands to the water body.

There are approximately 100,000 inhabitants in the Kyrönjoki area, out of which 70 % are included in the municipal sewer system. The industry leads its waste waters to municipal waste water treatment plants. There are 3,700 cattle farms and also some fur farms in the area. Maintenance of forest ditches is done annually on 3,000 hectares and almost 8,000 hectares are in peat production.

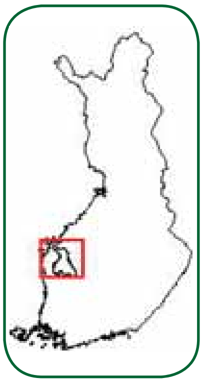


Figure 1. (Left)
The catchment area of Kyrönjoki, the subcatchments and lakes of over 50 hectares.

Figure 2. (Right)
The ground water areas of the catchment of River Kyrönjoki.

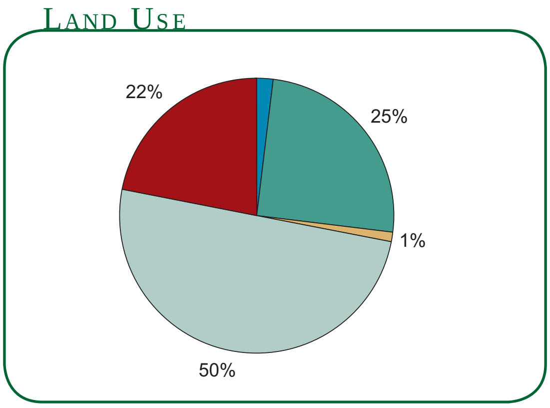


Figure 3.
Land use in the Kyrönjoki catchment

- Inland waters
- Arable land
- Urban areas
- Heath land
- Peat land

Agriculture, animal husbandry, settlement, forestry and peat production have all a significant influence to the quality of the surface and ground waters in the area.

The status of waters

The status of the waters of Kyrönjoki have been monitored since 1960s and the phosphorus concentration has reduced notably. On the other hand the nitrogen concentration has slightly increased (Figure 4).

The mean phosphorus load of River Kyrönjoki is 150 t P/a and nitrogen load is 2,800 t N/a. The proportion of open field cultivation is around 50 % of the total load. The effects of the nutrient load can be seen in the eutrophication of both inland and coastal waters.

The acidity originating from the soil has a significant influence to the condition of River Kyrönjoki and its coastal sea area. The acidity occasionally causes fish kills and metal washout due to low pH complicates fish reproduction. The lowest pH in the river water is annually around 4.7 (Figure 5).

Water constructions and regulation of water bodies also significantly affect the state of River Kyrönjoki. The main channel of Kyrönjoki and the Seinäjoki branch have been preliminary named as heavily modified water bodies.

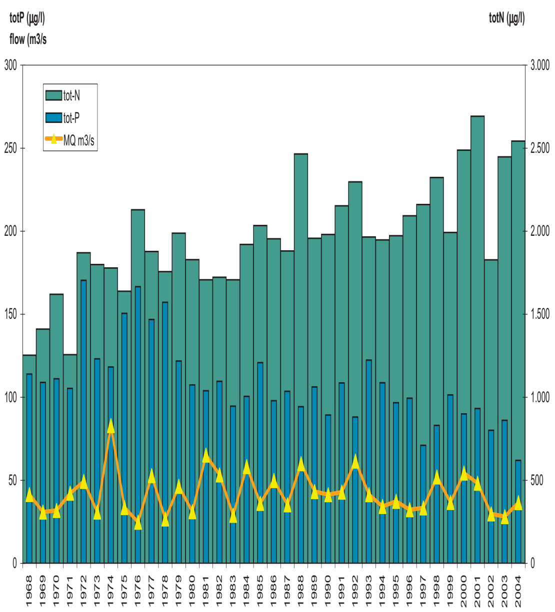


Figure 4.
Concentration of phosphorus and nitrogen and mean flow in River Kyrönjoki 1968-2003.

The objectives of water management

In this preliminary water management plan of River Kyrönjoki the aims have been set mainly from the point of view of fishery. The primary aim in the main branch of Kyrönjoki is to safeguard the existence of sea whitefish, sea trout and lamprey. The aim in Kauhajoki and Jalasjoki is to guarantee the living conditions of brown trout and crayfish populations and the aim in Seinäjoki is to guarantee the breeding possibilities of crayfish.

Therefore the aim in the water management of River Kyrönjoki is to reduce acidity peaks and nutrient load (Figure 6 and table 1). In addition fish migration must be possible and the ecological structure of the water bodies improved. In ground water areas some restoration is needed.

Preliminary program of measures

Basic measures, such as operations according to the new legislation and environmental permits, will essentially reduce the load of municipalities, scattered settlement, animal husbandry and peat production. Complementary measures are needed especially in reducing acidity, restoring water bodies and ground water areas, as well as reducing nutrient and sediment load from agriculture and forestry.

According to current knowledge the complementary measures are not sufficient in preventing acidity

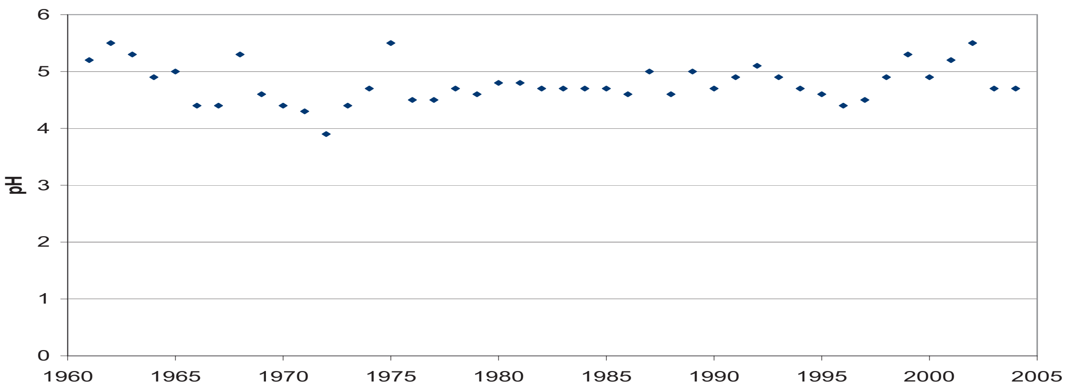


Figure 5.
The lowest pH of the year at Kyrönjoki (Skatila) 1960-2004.

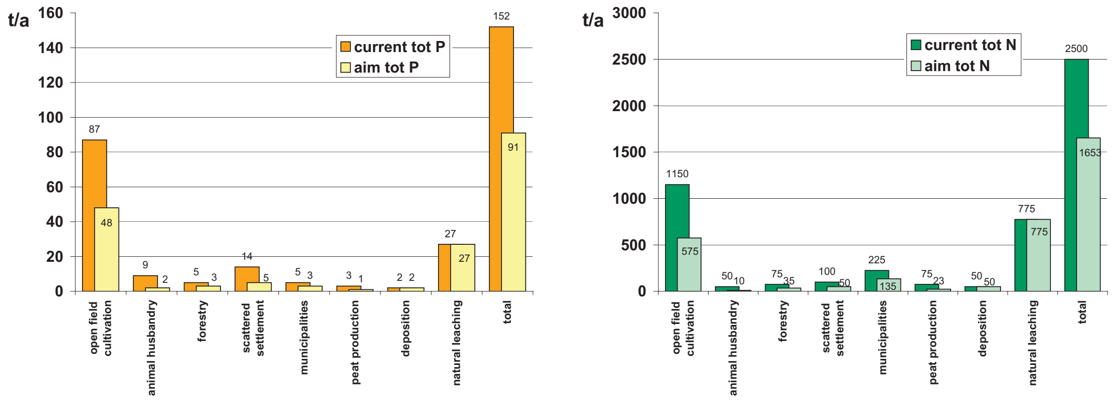


Figure 6.
The current target oriented nutrient load of River Kyrönjoki and its distribution

coming from the soil. Resources have to be invested in technological development in this field. However, acidity can be reduced by controlled drainage and liming filter ditches, which are the most cost-efficient alternatives at the moment.

Cost-effective complementary measures in reducing the nutrient load are, among other things, optimal fertilizing of fields, optimal management of waste water treatment plants and an increase of the use of dry closets. Central measures to improve the state of waters, are gathered in table 2.

Safeguarding the migration of fish together with other ecological restorations are in central role in improving the structure of the water body. Changes in water is also needed.

It has been estimated, that the outer coastal sea area of Kyrönjoki, Kauhajoki and Jalasjoki will attain good ecological status by 2015. Especially acidity, and partly also nutrients and structural matters, are the obstacles that prevent good ecological status

Physical regulation of streams and rivers to improve drainage and to prevent flooding is widespread in the Baltic Sea Region. In many areas, flooding poses a severe problem, as e.g. in West Finland, River Kyronjoki. Photo: Pertti Sevola, WFREC.

of the main channel of Kyrönjoki. Structural matters prevent Seinäjoki region from reaching a good ecological status. The inner archipelago will probably not attain a good ecological status, because of the nutrient load. Ground water areas are mainly in good condition.

The stakeholder co-operation group River Kyrönjoki Advisory Board has participated in preparing the water management plan of River Kyrönjoki. The Program of Measures has been drafted in a working group, which included representatives from West Finland Regional Environment Center, Department of Fishery of the Employment & Economic Development Centre, Water Protection association of Ostrobothnia and Central Union of Agricultural Producers and Forest Owners.

Table 1. Preliminary aims of water management of Kyrönjoki by 2015.

Parameter	Present status	The aim 2015
pH minimum of the river	4.7	>5.0 (5.5)
total phosphorus of the river	60- 110 µg/l	< 50 µg/l
migration hinders of the main channel	8 pieces	0 pieces
total phosphorus of the lakes	30 - 90 µg/l	< 50 µg/l
chlorophyll of the lakes	20 - 50 µg/l	< 20 µg/l
total phosphorus of coastal waters	5 - 30 µg/l	< 20 µg/l
total nitrogen of coastal waters	300 - 1000 µg/l	< 400-500 µg/l

Table 2. The central water management measures of Kyrönjoki.

Management measures

Reduction of acidity

- **developing new methods**
- **controlled drainage**
- **liming filter ditches**
- **liming**

Reduction of nutrients from settlements and industry

- **optimal management of communities waste water treatment plants**
- **increase of dry closets**
- **connecting scattered settlements to sewer and village treatment plants**
- **property specific waste water treatment of scattered settlements**

Reduction of nutrients from agriculture

- **good cultivation methods**
- **optimal fertilizing of fields and lightened tilling**
- **buffer zones and wetlands**
- **optimal the use of cattle manure and 12 months manure pits**
- **optimal feeding of animals**
- **optimal waste water treatment of dairies and fur farms**

Reduction of nutrients from forestry and peat production

- **optimal drainage and waste water treatment of peat production areas**
- **optimal water protection of forestry**
- **buffer zones and wetlands of forestry**
- **lightened tilling methods of forests**

Structural improvement of water courses

- **removing migration hindrances of fish**
- **alleviating of regulation**
- **ecological restorations of running waters**
- **restorations of small watercourses**
- **restorations of lakes**
- **restorations of ground water areas**

Catchment of the Schlei-Trave River Basin

The size of the Schlei/Trave river basin is 5.305 km² (omitting coastal waters) from the border to Denmark with the Krusau on the Danish side across the eastern parts of Schleswig-Holstein to Mecklenburg-Vorpommern and includes the Stepenitz sub-basin (See figure 1).

The Schlei/Trave river basin is characterised by a versatile landscape with variable morphology. The strong relief dates back to the later ice ages and beyond and is around 100.000 years old.

Moraines containing loam, sand and gravel cover the area. The moraines as arranged by drifting ice still dominate its morphology.

The river basin is characterised by one larger and several smaller streams which independently flow either directly into the Baltic Sea or through a fjord. Total length of the so-called reduced water system is around 1980 km.

The two largest streams are the Trave with a length of 113 km and a sub-basin of 1.807 km², which flows into Lübeck Bight and the Schwentine with a length of 70 km and a sub-basin of 726 km² which flows into Kiel Fjord.

The Schlei/Trave river basin contains 51 lakes with a size exceeding 50 ha. Their total surface area is 149 km², which is 2,5 % of the Schlei/Trave river basin. Largest lakes are Großer Plöner See with an area of 29 km² and Selenter See at 22 km². Deepest lake is Großer Plöner See at 58 m.

The Baltic coastline measures to 535 Kilometres. This includes the Schlei with 135 Kilometres and the coast of the Island of Fehmarn with 72 Kilometres.

RIVER SCHLEI-TRAVE BASIN

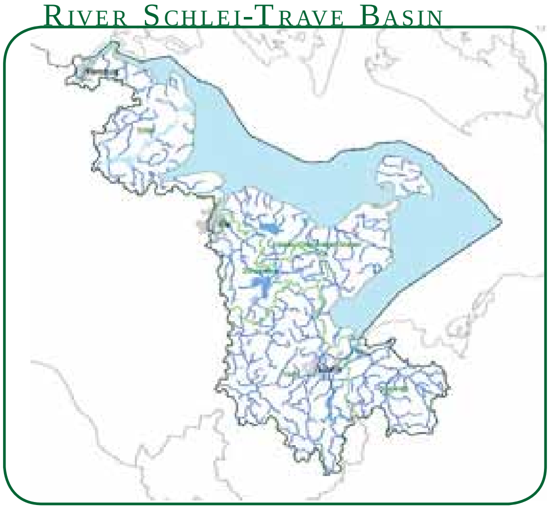


Figure 1: Catchment of the Schlei-Trave River basin

Figure 2: Kremper Au, example for a gravel-dominated watercourse (left side). Schluensee near Plön – likely to achieve the aims of the WFD (right side).

Assessment of impacts of significant pressures on the achievement of the aims for surface water bodies

Streams

Streams were assessed using the saprobic system, physical elements such as reconstruction, setting in drains, transversal constructions, specific pollutants as well as additionally the general chemical and physical elements.

Data on aquatic fauna and flora were included in the assessment where obtainable. Assessment as likely to meet the aims of the WFD depended upon the benthic invertebrate fauna showing a near typical community for the stream type in question and whether there were no doubts regarding other biological quality elements or pollutants, also that there were few or no deficits regarding water quality and physical elements. These data necessary for the assessment were however not obtainable for all water bodies yet.

Whenever there were any doubts regarding possible significant pressures or deficits in water quality the water body was assessed as being unlikely to meet the aims without additional measures. Mostly the reasons for this included physical or structural changes in the context of watercourse reconstructions. Straightening of waters, constructions along the stream or on the waterbed as well as regularly occurring maintenance resulted in significant deficits compared to the natural fauna and flora of waters. Significant chemical changes of the typical water quality were also a reason for possibly not achieving the aims of the WFD. In many cases a combination of chemical and physical deficits was observed.

Table 1: Assessment of achieving the aims of the WFD for water bodies in streams

Sub-basin	Number of WB	Achieving the aims			Reason for unlikely to achieve aims (if data available)		
		Likely	Unclear	Unlikely	Physical deficit	Chemical deficit	Biological deficit
Schlei	39	-	-	39	39	18	13
Schwentine	27	-	-	27	27	3	6
Kossau/Oldenburger Graben	55	4	-	51	52	7	15
Trave	69	1	-	68	68	24	38
Stepenitz	27	3	-	24	20	4	8
River basin	217	8	0	209	206	56	80

Table 2: Assessment of achieving the aims of the WFD for water bodies in lakes

Sub-basin	Number of water bodies	Achieving the aims			Excessive nutrients or deficits in biological elements	Deficits in salinity or calcium content
		Likely	Unclear	Unlikely		
Schlei	4		1	3	3	1
Schwentine	22	4	2	16	18	
Kossau	10		2	8	8	2
Trave	10		3	7	10	
Stepenitz	5	4		1	1	
River basin total	51	8	8	35	40	3

The following table 1 shows the assessment of achieving the aims of the WFD for watercourses. Deficits may contain multiple reasons if chemical and physical deficits were observed in the water bodies.

Lakes

The Schlei/Trave river basin contains eight lakes which are likely to achieve the aims of the WFD (see Table 2). These are Suhrer See, Schöhsee, Selenter See, Schluensee (see Figure 4), Lankower See, Mechower See, Röggeliner See and Tressower See. Further eight lakes were assessed as unclear because of insufficient data for reference conditions. 35 other lakes will not meet the aims without additional measures. Almost all of these have trophic deficits and insufficient aquatic flora communities. Chemical elements could not be included in the assessment as there is no data on specific elements. The analysis of pressures showed intensive use of the catchment for agriculture in most cases. Direct discharges from larger waste water treatment plants occur at seven lakes.

Measures in advance

Draft plans present appropriate measures for the improvement of watercourses with regard to mid-term chances of implementation based on the results of the risk assessment. It is not limited to the so-called reduced water system, it includes current data and knowledge and it will not usually require additional local research. The draft plan should be prepared in close co-operation with the relevant authority and will represent – after the working groups in the working zones have agreed – the basis for the allocation of funds from administration for the consecutive steps in planning and construction (tentative planning, detailed planning, planning for authority approval, implementation planning, implementation of measures).

The draft plan basically lists any of the possible measures which may lead to a fulfilment of the aims of the WFD. The removal of restrictions on migration is especially important if there are suitable habitats upstream or if such will be developed within the measures plan. Further development towards a good ecological quality will however only be possible to achieve if the draft plan contains the ecologi-

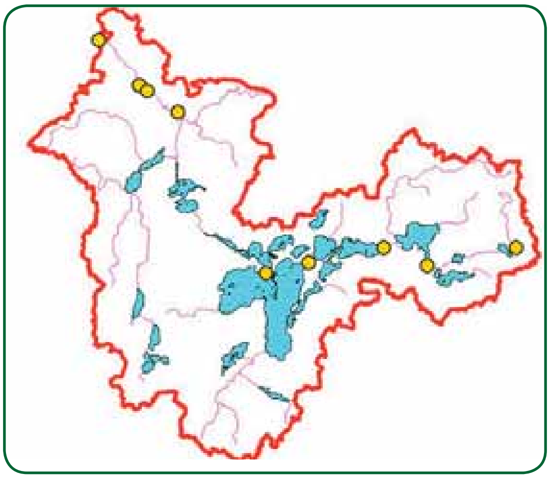
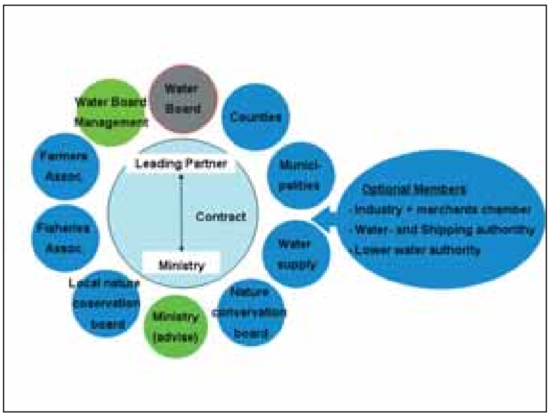


Figure 3: Obstacles for fish migration in the Schwentine Sub Basin

Figure 4: Helix-type Fish ladder at Power Plant Raisdorf (left side). Fish ramp with canoe path in Malente (right side).

Figure 5:
Left side: Round table,
right side:
www.wasser.sh



cal development of water bodies or several adjacent water bodies. A part of the aims will be to reduce the input of nutrients from adjacent areas. If a need arises to allocate the budget priority will be given to projects which promise a complete fulfilment of good ecological quality in water bodies.

In figure 4 obstacles for fish migration in the Schwentine Sub Basin are shown as part of a draft plan. In figure 5 two examples of measures in advance carried out in the Schwentine Sub Basin to allow fish migration are presented.

Public Participation

The principal issue when presenting and debating public participation is to be sure that all relevant stakeholders are involved and in agreement with the process of carrying out the different steps in the process. For the responsible River Basin Authority it is of importance, that public participation is carried out in a way that takes the power structure amongst stakeholders into serious consideration. As each of the federal states in the FRG has established a participation process of its own Schleswig-Holstein has developed a unique but consequent form based on a “bottom up approach”, as presented in figure 6 left side.

Information like on the Measures in advance can be published on

http://www.wasser.sh.

Odense Fjord catchment

The Odense Fjord catchment is situated at the island of Fyn central in Denmark (Figure A).

The catchment is draining a land area of some 1060 km^2 and includes 1100 km streams and 2600 lakes and ponds (>100 m^2) (Figure C).

Agriculture is dominating the land use in the catchment, (Figure B), including approx. 70.000 livestock units. The dominating crops are cereals (2/3 being winter cereals) accounting for 63% of the cultivated land, whereas only 10% of the farmland is grassland.

Urban areas includes Odense city which is the 3rd largest city in Denmark, giving a total population of approx. 240.000 inhabitants.

The main part of Odense Fjord, and Odense River, together with two major lakes in the catchment, are internationally protected as Natura 2000-areas.

Households, industry, motor traffic and agriculture affect the aquatic environment as a result of their release of a range of pollutants.

Odense Fjord Catchment

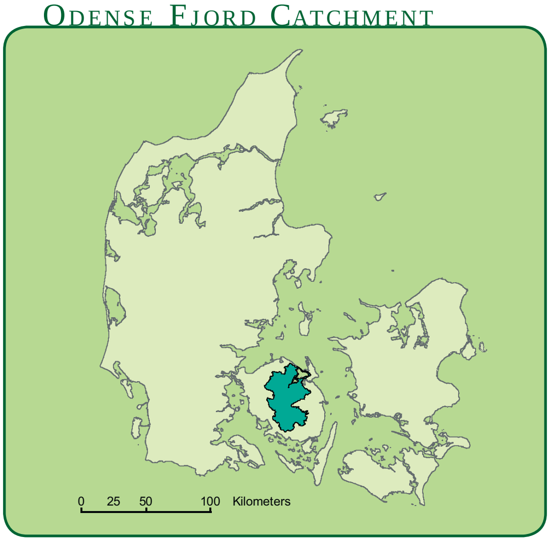
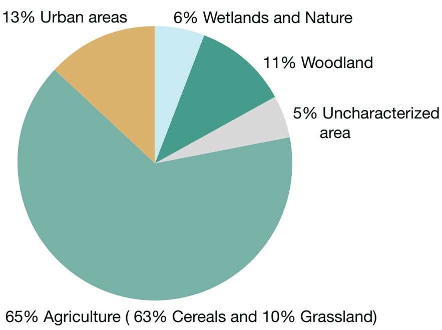


*Figure A
Denmark with the Odense Fjord catchment.*

Land Use



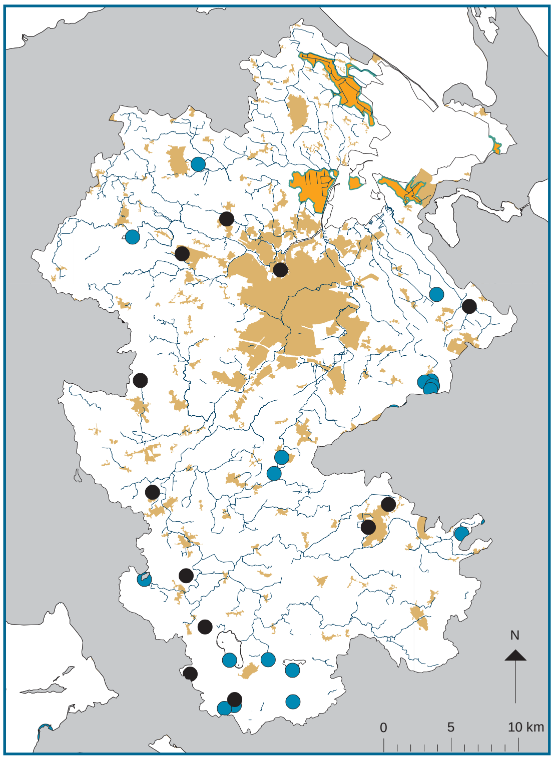


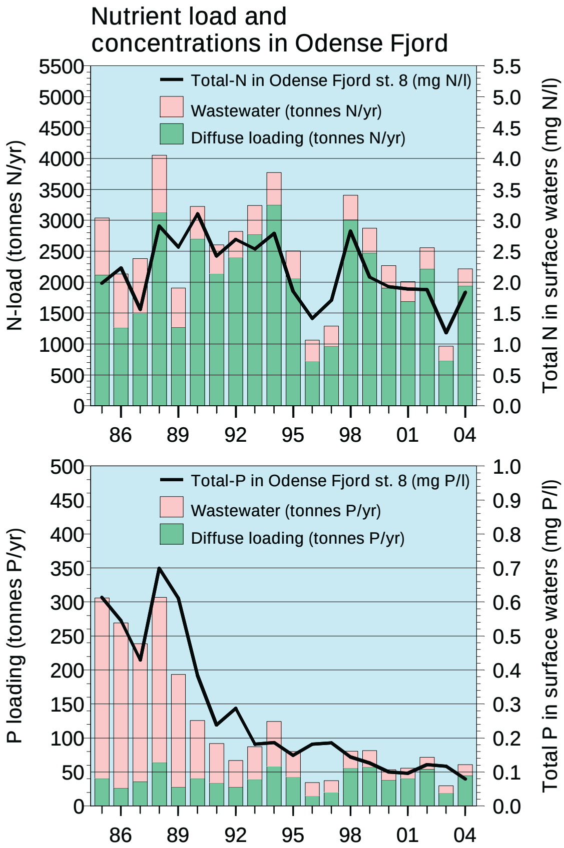
*Figure C (right)
The Odense Fjord catchment with urban areas, streams and lakes.*

Lake
Former lake (drained land)
Watercourse
Urban area
Land reclamation

*Figure B (left)
Land use in the Odense catchment.*

Figure D (right) Source-apportioned nutrient loading and annual mean concentration in the inner Odense Fjord. Diffuse loading includes wastewater from scattered houses.

Odense River and nearby catchment. Photo: Jan Kofod Winther Fyn County.



Environmental state of surface waters

Odense Fjord is affected by inputs of nutrients and hazardous substances from the land, atmosphere and adjacent water bodies and physical disturbances as land reclamation, dredging of shipping routes etc. Monitoring carried out by Fyn County Council since 1976 shows that the objectives of the Regional Plan are still not met, neither for the open coastal waters, nor the adjoining shallow water areas, fjords and coves. Phosphorus input to the coastal waters has been reduced by more than 75% due to improved treatment of wastewater, compared with the period 1976-1987. Land-based nitrogen input has been reduced by 35%.This latter reduction is caused by a combined effect of improved sewage treatment (10-15%point), and a reduction in diffuse pollution from farmed land (20-25%point). Nutrient input and nutrient concentrations in the fjord water are closely linked (Figure D). Although some improvement has been obtained, nutrient levels are still so high, that the animal and plant life of the fjord is severely affected (Figure E)

Figure E. Widgeon grass has returned to the inner fjord, but is still affected by filamentous algae. Photo: Nanna Rask, Fyn County.

None of the 20 water bodies designated in the Odense Fjord are expected to fulfil the criterion of Good Environmental Status (GES) in 2015.

The environmental state of 10 out of the 12 major lakes investigated in the catchment is not satisfactory, and these lakes are not expected to fulfil GES in 2015; neither are the more than 2.600 smaller lakes. The lakes are affected primarily by nutritional sewage outlets from scattered settlements and diffuse runoff from agriculture.

The environmental state of 25 out of 28 water course reaches will not meet the objectives due to physical conditions (24) and/or wastewater discharges (12). Wastewater from scattered settlements, storm water discharges as well as bad physical conditions caused by among other things heavy-handed maintenance are the major causes to this.

Sources of pollution by nutrients

Agriculture is the major source of nitrogen pollution accounting for approx. 70% of the waterborne N-sources and approx. 60% of the airborne N-sources.

PRIORITY MEASURES

REDUCING DIFFUSE PRESSURES – Agriculture

- **Better utilization of animal fodder.**
- **10% higher utilization of animal manure.**
- **Catch-crops: Optimized utilization.**
- **Catch-crops: Increased use.**
- **Wetlands in river valleys – Set aside for wetlands/nature.**
- **Fertilization demands: Reduced N-fertilizer quota (20%).**
- **Fertilization demands: Demands on phosphorus balance at field level.**
- **Fertilization demands: Requirement for reduced phosphorus content in soils - Reduced P-fertilizer quota.**
- **Cultivation restrictions on potentially erosive areas.**
- **Reduced ammonia evaporation due to livestock production.**
- **Reduced drainage.**

Reducing Point Source Pressures

- **Scattered settlements – improved sewage treatment.**
- **Storm Water Outlets – reduced outlets.**
- **Municipal treatment plants - improved sewage treatment.**
- **Enterprices and waste disposal sites.**

Reducing Physical Pressures and recreation of natural physical and hydromorphologic structures

- **Minimize River Maintenance.**
- **Removal of obstructions for fish migration.**
- **Extensivation of cultivation in river valleys.**
- **Re-meandering of regulated rivers.**
- **Re-open culverted streams.**
- **Remove/displace water abstractions.**
- **Restore gravel and stones into riverbed.**
- **Recreate Wetlands in river valleys.**

Others

- **Bio – manipulation LAKES.**
- **Removal of contaminated sediments.**

The surplus (loss) of N from agriculture has been reduced by about 25% since the mid 1980s. Measurements show that relatively large losses of phosphorus also occur from agricultural land.

Total outlets from point sources (municipal waste water, industry and stormwater outlets) in the catchment have since mid 1980s been reduced by about 90% for phosphorus and 60% for nitrogen.

Ground water

Drinking water is supplied by ground water of generally good quality. Nitrate in deeper ground water is generally low due to N-reduction in the overlying layers of clay. However, these protective layers are locally thin or absent, resulting in contamination with nitrate as well as pesticides and other hazardous substances.

Programme of measures

The programme of measures adresses:

- diffuse pressures (water- and airborne)
- point source pressures (i.e sewage outlets)
- Physical pressures (i.e drainage and river maintenance)

The specific measures related to each water type may help to improve the status of other water types.

For Odense Fjord, modelling based on historical data have shown that the nitrogen load to the fjord should be reduced from appr. 2.200 tonnes /yr to appr. 1.000 tonnes/yr, in order to achieve good eco-

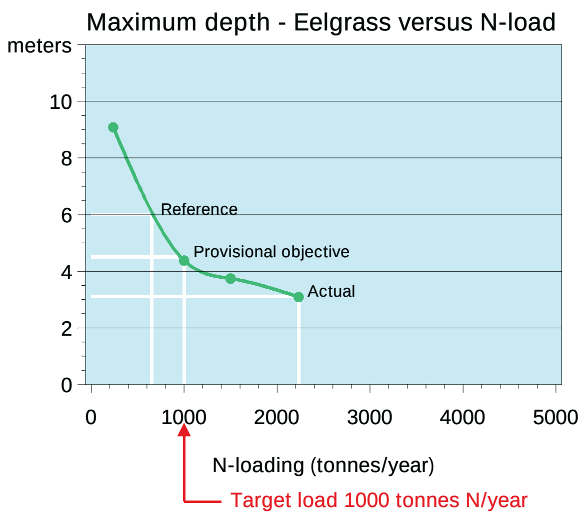


Figure F Relations between nitrogen loading and biological variables. A scenario from the outer fjord is shown.

logical status (GES)(Figure F).

Calculation of costs of a set of priority measures to reach this N-reduction objective show that with the most cost/effective measures (wetland restoration, catch-crops, better use of fodder i.a) the total cost of achieving the objective would be approx. 4 mio. ECU/yr. In comparison, the total costs of municipial sewage treatment today is approx. 40 mio ECU/yr.

The phosphorus load will also have to be reduced, and besides the already launched programmes to reduce load from scattered houses, a further reduction in P-load from agriculture will be necessary. Restoration of wetlands and reduction of P-application to the fields, in order to attain phosphorus balance at field level, are among the most important and cost/effective measures.

Turning to the rivers, the measures to obtain GES should include physical measures as well as reduction of storm water outlets from urban areas and sewage outlets from scattered houses.

For the lakes, the measures should primarily aim at reduction of phosphorus outlets from agricultural areas and scattered houses.

Odense Fjord seen from the south. Photo: Jan Kofod Winther, Fyn County.

Annex II

Annex 2.1. Important EU-directives dealing with water quality.

WFD annex IV.
The register of protected areas shall include areas encompassed by the following directives:

Item	Number	Year
Bathing water quality	(76/160/EEC)	1976
The Major Accidents (Seveso) Directive	96/82/EC	1996
The Sewage Sludge Directive	86/278/EEC	1986
Protection of bird breeding and resting areas	(79/409/EEC, altered by 97/49/EC)	1979
Protection of drinking water	(80/778/EEC, altered by 98/83/EC)	1980
Evaluation of the impact on the environment by major projects	(85/337/EEC, altered by 97/11/EC)	1985
Protection of the aquatic environment against nitrate from agriculture	(91/676/EEC)	1991
Urban Waste water directive	(91/271/EEC, altered by 98/15/EC)	1991
Habitate-directive on protection of nature, flora and fauna	(92/43/EEC, altered by 97/62/EC)	1992
IPPC-directive on integrated monitoring and pollution control	(96/61/EC)	1996
The Plant Protection Products Directive	91/414/EEC	1991

WFD annex VI.
Measures to be included within the programmes of measures are measures required under the following directives:

Protection of drinking water	(80/778/EEC, altered by directive 98/83/EC)	1980
Fresh water fish protection	(78/659/EEC)	1978 altered 1985
Shell fish water quality	(79/923/EEC)	1979
Bathing water quality	(76/160/EEC)	1976
Protection of the aquatic environment against nitrate from agriculture	(91/676/EEC)	1991
Urban Waste water directive	(91/271/EEC, altered by 98/15/EC)	1991
Habitate-directive on protection of nature, flora and fauna	(92/43/EEC, altered by 97/62/EC)	1992
Protection of bird breeding and resting areas	(79/409/EEC, altered by 97/49/EC)	1979

WFD annex IX.
Emission limit values and environmental quality standards under the re directives of Directive 76/464/EEC shall be considered emission limit values and environmental quality standards, respectively, for the purpose of the WFD. They are established in the following directives:

The Mercury Discharges directive	(82/176/EEC)	1982
The Cadmium Discharges Directive	(83/513/EEC)	1983
The Mercury Directive	(84/156/EEC)	1984
The Hexachlorocyclohexane Discharges Directive	(84/491/EEC)	1984
The Dangerous Substances Discharges Directive	(86/280/EEC)	1986

Annex 2.2. International conventions particularly mentioned in the pretale of WFD, (no. 21)

- Convention on the Protection of the Marine Environment of the Baltic Sea Area, signed in Helsinki on 9 April 1992 and approved by Council Decision 94/157/EC (HELCOM).

- Convention on the Protection of the Marine Environment of the North-East Atlantic, signed in Paris 22 Sept 1992, and approved by Council Decision 98/249/EC.

- Convention for the protection of the Mediterranean Sea Against Pollution, signed in Barcelona on 16 February 1976, and approved by Council Decision 77/585/EEC, and its Protocol for the protection of the Mediterranean sea Against Pollution from Land-based Sources, signed in Athens on 17 May 1980, and approved by Council Decision 83/101/EEC.

Annex 2.3. Important extracts and recommendations of HELCOM:

(See: http://www.helcom.fi/Recommendations/en_GB/front/)

HELCOM RECOMMENDATION 1/4
The Application by the Baltic Sea States of Resolution MEPC.2(VI) - Recommendation on International Effluent Standards and Guidelines for Performance Tests for Sewage Treatment Plants
- adopted 5 May 1980, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 7/2
Measures aimed at the reduction of discharges from agriculture
- adopted 11 February 1986, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 7/3
Measures aimed at the reduction of discharges from urban areas by the development of sewerage systems
- adopted 12 February 1986, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 9/2
Measures aimed at the reduction of discharges from urban areas by the use of effective methods in wastewater treatment
- adopted 15 February 1988, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 9/3
Measures aimed at the reduction of nutrient discharges from agriculture
- adopted 15 February 1988, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 9/11
Guidelines for the establishment of national counter pollution measures regarding pleasure craft
- adopted 16 February 1988, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 10/2
Assessments of the effects of pollution on the coastal areas of the Baltic Sea
- adopted 14 February 1989, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 10/5
Guidelines for the establishment of adequate reception facilities in ports
- adopted 15 February 1989, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 11/9
National regulations on the discharge of sewage in national waters
- adopted 14 February 1990, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 11/10
Guidelines for capacity calculation of sewage systems on board passenger ships
- adopted 14 February 1990, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 12/3
(Implemented in the 1992 Convention)
Definition of best available technology
- adopted 20 February 1991, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/2
Industrial connections and point sources other than household connected to municipal sewerage systems
- adopted 5 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/6
(Implemented in the 1992 Convention)
Definition of best environmental practice
- adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/7
Reduction of ammonia volatilization from storages.
- adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/8
Reduction of ammonia volatilization from field application of manure.
- adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/9
Reduction of nitrogen, mainly nitrate, leaching from agricultural land
- adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/10
Reduction of phosphorus leaching and erosion.
- adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 13/11
Reduction of farm waste discharges
- adopted 6 February 1992, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 14/4
Reduction of ammonia volatilization fromanimal housing
- adopted 3 February 1993, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 15/2
Pollution load compilation
- adopted 9 March 1994, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 16/9
Nitrogen removal at municipal sewage water treatment plants
- adopted 15 March 1995 having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 17/7
(supersedes HELCOM Recommendation 11/2)
Reduction of discharges from urban areas by proper management of stormwater
- adopted 12 March 1996 having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 17/11
Reception facilities
- adopted 13 March 1996 having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 18/3
(This Recommendation supersedes HELCOM Recommendation 15/3)
Measures aimed at the reduction of discharges from marine fish farming
- Adopted 12 March 1997 having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 18/4
(This Recommendation supersedes HELCOM Recommendation 13/12) Managing wetlands and freshwater ecosystems for retention of nutrients
- adopted 11 March 1997, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 19/3
The manual for the marine monitoring in the combine programme of HELCOM
- adopted 26 March 1998, having regard to Article 13, Paragraph b) of the Helsinki Convention

HELCOM RECOMMENDATION 19/4
Waterborne pollution load compilation 2000
- Adopted 26 March 1998, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 19/6
Amendments to Annex III of the Helsinki Convention concerning regulations on prevention of pollution from agriculture
- adopted 26 March 1998, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 19/9
Installation of garbage retention appliances and toilet retention systems and standard connections for sewage on board fishing vessels, working vessels and pleasure craft
- adopted 26 March 1998, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 19/12
Waste management plans for ports
- adopted 26 March 1998, having regard to Article 13, Paragraph b) of the Helsinki Convention.

HELCOM RECOMMENDATION 20/1
Measures aimed at the reduction of discharges from freshwater fish farming
- adopted 23 March 1999 having regard to Article 13, Paragraph b) of the Helsinki Convention 1974.

HELCOM RECOMMENDATION 20/3
Reduction of nutrients and other pollutants leaching from forestry land
- adopted 23 March 1999 having regard to Article 13, Paragraph b) of the Helsinki Convention 1974.

HELCOM RECOMMENDATION 21/1
Amendments to Annex III "Criteria and Measures Concerning the Prevention of Pollution from Land-based Sources" of the 1992 Helsinki Convention
- adopted 20 March 2000 having regard to Article 20 (1), Paragraph c) of the 1992 Helsinki Convention.

HELCOM RECOMMENDATION 21/4
Protection of Heavily Endangered or Immediately Threatened Marine and Coastal Biotopes in the Baltic Sea Area
- adopted 20 March 2000 having regard to Article 20 (1), Paragraph c) of the 1992 Helsinki Convention.

Annex III

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BERNET (Baltic Eutrophication Regional Network) is a network cooperation between water managers in seven regions of the Baltic Sea Region. The network was founded in 1999 to help improve the aquatic environment in the Baltic Sea region and of the regional waters in its catchment. Right from the start, BERNET has focused especially on Eutrophication problems. Doing this, the BERNET Partners have wished to contribute to full-filling the aim of the Helsinki Declaration in "assuring the ecological restoration of the Baltic Sea".

The present BERNET-CATCH project running for the period 2003-2006 focuses primarily on the regional implementation of the EU Water Framework Directive (WFD). Through their activities in BERNET CATCH, the partners present and evaluate different regional (and national) solutions in order to fulfill the objective of achieving at least "good ecological status" of all EU waters before 2015.

The co-operation involves the actual water managers in the regions, and takes place through face-to-face exchange of experiences and cross regional comparison of environmental threats to the waters within the Baltic Sea catchment, including cause-effect relationships. The main activities of BERNET-CATCH is the provision of Water Management Plans within regional pilot catchments in order to disseminate knowledge and experiences that may serve as good examples to Water Managers and Stakeholders involved in the implementation of the EU-Water Framework Directive.

The BERNET Partners:

- Fyn County, Denmark: Fyn County, Nature Management and Water Environment Division (Lead Partner)
- West Finland, Finland: West Finland Regional Environmental Center
- Gdansk Region, Poland: Gdansk Regional Board of Water Management
- Kaliningrad Oblast, Russia: Department of Federal Supervision Service for Natural Use for Kaliningrad Oblast - Ministery of Natural Resources of Russia and Government of Kaliningrad Oblast
- Laholm Bay Region, Sweden: Counties of Halland and Scania; Municipalities of Båstad, Laholm, and Halmstad
- Schleswig-Holstein, Germany: State Agency for Nature and Environment, Schleswig-Holstein
- Viru-Peipsi, Estonia: Peipsi Center for Transboundary Cooperation (NGO).

Reports:
The outcome of BERNET CATCH is published in an Executive Summary, one Main Report, two cross-regional Theme Reports and six regional Water Management Plans, all under the same heading, *Management Strategies for the Regional Implementation of EU Water Framework Directive in the Baltic Sea Catchment*:

- BERNET CATCH Executive Summary: Regional Implementation of the EU Water Framework Directive in the Baltic Sea Catchment

- BERNET CATCH Main Report: Water Quality Management in the Baltic Sea Region. Regional Implementation of the EU Water Framework Directive
- BERNET CATCH Theme Report: Public Participation and Water Management in the Baltic Sea Region. Regional Implementation of the EU Water Framework Directive in the Baltic Sea Catchment
- BERNET CATCH Theme Report: How to define, assess and monitor the ecological status of rivers, lakes and coastal waters. Regional Implementation of the EU Water Framework Directive in the Baltic Sea Catchment

- BERNET CATCH Regional Report: Odense Fjord, Water Management Plan
- BERNET CATCH Regional Report: River Stensåen, Water Management Plan
- BERNET CATCH Regional Report: River Pasleka , Water Management Plan
- BERNET CATCH Regional Report: River Kyronjoki, Water Management Plan
- BERNET CATCH Regional Report: River Mamonovka, Water Management Plan
- BERNET CATCH Regional Report: Schwentine River, Water Management Plan.

Contact us

Visit **http://www.bernet.org**

for further information and up-dated news about BERNET CATCH.
From here you may also order previous BERNET reports, including 7 reports on different aspects of Eutrophication Management in the Baltic Sea Region.