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Report of the Workshop on the Role of Phytobenthic Communities in ICES Waters

3–6 March

Askö, Sweden

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Executive summary

This meeting marks the first expert workshop on phytobenthos related matters in ICES history.

The importance of the phytobenthic communities for goods and services within the seascape was shown, e.g. with references to the vegetation covered substrate as a spawning and nursery area for commercially important fish, as a stabilizer of the shore line and protection from erosion as well as the direct use as food and as raw material for numerous chemical substances. The phytobenthic communities also serve as giant filters for land runoff by their nutrient uptake, sedimentation traps, etc.

Harvesting of algae is performed in the ICES waters, e.g. kelp in Norway and *Furcellaria lumbricalis* along the eastern coast of the Baltic Sea.

The phytobenthic communities' role in the WFD was discussed and examples from different parts of the Baltic Sea were presented. Whenever possible, there should be a goal to try to find criteria in common for all countries of the ICES waters.

In this context also the importance of data sharing, and the use of compatible data bases was emphasised. There is work performed to unify e.g. the use of same taxonomic list, etc. Also, the importance of data sharing and the need of communicating data bases between monitoring programmes of the countries was emphasised.

The methods used by the participants' countries for monitoring and surveying the phytobenthic communities were presented. A general consensus was, when possible, to harmonize the methods. The meeting decided to recommend the cost efficient method of free estimates along a given transect line to be used when possible. Plans were made to highlight this in a publication entitled "The importance of the phytobenthic plant and animal communities to marine ecosystems and their scientific study" to be published in the ICES TIMES series.

1 Opening of the meeting

The Chair of the workshop, Hans Kautsky, opened the session (2 March, 16:00) in the field station Askö. He welcomed the participants and gave a short introduction to the history of the Askö Laboratory, followed by safety instructions and some housekeeping information.

The participants then introduced themselves and gave a short review of their scientific activities. 11 participants from six countries were present (Sweden, Estonia, Latvia, Lithuania, Denmark and Norway).

Heye Rumohr was appointed Rapporteur of the meeting.

The group discussed the ToRs and the Rapporteur gave some explanations of ICES structure and its publications. This meeting marks the first expert workshop on phytobenthos-related matters in ICES history.

2 Adoption of the agenda

The group unanimously adopted the agenda without any changes.

3 ToR a) Explore and discuss the role of phytobenthic plant and animal communities in ICES waters, including epifauna and flora

The coastal phytobenthic systems are key areas for several ecological functions and for goods and services. They belong to the most species rich marine habitats found on earth, they form, a buffer between ocean and land, the seascape, providing food and shelter as well as serving as a giant filter for the land runoff binding nutrients and pollutants in the biota body tissues.

The natural phytobenthic communities are considered to be the most species rich areas of temperate waters. The plant communities provide a three-dimensional habitat and secondary hard substrate to serve as habitats to a wide range of plant and animal species.

The phytobenthic communities provide the human society with a large number of goods and services (Rönnbäck *et al*. 2007), e.g. functions as a gigantic filter of coastal nutrient release manifested in increased growth of filamentous and foliouse algae observed in eutrophicated areas and outside point sources of nutrient release. They stabilize the shoreline. They are the source as well as harbour species for consumption and facilitate the survival of juvenile fish of commercial importance, etc. The phytobenthic plant and animal communities form a link between the land and the open and deeper oceanic ecosystems being the first ecosystem to receive the land runoff. The drifting, loose algae (and higher plants) serve as food resource for the deeper benthic communities, or when drifted ashore, were/are used as fertilizer.

The shallow phytobenthic community serves as a base for commercially important fish that spawn and breed among the algae and find food and shelter within the plant belts (e.g. Anderson, 1994; Aneer, 1985; Aneer and Nellbring, 1982; Aneer *et al*., 1985; Jansson, 1985; Pihl *et al*., 1994; Rangeley and Kramer, 1995; Robertson, 1984). There is commercial harvest and exploitation of algal products for e.g. agar production, but also for consumption (see points below). Unpolluted phytobenthic communities have recreational values. They provide living space for rare and endangered species.

Historically, the disappearance of the *Zostera marina* communities in the northern European waters in the 1920s pin-pointed to the physical importance of these plant communities as a coastal zone erosion protection (e.g. Boström and Bonsdorff, 2000; Duarte, 1995; Greve, and Krause-Jensen, 2005; Borum *et al.*, 2004; Möller and Martin, 2007). This is also documented in the Mediterranean Posidonia meadows.

The species richness of the phytobenthic community provides a battery of both plant and animal species sensitive to different pollutants and/or eutrophication. As many of the species included in a monitoring programme of the phytobenthic communities are attached and perennial they integrate the environmental load over a longer time. In combination with the relative easiness to observe the communities, they are an important indicator of the quality of the water body and are therefore included, e.g. in the WFD (Selig *et al.*, 2006) and are used in several national monitoring programmes following the effects of eutrophication (e.g. Kruse-Jensen *et al.*, 2008). Observations can also be done with longer time intervals to detect change which makes the study of these communities cost efficient.

Nursery areas for fish

Field surveys in the Askö area of the spawning sites of herring and experimental studies of their egg survival on different plants indicated that opportunistic, filamentous algae associated to eutrophication had a negative effect on the eggs. Martynas added informations on spawning grounds of Baltic herring (*Clupea harengus membras*) at the Lithuania Baltic Sea coast Also in Lithuania herring eggs were found in high numbers on thick layers of epiphytic algae which may have a negative effect on the recruitment of the herring. Estonian experiences showed that whitefish spawning is impeded by epiphytes.

The first investigations of spawning grounds of Baltic herring at the Lithuania coast were performed during 1993–1994 (Maksimovas *et al.*, 1994; Olenin, Labanauskas, 1995; Olenin *et al.*, 1996). Two main spawning grounds were found on the overgrowths of perennial red alga *Furcellaria lumbricalis* (Huds.) Lamour, where eggs were attached to the thallus of algae. One of spawning grounds was situated close to the resort Palanga and the second in vicinity of Nemirseta. Fragmented beds of algae occurred at these sites, however no eggs were found in the other places where the *F. lumbricalis* also formed dense overgrowths. The similar pattern of distribution of spawning grounds was observed in surveys performed in 2006 and 2007 (M. Bucas, personal observation).

Monitoring of spawning grounds was started in 1995 at the seaside of southern breakwater of port Klaipeda (Olenin, Labanauskas, 1995; Olenin *et al.*, 1996). The outflow of Curonian lagoon brings waters rich with nutrients resulting one of the most productive site at the coast which attracts fishes. Thus, artificial substrates (stones, concrete tetrahedron and blocs) of breakwater are overgrown by filamentous green and brown algae (*Cladophora glomerata* and *Pilayella litoralis*), mussels and barnacles (*Mytilus edulis* and *Balanus improvisus*), and serve as suitable substrate for spawning to ca 5 m depth. Generally, the eggs were laid from the middle of April to the end of May (where the range of water temperature was 6–16 °C) down to 4 m depth. The layer of eggs was up to 5 cm height and their survival depended mostly from the temperature. The similar results were obtained in surveys of 2005–2006 (M. Bucas, personal observation).

Henning Steen reported on the role of Laminaria epiphytes as a shelter and carbon source for higher trophic levels The large *Laminaria hyperborea* kelp forests along the

Norwegian west coast are highly productive and species rich communities. The annual primary production in the kelp forest may be as high as 3000 g carbon per square meter, and the total biomass of *Laminaria hyperborea* along the Norwegian coast is estimated to be around 50 million tonnes (Sakshaug *et al.* 2002). More than 300 species of animals and macroalgae has been recorded in the Norwegian kelp forests (Norderhaug 2003), with an average density of almost 8000 individuals of small animals associated with each kelp plant (Christie *et al.*, 2003). Kelp forests are also important habitats and nursery grounds for several species of fish (Norderhaug *et al.*, 2005). The diversity and abundance of both epiphytic macroalgae and associated animals increases with the age of the kelp plants and the recovery time of the kelp associated communities after disturbances (e.g. kelp trawling, storm surging) increases with latitude (between 59ºN–63ºN) along the west Norwegian west coast (Christie *et al.*, 1998).

Coupling between phytobenthos and fish – Norwegian beach seine fish catch serie

Long-term ecological effects of changes in macroalgal vegetation (e.g. loss of canopy-forming species) on higher trophic levels (including fish) are poorly known. This is partly because of methodological difficulties, but also because of the lack of baseline inventories (as most studies are initiated well after such changes have occurred) and coupling of macrophytobenthos and fish abundance data. Along the Norwegian Skagerrak coast, the Norwegian Institute for Marine research Since 1919 the Norwegian Institute for Marine research have performed annual beach seine fish catches on more than 100 localities along the Norwegian Skagerrak coastline from the Swedish Border to Vest-Agder (Smith *et al.*, 2002). All specimens of each fish species is counted, and weight measurements are made for some selected gadoid species. Since the mid 1930s the dominant macrophytobenthic vegetation on each beach seine station has been recorded by aquascope (Fromentin *et al.*, 1997). In the early 1990 a more comprehensive inventory of the macrophytobenthic vegetation was made by scuba divers on more than 100 beach seine stations. This coupling between macrophytobenthos and fish abundance data recordings over such a long time span, may aid in identifying possible correlations between changes in macroalgal vegetation and fish populations on a large temporal and spatial scale.

Nutrient trap and nutrient pump

GM calculations in Estonian waters on role of phytobenthos as sink for primary production that is not released to the food chain. (Nutrient trap. Algal mats (Paalme *et al.*, 2004).

Phytobenthic communities act as seasonal traps for excessive amount of nutrients. Within the past few decades the extensive supply of nutrients into coastal ecosystems has resulted in the luxurious growth of filamentous macroalgal species in many regions of the world. As a consequence of large macroalgal "blooms", the mass drift of algae is increasingly observed. This is due to the detachment of sessile filamentous algae at the end of their lifecycles and/or disturbances, caused by heavy wave actions or currents. The algae are either washed up on the shore or they sink down and form drifting algal mats on the sea bottom.

The occurrence of drifting algal mats has become a widespread phenomenon also in shallow coastal waters of the Baltic Sea. The proliferation of annual filamentous algae and the formation of drifting algal mats has been observed in the whole Estonian coastal range. It is suggested that the occurrence of drifting algal mats reflects the shift in macroalgal communities from the perennial macrophytes to fast growing filamentous macroalgae, caused by increasing eutrophication of coastal waters in the Baltic Sea during the past decades. Naturally Baltic filamentous algae grow on different hard substrates and exhibit strong seasonality. However, after detachment and formation of loose lying algal mats, they may extend their growing area to a completely new niche, to soft bottoms. Occupying a unique habitat of higher aquatic plant and macrozoobenthos communities, the drifting algal mats represent a serious threat to the biodiversity of coastal areas. The accumulation and decomposition of these algal mats can modify nutrient dynamics both in a water column and sediment, affect negatively the underwater light climate, result in widespread hypoxic and anoxic conditions among the algae and in the sediment, and hence destabilize the whole shallow-water ecosystem.

Although the drifting macroalgal mats are a very important part of the productivity and functioning of the shallow coastal areas of the Baltic Sea, there are only a few papers dealing with various aspects of their development and occurrence.

Drift algae on shore changed their composition and increased filamentous algea reduced the value as fertilizers for agricultural use. Drifting *Furcellaria* in Archipelago Sea built a 3D habitat for inhabiting fauna more than underlying sand communities.

Seagrasses prevent beaches from erosion, Nutrient pump in Potamogeton (Henning) also Elodea re-mobilizes nutrients already buried in the lateral advection of loose algae to deeper parts acting as nutrient transport to the deep waters where they decompose. Sea urchin structuring is only present in fully marine areas.

Habitat builder

Macrophytes may play a crucial role in self-stabilization (alternative stable states) in Baltic water bodies as well. The theory of alternative stable states; i.e. that self-stabilizing alernatives (phytoplankton-dominated or macrophyte-dominated) exist for eutrophic conditions, were first descried by Scheffer (1998) for freshwater systems. Since them, the theory has been proven for several freshwater systems. Irrespective of the fact, that there is no such investigation done yet for brackish systems, at least for the DZBK the results reviewed by Schiewer (Schiewer 2008 and references therein) suggest, that this phenomenon might held true for the Baltic as well.

Adverse effects of fishery on phytobenthos

While coastal *Zostera* beds are normally safe for trawling effects due to local legislations, deeper algae beds may be adversely affected by heavy rock-hopper gears which may result in the loss of refuge and shelter for fish inhabiting these special habitats ,

Further research is needed on the effects of Global change and Climate change effects total phytobenthic community.

Kelp harvesting

Henning Steen reported on Kelp harvesting in Norwegian waters. *Laminaria hyperborea* stands for 80% of the norwegian algal stock. Distribution from Svalbard/Green land Island to the britsisch Isles and the Bretagne. In nOrland all stand are grazed down by sea urchins. 170.000 tonnes harvested by trawling. Used for alginate. Harvesting regulated by 5 years cyclic rotating system. Habitat for more than 300 species and 8000 individuals. Feeding grounds for fish and birds. Epiphytes on stipes show disturbance after 5 years. Monitoring programme by annual video transects on fixed stations. Marked effects of sea urchins show reduktion of kelp by intense sea urchin grazing. Trawling keeps kelp on a younger and more accessible status for the sea urchins. Increase of sea urchins in Soer- Trondelag.

Kelp forest monitoring, and effects of kelp harvesting in western Norway

The kelp species *Laminaria hyperborea* is harvested by trawl on the Norwegian west coast (between 59ºN–64ºN) for the production of alginate, and approximately 170.000 tonnes are harvested each year. The effects of kelp harvesting will depend on harvesting frequency (5 years closure between each harvest period) and efficiency (9–18% in average per trawlfield), as well as regrowth ability of kelp vegetation and associated organisms (Sivertsen, 1991; Christie *et al*., 1998; Rinde *et al*., 2006). The Institute of Marine Research has since 2004 yearly monitored the state of kelp forests and effects of kelp trawling on the west coast of Norway. The results from the monitoring surveys are reported yearly (Steen 2005, 2006, 2007, 2008). Conditions and regrowth of kelp forests after trawling incidents have mainly observed to be good during the last years surveys. The only exception being sections of the Sør-Trøndelag coastline, where parts of the kelp forest have been grazed down by red sea urchins (*Echinus esculentus*).

Irina Kulikova reported on macrophytos investigations in Gulf of Riga Bay. Three transects according to HELCOM COMBINE programme. Sampling with diverse depth distribution data from 1924 until now. Decrease from 15 m to 10 m in 2005 (maximum). East coast less than at west coast in all parameters measured. Reason may be river discharge (3 rivers). Heavy metal concentrations were measured and showed a decrease for Pb and copper over time whereas Cd and Hg and other metals seemed to stay stable over time. See Annex 5.

4 ToR b) Document the population dynamics and annual cycles of phytobenthos communities on a regional scale

Temperature related effects

Hendrik Schubert reported on new findings on Phytoplankton annual dynamics in the Western Baltic. Growth seems to be purely temperature related.

Hans Kautsky introduced the group into long-term studies of *Fucus vesiculosus* in the Askö area showing a gradual deepening distribution based on national monitoring data. The reasons for this phenomenon remain open since it could be unsuitable substrate and reduced water turbidity as a proxy for environmental improvement. Another reason for changes in depth distributions must be sought in the species internal population dynamics. Distribution of off-spring is local within meters. Long-distance spreading is more through drifting loose algae and fragments of those. Stands may disappear without obvious reasons. Experiments are underway in Germany to find out more about settlement and light acclimatization (HS). Phytobenthos as environmental indicators should be multiple rather than solistic. See Annex 9.

Georg Martin reported on ongoing experiments on ferry generated waves on marine algae In Tallinn Bay. Study on effect of fastferry generated wave action on the phytobenthic communities in the coastal areas of Tallinn Bay. Tallinn Bay is one of the most intensively used harbour areas having more than 20 departures of fastgoing ferries per day during the summer period. The problem of coastal erosion caused by additional wave energy generated by different types of ferries has been discussed intensively but the proposed speed limit has been not applied. The experimental setup includede the exposure of articificaial substrate in different depth intervals in affected and unaffected sea areas with similar set of environmental settings. (Tallinn

Bay – affected area, Muuga Bay – control). Exposure time varied from 1 months to 12–14 months. Data is still processed but preliminary results show high disturbance of PB communities in intermediate depths (2–5 m) by the waves generated by fastferries. The paper expected in late 2008.

H. Kautsky presented a shortly finished thesis work by Susanne Quarfordt on submerged granite blocks on colonization with algae determination of time for settling. The title of her thesis is "Phytobenthic communities in the Baltic Sea – seasonal patterns in settlement and succession" - Department of Systems Ecology, Stockholm University Stockholm 2006 and a more comprehensive summary of papers can be downloaded from http://www.diva-portal.org/su/theses/abstract.xsql?dbid=1153. The abstract is as follows. Seasonal changes in reproduction, recruitment, occurrence and growth of marine plant and animal species is a common phenomenon world-wide. This thesis investigates whether such seasonal changes could determine the succession in subtidal phytobenthic communities on free space in the low diverse Baltic Sea. My results showed circular seasonal patterns both in the settlement of species and in the annual appearance of communities. The circular seasonal pattern was also observed in the succession. Initial species assemblages were determined by the time space became available for colonisation. Although the succession seemed to be directed towards one site-specific final community structure determined by physical factors, the time of the year when space became available influenced the rate of the succession through species interactions. Rapid growth and timing of settlement and free space occurrence allowed early species to occupy all available space and prevent further colonisation, thereby slowing the succession. My results also showed that both settlement and community structure are influenced by substrate characteristics. Studying community development on vertical artificial structures revealed communities with few species and different composition compared to communities on vertical natural substrates. A field study showed that settlement and community structure changed significantly between 60° and 90° substrate slopes. This thesis shows that some differences in the final community structure are determined already at the settlement stage and that the succession pattern varies depending on when free space occurs. However, small inter-annual and site-specific differences in seasonal settlement periods and site-specific final communities mainly determined by physical factors, suggest that succession patterns are relatively predictable. Seasonal changes seem to cause a spiralling succession towards a final, seasonally undulating, state.

H. Rumohr introduced a new project with settlement plates attached to 24 navigation buoys in Kiel Bay, exposed for one year and brought back to the lab in early autumn. Scientific aim is the recording of regular and potential new species in the fouling community in Kiel Bay.

G. Martin reported on an experimental study of Charophyte community species (Ch. aspera) on recovery after disturbance, Removal of sediment had highest impact. Abstracts of papers can be found in Annex 6.

Another experimental project studied the effect of different grazing impacts. No grazing was observed in spring, and it was highest in autumn. See Annex 6.

Input from H. Schubert on Thesis of Susanna Qvarfordt. In the Baltic Sea, a couple of studies have been performed during the last decades with respect to Seasonality of macrophytobenthos (e.g. Wallentinus 1979, Kristiansen 1972, Wennberg 1992; for an overview, see Qvarfordt 2006, "Introduction"). In contrast to fully marine conditions, low saline-brackish macrophyte communities show a very strong seasonality, since the proportion of perennial species is low. However, as shown by Qvarfordt (2006) as well as Schygula (2007) the establishment of macrophyte communities is a multi-step process taking several years in the southern / central Baltic. Both before-mentioned authors showed a clear season-dependency of recruitement, influencing the following succession pattern, but not the final stage ("climax-stage").

Sargassum muticum is a very well studied species in Europe, many publications appeared in the eighties, A review of recent papers on the introduced Japanese brown alga *Sargassum muticum*, including studies on population dynamics and annual cycle is presented below.

Following the introduction and subsequent spread of the large Japanese brown alga, *Sargassum muticum*, in Europe, a number of studies were initiated, including studies of annual cycle, population dynamics, demography, associated organisms, etc. Crithcley, *et al.* (1990) lists more than 300 papers dealing with *S. muticum*, and numerous papers have appeared during the 1990s and 2000s. Some of the most recent published work on *Sargassum muticum* in European waters being the papers of Steen 2004, Wernberg *et al.*, 2004; Pedersen *et al.*, 2005; Sánchez and Fernández, 2005; Sánchez *et al.*, 2005; Buschbaum *et al.*, 2006; Plouguerné *et al.*, 2006; Thomson *et al.*, 2006; Harries *et al.*, 2007; Pizzolla, 2007.

Temperature increase most probably will influence macrophyte community composition as well as occurrence via direct and indirect effects. With respect to the first point, indirect effects, there are reports about direct dependency of phytoplankton biomass development from temperature (Figure X1) under eutrophic, but still nutrient limited (Figure X2) conditions (e.g. Schubert 2005). This implies, that larger phytoplankton biomass would develop at higher temperatures, leading to decreased irradiance availability for macrophytes. The net effects have still to be evaluated since this happens in summer / early autumn, a period where irradiance availability is quite high. With respect to the second point, direct effects, increasing temperatures will led to changes in species composition by A) allowing the survival of warm-water species, excluded from the Baltic by the cold winter conditions and B) eradicating cold-water species which, as shown for e.g. *Laminaria*-species, have a very narrow high-temperature resistance (see for review Bartsch *et al.*, 2008). For both phenomena the recent knowledge does not allow any kind of forecast more precise than "something will happen".

Seasonality studies for macrophytes

In the Baltic Sea, a couple of studies have been performed during the last decades with respect to Seasonality of macrophytobenthos (e.g. Wallentinus 1979, Kristiansen 1972, Wennberg 1992; for an overview, see Qvarfordt 2006, "Introduction"). In contrast to fully marine conditions, low saline-brackish macrophyte communities show a very strong seasonality, since the proportion of perennial species is low. However, as shown by Qvarfordt (2006) as well as Schygula (2007) the establishment of macrophyte communities is a multi-step process taking several years in the southern / central Baltic. Both before-mentioned authors showed a clear season-dependency of recruitement, influencing the following succession pattern, but not the final stage ("climax-stage").

5 ToR c) elaborate connections with the WFD and the role in ICZM and its socio-economic valuation

Mats Blomqvist, Hafok AB, Sweden presented the work behind a Swedish legal regulation (NFS 2008:1 only in Swedish) on how to assess ecological status according to the Water Framework Directive based on submerged aquatic vegetation. He also presented some results of his application of this regulation on data from Swedish coastal waters.

As an introduction the special features of the Swedish coastal waters with large and small scale salinity gradients were presented. To handle these gradients, when assessing ecological status, the coast is divided into 25 different types of which two are transitional. The typology is mainly based on salinity and exposure.

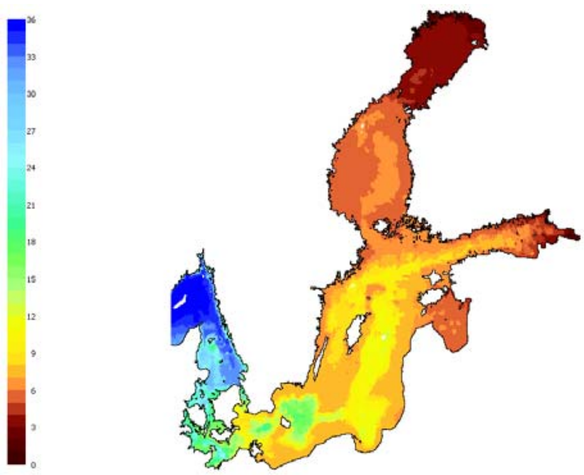

Figure 5.1. Mean bottom layer salinity 1990–2000 (PSU). Data from Baltic Nest Institute, graph made with DAS.

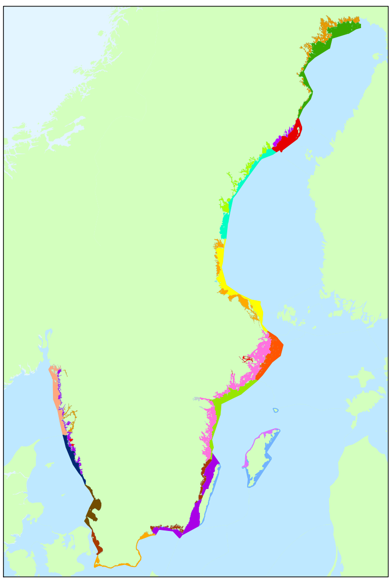

Figure 5.2. Swedish national typology (NFS 2006:1) mainly based on salinity and exposure.

As a result of eutrophication depth distribution of the plants is reduced due to shading. The assessment method is based on depth distribution of a selection of macroalgae and aquatic angiosperms. Each coastal type has a different selection of species. It was not possible to give assessment criteria for three types (two transitional and one coastal) due to large natural fluctuations in salinity and at the same time strong influence by human activities. The selected species are easy to identify and common in the type they represent. Dependent on how deep each selected species is occurring at a given locality a score is given for this species. The boundaries for different scores are based on expert evaluation, historical data and the empirical relationship between water clarity and depth distribution of bottom vegetation. An index is calculated as the mean score of the selected species per locality and year. To be given a score a species depth distribution must not be limited by substrate and the investigated depth must exceed a certain value (limit for highest score for all selected species in a type). To calculate the index at least 3 of the selected species must have been given a score.

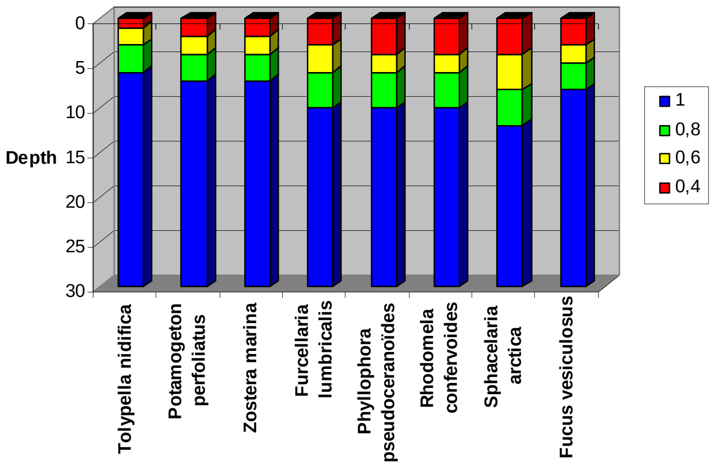

Figure 5.3. Example from national type 14 (outside Askö). In the graph the depth boundaries for the different scores are shown for the selected species in this type.

The ecological status is determined on water body level. The value used for assessment is the mean index value from the localities within the water body. There must be at least three localities within a water body to make an assessment. Due to lack of data and knowledge the boundaries between the five status classes have been set as five equally sized classes. In the future work this will be adjusted when more data and knowledge comes forward.

When applying this assessment method on data from the Swedish coastal water more than half of the transects are to shallow, excluding them from assessment. Most of the data present are from inventories in natural reserves and unpolluted places. As a result almost all assessed water bodies are in the status class high most of the years.

Figure 5.4. Macroalgae and angiosperm ecological status year 2006 and 2007 based on calculations according to rules in the regulation (NFS 2008:1). The blue colour represents status class high.

In Sweden five water authorities are responsible for classification of ecological status of the ~600 coastal water bodies. The regulation states that the water authorities shall check that the monitoring stations are representative for the water body and that the calculated status is reasonable. When this is not the case or data are missing they make an expert judgement of the ecological status class for submerged aquatic vegetation.

Hendrik Schubert introduced the German classification and valuation scheme for the Baltic coast. Germany, by federal state's definition, has no transitional water bodies, but discriminates "outer" and "inner" coastal waters, which is reflected by typification. For the outer coastal waters, a classification scheme basing on substrate-specific depth distribution of species found of indicative values are proposed, but not yet implemented. A first version was made public by Schories *et al*. (2005).

For the inner coastal water bodies with average depths of 2–5 m a depth distribution-based classification approach is impracticable. Moreover, with regard to the exceptional large salinity variability of the German Baltic coast (see Figure 5.3), a typification basing on mean salinity also would erroneous results. Therefore the classification approach for the German southern Baltic coast is basing on a water-body specific description of vegetations forms. Altogether 14 vegetation forms were identified and sorted for classification purposes. The reference conditions were derived from an analysis of herbar records (>8000 from 7 herbarias) and literature records. Approval of reference conditions was done by comparison with recent field data, which led to some adjustments. The complete classification approach for inner coastal waters can be found at:

http://www.biologie.uni-rostock.de/oekologie/archives/Endbericht_ELBO.pdf

The development of both, reference conditions description as well as classification approach are also published in English (Schubert *et al*., 2007; Selig *et al*., 2007 a,b) and German(e.g. Schubert *et al*., 2005).

Martynas explained the WFD sampling scheme at the Lithuanian Coast. 5 Waterbodies had been identified. Reference conditions were taken from Russian colleagues

1955 with *Furcellaria lumbricalis* estimates down to 19 m depth. "Bad" was defined as less than 5 m depth distribution of *Furcellaria*. Pattern the same since 10 years. Reference conditions were never observed again. Discussion whether this was based on drifting algae and whether shallower diver observations would be more applicable. For more details see Annex 5.

Georg Martin reported on a pragmatic approach to the WFD demands. The typology has 6 types of water bodies based of depth salinity and exposure. The classification scheme based on at least three indicators.: max. Depth distribution, max. Depth of Fucus, proportion of perennial species (biomass) special values for every water body. Reference from the Fifties. Borders definition followed, see Annex 5.

The Monitoring Programme along the Estonian coastline shows a great variety of coastal types, sheltered and exposed, which needs a new programme started in 2007

Phytobenthos Monitoring in 7 areas 1995–2006 based on the Riga Bay project under H. Kautsky. New monitoring scheme started in 2007. The first report is due in 2009. 48 transects, 12 sampled annually. Methods follow Kautsky methods/HELCOM guidelines by SCUBA. Problems with classification since reference conditions were assumed too tight. Use HEAT tool developed for HELCOM which computes the quality status of the waterbody. Critical quality element can be identified. Annex/input

The interpretation of results

The phytobenthic communities structure is highly dynamic and not only dependent on changes in environmental conditions. The plant species depth distribution is dependent on the water quality (depletion of light with depth) set by the environmental load and pollution but may also be set by the presence of suitable substrate. Also, the within species population dynamics on a temporal scale result in a species to disappear or reappear on a location. All these factors have to be considered when change is observed in field. For an example of the dynamics of *Fucus vesiculosus* in the Askö area from 1993 to present, see Annex 9.

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6 ToR d) Finalize the ICES TIMES draft on Phytobenthos sampling methodology

Harmonizing methods to make data comparable

Mats Blomqvist, Hafok AB, Sweden presented an overview of the national strategy for marine biological data.

To be able to exchange data, develop assessment methods, make national compilations, report data to international organisations, follow up on local, regional and national environmental objectives and many other things there is a great need for standardisation of field methods, standardisation of naming of species, software for entering of results and efficient national data hosts that makes information freely available on the internet.

Sweden has some standardised field methods both for monitoring and nature conservation inventories of phytobenthos

(http://www.naturvardsverket.se/sv/Tillstandet-i-miljon/Miljoovervakning/Handledning-for-miljoovervakning/Metoder/Undersokningstyper/Undersokningstyp-Kust-och-hav/ and http://swenviro.naturvardsverket.se/dokument/epi/basinventering/basinvent.htm#manualer). There is need to update these method descriptions to better fulfil new demands.

The Swedish Species Information Centre has a responsibility for managing a freely available database on species names (http://dyntaxa.artdata.slu.se). Each taxon is identified via a taxonID that never is deleted and never is changed. Each taxonID can have several names associated but only one can be valid. Names can be of different types (scientific, Swedish etc). This philosophy is now adopted in both monitoring and conservation studies and hence it is now possible to exchange data more easily.

There exists an application for entering of phytobenthic data (in Swedish) that is common to both monitoring and nature conservation. The purpose is to streamline data in order to make it easier for the data host to include data from different providers.

All national and regional data are supposed to be available through national data hosts in the future. There already exist several data hosts today. Phytobenthic transect data is stored at SMHI Swedish Oceanographic Data Centre (http://www.smhi.se/oceanografi/oce_info_data/SwedODC/data_host_sv.htm) (marine biological part under construction 2008).

It was concluded that lots of work remains in this area. The importance of having one national responsible body leading this work was stressed.

H. Kautsky presented methods within phytobenthic communities, from kitchen sieve to over oceanic vessels to satellites.

Standards to follow

HELCOM, ISO, OSPAR (JAMP guidelines), UK

Accepted and comprehensive manuals available from JNCC, ISO standards also recommend the Kautsky-method (with reference to http://www.naturvardsverket.se/upload/02_tillstandet_i_miljon/Miljoovervakning/undersokn_typ/hav/vegbotos.pdf). The method needs one week of intensive training in situ. In Sweden Hans Kautsky is responsible for key development for Baltic phytobenthos species based on BMB. HELCOM MONAS is planning the same.

There is a need for personal continuity in coastal monitoring and training as well as clear QA procedures. Hiring new cheap bidders every year is not the right way. This has clearly been demonstrated in workshops held by the Swedish EPA and practicing parties during spring 2008.

The Aim of the study defines taxonomic resolution, low overview can be obtained by remote techniques, while more detailed observations need video and SCUBA diving. The highest resolution is obtained by collection of random, destructive sampling, most efficient if stratified sampling is used using information (data) from prior estimates of species depth distribution and their coverage.

There is a need for SOP with mandatory and optional elements.

Jan Karlsson uses Lundälv camera at the Swedish west coast where six fixed stations are visited each year (not a standard method!) following an Underwood sampling scheme

Local settings need adaptations of standard methods to locality (Estonia and Lithuanian coast).

7 Any other business

Heye Rumohr presented a new project, the 'TaMOs' project - a scuba diver based monitoring at the Baltic coast of Schleswig-Holstein. TaMOS is the attempt to make the observations of lay divers available for environmental surveillance and scientific use. This is a scientifically supervised cooperation project with the national divers association (TLV-SH) and the league for environment and nature Germany (BUND-SH). The project runs a web based Documentation platform for information exchange. In special seminars Divers can learn to document geo-referenced environmental data by writing a log book after each dive. Taxonomic seminars for species identification allow the lay diver the Species identification of local fauna and flora Following the Ecosystem approach Divers become aware of ecosystem complexity and learn to survey the UW-habitats themselves

The TaMOs project is dedicated to experienced divers in Schleswig-Holstein in Germany. It is concerned with the collection, analysis and evaluation of marine biological and geological data from the Baltic Sea. The intended outcome of TaMOs is the documentation and demonstration of day to day, seasonal and annual variability in the Baltic Sea environment. Interested divers from Schleswig-Holstein will be educated in free seminars to give them the opportunity to join this project without further training. Recording the flora, fauna and sediment distribution are important parameters for the quality evaluation of the Baltic marine environment. Most of these parameters can be measured very easily by divers, if they know how to do it.

The recording of animal, plant and sediment distribution along the complete Baltic coastline of Schleswig-Holstein in Germany has not been done so far. The project is supported by the diving association of Schleswig-Holstein and one intention is to teach divers in seminars in the needed skills to achieve a complete detection of animals, plants and sediments. TaMOs aspires a close cooperation with the provincial environmental agency and for this reason it is necessary to obtain a nearly scientific standard. Such a high standard is needed to achieve comparability with scientific investigations performed by the environmental agency for evaluation of this geographically wide spread survey. The time consuming and expensive scientific studies can only be performed at certain areas at a certain time. Equal accuracy and reliability can not be achieved by a project like TaMOs, but this may not be necessary.

This project is not only supposed to address scientific experts. A further, maybe even more important goal is to show the variability of the Baltic Sea environment right next to our location. This documentation, performed by laymen for laymen during their spare time, is an opportunity to show the beauty of the marine environment. This can only be achieved by volunteers with their all year round support. The variability of the Baltic Sea ecosystem is part of dynamic processes that would be impossible to evaluate by a small group of people. As diving is a sport that is very closely related to nature, divers are the first to know about the changes. TaMOs provides now a platform to make these experiences public.

As part of TaMOs, the divers will be trained free of charge to identify animals and plants. This is supposed to teach the divers which animals can be determined by visual contact and which can't. All participants will be able to determine species on their own after the course and can start right after the course. To support this, TaMOs provides an underwater writing panel with species names and everything necessary to record the abundance and distribution of the most abundant species in a standardized way for each participant. The data exchange is on-line through the TaMOS web page.sargassum

Link:www.tauchmonitor.de

8 Recommendations and action list

Since there is no direct need for a new meeting, the workshop decided to have no new meeting and to solve upcoming problems by correspondence. Phytobenthos questions in general will be covered by the remits of the BEWG.

Action: Hasse to finish TIMES draft. Hasse to report on progress at BEWG meeting 2008

9 Adoption of draft report

The group adopted the draft report and will have a critical view on the final product.

10 Closing of the meeting

The Chair closed the meeting thanked the participants for their inputs and discussions. The group thanked Stockholm University and the Askö Laboratory for their hospitality and unique meeting facilities. The meeting participants left the island by boat at 14:00.

Annex 1: List of participants

Name	Address	Phone/Fax	Email
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Annex 2: Annotated Agenda

Workshop on the role of phytobenthic communities in ICES waters [WKPHYT]

Askö, Sweden, 3–6 March 2008

Group gathering at upper car park Stockholm Central Station, bus terminal and fast train stop Arlanda airport shuffle. Car transfer leaves at 14:00 to Trosa for ship transfer to the island of Askö.

Start 3 March 2008, 16:30

1) Opening & Local Organisation

- 1.1) Introduction of participants
- 1.2) Appointment of Rapporteur
- 1.3) Terms of Reference

2) Adoption of Agenda

- 2.1) Proposals for any other business

3) ToR a) explore and discuss the role of phytobenthic plant and animal communities in ICES waters, including epiflora and fauna

Input: all

4) ToR b) document the population dynamics and annual cycles of phytobenthos communities on a regional scale;

Input: all

5) ToRc) elaborate connections with WFD and the role of phytobenthos in ICZM and its socio-economic valuation

6) ToR d) discuss the urge of data sharing and storage; which parameters are in common, to what purpose and strategy to make data comparable

7) ToR e) finalize the ICES TIMES draft on Phytobenthos sampling methodology.

Hasse: to introduce the draft of the TIMES document

All: discuss and update the document having in view other method recommendations with the aim to avoid contradictive advice

8) Any other business

9) Recommendations and Action List

- Recommendations for next years meeting (2009)
- Recommendations for Theme Sessions/ Symposia
- Action List

10) Adoption of the report

(due 15 May 2008 for MHC and draft wk17 for BEWG)

11) Closing of the meeting

Depart from the island by ship to Trosa and bus transfer to Stockholm, arrival at ca 15:00 to Stockholm C.

Opportunity to attend EUNIS meeting at Naturvardsverket, Stockholm Thursday afternoon (at 16:00) until Friday afternoon at 17:00

Annex 3: WKPHYT terms of reference for the next meeting

Since there is no direct need for a new meeting, the workshop decided to have no new meeting and to solve upcoming problems by correspondence. Phytobenthos questions in general will be covered by the remits of the Benthos Ecology Working Group (BEWG).

Annex 4: Recommendations

Recommendation	For follow up by:
1.Harmonization of makrophytic taxa lists for Europe	BEWG, ICES Data Center
2.Development of determination keys for phytobenthic taxa from the Baltic	WKPHYT (by correspondance), BEWG

Annex 5: New environment monitoring programme in Estonian territorial waters of the Baltic Sea

New monitoring system corresponding to the requirements of WFD was esstablished starting from December 2006. The proposal for the new monitoring programme was developed by Estonian Marine Institute with consultation with Water Department of Estonian Ministry of Environment.

The proposal has been discussed on public hearing held in February 2006 involving representatives of Ministry of Environment, scientific institutions and NGOs.

Estonian Marine Monitoring Programme, proposal (short description of the monitoring scheme)

1 Monitoring of the coastal sea areas outside the 1 nm coastal zone.

The aim of this subprogramme is to collect the data for assessment of the state of the marine environment in Estonian territorial waters and EEZ of the Baltic Sea and fulfillment of the obligations under international conventions.

1.1 Seasonal cruises.

Station network of 17 stations are sampled twice a year: once in winter (ice free period) and once in mid summer (may-september). Station network is identical to previous monitoring programme valid during the period 1994-2006.

Monitoring parameters:

- Concentration of nutrients in sea water (winter)
- Oxygen concentrations in nearbottom water layer
- turbidity
- distribution of salinity and temperature in water column
- concentration of chlorophyll a
- abundance and biomass of phytoplankton
- abundance and biomass of zooplankton
- abundance and biomass of zoobenthos (summer)

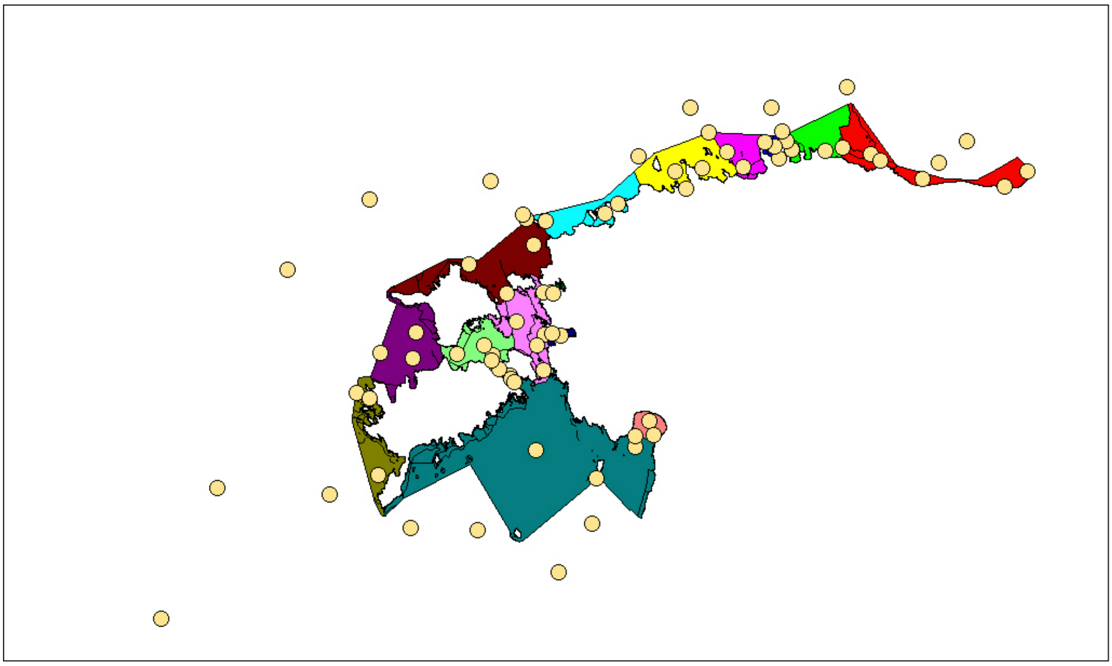

Figure 1. Location of proposed new station network and coastal waterbodies in 1 nm zone. Only pelagic station network is shown.

1.2. Ferrybox monitoring (automatic monitoring system performed from passenger ferries)

Transekts (actual amount of measurements depends on the agreements with ferry companies and other circumstances and should be revised annually)

Tallinn-Helsinki: 7 stations

Tallinn-Stockholm-Tallinn: 11 stations

Monitoring parameters:

- Abundance and biomass of phytoplankton in nearsurface layer
- concentration of chlorophyll a in nearsurface layer
- concentrations of nutrients
- salinity and temperature of nearsurface layer

2 Monitoring of coastal waters within the 1 nm zone counted from baseline.

The aim of this subprogramme is to fulfill the monitoring requirements of WFD and Habitat directive and also national assessment needs.

2.1. Surveillance monitoring.

Station network.

Station network covers all defined waterbodies. In each waterbody there are defined three stations for pelagic monitoring, three areas for monitoring of phytobenthic communities and three stations for monitoring of zoobenthos.

Stations are selected to cover the traditional station network in maximum extent (for preserving time series) and also requirements of monitoring of areas belonging to NATURA 2000 network are included.

Monitoring parameters:

Pelagic stations:

- Concentrations of nutrients in water column
- turbidity
- salinity
- temperatude profile
- qxygen concentrations in nearbottom layer
- biomass and species composition of phytoplankton
- concentration of chlorophyll a

Phytobenthos monitoring areas:

- species composition and vertical distribution of phytobenthic communities
- vertical distribution of phytobenthos biomass
- vertical distribution of phytobenthos coverage

Zoobenthos monitoring stations:

- abundance of zoobenthos communities
- species composition of zoobenthos communities
- biomass of zoobenthos species

Monitoring frequency:

Pelagic stations: From each waterbody all pelagic stations are sampled during one full year (in the period 2007–2009) with frequency 10–11 times per year.

Benthic stations: all stations are sampled once per year (july-august).

2.2. Operational monitoring.

This type of monitoring is carried out in waterbodies having classification of ecological state less than "good". These waterbodys in Estonian coastal sea are currently Tallinn Bay, Pärnu Bay, Narva Bay, Haapsalu Bay and Matsalu Bay.

Station network.

In each waterbody there are selected three pelagic stations, three areas for measuring phytobenthic parameters and three stations for measuring zoobenthos. Station network is selected to cover the traditional station network in greatest possible extent (to preserve long time series).

Monitoring parameters.

Pelagic stations:

- Concentrations of nutrients in water column
- turbidity
- salinity
- temperatude profile
- qxygen concentrations in nearbottom layer

- biomass and species composition of phytoplankton
- concentration of chlorophyll a

Phytobenthos monitoring areas:

- species composition and vertical distribution of phytobenthic communities
- verstical distribution of phytobenthos biomass
- vertical distribution of phytobenthos coverage

Zoobenthos monitoring stations:

- abundance of zoobenthos communities
- species composition of zoobenthos communities
- biomass of zoobenthos species

Frequency

Measurements are carried out at pelagic stations with frequency 10–11 times per year annually. Benthic stations are measured once per year.

2.3. Investigative monitoring.

Surveillance monitoring programme will be initiated in case of some exceptional phenomena occurring which needs asessment of ecological status. Structure and funding of such monitoring will be decided in each case separately.

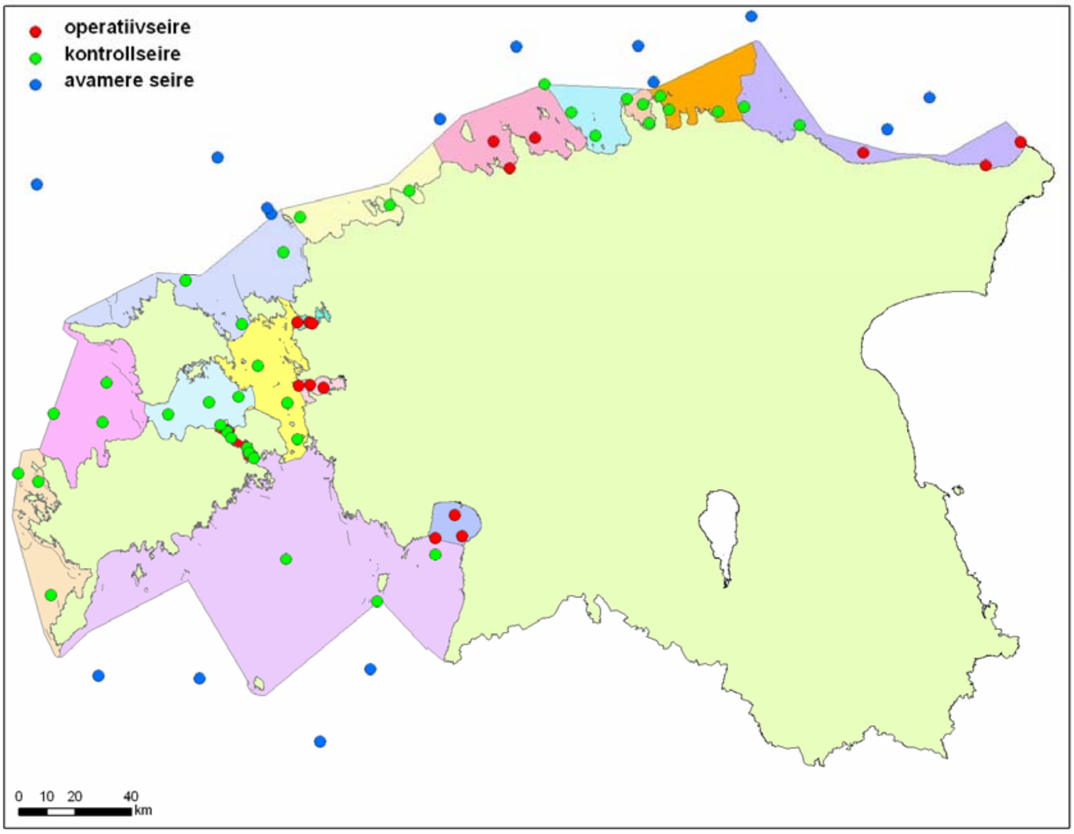

Figure 1. Pelagic station network of marine monitoring programme and waterbodies of Annex 6. Coastal waters. Green – surveillance monitoring (frequency one full year (11–13 times per year) during the assessment period; Red – operational monitoring (frequency every year, 11–13 times per year); Blue – open sea monitoring – frequency 2 times per year.

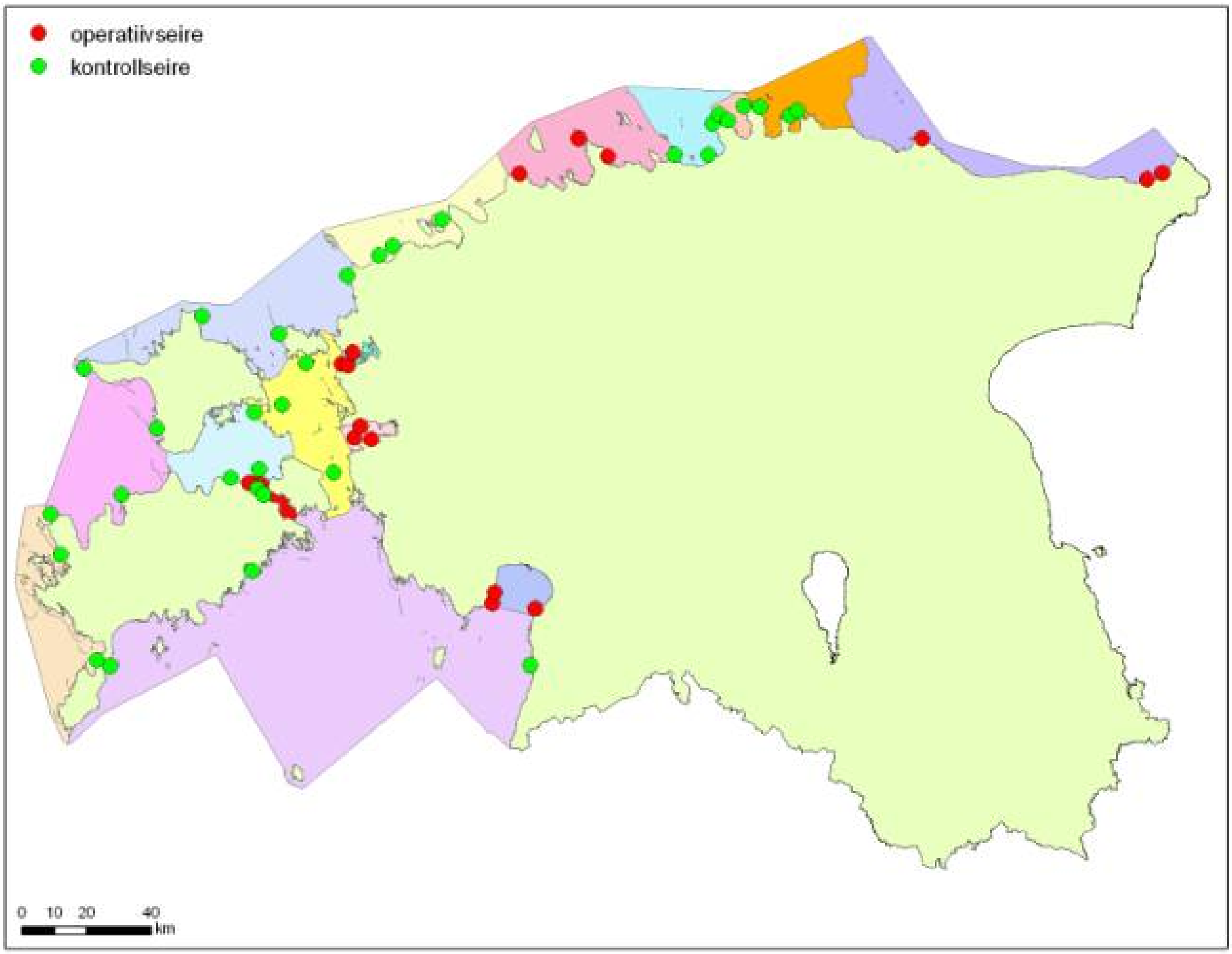

Figure 2. Phytobenthos monitoring station network and coastal waterbodies. Green – surveillance monitoring (monitored once per aasessment period); Red – operational monitoring (monitored every year).

Annex 6: The Distribution of Characeans in Estonian waters

Kotta, J., Torn, K., Martin, G., Orav-Kotta, H., Paalme, T. 2004. Seasonal variation of invertebrate grazing on *Chara connivens* and *C. tomentosa* in Kõiguste Bay, NE Baltic Sea. *Helgoland Mar. Res.* 58, 71-76.

Abstract

Charophtes are a highly endangered group of algae. In the Baltic Sea the species number, distribution area and biomass of charophytes have significantly decreased in the recent decades. Although eutrophication triggers their initial decline, the mechanism of the final extinction of charophyte populations is not fully understood. An *in situ* experiment was performed to study the role of the mesoherbivores *Idotea baltica*, *Gammarus oceanicus* and *Palaemon adspersus* in the decline of charophytes in the northeastern Baltic Sea. Invertebrate grazing showed a clear seasonality. Grazing pressure was low in April, moderate in July, and high in October. The grazing of *P. adspersus* on charophytes was negligible whereas *I. baltica* and *G. oceanicus* reduced significantly the biomass of charophytes in the field. Low photosynthetic activity (high decomposition rate) of the charophytes favoured grazing. The studied invertebrates preferred *Chara tomentosa* to *C. connivens*. Low consumption of *C. connivens* may reflect its non-native origin. The experiment suggests that under moderately eutrophicated conditions grazers are not likely to control charophyte populations. However, grazers have the potential to eliminate charophytes in severely eutrophicated systems under the stress of filamentous algae.

Torn, K.,Martin, G. & Paalme, T. 2006. Seasonal changes in biomass, elongation growth and primary production rate of Chara tomentosa in the NE Baltic Sea. Ann. Bot. Fennici 43, 276-283.

Abstract

The seasonal dynamics of the biomass, elongation growth and primary production rate of C. tomentosa were measured in Rame Bay (NE Baltic Sea) during the vegetation period of 2002. The measurements showed extremely high plant height (up to 142 cm) and biomass values (5.2 kgWW m--2), indicating the importance of C. tomentosa for the whole coastal water ecosystem. The apical part of the thallus grew more intensively from early spring to midsummer. The growth rate of the subapical section was very low during the entire observation period. The plant's diurnal net primary production rate peaked in July (43.4 mgO2 gDW--1 24h--1); remarkably lower rates were measured in May and September. The elongation growth and primary production were not correlated with water nutrient concentrations and water temperature. As the active growth of C. tomentosa takes place during a relatively short period at the beginning of summer, the amount of available PAR and the temperature levels during this sensitive time can have a significant effect on the community in the same year.

Annex 7: Typology and classification of ecological status of Lithuanian coastal and transitional waters: case of phytobenthos (Daunys *et al.*, 2007)

Parameters of phytobenthos (macroalgae and angiosperms) proposed for defining reference conditions were maximum depth of submerged macrophytes (later narrowed to potameids) and depth limit for *Furcellaria lumbricalis.* The use of depth limit of potameids was restricted to transitional waters of the Curonian lagoon. Due to environmental conditions (lack of suitable substrates, high wave exposure, etc.) none of the phytobenthos parameters can be applied to the southern sandy coast of the Baltic Sea, whereas criteria of the depth limit of *F. lumbricalis* is applied to stony (northern) coastal water of the Baltic Sea (Table 3.1.4.1).

Table 3.1.4.1 Description of reference and good water quality status (H/G) according to phytobenthos quality criteria for coastal and transitional waters. From: 1) Type specific reference …, 2004; 2) Razinkovas, 2006; 3) Olenin et al. 2006.

Parameter	The Baltic Sea		Plume of the Curonian lagoon in the Baltic Sea	Curonian lagoon	
	sandy coast (southern)	stony coast (northern)		Northern part	Central part
1) Maximum depth limit for submerged macrophytes (m) 2) Maximum depth limit for belt of potameids (m)	-	-	-	1) >2/>1.5 2) >3/>1	1) >2/>1.5 2) >3/>1
Depth limit of *Furcellaria lumbricalis* (m)	-	1) ≥18/≥15 3) ≥19/≥15	-	-	-

No angiosperms (e.g. sea grass *Zostera marina*) were found at the Lithuanian coast during underwater investigations in 1992-2006. Also there are no reliable historical data on their presence/absence in earlier time. Macroalgae are able to survive only if attached to sufficiently stable substrate (stones and boulders) due to very active hydrodynamic and destructive effect of waves and sand abrasion. The most important, habitat forming species at the Lithuanian coast is the red algae *Furcellaria lumbricalis*. Dense overgrowths of this species perform a crucial role in a coastal ecosystem providing spawning substrate for fish, shelter for fish fry and supporting the highest marine biodiversity at the Lithuanian coast. Due to commercial value of *F. lumbricalis*, its stock assessment was performed in late 1950s–1960s (Kireeva, 1960a,b; Blinova, Tolstikova, 1972). Thus, this is the only phytobenthos species for which the historical record dates back to the pre-eutrophication time.

The water quality assessment criteria are established comparing the historical data with patterns of recent distribution of *F. lumbricalis* in the Lithuanian coastal waters. The reference conditions are defined according to the maximum depth record of these red algae at the Lithuanian coast in late 1950s: 19 m (Kireeva, 1960). Similar depth limit (20 m) was recorded during the same time period at Blekinge, south-eastern coast of Sweden (Essays on biological productivity in the Baltic Sea, 1984). Good status is defined by the maximum depth record within the 15–19 m range which generally corresponds with the recent distribution limit of *F. lumbricalis*. This limit did not change significantly during the recent five decades (Olenin *et al.*, 2003; Bučas *et al.*, in prep.; unpublished data) (Table 3.3.3.1).

Table 3.3.3.1. Suggested description of water quality for the open Baltic Sea stony coast according to the maximum depth limit of the red algae *Furcellaria lumbricalis*

Water quality status	Maximum depth limit, m	Description
Reference	≥19 m	The maximum depth limit according to historical data (pre-eutrophication) time
Good	≥15 and <19 m	Recent depth limit which did not change significantly since 1968
Moderate	≥9 and <15 m	Decline in the most valuable dense overgrowths
Poor	≥5 and <9 m	Loss of the most valuable dense overgrowths
Bad	<5 m	Loss of the red algae

Moderate status is defined by the maximum depth record within the 9 – 15 m range. It is suggested that the decline of depth limit up to 15 m will result in subsequent reduction of the most valuable, dense overgrowths at lower depths, which may be interpreted as habitat alteration. If the maximum distribution depth will decline to 9 m it is unlikely that the dense overgrowths at lower depths will survive. Poor status is defined by the maximum depth record within the 5–9 m range, which is classified as a critical limit determining loss of dense overgrowths at lower depths. Bad status is defined by the maximum depth limit at less than 5 m, which is considered as a very high risk of *F. lumbricalis* extinction at the Lithuanian cost due to competition with opportunistic filamentous algae, reduced area of available substrate and strong wave effect.

Suggested classification of water quality according to maximum depth of *Furcellaria lumbricalis* in the plume of the Curonian lagoon in the Baltic Sea follows the same principle as those used in coastal waters. The water quality assessment is based on comparison of historical data with patterns of recent distribution of *F. lumbricalis* (Table 3.4.3.1). The reference conditions are defined according to the maximum depth records of these red algae south off Palanga in late 1950s, when the species was found in depths of 17 m (Kireeva, 1960). Good status is defined by the maximum depth records of the recent distribution of *F. lumbricalis* in the plume of the Curonian lagoon. This range of 14–17 m did not changesignificantly during the recent five decades (Olenin *et al.*, 2003; Bučas *et al.*, in press; unpublished data) (Table 3.4.3.1).

Table 3.4.3.1. Suggested description of water quality of plume of the Curonian lagoon in the Baltic Sea according to the maximum depth limit of the red algae *Furcellaria lumbricalis*

Water quality status	Maximum depth limit, m	Description
Reference	≥17 m	The maximum depth limit according to historical data (pre-eutrophication) time
Good	≥14 and <17 m	Recent depth limit which did not change significantly since 1968
Moderate	≥9 and <14 m	Decline in the most valuable dense overgrowths
Poor	≥4 and <9 m	Loss of the most valuable dense overgrowths
Bad	<4 m	Loss of the red algae

Moderate status is defined by the maximum depth records within the 9–14 range following assumption that the decline of the species depth limit up to 14–15 m will result in subsequent reduction of the most valuable, dense overgrowths at lower depths. If the maximum distribution depth will decline to 9 m it is unlikely that the dense overgrowths will survive at lower depths. Although the most valuable dense belts of *F. lumbricalis* are observed north off Palanga only, we consider depth range between 4 and 9 meters to be the most optimal in terms of transparency and shelter provided by underwater slope geomorphology. Therefore, poor status is defined by the maximum depth record within the 4–9 m range, which is classified as a critical limit determining loss of dense overgrowths at lower depths. Bad status is defined by the maximum depth limit at less than 5 m, which is considered as a very high risk of *F. lumbricalis* extinction at the Lithuanian cost due to competition with opportunistic filamentous algae, reduced area of available substrate and strong wave effect.

Comparison of Lithuanian classification of ecological status of coastal and transitional waters with those existing in neighboring countries: Latvia

Macroalgae as a quality element were used only in the stony coastal water types of Latvia, as the underwater habitat structure in the transitional waters and on soft sediments does not support growth of phytobenthos. The best data for underwater vegetation for the Gulf of Riga was found for depth limit of *Fucus vesiculosus* and macroalgal community, whereas along the Latvian coast of the Baltic Proper - depth limit of *Furcellaria lumbricalis* and macroalgal community. Consequently, maximal depth distribution of key species and macroalgal communities were selected as the most feasible parameter (Table 3.5.1.4).

Table 3.5.1.4. Values of indicators for the ecological status classes of coastal waters. (1) - values from Report on Article 5 (Ministry of the Environment of the Republic of Latvia, 2005) (2) - Transposition and Implementation of the EU Water Framework Directive in Latvia (2004)

Indicator	Stony coasts of the Gulf of Riga		Stony coasts of the Baltic Proper	
	High	Good	High	Good
Depth limit of *Fucus vesiculosus*	> 10(1) m	(6 – 10 m) (2)		
Depth limit *Furcellaria lumbricalis*			>20(1) m 15 - 20(2) m	(10 – 15 m)(2)
Depth limit of macroalgal community	> 11(1) m	(10 – 11 m) (2)	>22(1) m (15 - 22 m) (2)	(10 – 15 m)(2)

For the Baltic Proper all values are based on data from 1998 as the earlier references (Korolev *et al*., 1993) have records of reduced algal depth limits and distribution due to tanker accident in this area. Maximal depth limit both for *F. lumbricalis* and for whole macrophyte community may possibly be higher, i.e. the algae can grow deeper as the suitable substrate is present down to the depth of 30 meters, but no data are available.

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ToRc) Protected marine areas in Lithuania including concervation of phytobenthos

The Seaside Regional Park was established by the decision of The Supreme Council of Lithuania in 1992, in order to protect the seashore landscapes, natural and cultural heritage, the Baltic Sea biodiversity and spawning grounds. The Seaside Regional Park covers the area of 8000 hectares along the seashore (30 km) in Klaipeda and Palanga, where 5033 hectare is land area and the rest is sea (Karkle Thalasologic Preserve) (http://www.vstt.lt/VI/index.php#r/141).

Reefs (Natura 2000 Code 1170) were included in the draft list of habitats included in the Annex I of the Habitat Directive, occurring in Lithuania. Reefs described as stony bottom with dense overgrowths of red algae (*Furcellaria lumbricalis*) and clumps of mussels (*Mytilus edulis*) of the mainland sub-marine coastal slope extended from the shore down to 20–25 m depth (http://www.am.lt/natura2000/en/apie.php). The stones are exposed to air at the most of upper part of the slope. The preliminary total area is 1073 ha.

Annex 8: Macrophyte studies in the Gulf of Riga

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The macrophyte studies in the Gulf of Riga have been performed fragmentary by different scientists already from the middle of 19th century (Eichwald, 1852, Skuja, 1924, Kumsare *et al*. 1974, Kirejeva, 1960, Kukk *et al*., 1992). During this period different methods and approaches have been used by researchers to find out the species composition of the underwater vegetation of the Latvian part of the Gulf of Riga. These investigations there focused on species identification only. During this period different methods and approaches have been used.

In the 1990s within the Gulf of Riga Project for the first time phytobethic communities were sampled using SCUBA techniques (Kautsky *et al*., 1999).

From 1999, after first Guidelines for monitoring of phytobenthic plant and animal communities in the Baltic Sea (Annex for HELCOM COMBINE programme, 26 March. 1999) appeared, in a frame of grant form Latvian Council of Sciences "Functional biodiversity of the Gulf of Riga under anthropogenic impact" macrophyte studies became regular – 1999–2007 (every second year).

Three transects, with two additional for every transect, were chosen in the Gulf of Riga with different eutrophication impact. One main transect was located on the west coast of the gulf, second – at the southeastern part (three river impact) and one – close to the border Latvia/Estonia in the North Vidzeme Biosphere Reserve. According to guidelines for macrophytes following **core** v**ariables** were measured by using SCUBA diving:

- Site position;
- Transect depth profile;
- Substrate;
- Depth distribution of important plant species;
- Composition of plant species;
- Coverage% of plant species;
- Temperature;
- Water transparency;
- Salinity.

Main parameters

- Nutrients in water;
- Algae belt distribution.

Supporting studies

- Biomass, g dry weight/m^2;
- Chlorophyll *a*;
- Macrozoobenthos;

- Epifauna on macrophytes;
- Phytoplankton;
- Zooplankton;
- Microbial food web;
- Heavy metal concentrations in sediments and macrophytes.

According to historical data from 1924 till 2007 macrophyte maximum depth distribution has diminished from 14 m in the west part to 6 meter in the southeastern part of the Gulf.

According to our studies main results for macrophyte communities in the Gulf of Riga are following: together at three transects with 2 additional transects from 1999 till 2007 28 species were identified. At the Mersrags transects with Secci disk depth 3.2 m 26 species were identified. At the Saulkrasti transect (south-eastern part of the Gulf) with mean water transparency 2.2 m all together 16 species, and Ainazi (Biosphere Reserve) with water transparency – 2.0 m - 14 species were identified.

During 1999–2007 salinity ranges at the west coast from 4.96 PSU till 5.72; at the south-eastern coast from 3.99 till 5.42 PSU.

Both salinity, water transparency, nutrients in water, suspended material coming from rivers as well as many other factors (type of substrate, temperature, ice coverage, etc) are responsible for macrophyte community structure. Although from year to year there are some changes, long tern data illustrates that the west coast macrophyte communities are healthier and their diversity is higher in comparison with south-eastern transect communities. Data of epifauna from investigated transects are comparatively different: at the west coast transect 16 species and at the south-eastern coast – 10 species. This reflects as well to the plant belt biomasses. As an example of the biomasse distribution from 2007 is illustrated as follows:

Biomass of macrophytes in different belts, g dry weight/m^2 ,2007

Transects	0–1.5m	3m	5m	7m
West coast	104.58	445.05	57.1	53.7
South-eastern	56.86	188.1	4.54	-
Biosphere reserve	79.59	393.06	39.14	51.76

Long-term data of macrophyte communities are comparatively stable at different transects and therefore these chosen sites could be used as reference sites for macrophyte health indication according to WFD.

Recently Latvia together with Lithuania and Estonia are involved in Life project to establish marine Natura 2000 sites (www.bef.lv) in the Gulf of Riga and open Baltic coast.

Laboratory of Marine Ecology have a long time experience for heavy metal studies in the Gulf of Riga in sediments and littoral waters (Kulikova, 1995; Kulikova, 1996; Seisuma and Kulikova, 1999; Seisuma and Kulikova, 2000, Z.Seisuma, I.Kulikova, 2000a; Zinta Seisuma, Irīna Kulikova, 2000b), data 1997–2007 about their levels in bottom vegetation were measured.

The ability of some marine organisms to accumulate metals makes these species suitable for measuring the accumulation of metals in marine areas. An indicator organism should fulfill the following requirements, among others: be of reasonable size, be sedentary, be easily collected and be abundant in the study area. Water plants posses some characteristic features which enable them to absorb from sediments and water such metals which are essential for their growth and development. These metals include Cu, Zn, Ni, Fe and Mn. Water plants also accumulate toxic metals which may not have any biological function, and these metals include: Hg, Cd, Pb.

The macrophyte samples were collected in a coastal area of the Gulf of Riga in 1997, 1999, 2001, 2003, 2005, and 2007 on transects according to study design. Eight different species from *Phaeophyta* (*Fucus vesiculosus*), *Chlorophyta* (*Cladophora glomerata*, *Enteromorpha intestinalis*), *Rhodophyta* (*Ceramium tenuicorne*, *Furcellaria lumbricalis*), *Charophyta* (*Chara aspera*), and *Magnoliophyta* (*Potamogeton pectinatus*, *Zannichellia palustris)* groups were collected in the western coast of the Gulf of Riga- transect Mersrags – and eastern parts of the gulf (transects Saulkrasti and Ainazi) from a boat using SCUBA diver.

The concentrations of metals changed between sampling transects and investigation years. In different years (1997, 1999, 2001, 2003, 2005, 2007) and transects (Mersrags, Saulkrasti, Ainazi) concentrations of metals were compared in most widely distributed brown algae *Fucus vesiculosus*. The differences between Hg, Cd, Pb, Cu and Zn in *F. vesiculosus* were stated all times.

(Seisuma and Kulikova, 2005; Kulikova and Seisuma, 2005a; Kulikova, Z.Seisuma, 2006).

Comparing metal concentrations in sediment in 2005 with those in former years it was stated decrease tendency of Cu, Pb concentrations, but for Hg, Cd and Zn concentrations hesitated in small range. For algae too was stated decrease of Pb and Cu concentrations in time from 1999 till 2005, but for Hg, Cd and Zn concentrations were observed only fluctuations.

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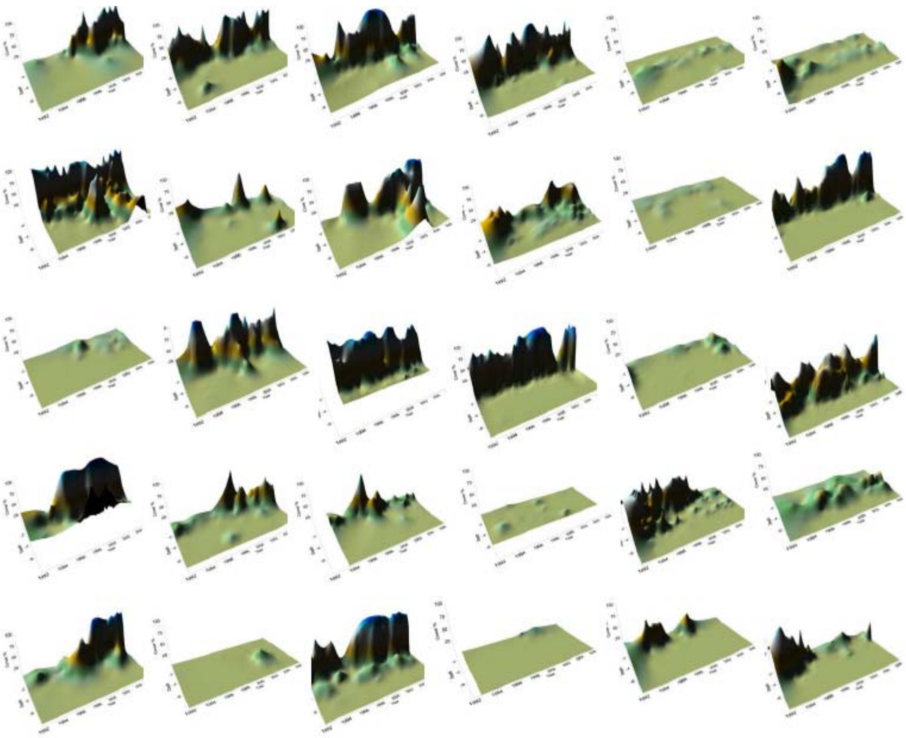
Annex 9: The interpretation of monitoring data

http://groupnet.ices.dk/WKPHYT2008/Report%202008/Fucus%20in%20Askö%20area%20II.pdf

In figure the change in depth distribution and cover degree of the bladder wrack *Fucus vesiculosus* L. in the Askö area is illustrated. In all, 30 stations each with one transect were visited once in August-September every year between 1993 and 2006. The upper left corner is the innermost station and in the opposite corner of the figure is the most wave exposed station. For several of the stations also earlier data are included (investigations started in 1974 but did not occur annually). The last years the WFD was developed for Sweden. For the base of the criteria we have chosen the maxim depth of a range of species which change with the basins along the entire Swedish coast (http://www.naturvardsverket.se/Documents/publikationer/620-0149-0.pdf). Fucus vesiculosus is one of the species used in the Baltic proper and in the Bothnian Sea. The hypothesis is that attached plants reflect the water quality of the water column. The cleaner the water is the deeper the plants can penetrate. The criteria for good was given by historical data (e.g. Waern, 1952) or derived from deepest observations in the different water basins.

When interpreting the data from the Askö area, the depth distribution alters considerable between the different stations and a blunt application of the quality criteria would lead to divergent classifications. Several would be directly wrong, as the applied method postulates the species being able to penetrate down to the depth that the water quality allows. In many cases, instead the lack of suitable substrate will set the depth limit. These stations have to be excluded from the analysis for the WFD. On some stations the Fucus community (coverage) fluctuates and also almost/totally disappear. These cases may not always be related to the water quality of the area. In that case a general decline would have been expected, at least on several stations within a given sub-area. More probable, this is due to population dynamics within the Fucus–community where senescent populations of equal age spawn, loose fitness and then are easily detached. Even in this case the observed change is not correlated to environmental changes.

The Askö case clearly demonstrates the importance of ecological knowledge when classifying water bodies. New programmes must be aware of the “pitfalls” and design accordingly, although this will not solve all problems.



Depth distribution and cover of *Fucus vesiculosus*, graphs based on national monitoring data from Askö area, x-axis is time 1992-2006, y-axis is depth 0-7 m, z-axis is cover 0-100%, localities are sorted by exposure, upper left corner sheltered, lower right corner exposed. Graphs made by Mats Blomqvist.