Contract EVK3-CT-2001-00065
Characterisation of the Baltic Sea Ecosystem (CHARM)






Final Report including 3rd Periodic Report, Management Report and Final T.I.P. from the CHARM Project

Contents

1 Preface

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Re: Contract: EVK3-CT-2001-00065

Characterisation of the Baltic Sea Ecosystem: Dynamics and Function of Coastal Types – CHARM

On behalf of the CHARM project I hereby submit:

- 2 signed copies of all cost statements,
- 3 copies of the 3rd Periodic Report, and
- 3 copies of the Final Report covering the period 1 December 2001 to 30 November 2004

At the end of the final report, there are 3 copies of each of the scientific products and some technical reports.

Yours sincerely

Bo Riemann
Co-ordinator

Roskilde, Denmark
31 January 2005

2 3rd Periodic Report

This report is divided into an administrative part and a technical part. The administrative part includes status from the project Characterisation of the Baltic Sea Ecosystem (CHARM) – Contract EVK3-CT-2001-00065, covering the period 1 December 2003 to 30 November 2004. With respect to the technical part, the reader is referred to the final report.

2.1 Administrative part

The majority of the activities has been interdiciplinary activities between the work packages, preparations of manuscripts, meetings in sub-groups, preparation of the Monitoring Strategy, the User's Guide, and the final report. A status of the major events in the period includes:

- All deliverables are done.

- The final workshop was held in Tallinn, Estonia, during August 23-25, 2005. The title of the workshop was "Towards operational management of coastal eutrophication in Europe". A total number of 71 participants attended the meeting.

- The final report has been the most urgent deliverable including the completion of a large number of manuscripts and reports.

2.2 Objectives

The overall objective of CHARM is to develop, test and validate a methodological approach to characterise type areas of the Baltic Sea coastal ecosystems and study the dynamics and function of these areas in relation to anthropogenic pressures. This study has been developed to provide a scientific foundation for fulfilling the requirements of the EC Water Framework Directive (WFD). The following key issues are addressed:

- Development of a common methodology for establishing coastal types in the Baltic Sea
- Identification of the key factors triggering ecosystem alteration and their relative importance
- Identification of the key indicators for ecosystem functioning in relation to alteration of the coastal ecosystems
- Development of quantitative ecological relationships and empirical models that describe the relationship between anthropogenic pressure and key indicators in the coastal zone
- Derive ecological reference conditions for Baltic coastal water bodies
- Development of recommendations for new monitoring strategies for Baltic Sea coastal ecosystems based on the developed typology, reference conditions and key indicators.

2.3 Status for deliverables

Over the total project period, several delays have been detected in the deliverables. Most of the reasons for the delays include e.g. complexity of data quality, availability of data, and difficulties in combining databases. All of the delays are now back on schedule, and many of the 36 deliverables contain a number of products above the quantity and quality promised in the CHARM DoW. This is a very fortunate situation, and is caused by the work of a number of dedicated scientists in CHARM.

The CHARM project has operated in the zone between basic and applied research and management in relation to the implementation of the European Water Framework Directive (WFD). This is a difficult research regime, which is partly outside the scope of more traditional ecological research. Nevertheless, the outcome of the project demonstrates that the partners certainly took up this challenge. In some of the more soft defined deliverables, the content of the deliverables can be discussed in relation to their ability to represent ready contributions to managers. The CHARM partners could certainly have needed more time to further improve these deliverables. On the other hand, it is also recognised that a number of the results from the CHARM project are now an integrated part of two new EU-projects (REBECCA and THRESHOLDS). This suggests that the CHARM results will continue to be a central part in the European implementation of the WFD and the Habitat Directive, and that dissemination will continue in the future.

In a few cases, additional problems have made it necessary to illustrate relationships and reference conditions for selected areas and not for the entire Baltic Sea. Within the area of bottom fauna, the planned deliverables were defined in too much detail at the outset of CHARM, and thus the quantitative relationships between the Baltic Sea environment (coastal typology) and zoobenthos on the one hand, and the numerical description of zoobenthos as an ecological quality element on the other has not been successful due to lack of fully comparable data (or data from what could be defined as "pristine conditions"; historic data are not sufficient, as the species composition varies over time in an unpredictable and non-reversible manner). Also, the definition of ecological reference conditions for zoobenthos has failed in the sense that it is impossible to use historic scenarios as reference points, since the natural succession of the assemblages indicates significant changes over time, and with an increasing number of successful non-native benthic species being permanently established along the coastal regions of the sea, these have to bee taken into account. On the other hand, on regional or national scales some success has been possible. See further on the comparison between deliverables and published material (page 25). These changes are outside our expectations, however, regional and national examples demonstrate that in some cases empirical relationships were found, in others there were no clear trends.

Below is inserted a section of the "Description of Work" document from CHARM (page 28) now including the status of all the 36 deliverables.

Deliverable no.	Deliverable title	Delivery date	WP no.	Dissemination level	Status
1	Workshop 1	Month 1	7	PU	done
2	Compilation of mailing list of authorities	Month 1	1	PU	done
3	Quality controlled data sets for surface sediments, phytoplankton, macrophytes, benthic fauna and water chemistry	Month 6	1-5	PU	done
4	Morphometrical inventory of the Baltic	Month 6	1	PU	done
5	Project web site	Month 6	7	PU	done
6	Report to the Commission	Month 6	1-7	PU	done
7	Draft of scientific paper on benthic monitoring data	Month 12	4	PU	done
8	Report on state-of-the-art monitoring	Month 12	6	PU	done
9	Map of sediment characteristics of the Baltic coastal zone	Month 12	1	Da	done
10	Report to the Commission	Month 12	1-7	PU	done
11	Analysis of benthos vs. environmental gradients	Month 18	4	PU	done
12	Forcing data for hydrodynamical modelling	Month 18	1	PU	done
13	Report to the Commission	Month 18	1-7	PU	done
14	Map of distribution and description of regulation of phytoplankton community indices	Month 20	2	PU	done
15	Small scale vegetation models	Month 20	3	PU	done
16	Maps of distribution patterns of water chemistry variables in the Baltic coastal region	Month 24	1	PU	done
17	Using phytoplankton community indices as quality elements for ecological classification	Month 24	2	PU	
18	Computation of retention times and stratification	Month 24	1	PU	done
19	First draft typology, including map of spatial distribution of type areas	Month 24	1	PU	done
20	First draft reference conditions	Month 24	2-5	PU	

Deliverable no.	Deliverable title	Delivery date	WP no.	Dissemination level	Status
21	Draft of scientific paper relating phyto plankton and macrophytes to typology	Month 24	1-3	PU	
22	Draft of scientific paper relating phytoplankton and benthic infauna to typology	Month 24	1,2 and 4	PU	done
23	Workshop 2	Month 24	7	PU	done
24	Report to the Commission	Month 24	1-7	PU	done
25	Large scale vegetation models	Month 30	3	PU	done
26	Draft of 2 scientific papers relating biological indicators and water quality parameters to physical gradients	Month 30	lead by WP1	PU	done
27	Report to the Commission	Month 30	1-7	PU	done
28	Workshop 3	Month 32	7	PU	done
29	Draft of 2 scientific papers relating biological indicators and water quality parameters to physical gradients with emphasis on reference conditions	Month 36	lead by WP1		done
30	Definition of vegetation indicators	Month 36	3	PU	done
31	Verified typology including map	Month 36	1 and 7	PU	done
32	Verified reference conditions (including map) for all quality elements	Month 36	2-5	PU	done
33	Numerical relationships between benthos and environmental gradients	Month 36	4	PU	done
34	Monitoring recommendations for the Baltic coastal zone	Month 36	2,5,6	PU	done
35	Final report to the Commission	Month 36	1-7	PU	done
36	User's Guide on type areas and reference conditions for the Baltic region	Month 36	7	PU	done

2.4 Updated Gantt diagram

Month in project period	0	4	8	12	16	20	24	28	32	36
CO-ORDINATION										
Administration management	M				M		R	M		R
Financial management					R			R		R
WP1: TYPOLOGY										
Data assimilation										
Modelling										
Drafting Typology							W			
Verifying typology									W	
WP2: PHYTOPLANKTON										
Data assimilation and compilation of the database			M							
Parameter specific analysis					W					
Cross parameter analysis						M				
Applicability of using bloom frequency										
Draft reference conditions for phytoplankton										
Validation of reference conditions									W	
WP3: MACROPHYTES [1]										
Data assimilation										
Small scale analysis										
Large scale analysis										
Draft reference conditions for macrophytes					W					
Validation of reference conditions									W	
WP4: BENTHIC FAUNA										
Data assimilation										
Parameter specific analysis										
Cross parameter analysis										
Draft reference conditions for macrophytes							W			
Validation of reference conditions									W	
WP5: WATER CHEMISTRY										
Data assimilation										
Parameter specific analysis										
Cross parameter analysis							W			
Draft reference conditions for macrophytes									W	
Validation of reference conditions										
WP6: MONITORING STRATEGY										
Evaluation of existing monitoring strategies										
Integration of indicators									W	
Development of new monitoring recommendations									W	
Comparison with existing monitoring programmes									W	
WP7: DISSEMINATION										
Workshop										
Workshop										
Workshop										
Guidelines for implementing WFD										

1) Note WP3: The Gantt chart is unchanged relative to the version appearing in the Description of Work except that time period for working on large-scale analysis has been corrected from month 24 to month 28 in order to match the EU deadline and the timing of a workshop was slightly changed.

Key:

M	Meeting
R	Co-ordinators annual report/ cost statement
W	Workshop

2.5 Distribution of consumables

Table C8-1. Distribution of consumables (% of partner consumables) and man-months between WP-tasks and partners. The first number represents percentage consumable per task and the second number represents man-months per task. The total values for consumables and man-months are indicated at the bottom. The total number of man-months for all partners and tasks are 361.

WP1-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
1.1	3-3	5-2			10-4	48-10	2-1	5-2	50-10	10-3	
1.2	2-2	5-2			5-2	10-5	2-1	2-1	15-4	4-1	
1.3	5-4	5-1			6-2	15-4	2-1	2-1	10-3	3-1	
1.4	4-3	5-1			7-2	12-5	2-0	2-1	5-3	3-1	
Total WP1	14-12	20-6			28-10	85-24	8-3	12-5	80-20	20-6	

WP2-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
2.1	1-1	2-1		30-4	14-3	2-1		3-1		4-2	3-1
2.2	1-1	1-0		10-2	6-2	1-0		3-1		4-1	3-1
2.3	1-1	1-0		5-1	6-2	1-0		2-1		4-1	3-1
2.4	1-1	2-1		5-1	2-2	1-0		2-1		4-1	3-1
2.5	0-0	2-1		10-2	2-1	2-1		2-0		2-1	2-1
2.6	1-1	2-0		3-0	1-0	1-0		1-0		2-0	1-1
Total WP2	5-5	10-3		63-12	31-10	8-2		13-4		20-6	15-6

WP3-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
3.1	9-6	7-2	10-2		2-1		8-3	3-1			25-5
3.2	9-6	7-2	12-2		2-1		8-2	3-1			20-3
3.3	9-6	7-3	10-2		2-1		8-2	3-1			15-2
3.4	10-6	10-4	10-2		2-0		8-2	3-1			20-5
Total WP3	37-24	31-11	42-8		8-3		32-9	12-4			80-15

WP4-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
4.1	5-4		10-5	10-2	8-3		5-2	4-2		5-2	
4.2	5-3		10-5	10-2	8-3		5-2	6-2		5-2	
4.3	5-3		10-5	10-2	8-3		5-1	3-1		5-2	
4.4	5-3		22-5	7-0	9-3		5-1	6-1		5-2	
Total WP4	20-13		52-20	37-6	33-12		20-6	19-6		20-8	

WP5-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
5.1	3-2	6-1					2-1	4-1	3-2	6-2	
5.2	3-2	6-2					2-1	3-1	3-2	6-2	
5.3	2-2	6-1						3-1	2-1	4-1	
5.4	2-1	5-1						2-1	2-1	4-1	
Total WP5	10-7	23-5					4-2	11-4	10-6	20-6	

WP6-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
6.1	2-1	4-1	2-1			2-1	8-3	7-2		5-1	
6.2	2-1	4-1	2-1			2-0	8-3	8-2		5-1	
6.3	1-1	3-1	1-0			2-1	9-2	8-2			
6.4	2-1	2-1	1-0			1-0	9-2	9-1			
Total WP6	7-4	13-4	6-2			7-2	34-10	32-7		10-2	

WP7-tasks	P1 NERI	P2 FEI	P3 AAU	P4 EC-JRC	P5 KU-CORPI	P6 IOW	P7 MEI	P8 IAE	P9 SUSE	P10 MIR	P11 EMAUG
7.1	2-2	1-1	0-1	0-1	0-1	0-1	2-1	1-1	3-2	5-1	3-1
7.2	2-1	1-0							3-2	5-1	2-0
7.3	2-1	1-0							2-1		
7.4	1-0								2-1		
Total WP7	7-5	3-1	0-1	0-1	0-1	0-1	2-1	1-1	10-7	10-2	5-1

Total WP 1-7	100	100	100	100	100	100	100	100	100	100	100

Total M-M	70	30	31	19	36	29	31	31	32	30	22

2.6 Other plans

In general, some of the results from CHARM is already an integrated part of two new EU-projects (REBECCA and THRESHOLDS), and several of the national authorities around the Baltic Sea Eco-region have made use of the data and knowledge from CHARM as an integrated part of the European Intercalibration and of the specific plans for the relationships between loads and effects in the Coastal zones around Europe.

3 Final Report - Executive summary

An overall project frame of the CHARM project has been to develop a typology for the Baltic Ecoregion. A number of factors were evaluated and salinity, depth equivalent to water column mixing and water residence time were used as factors in the classification of water types. The present CHARM typology is suitable for the coastal waters, however, it also allows the extension towards the entire Baltic Sea. The typology was used to test interrelationships between chemistry, phytoplankton, bentic vegetation and fauna. Statistical analyses on the seasonality of phytoplankton identified taxonomic assemblages indicative of climatic conditions, salinity and trophic status. In addition, a series of phytoplankton indicator distribution maps were produced. Analyses on diversity indices and bloom frequencies suggested that some indices appeared to be sensitive to the trophic status of different areas and that frequency of blooms could be linked to nutrient inputs. Quantitative analyses of the linkages between phytoplankton and macrophytes and zoobenthos were carried out and examples of such linkages are provided. The use of historical data to provide reference conditions were carried out. Most promising were the functional relationships between Secchi-depth and chlorophyll, annual mean nutrient levels and biomass and spring bloom indicator species and total nitrogen in winter. It appeared unlikely that any Ecological Quality Ratio classifications based on phytoplankton parameters would have a high level of confidence. A number of benthic plant indicators of water quality were evaluated. The indicators were evaluated based on response to changes in water quality, sensitivity, possibility to identify reference conditions, and geographical range. Empirical model results suggested that several vegetation indicators reflect changes in water quality. Depth limits of Eelgrass and macroalgal communities were the indicators that fulfilled most of the evaluation criteria showing relatively strong coupling to water quality and having reference conditions defined for the widest range of areas. The depth limit of Eelgrass and of the macroalgal community decline when nutrient concentration increases and water clarity declines. Existing models do only explain part of the variation in the selected vegetation indicators presumably because the models do not incorporate complex negative feedback mechanisms. This implies that classification boundaries should be adjusted depending on habitats. Reference conditions were available for many indicators. Reference conditions of a given vegetation indicators showed marked variation between water bodies belonging to the same type, suggesting that water body-specific reference conditions are more appropriate than type-specific reference conditions. Future fine-tuning of of indicators should focus on physical exposure, effects of eutrophication processes and identification of possible nutrient generated regime shifts in benthic plant communities. A number of multivariate analyses were carried out on the benthic fauna in order to test whether ecology followed typology. Hydro-morphologically based typologies were shown to reflect the zoobenthic community rather well, however, there were grounds to adjust the proposed typology borders with respect to salinity and exposure, both factors known to affect benthic community assemblages. Long-lived macrozoobenthos is an accurate and ecologically significant nominator of environmental quality by spatially and temporally integrating environmental changes. With respect to chemistry, the CHARM partners have contributed with a large number of coastal observations, earlier not available beyond regional and national authorities. The coastal CHARM database is described in detail at: http://data.ecology.su.se/models/CHARM/ACCESS_BED.htm. A monitor strategy and a User's Guide were made for the entire Baltic Sea Ecoregion.

4 Scientific achievements

4.1 WP1 - Baltic Sea Typology

The main task of the WP1 was to develop a typology for the Baltic Sea with spatial distribution of types. Development of a national typology is the responsibility of national authorities and the typology for every country has to be finished by the end of 2004. As a result, every country develops or has already developed an independent typology. The present work within the CHARM project approach focused on formulating a general typology – a classification system – for the entire Baltic Sea as an Ecoregion. The aim was to cover the entire Baltic Sea in a flexible manner and to keep the system general enough, that it can serve as an umbrella, linking all national approaches to coastal waters typology for all Baltic countries under one scheme (*Schernewski & Wielgat 2004*). Based on such typology, reference points for monitoring purposes can be established and inter-comparison between types can be conducted, as was recommended by the CIS Working Group. The CHARM work on typology closely followed the suggestions of the CIS Guidance Document on typology, so that the general typology can be accepted as an umbrella. Most of the countries will comply with these recommendations in the national typologies. The Baltic Sea typology was thus developed based on the list of factors described in the CIS Guidance Document.

Exposure and current velocity were considered to be of limited use as parameters for the enclosed sea, such as the Baltic Sea. Information on the duration of the ice cover for the Baltic Sea was considered as a parameter in the typology. However, it not used in the umbrella typology because of its regional importance limited to the Gulf of Bothnia. Sediment type is considered to be a crucial parameter defining bottom habitats and therefore maps of the sediment types were collected within the project. However, in some regions, sediments show high and small-scale variability and introducing sediment type as a factor in the general typology did not yield satisfying results. Therefore the sediment type was not included as a parameter in the whole Baltic Sea typology. In the umbrella topology for the Baltic Sea salinity, depth equivalent to water column mixing and water residence time were used as factors in classification of water types. Salinity, defined as one of the obligatory factors in the WFD, was used as a first classification factor in typology, following the division of the Venice system. As a next factor depth was used. Analysis based on the model results showed that the average depth of the thermocline in summer in the Baltic Sea is in a depth of about 10 m. Therefore, the 10 m isobath was used to distinguish the shallow coastal zone. Also, the 10 m depth threshold describes the euphotic zone in coastal areas, where water transparency is lower than in the open sea areas. The next factor used in typology is water exchange. It is known that enclosed systems differ from the open coast waters since many chemical as well as biological parameters depend on the water replacement time. For selected areas water residence time and stratification calculations were carried out by the use of numerical models based on data provided by CHARM partners and forcing data the 10-year period (1991-2000). Despite the fact that the Baltic Sea is defined as an Ecoregion, the Water Framework Directive is restricted to a coastal strip of only 1 nautical mile off the baseline. The narrow strip of coastal waters is artificially divided from open waters. The present CHARM typology is suitable for coastal waters, however, it also allows the extension towards the entire Baltic Sea and a further development (further division) of the open sea waters typology as needed for the EU Marine Strategy. An extension allows a more comprehensive view concerning reference conditions, water quality classification schemes and monitoring.

The CHARM proposal was presented at meetings and workshops to allow public discussions, modifications typology as well as an updating and comparisons with national typologies from all the countries around the Baltic Sea. Verification of typology and comparisons with national typologies were also described in published papers (see e.g. *Schernewski & Wielgat (Eds.) 2004*).

4.2 WP2 - Phytoplankton

The first step in developing phytoplankton indices for assessment of coastal waters is to define regimes of different environmental variables, which affects species composition and community structure. Thus we made a statistical analysis of the seasonality of phytoplankton in the different salinity area of the Baltic Sea. As a result, we identified taxonomic assemblages indicative of climatic conditions, salinity and trophic status (*Gasiunaite et al. submitted*). Secondly, we studied the spatial and seasonal distribution of some selected phytoplankton parameters (indicators), and compared distribution patterns of these phytoplankton indicators with typology. A series of phytoplankton indicator distribution maps were produced (*Thamm et al. 2004*). These two studies contributed to the Deliverable 14.

A number of common diversity indices were calculated using the CHARM phytoplankton data to investigate, if these indices can be used to aggregate taxonomic phytoplankton data and to be indicative for eutrophication. Some indices appeared to be sensitive for the trophic status of different areas. However, the natural variability was considerable, and thus there is a need to carry out further testing across wider trophic gradients than included in our study (*Gromisz et al. in prep.*). This work contributes to Deliverable 17.

In the WFD compliant assessment also phytoplankton bloom frequencies and intensities need to be considered. The analysis of temporal bloom patterns in the Baltic Sea area was performed using a statistical procedure developed for the Kattegat. Seasonal patterns of bloom frequecies were established for different coastal areas of the Baltic Sea. The frequency of blooms could be also linked to nutrient inputs or concentrations for the Danish waters (*Henriksen et al. in prep.*). This work contributed to Deliverable 17.

The linkages between the ecological quality indicator based on macrophyte, *Zostera marina*, and phytoplankton were studied using combined data from Danish coastal waters. The results indicated that biomass of a phototrophic 'red tide' ciliate (*Myrionecta rubrum*) increased along the decrease of the depth limits of *Zostera marina* in connection with decreasing Secchi depth and increasing total nitrogen. Thus the *Myrionecta* biomass could be also a potential indicator of the trophic status together with the *Zostera* depth limit, across a range types characterised by different salinities (*Sagert et al. in press*). This work is a contribution to Deliverable 21.

We studied the linkages between phytoplankton and zoobenthos parameters by carrying out an ordination analysis separately for zoobenthos and phytoplankton data derived from several areas around the Baltic Sea. CHARM typology factors (salinity, depth and water residence time) were apparently important for structuring both the macrozoobenthic and phytoplankton communities (i.e. Carstensen et al. 2004). This suggests that the chosen typology factors are, in principal, ecologically relevant, but more detailed work would be needed to set appropriate boundaries for the different typology factors (*Helminen et al. in prep.*). This work is an contribution to Deliverable 22.

We made an overview of applicability of the historical phytoplankton records to estimate reference conditions for the Baltic Sea. There is a whole lot of data from early 1900s, but most of this is not directly comparable with the present day monitoring data (*Heiskanen et al. in press*). Most promising approaches to estimate reference conditions were: established spatial reference network (particularly for the Bothnian Bay and Sea, functional relationships between: 1) Secchi-depth and chlorophyll a, 2) annual mean nutrient levels and phytoplankton biomass, and 3) spring bloom indicator species and total nitrogen in winter. For Danish waters indices of phytoplankton bloom frequency could be linked with nitrogen loading data (*Carstensen et al. in press*). These works are contributions to Deliverables 20 and 32.

Finally the current phytoplankton monitoring approaches were evaluated. In conclusion, it appeared unlikely that any Ecological Quality Ratio classifications based on phytoplankton parameters would have a high level of confidence, due to the large variability of the available data. Thus, it is proposed that at the current stage, it would be probably more useful to apply phytoplankton parameters to identify the areas in risk of failing the environmental objectives (Article 5 of the WFD), rather than in a detailed classification of the coastal areas. However, it is also important to conduct a similar analysis for indicators of other biological quality elements for prioritisation of the monitoring efforts. This work is a contribution to Deliverable 34: Recommendations for monitoring strategy.

4.3 WP3 - Macrophytes

The overall objective of CHARM WP3 was to identify good vegetation indicators of water quality. The following potential indicators were evaluated:

1) Depth limit - of eelgrass, macroalgal communities and the selected macroalgal species: Fucus vesiculosus and Furcellaria lumbricalis
2) Abundance at specific depths - of eelgrass/macroalgal communities
3) Community structure - measured as the relative abundance of opportunistic algae and as composition and depth distribution of macrophyte communities in brackish areas
4) Area distribution - of eelgrass.

The indicators were evaluated based on:

1) Response to changes in water quality - as described by empirical models compiled through literature studies and/or developed through the CHARM project
2) Sensitivity - involving strong coupling to water quality and low levels of unexplained temporal and spatial variability
3) Possibility to identify reference conditions through historical information, spatial information and/or modelling
4) Geographical applicability range - as evaluated by the geographical range to which the empirical models and reference conditions apply.

The compiled empirical models showed that several vegetation indicators indeed reflect changes in water quality. As nutrient concentration increases and water clarity declines, depth limits of eelgrass and of the macroalgal community decline. A similar tendency was found for depth limits of F. vesiculosus but the response was distinct only in restricted areas of low salinity where competition with other large macroalgae is limited. Cover of eelgrass and macroalgal communities in deeper water also declines as nutrient concentration/load increases. Moreover, opportunistic algae tend to be more dominant in eutrophic areas, though we failed to find any good empirical model describing this relationship. In brackish areas along the German Baltic coast macrophyte composition and depth range also relate to water quality; the relations being identified by comparing habitat requirements with habitat characteristics. Eventually, area distribution of eelgrass shows some connection to water quality.

Existing models do, however, only explain part of the variation in the selected vegetation indicators based on variation in nutrient concentration/load and water clarity. One reason for this limitation may be that existing models do not fully incorporate complex negative feedback effects of increased nutrient load. Other regulating factors such as differences in salinity also contribute to explaining some of the remaining variation in e.g. depth limits of F. vesiculosus, algal cover and relative abundance of opportunists and exposure levels and substrate composition also play a regulating role. This dependency on habitat characteristics implies that classification boundaries of these indicators should be adjusted depending on habitat. Considerable variation in vegetation parameters remains unexplained, however, and reduces the sensitivity of the indicators to changes in water quality and thus the predictive power of the developed models. This problem is most conspicuous for shallow-water indicators (cover, species composition and area distribution in shallow water), which are much affected by exposure to wind, waves, ice and desiccation. By contrast deep-water indicators like depth limits and abundance in deep water show less unexplained variation and are more sensitive to changes in water quality.

Reference conditions were available for many indicators, especially those regarding depth limits. Detailed historic information was also available regarding composition of macrophyte communities at different water depths in selected German waters. By contrast, quantitative historic information on abundance at given depths, relative abundance of opportunists and eelgrass area cover was relatively scarce so reference conditions for these indicators were only established for few areas. Reference conditions of given vegetation indicators showed marked variation between water bodies belonging to the same type, suggesting that water body-specific reference conditions are more appropriate than type-specific reference conditions.

In summary, depth limits of eelgrass and macroalgal communities were the indicators that fulfilled most of the evaluation criteria, showing relatively strong coupling to water quality and having reference conditions defined for the widest range of areas. Other tested indicators, i.e. depth limits of macroalgal species, abundance of eelgrass and macroalgal communities in deep water, composition and depth range of brackish macrophyte communities as well as relative abundance of opportunists also proved to be useful indicators in selected areas. The poorest indicators were those describing the abundance of very shallow eelgrass populations. The evaluation also identified needs for future fine-tuning of indicators. In order to increase the predictive power of future empirical models, we encourage future studies on effects of physical exposure, effects of eutrophication related processes like anoxic events and identification of possible nutrient generated regime shifts in benthic plant communities.

4.4 WP4 - Benthic infauna

The scientific achievements of WP4 have been summarised in (a) a meta-table on available data around the Baltic Sea (qualitative information only; the local data hosts were not willing to share actual monitoring raw data at that point), delivered to the CHARM web page after year 1 of the program, (b) workshop on zoobenthos, and tests and recommendations on the use of benthos in verifying or modifying environmental typology (see e.g. *Perus et al. 2004*), and (c) regional descriptions of coastal zoobenthos in relation to environmental descriptors and environmental quality (a complete cross-analysis for the entire Baltic Sea was not possible, and efforts to link zoobenthos & phytoplankton failed due to non-existant comparable data for the plankton-component. Efforts to compare macrophytobenthos & soft bottom macrofauna has only been possible for the *Zostera*-assemblages, common in the south, rare in the north - for details, see WP3). The national database on coastal zoobenthos for Finland (PET), constructed and completed within CHARM in close collaboration with the Finnish Environment Institute, to date holds 8076 samples (a total of roughly 300 spp), with information from all but one 15 Finnish coastal types; the final Finnish coastal typology is largely based on the information on macrozoobenthos as compiled within CHARM. The database contains quality-controlled information on sampling-year, information on replicate samples, method of conserving the samples, publicity level, station-ID, coordinates, method of sampling, mesh size, depth, abundance, biomass, temperature, salinity, oxygen, sediment organic content, and possible publication related to the data. The data is restricted to the 1990s to allow direct and reliable comparisons within and between coastal types and areas. Tests have been made on the applicability of the database (*Perus et al. 2004*).

For the Finnish coast the following analysis was conducted within CHARM:

Coastal marine zoobenthos as an ecological quality element in the EU WFD

The aquatic environment has for the last decades been stressed by an increasing supply of organic matter and several strategies for reducing the pace of eutrophication, a major threat to the health of coastal marine waters, have been taken. The European Water Framework Directive (WFD) establishes a framework for the protection of all waters and aims at achieving good ecological status for all waters by the year 2015.

The WFD focuses on the importance of biological and ecological quality elements (phytoplankton, macroalgae, zoobenthos and fish) in classification of the ecological status (EcoQ) of surface waters within Europe. Most surface waters typologies are constructed based on hydro-morphological factors while the EcoQ is based on the status of the biological, hydro-morphological and physico-chemical quality elements, with the importance of biological elements emphasised.

A crucial question is whether a typology constructed on hydro-morphological factors reflects the characteristics of the quality elements to be used in the assessing the EcoQ, i.e. whether “ecology” follows “typology”.

Using quality-assured abundance data from the national zoobenthos database, spatially covering the entire Finnish coastline, multivariate analyses were carried out. Coastal types tested against each other were either neighbouring types, types within mosaic archipelago regions, types residing within common subbasin or distant types having similar hydromorphological characteristics such as salinity

Hydro-morphologically based typologies were shown to reflect the zoobenthic community rather well, however, there were grounds to adjust the proposed typology borders with respect to salinity and exposure, both factors known to affect benthic community assemblages. The inner parts of Gulf of Bothnia and Gulf of Finland are areas were salinity (3-4 PSU) starts restricting the range of distribution for both marine and limnic species respectively. Exposure, indicative of archipelago zonations, also created different zoobenthic communities, not fully captured in the proposed typologies.

Long-lived macrozoobenthos is an accurate and ecologically significant nominator of environmental quality by spatially and temporally integrating environmental changes.

For the Lithuanian coast the following analysis was conducted within CHARM:

Species richness of soft bottom macrofauna in the Lithuanian coastal waters of the Baltic Sea

Comparative analysis of species richness was performed in the south-eastern part of the Baltic Proper and in the Curonian Lagoon, representing two different types of the coastal aquatic ecosystems. In the Sea two transects were considered: 1) the “East-West” along the depth gradient from the shallow (15 m) to the intermediate (50 m) depth zone; and 2) the “North – South” along the gradient of the Curonian lagoon discharge influence (*Figure 4.4.1*). In the Lagoon, the estuarine gradient was considered from the oligohaline (0-8 PSU, rapid fluctuations, annual mean 4 PSU) to the freshwater zone (*Figure 4.4.1*).

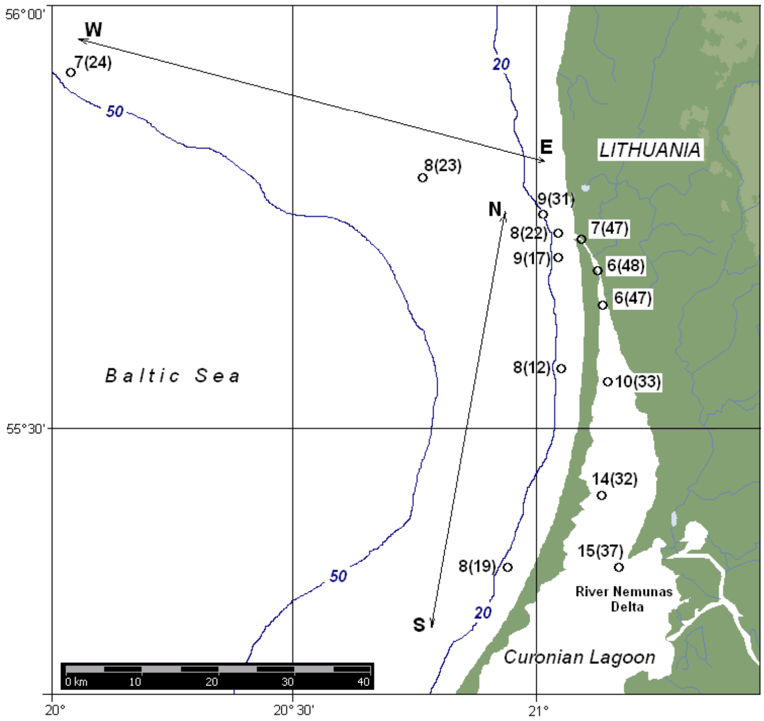


Figure 4.4.1 Scheme of the monitoring stations in the Lithuanian coastal waters. Numbers indicate mean number of species per sample and coefficient of variation (shown in parenthesis). E-W and N-S: direction of two transects in the sea (explanation in text).

Methods: In total the material comprised 458 samples, including 258 samples collected from 8 monitoring stations in the Sea (a standard 0.1 m^2 Van Veen grab) and 200 samples from 6 stations in the Lagoon (a Peteresen type 0.025 m^2 grab) during the period from 1980 to 2000. Additionally, the analysis of the relationships between environmental parameters (Corg content, grain size and sorting of bottom sediments, depth, mean annual salinity, distance from the sea) and species composition in the Curonian lagoon was performed using material collected during one extended survey (1999) at 46 stations.

Results and conclusions: Total number of species and higher taxa found was 126. The species richness was essentially higher in the Lagoon than in the Sea: 99 versus 27. However, some 30 additional species found on stony bottoms in the Lithuanian coastal zone outside of the monitoring stations (*Olenin 1997*) were not considered in the present analysis. Twelve eurihaline species common for both systems were found in the northernmost oligohaline part of the Lagoon; 7 of them were present constantly, while others occurred occasionally. No freshwater species were found in the coastal zone of the Sea. The average number of species per sample was relatively constant in the Sea, varying from 7±2 to 9±2. The highest variability of species number per sample was found in the vicinity of the Curonian

Lagoon outlet, most likely due to interaction of the coastal marine and outflowing freshwater masses. No decrease in variability was detected along the depth gradient (E-W transect), however variation in the species number was decreasing with distance from the Curonian Lagoon outlet (N-S transect).

The species richness in the Curonian Lagoon was clearly increasing from 6±3 to 15±6 towards the inner part while variability in the species number per sample was the highest in the area closest to the Sea. This variability was caused by immigration of the eurihaline species from the coastal zone which serves an essential species pool for the oligohaline part of the Lagoon (*Daunys et al. 2000*; *Daunys 2001*). Impulse-like invasions of euryhaline species into the impoverished community of oligochaetes and chironomids formed temporal groups of species within the seawater influence zone. The distinct temporal changes in macrofauna structure coincided with seasonal changes in salinity regime. When spring outflows prevailed, the most considerable shifts in bottom macrofauna occurred close to the lagoon's outlet (up to 5 km from the sea). In autumn, when the sea water inflows increased, structural changes were pronounced over larger distance inside the lagoon (up to 25 km from the sea) (*Daunys 2001*).

Spatial variability of species composition in the Lagoon was best related to the distance from the sea and mean annual salinity values (rank correlation 0.62 and 0.73 according to BIOENV procedure). Therefore the salinity is considered to be a major structuring agent, causing meso-scale (tens of km) variability in the bottom macrofauna composition. Increase in sediment Corg resulted in the decreased species richness (down to 4-5 species per sample) on the local scale (hundreds of m). Poorly sorted sediments (sorting 1.0-2.4) were occupied by the most widespread taxa – oligochaetes and chironomids, while unionids and zebra mussels occupied moderately-to-very well sorted sediments (sorting 0.4-1.0) of the higher mean grain size (> 100 µm) (*Figure 4.4.2*). On the other hand, biotic interactions may play an essential role on the local scale too. For instance, the zebra mussel beds comprised approximately half of the total macrofauna species found in the Lagoon (up to 26 species per sample).

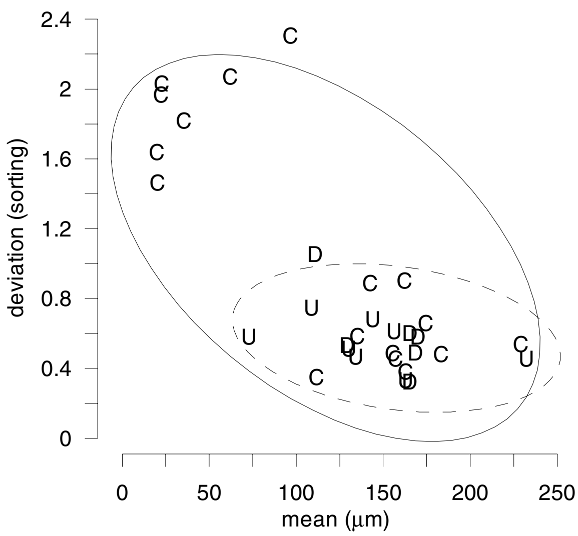


Figure 4.4.2 Characteristics of the sedimentary environment dominated by oligochaets/ chironomids (C, solid line); unionids and zebra mussels (U and D respectively, dashed line).

For the Estonian coast the following analysis was done within CHARM:

Macrozoobenthos assemblages in highly productive areas of the Estonian coastal sea

Macrozoobenthos communities were studied in the most productive areas of the Estonian coastal sea i.e. in bank slopes, fronts between different basins, river estuaries and sites in the vicinity of municipal wastewater discharges. The spatial and temporal variability in species number, abundance and biomass of macrozoobenthos were related to the concentration of nutrients in the seawater (winter values), temperature, salinity and sediment granulometry. The data were obtained from the available literature and the database of Estonian Marine Institute. The database covers the major bays of the Estonian coastal sea from the early 1950s to nowadays.

In the western Gulf of Finland species diversity and biomass were significantly higher in the upwelling areas than in the adjacent sea. Upwelling areas were characterised by higher share of filter-feeders and sedimentation areas deposit feeders, respectively. In these hydrodynamically active areas the species number increased significantly from 1994 to 1999 followed by a notable decline afterwards. This change was primarily explained by total N in water ($r = 0.85$, $p < 0.001$) supporting the earlier findings that nitrogen is a limiting factor for producers in the Gulf of Finland.

Similarly to zoobenthos, nectobenthos concentrates towards the upwelling areas. There exists some evidence that higher densities of mysids often occur on steep slopes where strong gradients in temperature are observed. The abundance values of mysids were relatively low both in the shallowest and deepest parts of the bank slopes. Significantly higher abundance values were observed in the areas where the thermocline touched the bottom.

The frontal areas (i.e. the areas where the water of different subbasins meets) were characterised by very high benthic biomass. The biomass of macrozoobenthos was positively correlated with total N in the nearbottom water ($r = 0.83$, $p < 0.001$). Neither the concentrations of nutrients nor the biomass correlated with the species number of macrozoobenthos ($p > 0.05$). Such high mysid densities as recorded in the studied fronts were observed only in the heavily polluted Pärnu Bay and adjacent sea to Daugava River.

Tallinn Bay is the most polluted area in the Estonian coastal sea. During the last 40 years the water quality of the area has been strongly affected by the input of pollution from land based sources. In the 1960s when large quantities of untreated wastewater were directly discharged into the bay benthic invertebrates were missing or had very low biomasses in wide areas between 0.5 and 15 m depth. Very high benthic biomasses were recorded below 15 m. Between 1978-1990 the water quality of Tallinn Bay has improved due to the reduction of coastal discharges and shutdown of Tallinn Pulp and Paper Mill. In the 1990s the lifeless zone (in sensu macrozoobenthos) has disappeared from the shallow areas of Tallinn Bay. The biomass values of macrozoobenthos did not significantly differ from the adjacent bays of lower nutrient load. Both the number of species and biomass increased with depth. Bivalves were still the dominating group among benthos. During 30 years the benthic biomass has declined about 3-4 times. The changes were mainly due to the decline of the biomass of bivalves.

Macrozoobenthos biomasses were higher in the rivermouths of the Gulf of Finland where substantially higher concentrations of nutrients were observed. During recent decades the biomass of macrozoobenthos has increased and the number of species remained unchanged at the mouths of Loobu, Valgejõgi and Jägala rivers. On the other hand both benthic diversity and biomass have decreased at the mouth of Narva River. The impoverishment of the benthic communities in Narva Bay is in accordance with the reduction of nutrient load into the Gulf of Finland in the 1990s. The increase in the benthic biomass in the remaining three rivermouths is likely connected to the mass development of the benthic filamentous algae in the Estonian coastal sea in the 1990s. The lack of these blooms in Narva Bay is related to the scarcity of suitable hard substrate in the area.

In the Gulf of Riga the effect of Pärnu River on macrozoobenthos was not observed in the 1950s. Since 1960 macrozoobenthos biomass has gradually increased in the bay with higher values close to the Pärnu rivermouth. Following the economic recession of Estonia in the 1990s macrobenthic biomass has significantly declined. During the recession the intensity of agriculture has substantialy reduced resulting in the decline of nutrient content in the seawater. Since 2000 the concentration of nutrients and macrozoobenthos biomass have been gradually increasing. The causality of this relationship is indicated by the significant correlations between the biomass of macrozoobenthos, total N ($r = 0.93$, p

< 0.001) and total P values in water ($r = 0.52$, $p < 0.01$). With the increase of nutrient concentrations *Corophium volutator*, *Macoma balthica* and Oligochaeta increased and *Prostoma obscurum*, *Hydrobia ulvae* and *H. ventrosa* decreased their density.

To conclude the macrozoobenthos and nectobenthos biomasses of the productive areas significantly exceeded the values of the adjacent sea. The concentration of total nitrogen positively correlated with the benthic biomass. The increase in the species number of macrozoobenthos followed the decrease of nutrients in Pärnu Bay whereas the relationship was insignificant in other regions. When the water currents were slow a clear negative effect of the discharged effluents on the benthic communities was observed. Very high nutrient enrichment results in the accumulation of hydrogen sulphide in the sediment and the disappearance of benthos in these areas.

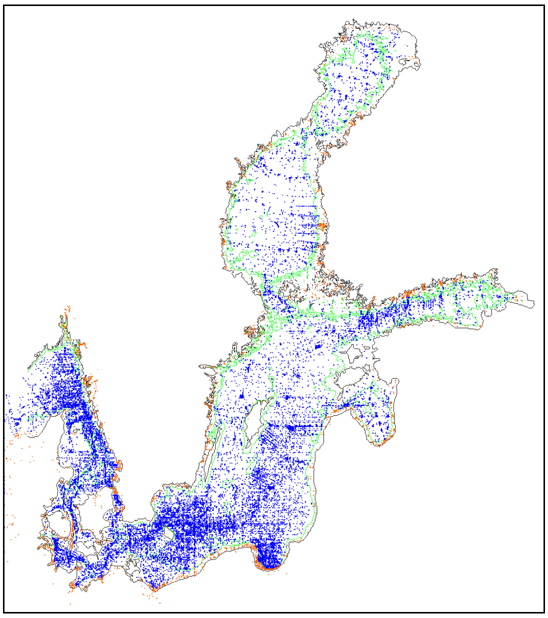
Effect of the introduction of the North-American polychaete *Marenzelleria viridis* on the macrozoobenthic communities of the northern Baltic Sea

The North-American polychaete *Marenzelleria viridis* was introduced to the Baltic Sea in 1985. Since then the species has quickly spread and established in the most parts of the sea. In the northern Baltic the establishment has been more successful either in more eutrophicated regions (low salinity) or in more uniform biotopes (deeper waters). In the shallower areas the success of the establishment increased with the number of macrozoobenthic species in the community whereas in the deeper sites the relationship was insignificant. Concurrent with this invasion the densities of the amphipod *Monoporeia affinis* and the polychaete *Hediste diversicolor* have dropped considerably. Field experiments combining natural densities of native species and the introduced polychaete showed that *M. viridis* enhanced the production of benthic microalgae. On the other hand *M. viridis* reduced the growth and survival of *H. diversicolor* and the growth of *M. affinis*. The polychaete was negatively affected by the adult specimens of the bivalve *Macoma balthica*. Competitive superiority of *M. balthica* over *M. viridis* is likely due to more efficient feeding regime of the bivalve. Competitive interactions between *M. viridis* and *M. balthica* appear a key factor limiting the further expansion of *M. viridis* in the area. These results suggest that the functional relationships between the recent macrozoobenthos data and environmental conditions should be the base of the computation of the reference conditions for the Baltic Sea as the historical approach does not take into account the recent introductions of alien species.

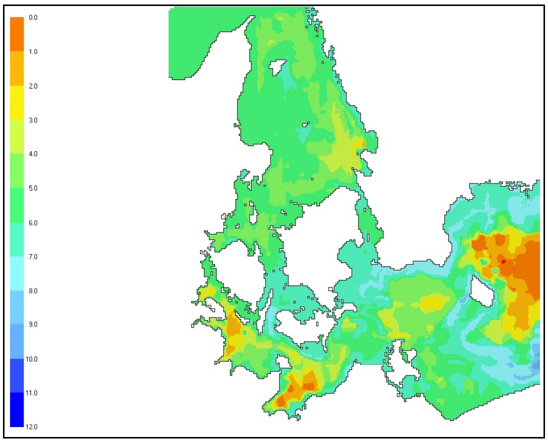
4.5 WP5 - Water chemistry

The CHARM partners have contributed with a very large number of coastal observations, earlier not available beyond regional and national authorities. The positions of all these coastal stations are shown in this map as orange dots. Blue dots represent off-shore stations.

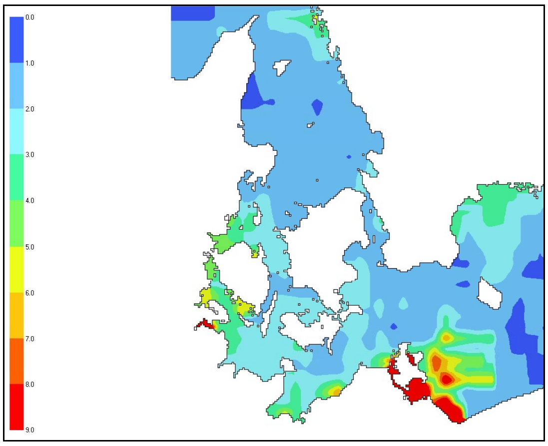
The Coastal CHARM database is described in detail at: http://data.ecology.su.se/models/CHARM/ACCESS_BED.htm.



The database has been used to produce distribution maps of different variables that are used by the different WPs to evaluate marine environmental quality criteria. Examples are:



Oxygen concentrations (ml/l) at the bottom in the southern Baltic, average concentrations calculated from all observations between 1990-2001.



Surface chlorophyll concentration, average concentrations calculated from all observations between 1990 and 2001.

WP5 has also provided data set for the typology work, i.e. by providing maps on salinity distributions and on forcing functions (nutrients, hydrology) for the modes used to calculate reference conditions (*see WP1*). Conceptual models of coastal ecosystems of the Baltic, outlining management options for an improved environment, seen from local and regional perspectives, have been compiled for the User's Guide (*see WP7*).

4.6 WP6 - Monitoring strategy

Current state of marine monitoring activities and requirements of WFD (Del. 8)

As present monitoring programmes in the Baltic Sea area have developed mostly country wise, according to national needs and available resources. There are obvious differences in monitoring strategies and sampling performance between countries. Implementation of EU water policies in almost all Baltic Sea countries will force to the co-ordinated changes in both management and monitoring of water resources. Following are listed main foreseen contradictions between present, operating monitoring programmes and future system following the demands of EU water policies.

Monitoring strategy
At present moment all existing monitoring programmes were designed, or at least had an aim to reflect the changes in the environment caused by human activity. These changes could be "negative" – increase in pollution, extension of exploitation of resources etc. or "positive" – results of regulatory measures. The assessment of the changes is made based on trend analyses and is based on keeping long time series. So the main aim of the monitoring programme is detect change in the environment and after the change has been detected – the conclusion has to be made on the cause of this change – either natural variability or human induced process. The potential drawback of this strategy is that a success of the programme depends on the design of the monitoring programme made many years ago (long time series) and level of understanding of natural processes having an influence on the variability of monitored parameters. In the future monitoring has to give the possibility to assess the state of the environment in any particular moment regardless of presence or absence of long time series.

Variables
At present moment the monitored variables are in general the same in all of the countries performing marine monitoring in the Baltic Sea. The variable set has been developed mostly through HELCOM monitoring programme. The need to jointly report on the state of the sea has forced the acceptance of more or less the same variable sets together with sampling methodology. Besides several parameters as microbiology, coastal fish communities, primary production, phytobenthos are not monitored in all countries.

Station network
At present moment 571 stations are listed in the HELCOM COMBINE station list for the Baltic Sea marine area. Historically there have been two directions in developing of the station network in Baltic Sea countries. One strategy was connected to the open parts of the Baltic Sea where the monitoring was co-ordinated by HELCOM already from 1970s. This station network covers the whole open sea area and is sampled by different countries and institutions. The other direction was local, so called CMP (Coastal Monitoring Programme) where monitoring station network was developed in countries following national needs. Different countries have different coverage of their national waters by monitoring station network depending on their coastline, aims and resources available. Here the "hot spot" approach is widely used where the higher density of stations is devoted to the problematic areas in terms of eutrophication or pollution while other coastal areas are covered by less frequent sampling. In future the proper quality assessment of all coastal waters has to be ensured so the obvious development has to be expansion of monitoring stations to all coastal areas.

Frequencies
At present moment sampling stations are usually divided into mapping, low frequency stations and extensive or high frequency stations. In many countries high frequency stations are mostly located in "hot spot" areas while mapping stations represent less affected areas. There is obviously need in revision of sampling frequency when the need will arise to assess at the similar level all the coastal waters.

Reporting
At the present moment the reporting and assessment of the monitoring results is based on trend analyses. In several countries the set of environmental quality standards is currently developed what will enable to simplify the reporting and assessment procedures based on environmental state indicators.

Design of networks for monitoring ecological status of coastal waters in the Baltic Sea Ecoregion (Del. 34)

The need for new marine monitoring system in the Baltic Sea area is forced through implementation of EU WFD and other measures to conserve the marine environment. Revision of monitoring systems currently in operation is carried out by individual countries and also by international organisations (HELCOM). New monitoring strategy has to be based on following assumptions:

- Monitoring networks have to be designed based on agreed typology and ensure equal coverage of different water bodies regardless of national belonging
- Monitoring activities have to enable to use relevant biological and physico-chemical water quality elements for assessment of the state of coastal waters
- Long-term series should be kept wherever possible
- Monitoring should be performed using standard, agreed methodology in accordance with QA requirements
- For optimisation of resources the multi-layer monitoring schemes should be applied in all water bodies.

Deliverables connected directly to activities of WP6 were:

- CHARM deliverable 8: An evaluation report (state-of-the-art-analysis) of existing monitoring programmes (national, HELCOM).

  The work was carried out stepwise starting from planning the report structure, then developing the questionnaire to be distributed between representatives of Baltic Sea countries in the project to collect relevant national information and afterwards data collection and analyses. Information from all countries surrounding the Baltic Sea was collected and summarised in the report. Additionally, detailed overview of HELCOM monitoring programme was given in the report. National monitoring systems were compared regarding parameters measured, station networks and monitoring frequencies and QA and reporting procedures. Report is available from CHARM web page.

- CHARM deliverable 34: A monitoring strategy for coastal waters, including identification of universal variables (quality elements) for the Baltic Sea.

  The monitoring strategy proposal was developed and formulated into paper. The strategy summarised the known knowledge on variability and indicative value of different biological parameters (quality elements) and some proposals were made concerning establishing Baltic Sea wide monitoring network in accordance with requirements of WFD. The multi level, typology based, monitoring station and sampling scheme was proposed to enable the maximum spatial end temporal coverage within the existing, limited resources. The proposal to use existing and adopted methods for the Baltic Sea area (used in HELCOM COMBINE programme) was made as at present CEN/ISO standards exists only for limited number of quality elements. The importance of keeping of long time series was stressed while designing new monitoring programmes.

4.7 WP7 - Dissemination

The three workshops were held as planned:

1. The CHARM kick-off meeting was organized in Copenhagen, January 15-16, 2002 by the Danish National Environmental Research Institute (NERI).
2. Integrated ecosystem view on reference condition was organized by Ernst-Mortitz-Arndt University Greifswald (EMAUG) at the island Vilm, April 8-11, 2003.
3. Towards operational management of coastal ecosystems was organised by Estonian Marine Institute (EMI) in Tallinn, August 23-25, 2004.

The two first workshops were restricted to CHARM participants. The final workshop was an open meeting for all interested scientists and managers. As a result of the dialogue meetings (see below), a manager from the Swedish Environmental Protection Agency presented a managers perspective.

Besides, two dialogue meetings with managers were organised. The first was held in Stockholm, March 31-April 1, 2003 and the second at the European Environmental Agency (EEA) in Copenhagen, April 26-27, 2004. The aim of the dialogue meetings was to involve managers in the discussion on the CHARM User's Guide.

Further information from the workshops and meetings are available on the CHARM web site.

Scientists from WP1-WP5 have summarised their scientific results in the User's Guide. Presently, it still needs further editorial work before published.

5 Comparison between deliverables and published material

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Work-package number
1	Workshop 1	Month 1	Work-shop	PU	7
	Done.				
2	Compilation of mailing list of authorities	Month 1		PU	1
	National authorities responsible for the implementation of the WFD in each partner country were contacted. A compilation of mailing list of authorities, as required in deliverable 2 is presented at the project web site [http://charm.dmu.dk].				
3	Quality controlled data sets for surface sediments, phytoplankton, macrophytes, benthic fauna and water chemistry	Month 6	Da	PU	1-5
	Done.				
4	Morphometrical inventory of the Baltic	Month 6	Da	PU	1
	A list of prioritised areas has been made and data requested from partners. Most data have been derived and were used in the model simulations, however not the complete list.				
5	Project web site	Month 6		PU	7
	Done.				
6	Report to the Commission	Month 6	Re	PU	1-7
	Done.				
7	Draft of scientific paper on benthic monitoring data	Month 12			4
	Perus, J., Bäck, S., Lax, H.-G., Westberg, V., Kauppila, P. & Bonsdorff, E. 2004: Coastal marine zoobenthos as an ecological quality element: a test of environmental typology and the European Water Framework Directive. – In: Schernewski, G. & Wielgat, M. (Eds.): Baltic Sea Typology. – Coastline Reports 4: 27-38.				
8	Report on state-of-the-art monitoring	Month 12	Re	PU	6
	Done				
9	Map of sediment characteristics of the Baltic coastal zone	Month 12	Da	PU	1
	Data on surface sediment types were requested from partner, however, no raw data sets were submitted by the partners, mainly due to a lack of data or limited access to existing data. Therefore, it was necessary to change the strategy to fulfil the task. Instead of data sets, maps in a digitalized form (at least 1:500000 in scale) were requested from all partner countries. The general map was split into regional maps - mainly countrywide maps. Digital maps were obtained for the whole Baltic Sea area except the Gulf of Finland and Gulf of Bothnia. For some regions, namely the coast of Finland, there are no sediment data available for the entire coast. All maps were prepared in the ARC/GIS software. To make the sediment maps available to a larger audience and the CHARM-partners, all maps were prepared for the internet and can be accessed via the CHARM web site [http://charm.dmu.dk] (in the Restricted Area | Data & publications). Starting with an overview map the project allows ac-				

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Work-package number
	cessing all maps systematically and provides the user with all necessary information about every single map and its content. Thus the deliverable 9 is available as a series of regional, national and large scale sediment maps - which can be accessed from one source.				
10	Report to the Commission	Month 12	Re	PU	1-7
	Done.				
11	Analysis of benthos vs. environmental gradients	Month 18	Me	PU	4
	National databases constructed for coastal zoobenthos and direct supporting environmental data in relation to classification and typology, see e.g. Bonsdorff, E., Laine, A. O., Hänninen, J., Vuorinen, I. & Norkko, A. 2003: Zoobenthos of the outer archipelago waters (N. Baltic Sea) - the importance of local conditions for spatial distribution patterns. – Boreal Envir. Res. 8: 135-145. Josefson, A.B. & Hansen, J.L.S. 2004: Species richness of benthic macrofauna in Danish estuaries and coastal areas. – Global Ecology and Biogeography 13: 273-288. Kotta, J., Simm, M., Kotta, I., Kanošina, I., Kallaste, K. & Raid, T. 2004: Factors controlling long-term changes of the eutrophicated ecosystem of Pärnu Bay, Gulf of Riga. – Hydrobiologia, 514: 259-268. Perus, J. & Bonsdorff, E. 2004: Long-term changes in macrozoobenthos in the Åland archipelago, northern Baltic Sea. – J. Sea Res. 52: 45-56. Perus, J., Bäck, S., Lax, H-G., Westberg, V., Kauppila, P. & Bonsdorff, E. 2004: Coastal marine zoobenthos as an ecological quality element: a test of environmental typology and the European Water Framework Directive. – In: Schernewski G. & Wielgat, M. (Eds.): Baltic Sea Typology. - Coastline Reports 4 (2004): 27-38.				
12	Forcing data for hydrodynamical modelling	Month 18	Da	PU	1
	A database (a file tree) connecting each sub-basin with relevant information with regard to relevant forcing fields (monthly averages and standard deviations, calculated over the period 1991-2000) was established at the Department of Systems Ecology at Stockholm University, Sweden (SUSE) by Björn Sjöberg.				
13	Report to the Commission	Month 18	Re	PU	1-7
	Done.				

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Work-package number
14	Map of distribution and description of regulation of phytoplankton community indices	Month 20	Re	PU	2
	Gasiunaite, Cardoso, Heiskanen, Henriksen, Kauppila, Olenina, Pilkaityte, Purina, Razinkovas, Sagert, Schubert, Wasmund: Seasonality of coastal phytoplankton communities in the Baltic Sea: influence of salinity and eutrophication. – *Submitted* to Estuarine, Coastal and Shelf Science. Thamm, R., Schernewski, G., Wasmund, N., Neumann, T. 2004: Spatial phytoplankton pattern in the Baltic Sea. – In: G. Schernewski & M. Wielgat (Eds.): Baltic Sea Typology. – Coastline Reports 4: 85-109.				
15	Small scale vegetation models	Month 20	Me	PU	3
	Krause-Jensen D., Carstensen J. & Dahl K.: Cover and composition of coastal macroalgae in relation to water quality. – *Submitted* to Estuaries. Martin G., Paalme T. & Torn K.: Production rate of loose-lying and attached forms of red algae *Furcellaria lumbricalis* and *Coccotylus truncatus* in Kassary Bay, West Estonian Archipelago. – *Submitted* to Hydrobiologia. Martin G., Paalme T. & Torn K.: Growth- and production rate of drifting *Furcellaria lumbricalis* community in waters of West Estonian Archipelago, the Baltic Sea. – *Submitted* to Hydrobiologia.				
16	Maps of distribution patterns of water chemistry variables in the Baltic coastal region	Month 24	Re	PU	1
	See database: http://data.ecology.su.se/models/CHARM/ ACCESS_BED.htm.				
17	Using phytoplankton community indices as quality elements for ecological classification	Month 24	Me/Re	PU	2
	Gromisz, S., Heiskanen, A-S, Hendriksen, P., Kauppila, P., Raateland, A., Kuuppo, P., Purina, I., Sagert, S., Wasmund, N., Witek, Z.: Applicability of phytoplankton diversity indices for the assessment of the ecological quality of the coastal Baltic Sea ecosystem. Draft manuscript, *in preparation*. Henriksen, P., Kauppila, P., Purina, I., Gromisz, S., Sagert, S.: Analysis of the temporal bloom patterns in the Baltic Sea. Draft manuscript, *in preparation*. Rieling, T., Schubert H.& Sagert S.: Phytoplankton indicators for the assessment of the ecological state of brackish coastal waters - a contribution to the implementation of the EU-WFD in Germany. Draft manuscript, *in preparation*. Kauppila, P., Pitkänen, H., Korhola, A., Pellikka, K., Vaalgamaa, S. & Weckström, K. 2005 (*in press*): Assessing ecological status in an urban estuary in the northern Baltic Sea and its recovery from pollution. – Proceedings of the International Association of Theoretical and Applied Limnology, Vol. 29.				

<table>
<tr><th>Delive-
rable
no.</th><th>Deliverable title</th><th>Delivery date</th><th>Nature</th><th>Dissemi-
nation
level</th><th>Work-
package
number</th></tr>
<tr><td>18</td><td>Computation of retention times and stratification.</td><td>Month 24</td><td>Da</td><td>PU</td><td>1</td></tr>
<tr><td></td><td colspan="5">This task was done at the Department of Systems Ecology at Stockholm University, Sweden (SUSE) by Björn Sjöberg. A crude partition of the coastal zone was made based on estimates of residence time based on the exchange between the open sea and stratification. Prioritized semi-enclosed bays have been modelled using 1D model, forced by runoff, local wind and barotropic/baroclinic forced exchange with open sea. Model calculations have been made for 31 out of 92 prioritized areas. Output consists of monthly averages of temp and salinity stratification. Averages are calculated for the whole integration period, 1991-2000. The output has been compared with observations. A dispersion model was also used to estimate turnover time, transit time and age of water. Final output of the work was used for the first draft typology (deliverable 19) and a second version of typology (deliverable 31).</td></tr>
<tr><td>19</td><td>First draft typology including map of spatial distribution of type areas.</td><td>Month 24</td><td>Re</td><td>PU</td><td>1</td></tr>
<tr><td></td><td colspan="5">Submitted with half-year report in May 2003 and presented again in the report of December 2003.</td></tr>
<tr><td>20</td><td>First draft reference conditions</td><td>Month 24</td><td>Re</td><td>PU</td><td>2-5</td></tr>
<tr><td></td><td colspan="5">Heiskanen A-S., Gromisz S., Jaanus A., Kauppila P., Purina I., Sagert S., Wasmund N. (in press): Developing reference conditions for phytoplankton in the Baltic coastal waters. Part I: Applicability of historical and long-term datasets for reconstruction of past phytoplankton conditions. – JRC Technical EU report.

Boström C., Baden S.P. & Krause-Jensen D. 2003: The seagrasses of Scandinavia and the Baltic Sea. – In Green E.P. & Short F.T. (Eds.): World atlas of seagrasses. California University Press. 310 pp.

Domin A., Schubert H., Krause J.C. & Schiewer U. 2004: Modelling of pristine depth limits for macrophyte growth in the southern Baltic Sea. – Hydrobiologia 514: 29-39. (Acknowledgement lacking by mistake).

Frederiksen M., Krause-Jensen D., Holmer M. & Laursen J. 2004: Long-term changes in area distribution of eelgrass (Zostera marina) in Danish coastal waters. – Aquatic Botany 78: 167-181.

Frederiksen M., Krause-Jensen D, Holmer M. & Laursen J. 2004: Long-term changes in eelgrass (Zostera marina) landscapes: influence of physical setting. – Aquatic Botany 78: 147-165.

Krause-Jensen D., Greve T.M. & Nielsen K. (in press): Eelgrass as a bioindicator under the Water Framework Directive. – Water resources Management.

Middelboe A.L., Sand-Jensen K. & Krause-Jensen D. 2003: Spatial and interannual variations with depth in eelgrass populations. – Journal of Experimental Marine Biology and Ecology 291: 1-15.</td></tr>
</table>

Delive-rable no.	Deliverable title	Delivery date	Nature	Dissemi-nation level	Work-package number
	Nielsen K., Sømod B., Ellegaard C. & Krause-Jensen D. 2003: Assessing reference conditions according to the European Water Framework Directive using modelling and historical data – an example from Randers Fjord, Denmark. – Ambio 32: 287-294. Torn K., Krause-Jensen D. & Martin G.: Present and past depth distribution of bladderwrack (*Fucus vesiculosus*) in the Baltic Sea. – *Submitted* to Aquatic Botany.				
21	Draft of scientific paper relating phyto-plankton and macrophytes to typology	Month 24	Re	PU	1-3
	Sagert S., Krause-Jensen D., Henriksen P., Rieling T., Schubert H. (*in press*): Integrated ecological assessment of Baltic Sea coastal areas by means of phytoplankton and macrophytobenthos. – Estuarine, Coastal and Shelf Science.				
22	Draft of scientific paper relating phyto-plankton and benthic infauna to typology	Month 24	Re	PU	1,2 and 4
	Carstensen; J., Helminen, U., Heiskanen, A.-S. 2004: Typology as a structuring mechanism for phytoplankton composition in the Baltic Sea. – In: G. Schernewski & M. Wielgat (Eds.): Baltic Sea Typology. – Coastline Reports 4: 55-64. Helminen, U., Josefson A.B., Perus, J., Heiskanen, A.-S. & van de Bund, W.: Towards functional typology of coastal Baltic Sea: verification of typology based on phyto-plankton and macrozoobenthos. *In preparation*. Draft paper completed and under revision by authors for final submitting to an international journal, (see Helminen, U., Josefson, A.B., Perus, J., Heiskanen, A.-S. & van de Bund, W.: Towards functional typology of coastal Baltic Sea: verification based on phytoplankton and macrozoobenthos. – *Submitted*.); abstract submitted to ASLO-meeting summer 2005: The ecological quality assessment in the Water Framework Directive requires that the impacts of pressures on the functioning and structure of aquatic ecosystems should be evaluated against type-specific reference conditions of the biological quality elements. In this work, we used the monitoring data from the Baltic Sea coastal areas to study whether the general a priori typology frame developed for the Baltic Sea coastal areas within the CHARM project, would allow identification of distinct biological communities within the types. Multidimensional scaling was applied to test whether macrozoobenthos monitoring data from 6 different countries and phytoplankton data from 7 different countries would cluster following the proposed typology. The selected physical and morphological type factors (salinity, depth and water residence time) were important for structuring both macrozoobenthos and phyto-plankton communities. The results indicate that the proposed Baltic Sea typology can be used to identify type-specific phytoplankton and zoobenthos communities, thus providing an appropriate starting point for further work on developing type specific reference conditions.				
23	Workshop 2	Month 24	Work-shop	PU	7
	Done.				
24	Report to the Commission	Month 24	Re	PU	1-7
	Done.				

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Workpackage number
25	Large scale vegetation models	Month 30	Me	PU	3

Boström C., Baden S.P. & Krause-Jensen D. 2003: The seagrasses of Scandinavia and the Baltic Sea. – In Green E.P. & Short F.T. (Eds.): World atlas of seagrasses. California University Press. 310 pp.

Krause-Jensen D., Carstensen J. & Dahl K.: Cover and composition of coastal macroalgae in relation to water quality. – *Submitted* to Estuaries.

Torn K. & Martin G. 2004 (*in press*.): Environmental factors affecting the distribution of charophyte species in Estonian coastal waters, Baltic Sea. – Proceedings of the Estonian Academy of Sciences. Biology. Ecology 53: 251-259.

Torn K., Krause-Jensen D. & Martin G.: Present and past depth distribution of bladderwrack (*Fucus vesiculosus*) in the Baltic Sea. – *Submitted* to Aquatic Botany.

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Workpackage number
26	Draft of 2 scientific papers relating biological indicators and water quality parameters to physical gradients	Month 30	Re	PU	lead by WP1

The responsibility for deliverable 26 was taken by Partner KORPI, Lithuania.

Pilkaityte, R., A. Razinkovas, Z. Gasiunaite, H. Shubert et al. Factors structuring cyanobacteria assemblages in the Baltic Sea (*in prep.*). To be submitted by March 2005 for the publications of the 3rd Plankton conference.

Daunys, D., S. Olenin and S. Gulbinskas: Evaluation of the dredge spoil dumping effects on the relationships between seabed properties and bottom macrofauna. *Submitted* to Marine Pollution Bulletin.

Gasiunaite, Z. et al. Seasonality of phytoplankton assemblages in the different salinity regimes of the Baltic Sea. *Submitted* to Estuarine & Coastal Science.

Additionally, detailed studies were carried out in the Oder estuary. The excellent availability of data and information made this area a very suitable test region. I two diploma-theses, and in co-operation with German and Polish authorities, the abundance and distribution of macro-zoobenthos as well as hydro-chemical parameters were analysed against the background of the typology. The results are published in:

Schernewski, G. & T. Dolch (Eds.) 2004: The Oder Estuary - against the background of the European Water Framework Directive. – Marine Science Reports 57. ISSN 0939-396X, 288 p.

Single papers in this volume are:

Bangel, H., G. Schernewski, A. Bachor & M. Landsberg-Uczciwek 2004: Spatial pattern and long-term development of water quality in the Oder estuary. – In: G. Schernewski & T. Dolch (Eds.): The Oder Lagoon – against the background of the European Water Framework Directive. – Marine Science Reports 57 (2004). ISSN: 0939 396X, pp. 17-65.

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Work-package number
	Rödiger, S. 2004: Die Makrofauna des Oderhaffs - Vorschläge für ein Monitoring nach EU-WRRL. – In: G. Schernewski & T. Dolch (Eds.): The Oder Lagoon – against the background of the European Water Framework Directive. Marine Science Reports 57 (2004). ISSN: 0939-396X, pp. 127-178. H. Bangel: Die Repräsentativität des Monitorings im Oderästuar – neue Anforderungen vor dem Hintergrund der Wasserrahmenrichtlinie. – In: G. Schernewski & T. Dolch (Eds.): The Oder Lagoon – against the background of the European Water Framework Directive. Marine Science Reports 57 (2004). ISSN: 0939-396X, pp. 67-84.				
27	Report to the Commission	Month 30	Re	PU	1-7
	Done.				
28	Workshop 3	Month 32	Workshop	PU	7
	Done.				
29	Draft of 2 scientific papers relating biological indicators and water quality parameters to physical gradients with emphasis on reference conditions	Month 36			lead by WP1
	Publications in preparation and in press were based on the modelling approach for the Baltic Sea (*Schernewski & Neumann, in press*; *Neumann & Schernewski, in prep.*) and the coastal zone – mainly one estuary in the Southern Baltic (*Wielgat & Schernewski, in prep.*). Krause-Jensen D., Greve T.M. & Nielsen K. (*in press*): Eelgrass as a bioindicator under the Water Framework Directive. – Water resources Management. Schernewski, G. & T. Neumann (*in press*): An ecological model evaluation of two nutrient abatement strategies for the Baltic Sea. – Journal of Marine Systems. Schernewski, G. & T. Neumann 2005: The trophic state of the Baltic Sea a century ago: A model simulation study. – Journal of Marine Systems 53: 109-124. Wielgat, M. & G. Schernewski: Pristine conditions in the Oder Lagoon. – *Submitted* to Acta hydrochimica et hydrobiologica.				
30	Definition of vegetation indicators	Month 36	Me	PU	3
	Greve T.M. & Krause-Jensen D.: Stability of eelgrass (*Zostera marina* L.) depth limits: influence of habitat types. – *Submitted* to Marine Biology. Krause-Jensen D., Greve T.M. & Nielsen K. (*in press*): Eelgrass as a bioindicator under the Water Framework Directive. – Water resources Management. Middelboe A.L., Sand-Jensen K. & Krause-Jensen D. 2003: Spatial and interannual variations with depth in eelgrass populations. – Journal of Experimental Marine Biology and Ecology 291: 1-15.				

Delive-rable no.	Deliverable title	Delivery date	Nature	Dissemi-nation level	Work-package number
	Torn K., Krause-Jensen D. & Martin G.: Present and past depth distribution of bladderwrack (*Fucus vesiculosus*) in the Baltic Sea. – *Submitted* to Aquatic Botany.				
31	Verified typology including map	Month 36	Re	PU	1 and 7
	In the course of the CHARM project most of the Baltic countries have already developed their national typologies, either in a draft form which has not been yet officially accepted, or in a final version (Germany) which is now legally binding on a national level. Since the work on national level is so advanced and national concepts on typology are for most countries already well established, the CHARM typology was developed as a general classification system for the Baltic Sea Ecoregion. The idea was to cover the entire Baltic Sea and to keep the classification system general enough, that it can serve as an "umbrella" linking all already existing national typologies. This was a different approach from originally planned which was a more specific typology for the entire Baltic Sea coastal zone. A general structure of the typology was not detailed enough so that the biotic elements might have been used for verification. The CHARM typology was presented at several conferences and workshop to receive a feedback from representatives from Baltic countries and get the idea of the "umbrella" typology for the overall classification of Baltic Sea types acknowledged. Schernewski, G. 2004: Umsetzung der Wasserrahmenrichtlinie in der Ostsee. – In: Die EG-Wasserrahmenrichtlinie – Grundlagen und Praxisbeiträge der Grünen-Liga-Seminarreihe, Band 2, Grüne-Liga, 47-48. Schernewski G. & M. Wielgat 2004: Towards a Typology for the Baltic Sea. – In: G. Schernewski & N. Loser (Eds.): Managing the Baltic Sea. Coastline Reports 2, ISSN 0928-2734, pp. 35-52. Schernewski G. & M. Wielgat 2004: A Baltic Sea Typology according to the EC-Water Framework Directive: Integration of national typologies and the water body concept. – In: G. Schernewski & M. Wielgat (Eds.): Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 1-26. A comparison between typology and phytoplankton will be provided within the diploma-thesis: Thamm, Ramona (*in prep.*): Darstellung und Analyse räumlicher Verteilungen des Phytoplanktons in der Ostsee vor dem Hintergrund der EU- Wasserrahmenrichtlinie. The results of comparison between national typologies and CHARM typology were published in: Schernewski, G. & M. Wielgat (Eds.) 2004: Baltic Sea Typology. Coastline Reports 4. ISSN 0928-2734, 109p. Single papers in this volume are: Schernewski G. & M. Wielgat 2004: A Baltic Sea Typology according to the EC-Water Framework Directive: Integration of national typologies and the water body concept. – In: G. Schernewski & M. Wielgat (Eds.). Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp.1-26.				

Deliverable no.	Deliverable title	Delivery date	Nature	Dissemination level	Work-package number
	Perus, J., S. Bäck, H.-G. Lax, V. Westberg, P. Kauppila & E. Bonsdorff 2004: Coastal marine zooben-thos as an ecological quality element: a test of environmental typology and the European Water Frame-work Directive. – In: Schernewski, G. & M. Wielgat (Eds.): Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 27-38. Krzyminski, W., L. Kruk-Dowgiallo, E. Zawadzka-Kahlau, R., M. Kaminska, E. Lysiak-Pastuszak 2004: Typology of Polish marine waters. – In: G. Schernewski & M. Wielgat (Eds.). Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 39-48. Christiansen, T., J. Andersen & J. B. Jensen 2004: Defining a Typology for Danish Coastal Waters. – In: Schernewski, G. & M. Wielgat (Eds.): Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 49-54. Carstensen, J., U. Helminen & A.-S. Heiskanen 2004: Typology as a structuring mechanism for phytoplankton composition in the Baltic Sea. – In: Schernewski, G. & M. Wielgat (Eds.): Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 55-64. Olenin, S & D. Daunys 2004: Coastal typology based on benthic biotope and community data: The Lithuanian case study. – In: Schernewski, G. & M. Wielgat (Eds.): Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 65-83. Thamm, R., G. Schernewski, N. Wasmund & T. Neumann 2004: Spatial phytoplankton pattern in the Baltic Sea. – In: Schernewski, G. & M. Wielgat (Eds.): Baltic Sea Typology. Coastline Reports 4, ISSN 0928-2734, pp. 85-109.				
32	Verified reference conditions (including map) for all quality elements	Month 36	Re	PU	2-5
	Carstensen, J., Heiskanen, A.-S., Henriksen, P., Gromizs, S. & Kauppila, P. (*in press*): Developing reference conditions for phytoplankton in the Baltic coastal waters. Part II: Examples of reference conditions developed from the Baltic Sea. – JRC Technical EU report. Boström C., Baden S.P. & Krause-Jensen D. 2003: The seagrasses of Scandinavia and the Baltic Sea. – In Green E.P. & Short F.T. (Eds.): World atlas of seagrasses. California University Press. 310 pp. Domin A., Schubert H., Krause J.C. & Schiewer U. 2004: Modelling of pristine depth limits for macrophyte growth in the southern Baltic Sea. – Hydrobiologia 514: 29-39. (Acknowledgement lacking by mistake). Frederiksen M., Krause-Jensen D., Holmer M. & Laursen J. 2004: Long-term changes in area distribution of eelgrass (*Zostera marina*) in Danish coastal waters. – Aquatic Botany 78: 167-181. Frederiksen M., Krause-Jensen D, Holmer M. & Laursen J. 2004: Long-term changes in eelgrass (*Zostera marina*) landscapes: influence of physical setting. – Aquatic Botany 78: 147-165. Krause-Jensen D., Greve T.M. & Nielsen K. (*in press*): Eelgrass as a bioindicator under the Water Framework Directive. – Water resources Management.				

Delive-rable no.	Deliverable title	Delivery date	Nature	Dissemi-nation level	Work-package number
	Nielsen K., Sømod B., Ellegaard C. & Krause-Jensen D. 2003: Assessing reference conditions according to the European Water Framework Directive using modelling and historical data – an example from Randers Fjord, Denmark. – Ambio 32: 287-294. Torn K., Krause-Jensen D. & Martin G.: Present and past depth distribution of bladderwrack (*Fucus vesiculosus*) in the Baltic Sea. – *Submitted* to Aquatic Botany. As typology for the entire CHARM-project did not materialize until very late in the project, several classification attempts were made at the national level (see Josefson, A.B., Perus, J., Jermakovs, V., Kotta, J., Daunys, D. & Olenin, S. 2004: Fitting biology to typology indicates importance of residence time for benthic macrofaunal community structure. – Oral presentation at: Towards operational management of coastal eutrophication in Europe. Charm Workshop. Book of Abstracts, August 23–25, 2004, Tallinn, Estonia, p. 10.). For the Finnish coastal waters, the national database (with 9000 entries on benthos and related environmental factors) is being used to make a comprehensive analysis of the Baltic Sea zoobenthos and numerical classification. Several methods will be tested, according to Borja et al. 2003 (Mar Pollut Bull), Rosenberg et al. 2004 (Mar Pollut Bull) and some numerical indice tested previously for rivers and lakes. Some tests have been made to link zoobenthos and oxygen (see the Swedish MARE-project at http://www.mare.su.se); but as data is scattered, equations show week regression factors. Tests at local levels show discrete clustering in relation to environmental data, as shown by Bonsdorff, E., Laine, A. O., Hänninen, J., Vuorinen, I. & Norkko, A. 2003: Zoobenthos of the outer archipelago waters (N. Baltic Sea) - the importance of local conditions for spatial distribution patterns. – Boreal Environment Research 8: 135-145.				
33	Numerical relationships between benthos and environmental gradients	Month 36	Re	PU	4
	Rönnberg, C. & Bonsdorff, E. 2004: Baltic Sea eutrophication: area-specific ecological consequences. – Hydrobiologia 514: 227-241. The planned deliverables were defined in too much detail at the outset of CHARM, and thus the quantitative relationships between the Baltic Sea environment (coastal typology) and zoobenthos on the one hand, and the numerical description of zoobenthos as an ecological quality element on the other has not been successful due to lack of fully comparable data (or data from what could be defined as "pristine conditions"; historic data not sufficient, as the species composition varies over time in an unpredictable and non-reversable manner). Also, the definition of ecological reference conditions for zoobenthos has failed in the sense that it is impossible to use historic scenarios as reference points, since the natural succession of the assemblages indicates significant changes over time, and with an increasing number of successful non-native benthic species being permanently established along the coastal regions of the sea, these have to bee taken into account. Rather, efforts were made to test the levels of variability that can be accepted within "natural reference conditions" (the concept has a different meaning in the species-poor northern Baltic Sea and the more marine southern Baltic Sea, where indicator-organisms have a greater value). Various efforts of defining regional quality elements have been made (see e.g. *Rosenberg et al. 2004* for an example for the Swedish west coast). On regional or national scales the efforts have been successful, but due to large geographic and topographical differences between coasts (e.g. the open sandy steep Polish coast vs. the shallow broad broken rocky Finnish coast), no direct comparisons have been possible. Also, the delayed common definition of coastal typology made ecological verification hazardous: the common CHARM-typology (see *Coastal Rep. 4/2004;* http://www.eucc-d.de/coastline_reports4.php) is too simplistic for e.g. the Finnish coasts,				

Delive-rable no.	Deliverable title	Delivery date	Nature	Dissemi-nation level	Work-package number
	and within Finland, a national working group defined one set of typology in 2002, but later in 2004 verified it primarily based on data on zoobenthos from WP4 within CHARM, and no further tests were possible after that (autumn 2004). Hence, results from WP4 are not as homogenous as was anticipated at the start of CHARM. But steps forward have been taken, and for the Gulf of Finland, CHARM redefined sampling-strategy along depth strata to cover all proposed environmental types in 2004; data currently under analysis. Local time-trends have been analysed as recovery-patterns and successional dynamics of zoobenthos in relation to organic enrichment (before - during - after extensive aquaculture since the early 1980s until 2002) in order to get a comprehensive view of long-term changes in the fauna needed to be understood in order to define ecological quality criteria and reference conditions. Similar efforts were done (using an EU-exchange MC-grant within CHARM) for the Danish coastal waters, where nutrient (primarily nitrogen) effluents have decreased dramatically during the last 10 y period, but where no effects were registered on zoobenthos (numerous stations covering the entire Danish coastal waters and fjords; *Perus & Josefson in prep.*). The Swedish national classification-scheme (tested primarily for the west coast by *Rosenberg et al. 2004*) gave promising results in an area with high species numbers, but a preliminary test of the same method for the Finnish coats showed some of the problems linked to the naturally low species numbers, and the fact that the key species occupy several natural niches.				
34	Monitoring recommendations for the Baltic coastal zone	Month 36	Re	PU	2,5,6
	Carstensen, J., Heiskanen, A.-S., Henriksen, P., Gromizs, S., Kauppila, P., Sagert, S. & Jaanus, A. (*in press*): Estimation of confidence on ecological quality classifications of Baltic Sea coastal waters based on phytoplankton parameters. – JRC Technical EU report. Design of networks for monitoring ecological status of coastal waters in the Baltic Sea Ecoregion, *unpublished report*.				
35	Final report to the Commission	Month 36	Re	PU	1-7
	Done.				
36	User's Guide on type areas and reference conditions for the Baltic region	Month 36	Re	PU	7
	Done.				