30-month report covering the period 1 December 2003 – 31 May 2004

Characterisation of the Baltic Sea Ecosystem (CHARM)

Contract EVK3-CT-2001-00065

Introduction

This report is divided into an administrative part and a technical part. The administrative part includes status and progress from the project Characterisation of the Baltic Sea Ecosystem (CHARM) – Contract EVK3-CT-2001-00065, covering the period 1 December 2002 to 31 May 2004. The technical part includes details on the progress of work carried out in the work packages.

Administrative part

During the past 6 months, most of the activity has been concentrated on finalising manuscripts and prepare material for the CHARM Workshop in Tallin 23-25 August 2004 "Towards operational management of coastal eutrophication in Europe". An invitation folder and registration are available on the CHARM homepage (http://charm.dmu.dk). The meeting will focus on scientific possibilities and limitations in providing tools to manage coastal ecosystems along the lines of the Water Framework Directive.

More specific activities include:

- Two of the four delayed deliverables are now on schedule.
- The third annual workshop is on schedule. The workshop will be held during 23-25 August 2004 in Tallin, Estonia and will be organised by the Estonian Marine Institute, partner no. 7.
- A second dissemination dialogue meeting was held in Copenhagen 26-27 April with participation of all countries around the Baltic Sea except Estonia. All info from the meeting is available at the CHARM web site under the headline meetings.

Updated versions of the Gantt diagram and the distribution of consumables do not differ from the versions presented in the Second Annual Report.

1. 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. Status for delayed deliverables

According to the Second Annual Report, there were delays in deliverables 17, 20, 21 and 22. Deliverables 20 and 21 are now completed. See further section 4.

3. Status for deliverables

Below is inserted a section of the "Description of Work" document from CHARM (page 28) now including the status of the first 27 deliverables with deadlines at or before month 30. Out of the 27 deliverables planned for the first 30-month period, 25 are done. There are minor delays of deliverables 17 and 22 (see below for details in section 4).

Deliver-able 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 regu-lation 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	delayed
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	done
21	Draft of scientific paper relating phytoplankton and macrophytes to typology	Month 24	1-3	PU	done
22	Draft of scientific paper relating phyto-plankton and benthic infauna to typology	Month 24	1,2 and 4	PU	delayed
23	Workshop 2	Month 24	7	PU	done
24	Report to the Commission	Month 24	1-7	PU	done
25	Large scale vegetation model	Month 30	3	PU	done
26	Draft of 2 scientific papers	Month 30	lead 1	PU	done
27	Report to the Commission	Month 30	1-7	PU	done

4. Comments on delayed deliverables and progress for the work to be carried out

Deliverable 17: Completion of the final deliverable is further delayed. A draft manuscript has been prepared by MIR and is now being finalised after comments from co-authors (Gromisz et al.: Applicability of phytoplankton diversity indices for quality status assessment of the coastal Baltic Sea). The final deliverable 17 should be ready soon after the CHARM workshop, where a poster will be presented on the subject.

Deliverable 22: A drafting meeting took place at JRC on 29-30 January 2004. First analyses have been carried out both for phytoplankton and zoobenthos, but work is still on-going. The results show that it is possible to group the faunal composition in the same way as the physical factors (typology). However, we have not yet linked plankton and benthos together. The final deliverable will be delayed until after the CHARM workshop, where presentations on this deliverable (Zoobenthos: Alf Josefson & Jens Perus; phytoplankton poster: Ulla Helminen) will be available.

5. Other plans

In general, progress for the coming deliverables seems to be on schedule. I have noticed that a number of activities have already started, and I expect that both the delayed deliverables and the coming deliverables will be fulfilled in the final report.

Technical part

Work package 1

Deliverable 12 – Forcing data for hydrodynamical modelling

Ready – 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.

Deliverable 18 – Computation of retention time and stratification

Ready – 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. Prioritised 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 prioritised 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).

Deliverable 19 – First draft typology including map of spatial distribution of type areas

Ready – Submitted with half year report in May 2003 and presented again in the report of December 2003.

Deliverable 26 – Draft of 2 scientific papers relating biological indicators and water quality parameters to physical gradients

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

Kaupplila, P., Pitkänen, H., Räike, A., Kiirikki, M., Back, S. & Kangas, P. 2004: The Baltic waters around Finland: Eutrophication continues despite decreased nutrient loading. *In press*.

Pilkaityte, R., Razinkovas, A., Gasiunaite, Z., Shubert, H. et al.: Factors structuring cyanobacteria assemblages in the Baltic Sea. *Final draft* August.

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

Fasiunaite et al.: Seasonality of phytoplankton assemblages in the different salinity regimes of the Baltic Sea. *Manuscript*.

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, 17-65.

Rödiger, S. 2004: Die Makrofauna des Oderhaffs - Vorschläge für ein Monitoring nach EU-WRRL. – In: G. Schernewski & T. Dolch (Eds.): The Oder Estuary – against the background of the European Water Framework Directive. Marine Science Reports 57, 2004. ISSN: 0939-396X, 127-178.

Bangel, H.: Die Repräsentativität des Monitorings im Oderästuar – neue Anforderungen vor dem Hintergrund der Wasserrahmenrichtlinie. – In: G. Schernewski & T. Dolch (Eds.): The Oder Estuary – against the background of the European Water Framework Directive. Marine Science Reports 57, 2004. ISSN: 0939-396X, 67-84.

Deliverable 29 – Draft of 2 scientific papers relating biological indicators and water quality parameters to physical gradients with emphasis on reference conditions

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).

Schernewski, G & T Neumann (in press): The trophic state of the Baltic Sea a century ago? A model simulation study. – J. Marine Systems.

Wielgat, M & G Schernewski (in prep.): Pristine conditions in the Oder Lagoon. – Acta hydrochim. hydrobiol.

Neumann, T & G Schernewski (in prep.): Managing the Baltic Sea via river basins. – Ocean & Coastal Managing.

Deliverable 31 – Verified typology including map

Ready/in progress – 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., M. Wielgat & T. Dolch (oral presentation): A draft typology for the Baltic Sea. Presentation at the workshop 'Baltic typology' during the Baltic Sea Science Congress 2003, Helsinki, 24-28 August 2003.

Schernewski G. & M. Wielgat (oral presentation by Heiskanen A.-S. & S. Bäck): Draft Typology for the Baltic Sea. Information prepared for the presentation at the EU COAST Group Meeting Ispra, 12-13 February 2004.

Schernewski G. & M. Wielgat (oral presentation): Towards a Typology for the Baltic Sea. Presentation at the Baltic Sea Research Institute Warnemuende (IOW), 30 March 2004.

Schernewski, G. & M. Wielgat (oral presentation): Towards a Typology for the Baltic Sea. Presentation at the CHARM Dialogue Meeting, 26-27 April 2004, European Environment Agency (EEA), Copenhagen, Denmark.

Schernewski, G. & T. Neumann (invited keynote lecture): Baltic Sea ecosystem management and EU policy. International Conference to commemorate 30 years of the Helsinki Convention "International Co-operation for the Baltic Environment: Past, Present and Future". 22-24 March 2004, Riga, Latvia.

Schernewski G. & M. Wielgat. (Poster). Towards a Typology for the Baltic Sea. International conference BaltCoast 2004 - Managing the Baltic Sea. Rostock-Warnemuende, 26 28 April 2004.

Schernewski G. & M. Wielgat. (Poster). Towards a Typology for the Baltic Sea. AMK-Tagung (Annual Meeting of the Association "Marine and Coastal Geography"). Rostock-Warnemuende, 27 29 April 2004.

Schernewski G. & M. Wielgat. (Poster). Entwurf einer Typologie für die Ostsee. Nationaler Workshop zur "Typologie und Bewertung von Küsten- und Übergangsgewässern nach EU-WRRL" am 16./17.06.2004 im BSH in Hamburg.

The new typology is already published and a detailed discussion within the CHARM project is planned for August 2004:

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, 35-52.

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.

Accumulated output of CHARM

Publications (international peer reviewed):

1. Schernewski, G & T. Neumann (in press): The trophic state of the Baltic Sea a century ago? A model simulation study. J. Marine Systems.
2. Wielgat, M & G Schernewski (in prep.): Pristine conditions in the Oder Lagoon. Acta hydrochim. hydrobiol.
3. Neumann, T & G. Schernewski (in prep.): Managing the Baltic Sea via river basins. Ocean & Coastal Managing.

Other publications:

1. Schernewski, G. (2003): CHARMante Forschung - Die Umsetzung der Wasserrahmen-richtlinie. In Wissenschaftsgemeinschaft Leibnitz (Hrsg.): Der verschwundene Hering und das Geheimnis des Regenmachers. Umweltforschung der Leibnitz-Gemeinschaft - Qualität und Vielfalt. Leibnitz-Gemeinschaft, Bonn, 136-137.
2. Rödiger, S., G. Schernewski & M. Zettler (2003): Die Makrozoobenthosbesiedlung des Oderhaffs vor dem Hintergrund der EU-Wasserrahmenrichtlinie. Tagungsbericht der Deutschen Gesellschaft für Limnologie (DGL) und der deutschen und österreichischen Sektion der Societas Internationlis Limnologieae (SIL), Braunschweig 2002, Bd. 2, 560-564.
3. Schernewski, G., T. Neumann & M. Wielgat (2003): Implementation of the Water Framework Directive in the Baltic Sea Ecoregion. Coastline 2003, 3/4, 22-23.
4. 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, 17-65.
5. Rödiger, S. (2004): Die Makrofauna des Oderhaffs - Vorschläge für ein Monitoring nach EU-WRRL. In: G. Schernewski & T. Dolch (eds.): The Oder Estuary – against the background of the European Water Framework Directive. Marine Science Reports 57 (2004). ISSN: 0939-396X, 127-178.
6. H. Bangel: Die Repräsentativität des Monitorings im Oderästuar – neue Anforderungen vor dem Hintergrund der Wasserrahmenrichtlinie. In: G. Schernewski & T. Dolch (eds.): The Oder Estuary – against the background of the European Water Framework Directive. Marine Science Reports 57 (2004). ISSN: 0939-396X, 67-84.

7. 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.
8. 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.
9. 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, 35-52.

Oral presentations:

1. Schernewski, G. (oral presentation): Typisierung der Küstengewässer im Rahmen des Projektes CHARM. Nationales Koordinierungstreffen zur Umsetzung der Wasserrahmenrichtlinie in Küstengewässern. Amt für ländliche Räume, Lübeck, 21. Feb. 2002.
2. Schernewski, G. (oral presentation): Umsetzung der Wasserrahmenrichtlinie in der Ostsee. EG-Wasserrahmenrichtlinie und Meeresschutz. Tagung der Grünen Liga und Aktionskonferenz Nordsee, Bremen, 17. Mai 2003. (Einladung).
3. Schernewski, G., M. Wielgat & T. Dolch (oral presentation): A draft typology for the Baltic Sea. Presentation at the workshop 'Baltic typology' during the Baltic Sea Science Congress 2003, Helsinki, 24-28 Aug. 2003.
4. Schernewski Gerald and Neumann Thomas (invited keynote lecture): The trophic state of the Baltic Sea a century ago: A large-scale model simulation study. Baltic Sea Science Congress 2003, 24.-28. 08. 2003, Helsinki.
5. Schernewski G. & M. Wielgat (oral presentation by Heiskanen A.-S. & S. Bäck): Draft Typology for the Baltic Sea. Information prepared for the presentation at the EU COAST Group Meeting Ispra 12-13th, February 2004.
6. Schernewski G. & M. Wielgat (oral presentation): Towards a Typology for the Baltic Sea. Presentation at the Baltic Sea Research Institute Warnemuende (IOW), 30th, March 2004.
7. Schernewski, G. & M. Wielgat (oral presentation): Towards a Typology for the Baltic Sea. Presentation at the CHARM Dialogue Meeting, April 26-27th, 2004, European Environment Agency (EEA), Copenhagen, Denmark.
8. Schernewski, G. & T. Neumann (invited keynote lecture): Baltic Sea ecosystem management and EU policy. International Conference to commemorate 30 years of the Helsinki Convention "International Co-operation for the Baltic Environment: Past, Present and Future". March 22-24, 2004, Riga, Latvia.

Poster presentations:

1. Schernewski G. & M. Wielgat. (Poster). Towards a Typology for the Baltic Sea. International conference BaltCoast 2004 - Managing the Baltic Sea. Rostock-Warnemuende, 26-28 April 2004.
2. Schernewski G. & M. Wielgat. (Poster). Towards a Typology for the Baltic Sea. AMK-Tagung (Annual Meeting of the Association "Marine and Coastal Geography"). Rostock-Warnemuende, 27-29 April 2004.
3. Schernewski G. & M. Wielgat. (Poster). Entwurf einer Typologie für die Ostsee. Nationaler Workshop zur "Typologie und Bewertung von Küsten- und Übergangsgewässern nach EU-WRRL" am 16./17.06.2004 im BSH in Hamburg.

Diploma thesis:

1. Bangel, H. (2001): Der Gewässerzustand des Oderästuars vor dem Hintergrund der Wasserrahmenrichtlinie. Diplomarbeit im Fach Geographie an der CAU zu Kiel.
2. Minning, M. (2003): Praktische, ökologische und planerische Konsequenzen der Ausbaggerung des Schifffahrtskanals im Oderhaff. Diplomarbeit im Fach Geographie an der CAU zu Kiel.

3. Rödiger, Silke (2003): Makrozoobenthos im Oderhaff vor den Hintergrund der Wasserrahmenrichtlinie. Diplomarbeit im Fach Biologie an der Universität Essen.
4. Thamm, Ramona (in prep.): Darstellung und Analyse räumlicher Verteilungen des Phytoplanktons in der Ostsee vor dem Hintergrund der EU- Wasserrahmenrichtlinie. Diplomarbeit an der Universität Rostock.

Work package 2

Status of deliverables and progress report

Deliverables 20 and 21

Deliverables 20 and 21 are completed.

Deliverable 14 - Publication of phytoplankton indices in relation to physico-chemical environment

- Draft manuscript is available (Gasiunaite et al.: Seasonality of phytoplankton assemblages along the salinity gradient in the Baltic Sea).
- Meeting was organized between some key authors in CORPI on 2 April. Second meeting for finalization of the manuscript was organized at JRC on 24-29 June.

Deliverable 17 - Report on phytoplankton indices applicable as quality elements for ecological classification

- Completion of the final deliverable is further delayed.
- A draft manuscript has been prepared by MIR and is now being finalized after comments from co-authors (Gromisz et al.: Applicability of phytoplankton diversity indices for quality status assessment of the coastal Baltic Sea).
- The final deliverable 17 should be ready soon after the CHARM workshop, where a poster on this topic will be presented.

Deliverable 22 - Draft of scientific paper relating phytoplankton and benthic infauna to typology

- A drafting meeting took place at JRC on 29-30 January 2004.
- First analyses have been carried out both for phytoplankton and zoobenthos, but work is still on-going.
- The results show that it is possible to group the faunal composition in the same way as the physical factors (typology). However, we have not yet linked plankton and benthos together.
- The final deliverable will be delayed until after the CHARM workshop, where presentations on this deliverable (zoobenthos: Alf Josefson & Jens Perus; phytoplankton poster: Ulla Helminen) will be available.

Updated timetable and status of contributions of WP2 partners to deliverables.
(D: Deliverable number, Resp.: Responsible partner, Contr.: Contributions from partners).

D	Deliverable	Original month	Delayed month	Resp.	Contr.
14	**Draft paper** on phytoplankton indices in relation to physico-chemical environment (including a **map of distribution** and description of regulation of phytoplankton community indices)	Month 20: July 2003	Month 31: June 2004 (manuscript available - should be finalised by end of July)	JRC, CORPI, EMAUG, SYKE	NERI, IOW, IAE, MIR
17	**Report** on phytoplankton indices applicable as quality elements for ecological classification	Month 24: Nov. 2003	Month 31: June 2004 (work on-going, delay until September 2004)	JRC, CORPI, MIR	NERI, SYKE, IOW, IAE, EMAUG
20	**Report** on reference conditions of phytoplankton	Month 24: Nov. 2003	Finalized 26 May 2004	JRC	SYKE, IOW, IAE, MIR, EMAUG
21	**Draft paper** relating phytoplankton and macrophytes to typology	Month 24: Nov. 2003	Finalized Jan. 2004	EMAUG	NERI
22	**Draft paper** relating phytoplankton and benthic infauna to typology	Month 24: Nov. 2003	Month 33: Aug. 2004 (work on-going, delay expected October 2004)	JRC, AAU	NERI, SYKE, SU, IOW (MIR)
32	**Final report** on reference conditions of phytoplankton	Month 36: Nov. 2004	No change	NERI, SYKE, CORPI, IOW, IAE, MIR, EMAUG	ALL
34	**Recommendations** for monitoring strategy	Month 36: Nov. 2004	No change	NERI, JRC, CORPI, MIR	SYKE, IOW, IAE, EMAUG

List of published papers and manuscripts/reports/presentations, etc.

Gasiūnaitė, Z., Pilkaitytė, R., Dučinskas, K., Razinkovas, A., Olenina, I. 2003: Seasonal changes in the Curonian lagoon (Baltic Sea) phytoplankton community structure. *Poster* presented in the Symposium of the European Marine Biologists.

Gasiunaite, Z., Rasincovas, A., Pilkaityte, R., Heiskanen, A.-S., Cardoso, A.-C.: Seasonality of phytoplankton assemblages along the salinity gradient in the Baltic Sea. *Draft manuscript for deliverable 14*, in prep.

Gromisz, S., Hendriksen, P., Kauppila, P., Raateland, A., Purina, I., Sagert, S., Wasmund, N., Witek, Z., Heiskanen, A-S.: Applicability of phytoplankton diversity indices for quality status assessment of the coastal Baltic Sea. *Draft manuscript for deliverable 17*, in prep.

Henriksen, P., Kauppila, P.,. Purina, I., Gromisz, S., Sagert, S.: Analysis of the temporal bloom patterns in the Baltic Sea. *Draft manuscript*, in prep.

Rieling, T., Sagert, S., Bahnwart, M., Selig, U. & Schubert, H. 2003: Definition of seasonal phytoplankton events for analysis of long term data from coastal waters of the southern Baltic Sea with respect to the requirements of the European Water Framework Directive. – In: Brebbia C.A., Almora D. & D. Sales, Water Pollution VII, Modelling, Measuring and Prediction, WIT Press, pp. 103-114 (*paper* presented at the Water Pollution Congress, Cadiz, 18-20.06.2003).

Rieling, T., Sagert, S., Bahnwart, M., Selig, U. & Schubert, H. 2003: A systematic approach for a phytoplankton based classifcation system of highly variable, eutrophicated Baltic coastal waters. *Poster* presented in the BMB Congress in Helsinki, 23.08-28.08.2003

Heiskanen, A-S., S. Gromisz, A. Jaanus, P. Kauppila, I. Purina, S. Sagert, N. Wasmund. 2004: 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. *In press* (JRC Special Publication).

Sagert, S., Krause-Jensen, D., Henriksen, P., Rieling, T., Schubert: Integrated ecological assessment of Baltic Sea coastal areas by means of phytoplankton and macrophytobenthos (*submitted* to Est. Coast. Shelf. Sci.).

Bäck, S., Likolammi, M. 2004: Phenology of Ceratium tenuicorne in the SW Gulf of Finland, the Northern Baltic Sea. – Ann. Bot. Fennini, 41: 95-101.

Work package 3

Status of WP3 - Overview of deliverables

WP3 is involved in the deliverables shown in the table below. The table shows the status of the deliverables.

Deadlines and status of the contributions of WP3 to the deliverables where this work package plays a role.

	Internal deadline	PL-deadline	EU-deadline	Status
Deliverable 3	15 Apr-02	15 May-02	01 June-02	Completed
- Datacompilation & QA				
- Metadata				
Deliverable 15	01 July-03	15 July-03	01 Aug-03	Completed
- Small scale veg. models				
- Actual and historic state				
Deliverable 20	01 Nov-03	15 Nov-03	01 Dec-03	Completed
- Reference conditions				
Deliverable 21	01 Nov-03	15 Nov-03	01 Dec-03	Completed
- Draft of paper				
Deliverable 25	01 May-04	15 May-04	01 June-04	Completed
- Large-scale veg. models				
Deliverable 29	01 Nov-04	15 Nov-04	01 Dec-04	Completed
- Draft of paper				
Deliverable 30	01 Nov-04	15 Nov-04	01 Dec-04	In progress
- Id. of veg. indicators				
Deliverable 31	01 Nov-04	15 Nov-04	01 Dec-04	In progress
- Verified typology				
Deliverable 32	01 Nov-04	15 Nov-04	01 Dec-04	In progress
- Verified reference con.				
Deliverable 34	01 Nov-04	15 Nov-04	01 Dec-04	In progress
- Recommendations				

In the past 6 months we have completed deliverable 21, 25 and 29. Deliverables 21 and 29 are manuscripts, which are mentioned in the reference list (21: Sagert et al. submitted; 29: Krause-Jensen et al. in press).

Plans for WP3 in the remaining project period

In august (23-25) we participate with various presentations in the CHARM workshop in Tallinn.

From August to November we will complete the remaining deliverables and continue the writing of manuscripts.

Deliverable 25 - Large-scale vegetation models

Prepared by the project group: Dorte Krause-Jensen, Sigrid Sagert, Hendrik Schubert, Georg Martin, Kaire Torn, Ari Ruuskanen, Anda Ikauniece, Christoffer Boström.

Introduction

Aim
The aim of this deliverable is to establish models that explain and predict changes in the vegetation based on changes in physicochemical factors on large spatial scales.

The ultimate goal of vegetation models in CHARM is to identify relations between anthropogenic impact and the response in vegetation parameters. The models should allow us to explain, predict and hindcast changes in the distribution and abundance of the vegetation from changes in water quality and to distinguish between anthropogenic-caused variation and variation caused by other factors. When working across large spatial scales like the Baltic Sea where e.g. salinity and ice-cover change markedly, it is necessary to account for the influence of such factors in addition to the influence of more local factors like sediment composition in order to identify effects on the vegetation of changes in water quality.

Approach and structure
The deliverable include studies of how the following selected vegetation indicators are regulated:

- Depth distribution of eelgrass
- Depth distribution of *Fucus vesiculosus*
- Depth distribution of *Furcellaria lumbricalis*
- Depth distribution of the total algal community
- Relative abundance of opportunistic or annual macroalgae
- Macrophyte community composition
- Area cover of eelgrass

The work has been written into scientific papers, some of which have already been published or accepted for publication while others have been submitted or are still under preparation. This deliverable presents the results as short summaries/abstracts and provides references to the publications. If full text versions of the work are needed, they will be sent upon request.

Some of the papers generate specific models relating vegetation indicators to water quality on a large spatial scale and thus constitute the most central work for this deliverable - these papers are marked with '*'. Other papers analyse large-scale patterns of spatial and temporal variability in the investigated parameters and thereby provide useful information on the range and time scales of variability in the indicators as well as knowledge on reference conditions.

Boström C, Baden SP, Krause-Jensen D. 2003: The seagrasses of Scandinavia and the Baltic Sea. – In Green EP, Short FT (Eds): World atlas of seagrasses. California University Press. 310 pp. *Full text: Available upon request.*

> *Abstract.* This work summarises the distribution and importance of eelgrass, *Zostera marina*, in Scandinavian and Baltic coastal waters. Although most of the quantitative information is based on research carried out in non-tidal areas of Denmark, Sweden and Finland, the approach is holistic, and includes distribution maps and anecdotal information on eelgrass from Iceland, Norway and the coastal areas of the Baltic sea including Germany, Poland, Lithuania, Latvia and Estonia. M&Ms has contributed with financial support for the Danish part of this work which focuses on large-scale and long-term changes in the area distribution of Danish eelgrass meadows in relation to the wasting disease and to increased turbidity that has caused a decline in colonisation depths of eelgrass.

Krause-Jensen, D., Greve, T.M., Nielsen, K. Eelgrass as a bioindicator under the Water Framework Directive. Water resources Management. *Accepted. Full text: see deliverable 29*

> *Abstract.* Eelgrass is the most widespread plant in temperate coastal waters. It is regarded as a useful indicator of water quality because water clarity regulates its extension towards deeper waters, i.e. the depth limit. This study analyses the use of eelgrass depth limits as a bioindicator under the Water Framework Directive (WFD). The WFD demands that ecological status is classified by relating the actual level of bioindicators to a so-called 'reference level', reflecting a situation of limited anthropogenic influence. The Directive further demands that reference levels are defined for 'water body types' with similar hydromorphological characteristics, and that the classification thereby becomes 'type-specific'.
>
> A large historic data set on depth limits of eelgrass around 1900 was used to characterise reference levels and a large data set from the Danish National Monitoring and Assessment Programme to characterise actual depth limits. Data represented a wide range of Danish coastal water bodies that were grouped into 10 water body types based on differences in salinity and water depth.
>
> The analyses clearly illustrate that the definition of ecological status classes markedly influence the assessment of ecological status according to the WFD. Moreover, the study demonstrates that the use of type-specific classification implies a risk of misinterpreting ecological status. Classification problems were pronounced in spite of a unique data material on reference conditions, and the problems are likely to be even greater in cases where reference conditions are less well defined. A more robust classification was obtained by using reference levels for individual sites in a site-specific classification.
>
> In conclusion, when classifying water quality on the basis of eelgrass depth limits, site-specific reference levels are recommended if such data are available. Alternatively, classification can be based on general reference levels representing e.g. inner estuaries or open coastal waters provided that local conditions affecting depth limits are taken into account.

*Krause-Jensen D, Pedersen MF, Jensen C. 2003. Regulation of eelgrass (*Zostera marina*) cover along depth gradients in Danish coastal waters. – Estuaries 26: 866-877. *Full text:available online or upon request* (Paper related to CHARM but financed by other sources).

> *Abstract.* A large data set, collected under the national Danish monitoring program, was used to evaluate the importance of photon flux density (PFD), relative wave exposure (REI), littoral slope,

and salinity in regulating eelgrass cover at different depth intervals in Danish coastal waters. Average eelgrass cover exhibited a bell-shaped pattern with depth, reflecting that different factors regulate eelgrass cover at shallow- and deep-water sites. The multiple logistic regression analysis was used to identify regulating factors and determine their role in relation to eelgrass cover at different depth intervals. PFD, REI, and salinity were main factors affecting eelgrass cover while littoral slope had no significant effect. Eelgrass cover increased with increasing PFD at water depths of more than 2 m, while cover was inversely related to REI in shallow water. This pattern favoured eelgrass cover at intermediate depths where levels of PFD and REI were moderate. Salinity had a minor, but significant, effect on eelgrass cover that is most likely related to the varying costs of osmoregulation with changing salinity. The analysis provided a useful conceptual framework for understanding the factors that regulate eelgrass abundance with depth. Although the regression model was statistically significant and included the factors generally considered most important in regulating eelgrass cover, its explanatory power was low, especially in shallow water. The largest discrepancies between predicted and observed values of cover appeared in cases where no eelgrass occurred despite sufficient light and moderate levels of exposure (almost 50% of all observations). These discrepancies suggest that population losses due to stochastic phenomena, such as extreme wind events, played an important regulating role that is not adequately described by average exposure levels. A more thorough knowledge of the importance of such loss processes and the time scales involved in recovery of seagrass populations after a severe disturbance are necessary if we are to understand the regulation of seagrass distribution in shallow coastal areas more fully.

*Sagert S, Krause Jensen D, Henriksen P, Rieling T & Schubert H. Integrated ecological assessment of Baltic Sea coastal areas by means of phytoplankton and macrophytobenthos. – *Submitted* to Estuarine, Coastal and Shelf Science. *Full text: see deliverable 21.*

Abstract. The Water Framework Directive (WFD) demands an integrated assessment of ecological quality based on biological parameters. In this context we analysed combined macrophytobenthos and phytoplankton data sets along the Danish Baltic Sea coast for similarities and differences in their response to abiotic variables. *Zostera marina* depth limits showed a significantly negative correlation with concentrations of total-nitrogen, total phosphorus and chlorophyll a as well as with *Myrionecta rubra* biomass and a strongly positive correlation with Secchi depth. The results thereby documented that selected phytobenthos and phytoplankton indicators show correlated responses to water quality. All biotic and abiotic parameters clustered in two groups, indicating two trophic states but, at the same time, also two distinct salinity classes. One class was characterised by low nutrient levels and low salinity while the other class was characterised by high nutrient levels and high salinity, indicating that the mixing of relatively nutrient poor brackish Baltic water with more nutrient rich North Sea water overruled traditional estuarine gradients in the investigated area. The results therefore allow an analysis of the eutrophication state regarding the additional influence of decreased salinity on euryhaline marine species. The consequences of the results are discussed in relation to classification systems for brackish water ecosystems.

Depth distribution of *Fucus vesiculosus*

Nappu N, Ruuskanen A, Kiirikki M, Kinnunen V, Bäck S. Depth distribution of *Fucus vesiculosus* in the Finnish Archipelago. (Preliminary title). *Draft. Full text version not available yet.*

Abstract. This work analyses changes in vertical distribution of Fucus in temporal and geographical scale during 1990s. We plot changes in growth depth to changes in secchi depth. Preliminary results indicate that the lower growth limit of the Fucus belt has become approximately 0,8 m deeper in the sheltered and moderately sheltered archipelago, but no changes occurred in the exposed archipelago. The trend is equal along the whole Gulf of Finland.

*Torn K, Krause-Jensen D et al. Present and past depth distribution of bladderwrack (*Fucus vesiculosus*) in the Baltic Sea. *Draft. Full text: Available upon request.*

Abstract. *Fucus vesiculosus* is one of the most important phytobenthic species in the Baltic coastal zone, but information on present and past depth distribution of the species is still scattered. Based on a compilation of existing information this study aimed to 1) assess the present depth distribution of *F. vesiculosus* in the Baltic Sea and evaluate differences between various districts and 2) assess long- and short-term changes in the depth distribution and evaluate reasons for such changes.

The compiled database included a total of 3356 observations on depth distribution of *F. vesiculosus* from 19 districts of the Baltic Sea. The deepest occurring *F. vesiculosus* individuals extended to water depths of 1.5-4.5 m on average, depending on district. Depth limits were shallowest in the Kattegat, the Danish Belts and the Øresund, located at the entrance of the Baltic Sea and markedly deeper in the central and inner parts of the Baltic. This increase in depth limits along the Baltic gradient to some extent matched the decline in salinity and may in part be explained by reduced competition at lower salinities. Secchi depths defined the maximum attainable depth limit at a given site, but depth limits seldom penetrated as deep as light levels allowed. On the whole, secchi depths only explained part (23%) of the variation in present depth limits and probably because of reduced competition, depth limits were more closely correlated to secchi depths in the central and inner Baltic Sea than at the entrance.

Data on long-term changes in depth distribution were available for 11 districts of which two had data dating back to ~1900, five to 1920s/1940s and the remaining to 1960s/1970s. Most areas showed declining depth limits over the investigation period and the decline typically occurred after 1960s/1970s most likely due to reduced light levels as a consequence of increased eutrophication. Over the latest 2 decades, both positive and negative shifts of Fucus depth limits have been described from different Baltic Sea areas. Whether *F. vesiculosus* can recolonise the lost areas upon possible future reductions in nutrient levels is an open question and we encourage future studies in this field.

Depth distribution of Furcellaria lumbricalis

*Martin, G. 2004: Distribution pattern of red algae *Furcellaria lumbricalis* in the Baltic Sea. Presentation for the 39th European Marine Biology Symposium - Genoa, 21-24 July 2004.

Abstract: Red macroalgae Furcellaria lumbricalis is one of the most widespread macroalgae species in the Baltic Sea. It is found in a great salinity range both as inhabitant of Fucus vesiculosus dominant communities and forming individual monodominant associations. Wide geographical distribution and salinity tolerance in brackish Baltic Sea conditions give a possibility of use of the species as water quality indicator for coastal waters. For this reason the Baltic Sea wide dataset on species distribution collected in the framework of EU 5FP CHARM project (Characterisation of Baltic Sea Ecosystem: Dynamics and Function of Coastal Types) was analysed against the available environment data to study the behaviour of different Furcellaria lumbricalis community parameters against different environmental variables. Studied parameters included maximum depth distribution of Furcellaria lumbricalis, quantitative depth distribution of species in relation to other macroalgae and different morphological parameters. Results of the analyses showed that depth distribution pattern is different among different regions of the Baltic Sea and is strongly correlated to water transparency. Also positive correlation was identified between depth distribution of species and nutrient load to the basin in different Baltic Sea areas. On the Baltic Sea scale different Furcellaria lumbricalis community characteristics could be used as water quality indicators as the response of those on human impact (nutrient loading) is predictable.

*Domin A, Schubert H, Krause JC, Schiewer U. 2004: Modelling of pristine depth limits for macrophyte growth in the southern Baltic Sea. – Hydrobiologia 514: 29–39, 2004. *Full text available online or upon request* (Paper related to CHARM but financed by other sources).

Abstract. The knowledge of plant and animal distributions within surface water ecosystems is a prerequisite to develop an ecological classification system based on the guidelines of the Water Framework Directive of the European Union (EU-WFD). We developed a system of typology for macrophytes of the inner coastal waters of the German Baltic Sea based on given physical and chemical descriptors of the EU-WFD, and so far known ecophysiological requirements of the plants. Analysis of these requirements led to a minimum matrix of 14 factor combinations for a sufficient ecological characterisation of the communities (Bluemel et al., 2002). Here, we report on a model to describe the pristine habitats based on specific physical and chemical properties and ecophysiological potentials of macrophytes. In order to evaluate the most likely depth limits for macrophyte distribution we calculated annual depth-dependent light intensities for our reference lagoons. Knowledge of minimum light requirements for growth of typical species enabled us to compute maximum depth distribution through the year. Comparison of computed limits for growth were found to be in accordance with historical records. Therefore, we suggest that anthropogenic eutrophication and increased phytoplankton concentrations can indirectly be responsible for presently observed loss of macrophytes coverage due to light limitation.

*Feuerpfeil P, Sagert S and Schubert H. Depth limits of macrophyte communities along the salinity gradient of the German Baltic coast. *Draft. The paper will we rewritten from a German report which is available upon request.*

Abstract. A first reconstruction to describe pristine habitats of macrophytes communities was developed for three coastal semi-enclosed waters of the southern Baltic Sea. This reconstruction based on the analyses of locally available herbar-material. Unfortunately, such historical data sets are not available for the outer parts of the German Baltic coast. Therefore the classification system for macrophytes must be derived from recent data and from the eco-physiological requirements of selected macrophyte communities in this region. In 1996 started a regular monitoring program along the outer German Baltic coast by order of the local federal authorities. This program comprised a yearly sampling along 14 transects. The main parameters were abundance/cover of higher taxonomic groups and depth distribution of main species. These data sets will be replenished with current samplings in hard bottom communities, which include resolutions down to the species level along the whole salinity gradient. The work aims at a first analysis of these data sets regarding to the requirements of the WFD. The main focus shall be directed to depth limits of growth for the main communities or species in relation to different salinities and underwater light climates.

*Krause-Jensen D, Carstensen J, Dahl K.: Cover and composition of coastal macroalgae in relation to water quality. *Draft. Full text: available upon request.*

Abstract. Based on a large data set from the national Danish monitoring program, this study tested the possibility of assessing coastal water quality based on depth–related changes in total algal cover and in relative abundance of opportunistic macroalgae.

The investigation demonstrated that variations in secchi depth and salinity combined with information on geographical location of sampling areas could explain almost 80% of the variation in algal cover between areas. A stepwise procedure relating secchi depths to concentrations of total-N, and total-N to nutrient load from land, illustrated principles for relating nutrient load to algal cover and for 'translating' a nutrient load scenario to corresponding levels of algal cover. The

ratio of opportunistic algae did not relate to water quality but instead responded to differences in salinity, being highest in the most brackish areas.

In conclusion, macroalgal cover along depth gradients reflected differences in water quality between coastal areas and may, therefore, be regarded as an indicator of water quality. However, coastal algal cover is still not a sensitive indicator as it responded only to large scale differences in water quality between areas and not to the smaller interannual changes. A higher sensitivity of algal cover and the ratio of opportunistic algae as indicators of water quality would require either an increased sensitivity of sampling methods and/or identification and inclusion of supplementary regulating factors in future models.

Relative abundance of opportunistic or annual macroalgae

*Krause-Jensen D, Carstensen J, Dahl K.: Cover and composition of coastal macroalgae in relation to water quality. *Draft*. *Full text: available upon request.*

Abstract: see above.

T. Möller, G. Martin: Evaluation of different phytobenthos parameters for water quality classification in the Baltic Sea. Presentation for the 39th European Marine Biology Symposium - Genoa, 21-24 July 2004.

Abstract: Phytobenthic communities in the Baltic Sea are influenced by variety of ecological gradients. North-south and east-west salinity gradient is one of the main ecological varaible responsible for phytobenthos variabilty on Baltic Sea scale. On local scales the bottom composition and light availability are the main structuring factors while biological interactions are proved to be of minor importance. The developing of water quality classification system for EU Water Framework Directive requires the evaluation of different biological water quality elements, among them phytobenthos. From different possible quantitative phytobenthos parameters the quantitative proportion of annual and perennial vegetation and depth distribution characteristics were selected to be tested against existing monitoring data from Estonian coastal waters of the Baltic Sea. The data from six monitoring areas representing different complexes of environmental factors was used in the analyses. Altogether quantitative data from more than 350 locations was used together with supporting physical-chemical background information. Depth distribution of phytobenthos communities turned out to be the best measure for the water quality classification but the use of this parameter in the conditions of NE Baltic Sea is complicated due to frequent substrate limitation of depth distribution of phytobenthos. The proportion of annual and perennial vegetation had different indicative value depending on the locality.

Macrophyte community composition

*Blümel C, Schubert M, Steinhart T and Schubert H.: Development of ecological quality standards for submersed macrophytes of coastal lagoons of the German Baltic Sea. *Draft*. *Full text: available upon request.*

Abstract: In the investigation area no coastal waters with very good ecological condition is present. Therefore it was tried to reconstruct this from historic data. 2869 records of submersed macrophytes could be found by the evaluation of the historical literature and the herbaria Berlin (B), Greifswald (GFW), Hamburg (HBG), Rostock (ROST) and German Oceanographic Museum Stralsund since 1796. For a more exact examination three characteristic transitional waters were selected along a gradient of salinity at the coast of Mecklenburg-Vorpommern: the Salzhaff, the Darß-Zingster Boddenkette and the Greifswalder Bodden. In these waters 80 macrophyte species could be recorded, which can be summarized taking into account the abiotical locational factors in

13 macrophyte comminities: Tubular and bladeforming green algal mats, Zo*stera noltii-Ruppia cirrhosa*-community, *Chara aspera-Chara canescens*-community, Characeen-*Ruppia cirrhosa* community, *Ruppia cirrhosa*-stands, *Najas marina*-stands, *Chara tomentosa*-community, epilithic green algae, Characeen-*Zostera marina*-community, *Chaetomorpha linum* drifting algae mats, *Chorda filum*-stands, epilithic green algae, *Fucus*-stands.

The reconstruction of the " very good ecological status " for macrophytes of the Salzhaff is possible only under certain circumstances by the evaluation of literature data. Herbar material from the area could not be found. It is documented that in the flat water areas of the Salzhaff where mud, silky sand and sandy mud appear as substrates, a very varied vegetation existed which is determined by Characeen and dwarf eelgrass (*Zostera noltii*). Exclusively on mud the Characeen-*Ruppia-cirrhosa* vommunity was proved. Up to depth where 1% of the surface radiation is available gravel, shingles and boulders are settled by *Fucus vesiculosus* and *Chorda filum*. In the flat water appear in addition tubular and bladeforming green algal mats. Data about other epilithische alga species are not present. It is to be supposed that - how in the Greifswalder Bodden - a multiplicity of these species were found in the Salzhaff. Characeen-*Zostera marina*-community settle on mud, to sandy mud, silky sand and sand till a depth penetrates into still 10% of the surface light. Also one of the substrate and light independent occurence of *Chaetomorpha*-drifting algae mats is to be accepted for the Salzhaff, but does not cover.

In the Darß-Zingster Boddenkette the submerse vegetation is more various: in the western, ß-oligohalin area silky locations are settled by *Chara tomentosa*-community and *Najas-marina*-stands. With increasing sandy interest in the sediment there appear *Chara aspera-Chara canescens*-community and the Characeen-*Ruppia cirrhosa* community. The latter also settles purely sandy locations. With increasing water depth the Characeen-*Zostera marina*-community joins. *Myriophyllum spicatum* and *Potamogeton pectinatus* can be assigned as euryoecious species to no plants community unambiguously. For the hard substrates only epilithic green algae are documented.

In the eastern part the Darß-Zingster Boddenkette the relations with the western part agree relatively well. They differ by the deep- and substrate-independent appearance from *Chaetomorpha*-drifting algae mats and in the settlement of the hard bottom substrates. For the flat water tubular and blade forming green algal mats are covered. Also epilithic green and red algae and *Fucus vesiculosus*-stands are documented.

The "pristine ecological state" of macrophytes for the Greifswalder Bodden can be described from the analysis of the historic data as well as the eco-physiological claims of the different species as followed: gravel, shingles and boulders are covered in the flat water area with tubular and blade forming green algal mats which consist of *Enteromorpha, Monostroma-, Ulva-, Ulvaria*-and *Ulvopsis*-species. All other epilithic algae communities (epilithic green algae and red algae as well as *Fucus*) are found in the flat water area as well as in higher water depth. The flat water areas in which still 40% of the surface light is available and have in those the substrates a grain size composition of sand, sandy mud and mud are the vegetation in the richest in types one. Together with several Characeen-communities appears *Najas marina*-stocks. In addition are found some ubiquists as for example *Myriophyllum spicatum* and *Potamogeton pectinatus* which can not be assigned unambiguously to a plant community. The information about the occurrence of *Ranunculus baudotii* is to be considered as doubtful, because by the separation of this species from other species of the *Ranunculus aquatilis*-group still difficulties exist. *Ruppia*-communities settle preferably on silky substrates - for the Greifswalder Bodden the occurence the Characeen-*Ruppia-cirrhosa*-community in this area provably. The areas of the Greifswalder Boddens in which only 10% of the light incident in the surface of the water are available are settled with the Characeen-*Zostera marina*-community. Against the *Zostera marina*-stands current to be found to it is with the Characeen-*Zostera*-community about a plants community which is dominated by

Zostera marina in which also species are found like *Zannichellia palustris* and *Tolypella nidifica* with high steadiness. Undependent on substrate and the lighting conditions drift meadows appear in all types, with the exception of 0.1 %-depth.

Area cover of eelgrass

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. *Full text available online or upon request.*

Abstract: For five shallow-water eelgrass stands in Denmark, changes in area distribution over the period 1940/50s–1990s were assessed from aerial photographs. In areas where the wasting disease had decimated eelgrass meadows in the 1930s, this included determination of the time scale of recolonization. In addition, we aimed at evaluating whether fluctuations in eelgrass area distribution were related to various natural and human-induced disturbances, namely storm events, ice-cover, water temperature and nutrient loading. We found that populations affected by the wasting disease exhibited a time lag of more than 10 years before substantial recolonization began, probably reflecting long distances to seed-producing populations and extreme climatic events in the period. After the initial time lag, eelgrass area distribution increased rapidly, and a substantial recovery had taken place in the 1960s. All eelgrass populations showed marked inter-annual fluctuations. Declines were often rapid with reductions of about 60% occurring in less than 6 years. Recoveries occurred over similar time scales and documented that recolonization may take place relatively fast when suitable environmental conditions are present. Fluctuations in eelgrass area distribution tended to be larger in enclosed, protected bays as compared to open coasts, probably because enclosed sites are often more eutrophic. Changes in shallow-water eelgrass area distribution did not correlate with the available long-term records of natural and human-induced disturbance parameters. Thus, while deep-water eelgrass populations have declined markedly over the last century in response to eutrophication, long-term changes in shallow-water populations are less equivocal and seem more stochastic.

Frederiksen, M., Krause-Jensen, D., Holmer, M. & Laursen, J. 2004: Spatial and temporal variation in eelgrass (*Zostera marina*) landscapes: influence of physical setting. – Aquatic Botany 78: 147-165. *Full text available online or upon request.*

Abstract. The distribution of eelgrass (*Zostera marina*) was mapped from aerial photographs at three Danish sites with different levels of physical exposure by digital image analysis at 1 m x 1 m resolution. A set of indices from landscape ecology was used to quantify various components of the eelgrass landscapes such as patch shapes and landscape aggregation in photographs from 1995. Furthermore, the long-term fluctuations in the spatial distribution of eelgrass were investigated during the period 1954–1995/1999. Eelgrass landscapes exposed to wave dynamics were less aggregated with more elongated patch shapes than the sheltered eelgrass areas. The outline of the larger patches also tended to be more complex at exposed sites. Patch size distribution at all sites was highly skewed with 75–95% of the patches being <10m2. Although the majority of the patches were small, they only constituted a small proportion of the total eelgrass area because most of the eelgrass-covered area was contained in a few, large patches. Large fluctuations in the spatial distribution of eelgrass occurred at both exposed and protected sites in the course of the investigation period. In the relatively short intervals of ~7 years between two consecutive photographs, on average 39–62% of the total eelgrass area covered in the photographs had changed (i.e., disappeared or recolonized) and the largest changes occurred at exposed sites. Overall, this study showed that shallow eelgrass populations form characteristic landscapes with a configuration that is highly related to the level of physical exposure and that the size and position of eelgrass beds changes substantially among years.

Conclusion

The generated models show that various vegetation indicators are indeed influenced by changes in water quality. As nutrient concentrations increase and water clarity declines, depth limits of eelgrass as well as of selected macroalgal species decline and the cover of eelgrass and macroalgal communities decline. Changes in water quality do, however, only explain part of the variation in the vegetation indicators. Changes in salinity contributes to explain some of the remaining variation in the vegetation indicators and is, in fact, the factor that best explains differences in the relative abundance of opportunistic macroalgae between Danish coastal areas. Some of the large-scale models also included exposure and substrate composition as independent variables which contributed to explain the variations in the vegetation indicators. Considerable variation in vegetation parameters remained unexplained, however, and limited the predictive power of the developed models. In order to improve future models, more of the variation in the vegetation indicators must be explained. This may demand inclusion of more stochastic independent variables like extreme wind events and anoxic events as well as a fine-tuning of some of the sampling methods.

List of published papers and manuscripts/reports/presentations, etc.

Oral presentations

Kauppila P, Nappu N, Ruuskanen A., Kiirikki M, Bäck S. 2002: 'Trends of Secchi depth and growth depth of Fucus along the Finnish coast. - The Changing State of the Gulf of Finland Ecosystem symposium in Tallin 28.-30. October 2002.

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 Sea. Baltic Sea Science Congress, Helsinki, September 2003.

Martin G, Paalme T, Torn K. 2004: Growth- and production rate of drifting Furcellaria lumbricalis community in waters of West Estonian Archipelago, the Baltic Sea. International Phycological Congress, Bergen, Norway.

Martin G. 2004. Distribution pattern of red algae Furcellaria lumbricalis in the Baltic Sea. Presentation for the 39th European Marine Biology Symposium - Genoa, 21-24 July 2004.

Möller T, Martin G.: Evaluation of different phytobenthos parameters for water quality classification in the Baltic Sea. Presentation for the 39th European Marine Biology Symposium - Genoa, 21-24 July 2004.

Schubert H. 2002: (Implementation of the Water-Framework-directive: Characterisation of the ecological status for inner coastal waters, German) Umsetzung der EU-WRRL: Indikation des ökologischen Zustandes der inneren Küstengewässer. - Meeting of the German Federal Environmental Foundation (DBU), Osnabrück, April 2002.

Schubert H. 2002: (Development of ecological quality standards for submersed macrophytes of coastal lagoons of the German Baltic Sea, German). “Entwicklung von leitbildorientierten Bewertungsgrundlagen für Übergangsgewässer entsprechend EU-Wasserrahmenrichtlinie". - Annual Meeting of the Federal Agency for Coastal Monitoring Programs (BLMP), Güstrow, May 2002.

Schubert H. 2002: (Ecological evaluation on the basis of submerged macrophytes along the German Baltic Coast, German). Bewertungsgrundlagen Makrophyten der Ostseeküste“. Kobio-Meeting, Essen, June 2002.

Posters

Martin G. 2002: Developing and testing of typology based water quality classification system for coastal waters of NE Baltic Sea using benthic biological indicators. Poster presentation at International Conference on Science in Support of European Water Policies Sustainability of Aquatic Ecosystems. Stresa, Italy, 2002.

Nielsen K, Sømod B, Ellegaard C, Krause-Jensen D. 2002: Reference conditions – a case study in Randers Fjord, Denmark. Poster presented at “12. Danske Havforskermøde”, University of Århus, Denmark, January 9-11, 2002.

Torn K. 2004: Present and past depth distribution of bladderwrack (*Fucus vesiculosus*) in the Baltic Sea. Marie Curie Fellowship in the domain of Marine Sciences. EurOCEAN 2004, Galway, Ireland 10th-13th May 2004.

Publications – published or accepted

Bäck S, Likolammi M. 2004: Phenology of *Ceramium tenuicorne* in the SW Gulf of Finland, the northern Baltic Sea. – Ann. Bot. Fennini 41:95-101.

Boström C, Baden SP, Krause-Jensen D. 2003: The seagrasses of Scandinavia and the Baltic Sea. – In Green EP, Short FT (Eds): World atlas of seagrasses. California University Press. 310 pp.

Domin A, Schubert H, Krause JC, Schiewer U. 2004: Modelling of pristine depth limits for macrophyte growth in the southern Baltic Sea. – Hydrobiologia 514: 29–39, 2004.

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 147-165.

Krause-Jensen D, Greve TM, Nielsen K.: Eelgrass as a bioindicator under the Water Framework Directive. – Water resources Management. In press.

Middelboe AL, 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.

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., Martin, G. 2004: Environmental factors affecting the distribution of charophyte species in Estonian coastal waters, Baltic Sea. – Proc. Est. Acad. Sci. Ecology. In press.

Publications – submitted

Sagert S, Krause Jensen D, Henriksen P, Rieling T & Schubert H.: Integrated ecological assessment of Baltic Sea coastal areas by means of phytoplankton and macrophytobenthos. – Submitted to Estuarine, Coastal and Shelf Science.

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 F*urcellaria lumbricalis* community in waters of West Estonian Archipelago, the Baltic Sea. – Submitted to Hydrobiologia.

Publications – in prep.

Blümel C, Schubert M, Steinhart T and Schubert H.: Development of ecological quality standards for submersed macrophytes of coastal lagoons of the German Baltic Sea.

Nappu N, Ruuskanen A, Kiirikki M, Kinnunen V, Bäck S.: Depth distribution of *Fucus vesiculosus* in the Finnish Archipelago. (Preliminary title).

Feuerpfeil P, Sagert S and Schubert H.: Depth limits of macrophyte communities along the salinity gradient of the German Baltic coast.

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

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Work package 4

Work has been concentrated on preparing material for the Workshop. Generally, progress is on schedule.

Work package 5

Work has been concentrated on preparing material for the Workshop. Generally, progress is on schedule.

Work package 6

Work has been concentrated on preparing material for the Workshop. Generally, progress is on schedule.

Work package 7

Work has been concentrated on preparing material for the Workshop. Generally, progress is on schedule.

Planned and actual used resources

Table 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. Values in brackets represent actual used man-months per 31 May 2004.

WP1-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (11)	20-6 (6)			28-10 (10)	85-24 (23)	8-3 (3)	12-5 (5)	80-20 (19)	20-6 (6)	
WP2-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (5)	10-3 (3)		63-12 (11)	31-10 (9)	8-2 (2)		13-4 (4)		20-6 (6)	15-6 (6)
WP3-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (23)	31-11(10)	42-8 (8)		8-3 (2)		32-9 (8)	12-4 (4)			80-15 (14)
WP4-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (12)		52-20(19)	37-6 (5)	33-12 (11)		20-6 (6)	19-6 (5)		20-8 (8)	
WP5-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (7)	23-5 (4)					4-2 (2)	11-4 (4)	10-6 (6)	20-6 (6)	
WP6-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (4)	13-4 (4)	6-2 (2)			7-2 (2)	34-10 (9)	32-7 (6)		10-2 (2)	
WP7-tasks	**P1 NERI**	**P2 FEI**	**P3 AAU**	**P4 EC-JRC**	**P5 KUCORPI**	**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 (4)	3-1 (1)	0-1 (1)	0-1 (1)	0-1 (1)	0-1 (1)	2-1 (1)	1-1 (1)	10-7 (6)	10-2 (2)	5-1 (1)
Total WP1-7	100	100	100	100	100	100	100	100	100	100	100
Total M-M	70 (66)	30 (28)	31(30)	19 (17)	36 (33)	29 (28)	31 (29)	31(29)	32 (31)	30 (30)	22 (21)