

# The Wadden Sea in an international perspective

Current Wadden Sea research in Germany and Denmark



Waddenacademie



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# The Wadden Sea in an International Perspective

A report for the Waddenacademie

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## **Introduction**

Since the establishment of the National Park status of the German Wadden Sea in the 1980ies various research projects have been conducted in order to understand basic functions and processes of this dynamic ecosystem. Besides various smaller projects in many research fields, particularly the large project “Ökosystemforschung Wattenmeer” should be mentioned which integrated various disciplines of natural and also partly socio-economic science in different parts of the German Wadden Sea during the 1990ies (Stock et al. 1996; Behrends et al. 2004). The results of this project led to a basic understanding of important natural processes and pointed out the complicated interactions with anthropogenic activities such as tourism, fisheries, agriculture, transport, oil exploitation and coastal defence. However, as the Wadden Sea is a highly dynamic system, it has undergone considerably changes since the 1990ies. Increasing anthropogenic pressure, sea level rise as a consequence of climate change, invasion of alien species, regime shifts, changes in hydro- and sediment dynamics as well as alarming declines in several bird species are only a few examples of ongoing changes. Since the 1990ies no research project of the scale as the “Ökosystemforschung” had been carried out. In fact, research projects that tried to integrate different research disciplines were rather scarce. However, in order to solve many of the actual problems scientific research integrating various disciplines will definitely be needed.

In order to facilitate the identification of research gaps in the International Wadden Sea by the Waddenacademie, this report will present a brief review on ten different research institutions and administrations in Germany and three in Denmark that are dealing with natural, socio-economic and cultural aspects in the Wadden Sea region. The report aims at providing an overview about the expertise of different institutions, their general research aims and important current projects. Furthermore, two case studies of actual research problems in Germany are presented that will briefly illustrate examples on how different institutions address several current questions and how networking among these institutions takes place. Finally, a synopsis is presented that summarizes the expertises of the institutions and tries to point out several gaps and shortcomings in the current research agenda in Germany and Denmark. It includes a number of suggestions of how different problems might be overcome in the near future. The report does not claim to introduce every institution in Germany and Denmark that is working on issues concerning the Wadden Sea, however the most important institutions (in terms of their size and number of projects) have been considered.

## Institutions

In the following section the ten German and three Danish institutions are presented briefly. The location of the different institutions is indicated by numbers in Figure 1. The numbering follows the institute descriptions below.

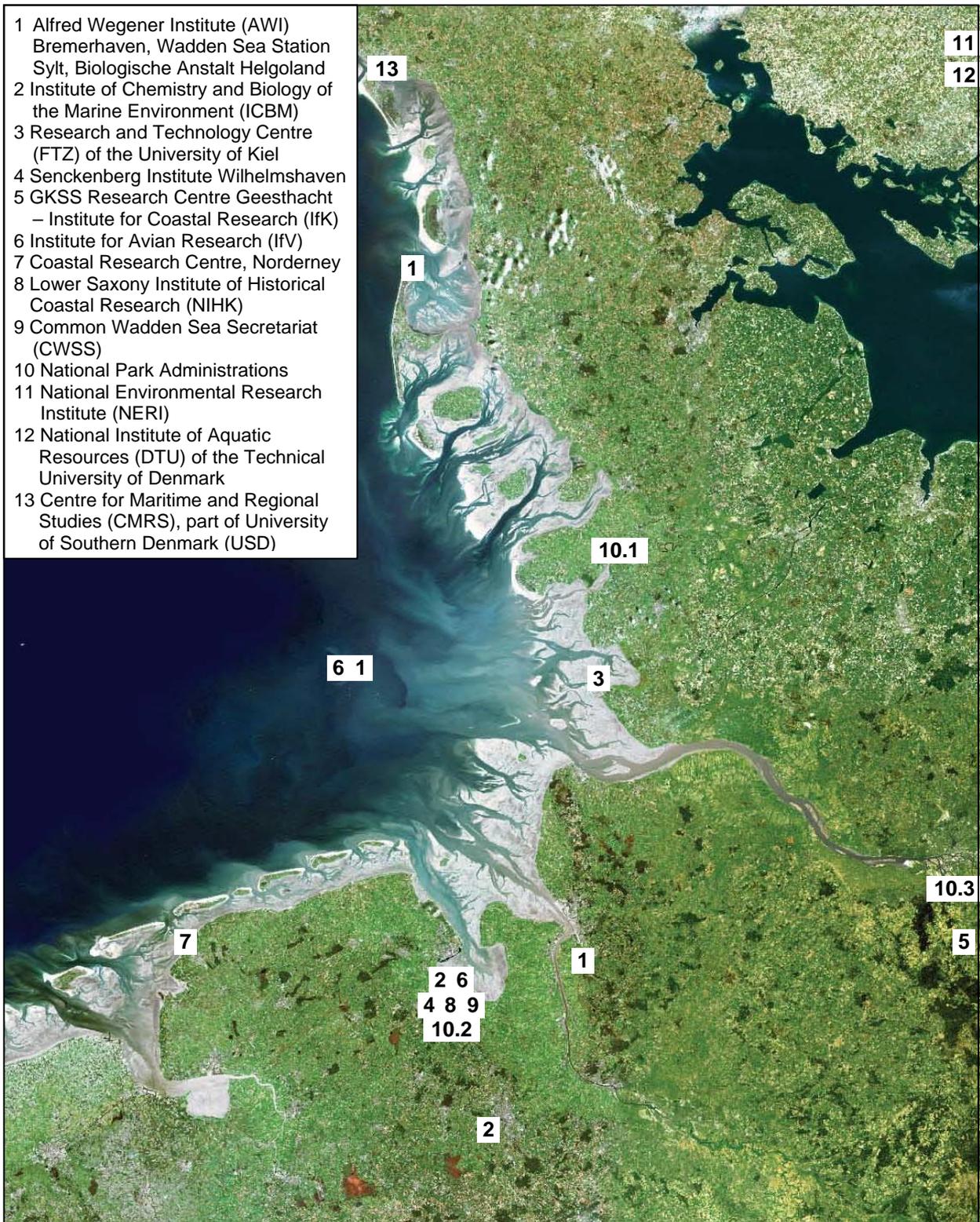


Fig. 1: Location of the 10 German and three Danish institutions described in this report. Satellite image provided by the Common Wadden Sea Secretariat.

## 1. Wadden Sea Station Sylt of the Alfred Wegener Institute for Polar and Marine Research (AWI)

### Address:

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Hafenstraße 43  
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### General Information:

The Alfred Wegener Institute is a member of the Helmholtz Association of German Research Centres. The German Federal Ministry of Education and Research (BMBF) covers 90% of its financing. It is one of the largest research facilities in Germany and currently employs ca. 780 people. Actual research projects have been carried out within the research framework MARCOPOLI (Marine, Coastal and Polarsystems and Infrastructure) from 2004 to 2008 and within the AWI/GKSS programme PACES on Polar Regions and Coasts in a changing Earth System from 2009 to 2014 (see chapter GKSS). Besides the Wadden Sea Station, the Institution has three further facilities: (1) the headquarter of the Alfred Wegener Institute for Polar and Marine Research located in Bremerhaven, (2) the Biologische Anstalt at the island of Helgoland and (3) the Potsdam Research Unit. In the following sections mainly the research at the Wadden Sea Station is described as the institution's main area is the Wadden Sea. However, the other three facilities should also be mentioned briefly:

**Alfred-Wegener-Institute for Polar and Marine Research:** The headquarter of the Alfred-Wegener-Institute is located in the city of Bremerhaven. The director of the institute is Prof. Dr. Karin Lochte. Various research disciplines are joined with the main aim to unravel questions concerning the global change of different ecosystems worldwide. The main focus is set on polar research; however several works of the institute are also taking place in waters of the temperate zone. This also includes research (and monitoring) projects in the North Sea. The institution develops new measurement tools, carries out monitoring of pollutants and investigates natural marine products. The most important (and most famous) research vessel, "Polarstern", is used for expeditions to the Arctic and Antarctic, where the Alfred-Wegener-Institute maintains different field stations and polar aeroplanes. There are three research vessels that are mainly used in temperate zones.

**Biologische Anstalt:** Founded in 1892 as "Königliche Biologische Anstalt", the Biologische Anstalt today belongs to the Alfred Wegener Institute. The director of the institute is Prof. Dr. Karen Wiltshire. The main aim is to investigate ecological processes in pelagic shallow water systems. Another important focus lies on studies of organisms and processes of the unique rocky intertidal area that is encompassing a large area of the island of Helgoland. The

Biologische Anstalt maintains a laboratory, where ecological research on different biota of the pelagic and benthic community is carried out. Furthermore, the institute is in charge of an important ecological long-term time series which has been provided data on plankton abundance and community structure (and its change) since the 1960ies. Additionally, several projects with an economic background are being carried out: (1) Basic ecological research (including breeding experiments) on marketable lobsters reveals important basic know-how for the commercial fishery. (2) Furthermore, the investigation of different natural marine products for industrial and commercial users is another important example of applied science.

The Biologische Anstalt maintains several research vessels (two small motor boats for coastal use and two larger vessels for offshore purpose).

**Potsdam Reseach Unit:** Prof. Dr. Hans-Wolfgang Hubberten is the leader of the Research Unit. The main fields of research are terrestrial geoscience in the periglacial regions, as well as experimental investigations and modelling of atmospheric processes in the Polar Regions against the background of human influence on climate.

### **Wadden Sea Station Sylt:**

#### Number of staff:

In total there are currently about 60 persons working in the Wadden Sea Station excluding members of courses and short-term guests.

#### Study areas:

The Wadden Sea Station Sylt carries out its main research in the Wadden Sea and adjacent shallow water areas in the vicinity of the island of Sylt. Many experiments are conducted in the littoral close to the island. Monitoring work is being carried out in the Sylt-Rømø tidal basin.

#### Facilities:

In May 2008 the new building of the Wadden Sea Station at the island of Sylt was opened. There are different labs that allow the analyses of various basic parameters of marine ecology. The institute is in charge of an aquarium and various climate chambers for cultivation experiments. Furthermore, there is a library, a workshop and a seminar room. Eventually, the institute holds a scanning electron micrograph and a research catamaran for coastal applications.

#### Expertise of the institution:

- Ecological interactions in the coastal zone
- Biodiversity and dynamics of the benthic-pelagic community
- Interactions of plants and animals with their environment
- Adaptations of plants and animals to a changing environment

- Cultivation of macro algae
- Long-term changes of the Wadden Sea and North Sea against the background of natural and anthropogenic effects

Aims / current projects:

The main aim of the research of the Wadden Sea Station Sylt is to unravel and anticipate coastal change in ecosystem functioning, biodiversity and sediment dynamics in a warmer world. Besides studies in the Wadden Sea and the North Sea, this aim should be achieved by studying other ecosystems worldwide and comparing results. Many current projects are part of the joint research project PACES together with the GKSS (see chapter GKSS for details). The following projects provide more detailed insight into current research:

The Wadden Sea Station investigates the material exchange and energy flow between benthic systems and their environment in the shallow and highly productive areas of the Wadden Sea. Another task is the evaluation of the role of mussel beds and eelgrass in the natural dynamics of the Wadden Sea with the main aim lying on the influence of mussel beds and eelgrass on sediment dynamics (erosion and deposition) and habitat effects of these structures for other species. Effects of mussel fisheries on mussel beds and causes for the current decline of eelgrass (eutrophication and changes in the wave regime) are considered.

Furthermore, interactions between different Wadden Sea species are investigated: A substantial focus lies on the biodiversity, predator-prey interactions, parasitism and food web dynamics for both plants and animals. Effects of the increasing domination of alien species in the Wadden Sea and their effects on the community composition are evaluated. In this connection the role of biodiversity in coastal food webs (benthic and pelagic), the role of succession, population dynamics and biodiversity on cascading effects of the community are studied. Investigations on gene flow are carried out that allow drawing conclusions on population dynamics and the role of invasive species.

Another main research field is to predict how natural processes and anthropogenic activities might influence the biological community in the Wadden Sea. In this context, effects of fisheries, eutrophication, sealevel rise and climate change are investigated.

Finally, the institute aims at linking basic research with economic aspects by investigating the growth dynamics of macro algae. Growth conditions which lead to an optimal yield of macro algae for providing substances such as protein-containing fibre and agar are investigated in controlled laboratory experiments.

The institute is able to utilize historic data as well as several long-term series from the Wadden Sea and North Sea in order to document past and ongoing changes of the environment. The following long-term series and analyses of historic data are being conducted by the Wadden Sea Station or affiliated institutions within the network of the Alfred-Wegener-Institute:

- (1) "Long-term development of macrozoobenthos German Bight": The development and annual variability of sublitoral soft-bottom macrozoobenthos communities are investigated

continuously at four representative stations. Additionally, large-scale mapping of the benthos takes place.

- (2) "Effects of climate change on coastal biota of the North Sea": Population dynamics on climate sensitive species (Cordgrass, Oysters, Slipper Limpets) are analyzed to predict spread, stasis and regional extinction.
- (3) "Benthic long-term change in the Wadden Sea": Data on intertidal and subtidal benthos recorded decades ago are being compared with the benthos encountered today. Observed differences are interpreted with respect to fisheries, eutrophication, species introductions and climate change.
- (4) "Long-term development of benthos in the eastern German Bight": Temporal and spatial variability of benthos is studied at a large scale to reveal causes of spatial change, effects in food web and effects of global change on community composition.
- (5) "Long term changes of plankton": Long term changes of phytoplankton and zooplankton and environmental parameters have been examined in the Sylt-Rømø tidal basin. Transformation processes of nutrients are assessed (salinity, pH, inorganic and organic nutrients, chlorophyll, suspended matter particulate C, N and P, biogenic silica) and the exchange rate of the tidal basin with offshore water are recorded.

It is planned to automate the collection of several of the long-term data. This is done in the connection with the programme COSYNA (see also Aims and current projects of the GKSS below).

## **2. Institute of Chemistry and Biology of the Marine Environment (ICBM)**

### Address:

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Postfach 2503  
26111 Oldenburg



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Fax: +49 441 798 3404

Email: [info@icbm.de](mailto:info@icbm.de)

### General information:

The Institute of Chemistry and Biology of the Marine Environment is an integrated part of the University of Oldenburg. The institute is located in Oldenburg and Wilhelmshaven. The director of the institute is Prof. Dr. Jürgen Rullkötter, whose main focus lies on organic geochemistry. The three major divisions of the ICBM are engaged in (1) geochemistry, (2) geobiology and ecology, and (3) physics and modelling. The marine laboratory is located in

Wilhelmshaven. In connection with Wadden Sea research it is probably most important to highlight the interdisciplinary research group on the biogeochemistry of tidal flats, funded by the German Research Association (DFG), which will be introduced in detail below.

Number of staff:

The total number of staff is 170 people, with 11 professorships and two junior professorships.

Facilities:

Labs at the ICBM hold a light and electron microscopy service unit and several instruments for organic and inorganic analyses. ICBM offers an official research diving training centre. The marine laboratory is lead by PD Dr. Holger Freund and is open to members of the ICBM and also other research institutions. It includes equipment for biological, chemical, sedimentological and geological analyses for projects in the coastal zone. Furthermore, there is a research vessel for scientific purposes in the Wadden Sea region.

Expertise of the institution:

- Geoecology
- Integrative modelling (systems for coastal management)
- Planctology (ecology of pelagic marine communities)
- Aquatic ecology (assessment of heavy metals in aquatic organisms, spatial analysis, hydrobiological studies)

**Research group “Biogeochemistry of tidal flats”:**

Study areas:

Research on processes in the Wadden Sea is mainly carried out in the tidal flat area on the East Frisian North Sea coast, especially in the backbarrier tidal flat of Spiekeroog island.

Aims / current projects:

The research unit “Biogeochemistry of tidal flats” is the largest research branch in ICBM. It is working interdisciplinary and thus involves a major part of various working groups. It is funded by the German Research Association in a project finished in 2009. The investigations aim at a fundamental understanding of important processes in a tidal flat system. For this purpose, biogeochemical transformations on water-column-suspended particles, at the sediment-water interface and in the sediments are studied. Research is partly done on a sandy plate in the backbarrier tidal flat southwest of Spiekeroog in order to clarify questions on the structure of sediments, influence of heterogeneities on transport processes and transformation reactions, relative importance of metabolic processes (e.g. fermentation) near the surface and in deeper layers. Another task is to get deeper insights into the processes in the water column, the possible key influence of plankton blooms and corresponding microbial activity on transformation of organic matter and on the concentrations of manganese and molybdenum in the water column and in the surface sediments. Models as well as in-situ

measurements and remote sensing data are used to understand the kind and extent of the exchange processes between the near-coastal zone and the open sea.

Another subproject aims at the development of a complex model as basis for analysing the dynamics of the backbarrier tidal flats.

In the future, for all projects modeling based on data achieved by the long-term observation system COSYNA (see GKSS) is planned.

### 3. Research and Technology Centre (FTZ) of the University of Kiel

Address:

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Hafentörn 1  
25764 Büsum



Phone: +49 4836 604 0

Fax: +49 4836 604 299

Email: [office@ftz-west.uni-kiel.de](mailto:office@ftz-west.uni-kiel.de)

General Information:

The Research and Technology Centre (FTZ) belongs to the University of Kiel and had been originally founded as a central institution within the University in 1988 to enhance the logistic possibilities of marine and coastal research in the Wadden Sea and adjacent offshore zone. Prof. Dr. Roberto Mayerle and Prof. Dr. Franciscus Colijn are the directors of the institution. Many applied projects are being conducted to provide basic information for economic stakeholders within the Wadden Sea region and the offshore zone – such as investigations on the influence of offshore wind farms on birds and marine mammals or models of hydrodynamic and sediment dynamics in connection with sea level rise. This up to date information brings conceptual contributions for an integrated coastal zone management. There are also several projects that are being conducted as basic research. More than 50% of the ongoing research activities are third party fundings.

There are four different working groups within the Research and Technology Centre that work in close cooperation: (1) Coastal Ecology/Environmental Research/Environmental Technology, (2) Ecology of Birds and Mammals, (3) Applied Physics/Marine Technology and (4) Coastal Research Laboratory.

The institute is engaged within the **excellence cluster “Future Ocean”**, besides various other institutions of the University of Kiel, the Leibniz Institute for Marine Sciences (IFM-Geomar), the Institute for the World Economy (IfW) and the Muthesius Academy of Fine Arts. This network of various research disciplines such as marine, geological and economic sciences as well as medical science, mathematics and jurisprudence aims at connecting the expertise of all these disciplines in order to gain information on important questions of effects of climate change and the changing marine environment.

Number of staff:

The number of staff is highly dependent on the third party funding. Generally, there are around 50 people including technicians, nautical staff, PhD students, postdocs and permanent academic positions.

Study areas:

Most of the projects focussing on coastal research are conducted within the Wadden Sea of Schleswig-Holstein. The working group dealing with marine birds and mammals conducts several projects within the Wadden Sea itself as well as within the adjacent offshore area of the North Sea and also the offshore zone of the Baltic Sea. Several projects aiming at hydro and sediment dynamics of shallow coastal zones are being conducted in cooperative projects in South America (Brazil) and Asia (Indonesia).

Facilities:

The Institute has a research vessel for coastal purposes as well as several motorized shallow bottom boats. There is a library with a variety of relevant literature on coastal ecology and coastal engineering. The institute has several labs including facilities for PCR analyses and flowcytometer for phytoplankton analyses. Furthermore, the institute possesses complex modelling software for modelling of geomorphologic issues in the coastal zone. Finally, there are facilities to study methods of aquaculture of algae and fish.

Expertise of the institution:

- Habitat use of marine birds and mammals
- Pathological investigations of the health status of marine birds and mammals
- Eutrophication processes
- Modelling of hydro- and sediment dynamics
- Development of measuring methods for marine environmental surveillance
- Methods of aquaculture of algae and fish

Aims / current projects:

The working group Coastal Ecology/Environmental Research/Environmental Technology focuses on marine eutrophication and transformation processes in the water column as well as on benthic-pelagic coupling and mechanisms of algal bloom formation. A current project aims at revealing the flux of nutrient rich interstitial water from different sediment types into the water column. Furthermore, the influence of small-scale hydrographical processes on phytoplankton blooms is investigated. A long-term monitoring for eutrophication processes in the south-eastern Wadden Sea had been set up more than 10 years ago, providing evidence on the source of nutrients. Additionally there is another long-term data set available on parameters of water quality at the harbour entrance of Büsum. Two other current projects focus on the impacts related to anthropogenic inputs of matter from large harbours in Brazil as well as of influence of aquaculture in Indonesia.

The working group Ecology of Birds and Mammals primarily focuses on the foraging habitat use of these two groups of top-predators. Statistical models are developed to find connections between the distribution of birds / mammals and biotic and abiotic predictors. This has been carried out over many years within the offshore zone in case of mammals and seabirds leading to long-term data sets. As a current project, presently also the habitat choice and foraging ecology of Wadden Sea birds on tidal flats is being investigated in order to find clues for the alarming population decline of various species of Wadden Sea birds. Additionally, pathologic investigations on marine mammals have been carried out for several years in order to evaluate the health status of this group. This project has also been expanded on Wadden Sea birds. Generally, mammals and birds as marine top predators are treated as bioindicators in order to reveal information on the status and health of the whole ecosystem. As applied projects, the influence of offshore wind farms on mammals and seabirds is being studied (see case study II below). This includes studies on habitat loss, changes of behaviour and acoustic interactions between wind farms and marine mammals. These bits of information provide the back-up for the authorities that approve wind-farm sites.

The working group Applied Physics/Marine Technology develops measuring units for monitoring in coastal areas. It focuses on systems that can be applied on vessels and measuring buoys. Furthermore, bioreactors for the cultivation of microalgae are being developed in close cooperation with a company.

The Coastal Research Laboratory within the Research and Technology Centre primarily deals with geological, engineering and environmental subjects in coastal areas. Current projects treat morphological changes at shallow coasts of the Wadden Sea over medium and short time scales. These projects are being carried out in close cooperation with the GKSS and the University of Hannover. Furthermore, the influence of sea state and tide on the Wadden Sea coast are being investigated against the background of climate change and potential coastal protection schemes. Finally, current systems and sediment dynamics around offshore wind turbines are investigated.

In connection with the Research and Technology Centre, the department of agriculture of the University of Kiel has recently set up a complex of laboratories to study methods of aquaculture of fish.

The variety of abiotic and biotic research activities within the same institution offers the opportunity to integrate hydrological, geomorphological and ecological studies.

#### **4. Senckenberg Institute Wilhelmshaven**



Address:

Forschungsinstitut Senckenberg  
German Centre for Marine Biodiversity Research  
Südstrand 44  
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Phone: +49 4421 9475 101

General information:

The headquarters and also the largest unit of the Senckenberg Research Institute are located at Frankfurt am Main where the Senckenberg Natural History Society was founded in 1817. The marine research station in Wilhelmshaven was founded 1928 by Prof. Dr. Rudolf Richter, the Director of the Department of Geology and Head of Geology/Palaeontology at the Johann Wolfgang Goethe University in Frankfurt a. M. and named "Research Station for Marine Geology and Palaeontology", later shortened to "Senckenberg by the Sea". The idea was to have a permanent research facility on the coast of the North Sea in order to study modern geological and palaeontological processes. Under the motto "the present is the key to the past", the principle of actualism was to be applied systematically in the field. In this connection, two new research disciplines were created, i.e. actuogeology and actuopalaeontology. Today, the Marine Science Department consists of five divisions, comprising actuopalaeontology, marine geology, marine sedimentology, sedimentary petrography, and marine biology. In 2001, the station was expanded by the incorporation of the German Centre for Marine Biodiversity Research (DZMB) which forms a Department of its own. Furthermore, work space for one scientist of the DZMB is provided by the Wadden Sea Station Sylt of the Alfred Wegener Institute for Polar and Marine Research (see above).

Number of staff:

In total, there are currently about 60 - 70 persons working in the Senckenberg Institute Wilhelmshaven, excluding members of courses and short-term guests.

Study areas:

The study sites reach from coastal regions such as the East Frisian Wadden Sea including the Jade Bay towards the open North Sea (German Bight, Dogger Bank, Skagerrak and Kattegat) to deep-sea areas (Arctic Ocean, Mediterranean Sea, South Atlantic).

Facilities:

The Senckenberg Institute Wilhelmshaven is owner of the research vessel "Senckenberg".

Expertise of the institution:

- Geological processes in coastal and shallow-marine environments
- Macrobenthic communities, cold-water carbonates
- Transport and deposition of marine sediments
- Heavy metal concentrations, transport pathways
- Benthic ecology, biodiversity patterns (including long-term studies)

Aims / current projects:

An important aspect of North Sea research undertaken by the Senckenberg Institute is the continuous sampling and analyses of benthos at fixed stations in the sublittoral area. Furthermore, correlations with environmental factors (e.g. biometeorological data) are carried

out. The biology and ecology of dominant species of the German Bight are studied over a long-term in order to understand changes and variations. These long-term studies of North Sea fauna are conducted by both DZMB and the Marine Science Department.

**German Centre for Marine Biodiversity Research (DZMB):**

Currently, the main focus of the department is set on the lightless deep sea, which is for example done by the coordination of the international project CeDaMar (Census of the Diversity of Abyssal Marine Life).

Furthermore, special emphasis is also given to zooplankton and phytoplankton biodiversity. The research group on Plancton Systems Ecology carries out the long-term Helgoland Roads time-series on meso- and macrozooplankton which had been initiated by the Biologische Anstalt Helgoland marine station (see Alfred Wegener Institute above). The aim was the production of time-series which would permit the testing of simulation models on the trophodynamics of the pelagic ecosystem as the decisive mechanism of population control.

**Marine Science Department:**

The marine science department covers several fields, from geology to sedimentology, petrography, actuopalaeontology and marine biology:

The marine geology division investigates geological processes in coastal and shallow-marine environments, sediments evolution, dynamics and internal sedimentary structures of wind- and wave-generated bedforms. The major aim is to obtain a better understanding of the hydrodynamic conditions under which different bedform hierarchies evolve, how this is reflected in the sediments, and how this information is ultimately transferred into the rock record. The Geology section is also involved in the Research Group on "Biogeochemistry at Tidal Flats" (see ICBM above).

The division of marine sedimentology deals with transport and deposition of marine sediments on various time scales. Within the framework of the Research Center on Ocean Margins (RCOM) – coordinated by the University of Bremen – projects concentrate on sedimentological and morphodynamic responses to human impacts in estuarine and nearshore environments, in particular harbor constructions, dredging activities and the construction of offshore wind farms. Another topic is the mapping of sediment types and benthic community structure by means of acoustic remote sensing (acoustic seabed classification). The section of marine sedimentology is also involved in the research group on "Biogeochemistry at Tidal Flats" (see ICBM above).

The division of sedimentary petrography investigates two major topics. Firstly, heavy metal concentrations are measured in the fine-grained fraction of the sediments to establish the anthropogenic environmental stress. The investigations include the open North Sea and Baltic Sea, wetlands and estuaries. Secondly, the origin, the transportation pathways and the deposition of fine-grained sediments are determined.

The division of actuopalaeontology investigates all aspects of the genesis of cold-water carbonates in shallow marine environments. Main aim, among others, is the determination of production rates and cycling of carbonates. Research on macrobenthic

communities in shallow marine environments also plays a major role. Projects deal with e.g. bioinvasion of the pacific oyster (*Crassostrea gigas*) in the Wadden Sea (see study case I below) or mass accumulation of vertically packed bivalve shells from the central sector of the German Wadden Sea.

Scientific work of the division of marine biology focuses on benthic ecology. Main topics are in- and epifaunal biodiversity patterns on different temporal and spatial scales, long-term studies on species number, abundance and biomass of in- and epifauna, relationship between benthic diversity and environmental factors, the role of food availability for the structure and function of infaunal communities and the relationship between different benthic size classes. These topics are elucidated in several projects like the long-term study on sublittoral macrofauna off the island of Norderney as well as a study on changes in macrofauna communities in the Jade Bay since 1930.

## 5. GKSS Research Centre Geesthacht – Institute for Coastal Research (IfK)

### Address:

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21502 Geesthacht

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### General information:

The Institute for coastal research (IfK) is part of the GKSS Research Centre Geesthacht, a member of the Helmholtz Association of German Research Centres. GKSS is engaged in long-term activities in the fields of material science and coastal research and is divided in three institutions: (1) Institute of Polymer Research, (2) Institute of Materials Research and (3) Institute of Coastal Research. In total, about 750 people are employed. The Institute for Coastal Research (IfK) was created in 2001. It is divided into two distinct sections, "System Analysis and Modeling" and "Development of Operational Systems", which are led by Prof. Dr. H. v. Storch and Prof. Dr. F. Colijn. Research activities span both the natural and human dimensions of coastal dynamics, analysing the coastal system in global and regional contexts, conducting assessments of the state and sensitivity of the coastal system to natural and human influences, and developing scenarios of future coastal use.

### Number of staff:

The institute for coastal research employs about 170 people.

Study areas:

The Institute carries out research activities worldwide.

Facilities:

The institute is equipped with the shallow water research vessel “Ludwig Prandtl” as well as with small boats for the coastal area, measuring piles in the Wadden Sea and a variety of laboratories.

Expertise of the institution:

- Modelling of hydro and sediment dynamics
- Statistical analysis of physical and environmental parameters
- Natural and human dimensions of coastal dynamics
- Analysis of the coastal system in global and regional contexts
- Long-term observation systems
- Development of scenarios of future coastal use

Aims / current projects:

The Institute aims at answering questions on how global change affects the coastal system, investigates the present state and present change of the coastal zone and develops tools to reliably and cost-effectively monitor processes in coastal systems. Together with the Alfred Wegener Institute, the GKSS is participating in the joint research programme **PACES (Programme Marine, Coastal and Polar Systems: Polar Regions and Coasts in a changing Earth System)**, funded by the Helmholtz Association of German Research Centres which is running from 2009 – 2014. Research will focus on four different topics: (1) the changing Arctic and Antarctic, (2) coasts affected and mediated by climatic and anthropogenic drivers, (3) lessons from the Earth's past, and (4) a synthesis via the integration of the polar perspective into earth system models. A substantial part of the programme devoted to coastal change (topic 2 above) elucidates and compares the consequences of global and regional change on the functioning and diversity of coastal systems in temperate and Polar Regions. There are four main topics that are going to be investigated in further detail: (1) changes in biological diversity, food web structure, and biological resources, (2) changes in cycling of matter with emphasis on eutrophication, contaminants and evolutionary strategies to deal with these changes, (3) long term changes of the hydrodynamics and sediment dynamics, and (4) improvement of temporal and spatial observational strategies and systematic integration of data into model systems.

There is a large number of other projects conducted by the GKSS Research Centre. These with the highest relevance for the Wadden Sea are listed as examples below:

The interdisciplinary project **Coastal Futures** tries to elucidate the sensitivity of the coastal system to natural and human influences. It is a joint research project on **Integrated Coastal Zone Management (ICZM)** that tries to combine biological and socio-economical research issues. One example for investigations of increasing utilization pressure on the

coastal region is the investigation of risks and opportunities associated with offshore wind farms in the German North Sea.

**COSYNA (Coastal Observation System for Northern and Arctic Seas)** is a large scale investment to install a long-term observation system which is currently tested in the Wadden Sea region. It is created as a comprehensive observation system in the area of the German North Sea for the collection, prediction and scientific analysis of the current condition and future development of the coastal sea. For detailed information visit [http://www.gkss.de/institute/coastal\\_research/structure/operational\\_systems/KOK/projects/ICON/index.html](http://www.gkss.de/institute/coastal_research/structure/operational_systems/KOK/projects/ICON/index.html)

The so called **Ferry Box System** is an in-situ technology to determine the chemical and ecological quality of sea water and can be installed on ferries. This enables continuous sampling along defined routes. The autonomous Ferry Box System consists of a flow-through unit with sensors for temperature, salinity, oxygen concentration, turbidity, pH, chlorophyll (fluorescence), algal groups and nutrient concentration (e.g. ammonia, nitrate/nitrite, phosphate and silicate).

The project **KRIM (Climate Change and Risk Management at the German North Sea Coast)** conducted in the GKSS division of Coastal Climate aims at providing knowledge on future coastal protection risks under uncertainties for decision makers.

## 6. Institute for Avian Research (IfV)

### Address:

Institute für Vogelforschung  
"Vogelwarte Helgoland"  
An der Vogelwarte 21  
26386 Wilhelmshaven

Phone: +49 4421 9689 0

Fax: +49 4421 9689 55

Email: [ifv@ifv.terramare.de](mailto:ifv@ifv.terramare.de)

Email Ringing Central: [ifv.ring@ifv.terramare.de](mailto:ifv.ring@ifv.terramare.de)

### General Information:

The Institute was founded in 1910 as part of the "Preußische Biologischen Anstalt" at the island of Helgoland. In 1947 the Institute moved to Wilhelmshaven. Today, the headquarter is still located in Wilhelmshaven, while the „Inselstation“, the second major part of the Institute is still located on the island of Helgoland. The latter carries out one of the Institute's most important research items, i.e. bird migration. Prof. Dr. Franz Bairlein is the head of the Institute for Avian research. The Inselstation is lead by Dr. Ommo Hüppop.



Number of staff:

In total there are about 40 persons working in the headquarter in Wilhelmshaven and at the Inselstation on Helgoland. Additionally, there are several students and short-term guests.

Study areas:

The bird migration is primarily studied at the Inselstation on Helgoland, which provides a unique spot as many song bird species visit the offshore island in order to fuel up and rest. Ecological investigations on Wadden Sea birds (at present mainly Redshanks *Tringa totanus*) are carried out within several breeding sites at the Jade Bay at the Wadden Sea coast of Lower Saxony. The studies on population ecology on Common Terns (*Sterna hirundo*) are mainly carried out at an artificial breeding colony in Wilhelmshaven.

Facilities:

Both, the headquarter in Wilhelmshaven as well as the Inselstation on Helgoland have libraries with special expertise on avian biology. The Institute owns a scientific collection of preparations which is accessible to the public. Furthermore, there are large aviaries for experimental research as well as laboratories for physiological and genetic analyses and several laboratories. The Institute is in charge of several radar devices and other optical and acoustical systems to study bird migration. The Institute runs a bird ringing central and plays an important role for the organisation of several ringing projects and the management of bird ringing data.

Expertise of the institution:

- Bird migration (in relation to global change)
- Physiological mechanisms of bird migration
- Population ecology of birds (mainly Common Terns)
- Ecology of coastal birds (mainly in the breeding areas)
- Monitoring of contaminants in bird eggs

Aims / current projects:

In general, the Institute's major aim is basic research on interactions between birds and their biotic and abiotic environment. In order to meet this aim the Institute has set up various long-term research projects. During the last few years also several projects with more applied and short-term character have been conducted (such as patterns of bird migration in connection with the establishment of offshore windfarms).

The following three fields of research have a long tradition within the Institute of Avian Research:

**(1) Bird migration:** One of the long-term research projects is to reveal migration routes and overwintering area of birds. This task had been conducted during the last two decades. At present, additionally steering factors of bird migration, such as genetic or environmental stimuli have been added on the agenda. Interactions between availability of resources and the energetic requirements for migration leading to ultimate decisions of

different individuals during migration are a key question. Furthermore, physiological mechanisms of bird migrations are investigated. For this purpose, up to date biochemical and physiological methods are applied that allow investigations on living birds. The physiological mechanisms of body fat deposition in different groups of birds are studied in great detail. Furthermore, effects of climate change on patterns of bird migration are studied.

**(2) Population ecology:** Studies on population ecology of various bird species have a very long tradition at the Institute of Avian Research. At present, the main study species is the Common Tern (*Sterna hirundo*) which is investigated at an artificial breeding site in Wilhelmshaven that is equipped with various electronic and automatic measurement devices. These analyses allow conclusions on aspects of demographic parameters, population dynamics, live history traits, life-time reproduction success and fitness of different individuals.

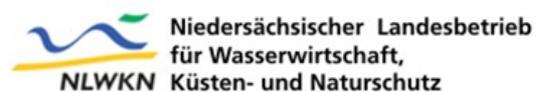
**(3) Ecology of coastal birds:** Several studies on the population dynamics, breeding habitat choice and predation pressure on coastal birds (mainly Redshanks *Tringa totanus*) in the Jade Bay are being conducted. The current focus is set on effects within breeding sites.

Within the TMAP-programme (Trilateral Monitoring and Assessment Programme) the Institute for Avian Research had been responsible for analyses of contaminants in bird eggs. However, it is most likely that this task is going to be removed from the TMAP agenda as firstly the general degree of contamination showed decreasing trends over the past years (e.g. Becker & Muñoz Cifuentes 2004) and secondly there is not necessarily a direct influence of contamination on the fitness of birds (Muñoz Cifuentes 2004). Due to various studies on contaminants, the Institute will keep an excellent expertise on this important issue.

## 7. Coastal Research Station Norderney (NLWKN)

### Address:

Nds. Landesbetrieb für Wasserwirtschaft,  
Küsten- und Naturschutz  
An der Mühle 5  
26548 Norderney



- Forschungsstelle Küste -

Phone: +49 4932 9160

Fax: +49 4932 1394

Email: [Poststelle@nlwk-nor.niedersachsen.de](mailto:Poststelle@nlwk-nor.niedersachsen.de)

### General Information:

Founded in 1937, the Coastal Research Centre Norderney today belongs to the Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN). It was originally founded to coordinate the coastal protection of the East Frisian Islands and

parts of the mainland of Lower Saxony. Already in the days after its foundation the institute performed an integrated approach by studying hydrographic and geologic parameters of coastal waters as well as biology of tidal flats and saltmarshes (under the view of coastal protection). This integrated concept is still being performed today. One of the institution's most important functions is the advice of the regional administrations for management decisions, regional development plans and certificates. Leader of the institute is Hanz-Dieter Niemeyer.

Number of staff:

There are around 30 persons employed in the Coastal Research Centre of Norderney.

Study areas:

Main study areas are the coastline of the East Frisian Islands, the large tidal systems separating the islands, the tidal flats of Lower Saxony as well as the adjacent shallow water regions.

Facilities:

The institution is in charge of several fully equipped research vessels and various hydrographical and geodetic measuring devices.

Expertise of the institution:

- Geomorphology of the coastal region with regard to coastal protection
- Coastal engineering
- Hydro- and sediment dynamics
- Alert service for storm floods

Aims / current projects:

The Coastal Research Centre regularly conducts topographical measurements of the coastal region off Lower Saxony in cooperation with the Federal Maritime and Hydrographic Agency (BSH). This is mainly done in order to update maps on the coastal region. Furthermore, sediment dynamics are analysed against the background of coastal protection and shipping within the Wadden Sea region. The institute develops and tests models on sediment and hydro dynamics and simulates the influence of storm floods on constructions for coastal protection. Moreover, it evaluates the effect of such constructions on sediment and hydro dynamics. Another important field of research is the interaction between hydrodynamic and ecology particularly with respect to the distribution and concentration of nutrients and contaminants in the shallow coastal area.

## 8. Lower Saxony Institute for Historical Coastal Research (NIHK)

### Address:

Institut für Historische Küstenforschung  
Viktoriastraße 26/28  
26382 Wilhelmshaven  
Postfach 2062  
26360 Wilhelmshaven



Phone: +49 04421 915 0

Fax: +49 04421 915 110

Email: [nihk@nihk.de](mailto:nihk@nihk.de)

### General Information:

The institute was founded in 1938 as a research institute of the federal state of Lower Saxony. Dr. Felix Bittmann is the head of the institute. The general aim of the institute is to investigate the landscape development and settlement history since the last glacial period of the mainland adjacent to the south-eastern North Sea. It cooperates with various other institutions dealing with geology, palaeontology, plant sociology and other natural and cultural sciences (including the Centre of Maritime and Regional Studies in Denmark; see below). In general the institute performs a two-fold research concept by linking natural with cultural sciences.

### Number of staff:

The Institute generally employs around 35 people, depending on the number of projects.

### Study areas:

The main study area is the coastal mainland of Lower Saxony i.e. mainly the lowland region including its various bog and fen systems to which is paid special attention.

### Facilities:

The Institute owns a large library which is accessible for the public.

### Expertise of the institution:

- Archaeological and historical-geographical investigations
- Geological and botanical investigations into landscape development

### Aims / current projects:

**Cultural Sciences:** Current projects focus on the reconstruction of the settlement by Romans in the coastal region of Lower Saxony. Archaeological investigations are being carried out in the vicinity of dwelling mounds in order to reconstruct the function of tools made out of bones and horns during the Bronze Age. There are several projects that are being conducted in cooperation with the University of Leiden in the Netherlands and with the

Historischen and Archaeologischen Versuchszentrum in Denmark as well as with the University of Kiel. Another major aim is to reconstruct the landscape development during the period of embarkations and agricultural developments since the Middle Ages. Using fragments of tools and ceramic partly preserved in the fen and bog systems, the history of settlements is determined by different means of age determination. Furthermore, geo-archaeological investigations are carried out to determine the consequences of the sea level rise caused by geological processes and climate development for the settlements and landscape use at the boarder of the Baltic Sea. Within an integrative project natural and cultural basic data available for the Jade Bay are analysed with a Geographical Information System and stored in a common data base.

**Natural Sciences:** Submarine peat is being analysed in order to reconstruct the early Holocene sea level rise. In cooperation with the Federal Maritime and Hydrographic Agency, the Federal Institute for Geosciences and Natural Resources and the Senckenberg Research Institute various early Holocene peat sequences from North Sea vibrocores have been determined using high resolution results of stratigraphy, pollen analysis and geochemistry. This allows drawing conclusion about processes of mire initiation, subsequent peat formation, flooding and marine deposition at the past coastline. In order to reveal the type of vegetation, settlement and climate history, several corings have been conducted in lakes and mires in lowland area of Lower Saxony. The project focuses on the relationships between the trophic status of the ecosystems and the land use intensity since medieval times. Radiocarbon analyses and archaeobotanical investigations on organic layers of corings taken at dwelling mounds have been conducted to reconstruct the settlement history. The Lower Saxony Institute for Historical Coastal Research is in close touch with local associations dealing with regional historical issues such as the “**Verein für Dithmarscher Landeskunde**” in the federal state of Schleswig-Holstein or the “**Ostfriesische Landschaft**” in Lower Saxony.

## 9. Common Wadden Sea Secretariat (CWSS)

### Address:

The Common Wadden Sea Secretariat (CWSS)  
Virchowstrasse 1  
26382 Wilhelmshaven

Phone: +49 4421 9108 0

Fax: +49 4421 9108 30

Email: [info@waddensea-secretariat.org](mailto:info@waddensea-secretariat.org)

### General Information:

The Common Wadden Sea Secretariat was established in 1987 in Wilhelmshaven by a trilateral agreement between The Netherlands, Denmark and Germany. Jens Enemark is the



head of the Secretariat. The main aim of the Common Wadden Sea Secretariat is to support, initiate, facilitate and coordinate activities of the Trilateral Wadden Sea Cooperation between The Netherlands, Germany and Denmark. The Wadden Sea Secretariat plays a crucial role in setting a common conservation and management agenda as well as for interdisciplinary and trilateral coordination of research and monitoring. A crucial function of the CWSS is to integrate upcoming regulations and directives (such as the EU Marine Strategy Directive) for their implementation on a trilateral level.

In more detail, the tasks of the Secretariat are (1) to provide assistance with regard to trilateral conferences (2) to collect and disseminate information on conservation measures (3) to collect and communicate information on activities that may impact the natural environment of the Wadden Sea, (4) to promote and review scientific research projects, (5) to support scientific symposia and (5) to make suggestions for a coordinated trilateral approach.

Furthermore, the Common Wadden Sea Secretariat publishes reports and documents produced within the Trilateral Wadden Sea Cooperation.

Number of staff:

Currently, in addition to the Secretary, there are 5 permanent and one project staff members, all of whom report to the Secretary. Four of the permanent staff have technical functions, and one provides the financial and administrative support functions of the CWSS.

Expertise of the institution:

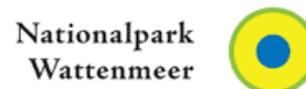
- Supporting, initiating and coordinating activities of the Trilateral Wadden Sea Cooperation
- Publications of documents produced by the Trilateral Wadden Sea Cooperation
- Organisation and facilitation of (international) meetings, symposia and workshops
- Coordination of research and monitoring

Aims / current projects:

The Common Wadden Sea Secretariat has pushed forward the nomination of the Dutch-German Wadden Sea as a natural world heritage site. In 2009 an update of the Quality Status Report for the international Wadden Sea will be published by the CWSS. This report addresses many biotic and abiotic structures and functions within the ecosystem of the Wadden Sea and points out various targets and recommendations for research and management. Due to the alarming trends of many migratory bird species in the Wadden Sea, the CWSS will publish actual trends of migratory birds on an annual basis. The 12<sup>th</sup> International Wadden Sea Symposium, hosted by the Common Wadden Sea Secretariat will be held in Wilhelmshaven from 29 March to 3 April 2009. Several workshops on important topics of changing issues within the Wadden Sea have recently been organised such as a workshop on Pacific Oysters, on Blue Mussels, on dune management and on migratory waterbirds.

According to the Common Wadden Sea Secretariat there is currently a lack of interdisciplinary, cross-border research and a need for integrated research on an ecosystem level.

## 10. National Park administrations



### Addresses:

#### **10.1 Nationalparkverwaltung im Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz**

Postfach 160  
25829 Tönning  
Phone: +49 48 61 616 0  
Fax: +49 48 61 616 -69  
Email: [detlef.hansen@lkn.landsh.de](mailto:detlef.hansen@lkn.landsh.de)

#### **10.2 Nationalparkverwaltung Niedersächsisches Wattenmeer**

Virchowstraße 1  
26382 Wilhelmshaven  
Phone: +49 4421 911 0  
Fax: +49 4421 911 280  
Email: [Peter.Suedbeck@nlpv-wattenmeer.niedersachsen.de](mailto:Peter.Suedbeck@nlpv-wattenmeer.niedersachsen.de)

#### **10.3 Nationalparkverwaltung Hamburgisches Wattenmeer**

Stadthausbrücke 8  
20355 Hamburg  
Phone: +49 40 42840 3392  
Fax: +49 40 42840 3552  
Email: [Klaus.Janke@bsu.hamburg.de](mailto:Klaus.Janke@bsu.hamburg.de)

### General Information, aims and current projects:

The National Park Administrations have been founded after the establishment of the National Park Wadden Sea in 1986. The main task of the National Park administrations is to develop nature protection schemes and to supervise the effects of their implementation. The administration is in a permanent dialogue with both, local stakeholders from agriculture, fisheries, tourism, coastal protection as well as with NGOs. Another main issue of the National park administrations is the monitoring of certain natural processes in order to reveal important long-term changes and trends and thus being able to react on these changes with appropriate management decisions such as limitation of certain anthropogenic utilizations of the Wadden Sea. The National Park Administrations might initiate own scientific investigations or allow external studies that aim to reveal information about the structure, status and development of the ecosystem and effects of anthropogenic activities on the

environment. Another important task is the environmental education of tourists and local people by visitor information systems, exhibitions, publications, booklets etc. The National Park Administration performs a socio-economical monitoring by interviewing different groups of people about their perception and acceptance of the Wadden Sea National Park including tourists, stakeholders and people living close to the Wadden Sea. This monitoring provides a solid basis on the role of the National Park for different groups of people and thus is an important indicator for management decisions.

Number of staff:

In total, there are around 70 people employed in the National Park Administrations of Schleswig-Holstein, Lower Saxony and Hamburg.

Expertise of the institution:

- Supervising of long-term monitoring of different parameters of the Wadden Sea
- Regulation of anthropogenic activities
- Environmental education

## 11. National Environmental Research Institute (NERI)

Address:

National Environmental Research Institute – Roskilde  
Frederiksborgvej 399  
PO Box 358  
DK-4000 Roskilde  
Denmark



Phone: +45 4630 1200

Fax: +45 4630 1114

Email: [dmu@dmu.dk](mailto:dmu@dmu.dk)

General information:

The National Environmental Research Institute (NERI) is a part of Aarhus University. It is divided into eight departments (including the department on marine ecology), that are centred at three locations: Roskilde near Copenhagen, Silkeborg in Jutland and Kalø in Jutland. Dr. Bo Riemann is the head of the department of marine ecology. NERI generally undertakes scientific consultancy work, monitoring of nature and the environment as well as applied and strategic research, including long-term data series. One of the major tasks of NERI is to establish a scientific foundation for environmental policy decisions. From 2008 to 2012 the research strategy focuses on five main themes that span the institute's competence areas: (1) Climate change, (2) biodiversity, (3) energy and the environment, (4) environment and health, and (5) assessments of the state of the environment and management models.

Study areas:

Besides studies in the Arctic, in freshwater and terrestrial ecosystems the National Environmental Research Institute focuses on coastal areas of the North Sea and particularly of the Baltic Sea. Most research projects are conducted in the pelagic environment, while a smaller amount of projects is set up in the Wadden Sea itself.

Facilities:

The three locations of NERI comprise fully equipped modern laboratories and facilities built in 1991 or later. These are able to handle toxic substances and genetically modified microorganisms and plants. Small research plots are also available at Roskilde and Silkeborg.

Expertise of the institution:

- Monitoring of the aquatic environment (particularly of Danish marine waters)
- Turnover and effects of nitrogen and phosphorus
- Effects of selected hazardous substances
- Ecology of marine birds and mammals
- Effects of global warming on the aquatic environment
- Constructing mathematical models for use in forecasting scenarios
- Providing scientific advice for management decisions

Aims/current projects:

Among the various research projects conducted by NERI, there are several projects in the Wadden Sea region and adjacent offshore zone. The following list provides an overview about several of the most important projects:

The institute deals with the status of eelgrass by investigating key parameters and processes affecting the reestablishment of eelgrass habitats in estuaries and coastal waters. A monitoring of xenobiotic compounds and metals in the Danish marine environment is being carried out against the background of the EU Water Framework Directive, which includes for instance the analyses of the load of metals in Blue Mussels (*Mytilus edulis*) and different sediment types. Another project focuses on effects of nutrient loads (N and P) and on the time lag between reduced loadings and improvements in the environmental quality in estuaries. It is the main aim to establish quantitative relationships between nutrient loads and chemical and biological indicators to gain information on environmental quality, which is achieved by modelling present data and validating these findings with long-term data sets. Moreover, there are several projects on an EU basis that aim to establish a network that can provide the platform for future national and European collaboration on research, education and management in ecological modelling in marine environments. Furthermore, the institute aims at the effects of climate change on ecosystem services for instance by predicting the effects of climate change on the sustainable exploitation and maximum yield of North Sea fish stocks. At the same time the effects of climate change on food-web dynamics are studied. There are various applied projects including studies on the effects of offshore wind

farm sites on the marine environment (see also case study II below) and possibilities for sustainable ways of mussel culture that – besides methods of cultivation – assess shellfish physiology and environmental impacts of shellfish cultivation. The influence of benthic alien species with particular focus on ecosystem engineers are investigated (compare research agenda of the Alfred Wegener Institute and case study I).

## **12. National Institute of Aquatic Resources (Technical University of Denmark, DTU)**



### Address:

DTU Aqua  
Jægersborg Allé 1  
DK-2920 Charlottenlund  
Denmark

Phone: + 45 33 96 33 00

Fax: +45 33 96 33 33

Email: [aqua@aqua.dtu.dk](mailto:aqua@aqua.dtu.dk)

### General Information:

The National Institute of Aquatic Resources was previously known as DIFRES - Danish Institute for Fisheries Research. Since 2007 it belongs to the Technical University of Denmark (DTU). The institute works on the sustainable exploitation of living marine and freshwater resources and ecosystems. Its main focus concerns fisheries and aquaculture, and the institute carries out monitoring of fish populations. Thus, many research questions are addressed against an applied socio-economic background. The institute is divided into 16 scientific sections that work in five main areas: (1) marine research and technology, (2) aquaculture and shellfish, (3) recreational fisheries and population genetics, (4) seafood and fish processing, and (5) advice and monitoring. The section working on marine research and technology – besides others – deals with specific questions on interactions between different marine organisms and their abiotic environment in shallow coastal systems. The main aims of this section are stated below. Fritz W. Köster is the director of the institute who is responsible for the overall institute management as well as for the research section "Marine Research and Technology".

### Number of staff:

The National Institute of Aquatic Resources employs approximately 330 people, about one third being scientific staff.

### Study areas:

The main study areas are the pelagic offshore zones of the Danish North Sea and Baltic Sea. However, several projects are being conducted in the Arctic.

Facilities:

The National Institute of Aquatic Resources is in charge of the large research vessel “RV Dana” which is a versatile multi-purpose vessel being capable of worldwide operation. It is classified for ice navigation and is equipped to carry out a wide range of investigations within different research fields such as cruises to the Arctic and fishery research. The vessel has five large laboratories provided with extensive and wide-ranging scientific equipment for analysis and measurements as well as different tools for trawl fishing, water sampling and sampling from the seabed. Additionally, there are four smaller motorized vessels available for activities in shallow areas. The Marine Service Centre which belongs to the National Institute of Aquatic Resources is the primary national supplier of technical services to marine research. The centre is responsible for the technical support and maintenance of all kinds of mechanical and electronic equipment used by the institute’s seagoing research.

Expertise of the institution:

- Oceanography
- Influence of climate change on marine ecosystems (particularly fish species)
- Fisheries monitoring technology
- Aquaculture
- Fish diseases
- Seafood and fish processing
- Monitoring of fish populations

Aims / current projects:

The section working on oceanography within the research branch marine research and technology is especially interested in how physical and chemical traits of the marine environment affect the structure and function of marine food webs. Primary focus is at the base of the food web (i.e. primary and secondary producers). Physical factors that have their most direct impact on this level (which in turn impacts higher trophic levels such as fish) are of major importance. The section working on population and ecosystem dynamics deals with physiology, behaviour and response of aquatic organisms to environmental factors on individual, population and ecosystem level. Stochastic modelling is used to determine anthropogenic and natural influences (especially climate changes) on regional ecosystems. The section dealing with coastal ecology is working on structure, dynamics and exploitation of coastal and estuarine ecosystems (including the Wadden Sea). Main topics are analyses on the carrying capacity of different habitats for juvenile fish as well as on fish community structure, habitat restoration and restoration of coastal fish populations. Furthermore, several projects are being set up in order to elucidate the effects of anthropogenic impacts such as the exploitation of biotic and abiotic resources, constructions and eutrophication. Finally, an integrated management of coastal ecosystems is being studied which includes the implementation of models that facilitate the integration of socio-economic and scientific data. The section working on fisheries- and monitoring technology develops new catch methods

that consider both the marine environment and the effectiveness and economy of the commercial fisheries in order to improve the catch selectivity.

The research area dealing with aquaculture and shellfish is focused on optimizing both fishery and marine shellfish cultures with regards to management and planning as well as on developing methods for production. Research includes analyses of environmental impact of shellfish production and development of innovative gear-types for fishery of bivalves and common shrimp.

### **13. Centre for Maritime and Regional Studies (CMRS) Esbjerg, Part of University of Southern Denmark (USD)**

Address:

Centre for Maritime and Regional Studies  
University of Southern Denmark  
Niels Bohrs Vej 9  
6700 Esbjerg  
Denmark



Phone: +45 6550 4177

Email: [hkraun@hist.sdu.dk](mailto:hkraun@hist.sdu.dk)

General information:

The Centre for Maritime and Regional Studies (CMRS) was established in 1994. It is a partnership of the University of Southern Denmark and the Fisheries and Maritime Museum. The Centre studies the historic interactions between oceans and human society. It connects the expertise from historians, archaeologists, ethnologists, and social anthropologists. Prof. Dr. Martin Rheinheimer is the head of the Centre. In the field of maritime archaeology, the Centre cooperates with the Lower Saxony Institute for Historical Coastal Research (see above).

Study areas:

The regional history of Western Jutland and the federal German state of Schleswig-Holstein (primarily the border area) is a core field of research.

Number of staff:

Around 20 people are employed at the Centre for Maritime and Regional Studies including staff maintaining the archives and the museum and PhD students.

Expertise of the institution:

- Marine archaeology
- Maritime and regional history

- Tourism and cultural heritage
- Historical and sociological investigations

*Aims/current projects:*

There are four major research aims: (1) Maritime studies with special emphasize on the human utilization of the sea as a resource and highway of transportation, (2) regional development which includes social and economic activities in a given geographic space, (3) maritime archaeology that aims at evaluating the maritime cultural landscape, its utilization and culture, and (4) studies on tourism and cultural heritage that take into account the conservation and utilization of coastal and marine resources.

An example of a current project is the participation in the joint research project “Consequences of weather and climate changes for marine and freshwater ecosystems – Conceptual and operational forecasting of the aquatic environment” (CONWOY). The intention of the project was to elucidate the interactions between weather/climate and the biogeochemical, biological and physical processes that define the state of aquatic environments found in and around Denmark. The CMRS played a major role by gathering and analysing historical fish landing records with focus on the North Sea area. Data were related to known climatic signals in order to evaluate how climate might have influenced fisheries over historical time scales. Furthermore, available historical data for possible climatic influences on the biological structure in lakes, rivers and shelf seas were analyzed with particular focus on the abundance and composition of marine and freshwater fish communities and the linkage to fisheries.

The CMRS generally aims at evaluating the consequences of changes in fish availability, species composition and catch regulations on the regional social development. Furthermore, socio-economic influences of the offshore oil and gas industry are investigated. A long term research project focusing on regional developments was set up in order to unravel the structure of maritime societies of the Wadden Sea islands, using the island of Amrum as a case. The unit focusing on maritime archaeology – besides other issues – investigates historic ship constructions as a proxy for societal developments. Furthermore, a project dealing with sustainable tourisms in the Danish North Sea region has been finished in 2008.

## **Case studies**

In order to briefly illustrate how actual research questions in the coastal zone of Germany are currently addressed the following two case studies on the topics of alien species and of the potential effects of offshore wind farms are presented.

### **Case Study I: Alien Species**

The introduction of alien Species into the Wadden Sea is a crucial issue since many years. The vast majority of invasive plants and animals has found its way into the Wadden Sea by transoceanic shipping (Reise et al. 2005), an issue which has been dealt with intensively by the Alfred-Wegener-Institute (particularly Wadden Sea Station Sylt) and the Leibniz Institute of Marine Research in Kiel. With the introduction of a range of non-native species into the Wadden Sea it has been postulated that the ecosystem stability may become lower (e.g. Reise & van Beusekom 2008). In Germany, particularly the link between climate change leading to milder winters, warmer summers and longer growth seasons and the abundance of alien species has been investigated, as many of these species are adapted to warm water systems (e.g. Reise 2008). In this connection special attention is paid to those taxa of alien species that function as ecosystem engineers because these species may affect biological traits by profound architectural changes in the environment leading to changes in the ecological niches and interactions among species. The Pacific Oyster (*Crassostrea gigas*) is probably one of the most important alien ecosystem engineers which has important effects on the abundance of the Blue mussel (*Mytilus edulis*) and strongly affects the community structure (e.g. Kochmann et al. 2008).

In the German Wadden Sea, the burning issue of alien species is being treated mainly by the Wadden Sea Station Sylt of the Alfred Wegener Institute (see above; the Senckenberg Institute conducted several studies on the issue of competition between Oysters and Blue Mussels as well). The Wadden Sea Station mainly conducts a series of mesocosmic field experiments. A joint project with the University of Odense in Denmark had been launched but has already been finished. The National Environmental Research Centre (NERI) in Denmark works on a similar issue (see above). However, overall, presently there is hardly any networking with other institutions taking place. In cooperation with the Ministry of Agriculture, Environment and Rural Areas of the State of Schleswig-Holstein an initial project has been launched to rapidly assess the abundance of alien species in order to achieve basic information for a management concept.

### **Case study II: Research related to the installation of offshore wind farms**

Discussions on renewable energies are a topic of major public interest since many years. Twenty to thirty years ago, only a “green minority” supported the idea of renewable energies, however, nowadays it has become an important and serious political and socio-economical issue. Wind farms on land are a common sight, especially in northern Germany. As winds on oceans are stronger and more consistent, consequently the idea arose to build wind farms offshore. The installation of offshore wind turbines requires authorisation – in the case of Germany – by the Federal Maritime and Hydrographic Agency (BSH). Authorisation must be

refused if goods of a marine environment are severely endangered and cannot be compensated. Currently, 20 wind farm sites have been licensed for the German North Sea and Baltic Sea, which led to a great deal of scientific questions regarding the impacts of erection and operation of offshore wind farms. The possible impacts include e.g. migration routes of birds, potential habitat loss for mammals and resting birds, effects on fish and benthos, impacts of wind turbine sound emissions on marine mammals, potential collisions of birds with wind turbines (for reviews see Dierschke & Garthe 2006; Keller et al. 2006; Lucke et al. 2006; Meißner & Sordyl 2006).

In Denmark the first offshore wind farms have been built already several years ago and environmental effects have been elucidated during the construction and operating phases (for environmental reports see e.g. <http://www.hornsrev.dk/Engelsk/Miljoeforhold/uk-rapporter.htm>). In contrast, in Germany the installation of the first wind turbines will be realized off the island of Borkum in 2009 (see below). Since 2002 research projects on the potential habitat loss of marine birds and mammals, effects on benthos and fish as well as collision risk of birds have been conducted in German waters in order to provide a solid baseline for the license process. For this purpose, networks of several research institutions have been created. Important examples of a network of institutions dealing with the potential effects of offshore wind farms on marine worm-blooded animals are the projects MINOS and MINOSplus ("Marine Warmblüter in Nord- und Ostsee"; Wollny-Goerke & Eskildsen 2008; for the final report see also [http://www.wattenmeer-nationalpark.de/themen/minos/minos2\\_download\\_rep.htm](http://www.wattenmeer-nationalpark.de/themen/minos/minos2_download_rep.htm)) that ran from 2002 to 2007. The Research and Technology Centre of the University of Kiel, the Leibniz Institute of Marine Sciences in Kiel, the German Oceanographic Museum at Stralsund, the University of Bochum, the German Federal Research Centre for Fisheries at Hamburg and the Administration for the National Park Wadden Sea of the federal state of Schleswig Holstein were involved in these long-term research projects. This network of institutions is a good example for comprehensive research that is of course dependent on active communication among the participating institutions, which in the present case was mediated by the National Park Administration as the project coordinator.

Another recent example of a research network involves several institutes dealing with the effects of the establishment of the first German wind farm site "Alpha Ventus" off the East Frisian island of Borkum. The German administrations aim at an integrated research project providing constant information and communication among all involved parties that include engineers responsible for the erection of wind turbines as well as scientists dealing with the ecological consequences during the construction and operation phases of the turbines.

## Conclusions and Suggestions

Currently, there is a variety of institutes in Germany and Denmark that focus on Wadden Sea research. The vast majority of these institutions is dealing with natural sciences on biotic and abiotic processes (primarily morphodynamics, research focusing on the pelagial as well as cycling of material and nutrients), whereas socio-economic and cultural aspects are studied at a far lower degree (Fig. 2; Table 1).

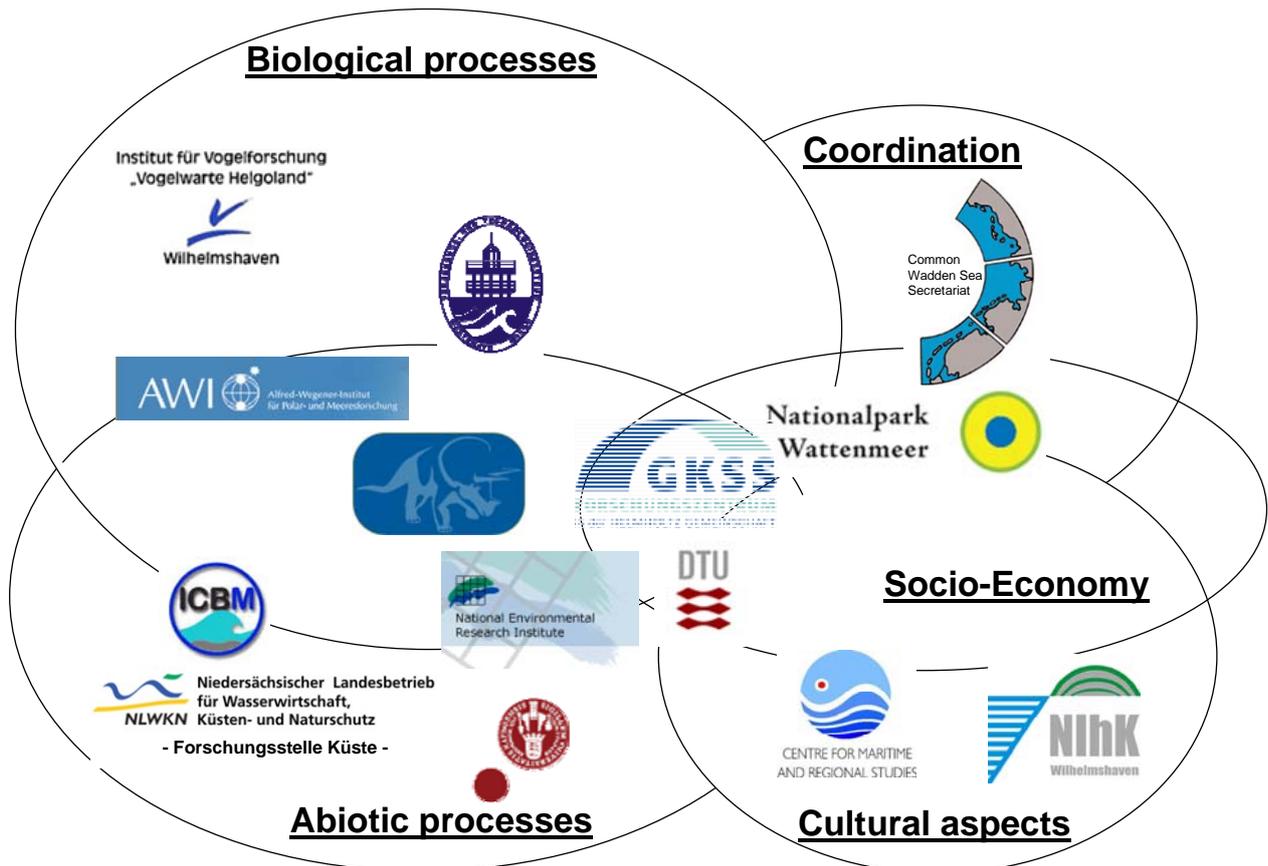
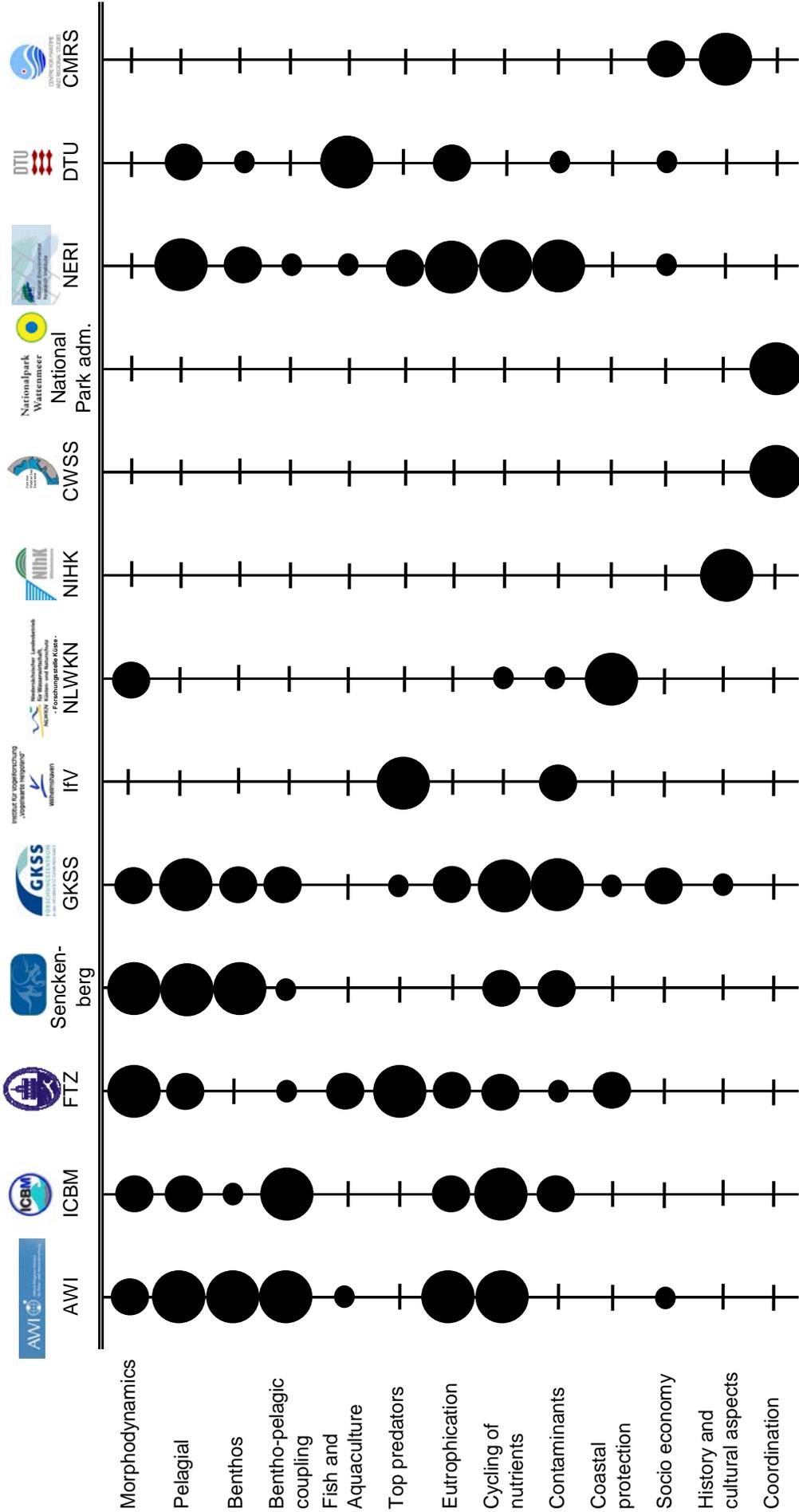


Fig. 2: Flow chart on the main research foci of the German and Danish institutions performing Wadden Sea research.

Table 1: Summary of the expertise of the 13 institutions for 13 different subjects of research. The size of the circles in the column of each institute represents the intensity of research spent on the according subject; a bar indicates that no research of the according subject is being carried out.



The Wadden Sea has been shaped by humans over many centuries and is still a rather densely populated area with many people living from, in and with the Wadden Sea. Thus, it is very important to bear in mind socio-economic interactions. Obviously it would be worthwhile to try to link different fields of research (primarily biological and socio-economical research issues) more closely. A good example for this intention is the **Integrated Coastal Zone Management (ICZM)** (see GKSS above), where socio-economical and ecological aspects are treated simultaneously. In the German Wadden Sea, currently, processes of the ecosystem are studied by various research disciplines in great detail but more or less separately. It will, however, be necessary to put more emphasis on a superior view on structures and functions of the whole ecosystem and at the same time including socio-economic research issues. For instance, the Department of Ecosystem Research of the University of Kiel (<http://www.ecology.uni-kiel.de/ecology/site/departments-en/za>) carries out studies that deal with such issues. Here, special emphasis is given to the identification of ecosystem goods and services, which provides the opportunity to express ecosystem parameters in economical currencies. This allows estimating the economical value of a whole ecosystem and surely could be a highly relevant approach for a culturally and economically significant ecosystem such as the Wadden Sea. At the same time, such integrative studies might be a crucially important tool for management decisions that take into account all involved stakeholders.

Another very suitable approach to link natural values with economic interests in natural reserves has been provided by Job et al. (2005): By determining the number of visitors and the amount of money that is being spent by these visitors in a natural reserve, it is possible to calculate the equivalent numbers of people that can be employed due to its tourist attraction. This allows gaining a scientific basis for management decisions and again enables to turn the value of a natural reserve into economic currency. Such an approach would be highly useful to be performed in the Wadden Sea region as it would be able to integrate different research disciplines and would be highly interesting for stakeholders and decision makers. For further information see also <http://www.bfn.de/fileadmin/MDB/documents/skript135.pdf>.

Besides the lack of links between the three superior research branches, natural, cultural and socio-economic science, also a lack of links between different research disciplines within each of these three branches must be stated (primarily within disciplines of natural sciences). In order to develop a more ecosystem-based approach, geological and biological disciplines should work together more strongly. For instance, geological processes may even affect organisms such as Wadden Sea birds that stand at a high trophic level in the food chain. Such interactions are presently poorly known. A better integration of hydrological, geological and ecological studies is probably highly needed. Another example is the lack of common studies of institutes that work on lower trophic levels and those working on higher levels in order to unravel food web dynamics of the Wadden Sea. Such combined top-down and bottom-up approaches would be highly promising to gain more insight into complex relationships within the food web.

The use of bioindicators could be highly relevant to gain information on the status of the health of the ecosystem as a whole. Such bioindicators could be birds or other top predators as well as organisms on a lower trophic level (such as copepods that have already been used successfully as indicators for regime shifts) that may be able to indicate shifts of the ecosystem from one phase into another.

As the study case of the research on alien species (see above) clearly shows, not enough effort is being spent on this important issue. Presently, the only institution working on this in Germany is the Wadden Sea Station of the Alfred-Wegener Institute at the Island of Sylt. The invasion of alien species is clearly linked to changes of the temperature regime. This connection should be studied in more detail and in a cross-boarder approach. Particularly the influence of these alien species on the stability of ecosystem functioning should be paid more attention. Concerning the role of the Pacific Oyster, in this connection, investigations on reef-building organisms (ecosystem engineers) and their effect on other marine organisms must be highlighted. As species with a high economic value – such as Blue Mussels – are touched by these ongoing changes, again there seems to be a suitable possibility to link natural, cultural and socio-economic sciences.

Another burning issue allowing to link different fields of research, is the role of anthropogenic activities in the Wadden Sea. The effects of mussel and shrimp fisheries, recreation, eutrophication, contaminants, shipping, harbours, construction of wind farms etc. should be investigated in closer detail (see also the case study II) and evaluated against the background of ongoing natural changes of the Wadden Sea ecosystem. Close attention must be paid to the role of cumulative effects in this context. This, again, can be addressed most suitably by linking different fields of science.

Both, the example of alien species in connection with climate change and ongoing anthropogenic utilization of the system, point to the question of the carrying capacity of the Wadden Sea ecosystem. This is probably an issue that can only be solved by conducting integrated ecosystem studies.

It is clear, of course, that the Wadden Sea is not a closed system. Thus, it is of great importance to take into account exchange with the adjacent ecosystems: While there are presently various (natural, cultural and socio-economic) research projects that take into account the adjacent mainland (as for instance shown in the Integrated Coastal Management project), there still seems to be a large gap regarding the adjacent offshore zone and particularly the sublittoral area which must be regarded as a black box. More attention should be paid to processes linking the Wadden Sea with the adjacent offshore zone and sublittoral area.

In this connection remote sensing and the use of automatic measurement devices (such as in the project **COSYNA** – see GKSS above) can provide up-to-date information that can be linked with data from the Wadden Sea.

Finally, it is of major importance to compare findings from the Wadden Sea coasts with other shallow coastal areas around the globe (which is for instance carried out by the Alfred-Wegener Institute). The comparison with other marine systems will be a powerful tool to understand parallels and analogies in the development of the Wadden Sea.

In general, there is a need for closer multilateral cooperation and a global research network (as is for instance needed to understand the status of migrating birds that link the Wadden Sea with their wintering and breeding grounds). Also within the International Wadden Sea itself, comparing studies should be aimed for, in order to take into account the connectivity between different sites and characteristic differences among different Wadden Sea habitat types in a geographical gradient. The set up of EU projects might facilitate such research projects. Particularly the CWSS could play a crucial role to support and coordinate such projects. The multilateral exchange of knowledge, methods, data and monitoring schemes should be considered of high importance in order to facilitate future research projects.

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## Ambitie

De Waddenacademie heeft de ambitie het waddengebied te (laten) ontwikkelen tot een kraamkamer voor breed toepasbare, integrale kennis over duurzame ontwikkeling van een kustgebied, waar natuurwaarden centraal staan en een dragend onderdeel vormen van de lokale en regionale economie. Het gebied ontwikkelt zich tot een ontmoetingsplaats voor wetenschappers uit binnen- en buitenland, bestuurders, beleidsmakers en beheerders. Samen zoeken zij op basis van interdisciplinaire kennis duurzame en innovatieve oplossingen. In 2020 vormt het trilaterale waddengebied het best gemonitorde en best begrepen kuststelsel in de wereld.

