SYMBIOSE

Ecologically relevant data for marine strategies

Technical Report from DCE – Danish Centre for Environment and Energy No. 62 2015

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Christian Mohn[1]
Cordula Göke[1]
Karen Timmermann[1]
Jesper H. Andersen (project leader)[1,2]
Karsten Dahl[1]
Rune Dietz[1]
Lars I. Iversen[1]
Lonnie Mikkelsen[1]
Ib Krag Petersen[1]
Jonas Koefoed Rømer[1]
Thomas Kirk Sørensen[3]
Peter Stæhr[1]
Signe Sveegaard[1]
Jonas Teilmann[1]
Jakob Tougaard[1]

[1] Aarhus University, Department of Bioscience
[2] NIVA Denmark Water Research
[3] DTU Aqua

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Data sheet

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Authors:	Christian Mohn[1], Cordula Göke[1], Karen Timmermann[1], (Jesper H. Andersen (projektleder)[1,2], Karsten Dahl[1], Rune Dietz[1], Lars I. Iversen[1], Lonnie Mikkelsen[1], Ib Krag Petersen[1], Jonas Koefoed Sørensen[1], Thomas Kirk Sørensen[3], Peter Stæhr[1], Signe Sveegaard[1], Jonas Teilmann[1] & Jakob Tougaard[1]
Institutions:	[1]Aarhus Univeristy, Department of Bioscience, [2]NIVA Denmark Water Research, [3]DTU Aqua

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Abstract: The main objective of the SYMBIOSE project was to develop spatial distributions of anthropogenic pressures and ecosystem components for nationwide Danish marine waters including the eastern North Sea, Skagerrak, Kattegat and Belt Sea. In this report we present the resulting data including distributions of 78 spatially harmonized indicators (38 human activities and 40 ecosystem components including key species and habitats). Knowledge of the spatial distribution of these indicators is a prerequisite for identifying and mapping cumulative human pressures and impacts in Danish marine waters. This report provides a detailed overview of the spatial distribution of human activities and ecosystem components based on the available data (see annex). The methodology is based on the methodology adopted by the HARMONY project for the eastern North Sea, but applied nationwide in SYMBIOSE. The result is a catalogue of spatial maps and data sheets with a detailed description of data sources and methods for selected data layers. The maps developed provide a state-of-the-art data collection for a future mapping of cumulative pressures and impacts in Danish marine waters.

Keywords:	Human activities, marine ecosystem components, Marine Strategy Framework Directive, North Sea, Skagerrak, Kattegat, Belt Sea, western Baltic Sea
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Contents

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1 Preface

A number of European Directives provide the framework for European water policy setting the objectives for present and future water protection and sustainable use of water resources including the Water Framework Directive (WFD), the Marine Strategy Framework Directive (MSFD) and the Directive for Maritime Spatial Planning. The Marine Strategy Framework Directive (MSFD) sets the target of Good Environmental Status (GEnS) for EU marine waters which must be achieved by 2020 (EC 2008, **www.msfd.eu**). The MSFD constitutes a list of 11 environmental descriptors including biodiversity, non-indigenous species, commercial species populations, food-web structure, eutrophication, sea-floor integrity, alterations to hydrography, contaminants, sea-food contaminants, marine litter and underwater noise. MSFD related activities incorporate a detailed assessment of the state of the marine environment, the identification of human pressures and their effect on the marine environment, the definition of clear environmental targets and necessary monitoring programmes.

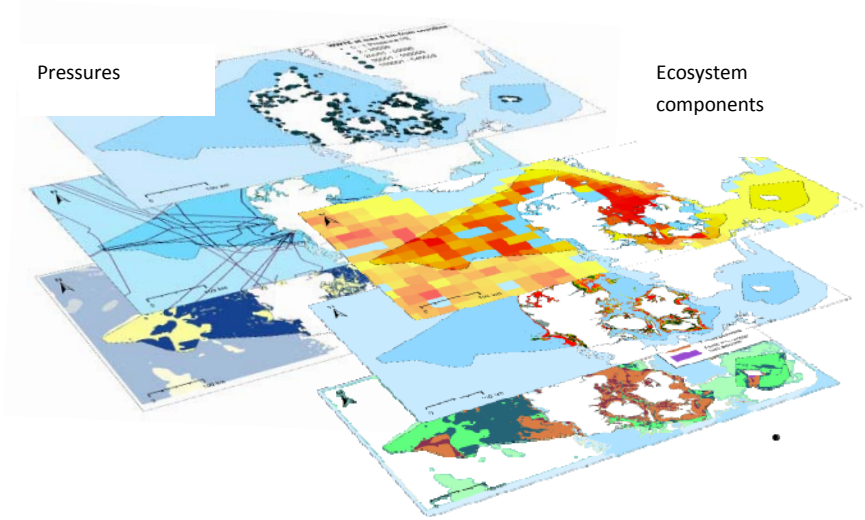
As part of the implementation of the MSFD, Denmark and other EU Member States are currently in the process of developing cost-effective marine strategies and actions to achieve GEnS on a regional and transnational level. These actions will also include the assessment of cumulative pressures and impacts created by multiple human activities. Two different international initiatives have recently been carried out to evaluate cumulative pressures, impacts and state of the marine ecosystem in which parts of the Danish national waters were included. The HARMONY project provided an initial assessment and management tools for the Greater North Sea sub-region including the Danish national waters of the eastern North Sea, Skagerrak and Kattegat (Andersen et al. 2013). Further, HELCOM presented a background document on the method, data and preliminary assessment of the Baltic Sea pressure and impact indices (HELCOM 2010a) including the Kattegat, Danish Straits and Belt Sea. However, a nationwide assessment covering the entire Danish marine waters was not available to date.

The result of the SYMBIOSE project is the development of nationwide spatial distributions of anthropogenic pressures and ecosystem components with the aim to create a comprehensive data catalogue to support cumulative impact assessments and ultimately the implementation of the Marine Strategy Framework Directive in Denmark.

SYMBIOSE is the first attempt to harmonize information from HELCOM, HARMONY and other data sources and to provide spatial maps of the nationwide distribution of MSFD relevant human activities and ecosystem components. As a result, the SYMBIOSE project has produced a large variety of harmonized data layers including information about nutrient loadings, fishing, underwater noise, the distribution of plastic particles (marine waste), as well as the distribution of eelgrass, marine mammals, seabirds and the location of stone reefs. The data layers are based on monitoring data in combination with advanced interpolation tools and spatial models. This report provides a detailed description of all data layers in the appendix including spatial maps, data sources and methods.

2 Summary

The main objective of the SYMBIOSE project was to develop spatial distributions of anthropogenic pressures and ecosystem components for nationwide Danish marine waters including the eastern North Sea, Skagerrak, Kattegat and Belt Sea. In this report we present the resulting data including distributions of 78 spatially harmonized indicators (38 human activities and 40 ecosystem components including key species and habitats). Knowledge of the spatial distribution of these indicators is a prerequisite for identifying and mapping cumulative human pressures and impacts in Danish marine waters. This report provides a detailed overview of the spatial distribution of human activities and ecosystem components based on the available data (see annex). The methodology is based on the methodology adopted by the HARMONY project for the eastern North Sea, but applied nationwide in SYMBIOSE. The result is a catalogue of spatial maps and data sheets with a detailed description of data sources and methods for selected data layers. The maps developed provide a state-of-the-art data collection for a future mapping of cumulative pressures and impacts in Danish marine waters.



3 Methods

A key task of the SYMBIOSE project was to compile a comprehensive nationwide data catalogue intended as the basis for future assessments of cumulative pressures and impacts of human use of sea space in the Danish marine environment. The selection of data comprises biological ecosystem components, human activities and associated pressures. It made use of existing data inventories of the HARMONY project (Andersen et al. 2013) and new data. The data from HARMONY cover only parts of Danish waters and coastal areas. Thus, the major focus of the SYMBIOSE activities was to spatially harmonize and integrate data from all available sources and to create one data layer for each parameter covering the full study area. In the case of missing new data, HARMONY data were used exclusively. The study area includes the eastern North Sea, Skagerrak, Kattegat, the Danish Straits, the Belt Sea and the western Baltic Sea surrounding the island of Bornholm (Figure 1).

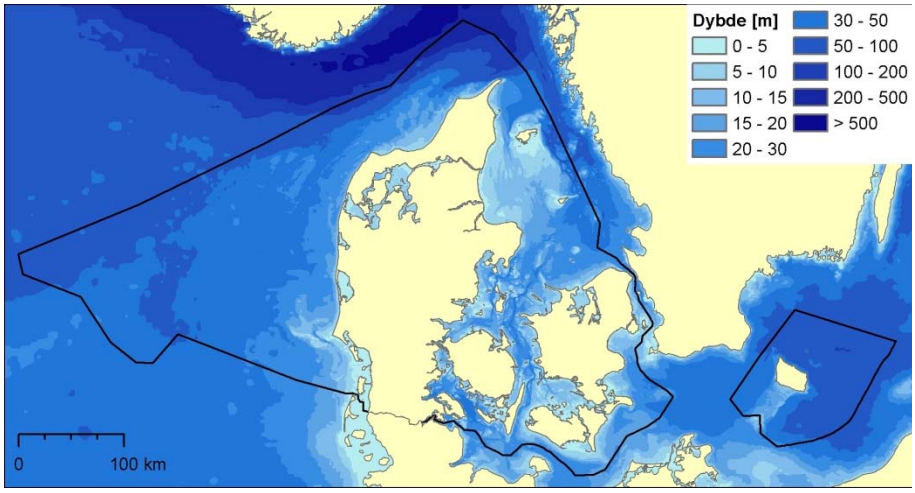


Figure 1. SYMBIOSE study area. The black line indicates the delineation of the Danish Exclusive Economic Zone (EEZ).

The adopted approach in SYMBIOSE largely followed the methodological framework prescribed in HARMONY and HELCOM HOLAS. Representative ecosystem components and anthropogenic stressors in the study area were chosen from previous HARMONY assessments. These assessments included both primary stressors by human activities (e.g. fisheries) and secondary stressors exerting pressures to the marine environment as defined in the MSFD (EC 2008 Annex III, Table 2). Following Andersen et al. (2013) the spatial distribution of the ecosystem components and anthropogenic stressors were mapped on the same regular grid. Ecosystem components were mapped as presence-absence. The intensity of anthropogenic stressors is log[x+1]-transformed and normalized to the range [0,1] from low to high intensity. The log-transformation was used to reduce the statistical bias of extreme values and outliers on the cumulative human impact mapping. Table 1 provides an overview of all ecosystem components and human stressors developed in SYMBIOSE.

SYMBIOSE added data on fish biomass and fisheries at a higher spatial resolution varying from 3 to 30 km compared to the resolution of ICES statistical rectangles (approximately 56 km). SYMBIOSE introduced a climate change pressure layer expressed as monthly sea surface temperature (SST) and salinity (SSS) anomalies relative to the corresponding long-term SST and SSS averages of a 19 year reference period (1990-2008) at a horizontal resolution of 0.05 ° in longitude and latitude.

Maps of spatial distribution of seabirds are based on modelled densities based on 2008 observations and modelled probability of presence based on 1995 – 2004 observations, respectively. Maps of spatial distribution of marine mammals were created from modelled densities based on satellite tracking (1997 – 2012) and modelled probability based on visual survey data (SCANS in 1995 and SCANS II in 2004).

Table 1. List of human stressors and ecosystem components developed in SYMBIOSE and presented in the Appendix. Data layers are log-transformed where applicable (n = no log transformation, y = log transformation, p/a = presence-absence, *inhomogeneous data source). Species names are provided in both in Danish and English (italic type).

Human activities / stressors - General	
Name	**Method**
Bridges and coastal dams	n
Climate anomalies	y
Coastal population density	y
Coastal waste water treatment plants	y
Disposal sites for dredged material	p/a
Dumped munitions	p/a
Heavy metal inputs from the atmosphere	y
Industrial ports	y
Marine aquaculture sites (fish and shellfish)	p/a
Microplastic in sediment	n
Military areas	p/a
Noise (bang days with harbours - impulsive sound)	y
Noise (ship continuous sound - 63 Hz)	y
Noise (ship continuous sound - 125 Hz)	y
Nutrient enrichment (atmospheric deposition)	y
Offshore oil and gas installations	p/a
Offshore wind turbines	p/a
Oil and gas pipelines	p/a
Oil spills	n
Recreational shipping	n
Riverine input of heavy metals	y
Riverine input of radionuclides	y
Riverine input of synthetic pollutants	y
Sea cables	p/a
Sediment extraction sites	p/a
Shipping intensity (commercial shipping)	y

Human activities / stressors – Fisheries	
Name	**Method**
Beam trawls, mesh size < 32 mm	y
Beam trawls, mesh size ≥ 100 mm	y
Demersal fishing, mesh size < 16 mm	y
Demersal fishing, mesh size 16 - 32 mm	y
Demersal fishing, mesh size 32 - 69 mm	y
Demersal fishing, mesh size 70 - 99 mm	y
Demersal fishing, mesh size ≥ 100 mm	y
Longlines	y
Mussel dredging	y
Pelagic fisheries Pelagic fisheries, mesh size 16 - 32 mm	y
Pelagic fishing, mesh size 33 - 80 mm	y
Setnet, all mesh sizes	y

Ecosystem components – General	
Name	**Method**
Benthic habitats (aphotic mud, aphotic rock or other, aphotic sand and coarse or mixed sediments, photic mud, photic rock or other, photic sand and coarse or mixed sediments)	n
Boulder reefs	p/a
Eelgrass distribution	n
N/P ratio winter	y
Plankton communities in nutrient-rich and nutrient-poor waters	n

Ecosystem components - Fish and shellfish (biomass distribution)	
Name	**Method**
Cod (Gadus morhua, *Torsk*)	y
Coalfish (Pollachius virens, *Sej*)	y
Common Hooknose (Agonus cataphractus, *Almindelig Panserulj*) / Monkfish (Lophius piscatorius, *Havtaske*)	y
Common Sole (Solea solea, *Almindelig Tunge*)	y
Dab (Limanda limanda, *Ising*)	y
Common Dogfish (Scyliorhinus caniculus, *Småplettet Rødhaj*)	y
Spiny Dogfish (Squalus acanthias, *Pighaj*)	y
Flounder (Platichthys flesus, *Skrubbe*)	y
Haddock (Melanogrammus aeglefinus, *Kuller*)	y
Herring (Clupea harengus, *Sild*)	y
Lumpfish (Cyclopterus lumpus, *Stenbider*)	y
Mackerel (Scomber scombrus, *Makrel*)	y
Northern Prawn (Pandalus borealis, *Dybhavsejer*)	y
Norway Lobster (Nephrops norvegicus, *Norway Jomfruhummer*)	y
Plaice (Pleuronectes platessa, *Rødspætte*)	y
Shrimp (Crangon crangon, *Hesterejer*)	y
Sperling (Trisopterus esmarkii, *Sperling*)	y
Sprat (Sprattus sprattus, *Brisling*)	y
Starry Ray (Raja radiata, Tærbe)	y
Turbot (Psetta maxima, *Pighvarre*)	y
Whiting (Merlangius merlangus, *Hvilling*)	y

Ecosystem components – Birds	
Name	**Method**
Auks (*Alkefugl*): Guillemot (Uria aalge, *Lomvie*), Razorbill (Alca torda, *Alk*)	y*
Common Scoter (Melanitta nigra, *Sortand*)	y*
Divers (*Lommer*): Red-throated Diver (Gavia stellata, *Rødstrubet Lom*), Black-throated Diver (Gavia arctica, *Sortstrubet Lom*)	y*
Eider (Somateria mollissima, *Ederfugl*)	y*
Fulmar (Fulmarus glacialis, *Mallemuk*)	y
Gannet (Morus bassanus, *Sule*)	y
Kittiwake (Rissa tridactyla, *Ride*)	y
Long-tailed Duck (Clangula hyemalis, *Havlit*)	y*
Red-breasted Merganser (Mergus serrator, *Toppet Skallesluger*)	y*

Ecosystem components - Marine mammals	
Name	**Method**
Grey Seal (Halichoerus grypus, *Gråsæl*)	y
Harbour Seal (Phoca vitulina, *Spættet Sæl*)	y
Harbour Porpoise (Phocoena phocoena, *Marsvin*)	y
Minke Whale (Balaenoptera acutorostrata, *Vågehval*)	y
White-beaked Dolphin (Lagenorhynchus albirostris, *Hvidnæsen*)	y

4 Results and discussion

In SYMBIOSE, data representing a total of 40 environmental components and 38 human activities and stressors were collected and produced for all Danish marine waters, for the most part based on data and methodologies developed by HARMONY and HELCOM HOLAS (HELCOM 2010b, Andersen et al. 2013).

The aim of the MSFD is to achieve good environmental status (GEnS) of EU marine waters by 2020. 11 qualitative descriptors have been defined as a guideline for EU Member States to assess and monitor the state of the environment in MSFD regions and sub-regions. The SYMBIOSE data catalogue is compiled in the context of these descriptors and associated environmental indicators, pressures and impacts as outlined by the MSFD Annex III (Table 1, 2).

4.1 Characteristics

4.1.1 Habitat types, physical and chemical features

- Predominant seabed and water column habitats, including physical and chemical characteristics and substrata seabed composition. SYMBIOSE data include the spatial distribution of major benthic habitats (appendix C1) and N / P ratio in surface waters (appendix C4).
- Special habitat types identified under community legislation and international conventions. SYMBIOSE data include the geographical locations and extent of boulder reefs in Danish coastal and marine waters (appendix C2).
- Seabed topography and bathymetry, spatial and temporal distributions of hydrography, nutrients, oxygen and pH. Most of these features were produced in SYMBIOSE as supplementary data layers, but are not included in this data catalogue.

4.1.2 Biological features

- Biological communities associated with predominant seabed and water column habitats including phytoplankton and zooplankton communities. SYMBIOSE data include the spatial distribution of eelgrass (appendix C3) and the spatial distribution of plankton communities in nutrient-rich and nutrient-poor waters (appendix C5).
- Fish, including structure of fish populations (abundance, distribution, age / size structure). SYMBIOSE data include biomass distribution of 21 commercial fish and shellfish species (appendix D1 – D21).
- Seabirds, including population dynamics, natural and actual species range and status. SYMBIOSE data include spatial distribution of modelled density or modelled probability of presence of 9 different seabird species (appendix E1 – E9).
- Mammals, including population dynamics, natural and actual species range and status. SYMBIOSE data include spatial distribution of modelled density or modelled probability of presence of 5 different marine mammal species (appendix F1 – F5).
- Other species protected by directives and conventions, including population dynamics, natural and actual species range and status. Not included in SYMBIOSE.

- Non-indigenous and genetically-modified species, including temporal occurrence, abundance and spatial distribution. Not included in SYMBIOSE.

4.2 Pressures and impacts

4.2.1 Physical damage

- Changes in siltation, e.g. caused by outfalls, increased run-off, dredging / disposal of dredge spoil. SYMBIOSE data include the locations of disposal sites for dredged material based on 2011 status (appendix A5).
- Resource extraction including the selective exploration and exploitation of living and non-living resources on seabed and subsoil). SYMBIOSE data include the locations of sediment extraction sites (appendix A24).
- Abrasion including impact on the seabed through commercial fishing, boating, anchoring. SYMBIOSE data include estimates of recreational shipping intensity (appendix A19) and the 2009 AIS based commercial shipping intensity (appendix A25). Estimates of shipping intensities are based on data for water depths less than 10 m and deeper than 10 m. SYMBIOSE data also include sites of commercial fishing activities for different gear types (appendix B1 – B12).

4.2.2 Physical disturbance

- Underwater noise introduced by shipping, underwater acoustic equipment, underwater construction. SYMBIOSE data include spatial distributions of ship noise estimates based on AIS data (appendix A13) and noise levels (bang days) from coastal and offshore construction activities (appendix A12). SYMBIOSE data also include the location of military areas (appendix A11) and the location of industrial ports and offshore energy constructions (appendix A8, A15, A16).
- Marine litter. SYMBIOSE data include the coastal population density (appendix A3), the distribution of microplastic in sediment (appendix A10) and the location of dumped munitions (appendix A6).
- Other disturbances including collisions, e.g. between whales and ships or birds and wind turbines, and the blocking effect of bridges on birds. Relevant SYMBIOSE data include commercial shipping intensity estimates (appendix A13), locations of offshore energy constructions (appendix A15, A16), and the location of bridges and dams (appendix A1).

4.2.3 Physical loss

- Sealing caused by permanent constructions. SYMBIOSE data include locations of man-made, permanent constructions (appendix A1, A15 - A17, A23).
- Smothering including disposal of dredge spoil. Relevant SYMBIOSE data include the location of disposal site for dredged material (appendix A5) and sediment extraction sites (A24).

4.2.4 Biological disturbance

- Introduction of microbial pathogens. Not included in SYMBIOSE.
- Introduction of non-indigenous species and translocations. Not included in SYMBIOSE.

- Selective extraction of species, including incidental non-target catches (e.g. by commercial and recreational fishing). SYMBIOSE data include sites of commercial fishing activities for different gear types (appendix B1 – B12).

4.2.5 Contamination by hazardous substances

- Synthetic compounds including pesticides, antifoulants, and pharmaceuticals. SYMBIOSE data include the distribution of riverine inputs of synthetic pollutants (appendix A22) and the location of coastal waste water treatment plants (A4).
- Non-synthetic compounds including heavy metals and hydrocarbons from riverine inputs, atmospheric deposition and pollution by ships and exploration and exploitation of marine resources. SYMBIOSE data include relative normalized heavy metal inputs from the atmosphere and rivers (appendix A7, A20) and detected oil spills (appendix A18).
- Radio-nuclides. SYMBIOSE data include the distribution of riverine inputs of radio-nuclides (appendix A21).

4.2.6 Nutrient and organic matter (OM) enrichment

- Input of nitrogen- and phosphorus-rich substances from point and diffuse sources. SYMBIOSE data include the nutrient enrichment from atmospheric deposition (appendix A14).
- Input of OM from sewers, riverine inputs and mariculture. SYMBIOSE data inlucde the location of marine aquaculture (fish, shellfish) sites (appendix A9) and the location of coastal waste water treatment plants (appendix A4).

4.2.7 Changes of hydrological processes

- Changes in the local temperature and salinity regime caused by permanent constructions. SYMBIOSE data include locations of permanent coastal and offshore constructions (appendix A1, A15 – A17).
- Long-term changes in the temperature and salinity regime caused by climate trends. SYMBIOSE data include distributions of sea-surface and bottom temperature and salinity anomalies (appendix A2).

4.2.8 Other disturbances

- Electromagnetic disturbances by magnetic fields and other electromagnetic radiation. SYMBIOSE data include the location of sea cables (appendix A23) and military areas (A11).

5 Conclusions and outlook

The development of ecosystem-specific multi-scale spatial models provided scientists, managers and conservationists with a powerful tool to analyse the human influence on the marine ecosystem in a spatially-explicit and quantitative way (Halpern et al. 2007, 2008). The methodology developed by Halpern et al. (2007, 2008) was recently used for a cumulative impact analysis in the eastern North Sea (HARMONY project, Andersen et al. 2013) and for developing and testing of Baltic Sea pressure and impact indices (HELCOM 2010a).

Both studies compiled a large data inventory on anthropogenic pressures and ecosystem indicators based on classifications according to the Marine Strategy Framework Directive Annex III (EU 2008). The main aim of SYMBIOSE was to collect a comparable catalogue of harmonized spatial data for Danish nationwide coastal and oceanic waters following the HARMONY approach. As a result, data on 40 marine ecosystem indicators and 38 anthropogenic pressures was compiled in SYMBIOSE.

The SYMBIOSE data catalogue allows for an improved assessment of MSFD descriptors and indicators in Danish nationwide coastal and open waters and provides a potentially useful foundation for a future cumulative impact analysis. Even though the data availability and quality is getting better, the data has to be understood and used with caution. In Halpern and Fujita (2013), the assumptions, challenges, and future directions when working with cumulative impact analysis are evaluated. Besides the general issues of resolution, type of responses, weighting etc., specific challenges and criteria have to be considered when using the SYMBIOSE data layers for a cumulative impact assessment:

- Ecological data layers representing different types of information: Current and / or recent state of the ecosystem based on collected ecological data, and ecological potential based on model results.
- Information is split up into a number of layers. Especially for the layers referred to as *human uses* it is possible that the information partly overlaps. For example, it was possible to obtain model results about noise from ships, but shipping is still kept as a surrogate for other impacts caused by shipping.
- Timeliness of data. Reliable cumulative impact assessment is based on an accurate and up-to-date representation of the state of human use and the marine environment. This requires a strategy for a regular review and update of the underlying data and an extension of data where applicable. The review and updating frequency may vary for individual uses and ecosystem components, but should reflect current conditions.

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7 Appendix

The appendix includes:

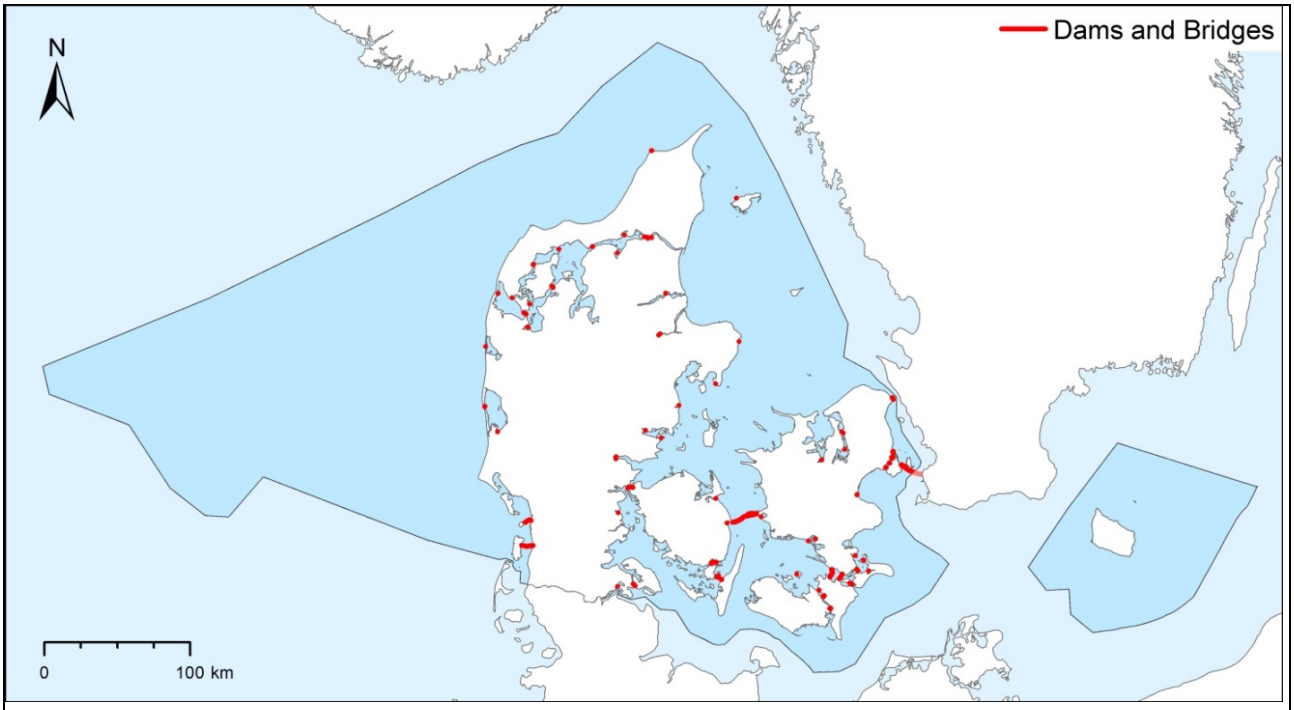
- Catalogue of human activities / stressors (general) including description of data sources and methodology – Appendix A
- Catalogue of human activities / stressors (fisheries) including description of data sources and methodology – Appendix B
- Catalogue of ecosystem components (general) including description of data sources and methodology – Appendix C
- Catalogue of ecosystem components (fish and shellfish) – Appendix D
- Catalogue of ecosystem components (birds) including description of data sources and methodology – Appendix E
- Catalogue of ecosystem components (marine mammals) including description of data sources and methodology – Appendix F.

For the maps illustrating the data layers, often the original data is shown. The original data is often easier to visualize, e.g. if point data with intensities is shown instead of colors on single grid cells. Additionally, the original data still shows the units in which the information is provided and provide maps as single layers.

Appendix A – Human activities/stressors (general)

- A1 - Bridges and coastal dams
- A2 - Climate anomalies
- A3 - Coastal population density
- A4 - Coastal waste water treatment plants
- A5 - Disposal sites for dredged material
- A6 - Dumped munitions
- A7 - Heavy metal inputs from the atmosphere
- A8 - Industrial ports
- A9 - Marine aquaculture sites (fish and shellfish)
- A10 - Microplastic in sediment
- A11 - Military areas
- A12 - Noise (bang days with harbours – impulsive sound)
- A13 - Noise (ship continuous sound 63 Hz)
- A14 - Noise (ship continuous sound 125 Hz)
- A15 - Nutrient enrichment (atmospheric deposition)
- A16 - Offshore oil and gas installations
- A17 - Offshore wind turbines
- A18 - Oil and gas pipelines
- A19 - Oil spills
- A20 - Recreational shipping
- A21 - Riverine input of heavy metals
- A22 - Riverine input of radionuclides
- A23 - Riverine input of synthetic pollutants
- A24 - Sea cables
- A25 - Sediment extraction sites
- A26 - Shipping intensity (commercial shipping)

A1 - Bridges and coastal dams



Map showing major bridges and coastal dams.

Data sources and methods

Data were obtained from the Danish topographic map 1:10000 (2008), supplemented by digitisation of Google maps. Traffic data layer overlapping with the sea was extracted from the Danish topographic map 1:10000. Roads < 3m are not included. Dams were digitised manually. Bridges were assigned a weight factor of 0.5 and coastal dams were assigned a weight factor of 1.0. Length is per grid cell. By applying this method, motorways recieve a higher weight than smaller roads, because they contain 1 line per direction.

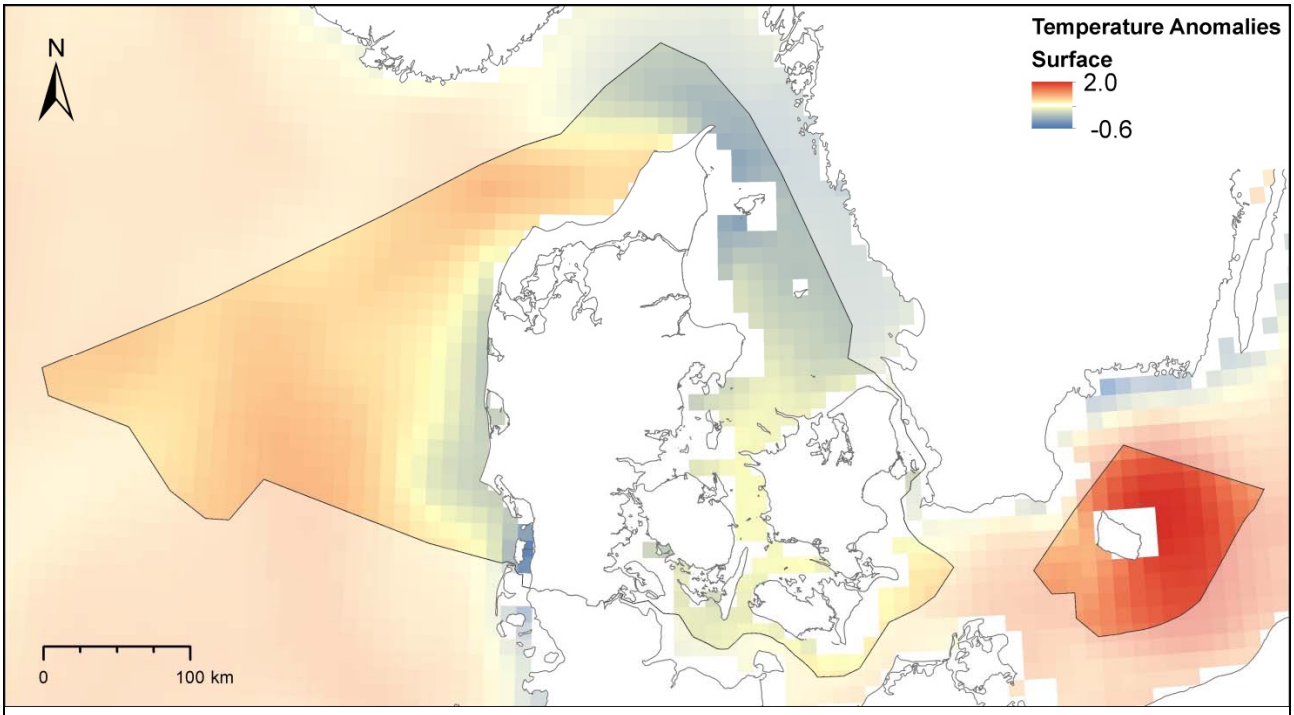
Spatial coverage

Danish waters

References

Scale or resolution	1:10000 ArcGis output raster: 1 * 1 km
Time period	2008.
Data access	Original: Danish Geodata Agency (Geodatastyrelsen)
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Bridges, dams

A2 - Climate anomalies



Map showing the sea surface temperature (SST) anomaly (°C, 2009-2010 average). SST anomalies were calculated from model hindcasts relative to the 1900-1996 long-term mean SST. In addition, anomalies for the same period were calculated for bottom temperature, seas surface salinity and bottom salinity (not shown, but available).

Data sources and methods

Sea surface and sea bottom anomalies of temperature (T) and salinity (S) were calculated from 2009 and 2010 T/S data. The T/S data were extracted from the output of the 3D ocean circulation model HIROMB-BOOS (HBM). The model domain covers the North Sea and Baltic Sea with a 6 nm horizontal resolution. The vertical grid has 50 layers with an average resolution of 2 m in the top 50 m of the water column. The model output is thoroughly validated against observation from North Sea and Baltic Sea monitoring stations (Maar et al., 2011). Surface and bottom T/S anomalies were calculated relative to the 1900-1996 T/S climatology by Janssen et al. (1999). The T/S climatology is on a 10 km x 10 km grid was interpolated to match the 6 nm resolution of model grid prior to calculation of the anomalies. The interpolation resulted in occasionally too high anomaly values at a few coastal and bottom locations due to the minor mismatch of the different coastline and bathymetry.

Spatial coverage

Original data are available for the entire Baltic (including Skagerrak, Kattegat and Belt Sea) and North Sea region. The spatial resolution of the original data is 6 nautical miles HBM model) and 10 km (T/S climatology) respectively.

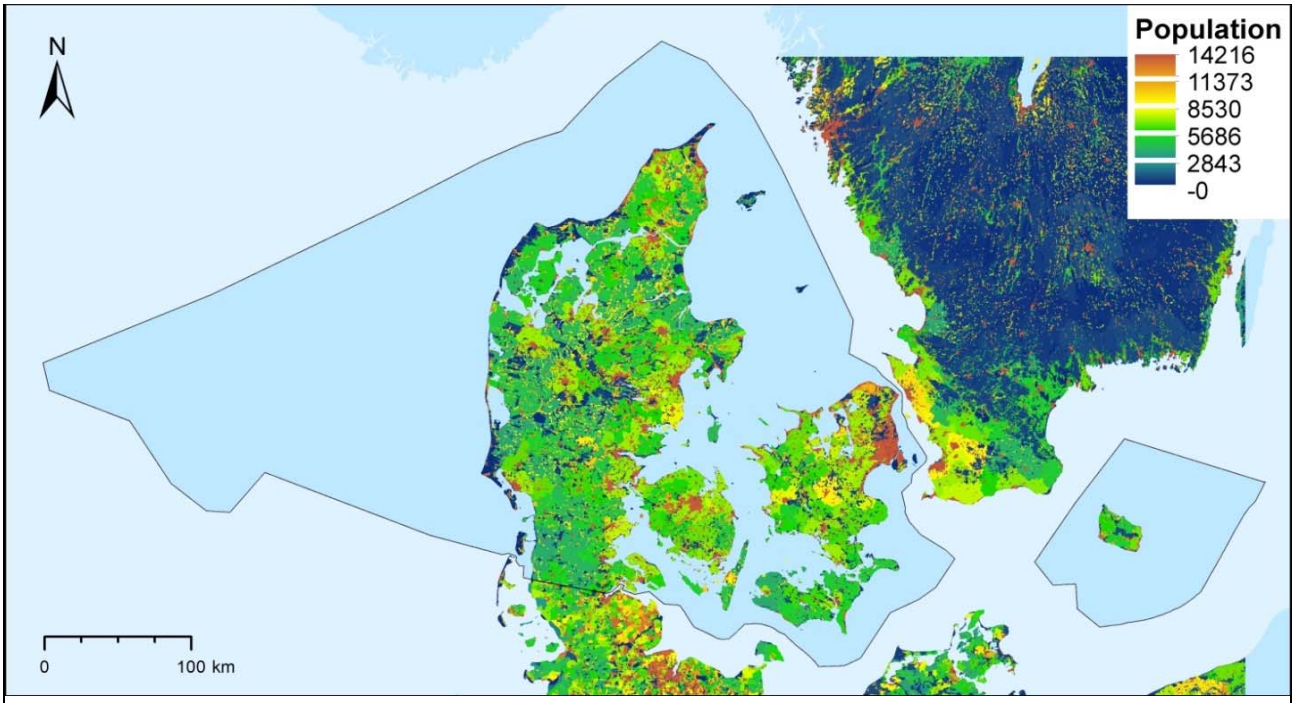
References

Janssen F, Schrum C., Backhaus J. (1999) A climatological data set of temperature and salinity for the Baltic Sea and the North Sea. Deutsche Hydrographische Zeitschrift, 51 (9 supplement), 5 -245.

Maar M, Møller EF, Larsen J, Madsen KS, Wan Z, She J, Jonasson L, Neumann T. (2011). Ecosystem modelling across a salinity gradient from the North Sea to the Baltic Sea. Ecological Modelling, 222 (10), 1696-1711.

Scale or resolution	ArcGis output raster: 1 x 1 km and smoothing factor: 20 km.
Time period	2009 – 2010 (2 year average)
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Christian Mohn
E-mail	chmo@bios.au.dk
Key words	Temperature and salinity anomalies, HBM model

A3 - Coastal Population density



Map showing population density on land (inhabitants/km2) in coastal areas, and the number of people living within 25 km from the coastline.

Data sources and methods

Population density disaggregated with Corine land cover 2000 v5, European Environment Agency (EEA). Based on the population density (Eurostat 2001) disaggregated with Corine land cover 2000 v5, the number of people living within a 25km radius was summarized for each cell touching the coastline. For all other cells (not touching the coastline), the value was set to zero.

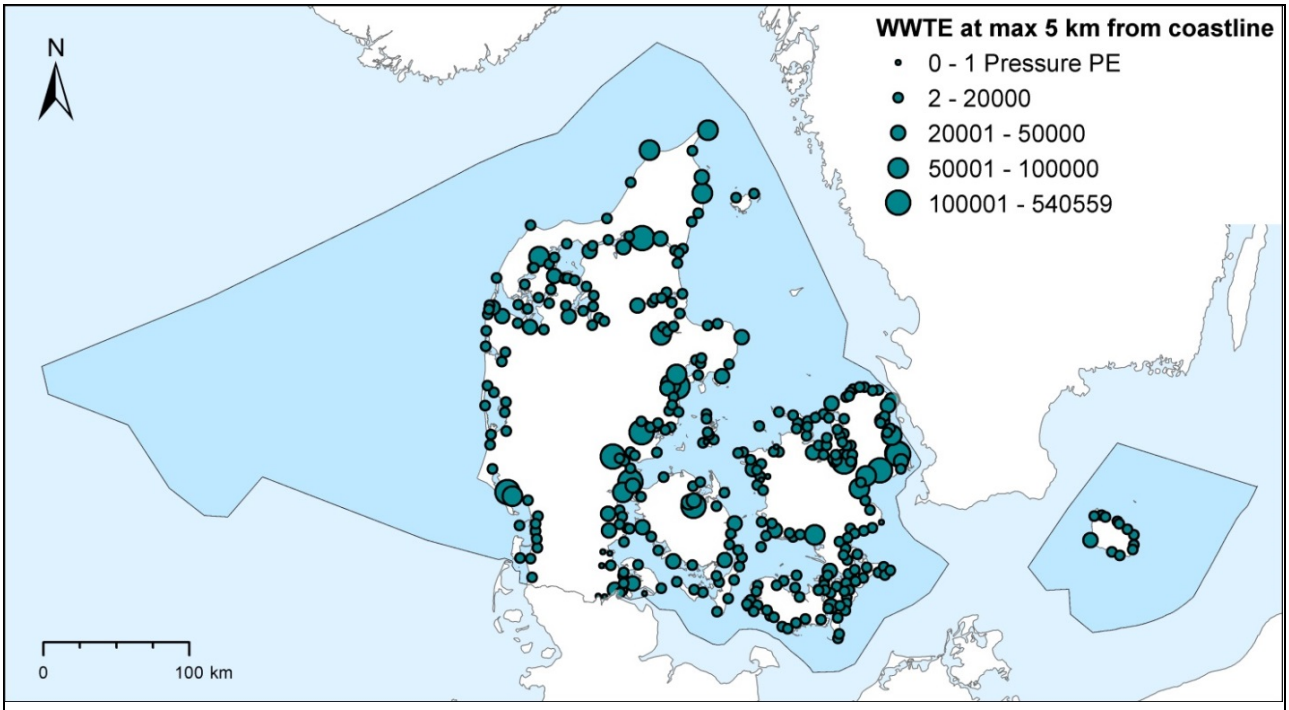
Spatial coverage

Original data are available for Denmark and neighbouring countries (original EU 27), SYMBIOSE output: Danish EEZ.

References

Scale or resolution	1km (original data: 100m)
Time period	2001
Data access	Original data: http://www.eea.europa.eu/data-and-maps/data/population-density-disaggregated-with-corine-land-cover-2000-2#tab-gis-data
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Population density

A4 - Coastal waste water treatment plants



Map showing discharge points and their pressure (UWWTP - Urban Waste Water Treatment Directive) within 25 km from the coastline.

Data sources

Locations provided by the Danish Nature Agency (Naturstyrelsen).

Spatial coverage:

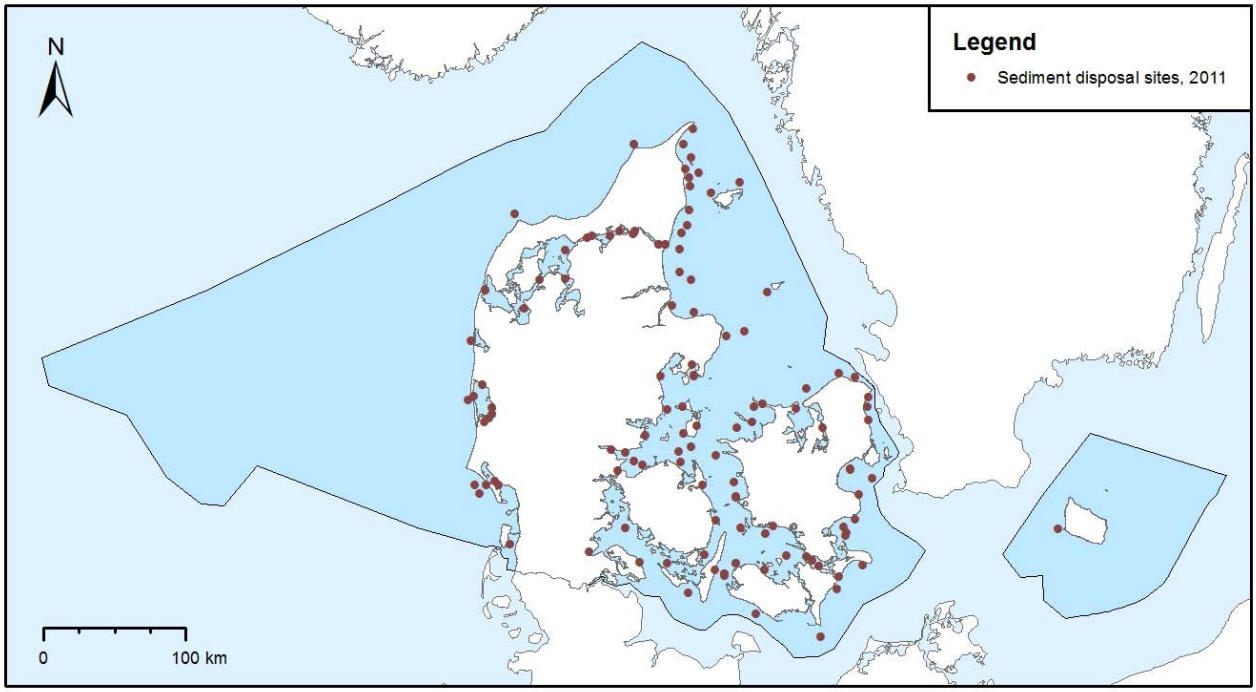
Denmark and neighbouring countries (original EU 27)

Lineage and data quality

Only discharge locations within 5 km of the sea where included in the compiled data set. The data contains pressure in PE (Population Equivalent). Therefore, in order to calculate the impact index, two dataset variants were produced. For the first, following the methodology from HARMONY, each waste water treatment plant was assigned to the closest cell of the mapping grid. The values of cells with an assigned plant were set to 1, and those of all others to 0. In the second dataset the pressure was summed from all discharge points for which the cell is the closest one and afterwards normalized to values between 0 and 1.

References	
Scale or resolution	10 m
Time period	2009
Data access	Original data: Danish Nature Agency (Naturstyrelsen)
Additional information sources	None
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Waste water treatment plants

A5 - Disposal sites for dredged material (sediment disposal sites)



Map showing locations of authorised landfill / sediment disposal sites.

Data sources and methods

The data set of sediment diposal sites consists of locations within the Danish exclusive economic zone (EEZ), with authorized landfill / disposal of sediment. The locations are point data and are represented as presence (1) / non-presence (0) of sediment desposal for each grid cell of the SYMBIOSE grid. The Danish Nature Agency (Naturstyrelsen) administers the licenses for sediment disposal, and data quality is expected to be high.

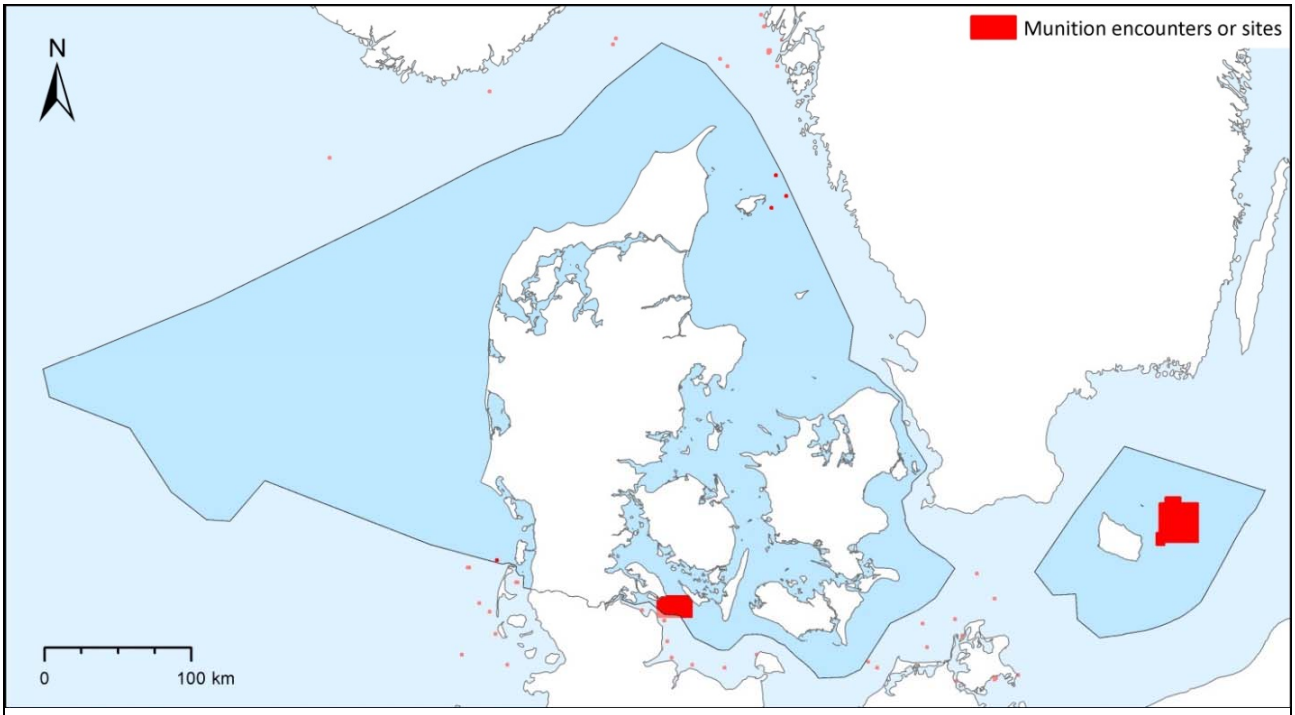
Spatial coverage

Danish exclusive econimic zon (EEZ), primarily coastal.

References

Scale or resolution	Point data. Unknown scale, but it is assumed that positions are accurate.
Time period	2011.
Data access	Information on current permits for sediment disposal available via the Danish Nature Agency (Naturstyrelsen).
Responsible institution	DCE, AU.
Contact person	Jonas Koefoed Rømer.
E-mail	jkr@bios.au.dk
Key words	Sediment, disposal, human activities.

A6 - Dumped munitions



Map showing locations for official dumping sites and encounters outside the official sites.

Data sources and methods

HELCOM, German Reports, OSPAR. Information from German reports was converted to spatial data (points and areas). The used data from the other sources is a mixture of points and polygons. Occurrence of a site or encounter in a grid cell was set to 1.

Spatial coverage

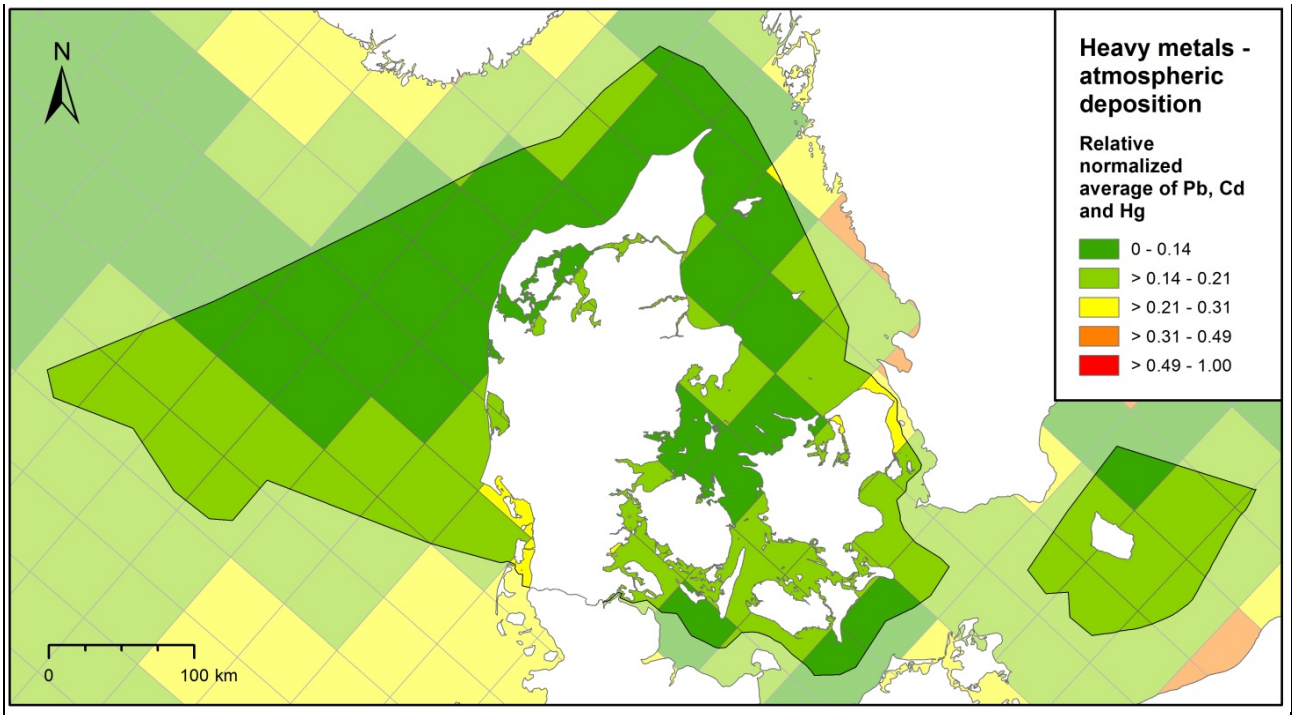
Denmark and neighbouring countries.

References

- HELCOM: datalayer from Web GIS was used, additional information at: http://www.helcom.fi/environment2/hazsubs/en_GB/chemu/
- OSPAR: http://www.ospar.org/html_documents/ospar/html/data/OSPAR_Munitions_Dumpsites.zip, http://www.ospar.org/html_documents/ospar/html/data/OSPAR_Munitions_Encounters-2011.zip
- Germany: http://www.schleswig-holstein.de/UXO/DE/Bericht/Bericht_node.html

Scale or resolution	Unknown
Time period	Germany 2011, OSPAR: 1999/04/13 – 2011/12/31, HELCOM: 2009/11
Data access	Yes, for original data see references
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Dumped munitions

A7 - Heavy metal inputs from the atmosphere



Map showing normalized heavy metal inputs from the atmosphere.

Data sources and methods

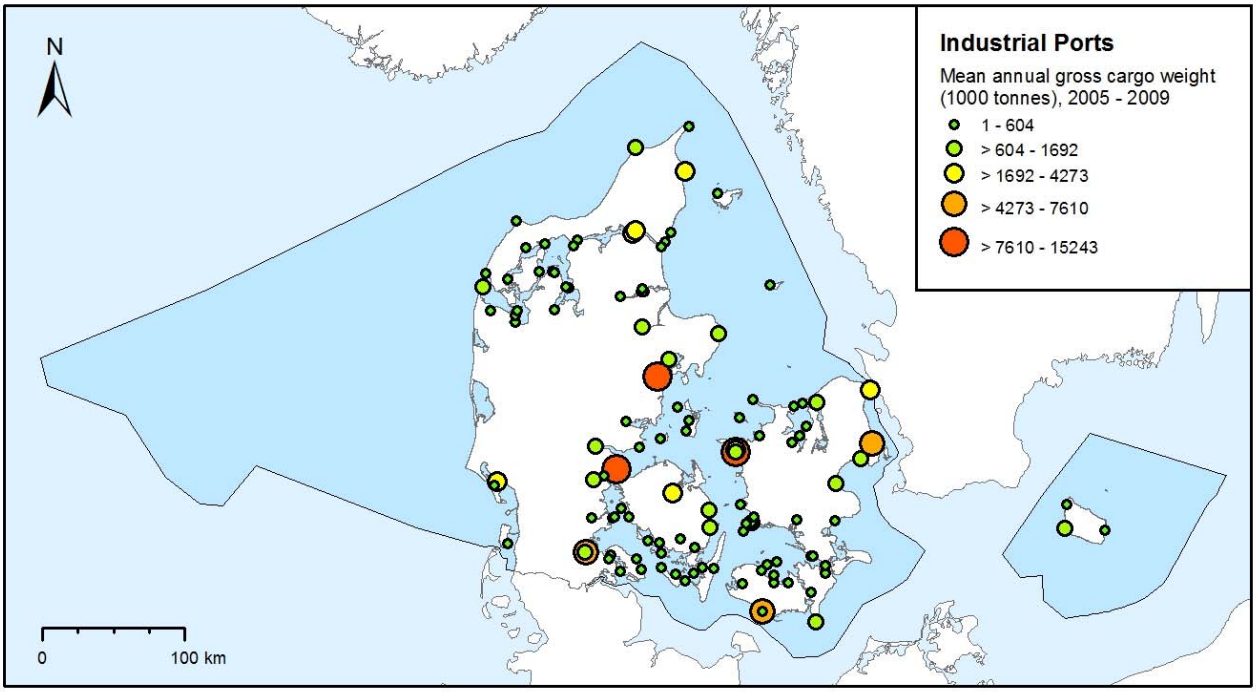
Spatial coverage

Denmark and neighbouring countries.

References

Scale or resolution	
Time period	
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Heavy metal inputs from atmosphere

A8 - Industrial ports



Map showing the average cargo throughput (in 1000 tons) in Danish industrial ports for the years 2005 – 2009.

Data sources and methods

The data set of industrial ports consists of locations of Danish industrial ports; ports where goods are received and shipped. The locations are point data and are represented in the analysis as relative size of the annual average total cargo throughput. For example, Fredericia industrial port, which has the largest annual cargo turnover, is assigned the value 1.0 in the cell in SYMBIOSE grid corresponding to the location of Fredericia industrial port.The cells, which correspond to the locations of other Danish industrial ports were assigned relative values in the range [0.0 .. 1.0], calculated as their cargo turnover compared to Fredericia industrial harbor.Cargo turnover per industrial port is taken from the European statistics database. The used data set is *mar_go_aa* available via *"Database by themes - Transport - Maritime transport - Maritime transport - goods"*. This data does not include geographical positions of the ports, but their unique REP_MAR code.A point dataset containing the locations of all Danish industrial ports as well as their unique REP_MAR code was used from the HARMONY project. The cargo turnover can be linked to each location via its REP_MAR code.

Spatial coverage

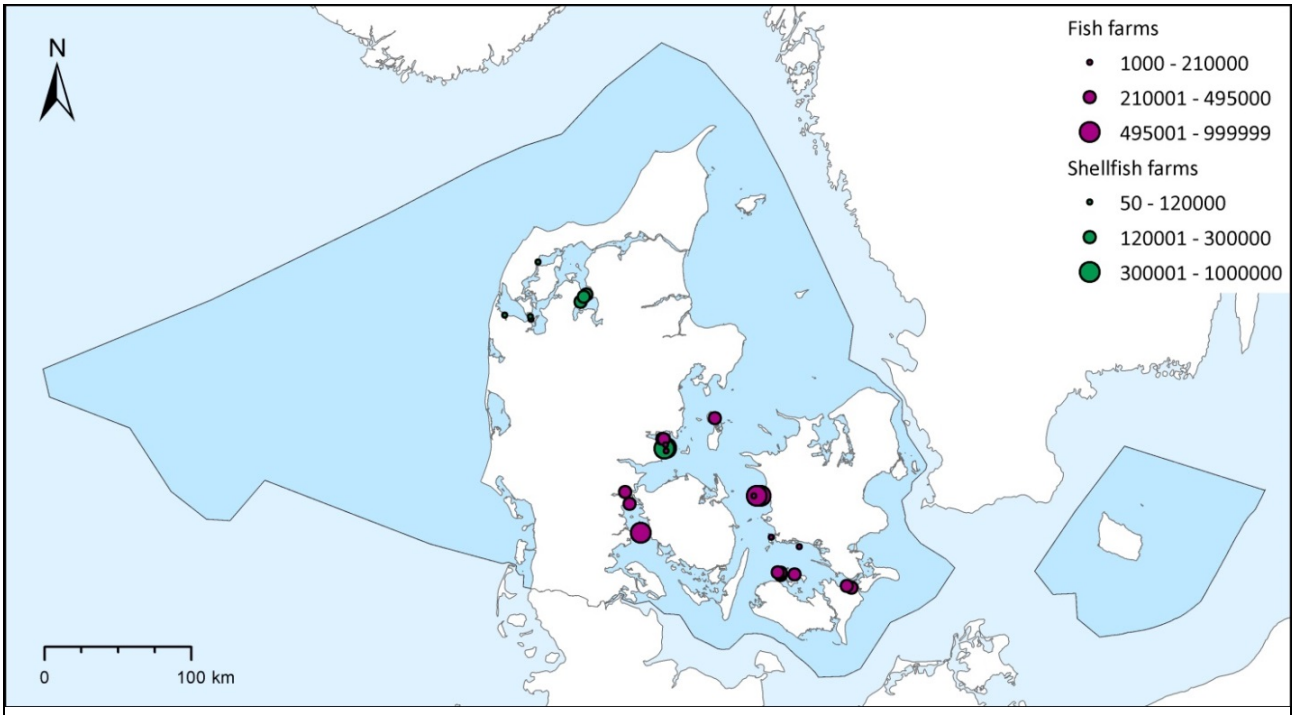
Danish exclusive economic zone (EEZ), coastal areas. It was necessary to adjust the industrial port locations relative to the SYMBIOSE grid. ArcGIS 10.2 was used to move ports from their exact location, which in most cases fell into cells defined as dry land, to the nearest cell defined as the sea (ports found on the border between land and sea).

References

Eurostat: http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Scale or resolution	Point data. Unknown scale, but it is assumed that positions are accurate.
Time period	Average for years 2005 – 2009.
Data access	Data on cargo turnover is freely accessible via Eurostat and point data of industrial ports are accessible via AU, DCE.
Responsible institution	DCE, AU.
Contact person	Jonas Koefoed Rømer.
E-mail	jkr@bios.au.dk
Key words	Ports, industry, human activities, transport.

A9 - Marine aquaculture sites (fish, shellfish)



Map showing shellfish and fish production in farms in 2013.

Data sources and methods

Separate data layers for fish farms and shellfishfarms were produced. For Symbiose, the data was converted into presence-absence values within the 1 km^2 grid cells.

Spatial coverage

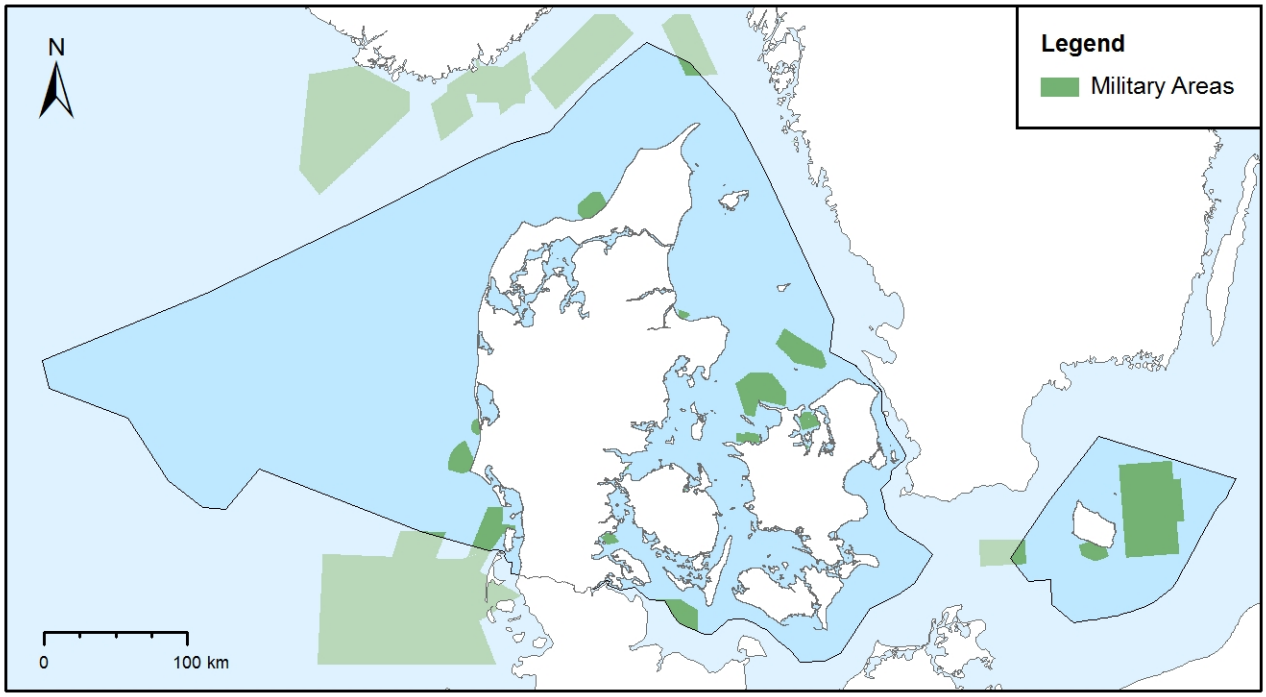
Denmark

References

Danish Veterinary and Food Administration (Fødevarestyrelsen), online database https://chr.fvst.dk/chri/faces/frontpage?_adf.ctrl-state=n7s27hy4k_3

Scale or resolution	Unknown
Time period	Download at 2013/09/02
Data access	Yes, for original data see references
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**coq@bios.au.dk**
Key words	Fish farm, shellfish farm

A10 - Military areas



Map showing military training areas with periodic military activities.

Data sources and methods

The data set of military areas (polygon data) was available from the HARMONY project, where the Danish nature Agency (Naturstyrelsen) supplied the digitized data from nautical charts. In the analysis, weight factors for presence (1) / non-presence (0) of the military activity were used for each cell in the SYMBIOSE grid. If a cell falls within a military area (the center of the cell) it is assigned a value of 1, otherwise 0.

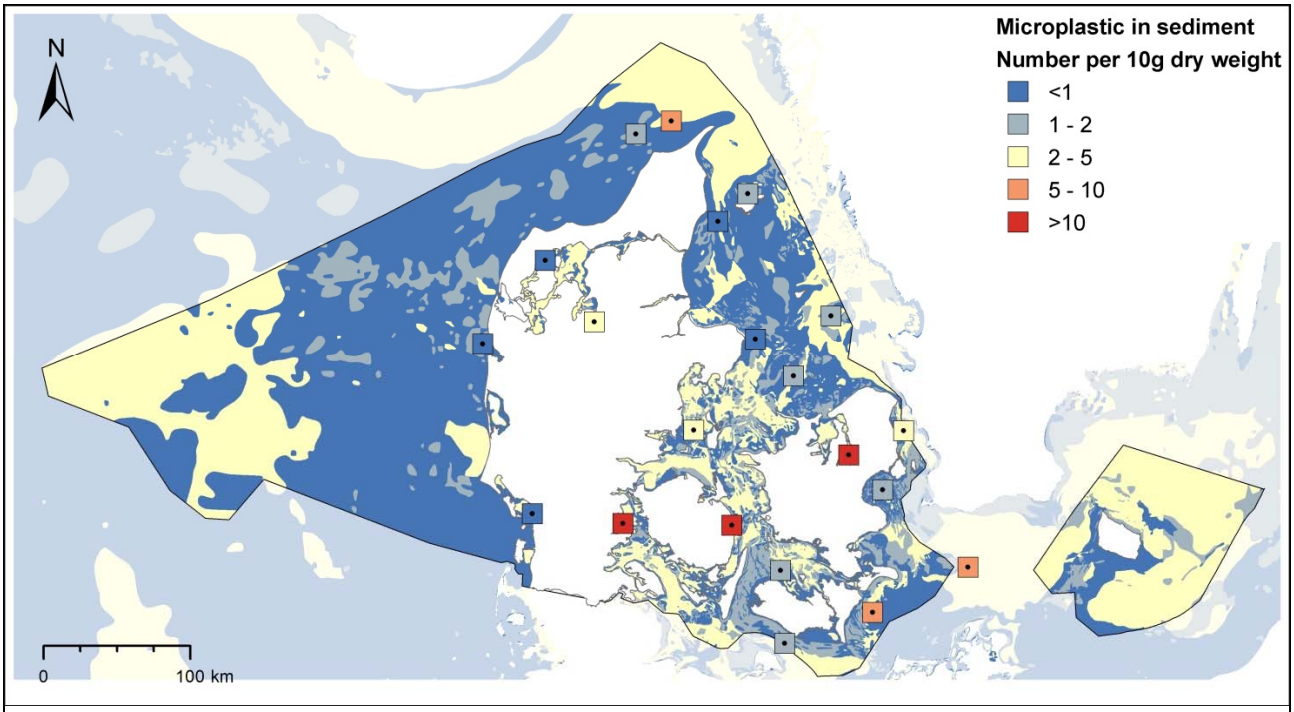
Spatial coverage

The highlighted military areas lie within the SYMBIOSE area, whereas grayed areas fall outside the Symbiose area.

References

Scale or resolution	Polygon data. Unknown scale, simple polygons.
Time period	2011.
Data access	Can be provided by AU, DCE upon request. See also information in Danish nautical charts.
Responsible institution	DCE, AU.
Contact person	Jonas Koefoed Rømer.
E-mail	jkr@bios.au.dk
Key words	Military, training, human activities.

A11 - Microplastic in sediment



Map showing the number of micro-plastic particles in sediment (number per 10 g dry matter) divided into 5 classes based on color codes for load levels. Numbers are provided partly for measured data from 21 sampling stations in 2012-13, partly as estimated "background levels" throughout Danish waters, which are extrapolated from available sediment maps.

Data sources and methods

Data was obtained from new project data provided for the Danish waters. The content of the micro plastic is examined in the surface layer of 21 sediment samples. The samples were partly collected in coordination with the NOVANA sediment sampling for the analysis of hazardous substances in 2012, partly by additional sampling in 2013. Estimated "background levels" for micro plastic everywhere in Danish waters are extrapolated from a general relationship (identified in this project) between the content of micro-plastic and the fine sediment fraction (% <63µm) in sediment samples based on the function y = 3.02 + 0.50. GEUS sediment maps for sediment characteristics are used as a basis for mapping the % <63µm fractions of the sediment and the subsequent extrapolation of the content of micro plastic. On this basis, areas considered more loaded with micro plastic than expected in relation to estimated "background levels" can be better identified and designated.

Spatial coverage

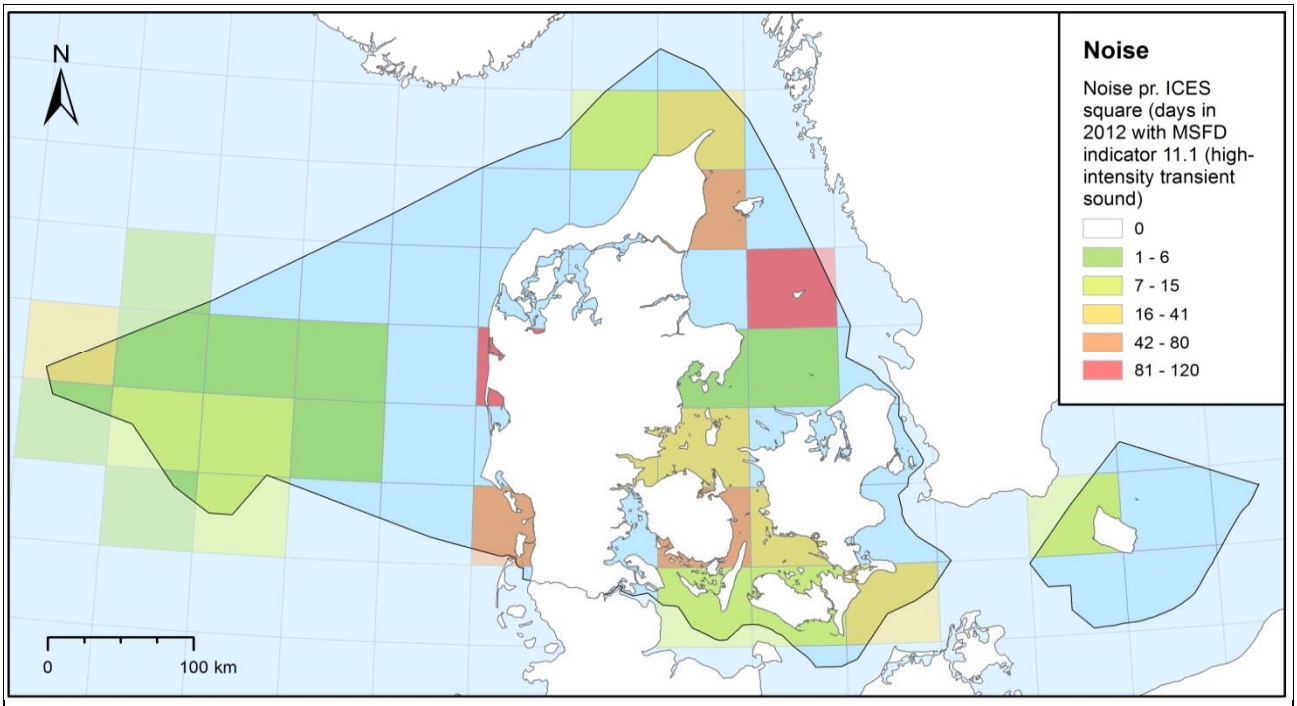
Danish waters from the Baltic Sea to the North Sea. However, station data are only represented by single sediment samples from the western Baltic Sea to the Skagerrak, as well as from the west coast of Jutland and the Wadden Sea.

References

Strand J., Lassen P., Shashoua Y., Andersen, J.H. Microplastic particles in sediment from Danish waters, poster presented at ICES Annual Science Conference, 23 – 27 September 2013, Reykjavík, Iceland.

Scale or resolution	1:500000
Time period	September 2012 - May 2013.
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Jakob Strand
E-mail	jak@bios.au.dk
Key words	Marine litter, microplastic, sediment, Marine Strategy Framework Directive

A12 - Noise (bang days), impulsive underwater noise (MSFD 11.1)



Number of impulsive noise days per ICES square, i.e. days with at least one activity resulting in the emission of an impulsive sound, which can be expected to affect marine organisms in the frequency range up to 10 kHz. The dominant sources are offshore wind park constructions (Anholt) and construction works in Danish ports (Havneby, Faaborg, Hvide Sande, Thorsminde, Sæby amongst others).

Data sources and methods

Historical data from 2012 was obtained from various sources. The data quality is not convincing, because registration procedures for activities are not in place yet. In future, these activities will have to be reported, in accordance with the Marine Strategy Framework Directive. The impact has been calculated in rectangles and specified as number of pulse-days per year according to Van der Graff et al. (2012). A pulse day is a day, where at least one transient sound is emitted at an intensity, which is expected to affect wildlife. The following data sources are included:

Seismic surveys. Source: Danish Energy Agency (Energistyrelsen). Number of active days per rectangle was estimated from ship speed and length of transect lines.

Pile driving at offshore wind parks. Source: DONG A/S. The number of days when driving of turbine foundations took place at the Anholt offshore wind farm was obtained directly from the source.

Harbour constructions involving driving of sheet pilings. Source: Danish Coastal Authority (Kystdirektoratet). There is no inventory of port constructions and there is no registration of individual pile driving activities of sheet pilings. All construction permits issued by the Coastal Authority in the coastal zone in 2011 (part of which were first realised in 2012) and 2012 were reviewed and categorized. A total of 24 constructions were estimated to include pile driving of sheet pilings in the open sea and/or on the outside of harbour piers. Each was assigned between 10 and 60 pulse days, estimated from construction size. It has not been possible to assess to which degree different activities in the same rectangle took place on the same day, which means that an unknown fraction of the days will be counted twice.

Underwater detonations. Source: Danish Ministry of Defence (Forsvaret). The number of planned detonations of mines and other explosives werecounted from screening notes prepared by DCE. The actual number of detonations may be less, but since the total number of detonations included is low (under 10), their importance to the overall impact is minimal. It was not been possible to obtain information about civilian detonations.

Spatial coverage

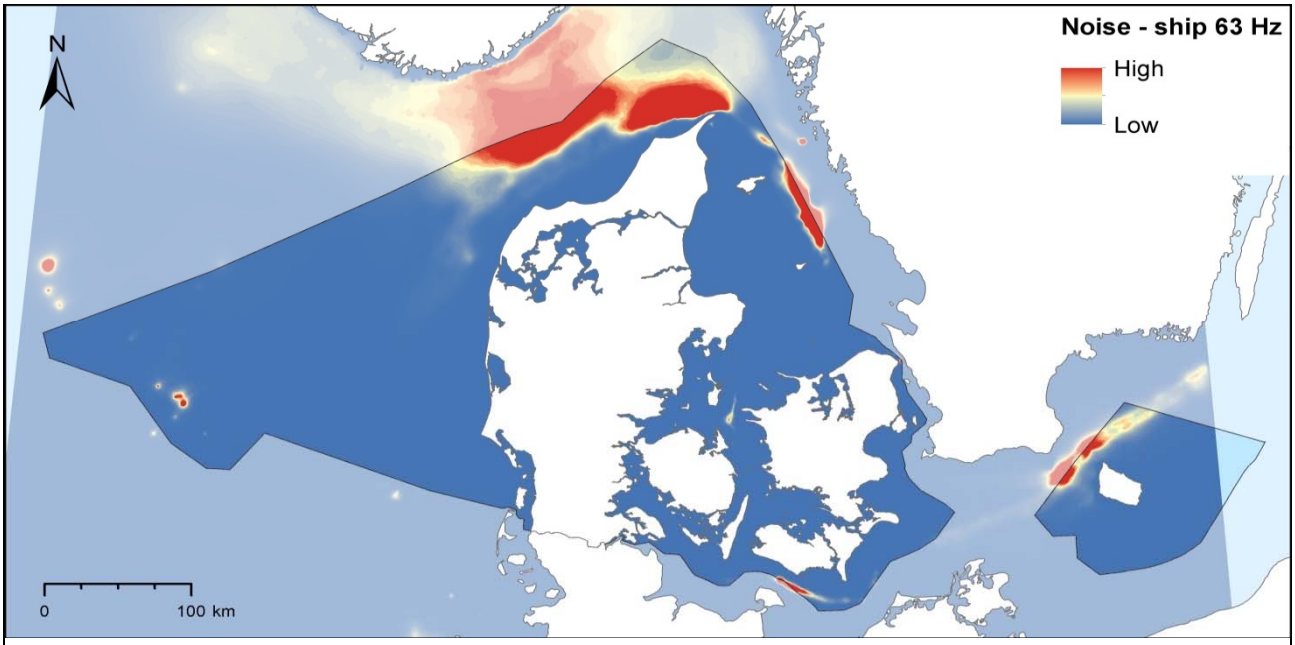
Danish waters from the western Baltic Sea to the central/northern North Sea. Activities outside Danish waters, but in rectangles extending into the study area are not included.

References

Van der Graaf AJ, Ainslie MA, André M, Brensing K, Dalen J, Dekeling RPA, Robinson S, Tasker ML, Thomsen F, Werner S (2012). European Marine Strategy Framework Directive - Good Environmental Status (MSFD GES): Report of the Technical Subgroup on Underwater noise and other forms of energy.

Scale or Resolution	ICES rectangles (0.5 degree latitude x 1 degree longitude). Area per rectangle ca. 3500 km^2.
Time Period	2012.
Data access	Pile driving data at Anholt windpark is confidential. Other data are accessible.
Responsible institution	DCE/AU
Contact person	Jakob Tougaard
E-mail	jat@bios.au.dk
Key words	Underwater noise, pile driving, offshore wind parks, seismic, oil exploration, marine mammals, MSFD 11.1

A13 – Ship noise 63 Hz (MSFD 11.2.1)



Underwater noise in the 63 Hz 1/3 octave band. The values are maximum median values in the water column for each grid cell.

Data sources and methods

Noise was modeled from ship traffic in Danish waters based on AIS data. The ships were divided into a small number of classes (tankers, container ships, passenger ships, etc.). Noise emissions from those classes were represented by typical ship noise signatures from literature. Noise levels propagating through the water column were determined by Quiet Oceans Quonops modeling tool that includes information about bathymetry, bottom sediment, hydrography (typical sound velocity profile) and surface roughness (significant wave height). The model's main uncertainty factor is that it is not calibrated against actual measurements. The absolute levels must therefore be considered uncertain, whereas relative differences are more robust. Input data were obtained from the following sources: Bathymetry: Composite data set from the Danish Geodata Agency (Kort og Matrikelstyrelsen), 50m grid, BALANCE 200m grid and ETOPO 1 arc minute grid (Cordula Göke, Dep. of Bioscience, Aarhus University).Bottom Sediment: Composite data sets from GEUS and EUSEAMAP (Al-Hamdani et al. 2013, Stevenson et al. 2011). Hydrography (sound velocity profile): Sea surface sound velocity was calculated based on near-surface (5m) temperature/salinity/pressure (T/S/P) data from model output of the DMI-BSHcmod model of the North Sea and Baltic Sea. 2009-2010 T/S/P model data were used to calculate seasonal averages (see above) at a 6 nautical mile grid. Model data for the AVISO period 2011-2012 were not available. Using different time periods for significant wave height and sound velocity may therefore result in a slight temporal bias. Surface roughness: 3 years of significant wave height data (2010-12) from the global 1 ° x 1 ° AVISO altimetry (http://www.aviso.oceanobs.com/en/data/products/wind-waves-products.html). AIS data: Collected in September 2013 from Marinetraffic.com.

Spatial coverage

North Sea and Baltic Sea covering 2-17 degrees East and 53-59 degrees North.

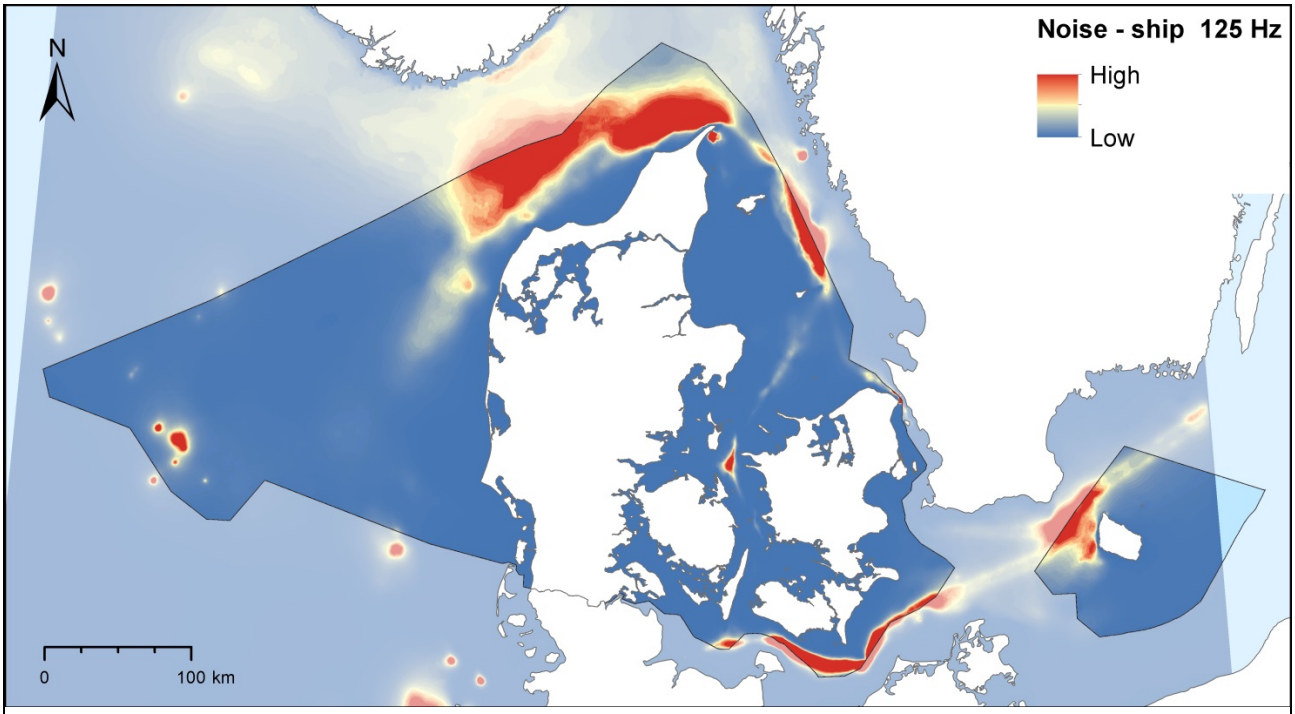
References

Folegot, T. (2012) Ship Traffic Noise Distribution in the Strait of Gibraltar: An Exemplary Case for Monitoring Global Ocean Noise Using Real-Time Technology Now Available for Understanding the Effects of Noise on Marine Life. In: A.N. Popper and A. Hawkins (eds.), The Effects of Noise on Aquatic Life. Advances in Experimental Medicine and Biology 730: 601-604.

Clorennec, D. and Folegot, T. (2013) SYMBIOSE – MSFD – Support research in descriptor 11 (Noise. Danish Ocean Seasonal Statistical Soundscapes in relationship with Meteoceano and Anthropogenic Environment. Quiet Oceans, Plouzane, France.

Scale or resolution	
Time period	2012.
Data access	Accessible
Additional sources of information	Clorennec, D. (2013).
Reponsible institution	DCE/AU and Quiet Oceans, Plouzane France
Contact person	Jakob Tougaard and Thomas Folegot
E-mail	jat@bios.au.dk and thomas.folegot@quiet-oceans.com
Key words	Underwater noise, ships, marine mammals, MSFD 11.2

A 14 – Ship noise 125 Hz (MSFD 11.2.2)



Underwater noise in the 125 Hz 1/3 octave band. The values are maximum median values in the water column for each grid cell.

Data sources and methods

Noise was modeled from ship traffic in Danish waters based on AIS data. The ships were divided into a small number of classes (tankers, container ships, passenger ships, etc.). Noise emissions from those classes were represented by typical ship noise signatures from literature. Noise levels propagating through the water column were determined by Quiet Oceans Quonops modeling tool that includes information about bathymetry, bottom sediment, hydrography (typical sound velocity profile) and surface roughness (significant wave height). The model's main uncertainty factor is that it is not calibrated against actual measurements. The absolute levels must therefore be considered uncertain, whereas relative differences are more robust. Input data were obtained from the following sources: Bathymetry: Composite data set from the Danish Geodata Agency (Kort og Matrikelstyrelsen), 50m grid, BALANCE 200m grid and ETOPO 1 arc minute grid (Cordula Göke, Dep. of Bioscience, Aarhus University).Bottom Sediment: Composite data sets from GEUS and EUSEAMAP (Al-Hamdani et al. 2013, Stevenson et al. 2011). Hydrography (sound velocity profile): Sea surface sound velocity was calculated based on near-surface (5m) temperature/salinity/pressure (T/S/P) data from model output of the DMI-BSHcmod model of the North Sea and Baltic Sea. 2009-2010 T/S/P model data were used to calculate seasonal averages (see above) at a 6 nautical mile grid. Model data for the AVISO period 2011-2012 were not available. Using different time periods for significant wave height and sound velocity may therefore result in a slight temporal bias. Surface roughness: 3 years of significant wave height data (2010-12) from the global 1 ° x 1 ° AVISO altimetry (http://www.aviso.oceanobs.com/en/data/products/wind-waves-products.html). AIS data: Collected in September 2013 from Marinetraffic.com.

Spatial coverage

North Sea and Baltic Sea covering 2-17 degrees East and 53-59 degrees North

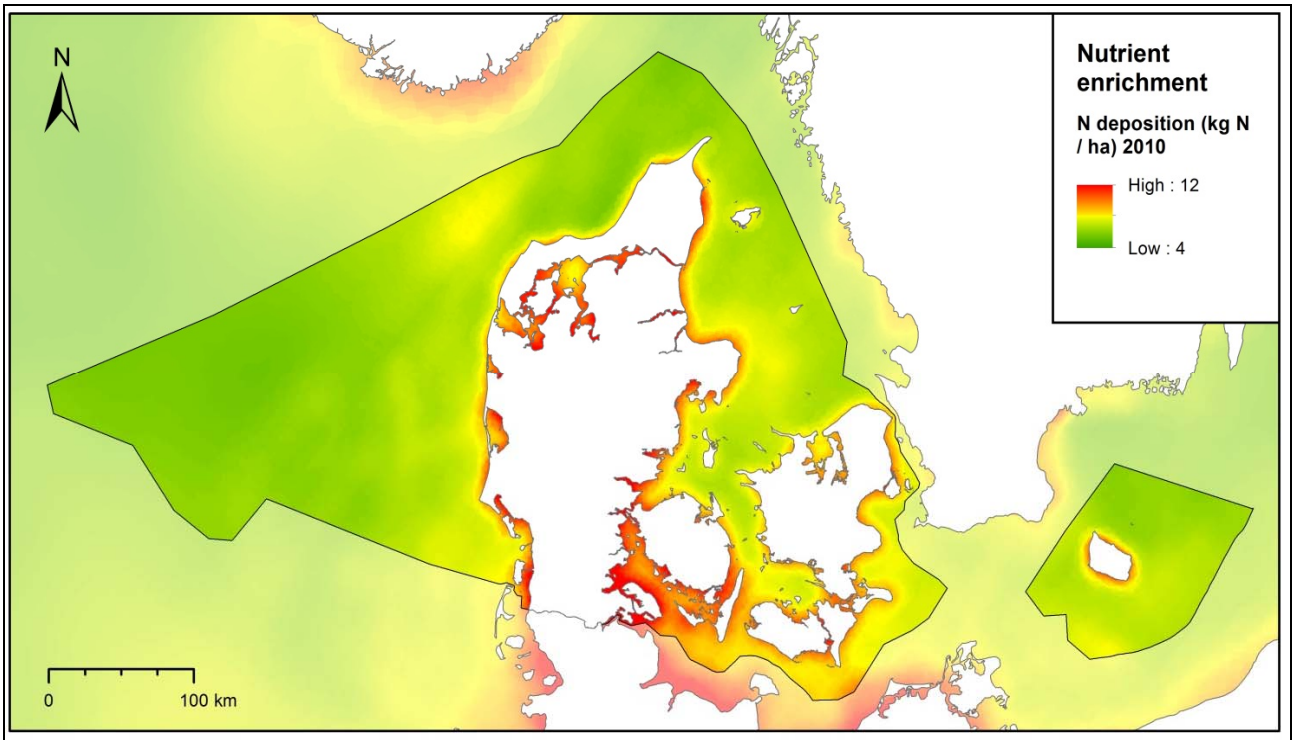
References

Folegot, T. (2012) Ship Traffic Noise Distribution in the Strait of Gibraltar: An Exemplary Case for Monitoring Global Ocean Noise Using Real-Time Technology Now Available for Understanding the Effects of Noise on Marine Life. In: A.N. Popper and A. Hawkins (eds.), The Effects of Noise on Aquatic Life. Advances in Experimental Medicine and Biology 730: 601-604.

Clorennec, D. and Folegot, T. (2013) SYMBIOSE – MSFD – Support research in descriptor 11 (Noise. Danish Ocean Seasonal Statistical Soundscapes in relationship with Meteoceano and Anthropogenic Environment. Quiet Oceans, Plouzane, France.

Scale or resolution	
Time period	2012.
Data access	Accessible
Additional sources of information	Clorennec, D. (2013).
Responsible institution	DCE/AU and Quiet Oceans, Plouzane France
Contact person	Jakob Tougaard and Thomas Folegot
E-mail	jat@bios.au.dk and thomas.folegot@quiet-oceans.com
Key words	Underwater noise, ships, marine mammals, MSFD 11.2

A 15 - Nutrient enrichment (atmospheric deposition)



Map showing modelled atmospheric nitrogen deposition 2010.

Data sources and methods

The nitrogen deposition is modelled on the basis of emissions to the atmosphere. The calculation covers the lower 15 km of the atmosphere, which is divided into 29 grid cells, the bottom layer is relatively thin (60 m) and the top layer is thicker (200 m) (Ellermann et al., 2011). Calculations are performed with the system THOR (see Thor.DMU.dk). The meteorological modelling is based on the model MM5 (Greel et al., 1995). Emission information for Europe in a resolution of 17 * 17 km is used (Hertel et al., 2002). These emission compilations are based on the EMEP 50 * 50 km (EMEP 2011), a detailed nested system for the EU land area of 17 * 17 km and a detailed nested Danish system of 6 * 6 km. Deposition rates for 2010 are based on the national emission compilations from 2009 (Nielsen et al., 2011) and international compilations from EMEP from 2008, which were the latest available. The emission compilations from shipping in Danish waters are from 2007 with a geographical resolution of 1 * 1 km (Olesen et al., 2009).

Spatial coverage

North Sea, Kattegat, Danish Straits, Belt Sea and Baltic Sea.

References

Ellermann, T., et al (2011). Atmosfærisk deposition 2010. NOVANA. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi. 109 s-- Videnskabelig rapport for DCE - Nationalt Center for Miljø og Energi, nr. 2. http://www2.dmu.dk/Pub/SR2.pdf

EMEP, (2011). www.EMEP.int

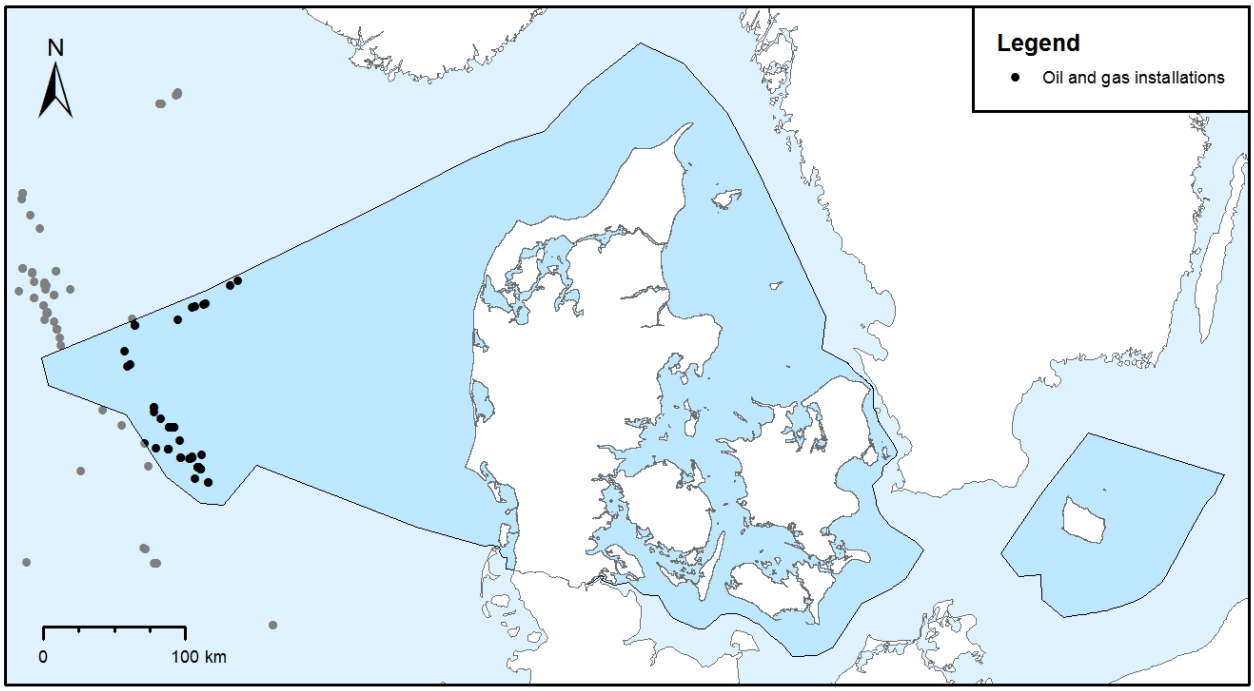
Hertel, O., et al (2002). Assessment of the atmospheric nitrogen and sulphur inputs into the North Sea using a Lagrangian model. Physics and Chemistry of the Earth 27, 1507-1515.

Nielsen, K.E., et al (2011): Annual Danish Informative Inventory Report to UNECE. Emission inventories from the base year of the protocols to year 2009. National Environmental Research Institute, Aarhus University. 601 pp. – NERI Technical Report No. 821.

Olesen, H.R., et al (2009). Ship emissions and air pollution in Dnemark. Present situation and future scenarios. Report from Danish Environmental Protection Agency, Copenhagen, Denmark. Environmental project No. 1307 2009, Miljøprojekt.http://www2.mst.dk/udgiv/publikationer/2009/978-87-92548-77-1/pdf/978-87-92548-78-8.pdf

Scale or resolution	
Time period	2010.
Data access	Accessible
Additional sources of information	http://dce.au.dk/aktuelt/nyheder/nyhed/artikel/dce-offentliggoer-baggrundsnotater-til-havstrategi/
Responsible institution	DMU/AU
Contact person	Jonas Koefoed Rømer.
E-mail	jkr@bios.au.dk
Key words	Nitrogen deposition, atmosphere

A16 - Offshore oil and gas installations



Map showing locations of established offshore oil and gas installations (platforms, etc.)

Data sources and methods

There is no oil and gas exploration within the new area covered by SYMBIOSE compared to the HARMONY project (South Kattegat, Belt Sea and the Western Baltic). Therefore, HARMONY data was used and supplemented by a value of 0 for cells in the SYMBIOSE grid, which were not covered by the HARMONY project. Presence (1) / non-presence (0) values were set for oil and gas installation for each cell of the SYMBIOSE grid. The original data source of data for HARMONY was the Danish Nature Agency (Naturstyrelsen).

Spatial coverage

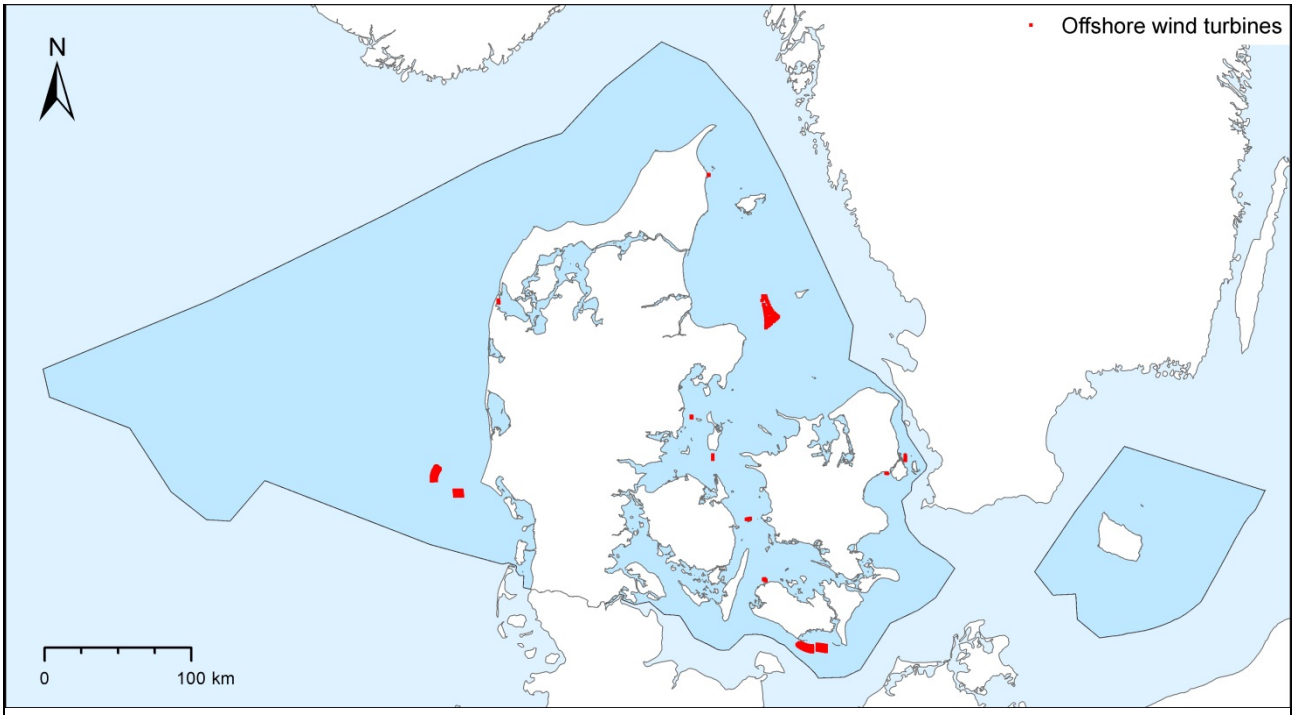
Installations for oil and gas exploration are found in the North Sea. On the map above gray points represent data points falling outside the SYMBIOSE grid, whereas black points are locations inside the SYMBIOSE grid.

References

HARMONY report (Andersen et al., 2013)

Scale or resolution	Point data. Unknown scale, but positions are assumed to be accurate.
Time period	2011.
Data access	Information on current installations for oil and gas is available via the Danish Nature Agency (Naturstyrelsen).
Responsible institution	DCE, AU.
Contact person	Jonas Koefoed Rømer.
E-mail	jkr@bios.au.dk
Key words	Oil, gas, installations, human activities.

A17 - Offshore wind turbines



Map showing locations of offshore wind parks in Denmark (2013). In the map the extent of the parks as a single unit is shown.

Data sources and methods

The location of individual wind turbines was downloaded from the Danish Energy Agency (Energistyrelsen). The presence of one or more wind turbines in each SYMBIOSe grid cell is represented by 1, the absence by 0.

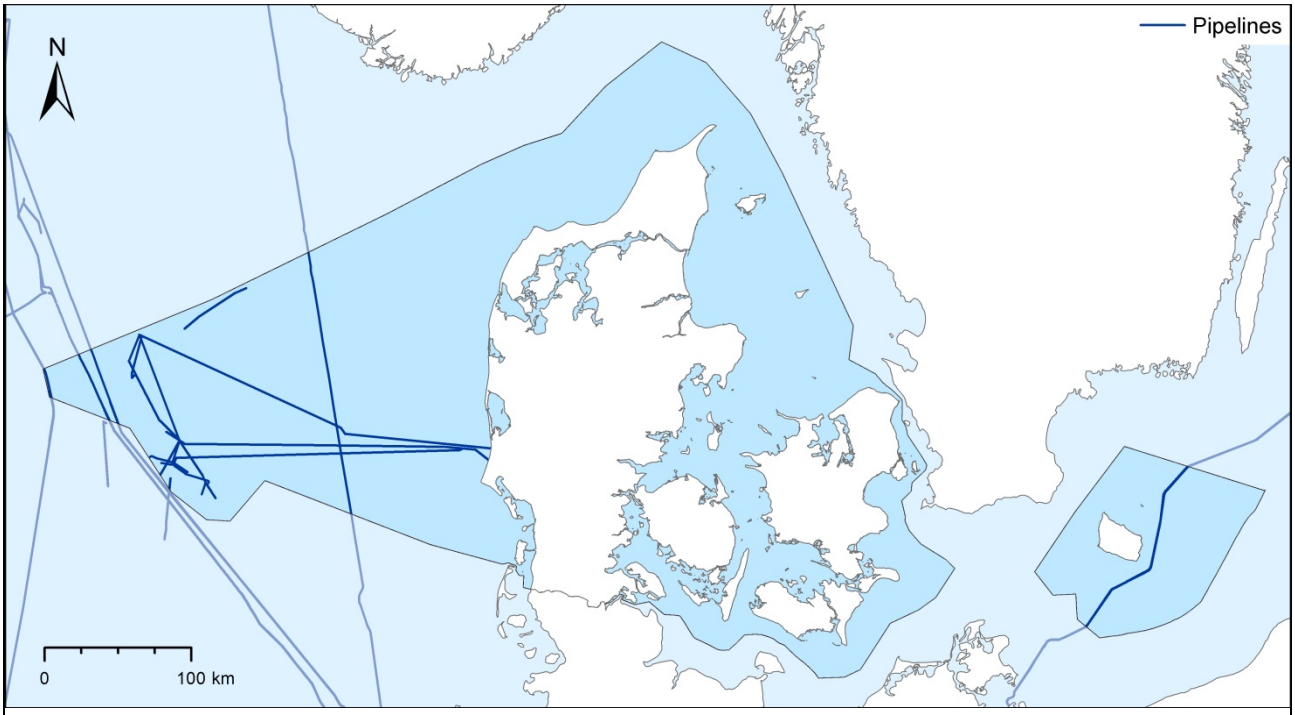
Spatial coverage:

Danish EEZ

References

Scale or resolution	Point data. Unknown scale, but positions are assumed to be accurate.
Time period	May 2013
Data access	For up to date dataset contact the Danish Energy Agency (Energistyrelsen, ENST).
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Offshore wind park

A18 - Oil and gas pipelines



Map showing main oil and gas pipelines with relevance to Denmark

Data sources and methods

Compared to the HARMONY dataset, one pipeline in the Baltic Sea was added by digitizing it from the recent Sea Chart. The original data for the HARMONY project was provided by the Danish Environmental Agency (Naturstyrelsen, NST) for Denmark. The presence of a part of a pipeline within a SYMBIOSE grid cell was set to 1.

Spatial coverage

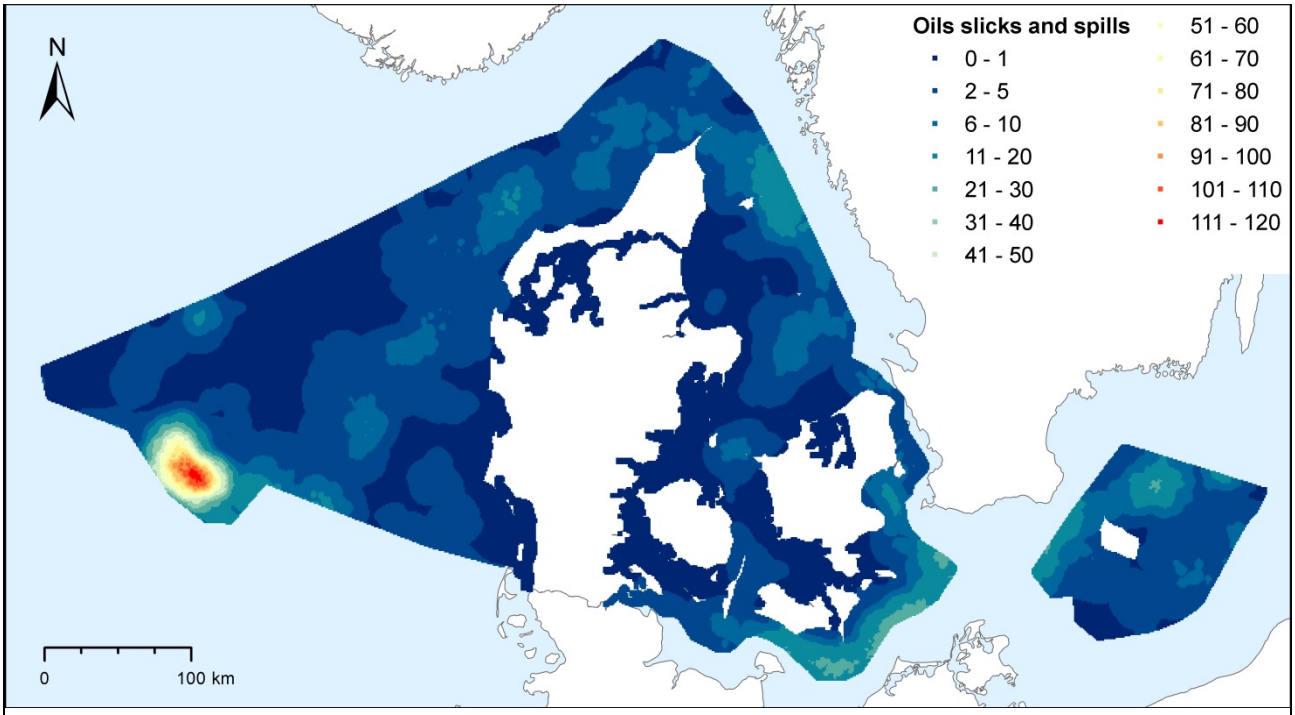
Danish EEZ

References

HARMONY report (Andersen et al., 2013).
Additional data sources for Germany: BSH, CONTIS database (http://www.bsh.de/en/Marine_uses/Industry/CONTIS_maps/index.jsp).
Additional data sources for Norway: Norwegian Petroluem Directorate (NPD), data can be downloaded from http://factpages.npd.no/factpages/Default.aspx?culture=en

Scale or resolution	Unknown
Time period	2011.
Data access	For updated dataset contact NST.
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	oil, gas, pipelines

A 19 - Oil spills



Oil spills in the Danish EEZ, detected by monitoring under the Bonn Agreement and by HELCOM. Based on the detected spill locations, an 'oil spill risk index' was calculated.

Data sources and methods

The original input data from the HARMONY project was used.The value of the index in any location has been calculated as a distance-weighted number of oil spills within a 25 km radius. Weights were linearly diminishing from 1 to 0 over 25 km. As an example, an oil spill being detected directly at a given location would add 1 to this location's index value, and another spill detected 12.5 km away would add 0.5. Detections more than 25 km away do not influence the index.

Spatial coverage

Danish EEZ

References

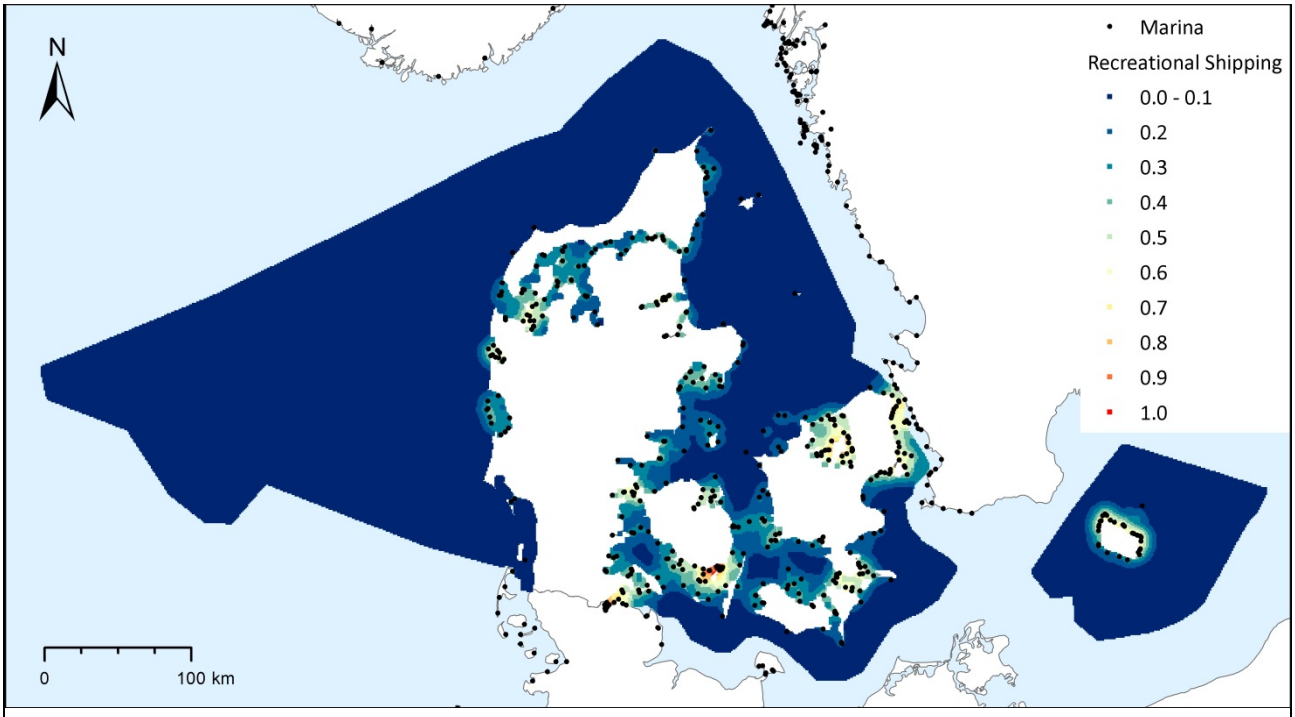
HARMONY report (Andersen et al., 2013)

Additional data sources: Bonn Agreement data, 2003-2009, OSPAR Secretariat (North Sea excluding most of the Kattegat).

Additional data sources forKattegat and Baltic Sea: HELCOM Map and Data Service.

Scale or resolution	Unknown
Time period	2003 - 2009
Data access	For updated dataset see data sources.
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	oil, oil spill

A20 - Recreational shipping



Estimated intensity of recreational shipping based on distance to marina.

Data sources and methods

The original input data from the HARMONY project was used and extended for the eastern coast of Germany by digitizing from google maps.The locations of leisure harbours were used to estimate the intensity of recreational shipping as follows: All leisure harbours within 20 km distance were assigned values based on the normalized inverse squared distance to the point in question. For example, a leisure harbour right at the point in question would have a value of 1. A leisure harbour 20 km or further away would have a value of 0. Between these extremes, values diminish proportional to the square of the distance. The method corresponds to inverse square-distance weighted interpolation, but differs in that a sum rather than an average is calculated. The maximum distance of 20km was chosen based on the assumption that most recreational boating trips in the study area's coastal waters are short-term trips, and that potential pressures are dominated by motor boats, but is otherwise arbitrary. Thus, a different maximum distance might be more appropriate for some purposes.The depth to which impacts on the sea bottom occur depends on a variety of factors, e.g. for physical impacts the wavelength of the produced waves. Here, a depth of 10m was chosen as a threshold. To account for potential impacts on the sea bottom (such as re-suspension of sediment), the data set was split up into two layers: Recreational shipping in deep waters and in shallow waters.

Spatial coverage

Danish EEZ

References

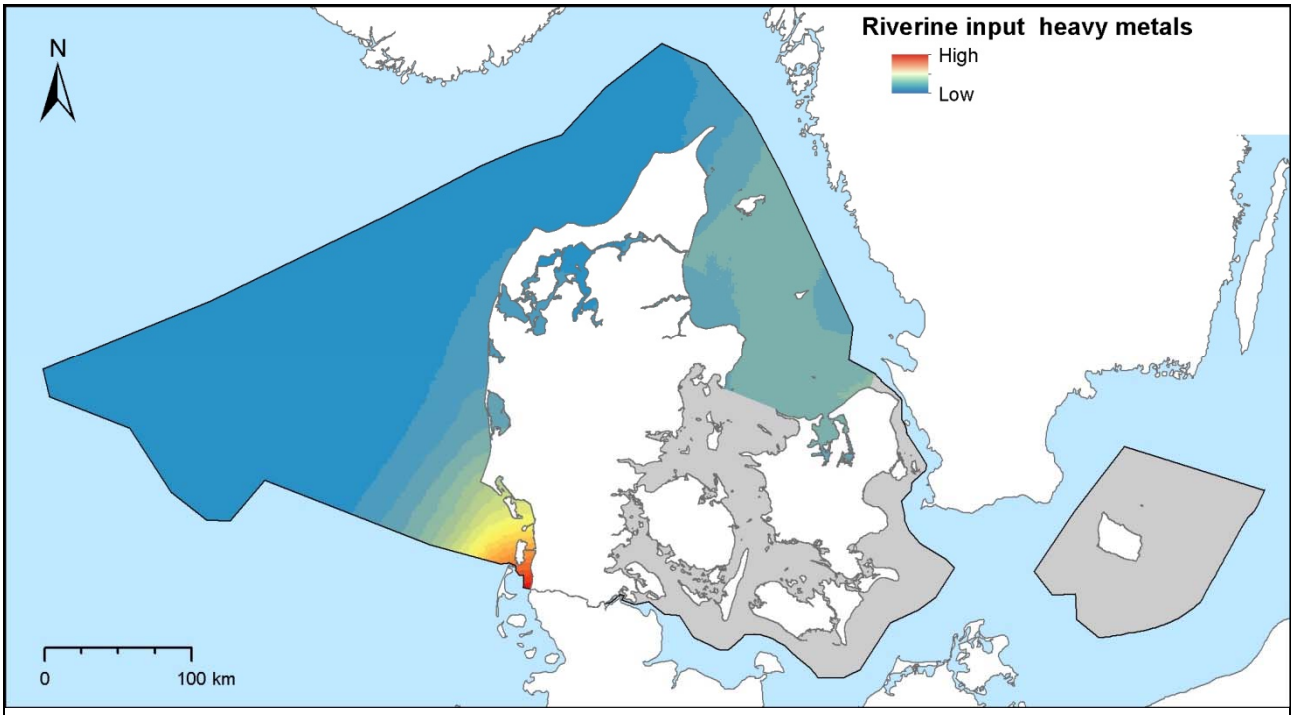
HARMONY report (Andersen et al., 2013)

Data sources for neighboring countries:

- Germany: Harbours and landing piers from the ATKIS DLM (provided by UBA) for the states Schleswig-Holstein and Niedersachsen.
- Denmark: Leisure harbours extracted from Danish topographic map 1:10000 (provided by NST).
- Sweden: Leisure harbours provided by Metria (layer produced in collaboration with the Swedish Maritime Administration).
- Norway: www.havneportalen.no

Scale or resolution	1 km
Time period	2011 and 2013 for the digitized data
Data access	For updated dataset see data sources.
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	recreational shipping, leisure boats, marina

A21 - Riverine input heavy metals



Riverine input of heavy metals based on HARMONY data and methodology.

Data sources and methods

The original input data from the HARMONY project was used.

Spatial coverage

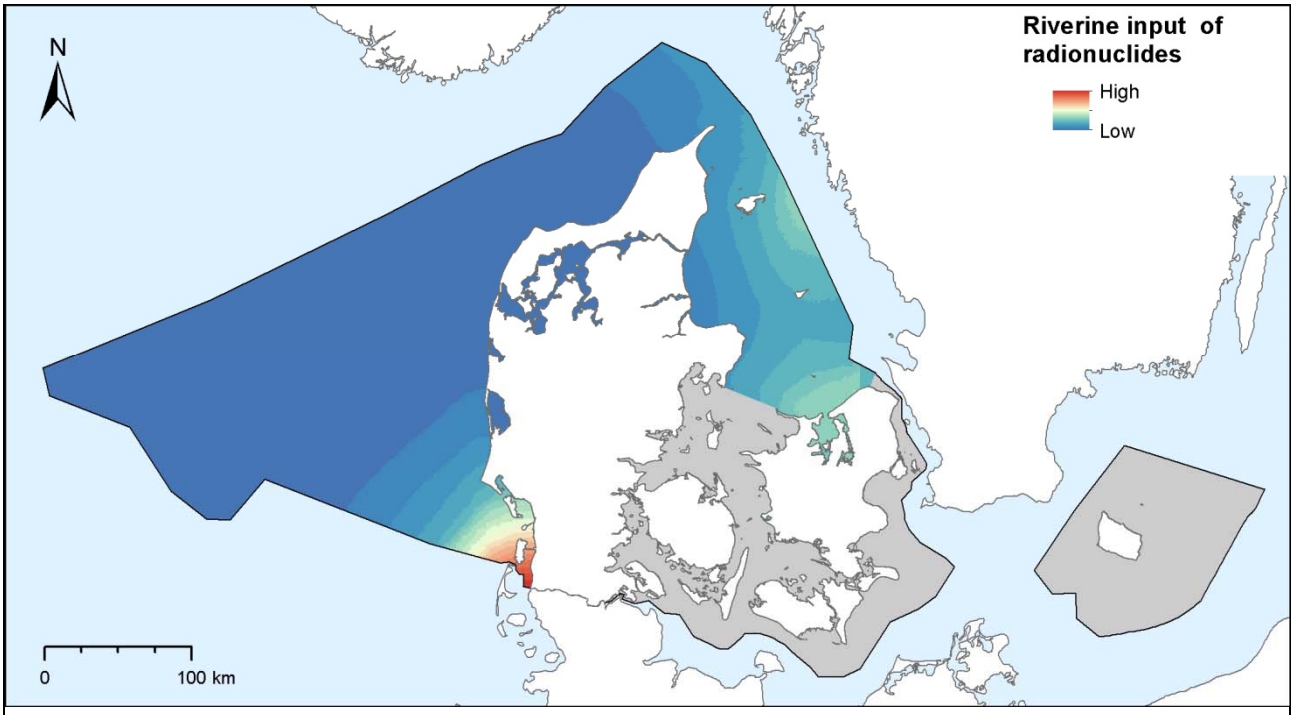
Danish EEZ without Danish Straits, Belt Sea and western Baltic Sea.

References

HARMONY report (Andersen et al., 2013).

Scale or resolution	1 km
Time period	2003 – 2009 averages
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	riverine input, heavy metals

A22 - Riverine input of radionuclides



Riverine input of radionuclides based on HARMONY data and methodology.

Data sources and methods

The original input data from the HARMONY project was used.

Spatial coverage

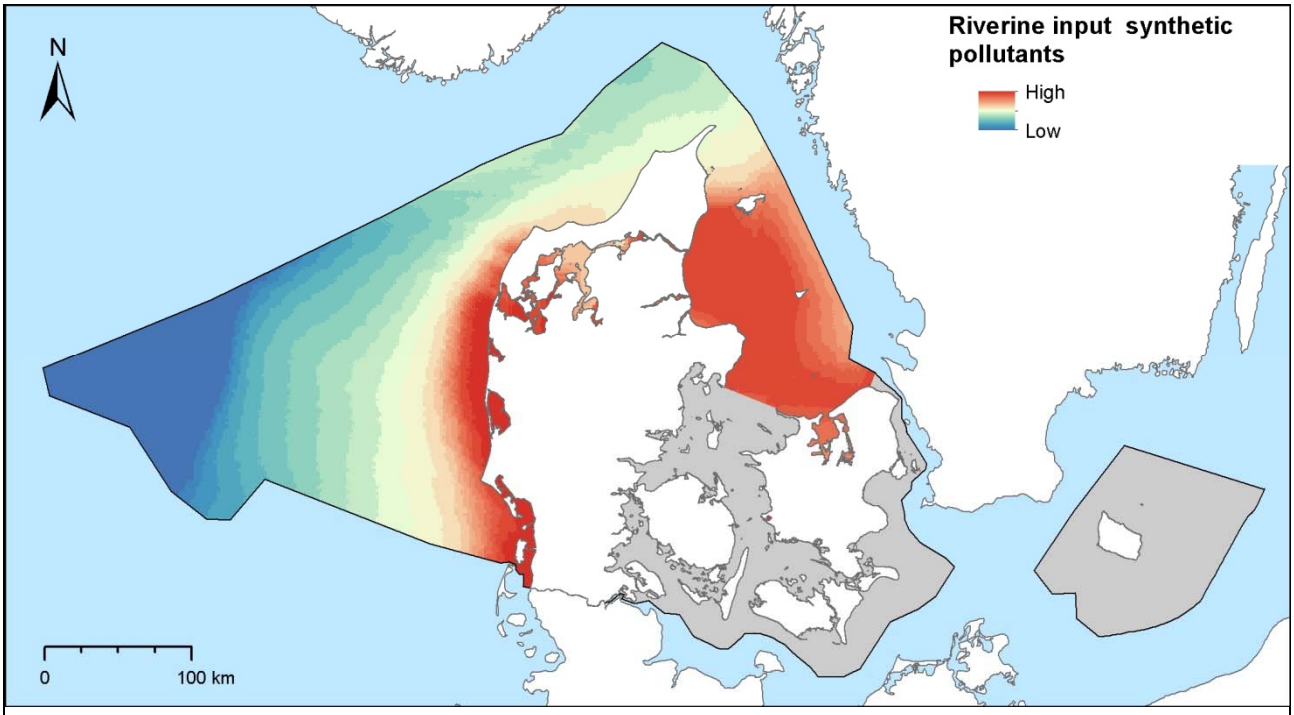
Danish EEZ without Danish Straits, Belt Sea and western Baltic Sea.

References

HARMONY report (Andersen et al., 2013)

Scale or resolution	1 km
Time period	2011 snapshot
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	riverine input, radionuclides.

A23 - Riverine input of synthetic pollutants



Riverine input of synthetic poolutants based on HARMONY data and methodology.

Data sources and methods

The original input data from the HARMONY project was used.

Spatial coverage

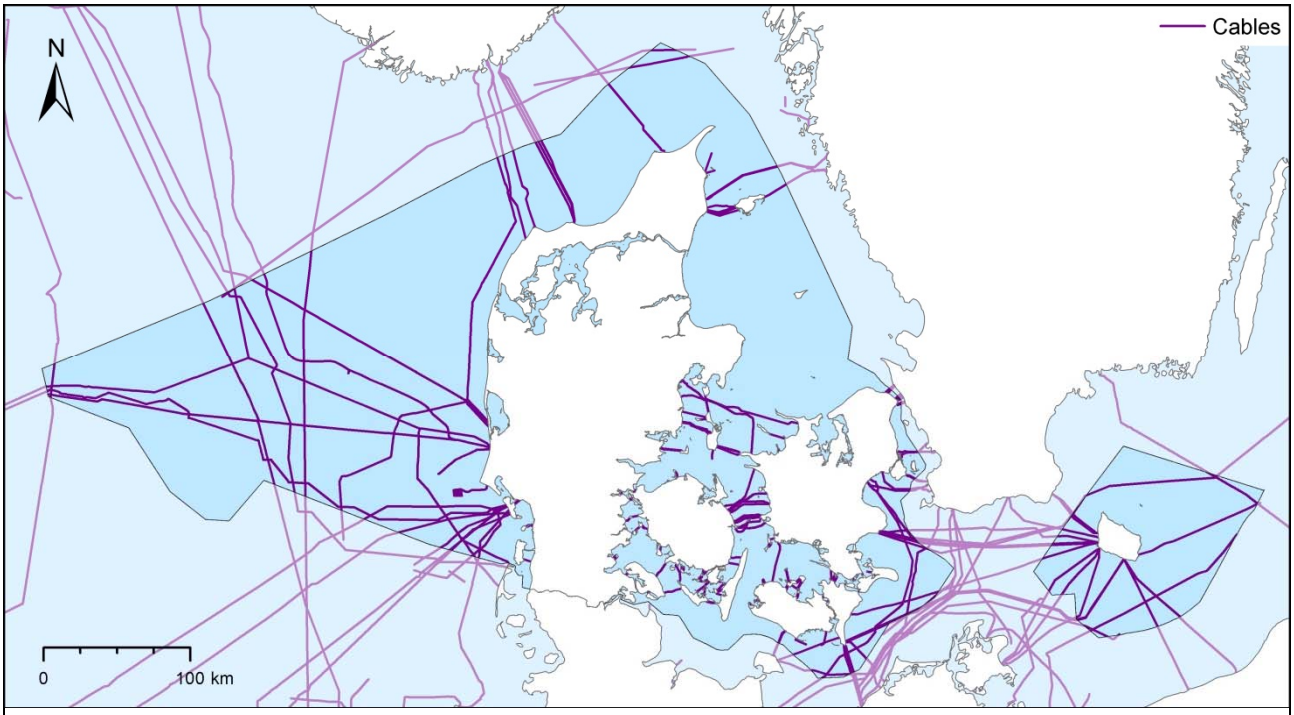
Danish EEZ without Danish Straits, Belt Sea and western Baltic Sea.

References

HARMONY report (Andersen et al., 2013)

Scale or resolution	1 km
Time period	Snapshot
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	riverine input, synthetic pollutants.

A 24 - Sea cables



Map showing location of sea cables in Danish waters and beyond.

Data sources and methods

Data on sea cables were compiled from national sources, merged, and compared against two other data sets:

A shapefile with cables compiled by OSPAR: The exact locations of cables existing in both data sets differed by distances up to several kilometers in a few cases. In such situations, the locations given in the national data sets were assumed to be more reliable. Cables shown in the OSPAR data, but missing from the national data sets, have been searched for in Kystverket's (Norway) online nautical charts and on the internet, if a name was given in the OSPAR data set. If either of the searches verified the existence of a specific cable, it was added to the final data set.

The second data source is the Norwegian nautical charts from Kystverket. One additional cable was identified and added manually. The data were finally clipped to the Norwegian, Swedish, Danish and German EEZ. Given the discrepancies between the different data sets, it must expected that some cables are missing from the data, especially old cables which have been out of use for a long time. Furthermore, some cable locations may not be exact. Planned cables have not been considered. The BorWin 1 cable marked as "under construction" in the original German data was completed in 2009 and is operational, and was thus normally included in this data set.

- Norway: NVE (only power cables), data received upon request; checked against online nautical charts available from Kystverket, one additional cable was added (http://kart.kystverket.no/default.aspx?gui=1&lang=2)
- Denmark: provided by the Danish nature Agency (Naturstyrelsen – NST)
- Germany: BSH, CONTIS data base (http://www.bsh.de/en/Marine_uses/Industry/CONTIS_maps/index.jsp)
- OSPAR: data set from the QSR 2010; used to add some cables missing from the national data, such as telecommunication cables in Norway

Spatial coverage

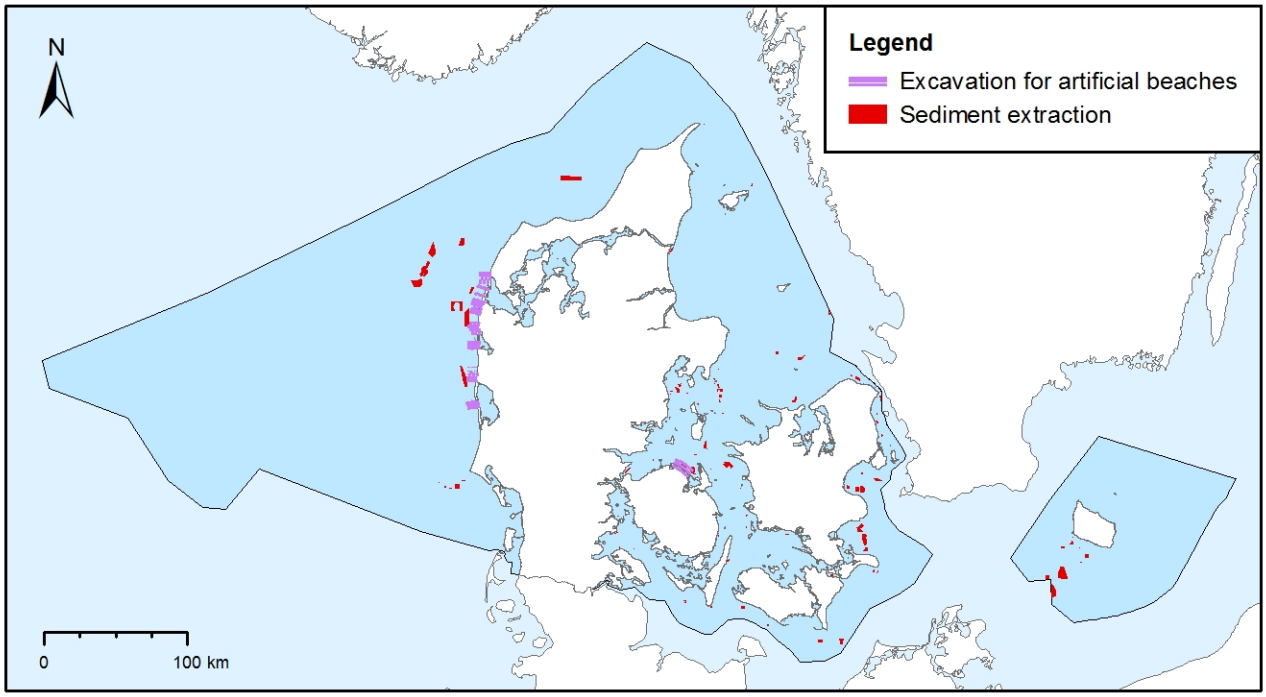
Danish waters.

References

HARMONY report (Andersen et al., 2013).

Scale or resolution	Unknown
Time period	Norway: 2011; Sweden: 2011; Denmark: 2011; Germany: 2009 or earlier, OSPAR data are older.
Data access	Yes, for original data see data sources
Responsible institution	DCE/AU
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Sea cable, MSFD

A25 - Sediment extraction sites



Map showing locations where removal / dredging of sediment was authorized.

Data sources and methods

The data set of removal/dredging sites of sediment consists of authorized sediment extraction locations in Danish waters. The locations are composed of two complementary data sets: General removal of sediment (polygon data), and excavation for artificial sand beaches (line data). Data represent presence (1) / non-presence (0) of sediment removal/dredging activities for each cell of the SYMBIOSE grid. The Danish nature Agency (Naturstyrelsen) administers permits for removal / dredging of sediment.

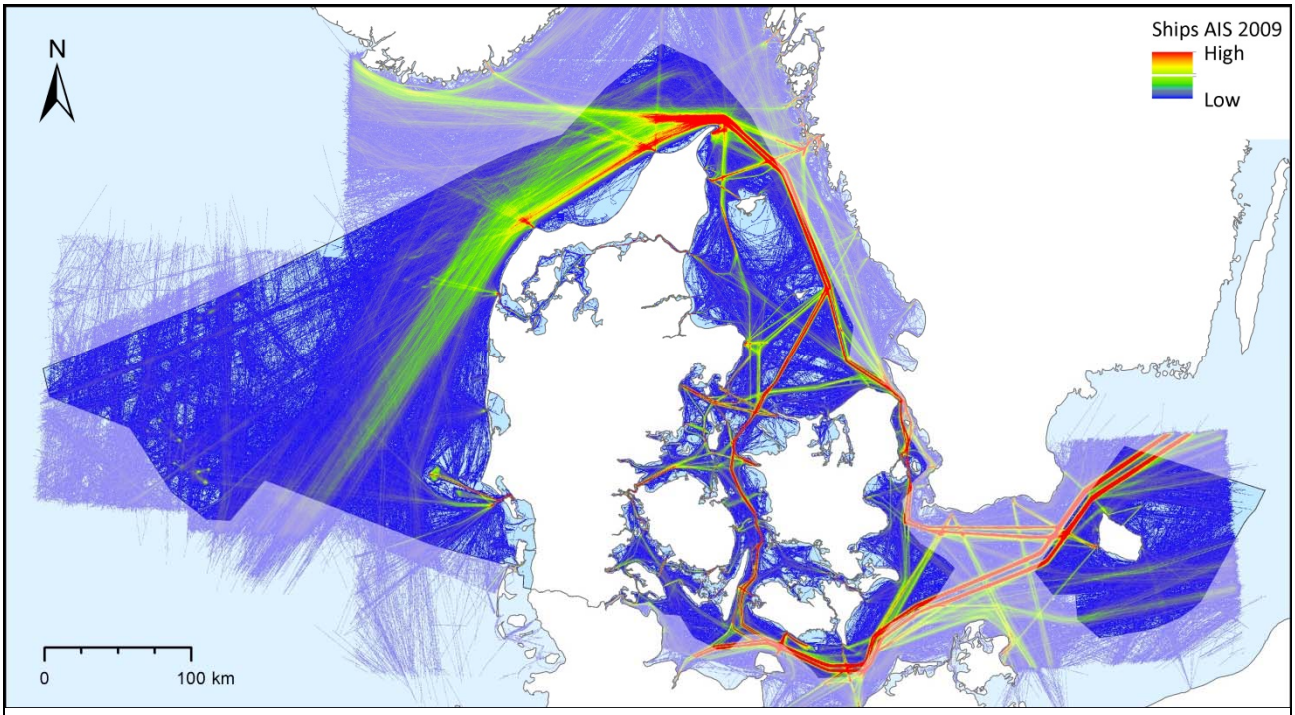
Spatial coverage

Danish waters. Sediment extraction for artificial beaches goes inshore, while removal / dredging of sediment generally occur more widespread.

References

Scale or resolution	Polygon data and line data. Unknown scale - simple lines and polygons..
Time period	2011.
Data access	Information on current permits for the removal of sediment and excavation for artificial sand beaches available via the Danish Nature Agency (Naturstyrelsen).
Responsible institution	DCE, AU.
Contact person	Jonas Koefoed Rømer.
E-mail	jkr@bios.au.dk
Key words	sediment, excavations, artificial beaches, human activities.

A26 - Shipping intensity (commercial shipping)



Shipping intensity for the Danish EEZ as registered in AIS for 2009

Data sources and methods

The data which was provided by the Danish Nature Agency (Naturstyrelsen, NST) for the Harmony project was used. The data was divided into deep and shallow (threshold 10 m) to accommodate the possibility to use the data as different pressures. It is expect that shipping in shallow waters has a higher impact on the sea bottom. In HARMONY the pressures which were derived from the two datasets were defined quite differently.(see HARMONY report).

Spatial coverage

Danish EEZ.

References

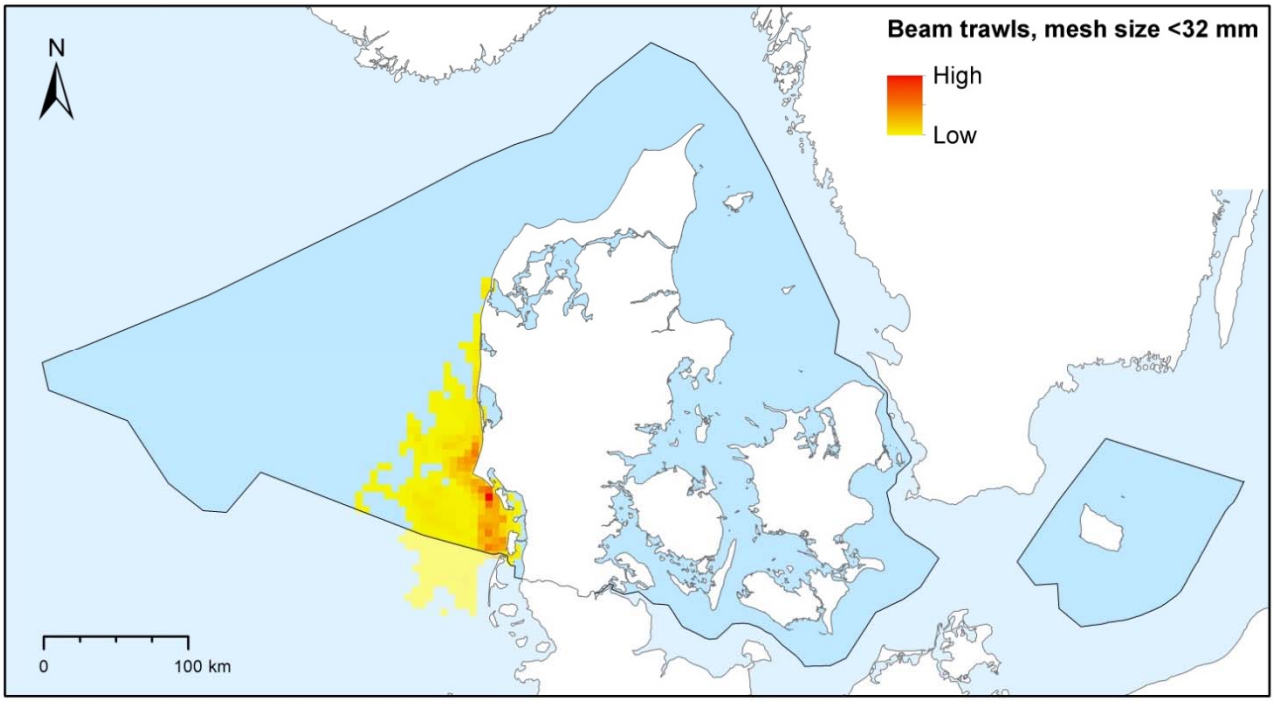
HARMONY report (Andersen et al., 2013).

Scale or resolution	1 km
Time period	2009
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	shipping intensity, AIS

Appendix B – Human activities/stressors (fisheries)

- B1 - Beam trawls (mesh size < 32 mm)
- B2 - Beam trawls (mesh size ≥ 100 mm)
- B3 - Demersal fishing (mesh size < 16 mm)
- B4 - Demersal fishing (mesh size 16 - 32 mm)
- B5 - Demersal fishing (mesh size 33 - 69 mm)
- B6 - Demersal fishing (mesh size 70 - 99 mm)
- B7 - Demersal fishing (mesh size ≥ 100 mm)
- B8 - Longlines
- B9 - Mussel dredging
- B10 - Pelagic fishing (mesh size 16 – 32 mm)
- B11 - Pelagic fishing (mesh size 33 – 80 mm)
- B12 - Setnet (all mesh sizes)

B1 - Beam trawls (mesh size < 32 mm)



Map showing beam trawl VMS effort in Danish waters for mesh size < 32 mm..

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

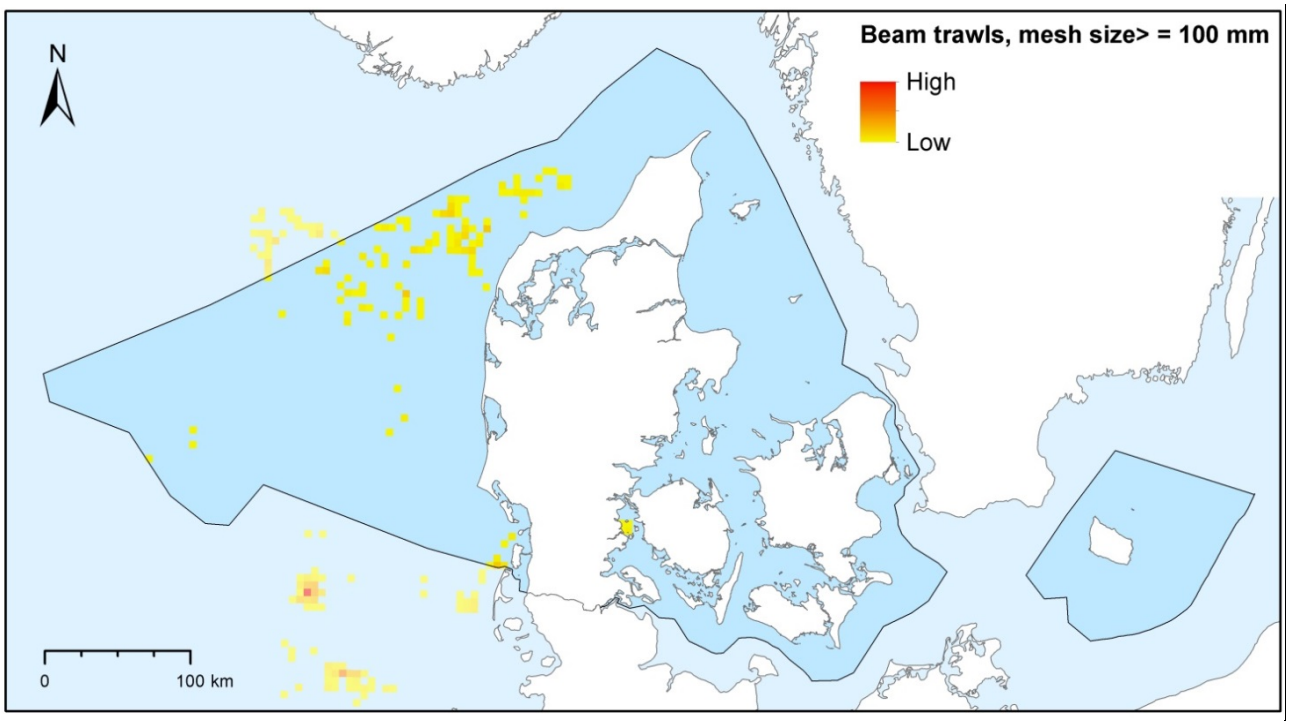
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, beam trawls

B2 - Beam trawls (mesh size ≥ 100 mm)



Map showing beam trawl VMS effort in Danish waters for mesh size ≥ 100 mm.

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

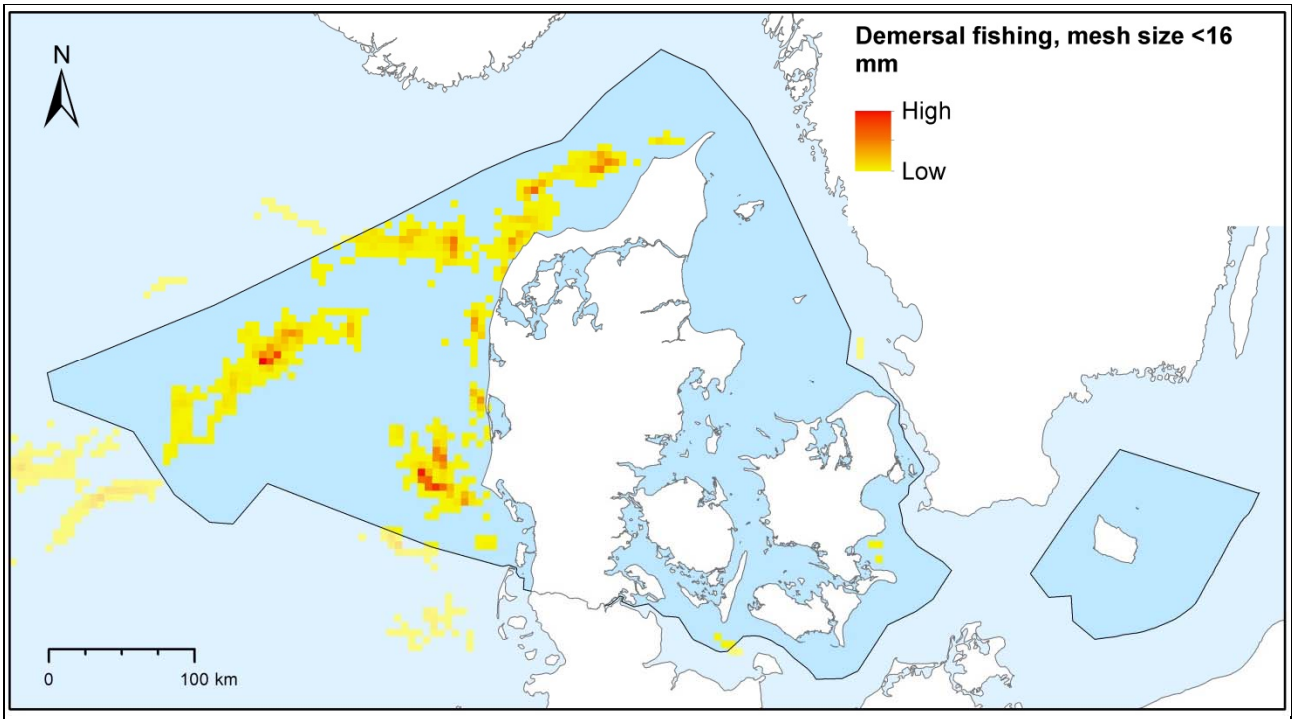
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, beam trawls

B3 - Demersal fishing (mesh size < 16 mm)



Map showing demersal fishing effort in Danish waters (mesh size < 16 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

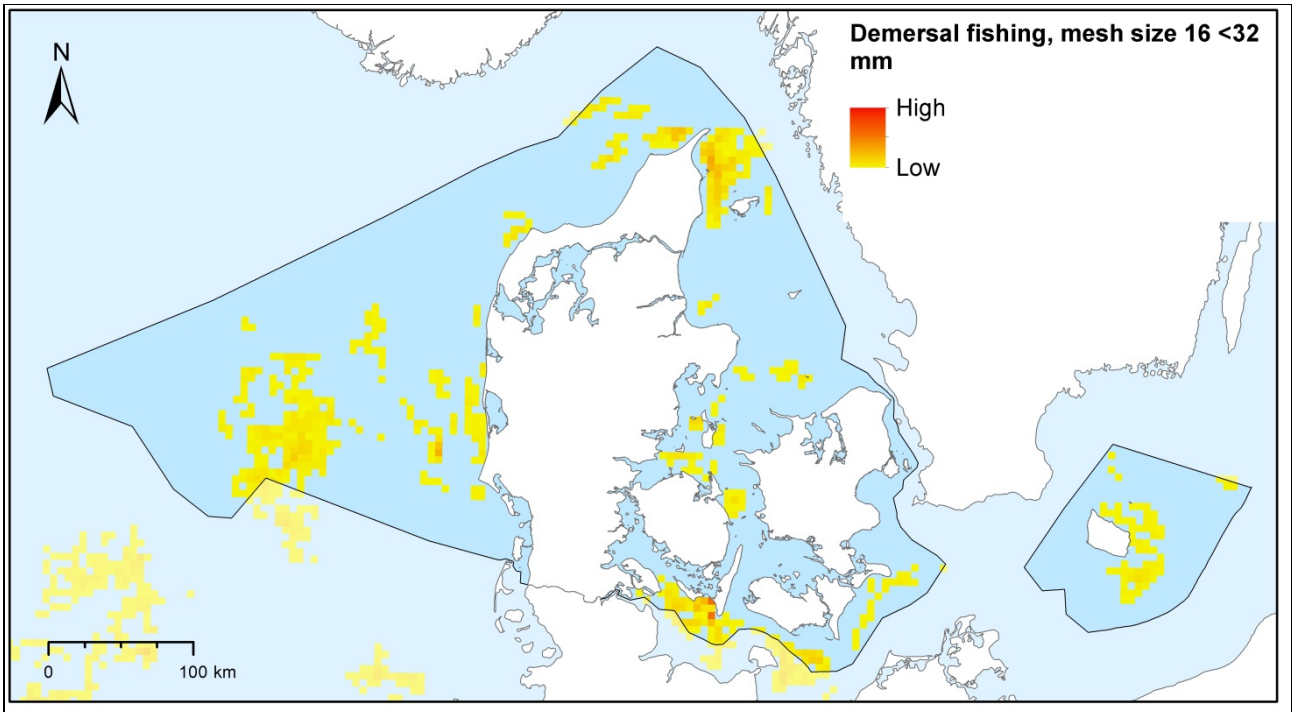
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, demersal fishing

B4 - Demersal fishing (mesh size 16 – 32 mm)



Map showing demersal fishing effort in Danish waters (mesh size 16 - 32 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

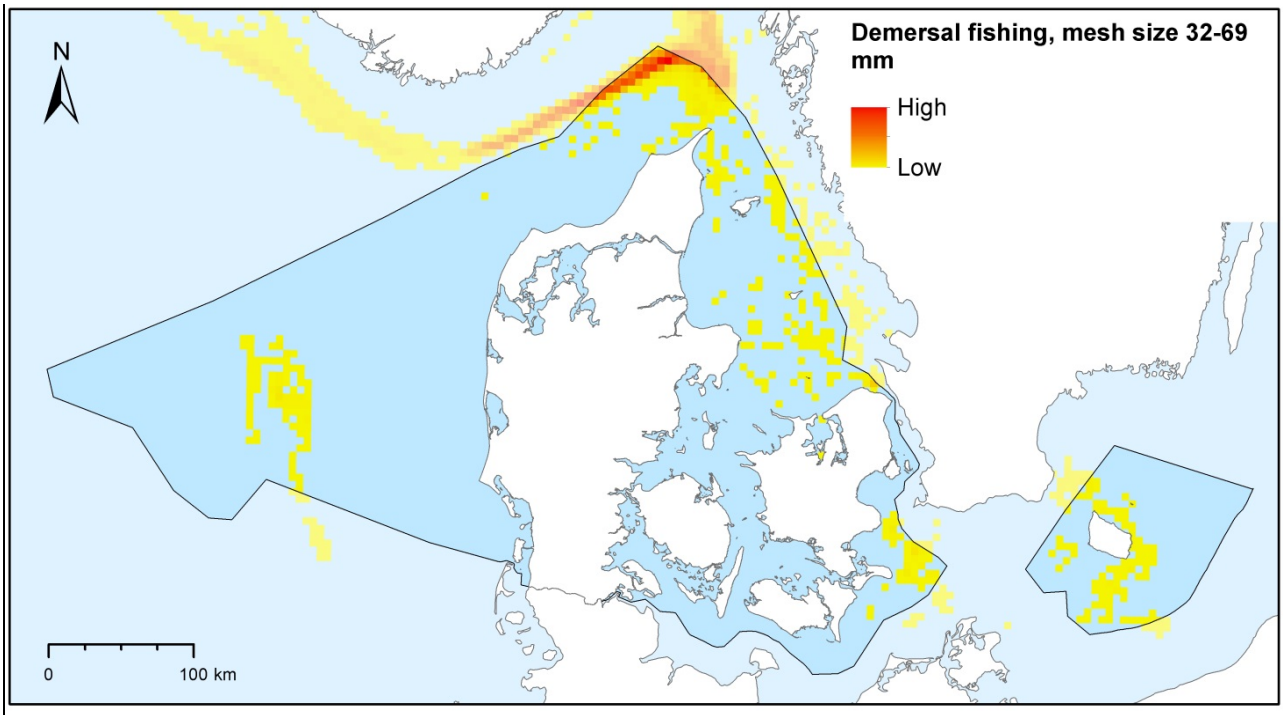
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	fisheries, demersal fishing

B5 - Demersal fishing (mesh size 32 – 69 mm)



Map showing demersal fishing effort in Danish waters (mesh size 32 - 69 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

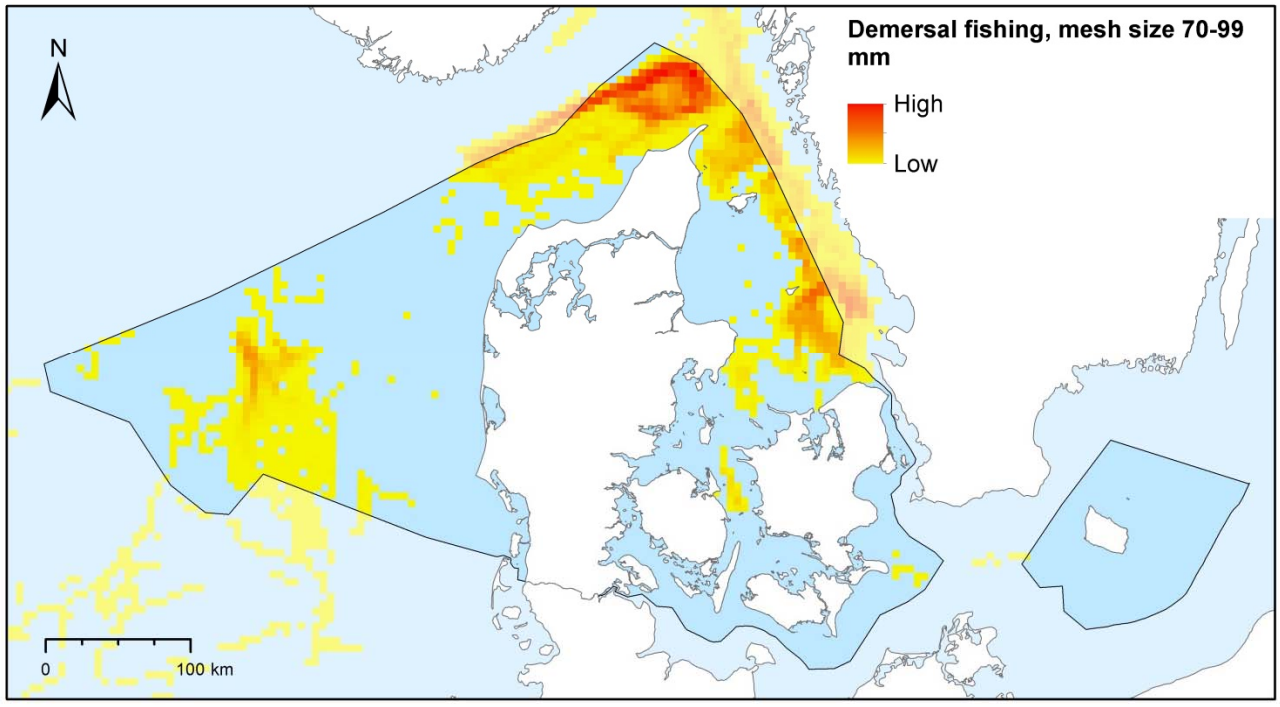
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, demersal fishing

B6 - Demersal fishing (mesh size 69 – 99 mm)



Map showing demersal fishing effort in Danish waters (mesh size 70 - 99 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

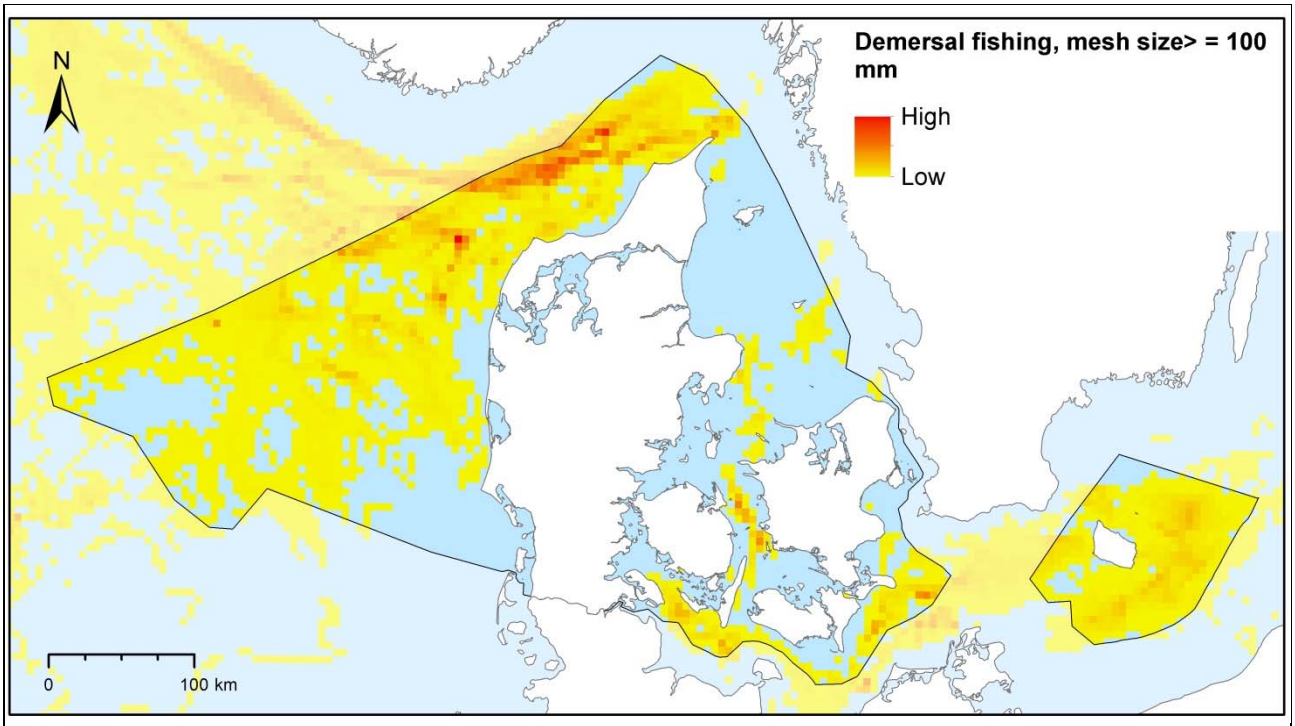
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, demersal fishing

B7 - Demersal fishing (mesh size ≥ 100 mm)



Map showing demersal fishing effort in Danish waters (mesh size ≥ 100 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

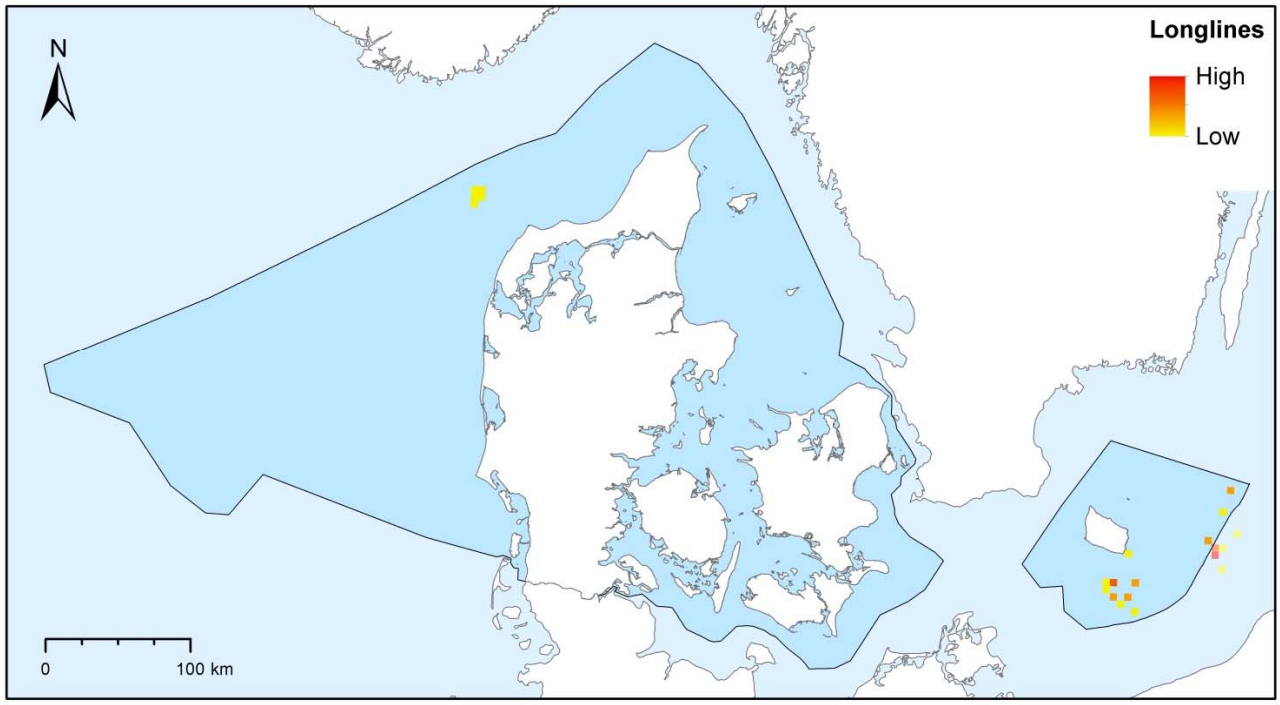
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, demersal fishing

B8 - Longlines



Map showing longline fishing effort in Danish waters.

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

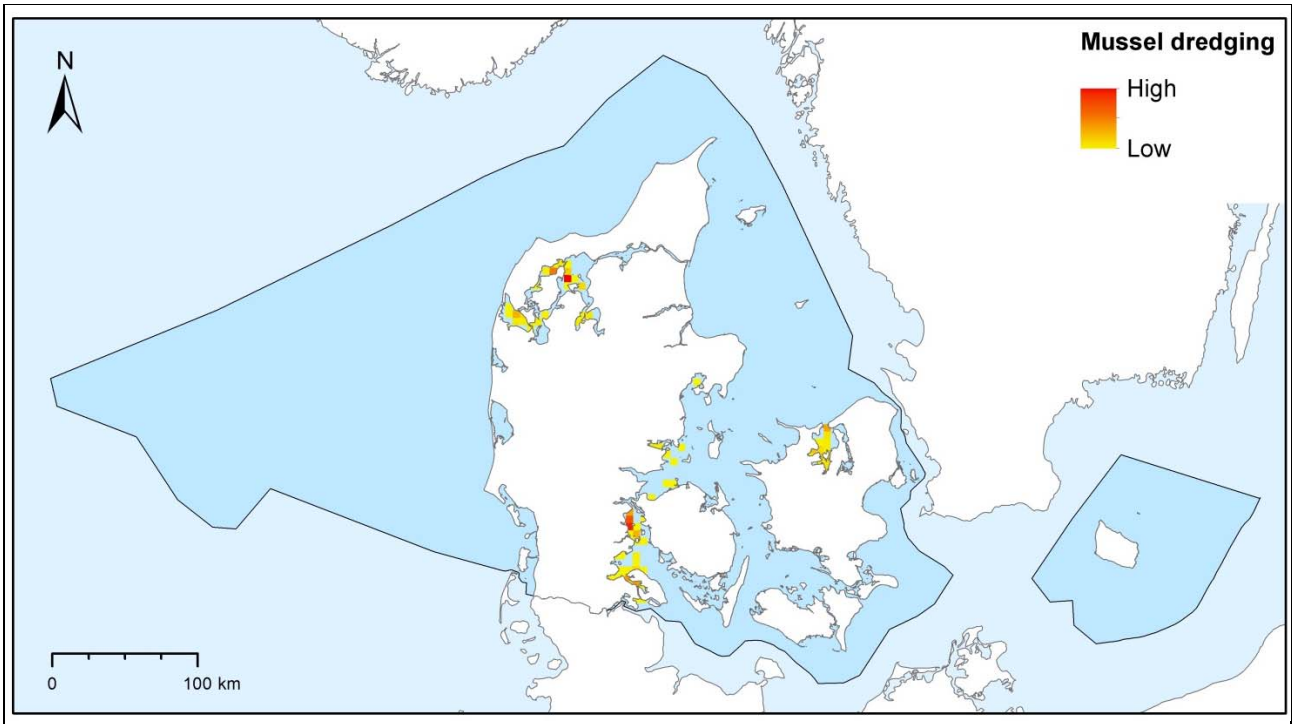
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, longline fishing

B9 - Mussel dredging



Map showing mussel dredging effort in Danish waters.

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

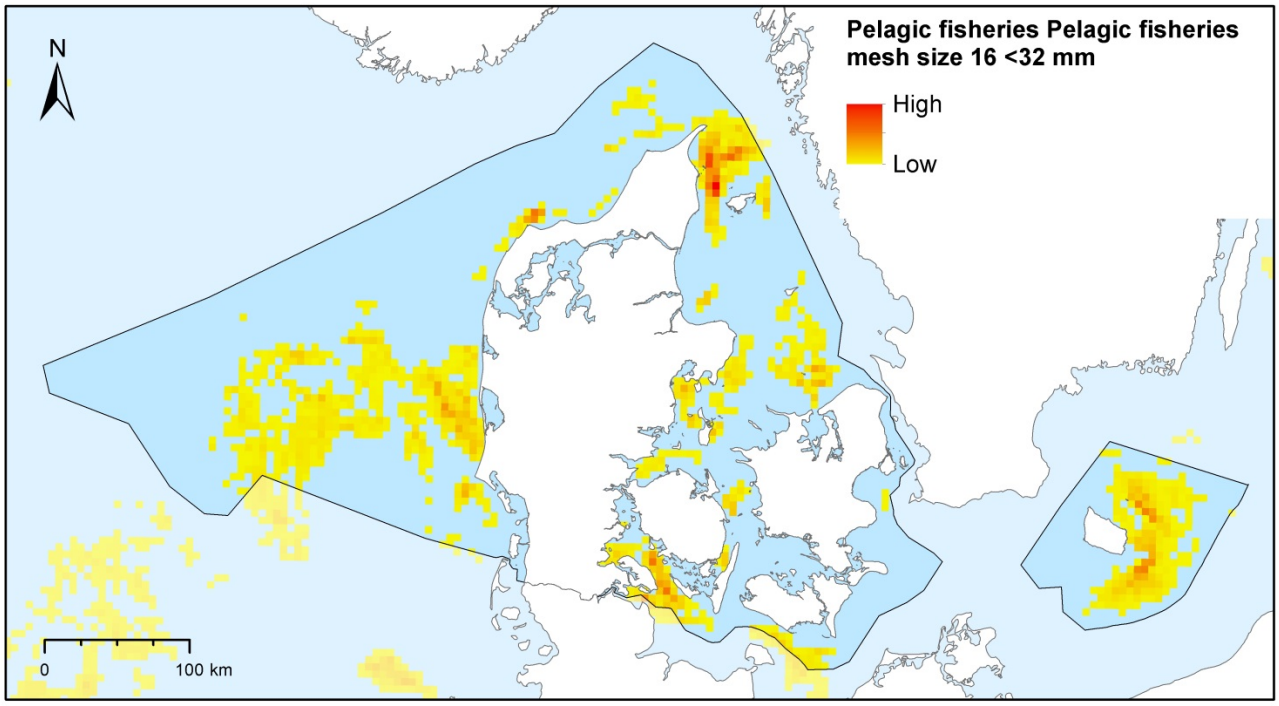
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, mussel dredging

B10 - Pelagic fishing (mesh size 16 – 32 mm)



Map showing pelagic fishing effort in Danish waters (mesh size 16 – 32 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

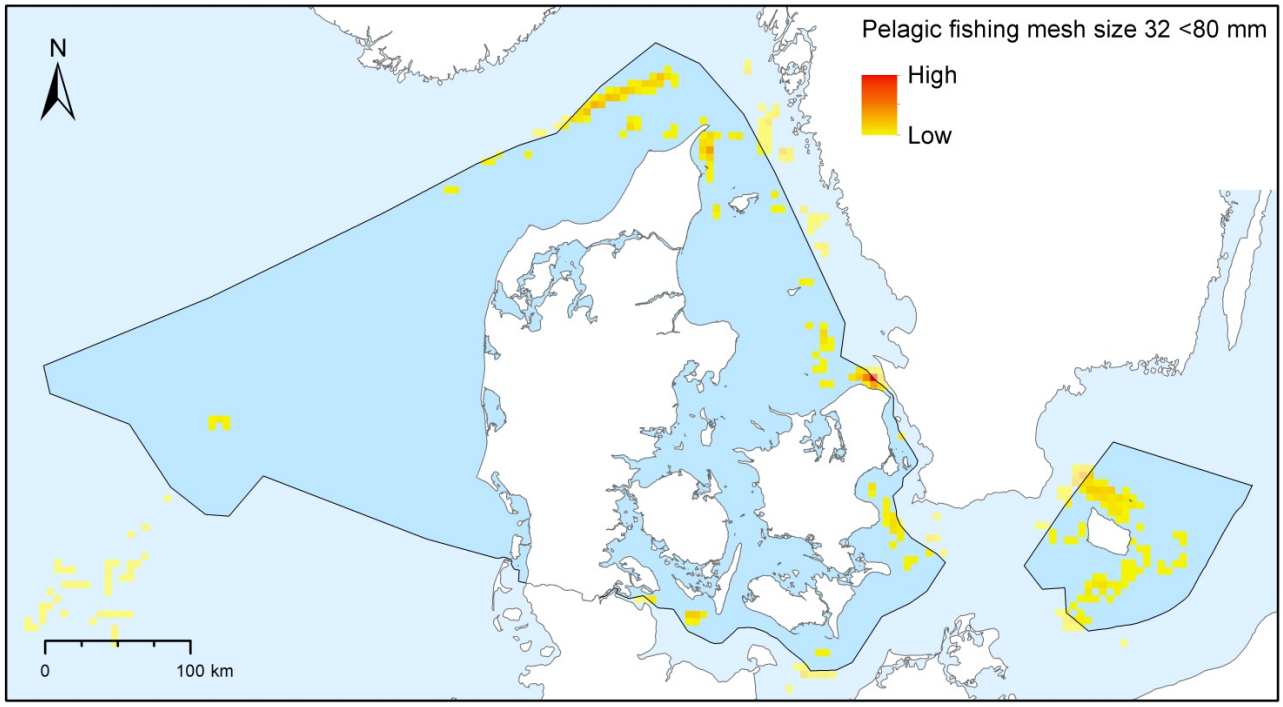
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, pelagic fishing

B11 - Pelagic fishing (mesh size 32 – 80 mm)



Map showing pelagic fishing effort in Danish waters (mesh size 32 – 80 mm).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

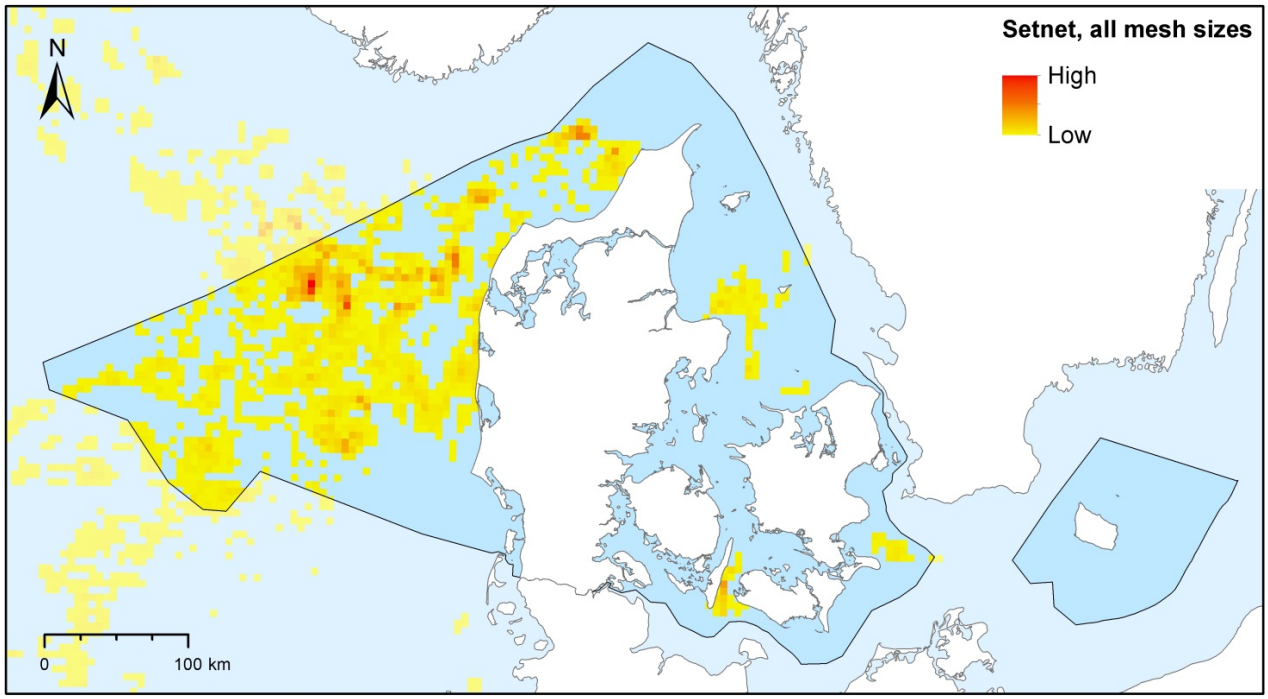
Danish EEZ.

References

Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, pelagic fishing

B12 - Set net (all mesh sizes)



Map showing setnet fishing effort in Danish waters (all mesh sizes).

Data sources and methods

See Dalskov et al. (2012).

Spatial coverage

Danish EEZ.

References

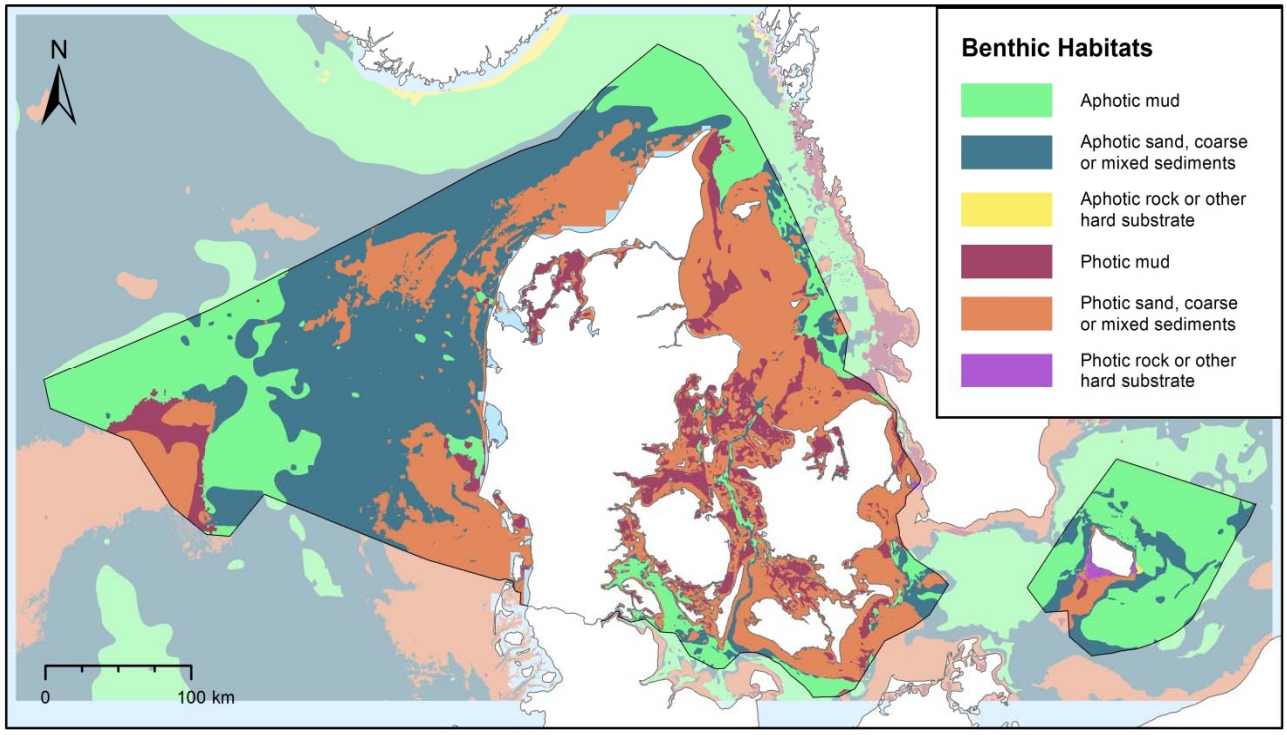
Dalskov, J., Egekvist, J., Vinther, M., Sparrevohn, C.R., Larsen, F., Warnar, T., Dolmer, P., Sørensen, T.K. (2012). Biologisk forstyrrelse: Selektiv udtagning af arter, herunder tilfældige fangster af ikke-målarter (f.eks. ved erhvervs- og fritidsfiskeri). Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 255-2012.

Scale or resolution	5 km
Time period	2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	fisheries, setnet fishing

Appendix C – Ecosystem components (general)

- C1 - Benthic habitats (aphotic mud, aphotic rock or other, aphotic sand and coarse or mixed sediments, photic mud, photic rock or other, photic sand and coarse or mixed sediments)
- C2 - Boulder reefs
- C3 - Eelgrass distribution
- C4 - N / P ratio winter
- C5 - Plankton communities in nutrient-rich and nutrient-poor waters

C1 – Benthic habitats



Broad-scale benthic habitats for the North Sea provided by the EUSeaMap project. Habitats were grouped into six major classes for the HARMONY project based on substrate and light availability.

Data sources and methods

EUSeaMap (http://jncc.defra.gov.uk/page-5020).

Data quality varies throughout the North Sea region depending on the quality of the data on which the original habitat map is based. See the EUSeaMap report (http://jncc.defra.gov.uk/page-5020) for a detailed description of data quality and uncertainties. The original data contain seven substrate types, six biological zones, as well as several salinity and energy classes, resulting in more than 50 combinations for the North Sea region at the finest level of detail. Within HARMONY, the data have been generalized based on substrate and light availability, distinguishing only six broad classes (substrate: mud; sand, coarse or mixed; rock and other hard; light: aphotic; euphotic). The same approach was used in SYMBIOSE. The data cover the whole Danish EEZ, however there are some gaps. First, relatively large areas – especially off the Norwegian coast – have the substrate type "seabed", which means that the substrate is unknown. Second, in some areas close to the coastline there are spots without any data, e.g. most of the Danish Limfjord. In each cell *c*, the density of benthic habitat *h* was set to *p(h) / n(c)*, where *p(h)* is presence or absence (1 or 0) of *h* and *n(c)* is the number of benthic habitats (1…6) present in *c*. For example, in a cell containing euphotic rock, aphotic rock and aphotic mud, the density of each of the three benthic habitats would be set to 1/3, and that of all other benthic habitats to 0. However, in some cells no information on substrate was available, but it was known whether it contained aphotic bottoms, euphotic bottoms or both. In these cases, the densities of the three aphotic or, respectively, euphotic benthic habitats were set to 1/3 each. Similarly, in cells without any information on benthic habitats, the densities of all 6 benthic habitats were set to 1/6. Finally, in the areas covered by broad-scale coastal ecosystems (for which data on benthic habitats were mostly missing), the densities of all six benthic habitats were set to 0.

Spatial coverage

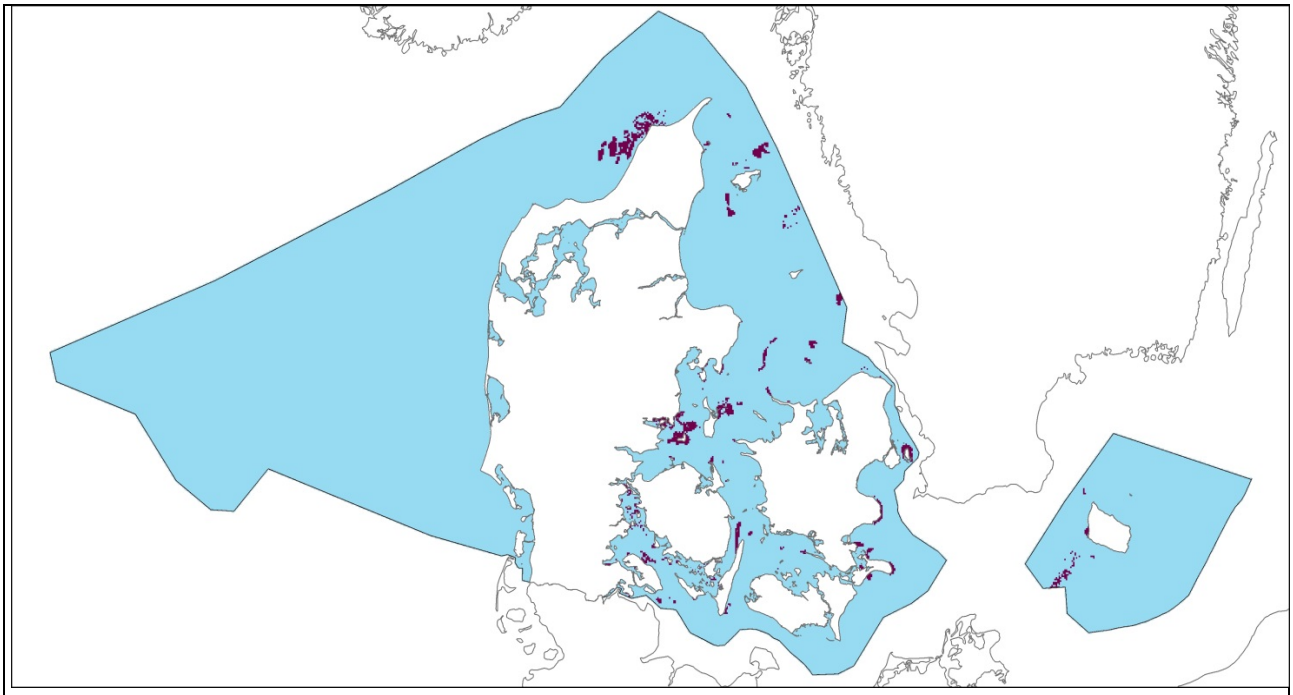
Danish EEZ.

References

HARMONY report (Andersen et al., 2013)

Scale or resolution	1 km
Time period	Unknown.
Data access	For the original data, see Data sources. Conditions of use: http://jncc.defra.gov.uk/plugins/newmapper/EUSeaMap_webGIS_Terms_&_Conditions_and_Privacy_Privacy_Policy_(WEB).pdf.
Responsible institution	DCE, AU.
Contact person	Jonas Koefoed Rømer
E-mail	jkr@bios.au.dk
Key words	benthic habitats, substrate, light availability

C2 – Boulder reefs



Map showing the distribution of known boulder reefs in Danish waters based on an evaluation of existing mapping activities.

Data sources and methods

The above map is a product of several mapping efforts with varying methodology and therefore also varying certainty. The map is based on the Danish Nature Agency's (NST) definition of boulder reefs which incorporates only a subset of the hard substrate in comparison to the definition given in Dahl et al (2003). Here, reef is defined as an area consisting of at least 25% stones with a typical size of 10 – 15 cm due to technical measurement reasons. A boulder reef is separated by surrounding substrate types with a stone coverage of 10%. With a few exceptions, reef mapping is limited to Natura-2000 areas. In the majority of the Danish marine waters mapping was not carried out. The original mapping of reefs (Foverskov 2004) was the basis for the Danish call for the habitat reef in relation to the EC Habitats Directive, but was based on very limited information from nautical charts, individual dives and assumptions. An acoustic mapping of reefs in the Kattegat and the western Baltic was conducted in 2011 by Orbicon / Geus using side scan sonar supplemented by visual verification (Jensen et al, 2012). In addition, an acoustic survey in other parts of the inner Danish waters was carried out in 2012, which was not yet publicly available during data analysisand writing of this report. There was also mapping of reefs in the North Sea / Skagerrak in 2010, but this mapping is conducted based on other definitions of reefs and is therefore not directly comparable. DCE has mapped reefs in an area of Samsø Belt and Little Belt using a method other than GEUS / Orbicon based on high-resolution multibeam data and an associated verification. More thorough surveys with side scan and multibeam have revealed serious shortcomings in the delinitation of reefs indicated by Foverskov (2004). Surveys based on interviews of fishermen and other locals in Anholt (Dahl, pers. communication) raise serious doubts whether there had been reefs in Anholt Vesterrev at all. In general, the estimated numbers of reef areas in Foverskov (2004) were too high. The spatial coverage of the completed mapping projects also varies considerably ranging from areas of full coverage (high certainty) to areas with very sporadic coverage (e.g. large parts of the Natura-2000 area 'Kim's Top' in the central Kattegat). Estimates of reefs in areas with sporadic coverage are subject to great uncertainty.

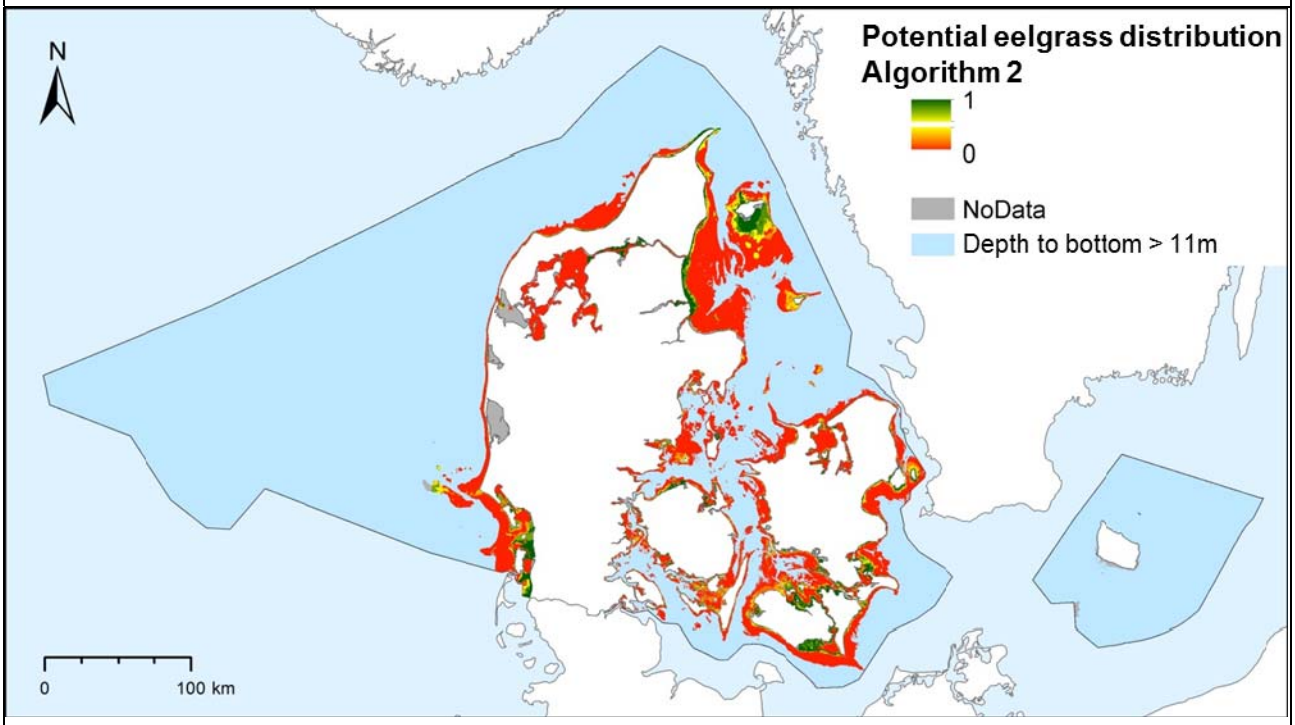
The above map is based on the following data: Acoustic mapping conducted in 2011 (Jensen et al, 2012), DCE's mapping results from the area around the Hatter Barn and Lillebælt areas. However, spatial coverage of known reef and adjacent areas in Foverskov's (2014) original mapping, where only limited data was available, was reduced based on expert assessment (valid for H147, H148 and H152) or completely removed (Anholt Vesterrev). In addition, reefs discovered by dive surveys were included (Gilleleje Flak, Hornbæk Plantage, Samso Pulle and Sjælland's Reef).

Spatial coverage

The map does not cover reef occurrences in larger ocean areas outside the Natura-2000 areas and reefs in the more open parts of the Skagerrak and North Sea.

References Dahl, K., Lundsteen, S., and Helmig, S. (2003) Stenrev, Havbundens oaser, Gads Forlag. Signe Foverskov, 2004. Marine naturtyper i habitatområder. Skov- og naturstyrelsen. Jensen, J.B., Nicolaisen, J.F., Al-Hamdani, Z., Nørgaard-Pedersen, N., Addington, L.G., Christensen, L., Lomholt, S., Schmedes, M. 2012. Marin råstof- og naturtypekortlægning i Kattegat og vestlige Østersø 2011. Danmarks og Grønlands Geologiske Undersøgelse Rapport 2012. Nicolaisen, J.F. og Schmedes, M.L., GEUS: Jensen, J.B., Borre, S., Leth, J.O., Al-Hamdani, Z. and Addington, L.G. 2011: Marin råstof og naturtypekortlægning i Nordsøen 2010. Under udgivelse af Naturstyrelsen 2011.	
Scale or resolution	1 km x 1 km
Time period	The map is based on data from the period 2004-2011
Data access	Original data Danish nature Agency (NST): Natura 2000 mapping, DCE/AU: Lillebælt
Responsible institution	DCE/AU
Contact person	Cordula Göke, Karsten Dahl
E-mail	**cog@bios.au.dk** , **kda@bios.au.dk**
Key words	Boulder reef, mapping

C3 - Eelgrass distribution



Map showing the potential distribution of eelgrass (Zostera *marina*) in Danish waters based on a GIS model.

Data sources and methods

The eelgrass map is a product of a number of integrated GIS maps (bathymetry, light at the bottom, bottom temperature, bottom salinity, physical exposure, oxygen and sediments). Maps of physical exposure and sediment conditions were obtained from EU Seamaps (Stevenson et al. 2011, Cameron et al. 2011, Al-Hamdani et al. 2013), and bathymetry. Maps of light, temperature and salinity were generated based on light and CTD profiles from the marine monitoring program (NOVANA), and represent summer (April-October) averages for the period 1994-2010. Each pixel in the GIS layers has been converted to a scale ranging from poor (0), medium (0.5) to good (1) conditions for distribution of eelgrass. The scale of each layer is based on a review of different previous studies (light, temperature and salt (Staehr & Borum 2011; Nejrup & Pedersen 2008)), as well as frequency distributions and expert judgment (oxygen and exposure). Layers were combined in a GIS algorithm with a resolution of 100x100m: Eelgrass potential = light index * exposure index * ((Temp index + sediment index + salinity index + oxygen index) / 4). Light and exposure are set to multiplicative parameters of the algorithm based on the view that eelgrass will only occur if all these requirements are met, whereas temperature, sediment, salinity and oxygen are weighted lower. The chosen algorithm was evaluated in relation to existing detailed maps of the distribution of eelgrass in confined areas. A more thorough validation in relation to the nationwide eelgrass mapping has been initiated and performed for Øresund (Lomholt et al 2015).

Spatial coverage

Danish waters in the depth interval 0-10m from the western Baltic Sea to the central/northern North Sea. Some areas with missing data layers were not considered.

References

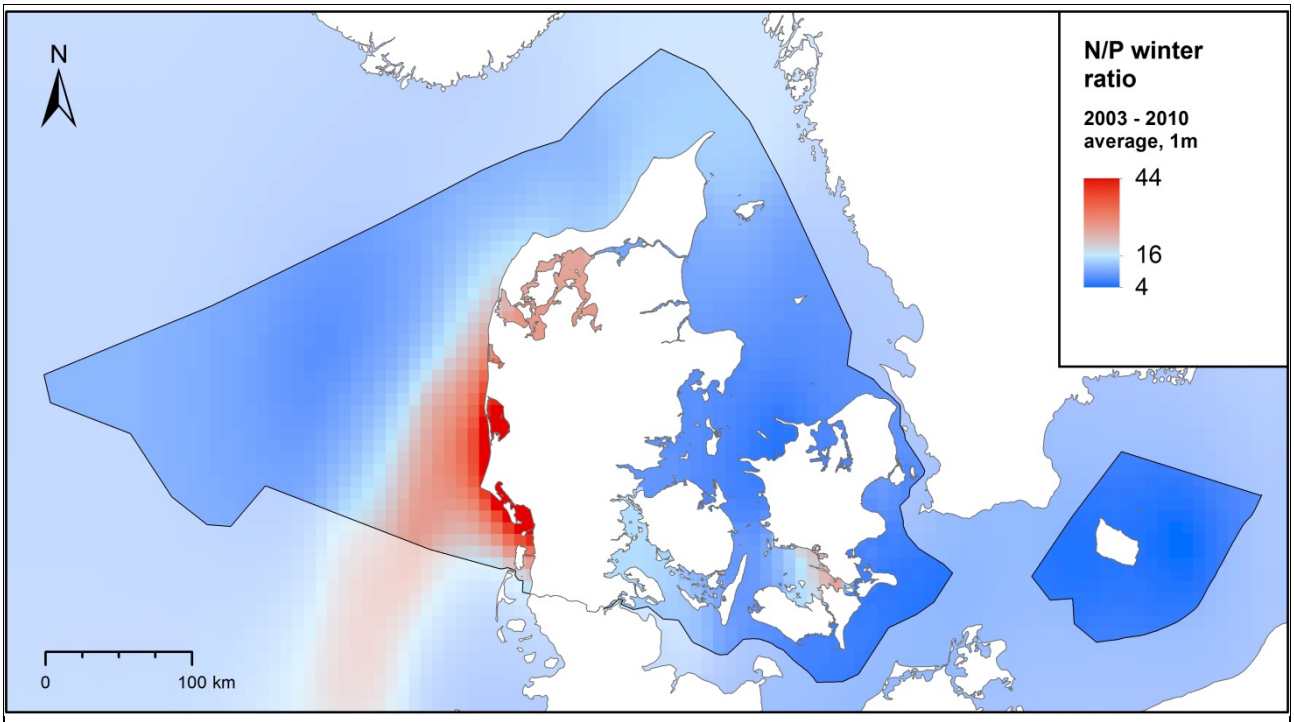
Stevenson, A., Kotilainen, A., Kaskela, A., Alanen, U., Asch, K., Schubert, C., van Heteren, S., van de Ven, T., Thorsnes, T., Verbruggen, K., Robinson, A., Guinan, J., Glaves, H., and the Project Team, 2011. EMODnet Geology Project Draft Final. Report. Preparatory Actions for a European Marine Observation and Data Network. Lot No 2 – Geological data. 40 pages.

Cameron, A. and Askew, N. (eds.). 2011. EUSeaMap - Preparatory Action for development and assessment of a European broad-scale seabed habitat map final report. Available at http://jncc.gov.uk/euseamap.

Al-Hamdani, Y. K., Leth, J. O., Jensen, J. B., Nørgaard-Pedersen, N., Addington, L. G., Christensen, L. and Lomholt, S.2013. EUSeaMap verifikation og opgradering Fase 2: Opgradering af sediment kort over den danske del af Kattegat og Østersøen Udført for Naturstyrelsen, GEUS rapport 2013/42.

Lomholt S, Riemann B, Dahl K, Pedersen NN, Leth JO, Göke C, Rasmussen MB, Skar S, Andersen, ON. Marin råstofkortlægning og miljøundersøgelse i Øresund 2014. GEUS rapport 20. Bathymetri: http://frv.dk/Maalinger/Farvandsmaalinger/Dybder/Pages/Digitale_dybdemodeller.aspx. Nejrup, L. B., and M. F. Pedersen 2008. Effects of salinity and water temperature on the ecological performance of Zostera marina. Aquatic Botany 88: 239-246. Staehr, P. A., and J. Borum 2011. Seasonal acclimation in metabolism reduces light requirements of eelgrass (Zostera marina). Journal of Experimental Marine Biology and Ecology 407: 139-146.	
Scale or resolution	0.003° x 0.003°
Time period	The map is based on data from the period 2000-2010.
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Karen Timmerman, Peter Stæhr
E-mail	kti@bios.au.dk, **pst@bios.au.dk**
Key words	Eelgrass, Zostera *marina,* GIS, Temperature, Oxygen, Salinity, Light, Exposure, Sediment.

C4 - N/P ratio winter



Map showing the N/P ratio in surface waters (1 m water depth). The map represents an 8 year extended winter average (2003-2010) based on observations from the Danish monitoring programme. All data were interpolated using objective analysis.

Data sources and methods

8 year averages (2003-2010, November to April) of Nitrate and Orthophosphate were extracted from the Danish monitoring programme data base (http://dce.au.dk/old/danmarksmiljoeundersoegelser/en/water/marinemonitoring/mads/).Data covers the North Sea, Skagerrak, Kattegat, the Belt Sea and part of the Baltic Proper. Data sets were interpolated to a 0.1° x 0.1° grid prior to the calculation of N/P ratios. Observed data were interpolated across the whole SYMBIOSE area using objective analysis (correlation scale = 0.6°, signal to noise ratio = 2) provided by the DIVA (http://www.seadatanet.org/Standards-Software/Software/DIVA) software package.

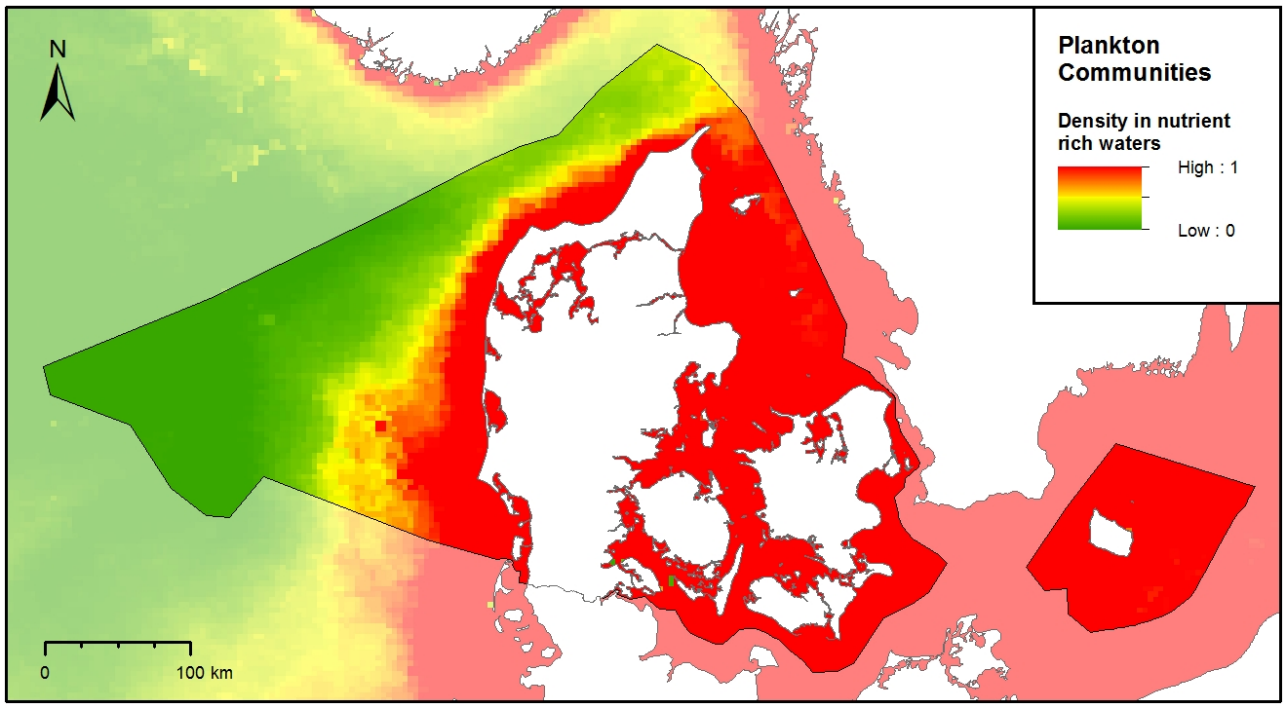
Spatial coverage

2003-2010 nitrate and orthophosphate data was available for parts of the North Sea, Skagerrak, Kattegat, Belt Sea and Baltic proper. The monitoring stations are unevenly distributed and were interpolated to a 0.1° x 0.1° grid.

References

Scale or resolution	ArcGis output raster: 1 x 1 km og smoothing factor: 20 km.
Time period	2003 – 2010 (8 year average)
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Christian Mohn
E-mail	chmo@bios.au.dk
Key words	Surface Nitrate and Phosphate concentrations, N/P ratio, Danish monitoring programme

C5 - Plankton communities



Map showing the plankton communities in nutrient rich and poor waters. Nutrient rich and poor waters were used as a proxy for the spatial distribution of plankton communities according to the methodology by Andersen et al. (2013).

Data sources and methods

A global average for the period 2003-2010 of marine chlorophyll concentrations (MODIS Aqua L3 product) was downloaded from the NOAA/NASA data service http://oceancolor.gsfc.nasa.gov/ in netcdf format. The original data resolution is 4 km and was interpolated to the Symbiose 1 km raster. The spatial distribution of plankton communities is based on thresholds for classifying trophic states based on chlorophyll (chl) given by Wasmund et al. (2001). The classification is defined as oligotrophic state (chl < 0.8 mg m^{-3}), mesotrophic (chl = 0.8-4 mg m^{-3}), eutrophic (chl = 4-10 mg m^{-3}) and poly/hypertrophic (chl > 10 mg m^{-3}). Accordingly, the densities of nutrient-rich waters were set to 1 (chl ≥ 4 mg m^{-3}), to 0 (chl ≤ 0.8 mg m^{-3}) and a linear range from 0 to 1 for chlorophyll values in between (Andersen et al., 2013). The densities of nutrient-poor waters have been set to 1 – dr, where dr is the density of nutrient-rich waters in this location (Andersen et al., 2013).

Spatial coverage

Original data were extracted from the global dataset for the entire Baltic Sea (including Skagerrak, Kattegat and Belt Sea) and North Sea region. The spatial resolution of the original data is 4 km.

References

Andersen JH, Stock A, Heinänen S, Mannerla M, Vinther M (2013) Human uses, pressures and impacts in the eastern North Sea. DCE Technical Report No. 18, Aarhus University, 139 pp.

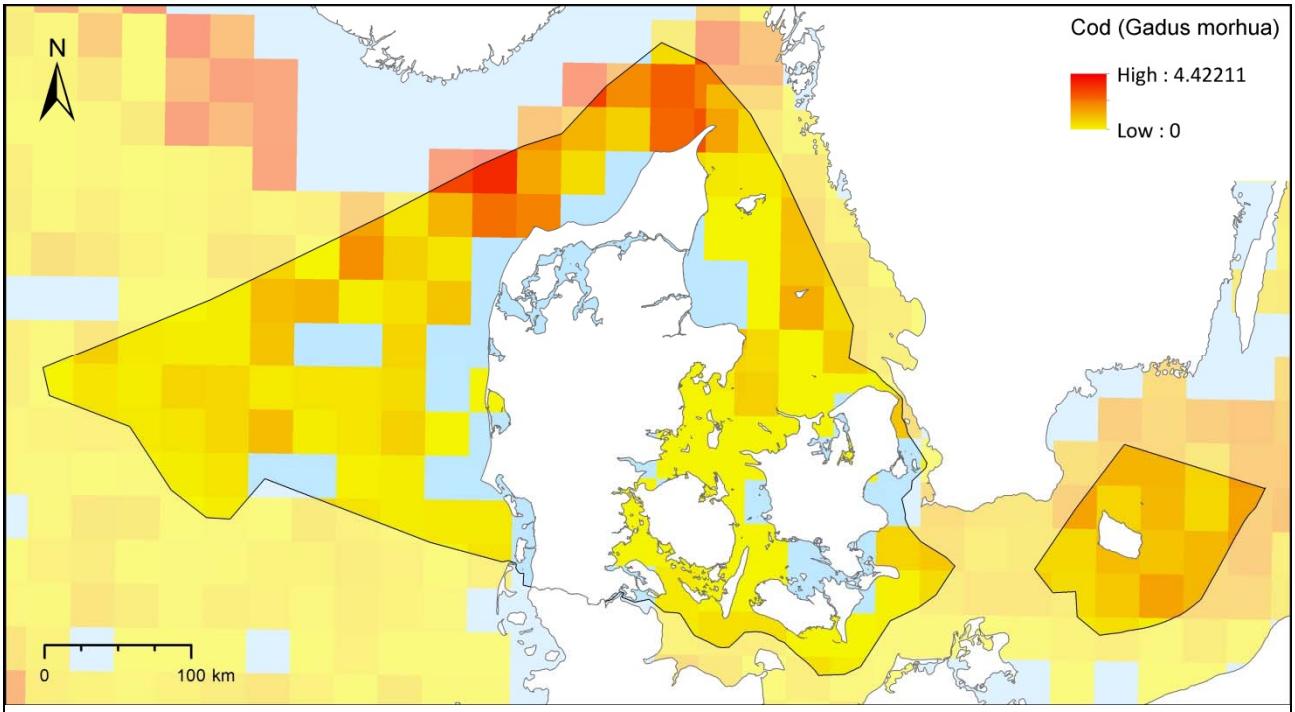
Wasmund N, Andrushaitis A, Łysiak-Pastuszak E, Müller-Karulis, Nausch B.G., Neumann T, Ojaveer H, Olenina I, Postel L, Witek Z (2001) Trophic Status of the South-Eastern Baltic Sea: A Comparison of Coastal and Open Areas. - Estuarine, Coastal and Shelf Science 53: 849-864.

Scale or resolution	ArcGis output raster: 1 x 1 km og smoothing factor: 20 km.
Time period	2003 – 2010 (8 year average)
Data access	Originaldata er tilgængelige.
Responsible institution	DCE/AU
Contact person	Christian Mohn
E-mail	chmo@bios.au.dk
Key words	Plankton communities, chlorophyll, MODIS aqua L3

Appendix D – Ecosystem components (fish and shellfish – biomass distribution)

- D1 - Cod (Gadus morhua, *Torsk*)
- D2 - Coalfish (Pollachius virens, *Sej*)
- D3 – Common Hooknose (Agonus cataphractus, *Almindelig Panserulk*) / Monkfish (Lophius piscatorius, *Havtaske*)
- D4 – Common Sole (Solea solea, *Almindelig Tunge*)
- D5 – Dab (Limanda limanda, *Ising*)
- D6 – Common Dogfish (Scyliorhinus caniculus, *Småplettet Rødhaj*)
- D7 – Spiny Dogfish (Squalus acanthias, *Pighaj*)
- D8 - Flounder (Platichtys flesus, *Skrubbe*)
- D9 – Haddock (Melanogrammus aeglefinus, *Kuller*)
- D10 - Herring (Clupea harengus, *Sild*)
- D11 - Lumpfish (Cyclopterus lumpus, *Stenbider*)
- D12 - Mackerel (Scomber sombrus, *Makrel*)
- D13 – Northern Prawn (Pandalus borealis, *Dybhavsrejer*)
- D14 – Norway Lobster (Nephrops norvegicus, *Jomfruhummer*)
- D15 - Plaice (Pleuronectes platessa, *Rødspætte*)
- D16 - Shrimp (Crangon crangon, *Hesterejer*)
- D17 - Sperling (Trisopterus esmarkii, *Sperling*)
- D18 - Sprat (Sprattus sprattus, *Brisling*)
- D19 – Starry Ray (Raja radiate, *Tærbe*)
- D20 - Turbot (Psetta maxima, *Pighvarre*)
- D21 – Whiting (Merlangius merlangus, *Hvilling*)

D1 - Cod (Gadus morhua, *Torsk*)



Map showing Cod distribution in Danish waters.

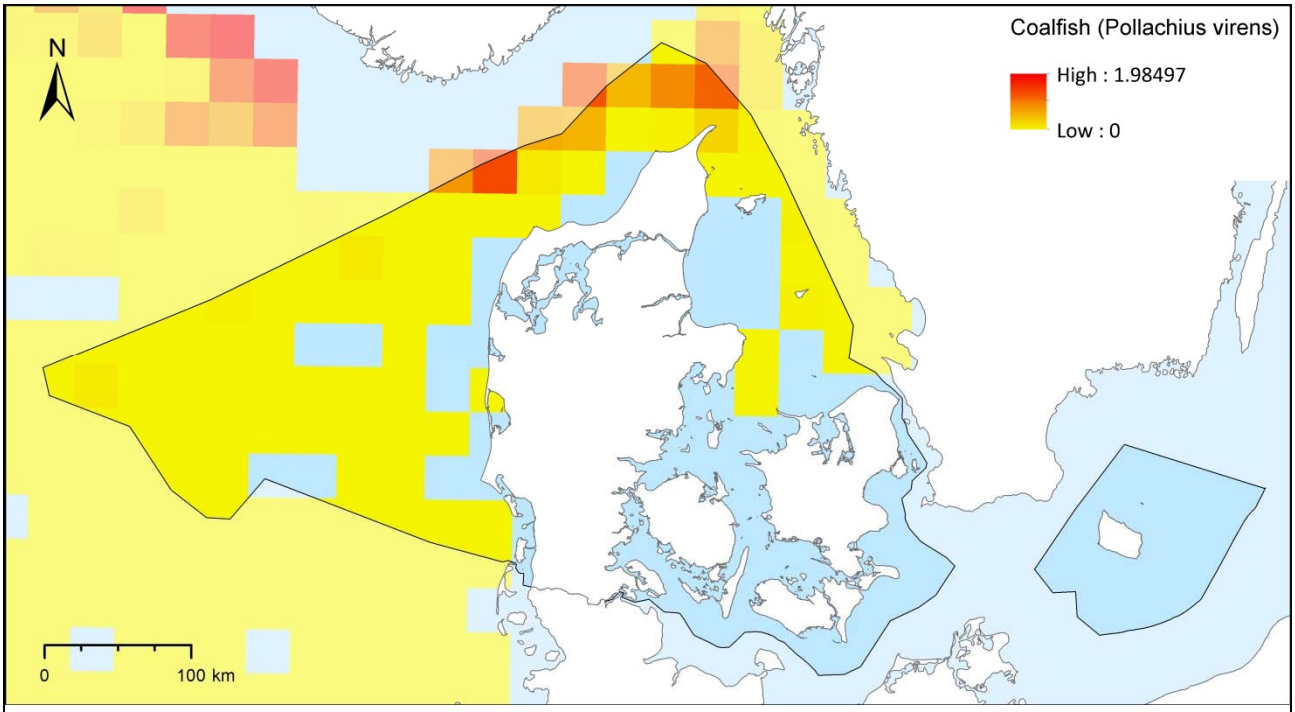
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Cod, spawning stock biomass

D2 - Coalfish (Pollachius virens, *Sej*)



Map showing Coalfish distribution in Danish waters.

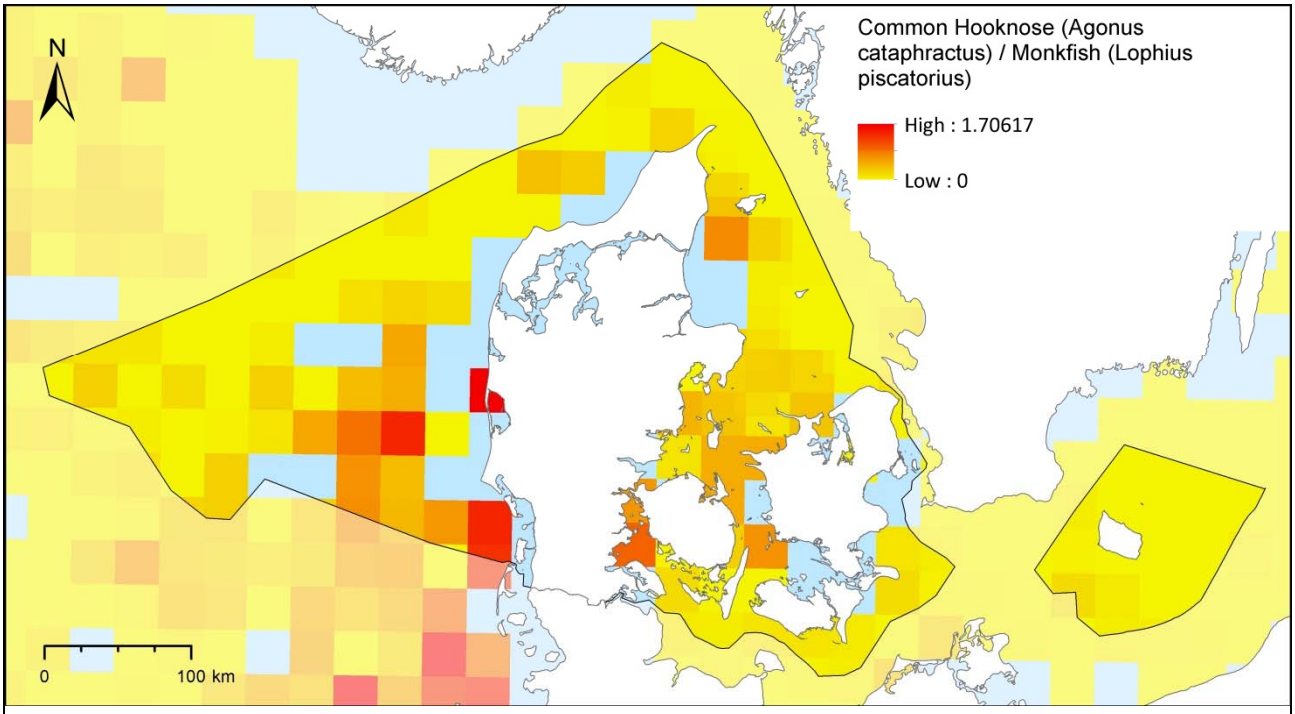
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Coalfish, spawning stock biomass

D3 – Common Hooknose (Agonus cataphractus, *Almindelig Panserulk*) / Monkfish (Lophius piscatorius, *Havtaske*)



Map showing Common Hooknose / Monkfish distribution in Danish waters.

Data sources and methods

See Warnar et al. (2012).

Spatial coverage

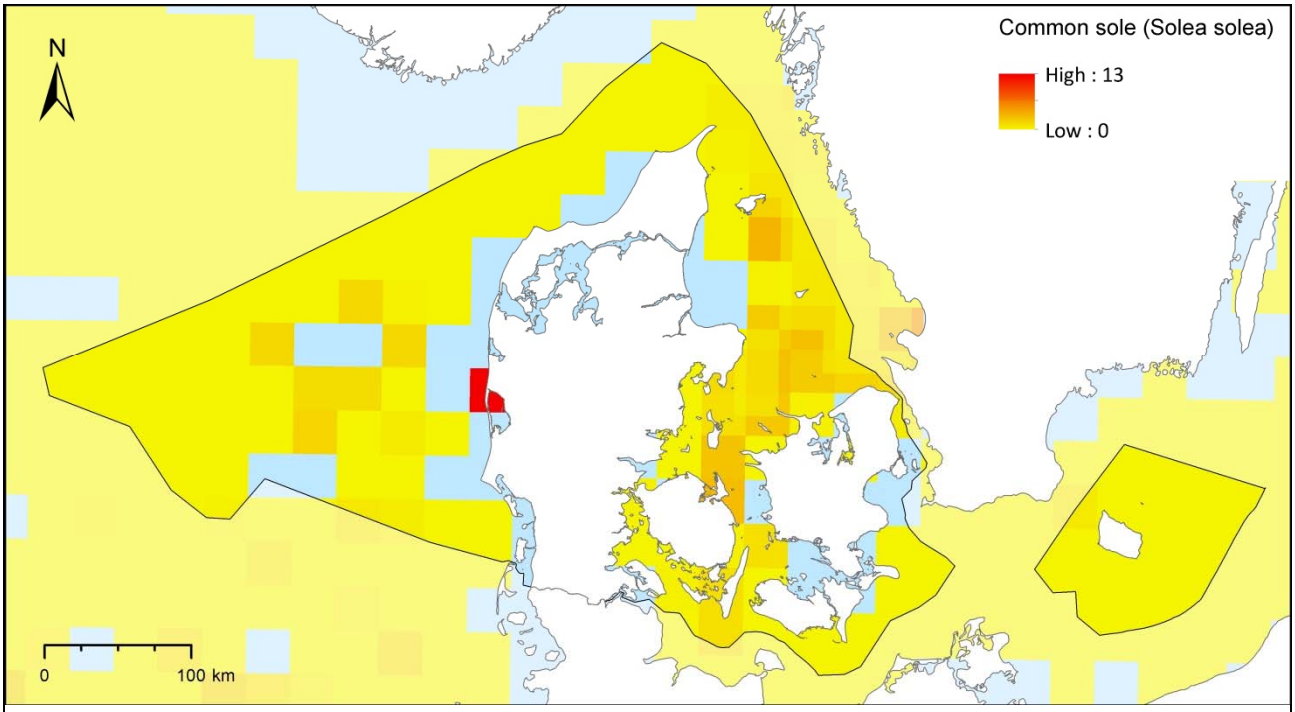
Danish EEZ.

References

Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Common Hooknose, Monkfish, spawning stock biomass

D4 – Common Sole (Solea solea, *Almindelig Tunge*)



Map showing Common sole distribution in Danish waters.

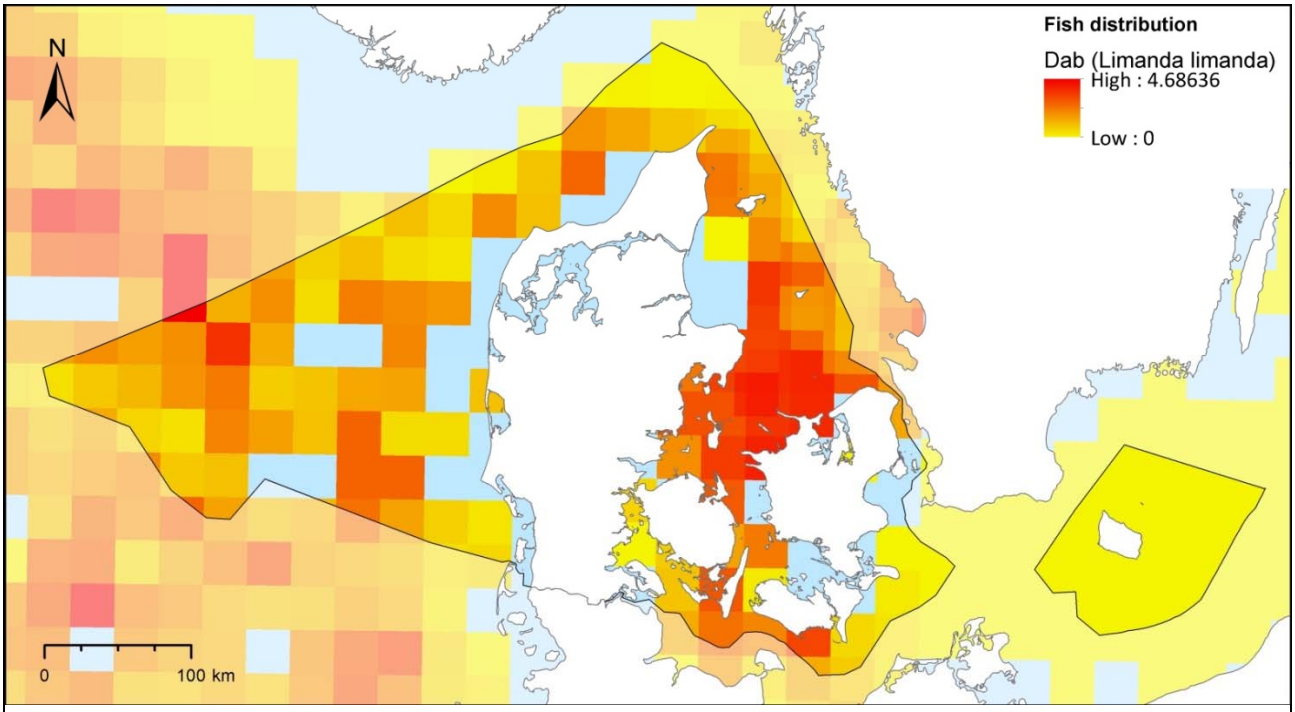
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Common sole, spawning stock biomass

D5 - Dab (Limanda limanda, *Ising*)



Map showing Dab distribution in Danish waters.

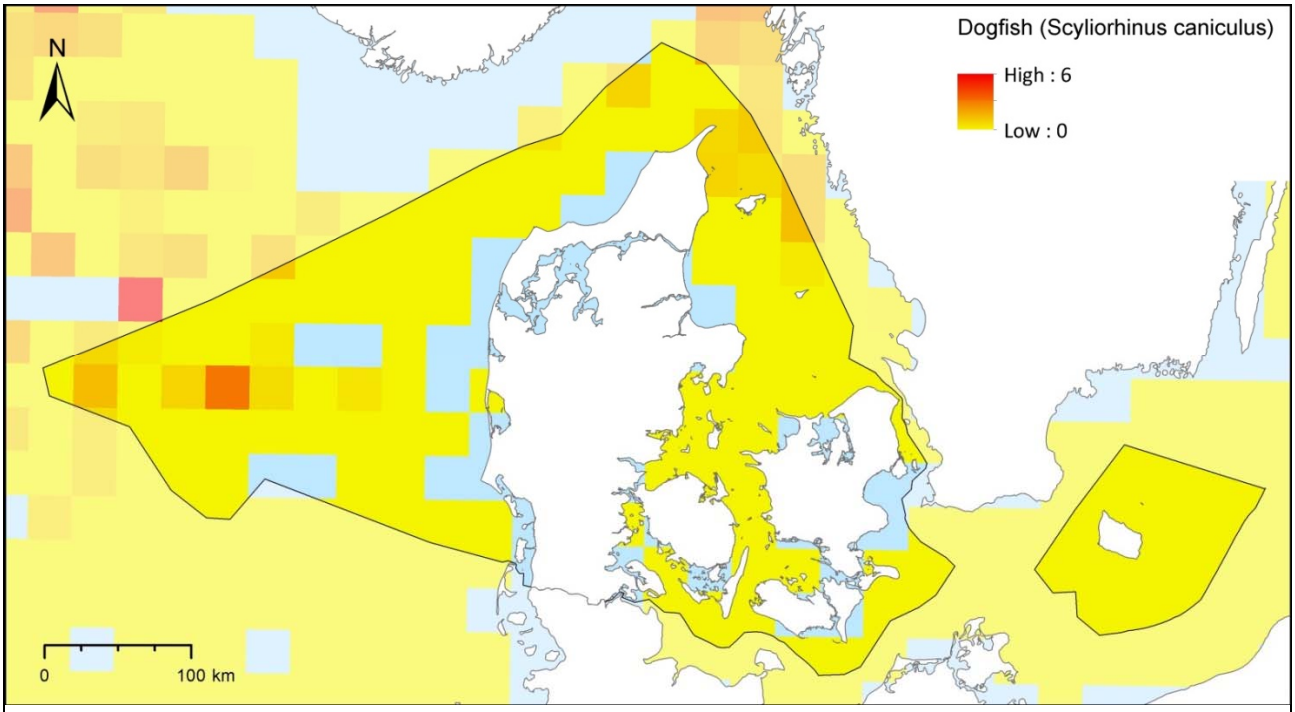
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Dab, spawning stock biomass

D6 – Common Dogfish (Scyliorhinus caniculus, *Småplettet rødhaj*)



Map showing Common Dogfish distribution in Danish waters.

Data sources and methods

See Warnar et al. (2012).

Spatial coverage

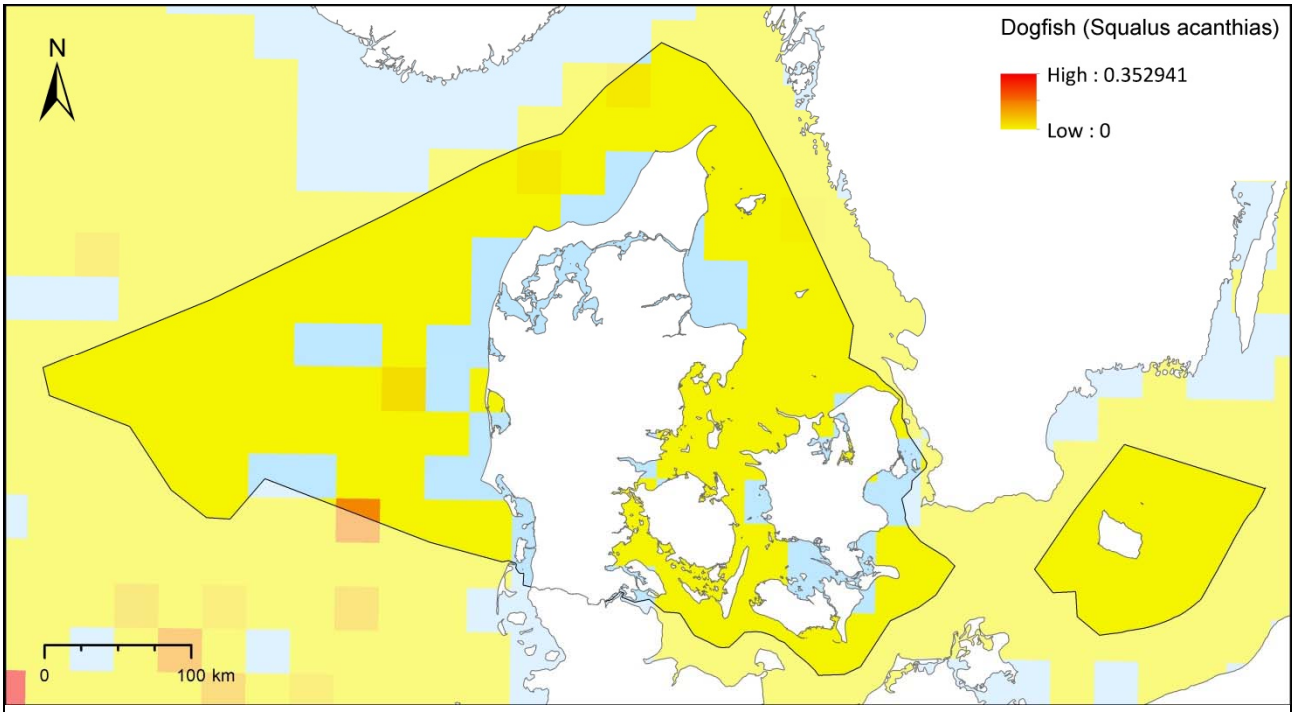
Danish EEZ.

References

Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Dogfish, spawning stock biomass

D7 – Spiny Dogfish (Squalus acanthias, *Almindelig Pighaj*)



Map showing Spiny Dogfish distribution in Danish waters.

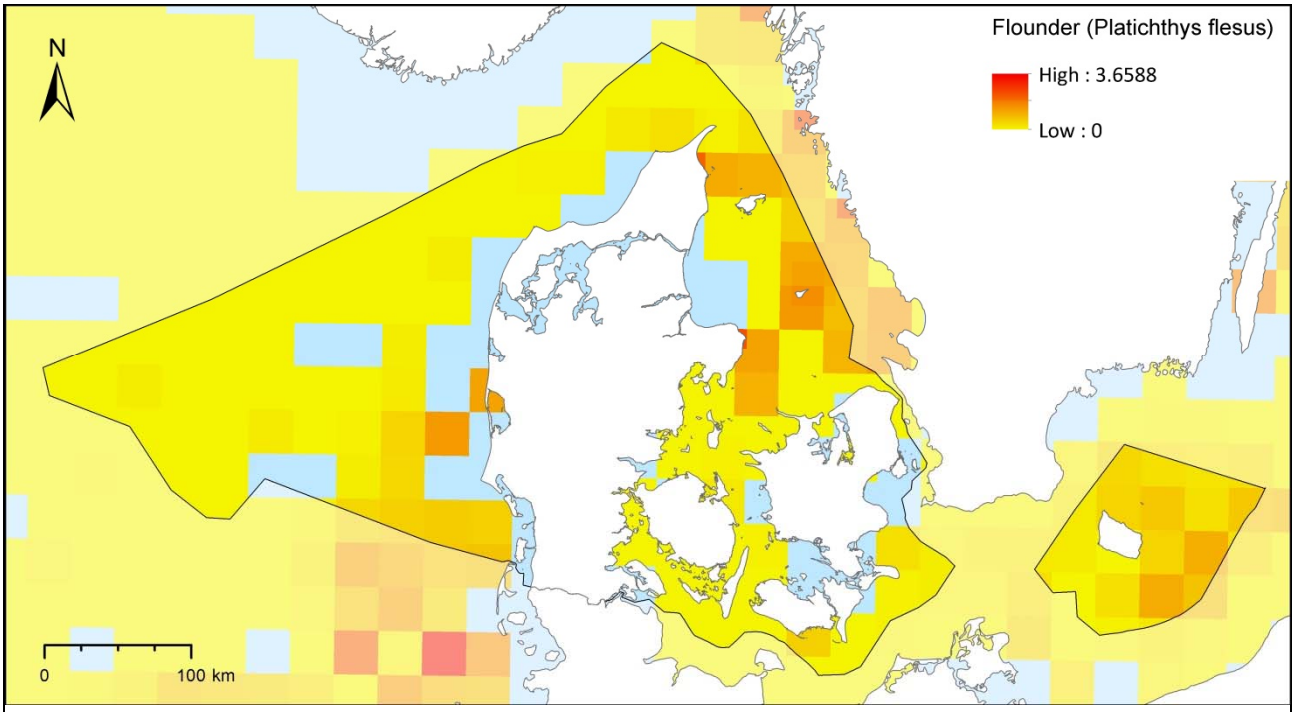
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Dogfish, spawning stock biomass

D8 – Flounder (Platichthys flesus, *Skrubbe*)



Map showing Flounder distribution in Danish waters.

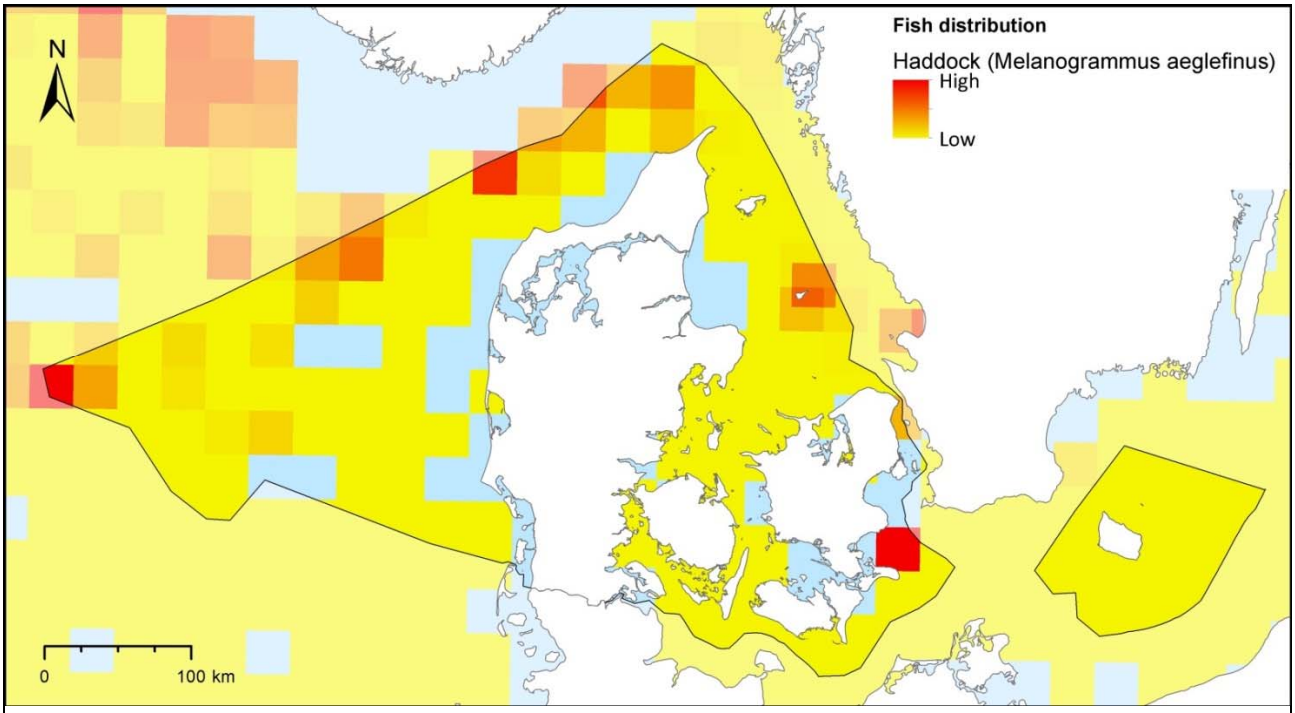
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Flounder, spawning stock biomass

D9 – Haddock (Melanogrammus aeglefinus, *Kuller*)



Map showing Haddock distribution in Danish waters.

Data sources and methods

See Warnar et al. (2012).

Spatial coverage

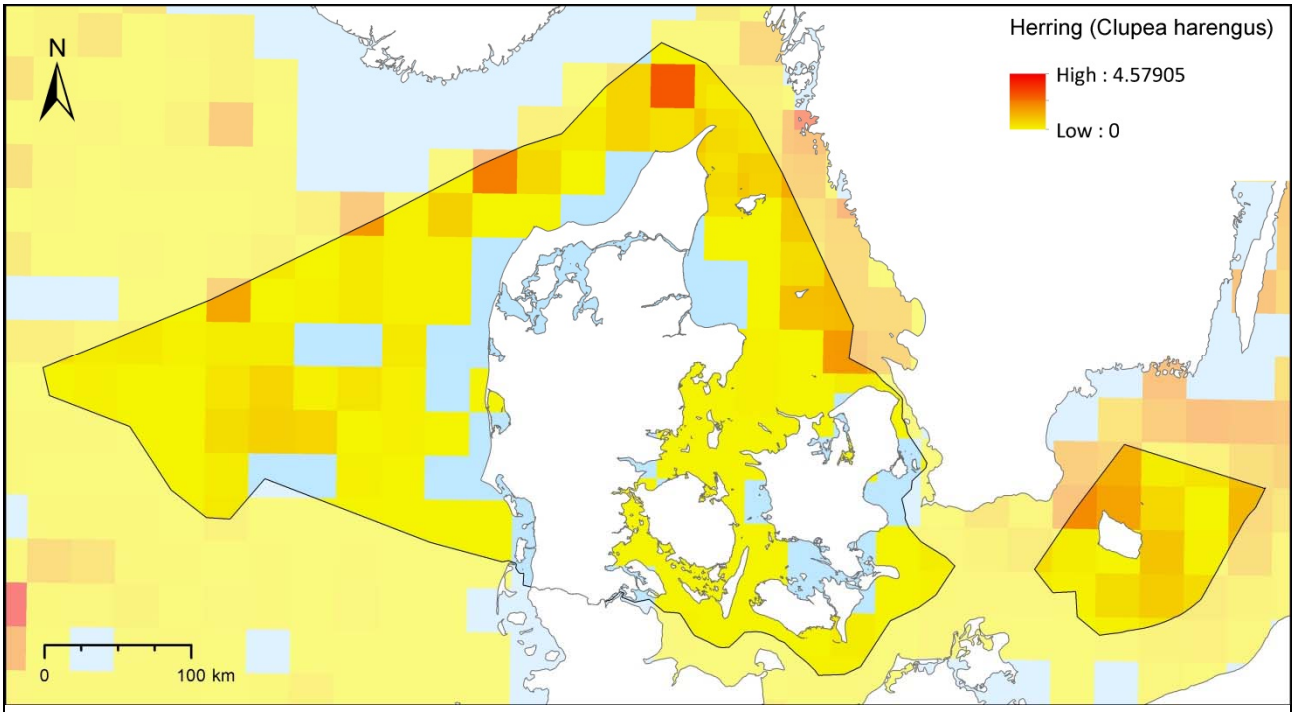
Danish EEZ.

References

Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Haddock, spawning stock biomass

D10 - Herring (Clupea harengus, *Sild*)



Map showing Herring distribution in Danish waters.

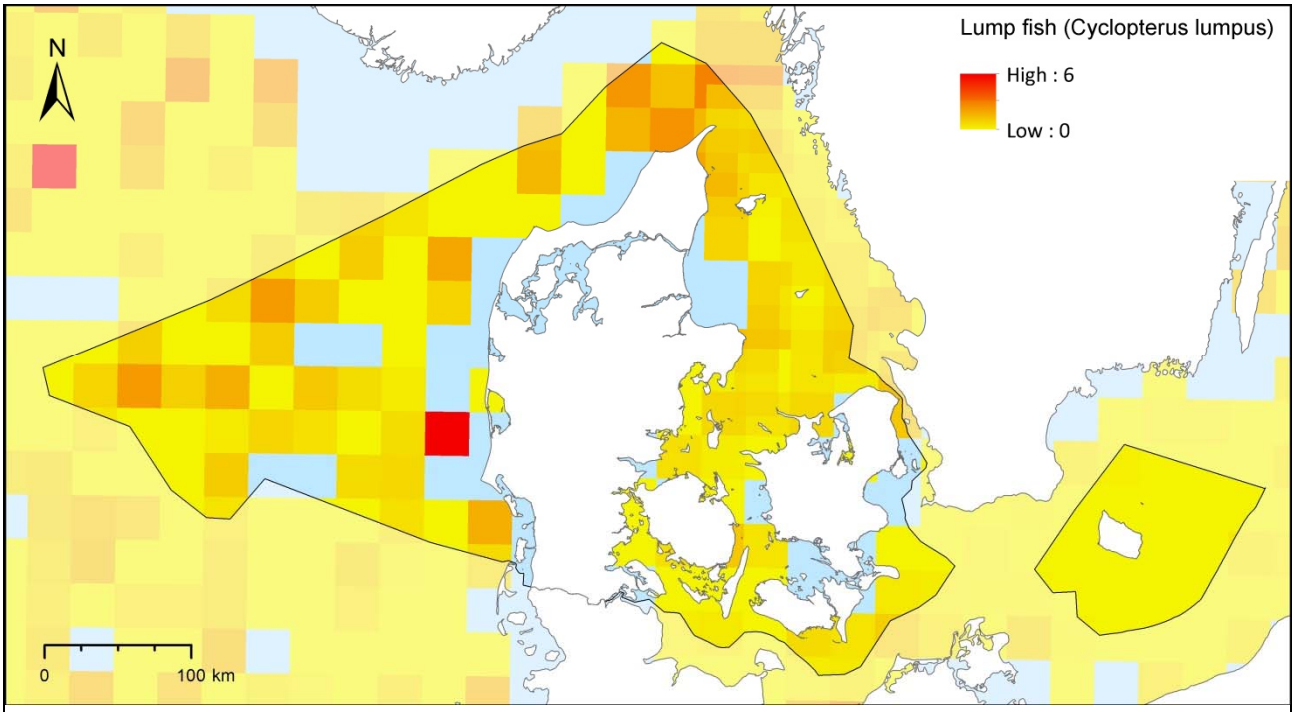
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Herring, spawning stock biomass

D11 - Lumpfish (Cyclopterus lumpus, *Stenbider*)



Map showing Lump fish distribution in Danish waters.

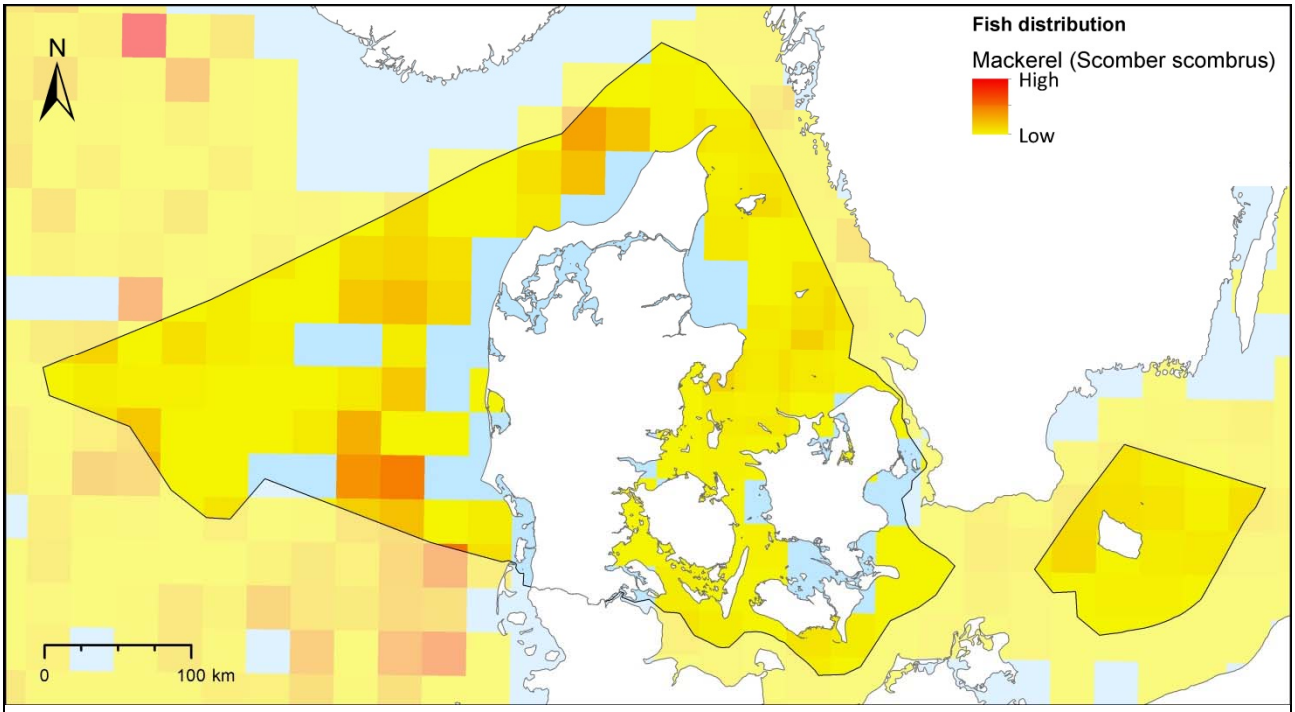
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Lump fish, spawning stock biomass

D12 - Mackerel (Scomber scombrus, *Makrel*)



Map showing Mackerel distribution in Danish waters.

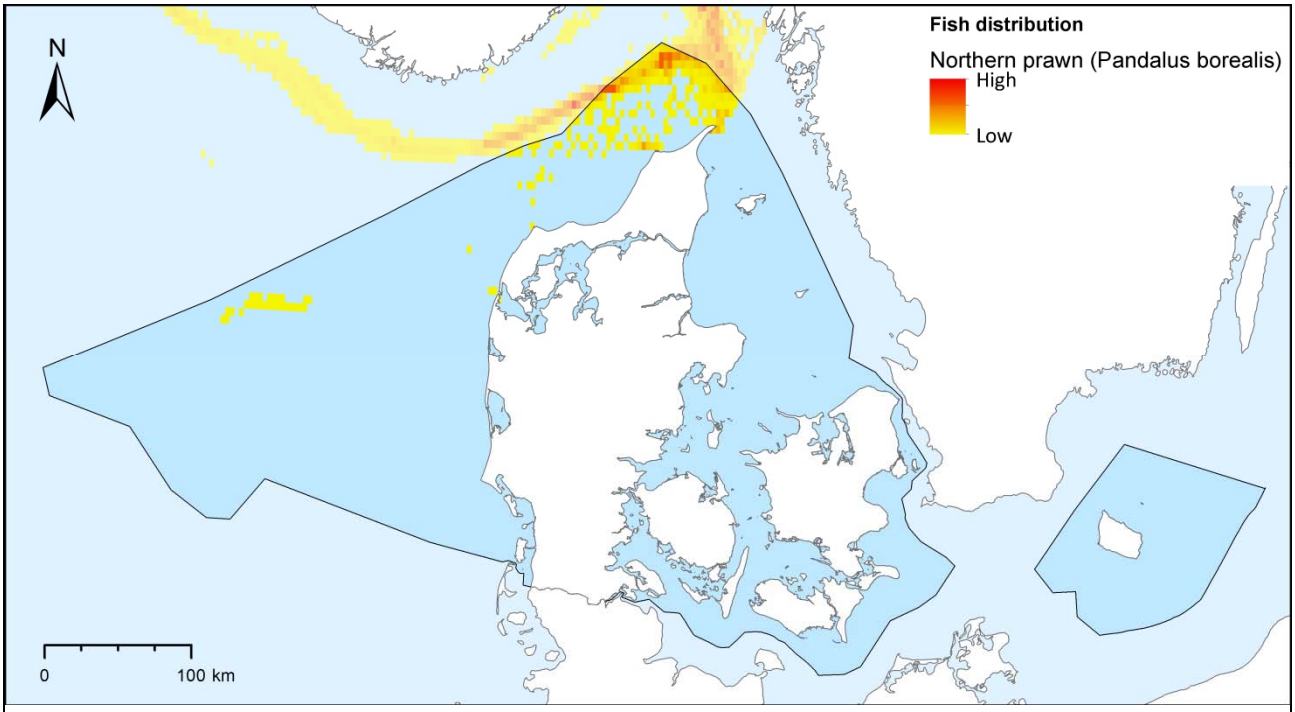
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Mackerel, spawning stock biomass

D13 – Northern Prawn (Pandalus borealis, *Dybhavsrejer*)



Map showing Northern prawn distribution in Danish waters.

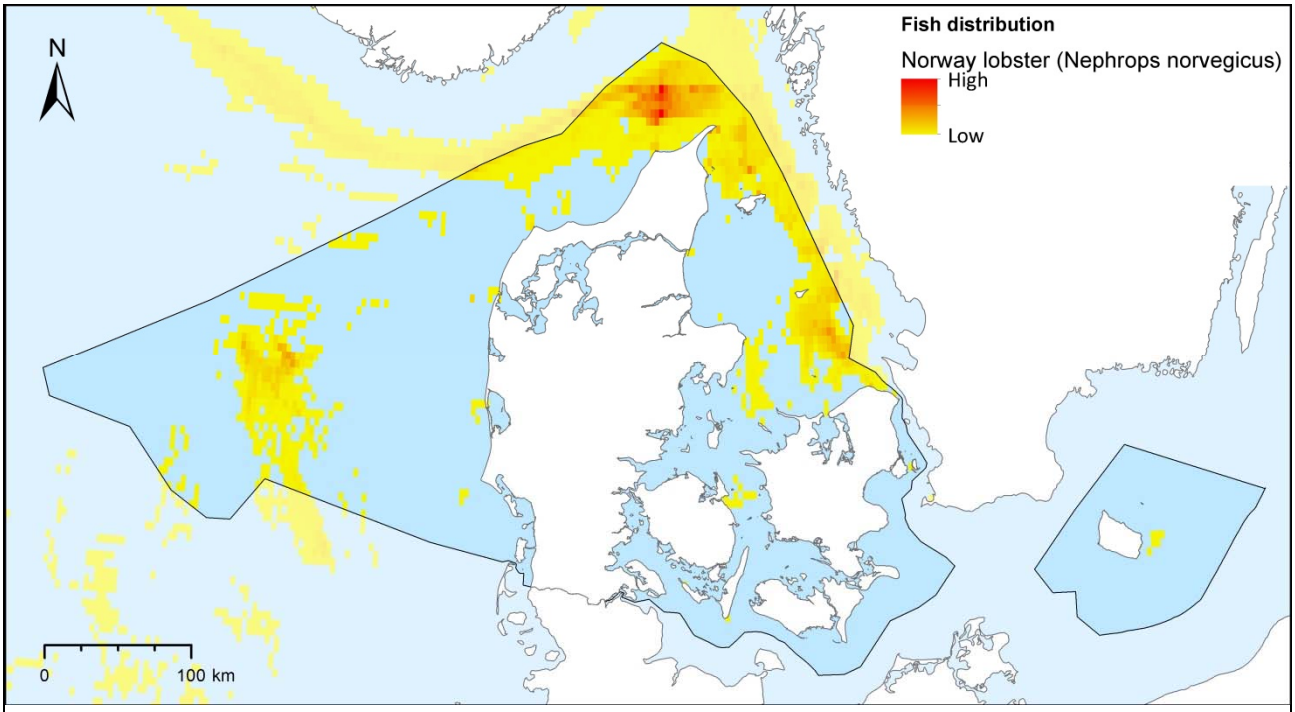
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	0.05 °
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Northern prawn, spawning stock biomass

D14 – Norway Lobster (Nephrops norvegicus, *Jomfruhummer*)



Map showing Norway lobster distribution in Danish waters.

Data sources and methods

See Warnar et al. (2012).

Spatial coverage

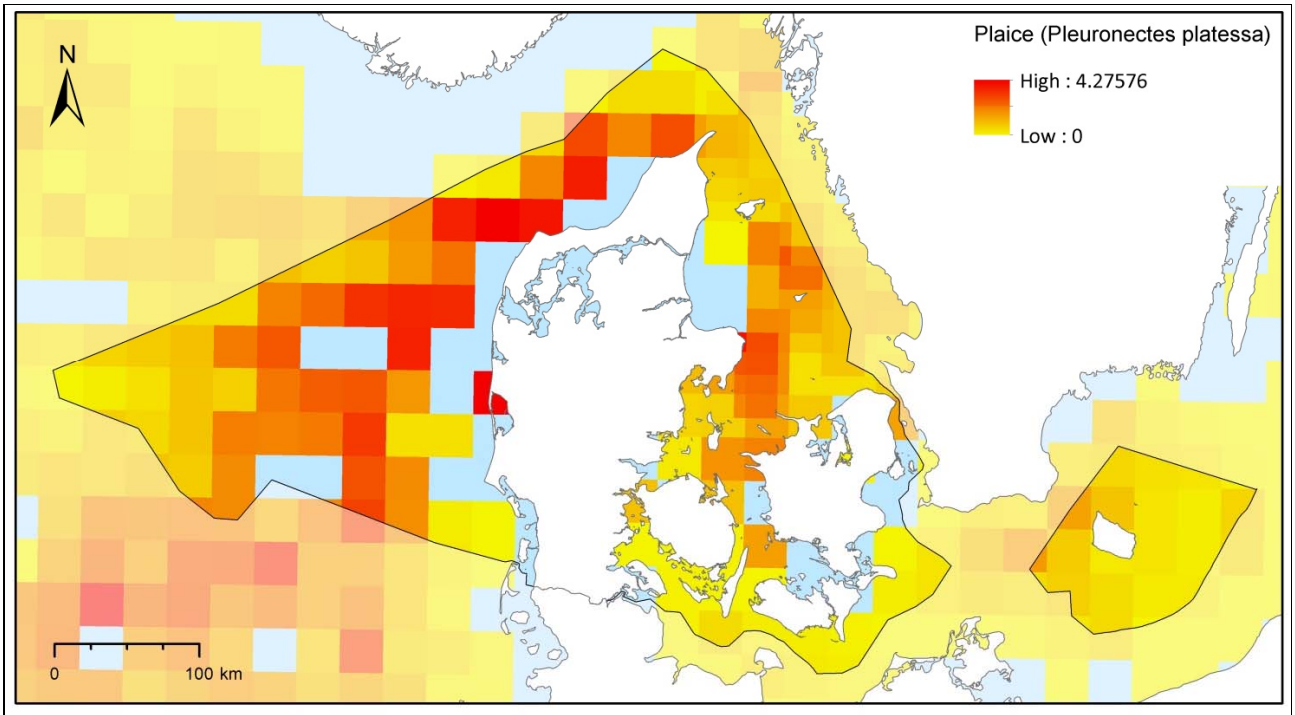
Danish EEZ.

References

Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	0.05 °
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Norway lobster, spawning stock biomass

D15 - Plaice (Pleuronectes platessa, *Rødspætte*)



Map showing Plaice distribution in Danish waters.

Data sources and methods

See Warnar et al. (2012).

Spatial coverage

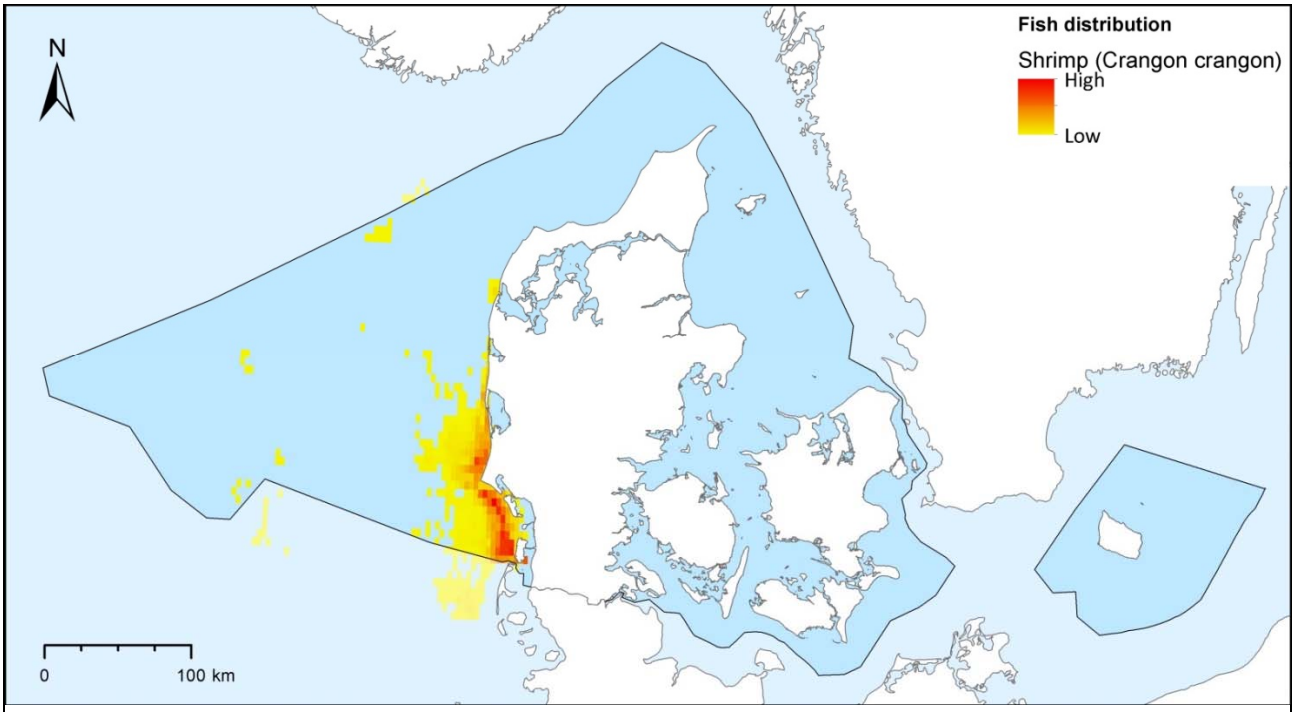
Danish EEZ.

References

Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Plaice, spawning stock biomass

D16 - Shrimp (Crangon crangon, *Hesterejer*)



Map showing Shrimp distribution in Danish waters.

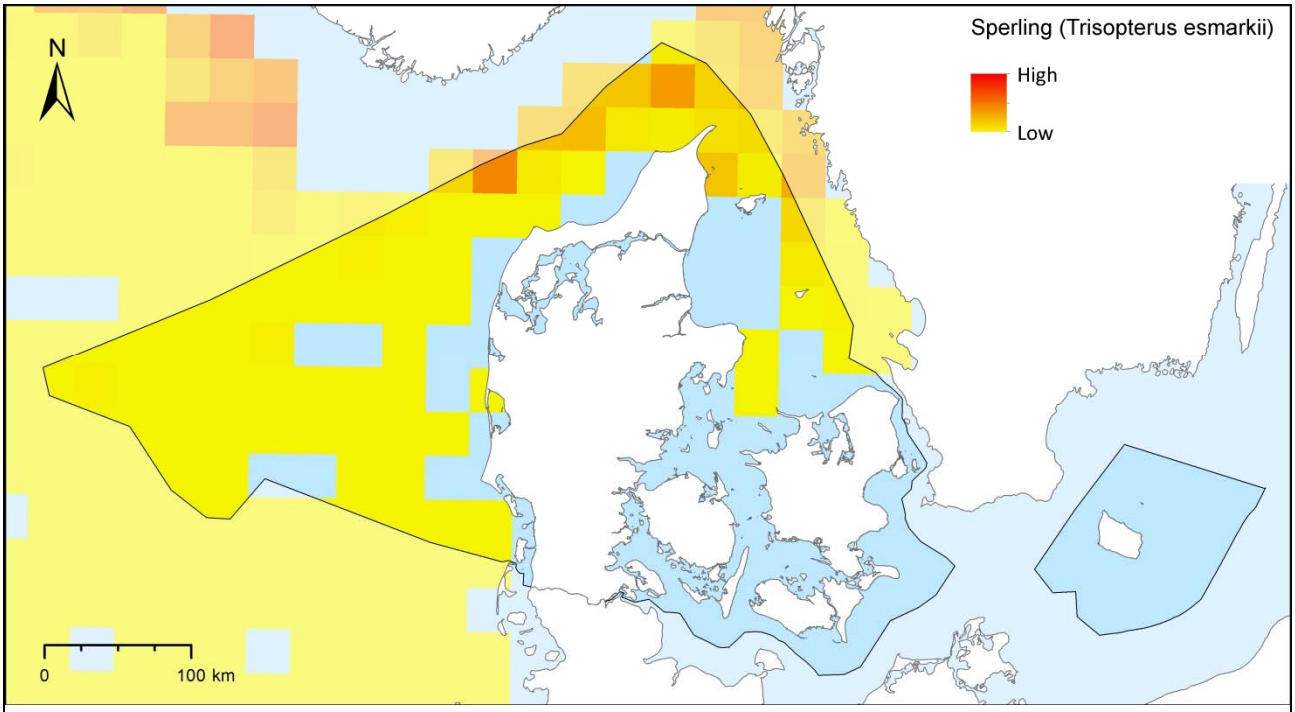
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	0.05 °
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Shrimp, spawning stock biomass

D17 - Sperling (Trisopterus esmarkii, *Sperling*)



Map showing Sperling distribution in Danish waters.

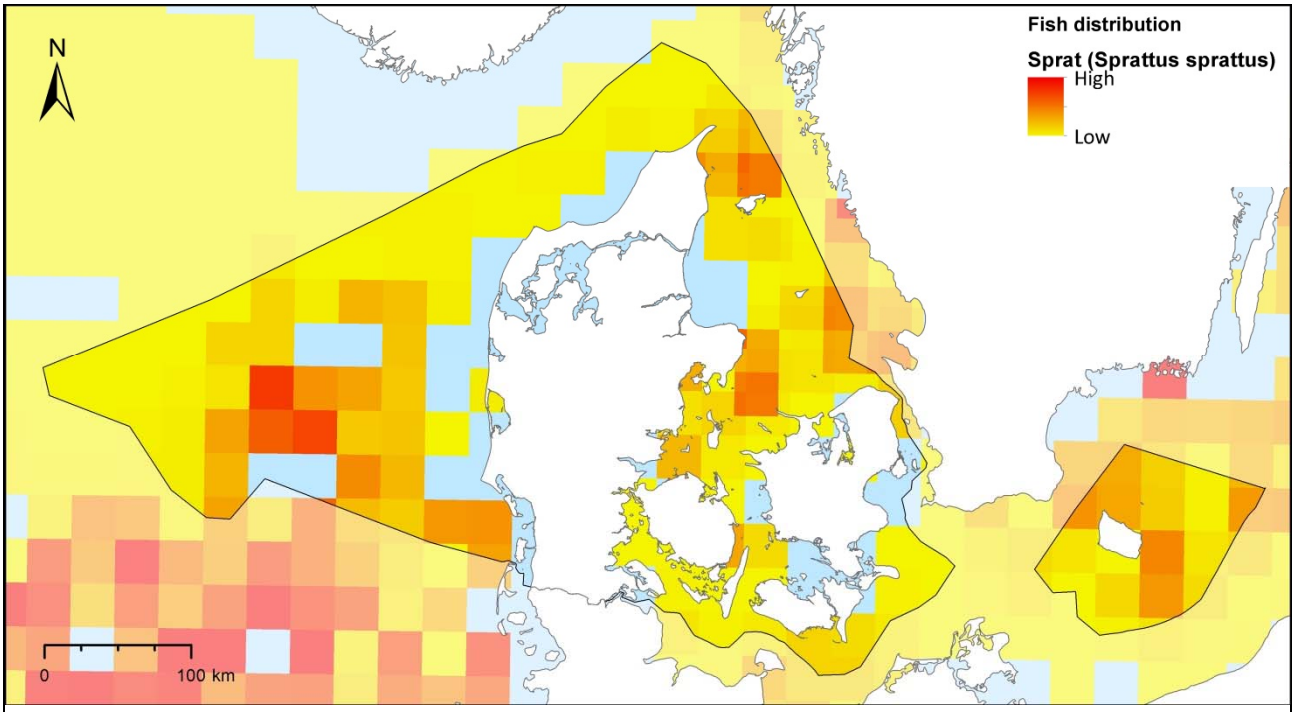
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Sperling, spawning stock biomass

D18 - Sprat (Sprattus sprattus, *Brisling*)



Map showing Sprat distribution in Danish waters.

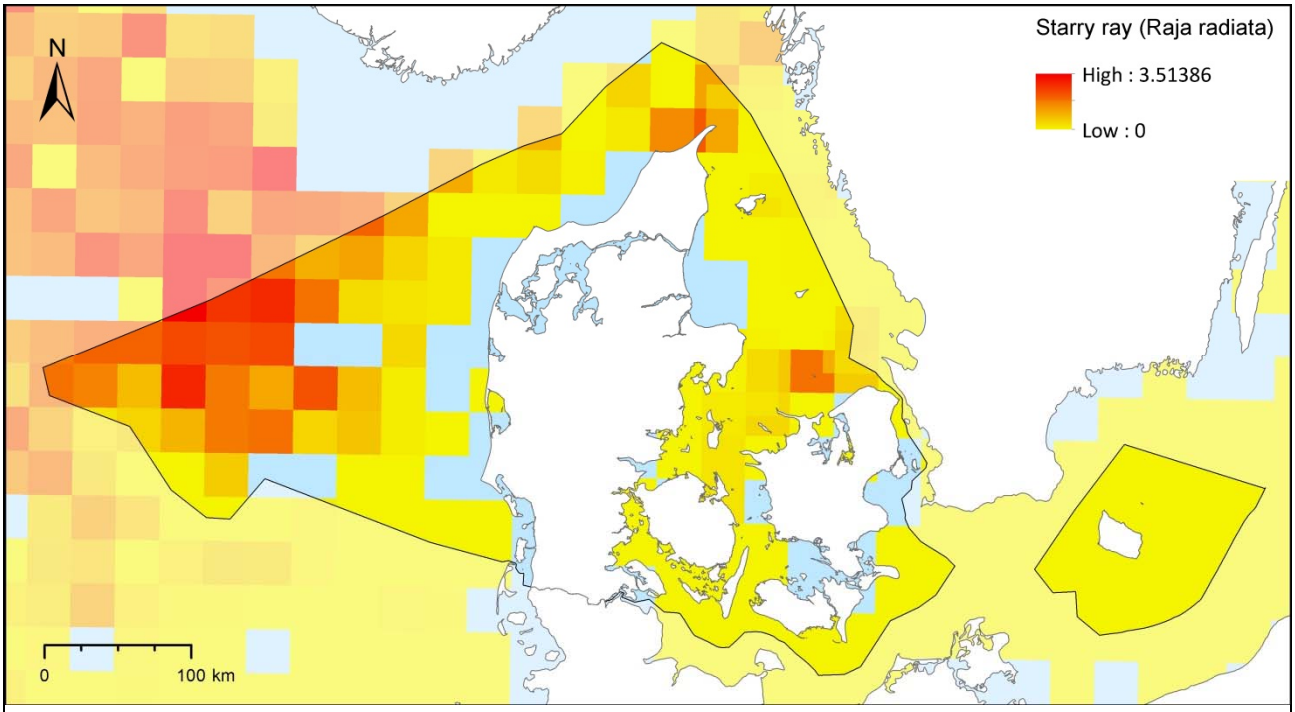
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Sprat, spawning stock biomass

D19 – Starry Ray (Raja radiate, *Tærbe*)



Map showing Starry Ray distribution in Danish waters.

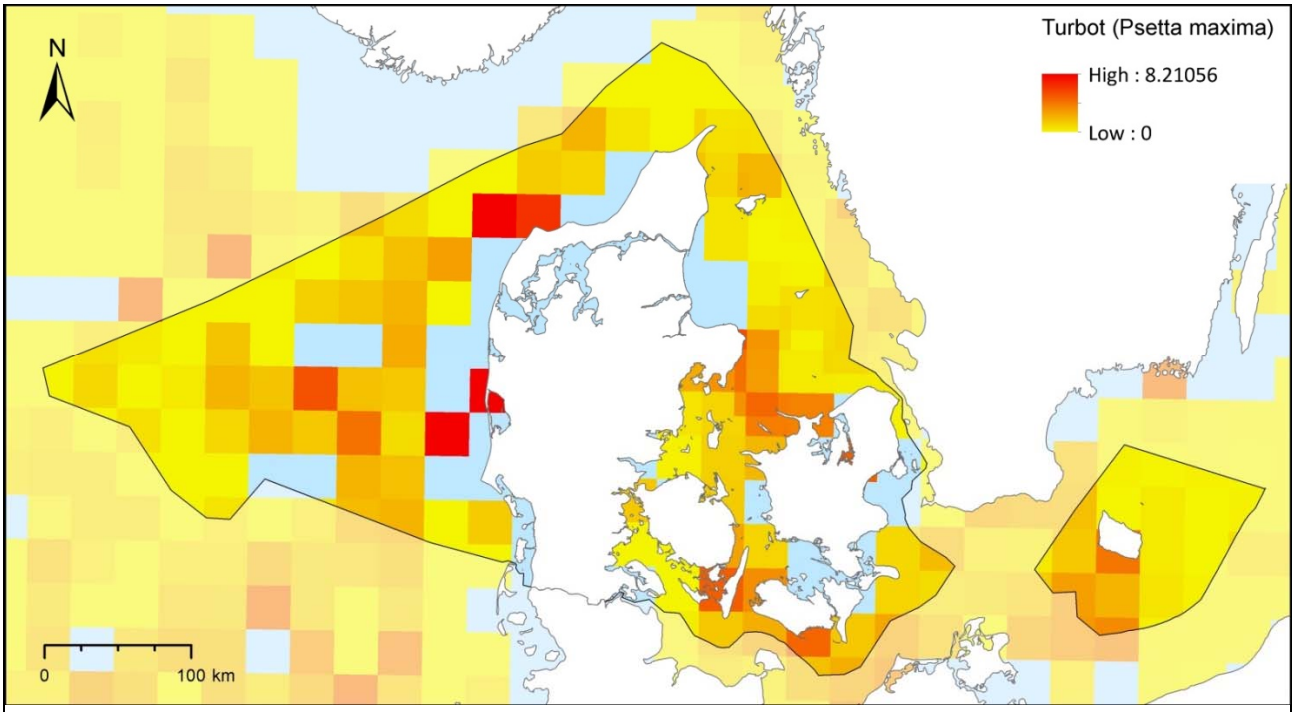
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Starry ray, spawning stock biomass

D20 - Turbot (Psetta maxima, *Pighvarre*)



Map showing Turbot distribution in Danish waters.

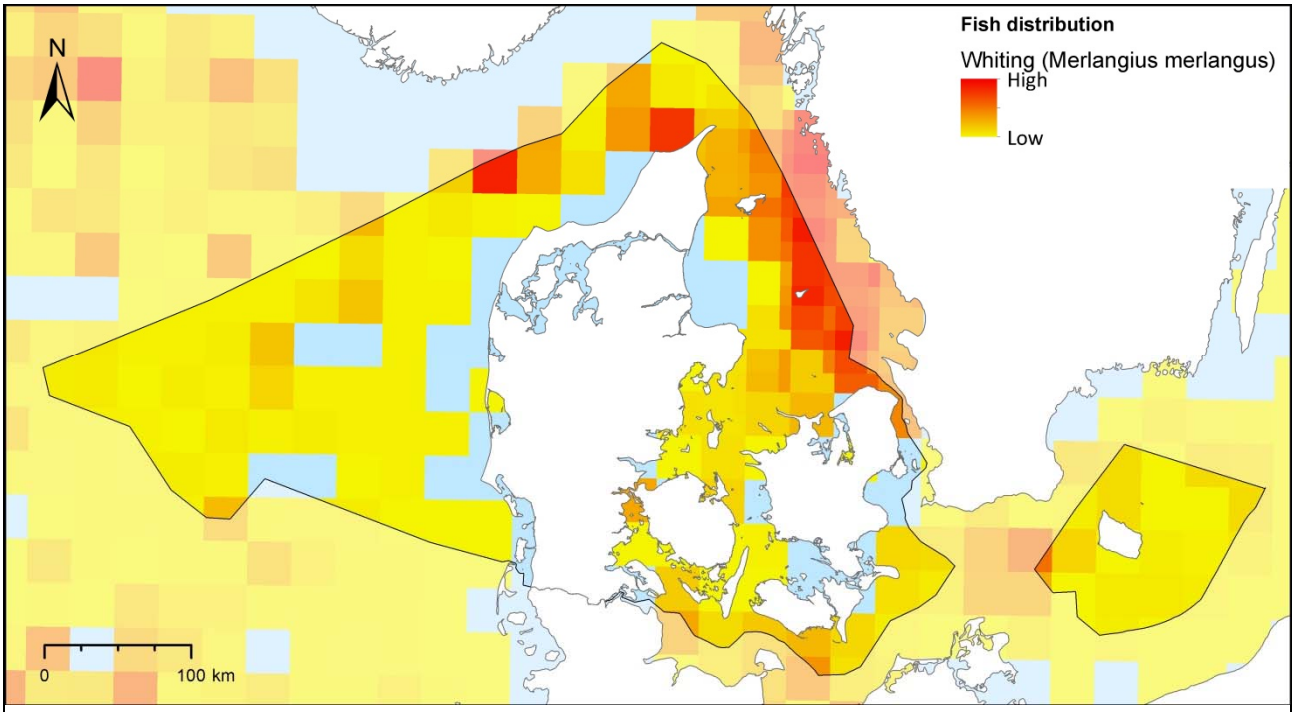
Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	**cog@bios.au.dk**
Key words	Turbot, spawning stock biomass

D21 - Whiting (Merlangius merlangus, *Hvilling*)



Map showing Whiting distribution in Danish waters.

Data sources and methods
See Warnar et al. (2012).

Spatial coverage
Danish EEZ.

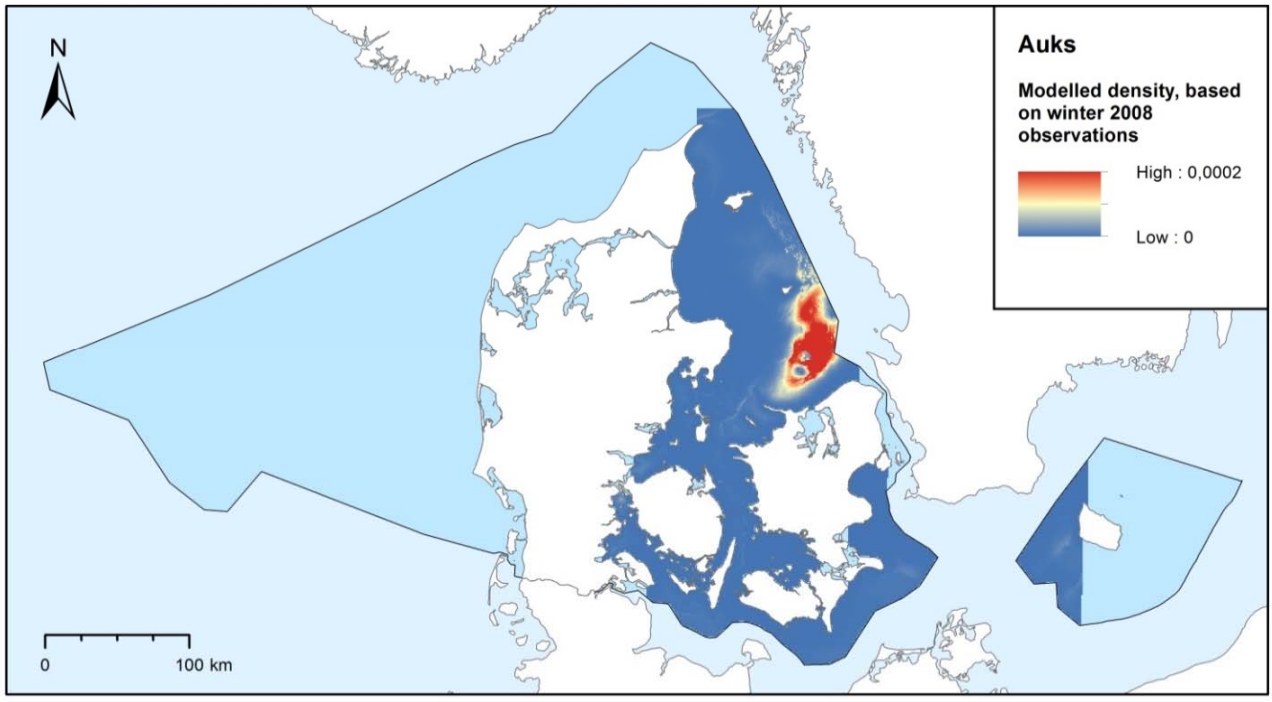
References
Warnar, T., Huwer, B., Vinther, M., Egekvist, J., Sparrevohn, C.R., Kirkegaard, E., Dolmer, P., Munk, P., Sørensen, T.K. (2012). Fiskebestandenes struktur. Fagligt baggrundsnotat til den danske implementering af EU's havstrategidirektiv. DTU Aqua-rapport nr. 254-2012.

Scale or resolution	≈ 30 km
Time period	2001 – 2010
Data access	
Responsible institution	DCE, AU.
Contact person	Cordula Göke
E-mail	cog@bios.au.dk
Key words	Whiting, spawning stock biomass

Appendix E – Ecosystem components (birds)

- E1 – Auks (*Alkefugl*): Guillemot (Uria aalge, *Lomvie*), Razorbill (Alca torda, *Alk*)
- E2 – Common Scoter (Melanitta nigra, *Sortand*)
- E3 – Divers (*Lommer*): Red-throated diver (Gavia stellate, *Rødstrubbet Lom*), Black-throated Diver (Gavia arctica, *Sortstrubbet Lom*)
- E4 - Eider (Somateria mollissima, *Ederfugl*)
- E5 - Fulmar (Fulmarus glacialis, *Mallemuk*)
- E6 – Gannet (Morus bassanus, *Sule*)
- E7 – Kittiwake (Rissa tridactyla, *Ride*)
- E8 – Long-tailed Duck (Clangula hyemalis, *Havlit*)
- E9 – Red-breasted Merganser (Mergus serrator, *Toppet Skallesluger*)

E1 – Auks (*Alkefugl*): Guillemot (Uria aalge, *Lomvie*), Razorbill (Alca torda, *Alk*)



Map showing the density and distribution of wintering Razorbill / Guillemot (Alca torda / Uria aalge) in Danish waters based on line-transect counts in the specified area (January - March 2008). There were an estimated total number of 76,573 birds within the model area.

Data sources and methods

Data originates from the Danish NOVANA monitoring programme. Waterbird counts were conducted primarily in the form of line-transect counts in large parts of the Danish waters. This is a sampling method that permits density calculations using the Distance Sampling method in combination with subsequent spatial modeling to describe the geographical distribution. Counts were made at predefined parallel transect lines, either orientated east-west or north-south and in most cases with a distance of 5 km. Densities were calculated with the Distance Sampling software and distributions are described using spatial modeling. To calculate the densities, a detection function was calculated describing the decreasing probability of detecting a given bird with increasing distance away from the counting route. To calculate the function, variables were used that are significant for detection probability, such as wave activity and flock size. Further, environmental variables, such as water depth and distance to the shore, were used for modeling of the spatial distribution of the birds.

Spatial coverage

The open ocean parts of the inner Danish waters. The waters east of Bornholm were not covered, as well as small parts of the Kattegat. Topographically complex areas such as the Limfjord, larger fjord systems, the 'Smålandsfarvandet' (a bay between the islands of Zealand and Lolland) and the southern Fyn archipelago were counted using total-counting methods. Therefore, densities and spatial distribution could not be generated for these particular areas.

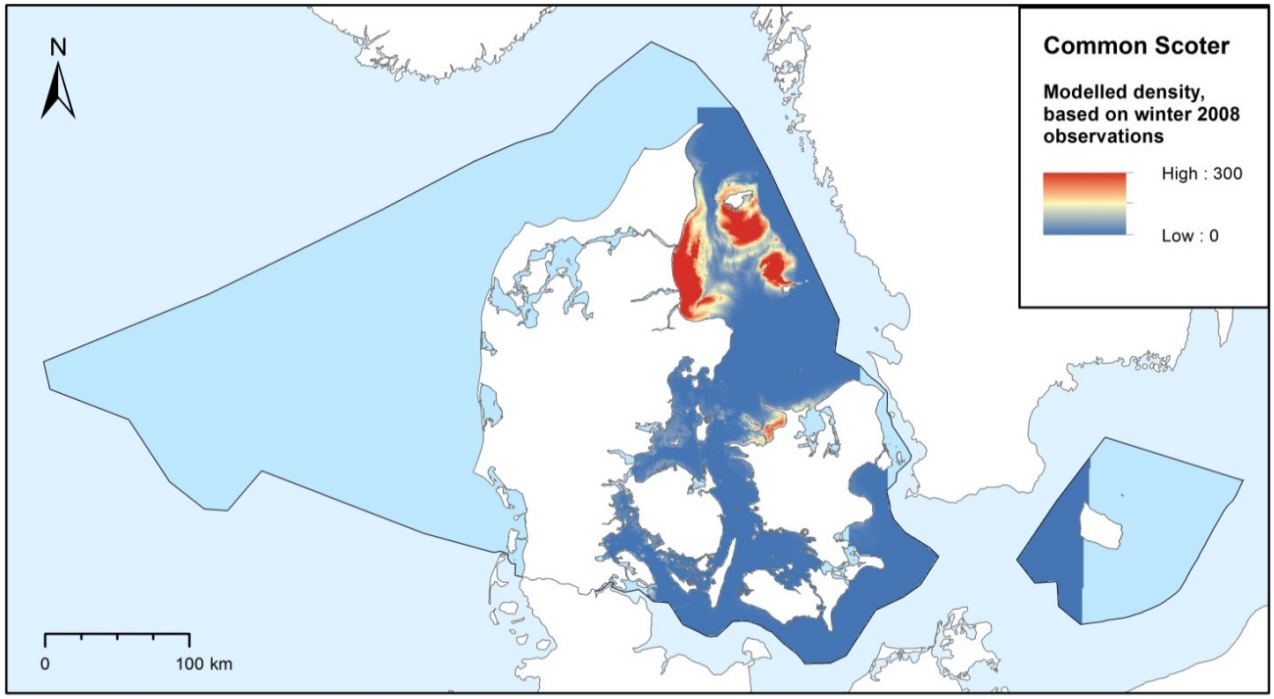
References

Petersen, I.K., Nielsen, R.D., Pihl, S., Clausen, P., Therkildsen, O., Christensen, T.K., Kahlert, J. & Hounisen, J.P. 2010. Landsdækkende optælling af vandfugle i Danmark, vinteren 2007/2008. Danmarks Miljøundersøgelser, Aarhus Universitet. 78 s. – Arbejdsrapport fra DMU nr. 261. http://www.dmu.dk/Pub/AR261.pdf

Petersen, I.K. & Nielsen, R.D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Denmark. 62 pp.

Scale or resolution	ArcGis output polygon: 500 x 500 m
Time period	Januar - March 2008.
Data access	Original data are accessible.
Responsible institution	AU Bioscience, DCE
Contact person	Ib Krag Petersen
E-mail	ikp@bios.au.dk
Key words	Guillemot, Razorbill, *Alca torda, Uria aalge*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity

E2 – Common Scoter (Melanitta nigra, *Sortand*)



Map showing the density and distribution of wintering Common scoter (Melanitta nigra) in Danish waters based on line-transect counts in the specified area (January - March 2008). There were an estimated total number of 401.339 birds within the model area.

Data sources and methods

Data originates from the Danish NOVANA monitoring programme. Waterbird counts were conducted primarily in the form of line-transect counts in large parts of the Danish waters. This is a sampling method that permits density calculations using the Distance Sampling method in combination with subsequent spatial modeling to describe the geographical distribution. Counts were made at predefined parallel transect lines, either orientated east-west or north-south and in most cases with a distance of 5 km. Densities were calculated with the Distance Sampling software and distributions are described using spatial modeling. To calculate the densities, a detection function was calculated describing the decreasing probability of detecting a given bird with increasing distance away from the counting route. To calculate the function, variables were used that are significant for detection probability, such as wave activity and flock size. Further, environmental variables, such as water depth and distance to the shore, were used for modeling of the spatial distribution of the birds.

Spatial coverage

The open ocean parts of the inner Danish waters. The waters east of Bornholm were not covered, as well as small parts of the Kattegat. Topographically complex areas such as the Limfjord, larger fjord systems, the 'Smålandsfarvandet' (a bay between the islands of Zealand and Lolland) and the southern Fyn archipelago were counted using total-counting methods. Therefore, densities and spatial distribution could not be generated for these particular areas.

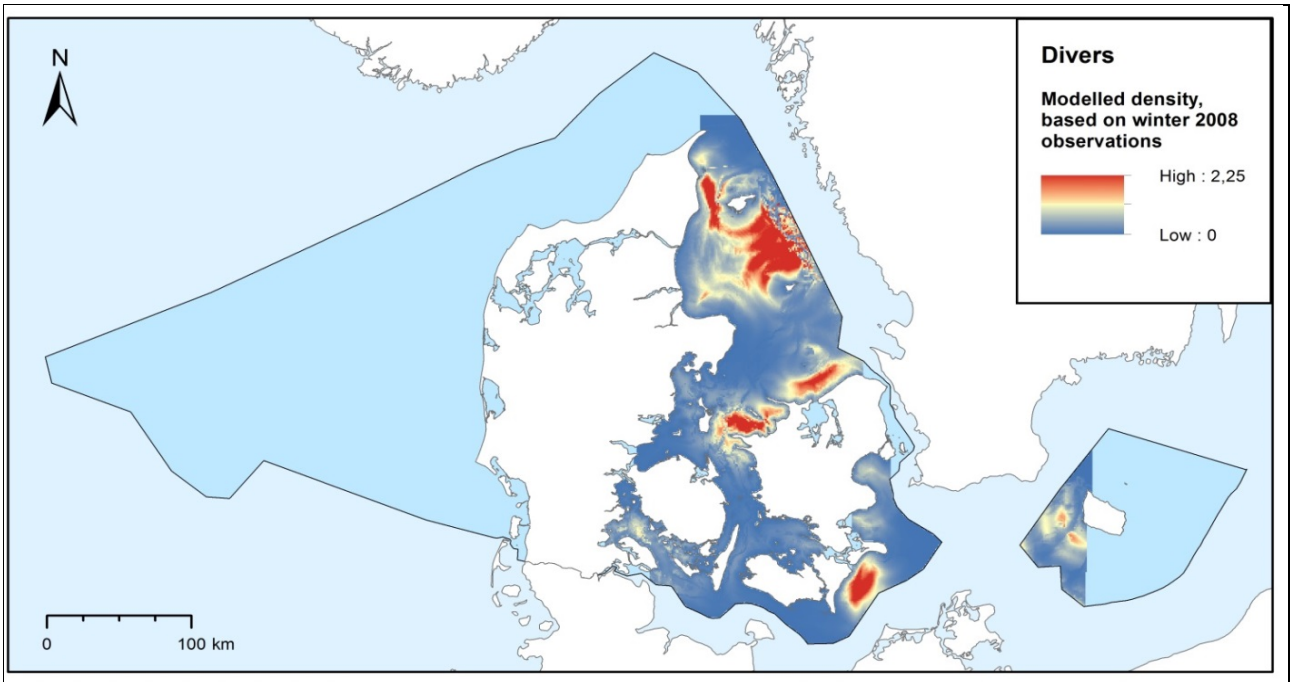
References

Petersen, I.K., Nielsen, R.D., Pihl, S., Clausen, P., Therkildsen, O., Christensen, T.K., Kahlert, J. & Hounisen, J.P. 2010. Landsdækkende optælling af vandfugle i Danmark, vinteren 2007/2008. Danmarks Miljøundersøgelser, Aarhus Universitet. 78 s. – Arbejdsrapport fra DMU nr. 261. http://www.dmu.dk/Pub/AR261.pdf

Petersen, I.K. & Nielsen, R.D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Denmark. 62 pp.

Scale or resolution	ArcGis output polygon: 500 x 500 m
Time period	Januar - March 2008.
Data access	Original data are accessible.
Responsible institution	AU Bioscience, DCE
Contact person	Ib Krag Petersen
E-mail	ikp@bios.au.dk
Key words	Common scoter, *Melanitta nigra*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity

E3 – Divers (*Lommer*): Red-throated Diver (Gavia stellate, *Rødstrubet Lom*), Black-throated Diver (Gavia arctica, *Sortstrubet Lom*)



Map showing the density and distribution of wintering Red-throated /Black-throated divers (*Gavia stellata/arctica* in Danish waters based on line-transect counts in the specified area (January - March 2008). There were an estimated total number of 5997 birds within the model area.

Data sources and methods

Data originates from the Danish NOVANA monitoring programme. Waterbird counts were conducted primarily in the form of line-transect counts in large parts of the Danish waters. This is a sampling method that permits density calculations using the Distance Sampling method in combination with subsequent spatial modeling to describe the geographical distribution. Counts were made at predefined parallel transect lines, either orientated east-west or north-south and in most cases with a distance of 5 km. Densities were calculated with the Distance Sampling software and distributions are described using spatial modeling. To calculate the densities, a detection function was calculated describing the decreasing probability of detecting a given bird with increasing distance away from the counting route. To calculate the function, variables were used that are significant for detection probability, such as wave activity and flock size. Further, environmental variables, such as water depth and distance to the shore, were used for modeling of the spatial distribution of the birds.

Spatial coverage

The open ocean parts of the inner Danish waters. The waters east of Bornholm were not covered, as well as small parts of the Kattegat. Topographically complex areas such as the Limfjord, larger fjord systems, the 'Smålandsfarvandet' (a bay between the islands of Zealand and Lolland) and the southern Fyn archipelago were counted using total-counting methods. Therefore, densities and spatial distribution could not be generated for these particular areas.

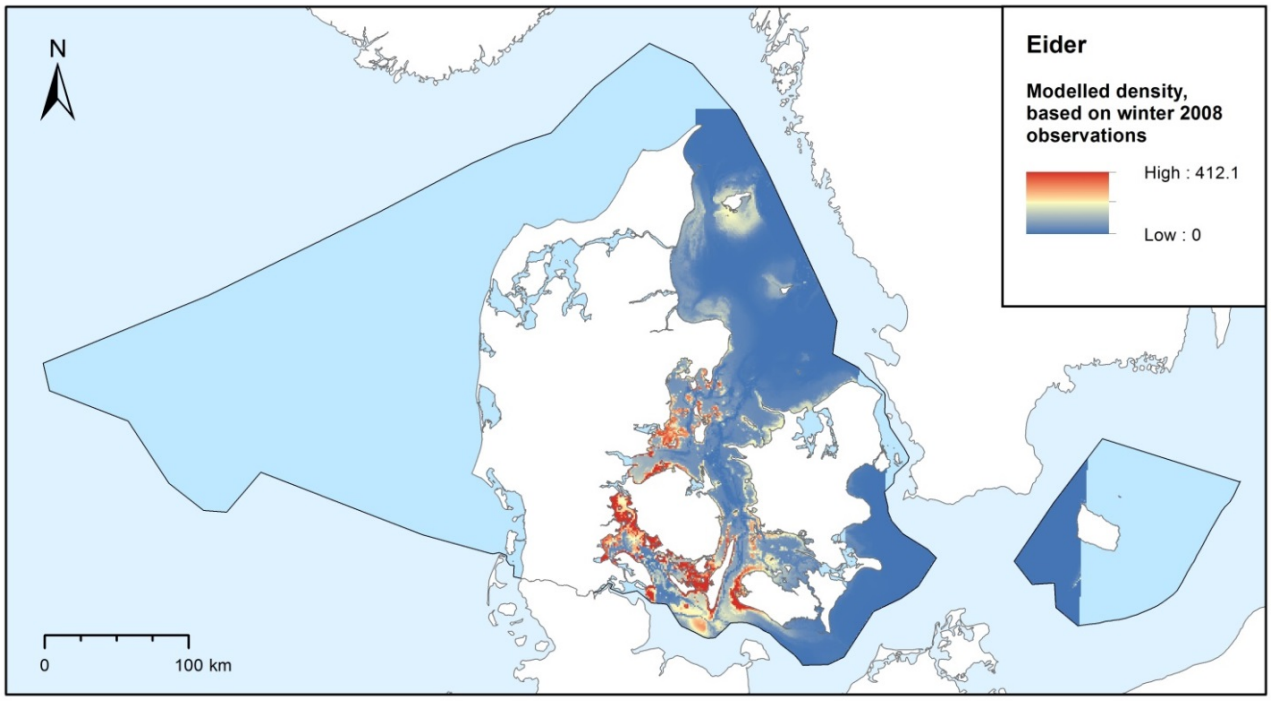
References

Petersen, I.K., Nielsen, R.D., Pihl, S., Clausen, P., Therkildsen, O., Christensen, T.K., Kahlert, J. & Hounisen, J.P. 2010. Landsdækkende optælling af vandfugle i Danmark, vinteren 2007/2008. Danmarks Miljøundersøgelser, Aarhus Universitet. 78 s. – Arbejdsrapport fra DMU nr. 261. http://www.dmu.dk/Pub/AR261.pdf

Petersen, I.K. & Nielsen, R.D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Denmark. 62 pp.

Scale or resolution	ArcGis output polygon: 500 x 500 m
Time period	Januar - March 2008.
Data access	Original data are accessible.
Responsible institution	AU Bioscience, DCE
Contact person	Ib Krag Petersen
E-mail	ikp@bios.au.dk
Key words	Red-throated diver, Black-throated diver, *Gavia stellata, Gavia arctica*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity

E4 - Eider (Somateria mollissima, *Ederfugl*)



Map showing the density and distribution of wintering Eider *(Somateria mollissima)* in Danish waters based on line-transect counts in the specified area (January - March 2008). There were an estimated total number of 468.000 birds within the model area.

Data sources and methods

Data originates from the Danish NOVANA monitoring programme. Waterbird counts were conducted primarily in the form of line-transect counts in large parts of the Danish waters. This is a sampling method that permits density calculations using the Distance Sampling method in combination with subsequent spatial modeling to describe the geographical distribution. Counts were made at predefined parallel transect lines, either orientated east-west or north-south and in most cases with a distance of 5 km. Densities were calculated with the Distance Sampling software and distributions are described using spatial modeling. To calculate the densities, a detection function was calculated describing the decreasing probability of detecting a given bird with increasing distance away from the counting route. To calculate the function, variables were used that are significant for detection probability, such as wave activity and flock size. Further, environmental variables, such as water depth and distance to the shore, were used for modeling of the spatial distribution of the birds.

Spatial coverage

The open ocean parts of the inner Danish waters. The waters east of Bornholm were not covered, as well as small parts of the Kattegat. Topographically complex areas such as the Limfjord, larger fjord systems, the 'Smålandsfarvandet' (a bay between the islands of Zealand and Lolland) and the southern Fyn archipelago were counted using total-counting methods. Therefore, densities and spatial distribution could not be generated for these particular areas.

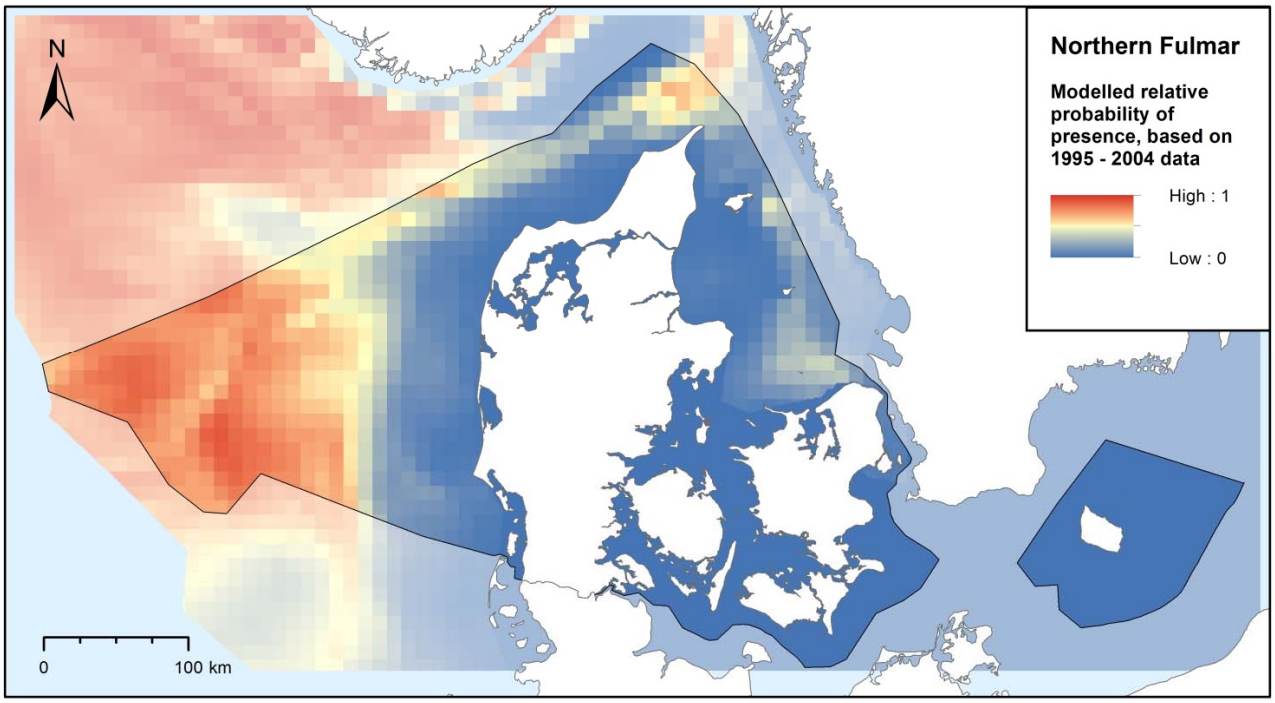
References

Petersen, I.K., Nielsen, R.D., Pihl, S., Clausen, P., Therkildsen, O., Christensen, T.K., Kahlert, J. & Hounisen, J.P. 2010. Landsdækkende optælling af vandfugle i Danmark, vinteren 2007/2008. Danmarks Miljøundersøgelser, Aarhus Universitet. 78 s. – Arbejdsrapport fra DMU nr. 261. http://www.dmu.dk/Pub/AR261.pdf

Petersen, I.K. & Nielsen, R.D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Denmark. 62 pp.

Scale or resolution	ArcGis output polygon: 500 x 500 m
Time period	Januar - March 2008.
Data access	Original data are accessible.
Responsible institution	AU Bioscience, DCE
Contact person	Ib Krag Petersen
E-mail	ikp@bios.au.dk
Key words	Eider, *Somateria mollissima*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity

E5 - Fulmar (Fulmarus glacialis, *Mallemuk*)



Map showing the modelled relative probability of presence of Northern Fulmar *(Fulmarus glacialis)* in Danish waters.

Data sources and methods

The original input data from the HARMONY project was used.

Spatial coverage

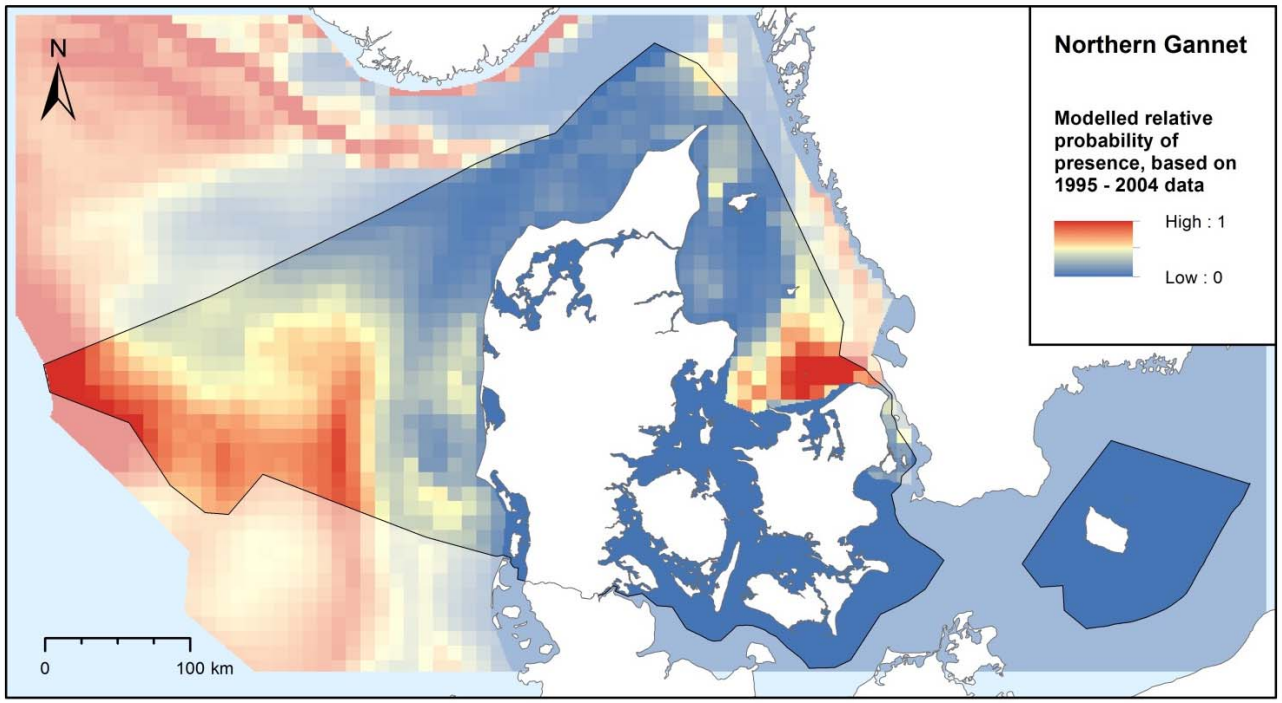
Danish EEZ.

References

HARMONY Report (Andersen et al., 2013)

Scale or resolution	10 km
Time period	1995 – 2004
Data access	Predicted distribution: Contact the HARMONY Team.
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	**cog@bios.au.dk**
Key words	Northern Fulmar, *Fulmarus glacialis,* Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity.

E6 – Gannet (Morus bassanus, *Sule*)



Map showing the modelled relative probability of presence of Northern Gannet *(Morus bassanus)* in Danish waters.

Data sources and methods

The original input data from the HARMONY project was used.

Spatial coverage

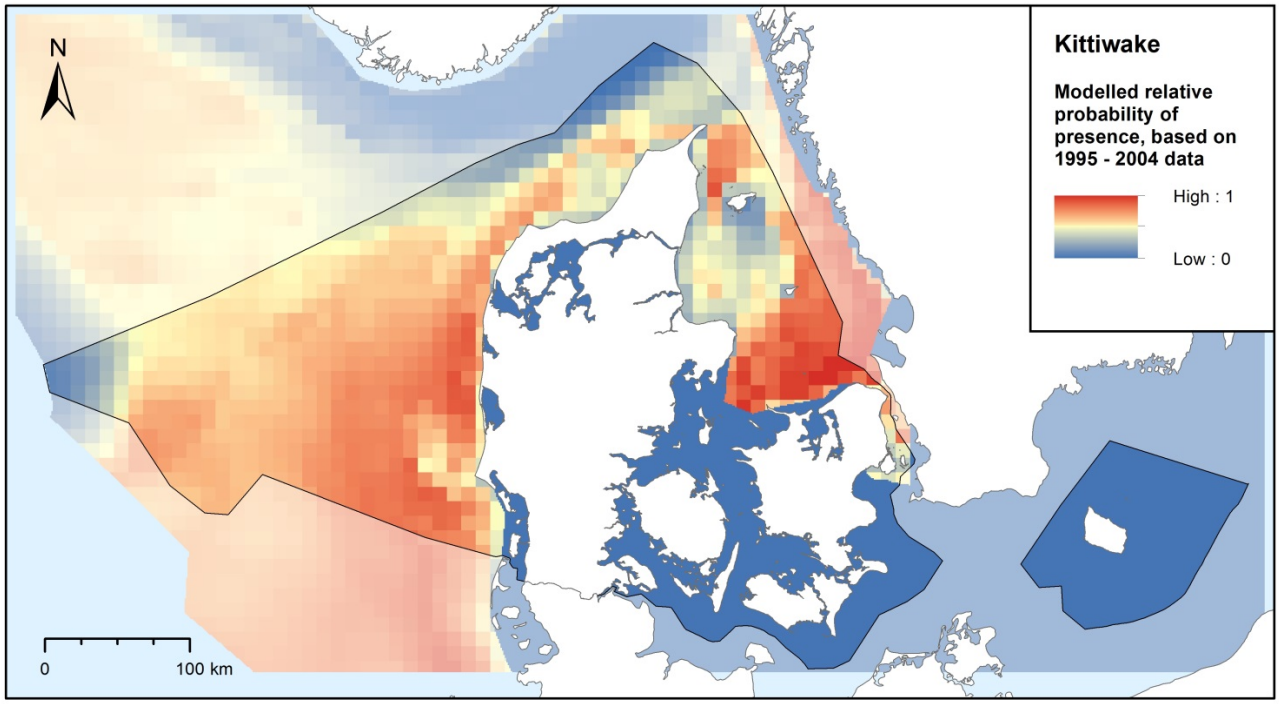
Danish EEZ.

References

HARMONY report (Andersen et al., 2013)

Scale or resolution	10 km
Time period	1995 – 2004
Data access	Predicted distribution: Contact the HARMONY Team.
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	Northern Gannet, *Morus bassanus*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity.

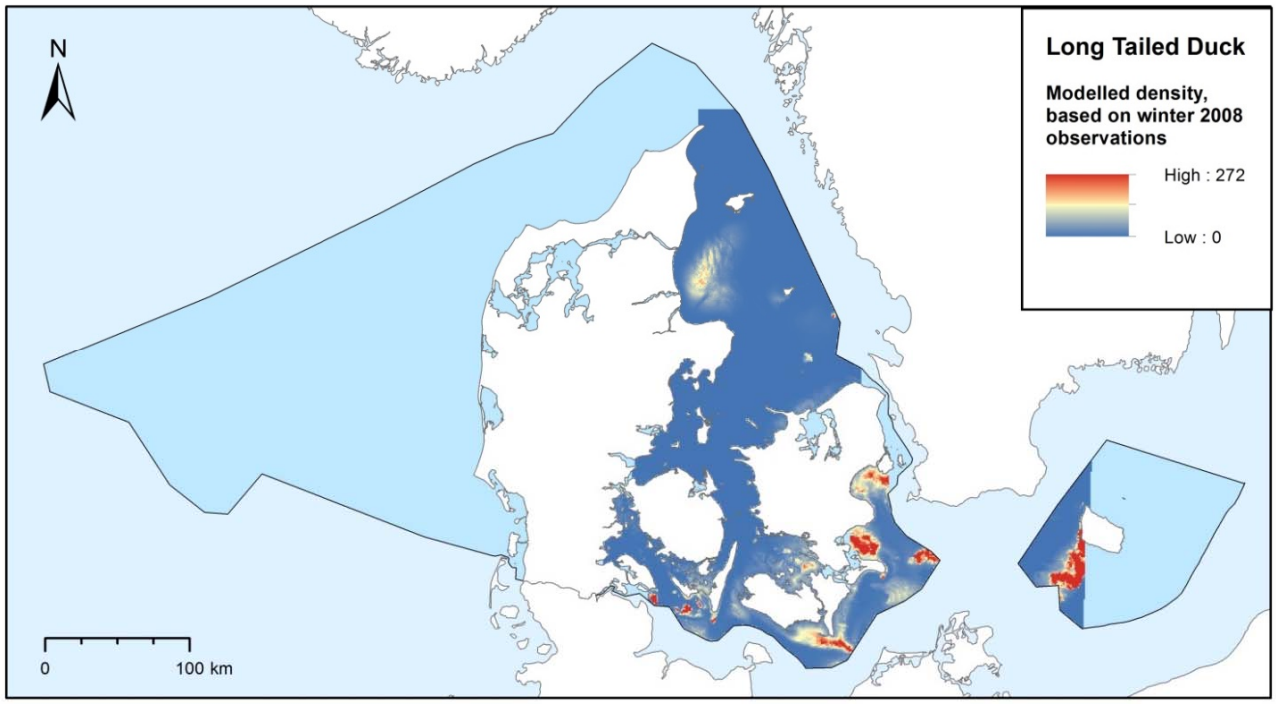
E7 – Kittiwake (Rissa tridactyla, *Ride*)



Map showing the modelled relative probability of presence of Kittiwake *(Rissa tridactyla)* in Danish waters.

Data sources and methods The original input data from the HARMONY project was used.	
Spatial coverage Danish EEZ.	
References HARMONY report (Andersen et al., 2013)	
Scale or resolution	10 km
Time period	1995 – 2004
Data access	Predicted distribution: Contact the HARMONY Team.
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	Kittiwake, *Rissa tridactyla*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity.

E8 – Long-tailed Duck (Clangula hyemalis, *Havlit*)



Map showing the density and distribution of wintering Long Tailed Duck *(Clangula hyemalis)* in Danish waters based on line-transect counts in the specified area (January - March 2008). There were an estimated total number of 28.255 birds within the model area.

Data sources and methods

Data originates from the Danish NOVANA monitoring programme. Waterbird counts were conducted primarily in the form of line-transect counts in large parts of the Danish waters. This is a sampling method that permits density calculations using the Distance Sampling method in combination with subsequent spatial modeling to describe the geographical distribution. Counts were made at predefined parallel transect lines, either orientated east-west or north-south and in most cases with a distance of 5 km. Densities were calculated with the Distance Sampling software and distributions are described using spatial modeling. To calculate the densities, a detection function was calculated describing the decreasing probability of detecting a given bird with increasing distance away from the counting route. To calculate the function, variables were used that are significant for detection probability, such as wave activity and flock size. Further, environmental variables, such as water depth and distance to the shore, were used for modeling of the spatial distribution of the birds.

Spatial coverage

The open ocean parts of the inner Danish waters. The waters east of Bornholm were not covered, as well as small parts of the Kattegat. Topographically complex areas such as the Limfjord, larger fjord systems, the 'Smålandsfarvandet' (a bay between the islands of Zealand and Lolland) and the southern Fyn archipelago were counted using total-counting methods. Therefore, densities and spatial distribution could not be generated for these particular areas.

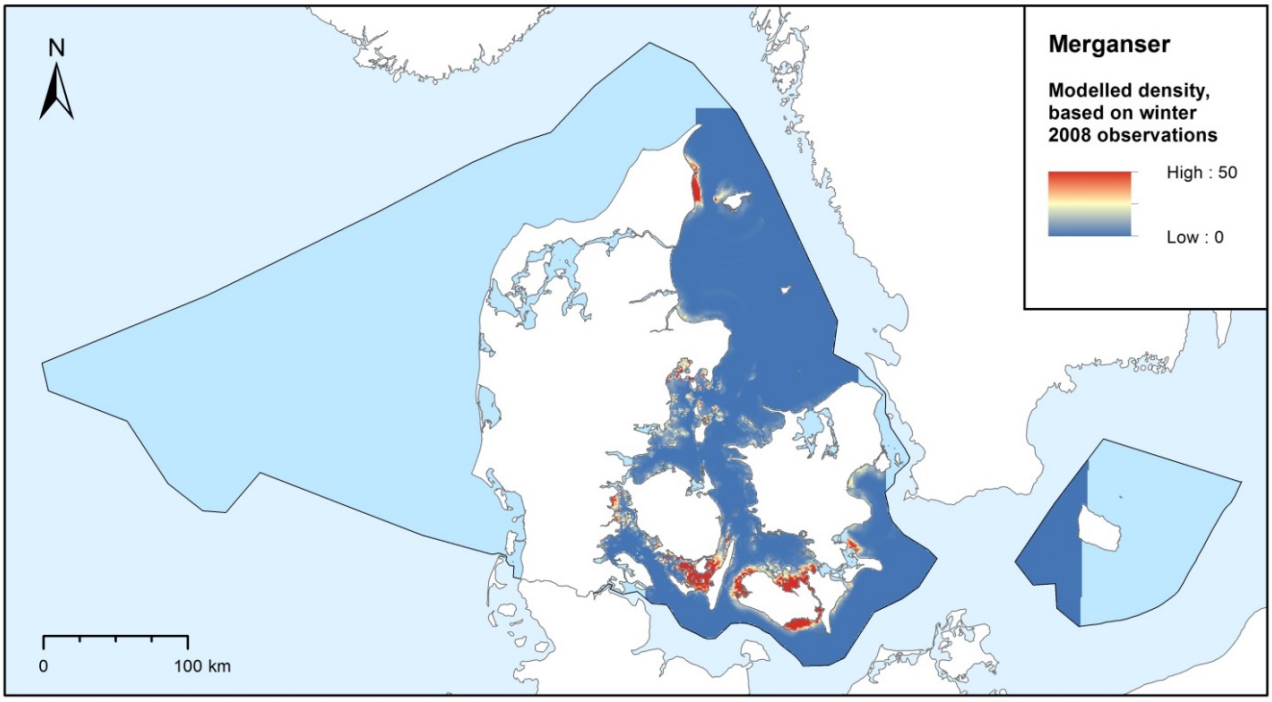
References

Petersen, I.K., Nielsen, R.D., Pihl, S., Clausen, P., Therkildsen, O., Christensen, T.K., Kahlert, J. & Hounisen, J.P. 2010. Landsdækkende optælling af vandfugle i Danmark, vinteren 2007/2008. Danmarks Miljøundersøgelser, Aarhus Universitet. 78 s. – Arbejdsrapport fra DMU nr. 261. http://www.dmu.dk/Pub/AR261.pdf

Petersen, I.K. & Nielsen, R.D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Denmark. 62 pp.

Scale or resolution	ArcGis output polygon: 500 x 500 m
Time period	Januar - March 2008.
Data access	Original data are accessible.
Responsible institution	AU Bioscience, DCE
Contact person	Ib Krag Petersen
E-mail	ikp@bios.au.dk
Key words	Long Tailed Duck, *Clangula hyemalis*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity

E9 – Red-breasted Merganser (Mergus serrator, *Toppet Skallesluger*)



Map showing the density and distribution of wintering Red-breasted mergamser *(Mergus serrator)* in Danish waters based on line-transect counts in the specified area (January - March 2008). There were an estimated total number of 28.255 birds within the model area.

Data sources and methods

Data originates from the Danish NOVANA monitoring programme. Waterbird counts were conducted primarily in the form of line-transect counts in large parts of the Danish waters. This is a sampling method that permits density calculations using the Distance Sampling method in combination with subsequent spatial modeling to describe the geographical distribution. Counts were made at predefined parallel transect lines, either orientated east-west or north-south and in most cases with a distance of 5 km. Densities were calculated with the Distance Sampling software and distributions are described using spatial modeling. To calculate the densities, a detection function was calculated describing the decreasing probability of detecting a given bird with increasing distance away from the counting route. To calculate the function, variables were used that are significant for detection probability, such as wave activity and flock size. Further, environmental variables, such as water depth and distance to the shore, were used for modeling of the spatial distribution of the birds.

Spatial coverage

The open ocean parts of the inner Danish waters. The waters east of Bornholm were not covered, as well as small parts of the Kattegat. Topographically complex areas such as the Limfjord, larger fjord systems, the 'Smålandsfarvandet' (a bay between the islands of Zealand and Lolland) and the southern Fyn archipelago were counted using total-counting methods. Therefore, densities and spatial distribution could not be generated for these particular areas.

References

Petersen, I.K., Nielsen, R.D., Pihl, S., Clausen, P., Therkildsen, O., Christensen, T.K., Kahlert, J. & Hounisen, J.P. 2010. Landsdækkende optælling af vandfugle i Danmark, vinteren 2007/2008. Danmarks Miljøundersøgelser, Aarhus Universitet. 78 s. – Arbejdsrapport fra DMU nr. 261. http://www.dmu.dk/Pub/AR261.pdf

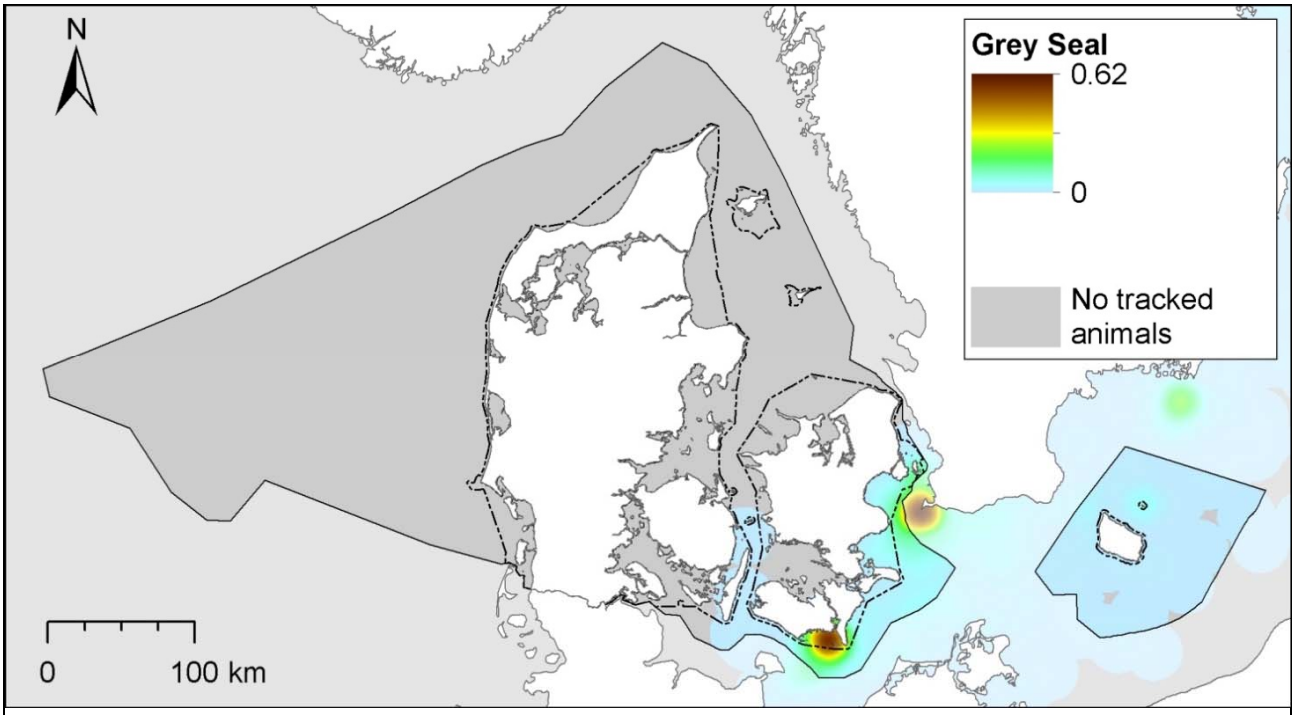
Petersen, I.K. & Nielsen, R.D. 2011. Abundance and distribution of selected waterbird species in Danish marine areas. Report commissioned by Vattenfall A/S. National Environmental Research Institute, Aarhus University, Denmark. 62 pp.

Scale or resolution	ArcGis output polygon: 500 x 500 m
Time period	Januar - March 2008.
Data access	Original data are accessible.
Responsible institution	AU Bioscience, DCE
Contact person	Ib Krag Petersen
E-mail	ikp@bios.au.dk
Key words	Red-breasted mergamser, *Mergus serrator*, Denmark, Baltic Sea, Skagerrak, Kattegat, Danish waters, biodiversity

Appendix F – Ecosystem components (marine mammals)

- F1 – Grey Seal (Halichoerus grypus, *Gråsæl*)
- F2 – Harbour Seal (Phoca vitulina, *Spættet sæl*)
- F3 – Harbour Porpise (Phocoena phocoena, *Marsvin*)
- F4 – Minke Whale (Balanoptera acutorostrata, *Vågehval*)
- F5 – White-beaked Dolphin (Lagenorhynchus albirostris, *Hvidnæsen*)

F1 – Grey Seal (Halichoerus grypus, *Gråsæl*)



Map showing the density of Grey Seal (*Halichoerus grypus*) in Danish waters based on positions from tagged animals.

Data sources and methods

Data were derived from tagging of 19 Grey seals with Argos satellite transmitters or GPS/GSM transmitters. The seals have been tagged in various resting places including Rødsand, Falsterbo in Sweden and Vitsten (northern Sweden, 1 animal). Seal positions from Argos transmitters were determined by transmitted signals from the transmitters to satellites every time the transmitters reached the sea surface. The precison of satellite positions is determined by the Argos system, but it does not provide the same quality of precision as GPS. To eliminate unrealistic satellite positions all positions have therefore been filtered with a so-called DAR (Distance-Angle-Rate) filter in the SAS software, Argos Filter v7.03 (Douglas 2006), see Dietz et al. (2012) for further details. GPS / GSM transmitters are capable of recording more positionss per minute, which are sent over the mobile phone network. For all datasets one position per animal per day was extracted, regardless of how long the individual transmitters have sent signals. All positions are then plotted in ArcGIS version 10.1 and kernel densiteter (Arc toolbox) were calculated. The tagging in Anholt was funded by Aage V. Jensen Foundation, Nature Agency, Gorenje and Outdoor Council. The Rødsand tagging was funded by the the Danish Energy Agency (Energistyrelsen) through contract with SEAS and the Crown Estate, UK. Falsterbo tagging was funded by EnergiNet.dk. The single animal from Vitsten was tagged by the Naturhistoriska Riksmuseet, Stockholm.

Spatial coverage

The Grey seal distribution (outside resting places) in Denmark is not very well known, becaue they move around a lot. The tagged animals most likely originate from the Baltic Sea population, which in Denmark can be found in the Baltic Sea, the Belt Sea and the Kattegat. Grey seals from the Atlantic population occur in Denmark in the Wadden Sea, the western Limfjord and Kattegat, where the apparently overlap with Baltic Sea seals.

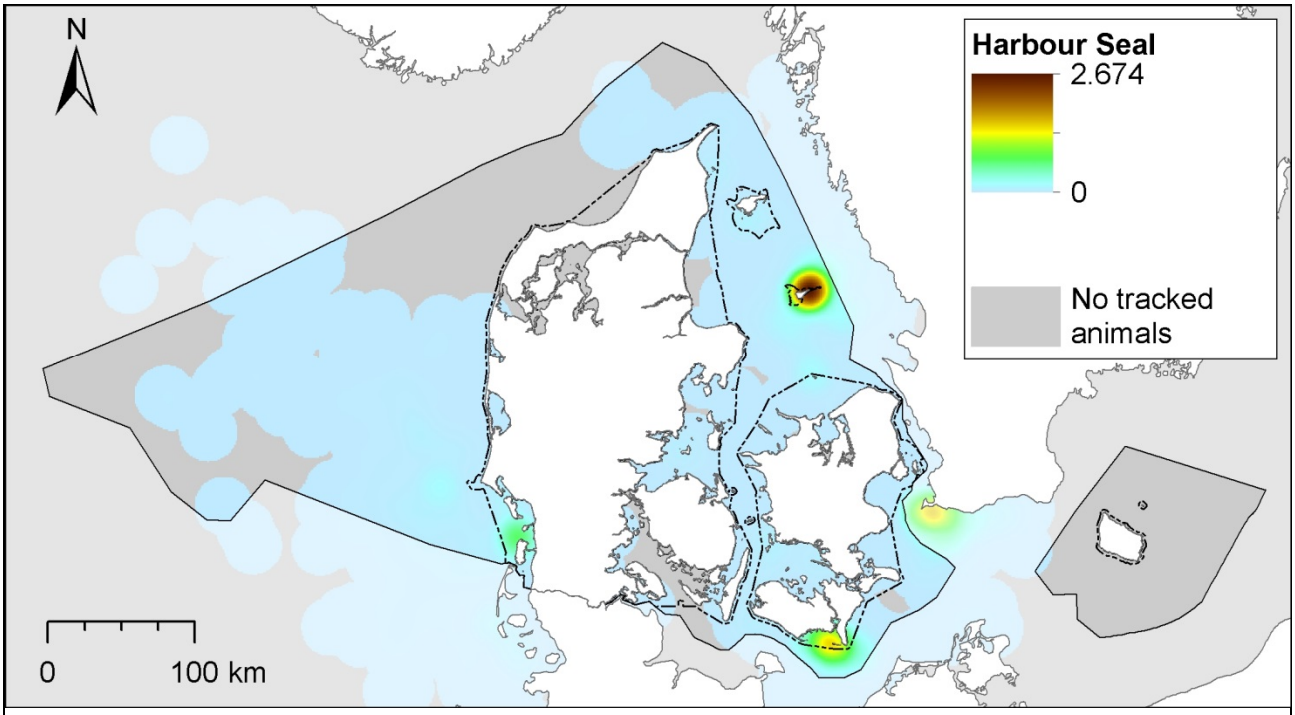
References

Dietz, R; Teilmann, J; Andersen, S M; Rigét, F; Olsen, M T (2012). Movements and site fidelity of harbour seals (Phoca vitulina) in Kattegat, Denmark, with implications for the epidemiology of the phocine distemper virus. ICES J Mar Sci 69(10): 1-10.

Douglas, D. (2006): The Douglas Argos-filter algorithm, Version 7.03. U.S. Geological Survey, Anchorage, AK. Available at http://alaska.usgs.gov/science/biology/spatial/pdfs/argosfilterv703_manual.pdf.

Scale or resolution	ArcGis output raster: 1 x 1 km and smoothing factor: 20 km.
Time period	November 2000 - May 2013
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Jonas Teilmann
E-mail	jte@bios.au.dk
Key words	Grey seal, *Halichoerus grypus,* tagging

F2 – Harbour Seal (Phoca vitulina, *Spættet sæl*)



Map showing the density of Harbour Seal (*Phoca vitulina*) in Danish waters based on positions from tagged animals.

Data sources and methods

Data were derived from tagging of 69 harbor seals with Argos satellite transmitters or GPS/GSM transmitters. The seals have been tagged in various resting places including Anholt, Rødsand, Wadden Sea and Falsterbo in Sweden. Seal positions from Argos transmitters were determined by transmitted signals from the transmitters to satellites every time the transmitters reached the surface. The precison of satellite positions is determined by the Argos system, but it does not provide the same quality of precision as GPS. To eliminate unrealistic satellite positions all positions have therefore been filtered with a so-called DAR (Distance-Angle-Rate) filter in the SAS software, Argos Filter v7.03 (Douglas 2006), see Dietz et al. (2012) for further details. GPS / GSM transmitters are capable of recording more positionss per minute, which are sent over the mobile phone network. For all datasets one position per animal per day was extracted, regardless of how long the individual transmitters have sent signals. All positions are then plotted in ArcGIS version 10.1 and kernel densiteter (Arc toolbox) were calculated. The tagging in Anholt was funded by Aage V. Jensen Foundation, Nature Agency, Gorenje and Outdoor Council. The Rødsand tagging was funded by the the Danish Energy Agency (Energistyrelsen) through contract with SEAS and the Crown Estate, UK. Tagging in the Wadden Sea was conducted in cooperation with the Fisheries and Maritime Authority in Esbjerg, funded by the the Danish Energy Agency through contract with Elsam A / S. Falsterbo tagging was funded by EnergiNet.dk.

Spatial coverage

Part of the Danish harbour seal sites are covered by the data. However, there are several other well-known resting places, where the data do not cover the entire area, These areas include Aunø Fjord and Bøgestrømmen (the waters south of Zealand), Svanegrunden, Bosserne, Sjællands reef and Vejrø (central Kattegat), Læsø, Øresund and Limfjorden. Since harbour seals that are older than a few years rarely move far away from their central resting places, these latter resting areas are underrepresented.

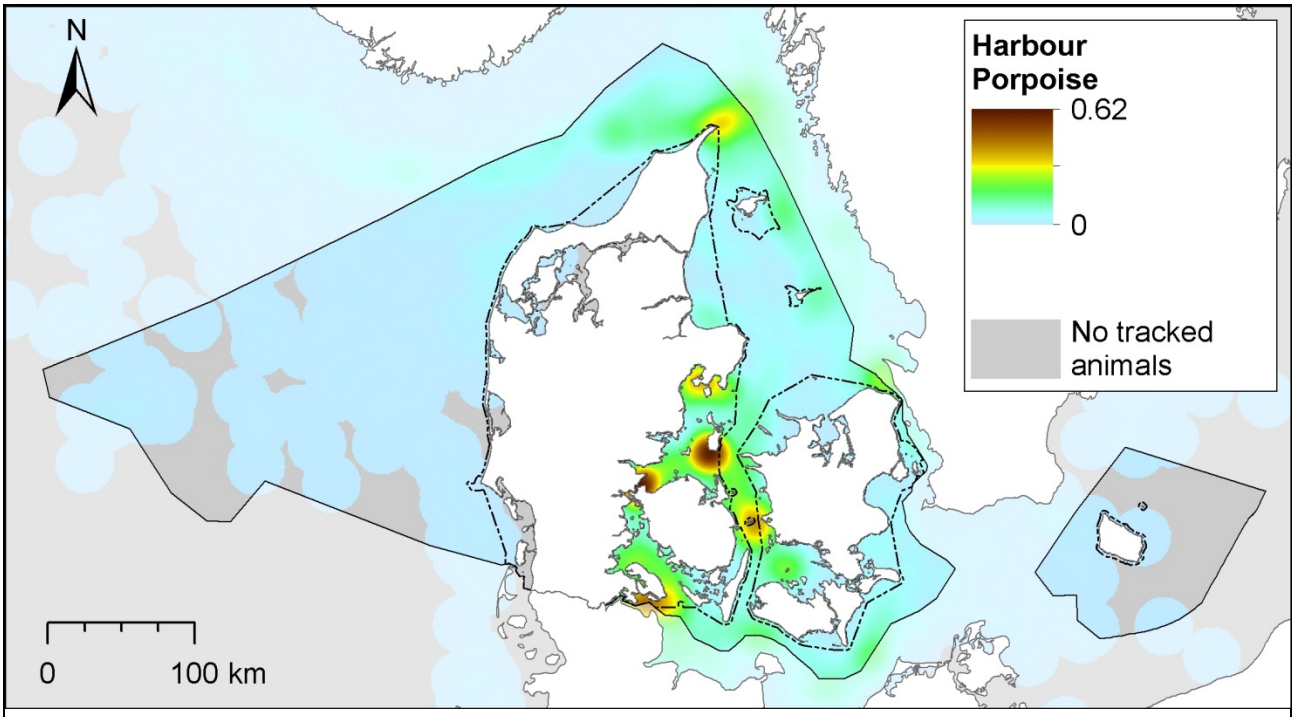
References

Dietz, R; Teilmann, J; Andersen, S M; Rigét, F; Olsen, M T (2012). Movements and site fidelity of harbour seals (Phoca vitulina) in Kattegat, Denmark, with implications for the epidemiology of the phocine distemper virus. ICES J Mar Sci 69(10): 1-10.

Douglas, D. (2006): The Douglas Argos-filter algorithm, Version 7.03. U.S. Geological Survey, Anchorage, AK. Available at http://alaska.usgs.gov/science/biology/spatial/pdfs/argosfilterv703_manual.pdf.

Scale or resolution	ArcGis output raster: 1 x 1 km and smoothing factor: 20 km.
Time period	April 2001 - May 2013
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Jonas Teilmann
E-mail	jte@bios.au.dk
Key words	Harbour seal, *Phoca vitulina,* tagging

F3 – Harbour Porpoise (Phocoena phocoena, *Marsvin*)



Map showing the density of harbor porpoise (Phocoena phocoena) in Danish waters based on positions of tagged animals.

Data sources and methods

Data were derived from tagging of harbour porpoises with Argos satellite transmitters. The animals have been tagged in different locations in the Belt Sea, the Kattegat and at Skagen. The individual transmitters have sent up to 1½ years. A total of 97 animals have been tagged. Harbour porpoise positions were determined by transmitted signals from the transmitters to satellites every time the transmitters reached the surface. The precison of satellite positions is determined by the Argos system, but it does not provide the same quality of precision as GPS. To eliminate unrealistic satellite positions all positions have therefore been filtered with a so-called DAR (Distance-Angle-Rate) filter in the SAS software, Argos Filter v7.03 (Douglas 2006), see Sveegaard et al. (2011) for further details. For all datasets one position per animal per day was extracted, regardless of how long the individual transmitters have sent signals. All positions are then plotted in ArcGIS version 10.1 and kernel densiteter (Arc toolbox) were calculated. Of the 97 animals, 51 animals were tagged as part of a joint project between the Danish Fisheries Institute, Fjord and Bælt Center, University of Southern Denmark and DMU in the period 1997-2002. 13 animals are labeled as a joint project between DMU and Kiel University in the years 2003-2007. In the years 2008-2011, the taggings were funded by the Danish Nature Agency (Naturstyrelsen). In the years 2011-2012, the taggings were carried out as a joint project between NERI / AU and ITAW, The Veterinary University in Hanover, Germany.

Spatial coverage

Danish waters from the western Baltic Sea to the central / northern North Sea. Data is only representative of animals taggedd in the Belt Sea, the Kattegat and at Skagen. There are areas that are not covered by these data, including the sea around the island of Bornholm and the southern North Sea. We know, for example from air and sea countings, that there is a large population of porpoises along the southern part of the North Sea and very few harbour porpoises at Bornholm.

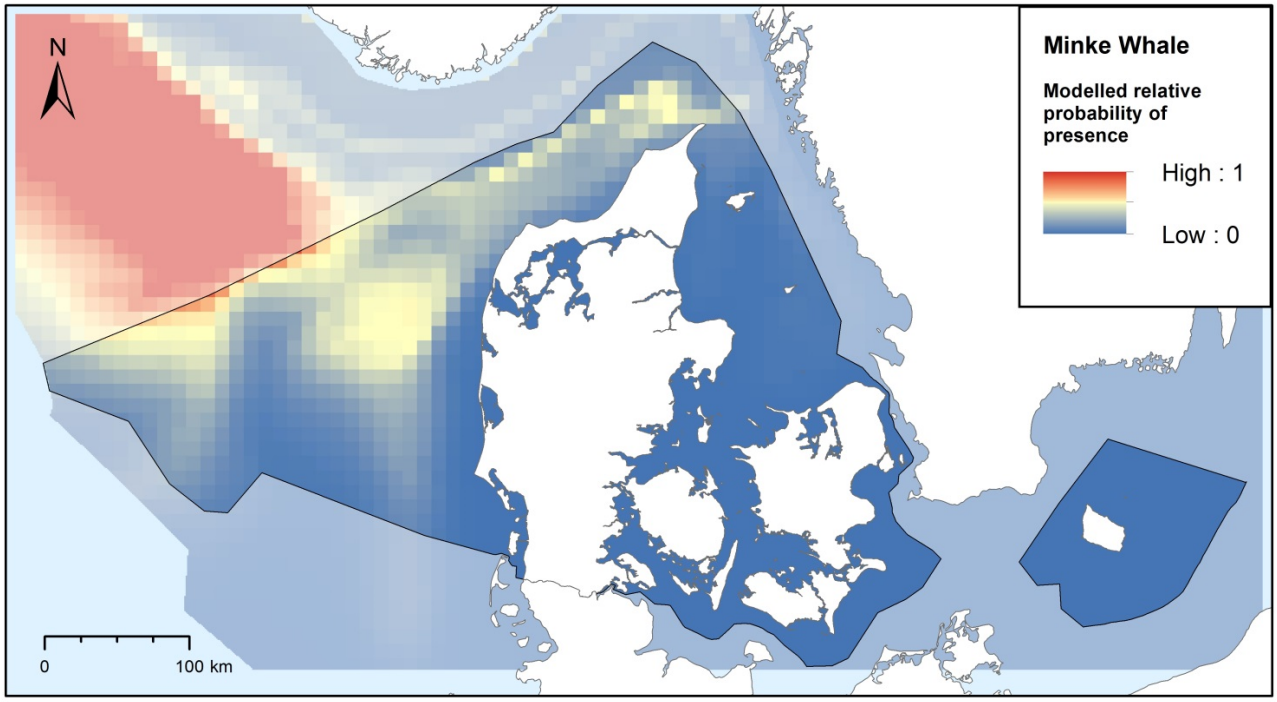
References

Sveegaard S, Teilmann J, Tougaard J, Dietz R, Mouritsen KN, Desportes G, Siebert U (2011): High density areas for harbour porpoises (*Phocoena phocoena*) identied by satellite tracking. Mar Mamm Sci 27:230-246.

Douglas, D. (2006): The Douglas Argos-filter algorithm, Version 7.03. U.S. Geological Survey, Anchorage, AK. Available at http://alaska.usgs.gov/science/biology/spatial/pdfs/argosfilterv703_manual.pdf.

Scale or resolution	ArcGis output raster: 1 x 1 km and smoothing factor: 20 km.
Time period	April 1997 - November 2012.
Data access	Original data are accessible.
Responsible institution	DCE/AU
Contact person	Jonas Teilmann
E-mail	jte@bios.au.dk
Key words	Harbour porpoise, *Phocoena phocoena*, marine mammals, HELCOM, OSPAR, food webs, biodiversity

F4 – Minke Whale (Balanoptera acutorostrata, *Vågehval*)



Map showing the modelled relative probability of presence of Minke Whale *(Balanoptera acutorostrata)* in Danish waters.

Data sources and methods

The original input data from the HARMONY project was used.

Spatial coverage

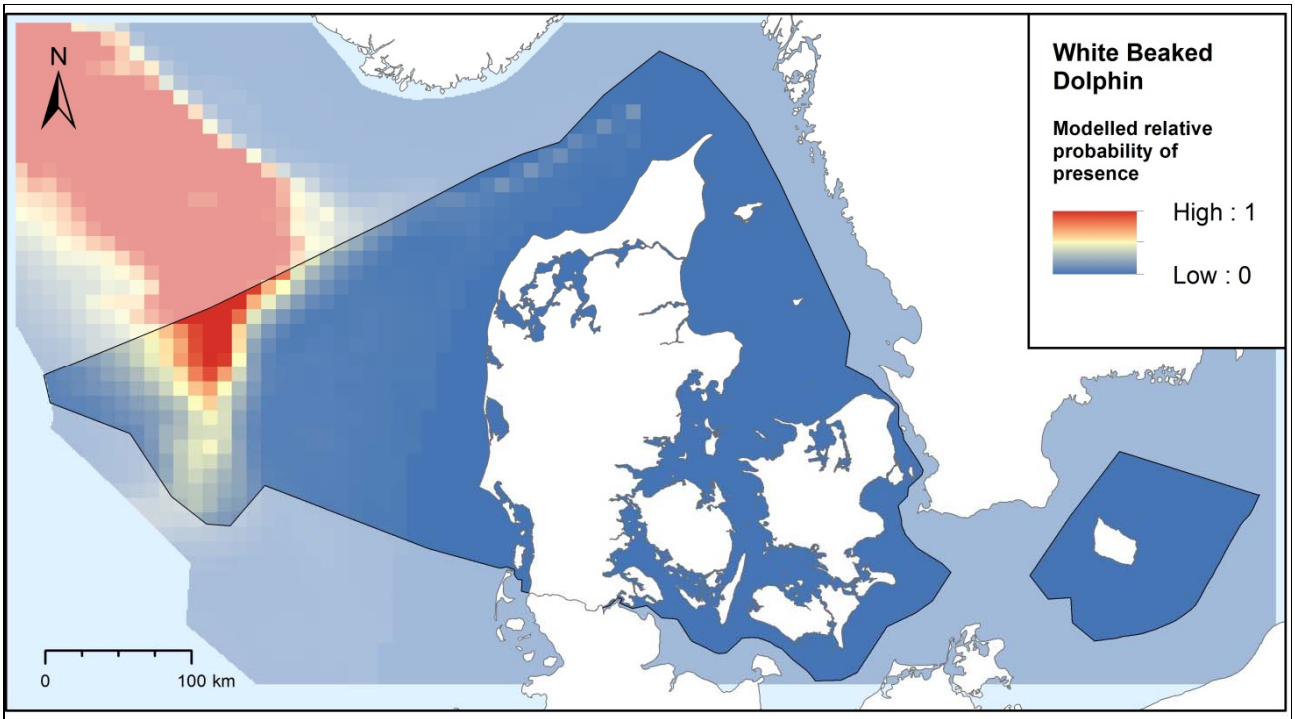
Danish EEZ.

References

HARMONY report (Andersen et al., 2013)

Scale or resolution	10 km
Time period	1994 and 2005 surveys combined
Data access	Predicted distribution: Contact the HARMONY Team.
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	Minke Whale, *Balanoptera acutorostrata,*, biodiversity

F5 – White-beaked Dolphin (Lagenorhynchus albirostris, *Hvidnæsen*)



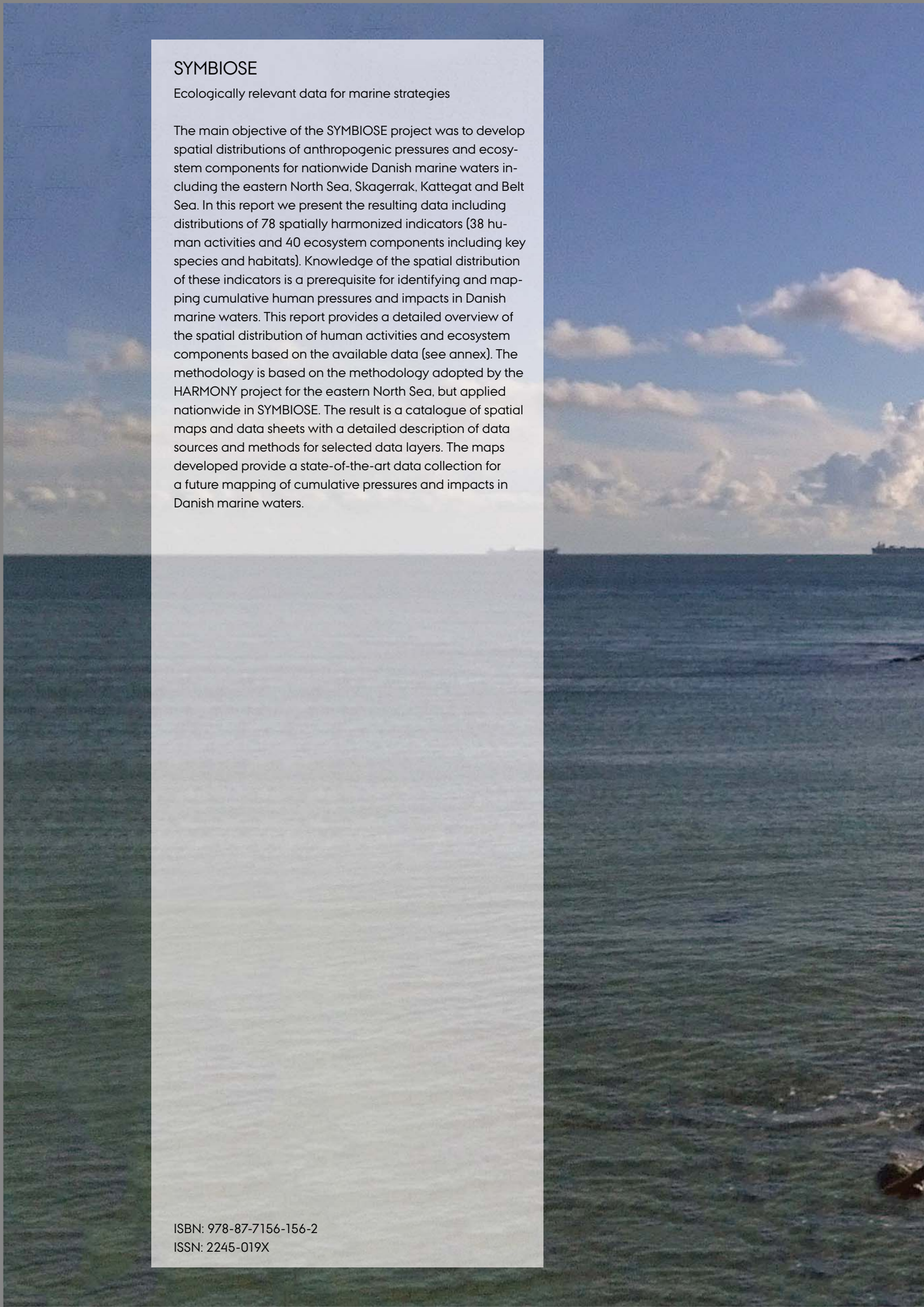
Map showing the modelled relative probability of presence of White Beaked Dolphin *(Lagenorhynchus albirostris)* in Danish waters.

Data sources and methods
The original input data from the HARMONY project was used.

Spatial coverage
Danish EEZ.

References
HARMONY report (Andersen et al., 2013)

Scale or resolution	10 km
Time period	1994 and 2005 surveys combined
Data access	Predicted distribution: Contact the HARMONY Team.
Responsible institution	DCE, AU.
Contact person	Cordula Göke, HARMONY team
E-mail	cog@bios.au.dk
Key words	White Beaked Dolphin, *Lagenorhynchus albirostris,* biodiversity.



SYMBIOSE

Ecologically relevant data for marine strategies

The main objective of the SYMBIOSE project was to develop spatial distributions of anthropogenic pressures and ecosystem components for nationwide Danish marine waters including the eastern North Sea, Skagerrak, Kattegat and Belt Sea. In this report we present the resulting data including distributions of 78 spatially harmonized indicators (38 human activities and 40 ecosystem components including key species and habitats). Knowledge of the spatial distribution of these indicators is a prerequisite for identifying and mapping cumulative human pressures and impacts in Danish marine waters. This report provides a detailed overview of the spatial distribution of human activities and ecosystem components based on the available data (see annex). The methodology is based on the methodology adopted by the HARMONY project for the eastern North Sea, but applied nationwide in SYMBIOSE. The result is a catalogue of spatial maps and data sheets with a detailed description of data sources and methods for selected data layers. The maps developed provide a state-of-the-art data collection for a future mapping of cumulative pressures and impacts in Danish marine waters.

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