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REGIONAL WORKSHOP TO FACILITATE THE DESCRIPTION OF ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS IN THE NORTH-EAST ATLANTIC OCEAN AND TRAINING SESSION ON ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS
Stockholm, 22-27 September 2019

DATA TO INFORM THE REGIONAL WORKSHOP TO FACILITATE THE DESCRIPTION OF ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS IN THE NORTH-EAST ATLANTIC OCEAN

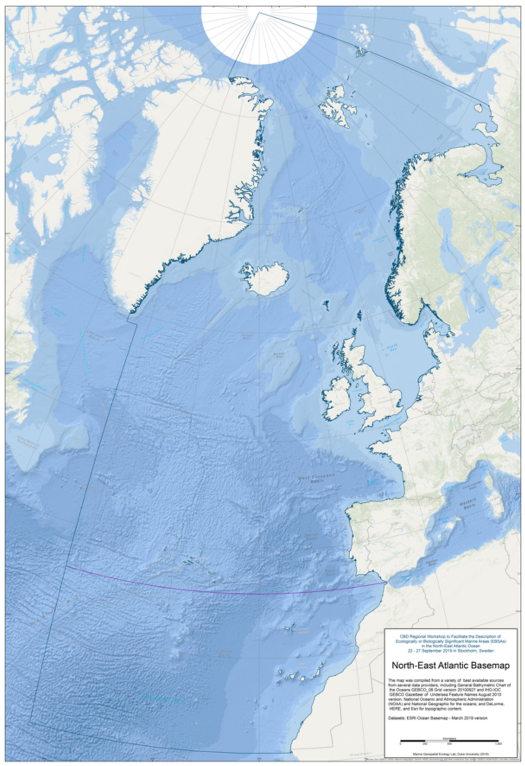
Note by the Executive Secretary

1. The Executive Secretary is circulating herewith a background document containing data to inform the Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas in the North-East Atlantic Ocean. This document was prepared by the Marine Geospatial Ecology Lab, Duke University, in support of the Secretariat of the Convention on Biological Diversity in its scientific and technical preparation for the above-mentioned workshop, with the financial support of the Government of France.

2. The document is being circulated in the form and language in which it was received by the Secretariat.

Data to Inform the CBD Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic Ocean

23 September - 27 September 2019
Stockholm, Sweden



Jesse Cleary, Sarah DeLand, Ben Donnelly, Ana Cañadas, Patrick Halpin
Marine Geospatial Ecology Lab, Duke University

Marine Geospatial Ecology Lab • Duke University

Prepared for the Secretariat of the Convention on Biodiversity (SCBD)

Inquiries should be addressed to:

Jesse Cleary
Marine Geospatial Ecology Lab, Duke University
Durham, NC, USA
Telephone : +1 919-684-3660
Email : jesse.cleary@duke.edu
Web : http://mgel.env.duke.edu

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Contents

Figures

1 Background

The Marine Geospatial Ecology Lab at Duke University, in conjunction with international partners, has identified and mapped a large number of data sets and analyses for consideration by the Convention on Biological Diversity (CBD) Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas (EBSAs) in the North-East Atlantic Ocean. Biogeographic, biological and physical data sets are included. The data are intended to be used by the expert regional workshop convened by the CBD Secretariat to aid in describing EBSAs through the application of the scientific criteria in annex I of decision IX/20.

Printed map posters and map books will be available for review at the workshop. Digital versions of these maps are also available:
https://duke.box.com/s/3rb1dwbg6pvpdyy3okwl3d3cc6f6b3uv

1.1 Data Collection Scope

Data and supporting documents for this report were collected and collated for the broader North-East Atlantic. The exact geographic focus of the workshop will be established by the workshop attendees at the meeting. The geographic scope of the information contained in this report is not intended to pre-judge the selection of the geographic scope of the workshop.

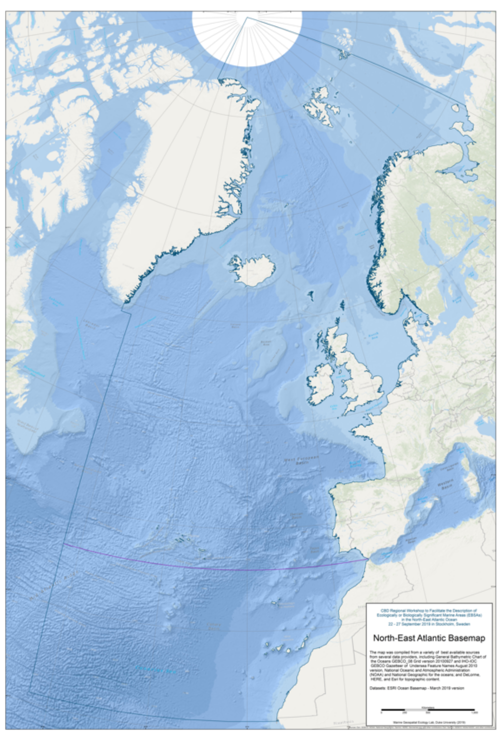

Figure 1.1-1 Data collection scope

2 Biogeography

2.1 Longhurst Marine Provinces

"This dataset represents a partition of the world oceans into provinces as defined by Longhurst (1995; 1998; 2006), and are based on the prevailing role of physical forcing as a regulator of phytoplankton distribution. The dataset represents the initial static boundaries developed at the Bedford Institute of Oceanography, Canada. Note that the boundaries of these provinces are not fixed in time and space, but are dynamic and move under seasonal and interannual changes in physical forcing. At the first level of reduction, Longhurst recognized four principal biomes (also referred to as domains in earlier publications): the Polar Biome, the Westerlies Biome, the Trade-Winds Biome, and the Coastal Boundary Zone Biome. These four Biomes are recognizable in every major ocean basin. At the next level of reduction, the ocean basins are partitioned into provinces, roughly ten for each basin. These partitions provide a template for data analysis or for making parameter assignments on a global scale."

Source:
VLIZ (2009). Longhurst Biogeographical Provinces. Available online at http://www.marineregions.org/. Consulted on 2013-01-14.

Reference:
Longhurst, A.R. (2006). Ecological Geography of the Sea. 2nd Edition. Academic Press, San Diego, 560p.

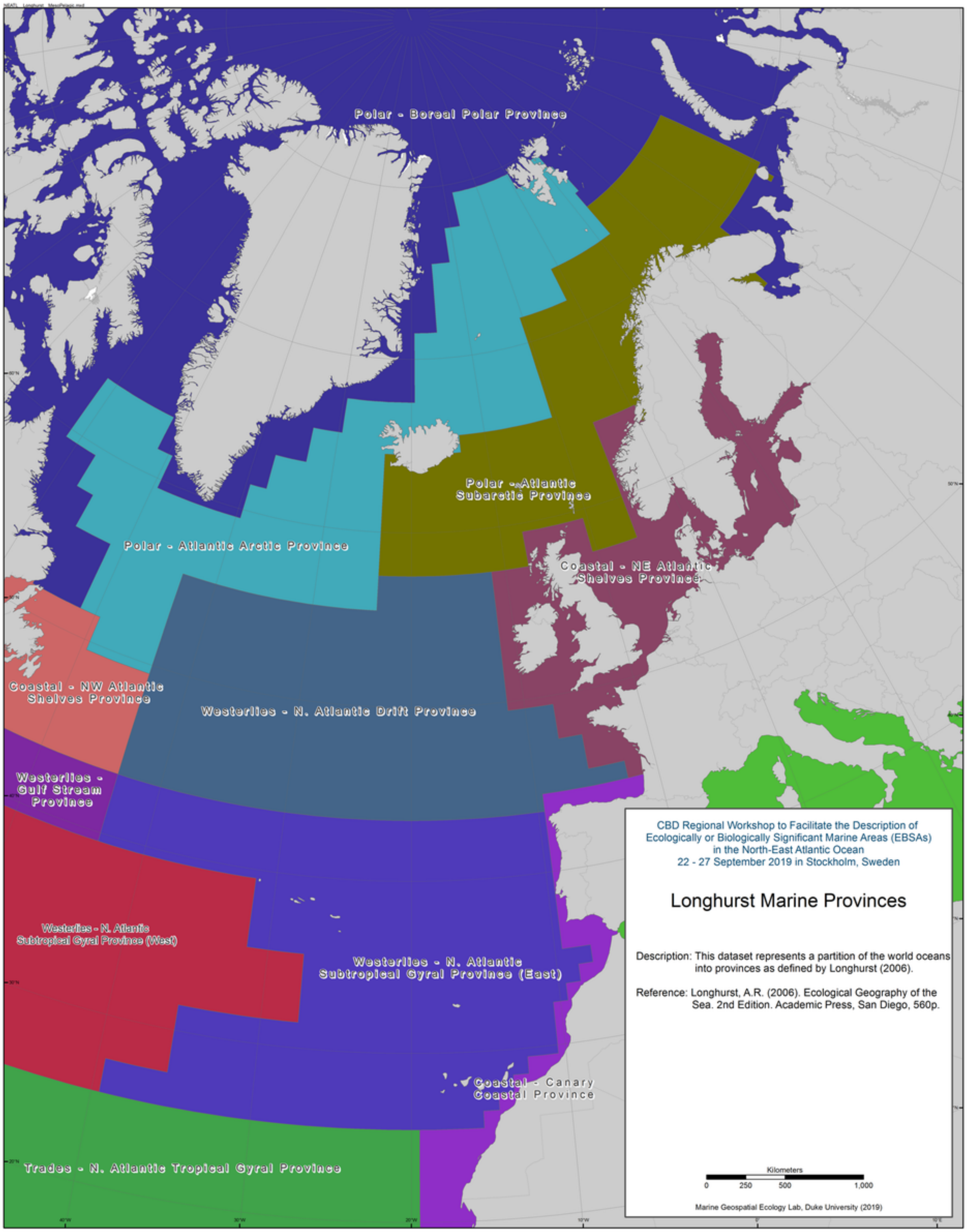

Figure 2.1-1 Longhurst marine provinces

2.2 Global Open Oceans and Deep Seabed (GOODS) Biogeographic Classification

"GOODS is the first attempt at comprehensively classifying the open-ocean and deep seafloor into distinct biogeographic regions (UNESCO, 2009). The classification was produced by an international and multidisciplinary group of experts under the auspices of a number of international and intergovernmental organizations as well as governments, and under the ultimate umbrella of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and its Intergovernmental Oceanographic Commission (IOC). The maps shown below include the updates made by Watling et al. (2013).

The biogeographic classification classifies specific ocean regions using environmental features and – to the extent data are available – their species composition. GOODS is hypothesis-driven and still preliminary, and will thus require further refinement and peer review in the future. However, parts of it have already been published (e.g. pelagic provinces; Spalding et al. 2012). Watling et al. (2013) tried to refine the GOODS bathyal and abyssal provinces including some new variables. Physical and chemical proxies thought to be good predictors of the distributions of organisms at the deep-sea floor, and thus used for the definition of biogeographic provinces, were: depth, temperature (T), salinity (S), dissolved oxygen (O), and particulate organic carbon flux (POC) to the sea- floor.

The major open ocean pelagic and deep sea benthic zones presented by the GOODS report and by Watling et al. (2013) are considered by their authors a reasonable basis for advancing efforts towards the conservation and sustainable use of biodiversity in marine areas beyond the limits of national jurisdiction in line with a precautionary approach."

Reference:

UNESCO. 2009. *Global Open Oceans and Deep Seabed (GOODS) – Biogeographic Classification*. Paris, UNESCO-IOC. (IOC Technical Series, 84.)

Watling, L., Guinotte, J., Clark, M. R., and Smith, C. R. (2013) A proposed biogeography of the deep ocean floor. Progress in Oceanography, 11, 91-112.

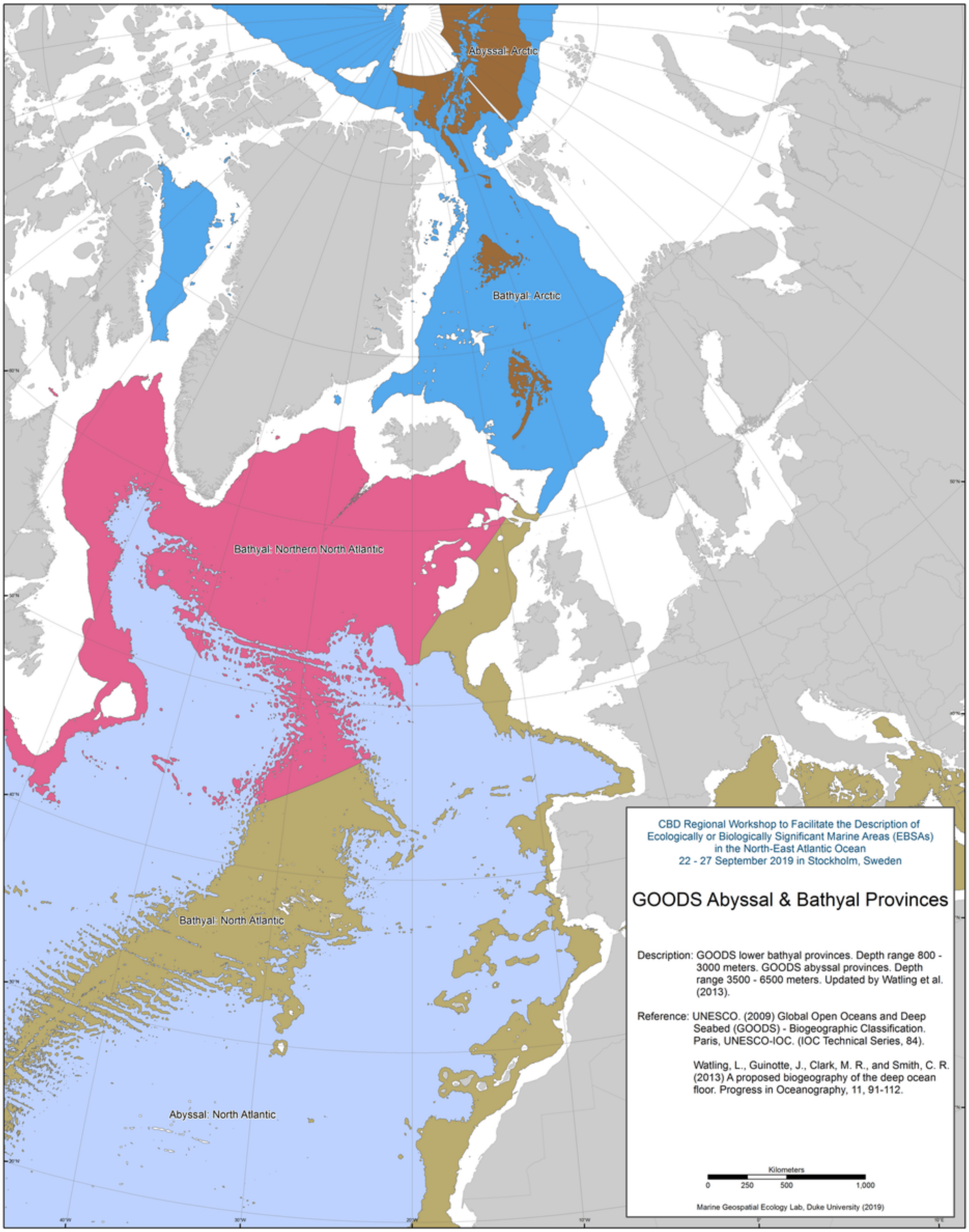

Figure 2.2-1 GOODS abyssal and bathyal provinces

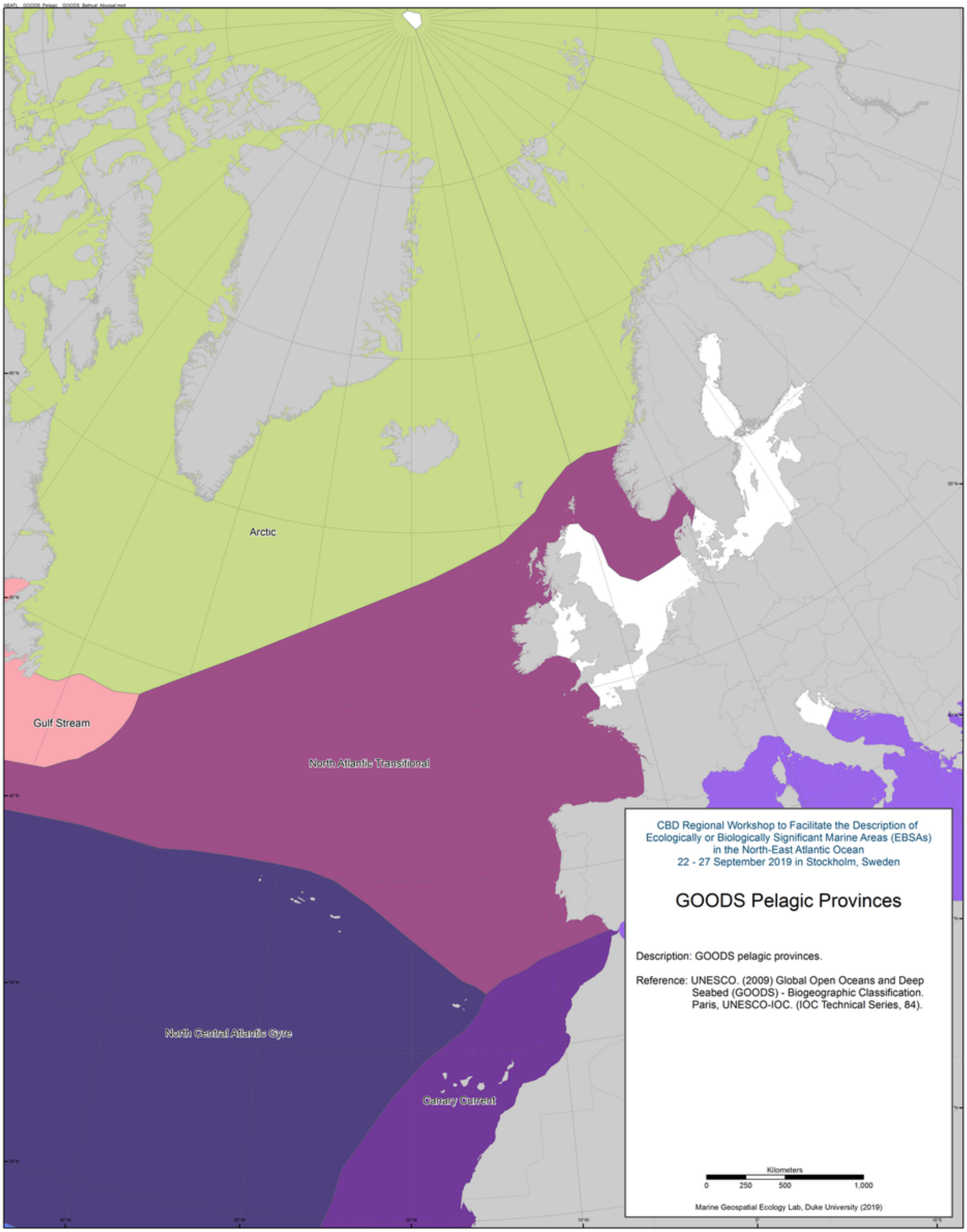

Figure 2.2-2 GOODS pelagic provinces

2.3 Large Marine Ecosystems (LMEs)

“Large Marine Ecosystems (LMEs) are regions of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundary of continental shelves and the seaward margins of coastal current systems. Fifty of them have been identified. They are relatively large regions (200 000 km2 or more) characterized by distinct bathymetry, hydrography, productivity and trophically dependent populations.

The LME approach uses five modules:

- *productivity module* considers the oceanic variability and its effect on the production of phyto and zooplankton
- *fish and fishery module* concerned with the sustainability of individual species and maintenance of biodiversity
- *pollution and ecosystem health module* examines health indices, eutrophication, biotoxins, pathology and emerging diseases
- *socio-economic module* integrates assessments of human forcing and the long-term sustainability and associated socio-economic benefits of various management measures, and
- *governance module* involves adaptive management and stakeholder participation.”

(source: http://www.fao.org/fishery/topic/3440/en)

Reference:

Sherman, K. and Hempel, G. (Editors) 2009. The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world’s Regional Seas. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. Nairobi, Kenya.

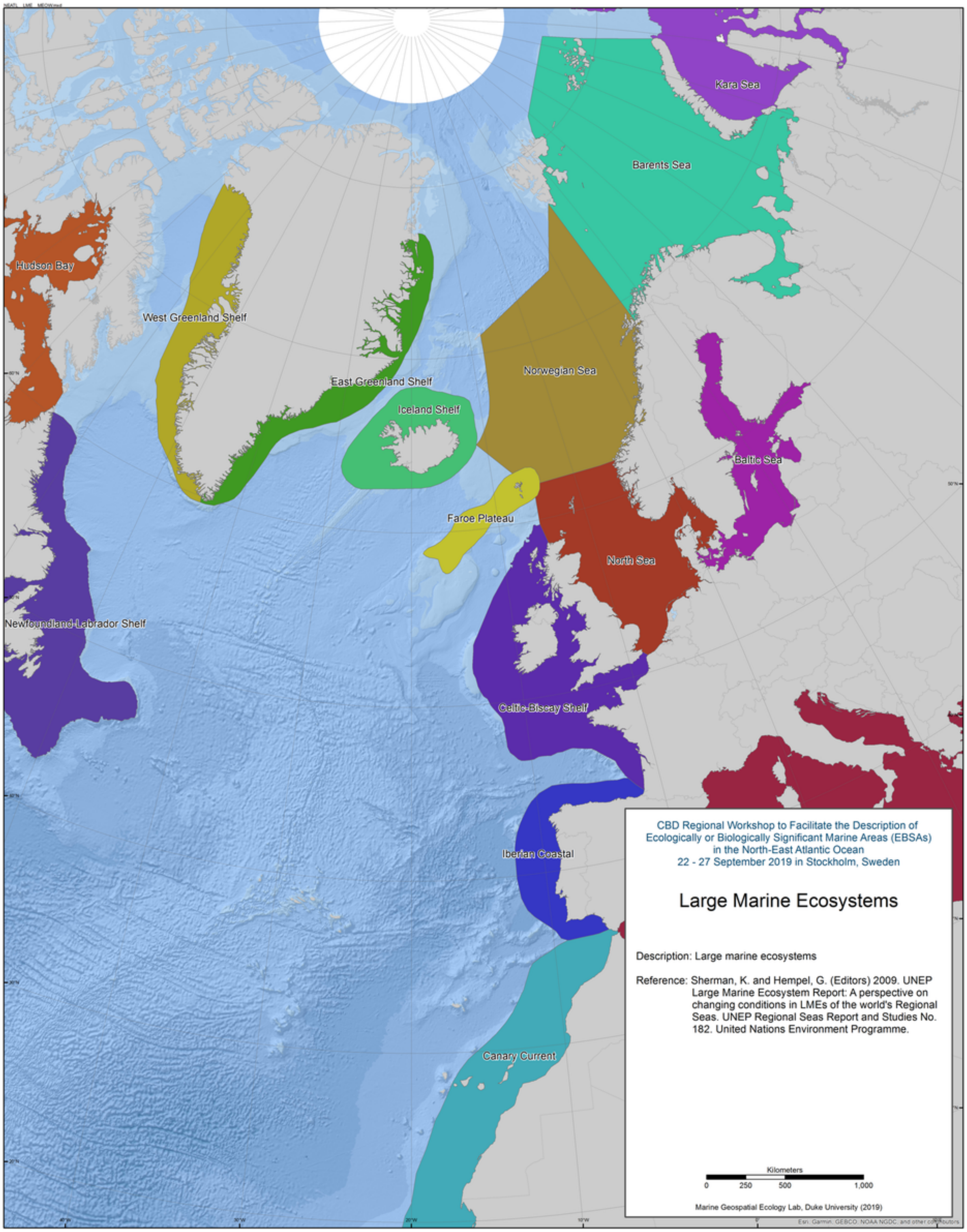

Figure 2.3-1 Large marine ecosystems

2.4 Marine Ecoregions of the World (MEOWs)

"MEOW is a biogeographic classification of the world's coasts and shelves. It is the first ever comprehensive marine classification system with clearly defined boundaries and definitions and was developed to closely link to existing regional systems. The ecoregions nest within the broader biogeographic tiers of Realms and Provinces.

MEOW represents broad-scale patterns of species and communities in the ocean, and was designed as a tool for planning conservation across a range of scales and assessing conservation efforts and gaps worldwide. The current system focuses on coast and shelf areas (as this is where the majority of human activity and conservation action is focused) and does not consider realms in pelagic or deep benthic environment. It is hoped that parallel but distinct systems for pelagic and deep benthic biotas will be devised in the near future.

The project was led by The Nature Conservancy (TNC) and the World Wildlife Fund (WWF), with broad input from a working group representing key NGO, academic and intergovernmental conservation partners."

Reference:
Spalding, M. D. Fox, H. E. Allen, G. R. Davidson, N. Ferdana, Z. A. Finlayson, M. Halpern, B. S. Jorge, M. A. Lombana, A. Lourie, S. A., (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. Bioscience 2007, VOL 57; numb 7, pages 573-584. doi: 10.1641/B570707

Data available from: http://www.marineregions.org/sources.php#meow

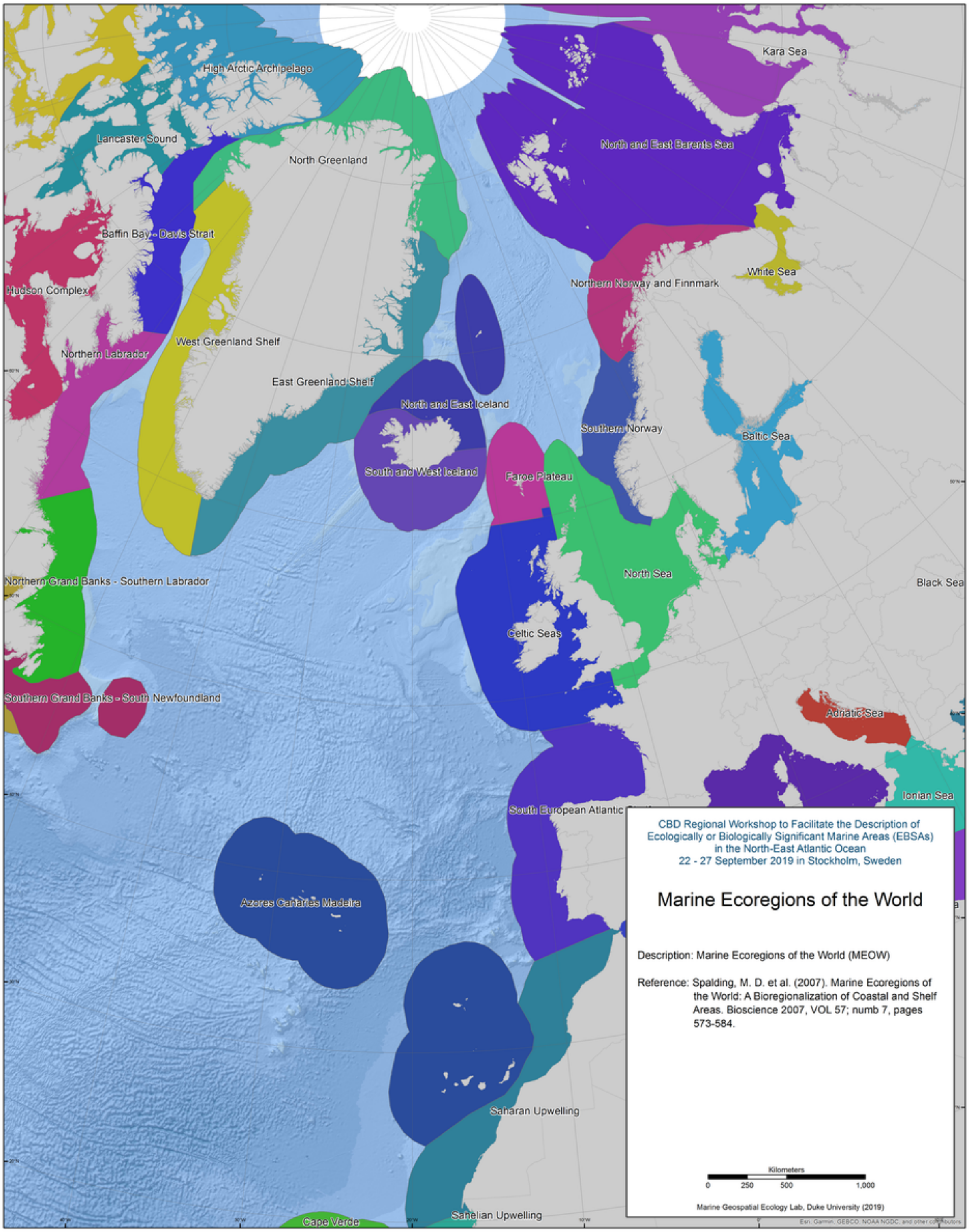

Figure 2.4-1 Marine ecoregions of the world

2.5 Global Mesopelagic Biogeography

Abstract:
"We have developed a global biogeographic classification of the mesopelagic zone to reflect the regional scales over which the ocean interior varies in terms of biodiversity and function. An integrated approach was necessary, as global gaps in information and variable sampling methods preclude strictly statistical approaches. A panel combining expertise in oceanography, geospatial mapping, and deep-sea biology convened to collate expert opinion on the distributional patterns of pelagic fauna relative to environmental proxies (temperature, salinity, and dissolved oxygen at mesopelagic depths). An iterative Delphi Method integrating additional biological and physical data was used to classify biogeographic ecoregions and to identify the location of ecoregion boundaries or inter-regions gradients. We define 33 global mesopelagic ecoregions. Of these, 20 are oceanic while 13 are 'distant neritic.' While each is driven by a complex of controlling factors, the putative primary driver of each ecoregion was identified. While work remains to be done to produce a comprehensive and robust mesopelagic biogeography (i.e., reflecting temporal variation), we believe that the classification set forth in this study will prove to be a useful and timely input to policy planning and management for conservation of deep pelagic marine resources. In particular, it gives an indication of the spatial scale at which faunal communities are expected to be broadly similar in composition, and hence can inform application of ecosystem-based management approaches, marine spatial planning and the distribution and spacing of networks of representative protected areas."

Reference:
Sutton, T. T. et al. 2017. A global biogeographic classification of the mesopelagic zone. - Deep Sea Research Part I: Oceanographic Research Papers 126: 85–102.

Dataset downloaded from Marine Regions (August 2019)
http://www.marineregions.org/gazetteer.php?p=details&id=50384

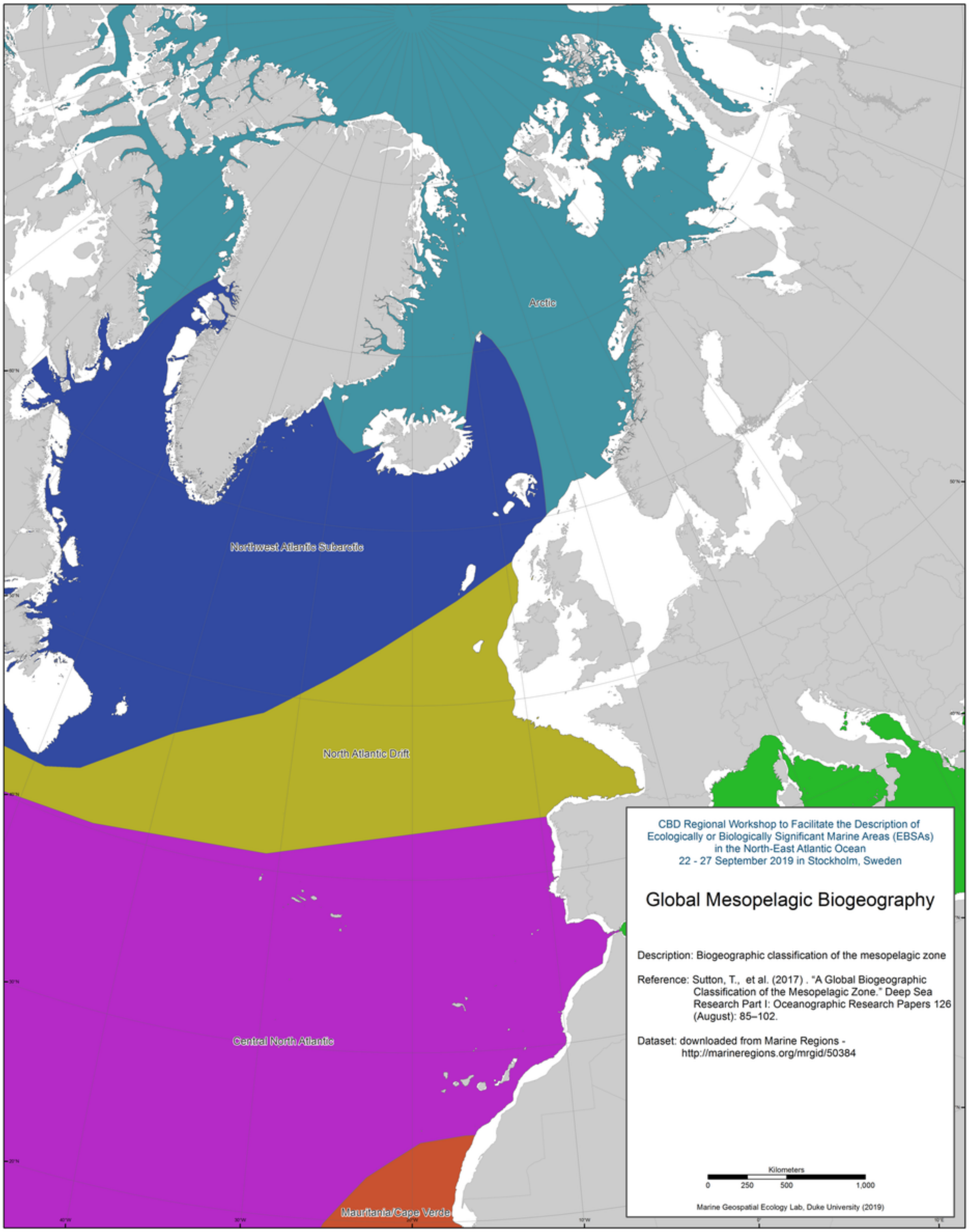

Figure 2.5-1 Global mesopelagic biogeography

2.6 ICES Ecoregions and Advisory Areas

"ICES advice is divided by ecoregions, allowing for further development of an ecosystem approach in European waters. For each ecoregion the advice includes an ecosystem overview, which provides a description of the ecosystem components and the major ecological events and trends. The ecoregions are based on biogeographic and oceanographic features and existing political, social, economic, and management divisions."

Source:
https://www.ices.dk/community/advisory-process/Pages/ICES-ecosystems-and-advisory-areas.aspx

ICES Ecoregions, ices.dk. Dec 2017

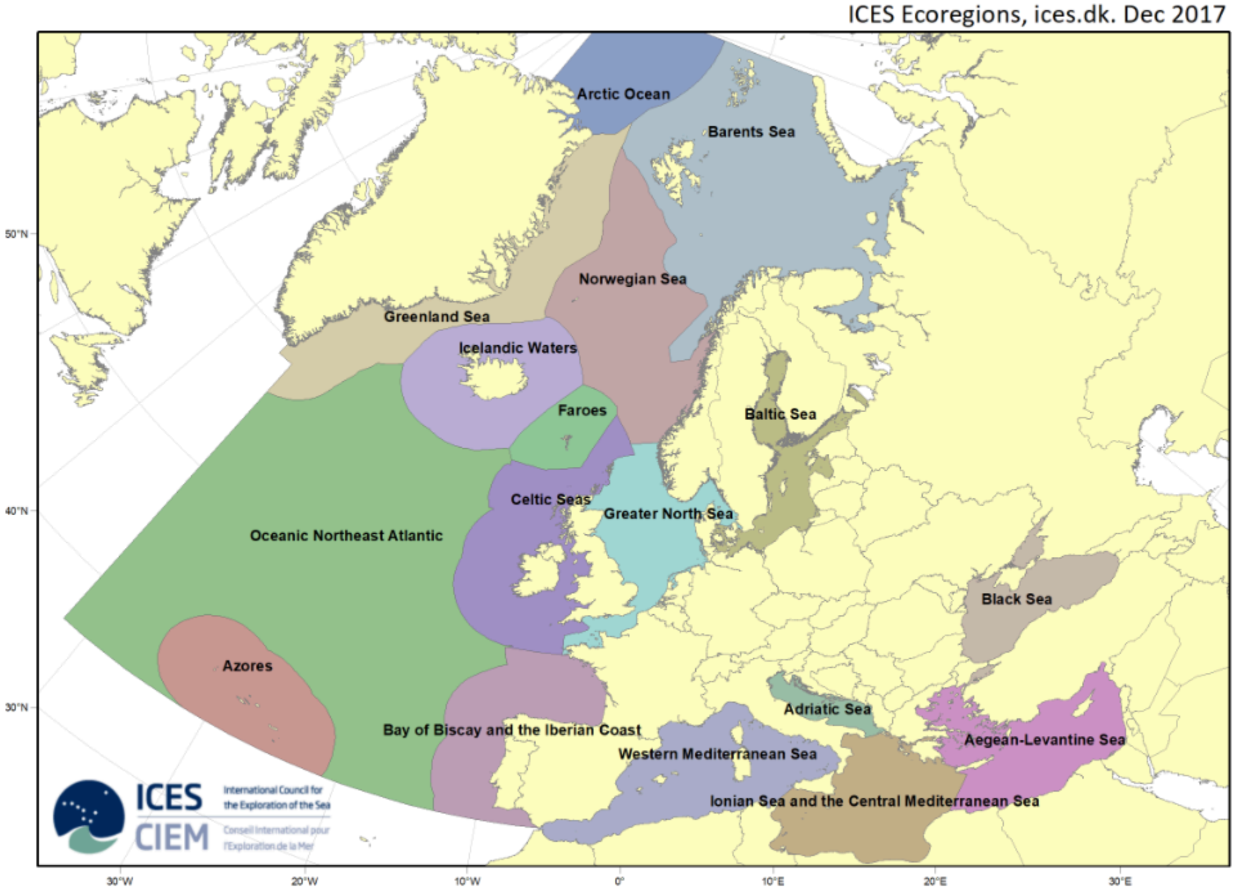

Figure 2.6-1 ICES ecoregions

2.7 Dinter Biogeographic Classification

"The Dinter Biogeographic Classification divides the seafloor, the deep sea and open oceanic waters into a series of representative biogeographic zones, each having a specific oceanography which supports characteristic biological communities. "

Source:
https://qsr2010.ospar.org/en/ch02_03.html

Reference:
Dinter, Wolfgang P 2001. Biogeography of the OSPAR Maritime Area. A Synopsis and Synthesis of Biogeographical Distribution Patterns described for the North-East-Atlantic. German Federal Agency for Nature Conservation (BfN) 168 pp

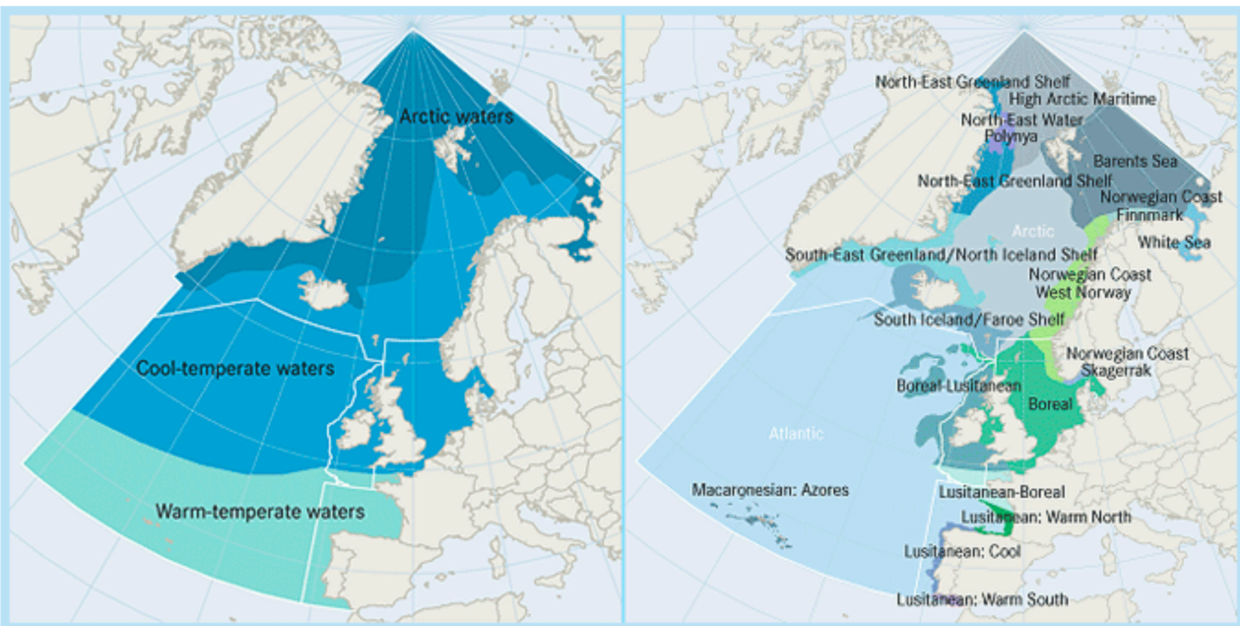

Figure 2.7-1 Dinter biogeographic regions

Original Caption: "Left: The water column less than 1000 m depth is divided into three characteristic biogeographic zones for the pelagic environment.

Right: Biogeographic zones for the benthic and deep-sea environments. The deep-sea benthos and deep-sea environments (>1000 m) are separated into two broad zones: Arctic and Atlantic, separated by the Iceland-Faroe Shelf. The benthic environment less than 100 m depth is separated into a series of characteristic zones."

3 Biological Data

3.1 Ocean Biogeographic Information System (OBIS) Data Summaries

"The Ocean Biogeographic Information System (OBIS) seeks to absorb, integrate, and assess isolated datasets into a larger, more comprehensive picture of life in our oceans. The system hopes to stimulate research about our oceans to generate new hypotheses concerning evolutionary processes, species distributions, and roles of organisms in marine systems on a global scale. The abstracts that OBIS generates are maps that contribute to the 'big picture' of our oceans: a comprehensive, collaborative, worldwide view of our oceans.

OBIS provides a portal or gateway to many datasets containing information on where and when marine species have been recorded. The datasets are integrated so researchers can search them all seamlessly by species name, higher taxonomic level, geographic area, depth, and time; and then map and find environmental data related to the locations."

Source:
https://obis.org/about/

Reference:
Intergovernmental Oceanographic Commission (IOC) of UNESCO. The Ocean Biogeographic Information System. Web. http://www.iobis.org.

The data provided here are summaries of available OBIS data. Species Richness and Hurlbert's Index (ES[50]) data summaries for hexagons are provided for all species, mammals, sea turtles, shallow observations (<100m depth), and deep observations (>100m depth). Data gaps do exist in OBIS and thus these summaries are not exhaustive.

EBSA data preparation code repository - https://github.com/iobis/ebsa

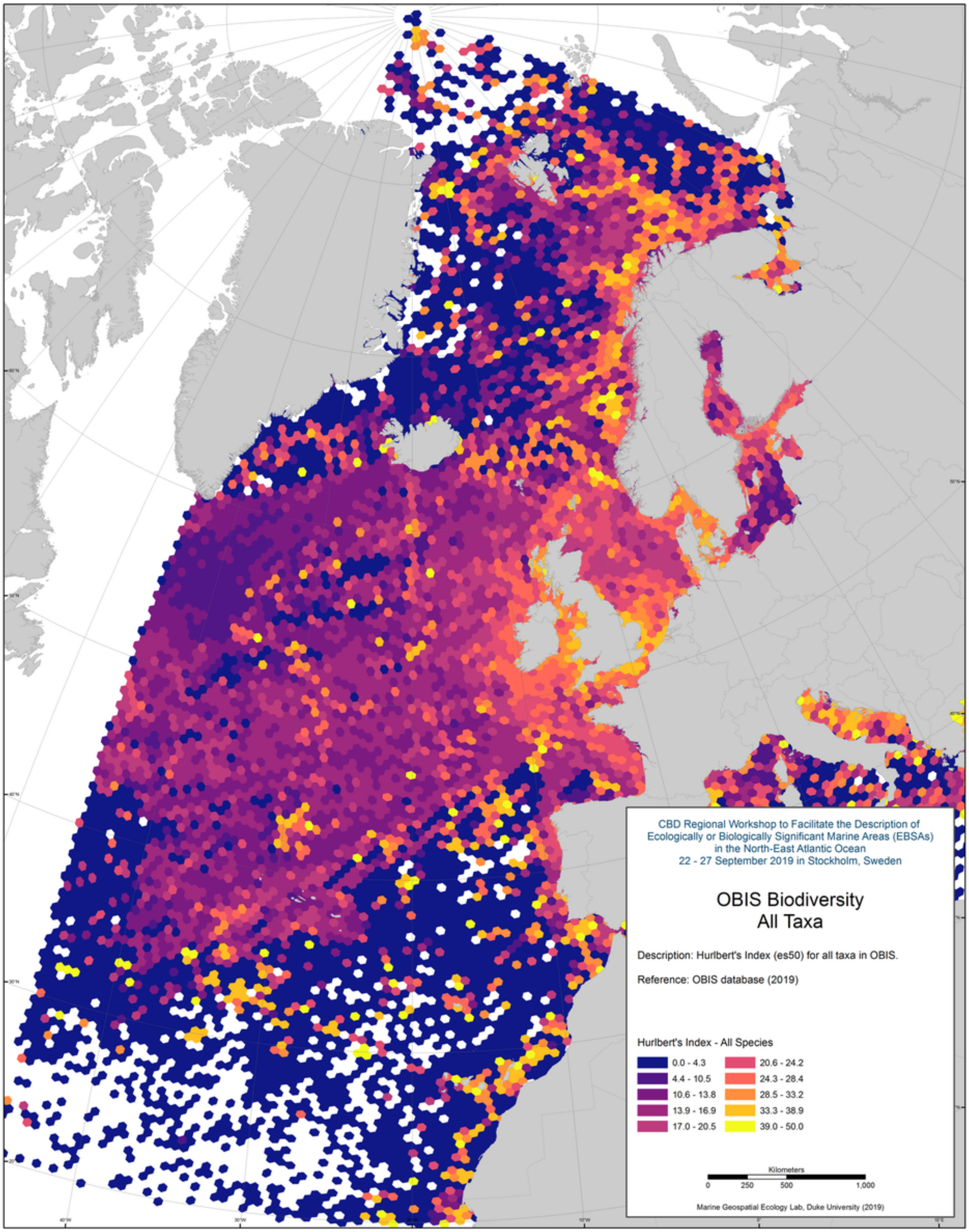

Figure 3.1-1 Biodiversity for all taxa, es(50)

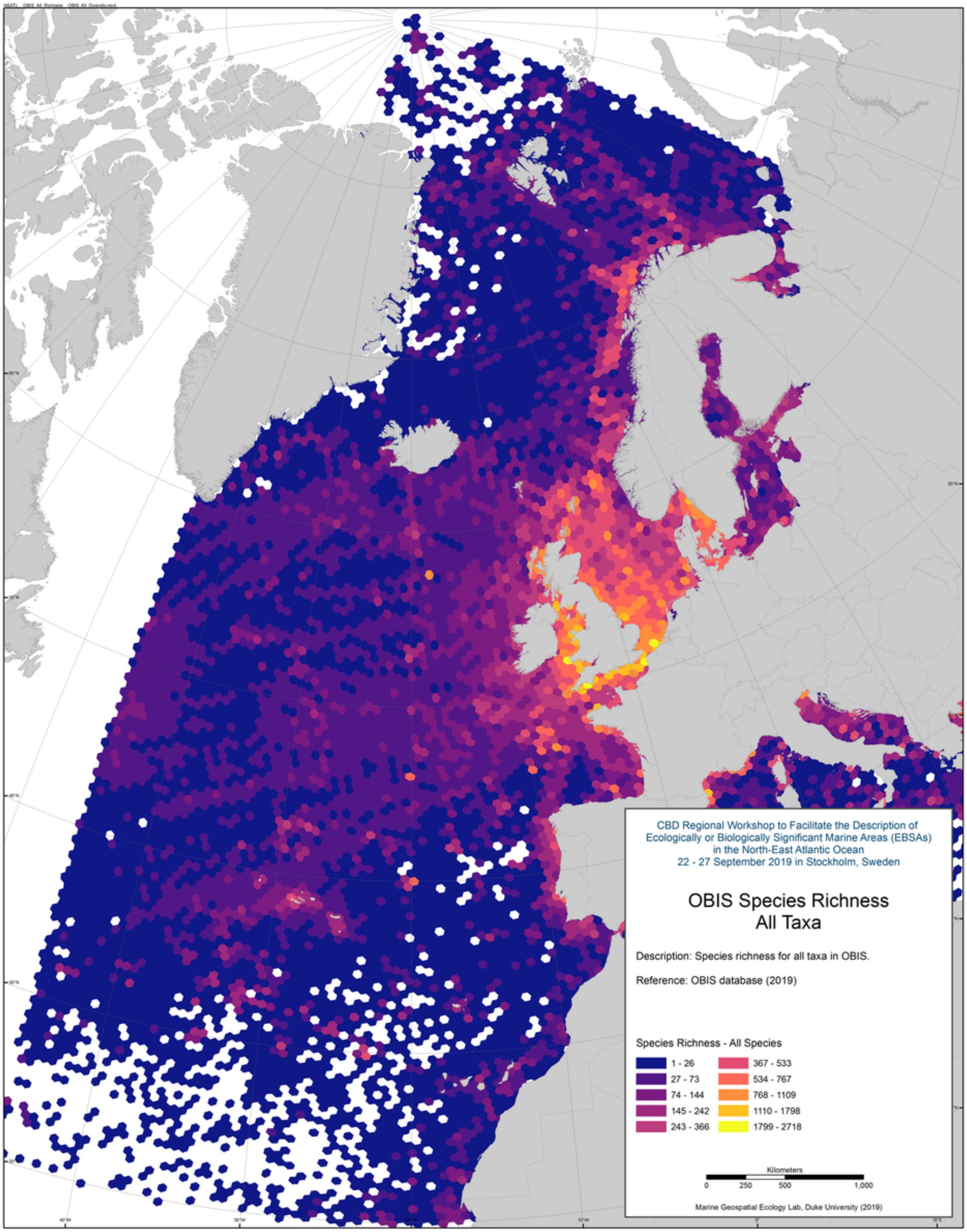

Figure 3.1-2 Species richness for all taxa

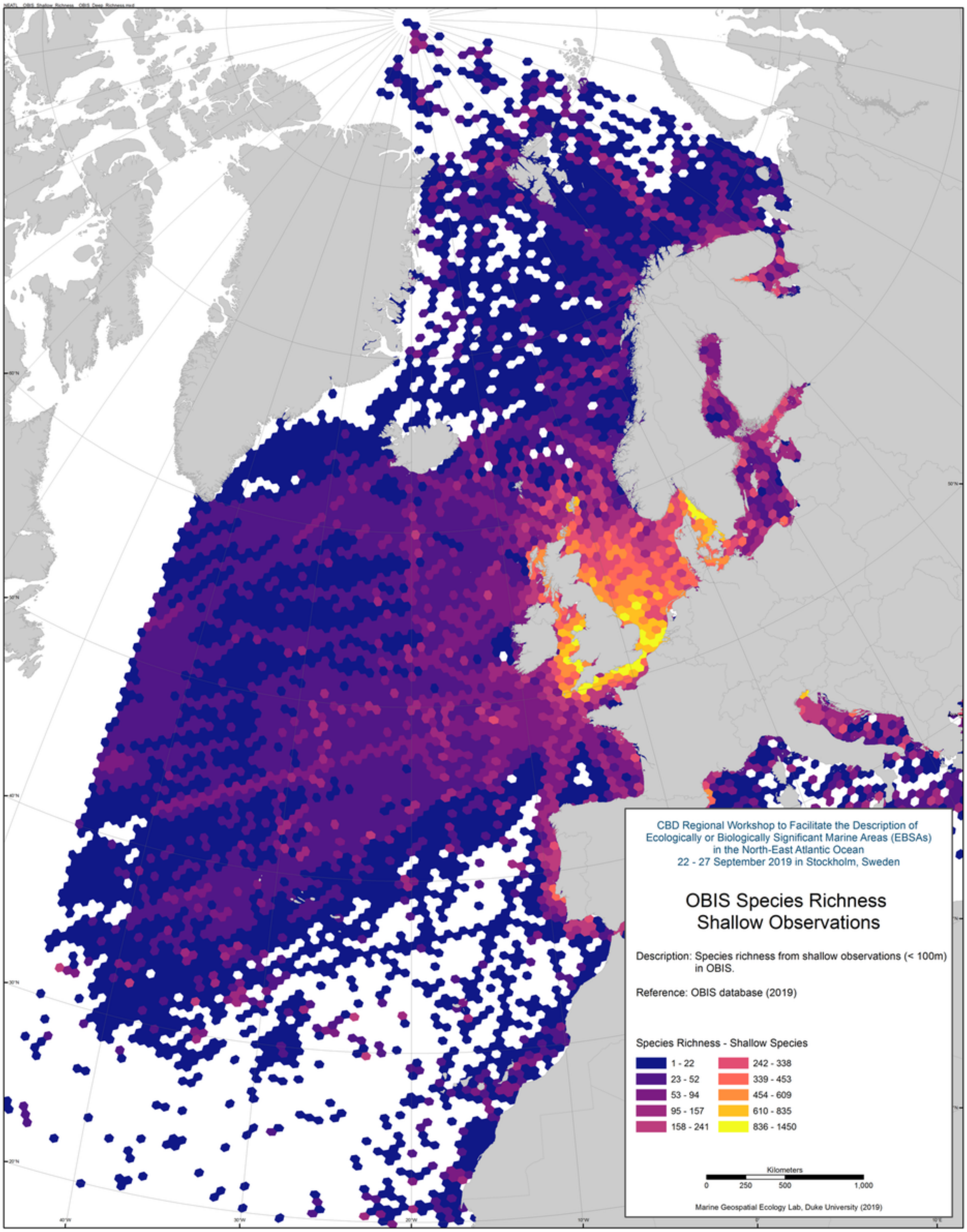

Figure 3.1-3 Species richness for shallow observations

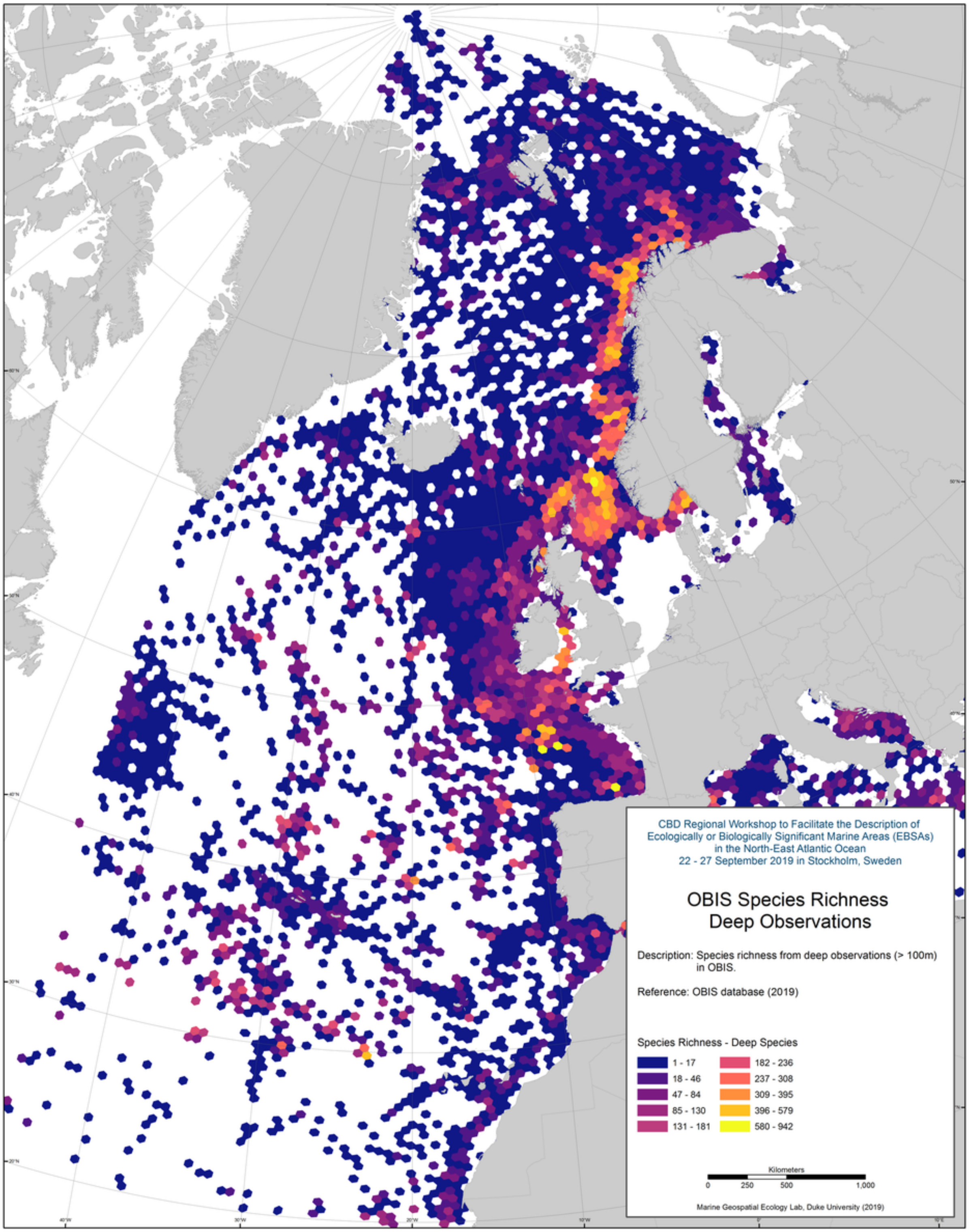

Figure 3.1-4 Species richness for deep observations

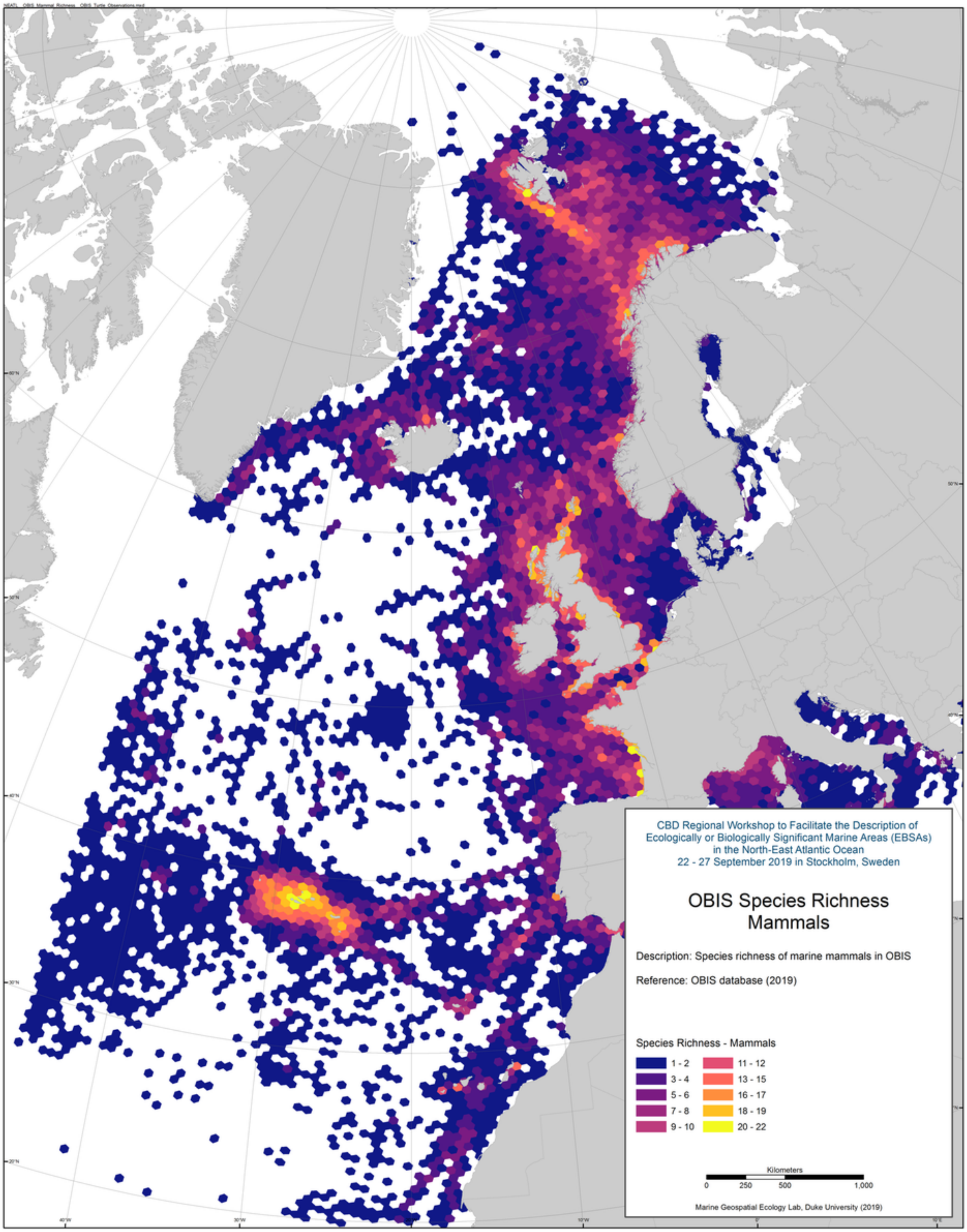

Figure 3.1-5 Species richness for marine mammals

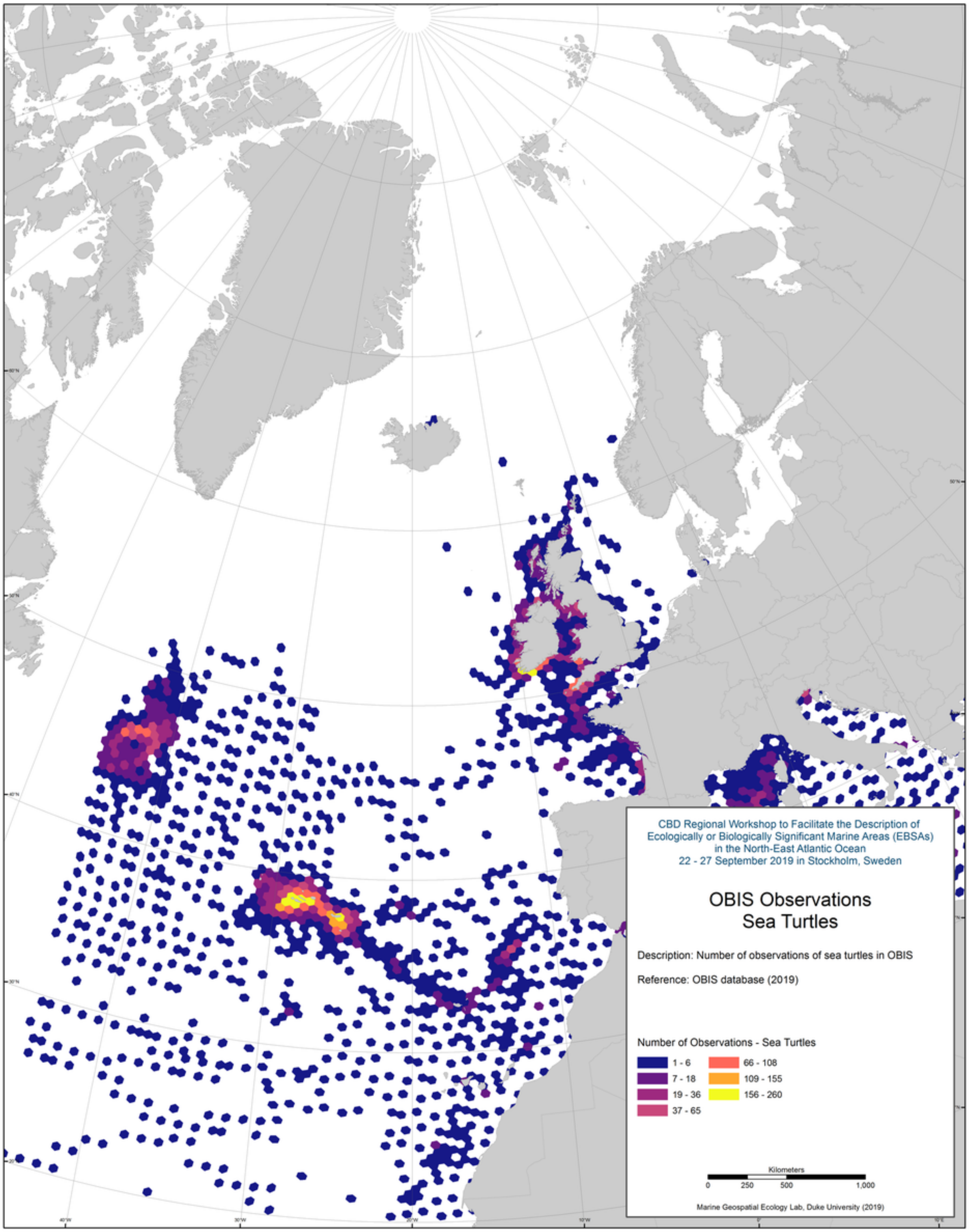

Figure 3.1-6 Observations of sea turtles

3.2 BirdLife International - Tracking Summaries

Tracking data for 23 seabird species from 105 colonies were compiled from the Seabird Tracking Database, resulting in 2188 individual birds within the OSPAR Maritime Areas that are Beyond National Jurisdiction (ABNJ). This tracking data was summarized into kernel densities for individuals and species, representing the 50% utilization distribution. The density for all species was compiled and divided by the total number of species in the area of analysis to produce a combined density map for all species and all quarters of the year. To generate species richness, the kernel densities for each species were converted to presence/absence and the overlap for all species was summed. Species of particular importance, such as OSPAR listed priority species or globally and European threatened species, were given a higher weight to prioritize regions where these species are present. Finally, to generate a combined density-richness map, the density and richness map for all species and year quarters were multiplied and then standardized to obtain values varying between 0 and 1 (by dividing by the maximum value).

Prepared by: Ana Carneiro and Maria Dias, BirdLife International. August 2017, and updated February 2019

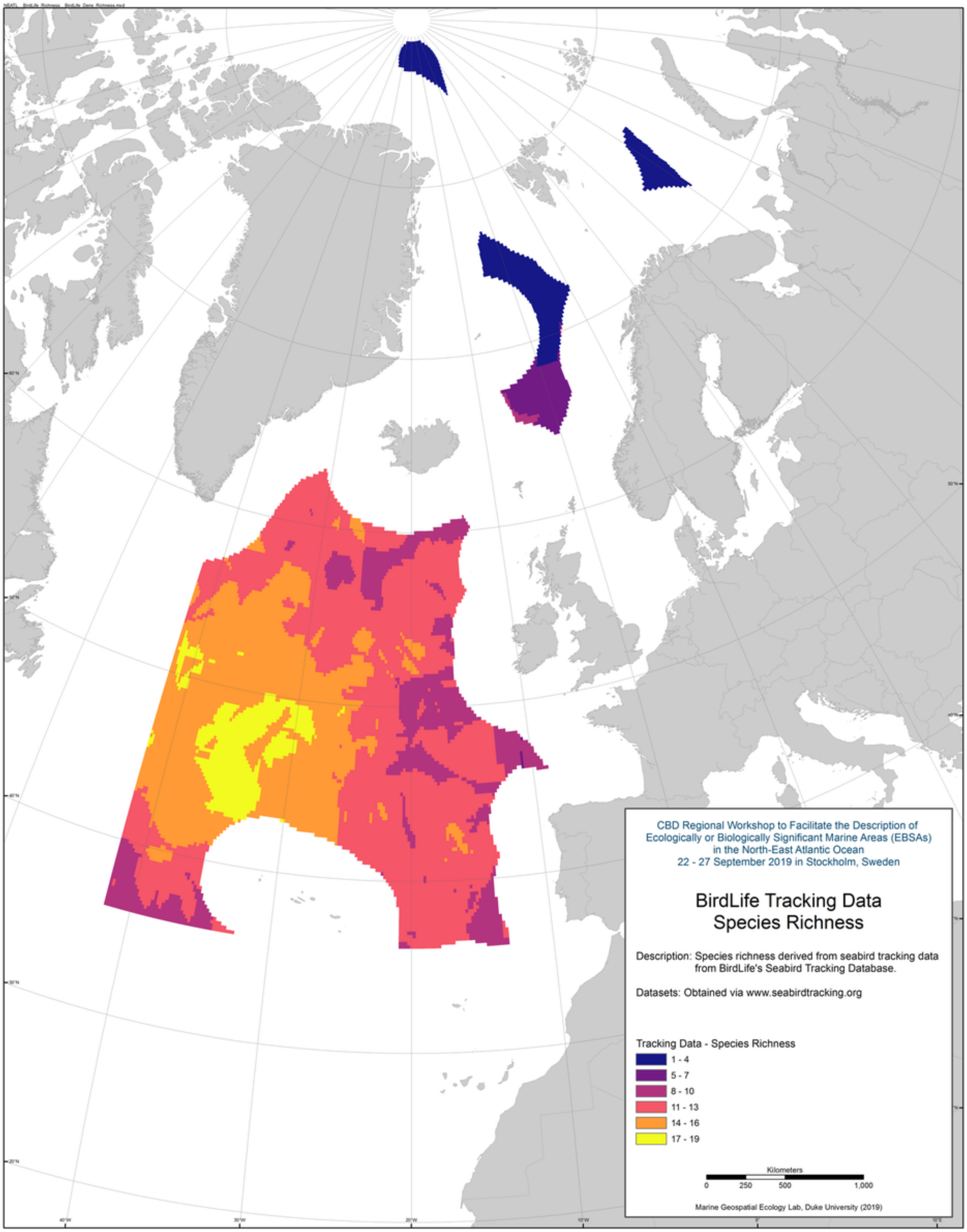

Figure 3.2-1 BirdLife tracking data – species richness

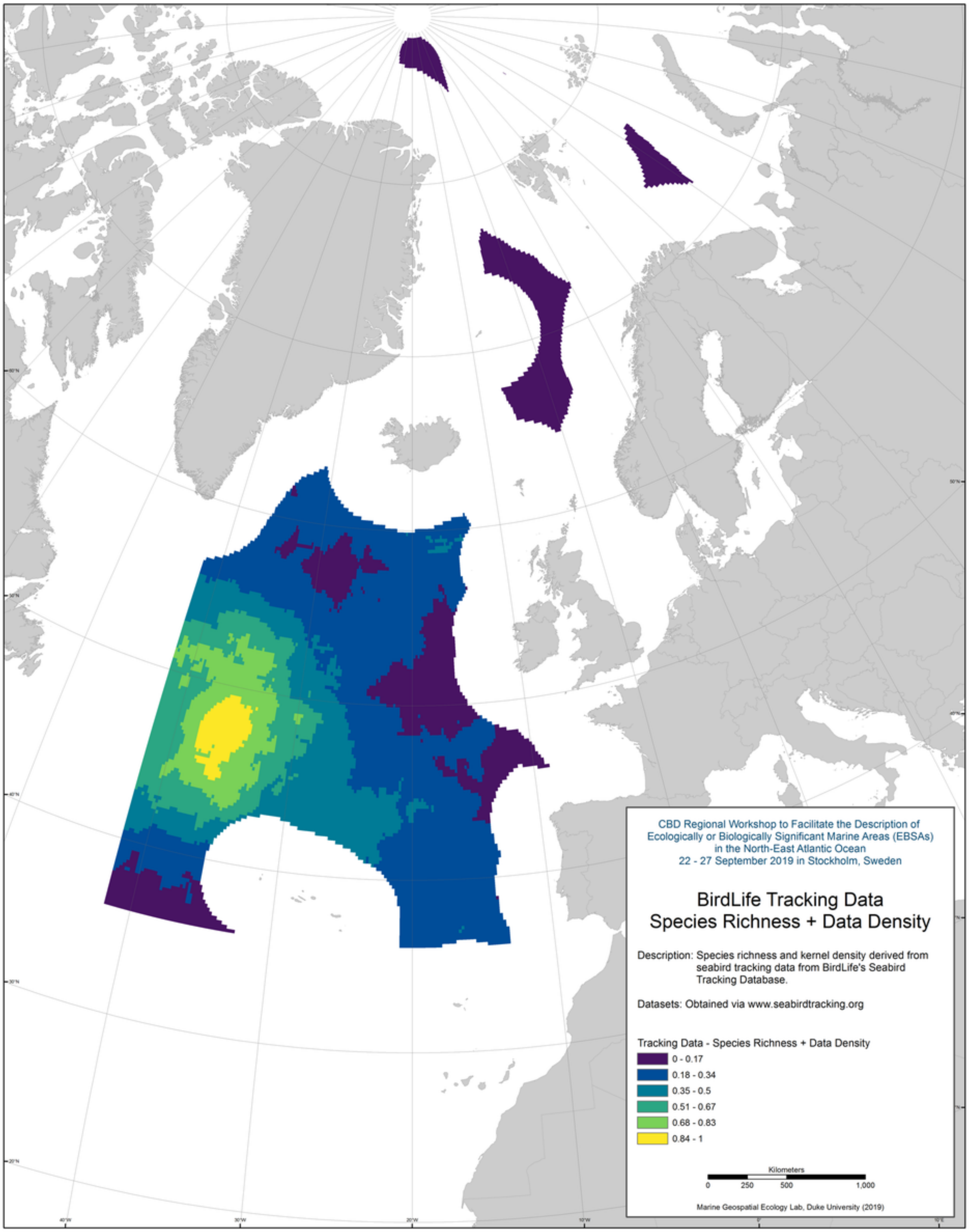

Figure 3.2-2 BirdLife tracking data – species richness and data density

3.3 Marine Mammal Surveys

As part of a marine mammal modeling project for the US Navy's CNETT training area, Duke University's Marine Geospatial Ecology Lab (MGEL) have been collecting survey and sighting data from survey programs across the North-East Atlantic. The combined database of these survey programs includes 15 aerial surveys and 28 shipboard surveys. Summaries of species richness and sightings from this combined database are available.

Baleen whales:
Balaena mysticetus
Balaenoptera acutorostrata
Balaenoptera borealis
Balaenoptera edeni
Balaenoptera musculus
Balaenoptera physalus
Eubalaena glacialis
Megaptera novaeangliae

Deep divers:
Globicephala macrorhynchus
Globicephala melas
Grampus griseus
Hyperoodon ampullatus
Kogia breviceps
Kogia simus
Mesoplodon bidens
Mesoplodon densirostris
Mesoplodon europaeus
Mesoplodon mirus
Physeter macrocephalus
Ziphius cavirostris

Dolphin/Porpoise
Delphinus delphis
Feresa attenuata
Lagenorhynchus acutus
Lagenorhynchus albirostris
Orcinus orca
Phocoena phocoena
Pseudorca crassidens
Stenella coeruleoalba
Stenella frontalis
Steno bredanensis
Tursiops truncatus

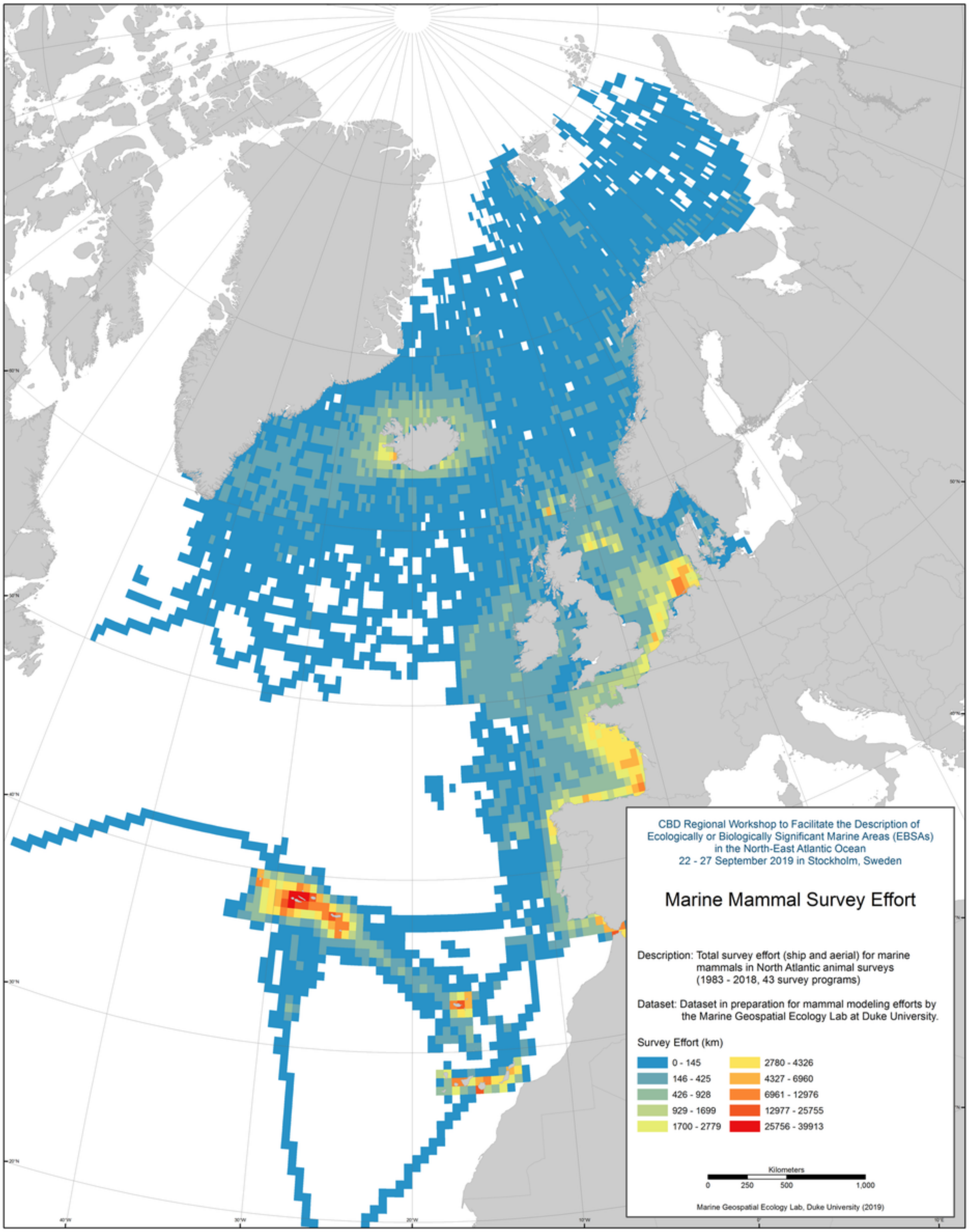

Figure 3.3-1 Marine mammal survey effort from north-east Atlantic surveys

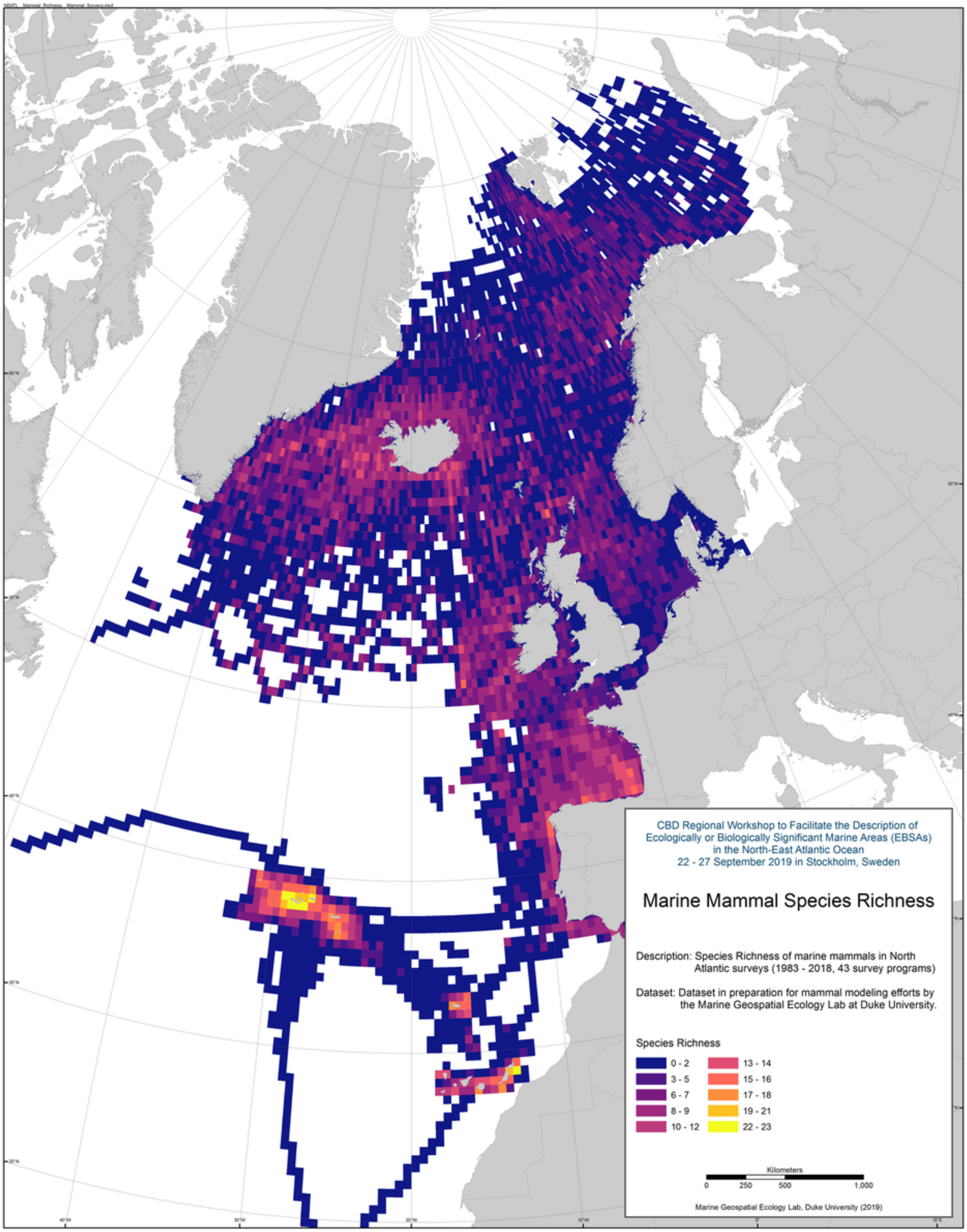

Figure 3.3-2 Marine mammal species richness from north-east Atlantic surveys

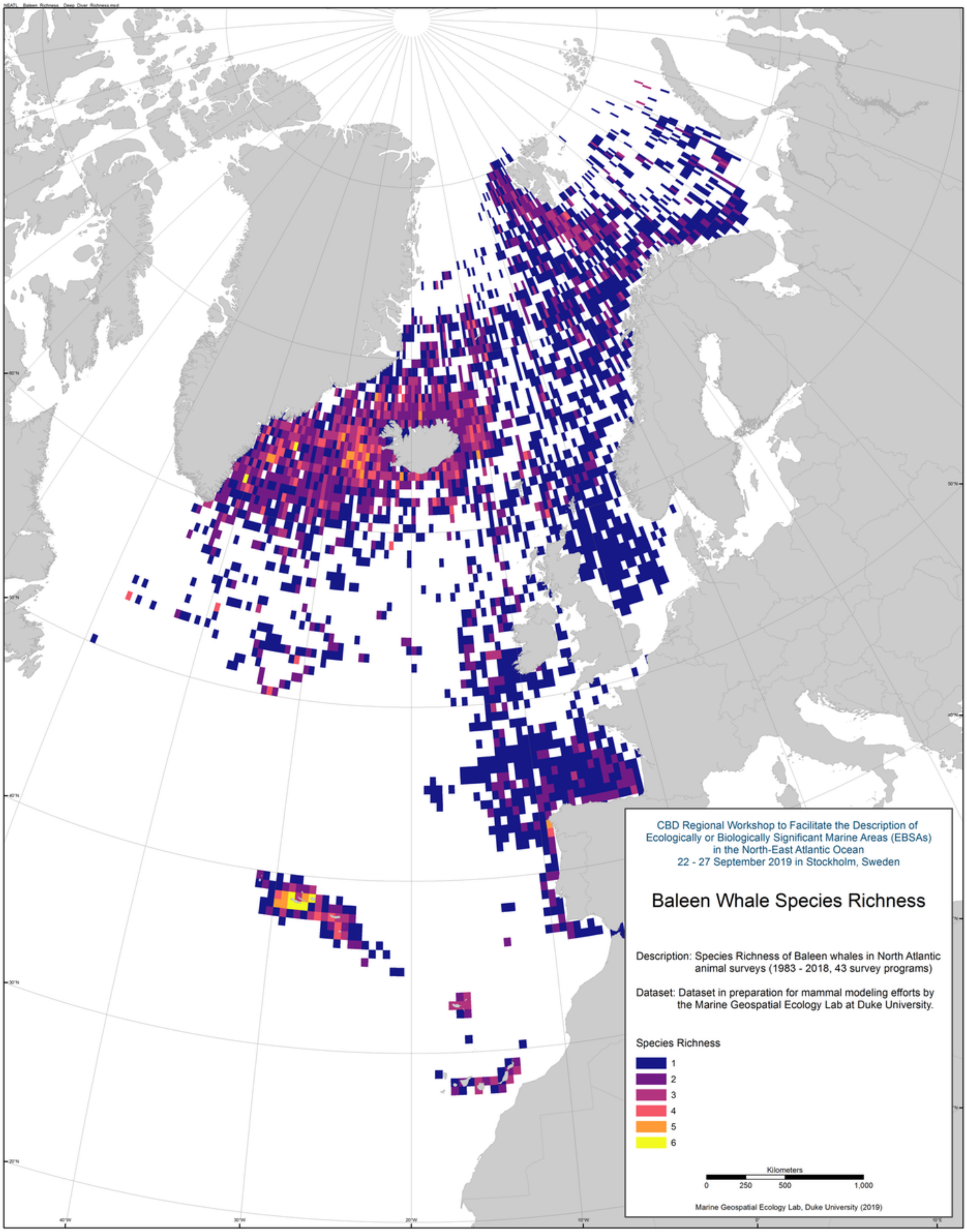

Figure 3.3-3 Baleen whale species richness from north-east Atlantic surveys

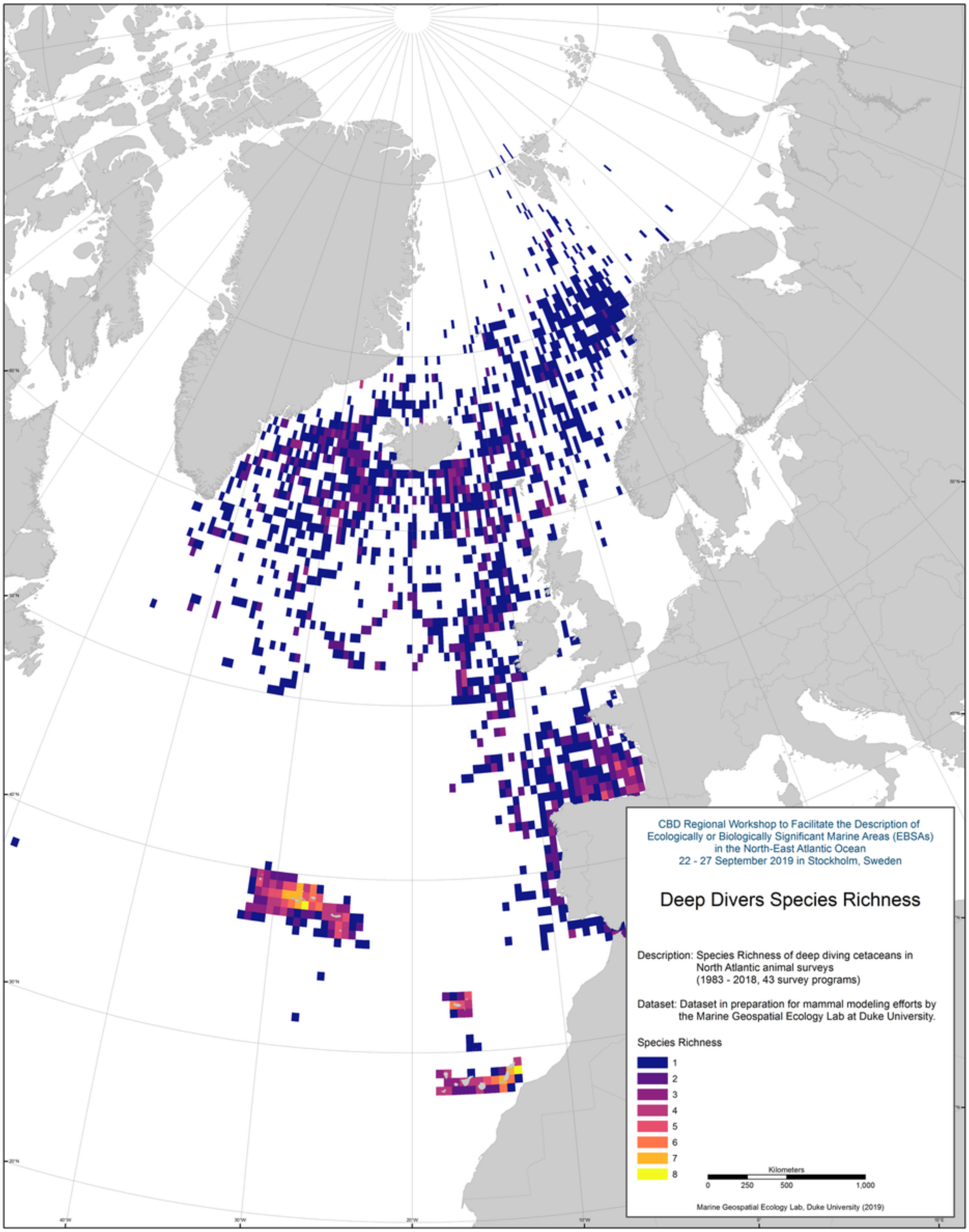

Figure 3.3-4 Deep diver species richness from north-east Atlantic surveys

3.4 Gridded abundance maps of mammal taxa in the North Sea

These datasets provide gridded abundance maps of aggregated seal, whale and dolphin species, as well as abundance of *Phocoena phocoena* specifically. Data products are derived from the European Seabirds at Sea (ESAS) database project, which also contains mammal data. Data are interpolated over ten year spans by season per taxa group. Earliest dataset covers 1980-1989 in spring. Final dataset covers 2001-2010 in winter. This product was developed with DIVA (Data-Interpolating Variational Analysis). Data was provided by JNCC (Joint Nature Conservation Committee): Dunn, T. 2012. JNCC seabird distribution and abundance data (all trips) from ESAS database. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/427). Abundance data products available from EMODnet Biology (http://www.emodnet-biology.eu/data-catalog?module=dataset&dasid=5457).

Reference:
European Marine Observation Data Network (EMODnet) Biology project (www.emodnet-biology.eu), funded by the European Commission's Directorate - General for Maritime Affairs and Fisheries (DG MARE).

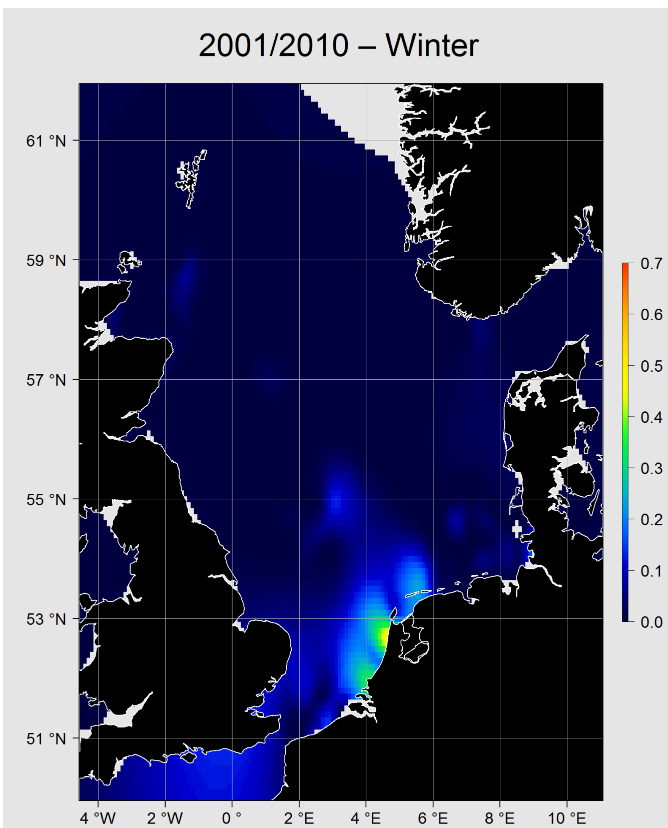

Figure 3.4-1 Harbor porpoise abundance in the North Sea

3.5 Gridded abundance maps of bird species in the North Sea

These datasets provide gridded abundance maps of marine birds from the North Sea. All the bird species of this dataset are indicator species for Descriptor 1 Biodiversity of the MSFD for the North East Atlantic. Data are interpolated over ten year spans by season per species. Earliest dataset covers 1980-1989 in spring. Final dataset covers 2001-2010 in winter. This product was developed with DIVA (Data-Interpolating Variational Analysis). Data was provided by JNCC (Joint Nature Conservation Committee): Dunn, T. 2012. JNCC seabird distribution and abundance data (all trips) from ESAS database. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/427). Abundance data products available from EMODnet Biology (http://www.emodnet-biology.eu/data-catalog?page=image&p=search&dasid=5454).

Species: *Alca torda, Fulmarus glacialis, Larus argentatus, Morus bassanus, Rissa tridactyla, Somateria mollissima, Stercorarius skua, Thalasseus sandvicensis*

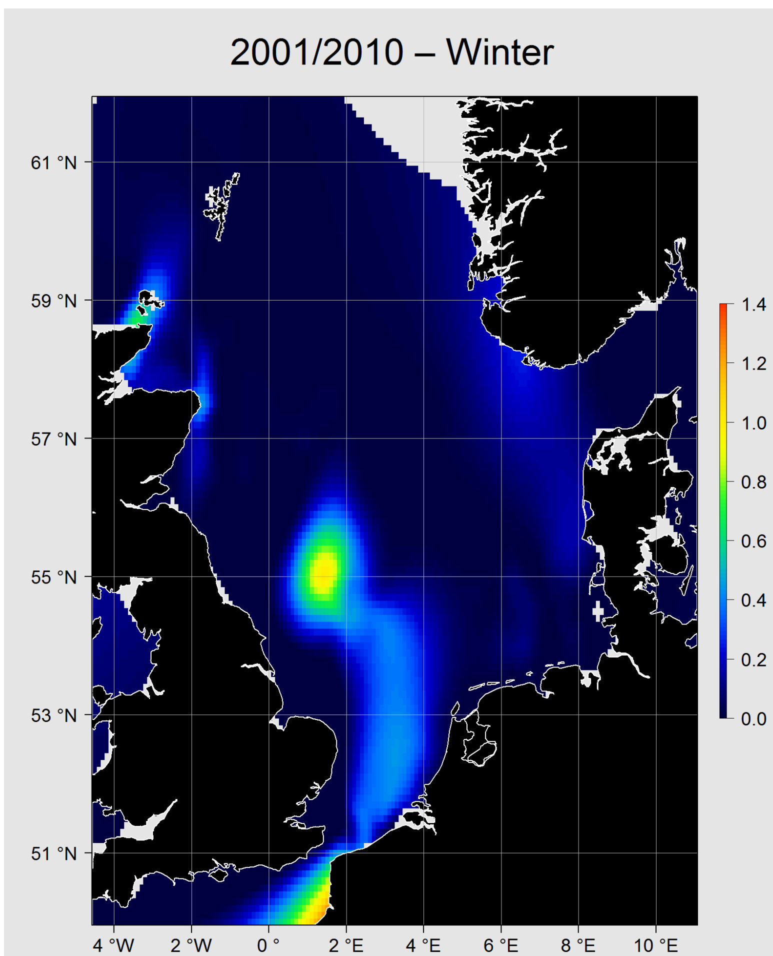

Figure 3.5-1 Lesser auk abundance in the North Sea

3.6 AquaMaps Species Richness

"AquaMaps is a tool for generating model-based, large-scale predictions of natural occurrences of species. For marine species, the model uses estimates of environmental preferences with respect to depth, water temperature, salinity, primary productivity, and association with sea ice or coastal areas. These estimates of species preferences, called environmental envelopes, are derived from large sets of occurrence data available from online collection databases such as GBIF (www.gbif.org) and OBIS (www.iobis.org), and from independent knowledge from the literature about the distribution of a given species and its habitat usage that are available in FishBase (and in SeaLifeBase and AlgaeBase for non-fish). The environmental envelopes are matched against local environmental conditions to determine the suitability of a given area in the ocean for a particular species. Predictions of relative probabilities of species occurrence are shown as color coded species range maps in a global grid of half-degree latitude and longitude cell dimensions. The maps are displayed on the web through the use of C-squares Mapper developed at CSIRO Marine and Atmospheric Research in Australia (Rees 2002, 2003)."

Source:
https://www.aquamaps.org/search.php

Reference:
Kaschner, K., K. Kesner-Reyes, C. Garilao, J. Rius-Barile, T. Rees, and R. Froese. 2016. AquaMaps: Predicted range maps for aquatic species. World wide web electronic publication, www.aquamaps.org, Version 08/2016d.

Species richness was created for species listed as Threatened or Endangered on the IUCN RedList and for species on the OSPAR List of Threatened and/or Declining Species.

- IUCN Red List - https://www.iucnredlist.org/
- OSPAR List of Threatened and/or Declining Species - https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats

Species Richness was also created for selected taxonomic groups using the AquaMaps website:

- Computer Generated Richness Map for Animalia. www.aquamaps.org, version Aug. 2016. Web. Accessed 16 Jul. 2019. Map generated 2017-09-22.
- Computer Generated Richness Map for Mammalia. www.aquamaps.org, version Aug. 2016. Web. Accessed 16 Jul. 2019. Map generated 2017-09-22.
- Computer Generated Richness Map for Elasmobranchii. www.aquamaps.org, version Aug. 2016. Web. Accessed 16 Jul. 2019. Map generated 2016-09-15.

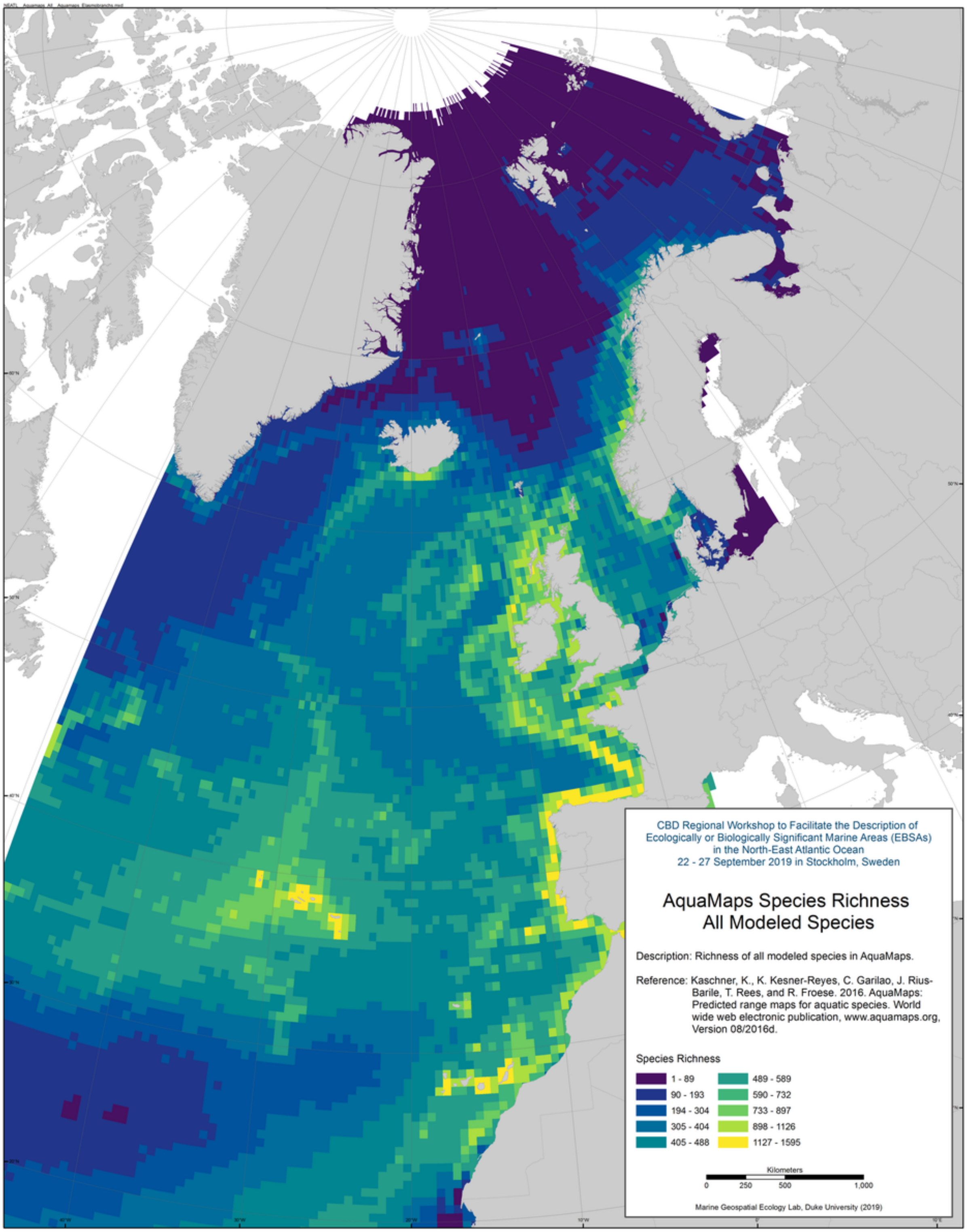

Figure 3.6-1 AquaMaps species richness for all modeled species

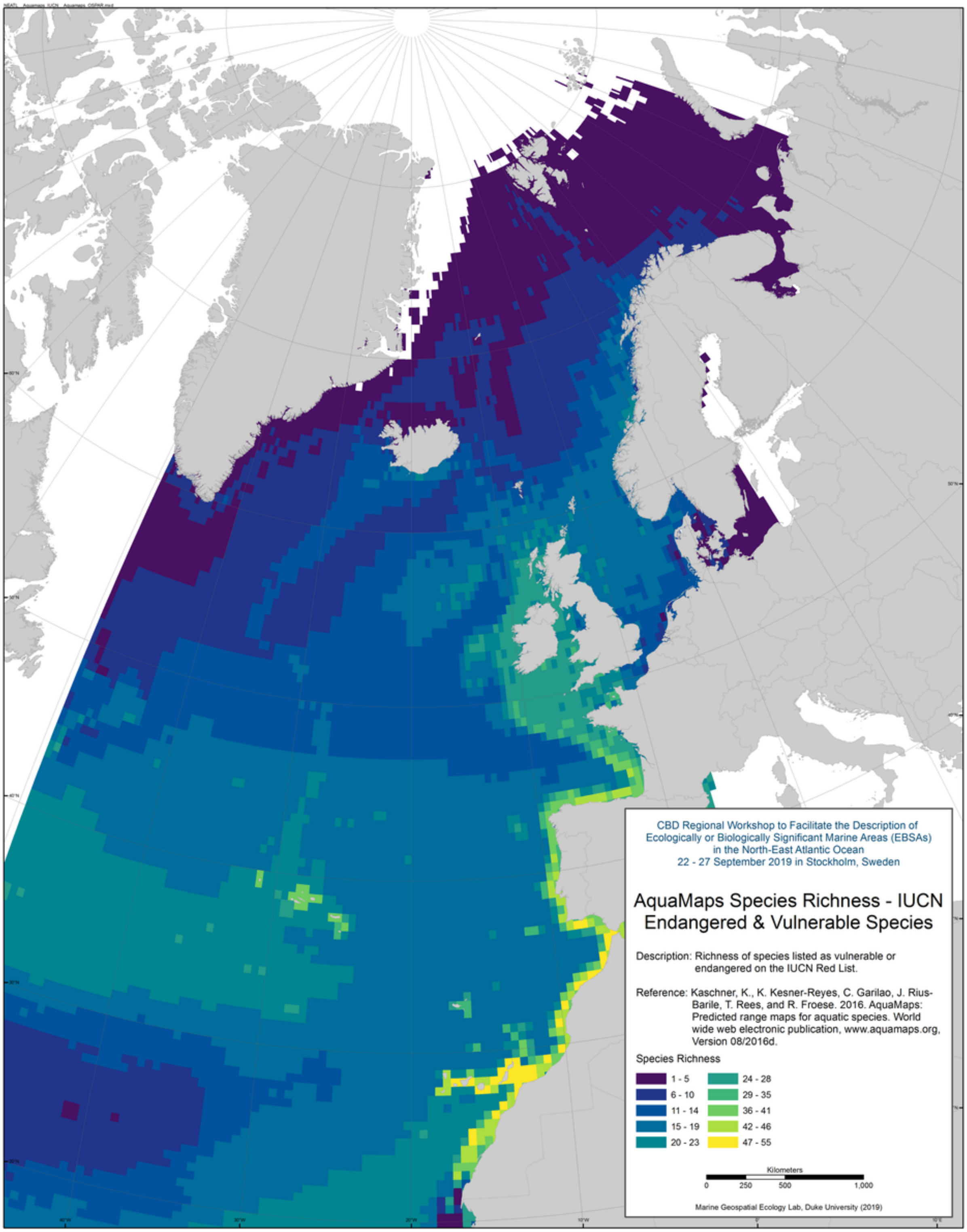

Figure 3.6-2 AquaMaps species richness for IUCN endangered and vulnerable species

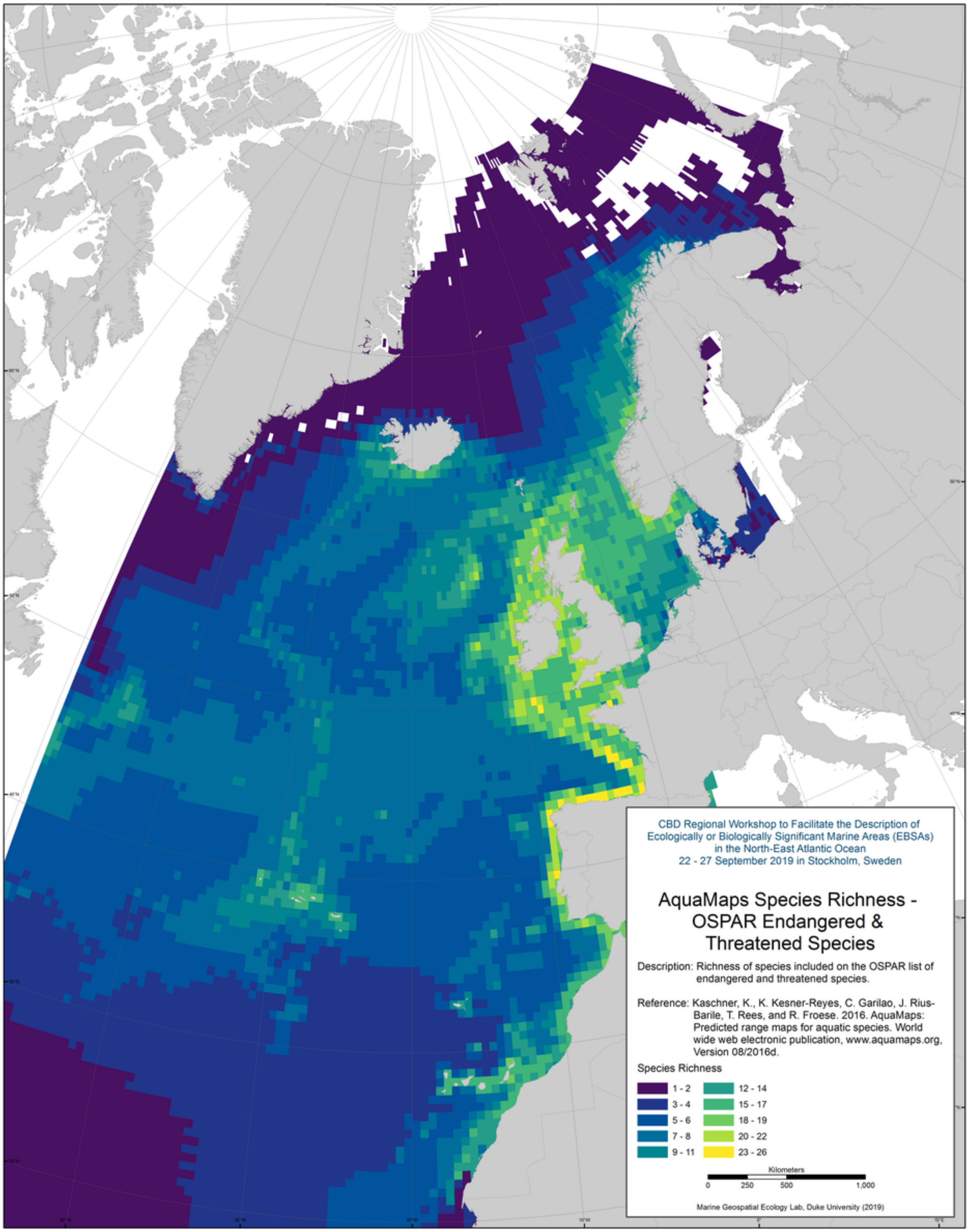

Figure 3.6-3 AquaMaps species richness for OSPAR endangered and threatened species

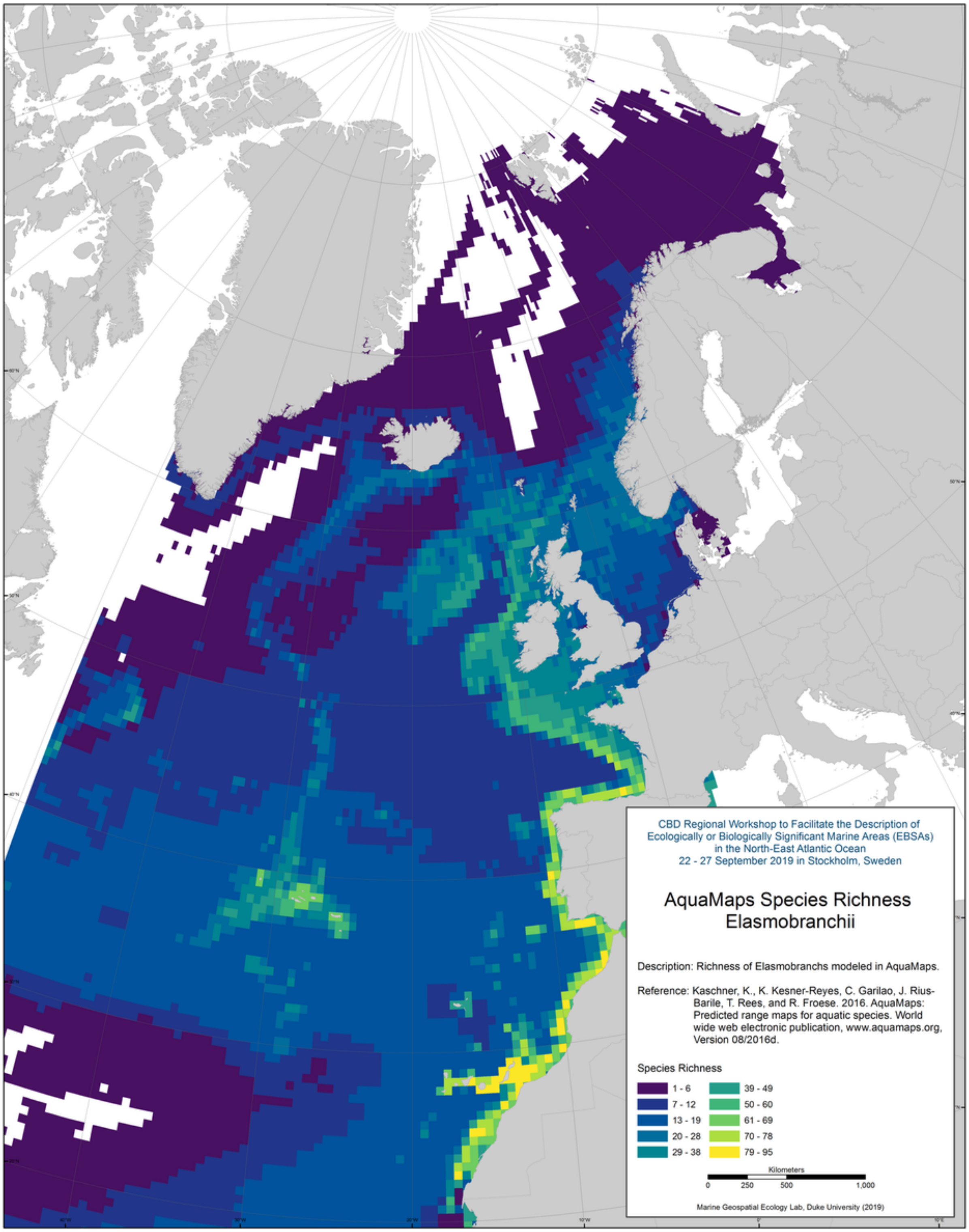

Figure 3.6-4 AquaMaps species richness for Elasmobranchs

3.7 Circumpolar Depiction of Species Richness

"Circumpolar depiction of species richness based on the distributions of the 11 ice-associated Focal Ecosystem Components (according to the distributions reported in IUCN Red List species accounts). A maximum of nine species occur in any one geographic location. The Arctic gateways in both the Atlantic and Pacific regions have the highest species diversity."

"The State of the Arctic Marine Biodiversity Report (SAMBR), is a product of the Circumpolar Biodiversity Monitoring Program (CBMP) of the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) Working Group. The SAMBR is a synthesis of the state of knowledge about biodiversity in Arctic marine ecosystems, detectable changes, and important gaps in our ability to assess state and trends in biodiversity across six Focal Ecosystem Components (FECs): sea ice biota, plankton, benthos, marine fishes, seabirds and marine mammals.

Source:
https://www.arcticbiodiversity.is/marine

Reference:
CAFF (2017). State of the Arctic Marine Biodiversity Report. Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland. 978-9935-431-63-9

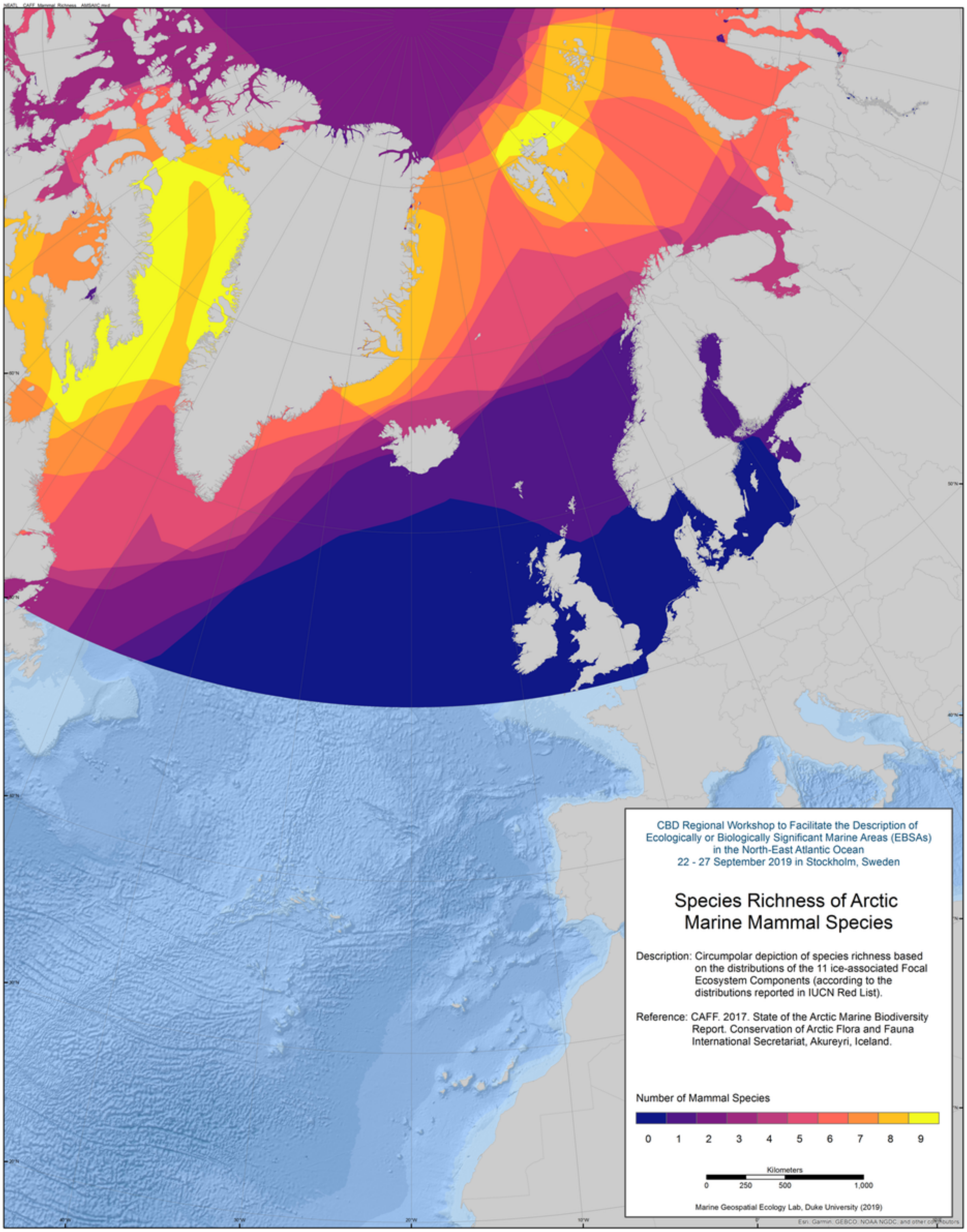

Figure 3.7-1 Species richness of arctic marine mammal species

3.8 Biological Data from the AMSA II(c) report

Preface:
"The Arctic Council's 2009 Arctic Marine Shipping Assessment (AMSA) identified a number of recommendations to guide future action by the Arctic Council, Arctic States and others on current and future Arctic marine activity. Recommendation II C under the theme *Protecting Arctic People and the Environment* recommended:

"That the Arctic states should identify areas of heightened ecological and cultural significance in light of changing climate conditions and increasing multiple marine use and, where appropriate, should encourage implementation of measures to protect these areas from the impacts of Arctic marine shipping, in coordination with all stakeholders and consistent with international law."

As a follow-up to the AMSA, the Arctic Council's Arctic Monitoring and Assessment Programme (AMAP) and Conservation of Arctic Flora and Fauna (CAFF) working groups undertook to identify areas of heightened ecological significance, and the Sustainable Development Working Group (SDWG) undertook to identify areas of heightened cultural significance.

The work to identify areas of heightened ecological significance builds on work conducted during the preparation of the AMAP (2007) Arctic Oil and Gas Assessment. Although it was initially intended that the identification of areas of heightened ecological and cultural significance would be addressed in a similar fashion, this proved difficult. The information available on areas of heightened cultural significance was inconsistent across the Arctic and contained gaps in data quality and coverage which could not be addressed within the framework of this assessment. The areas of heightened cultural significance are therefore addressed within a separate section of the report (Part B) and are not integrated with the information on areas of heightened ecological significance (Part A). In addition, Part B should be seen as instructive in that it illustrates where additional data collection and integration efforts are required, and therefore helps inform future efforts on identification of areas of heightened cultural significance.

The results of this work provide the scientific basis for consideration of protective measures by Arctic states in accordance with AMSA recommendation IIc, including the need for specially designated Arctic marine areas as follow-up to AMSA recommendation IId."

Link: http://www.amap.no/documents/doc/Identification-of-Arctic-marine-areas-of-heightened-ecological-and-cultural-significance-Arctic-Marine-Shipping-Assessment-AMSA-IIc/869

Reference:
AMAP/CAFF/SDWG, 2013. Identification of Arctic marine areas of heightened ecological and cultural significance: Arctic Marine Shipping Assessment (AMSA) IIc. Arctic Monitoring and Assessment Programme (AMAP), Oslo. 114 pp.

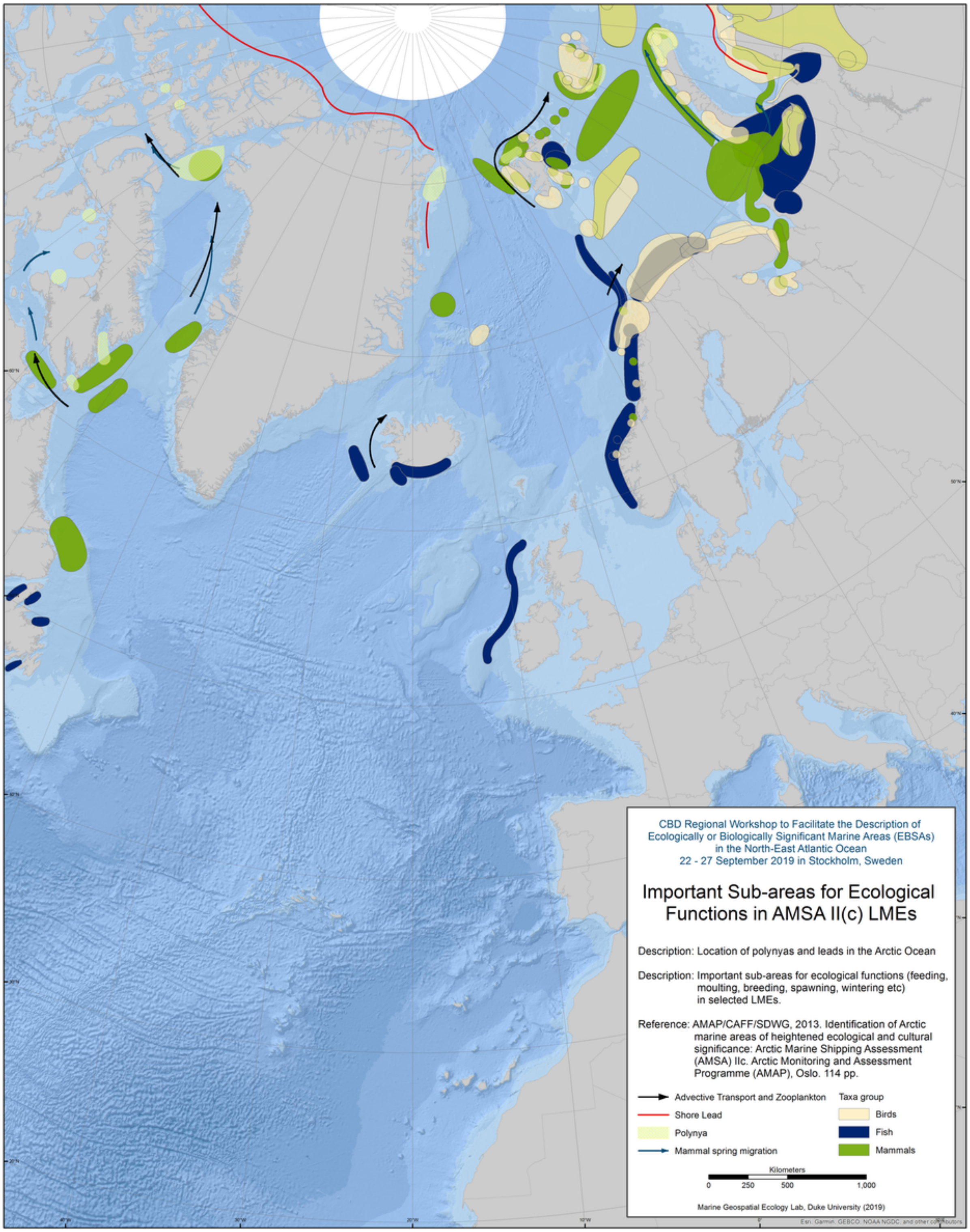

Figure 3.8-1 Important sub-areas for ecological functions in AMSA II(c) report

3.9 Habitat Suitability of Cold-Water Octocorals

Abstract:
"Three-quarters of Octocorallia species are found in deep waters. These cold-water octocoral colonies can form a major constituent of structurally complex habitats. The global distribution and the habitat requirements of deep-sea octocorals are poorly understood given the expense and difficulties of sampling at depth. Habitat suitability models are useful tools to extrapolate distributions and provide an understanding of ecological requirements. Here, we present global habitat suitability models and distribution maps for seven suborders of Octocorallia: Alcyoniina, Calcaxonia, Holaxonia, Scleraxonia, Sessiliflorae, Stolonifera and Subselliflorae."

Reference:
Yesson C, Taylor ML, Tittensor DP, Davies AJ, Guinotte J, Baco A, Black J, Hall-Spencer JM, Rogers AD (2012) *Global habitat suitability of cold-water octocorals*. Journal of Biogeography 39:1278–1292.

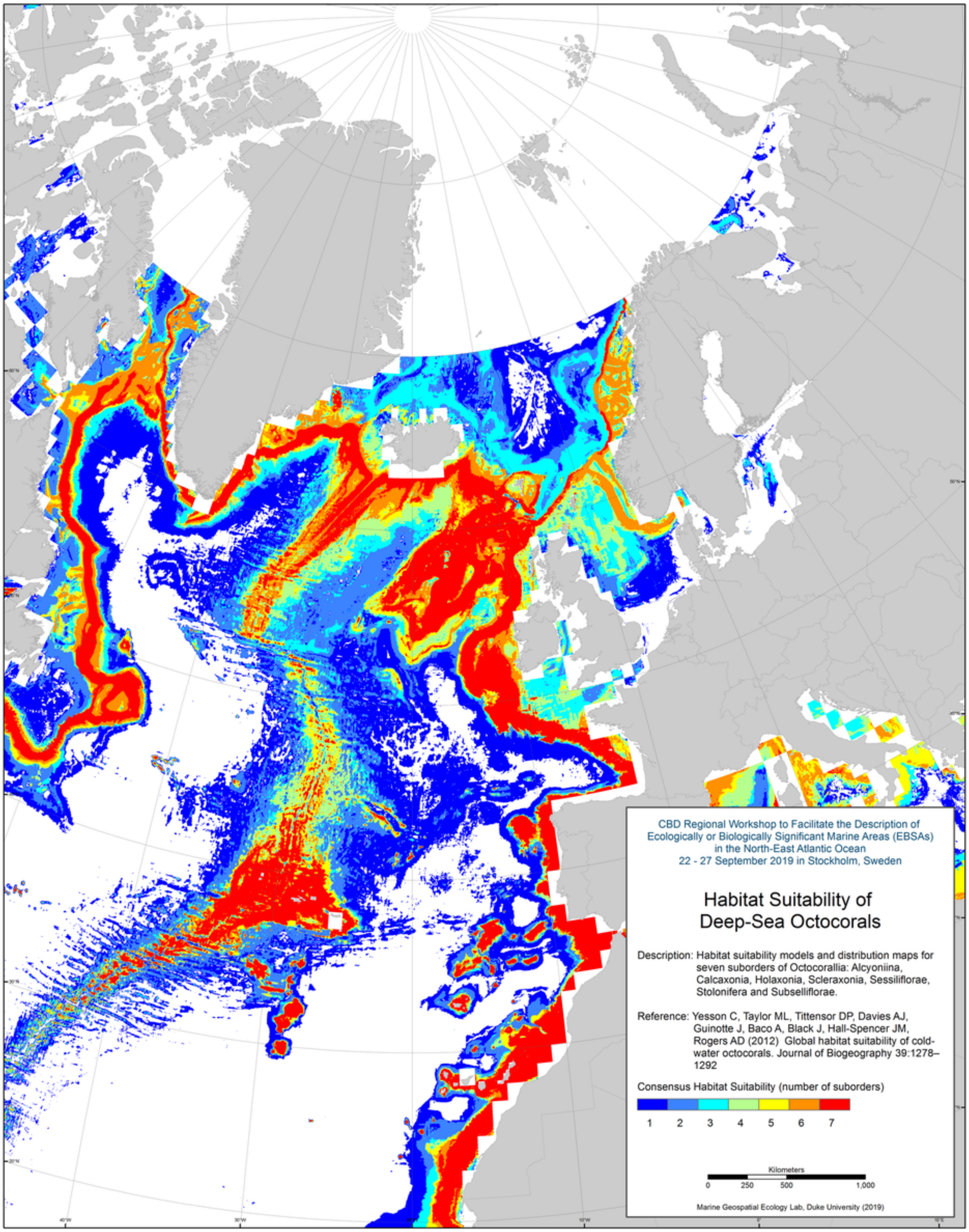

Figure 3.9-1 Consensus habitat suitability for deep-sea octocorals

3.10 Habitat Suitability for *Lophelia pertusa* Reefs in the Irish Continental Margin

Abstract:

"The distribution of vulnerable marine ecosystems in the deep sea is poorly understood. This has led to the emergence of modelling methods to predict the occurrence of suitable habitat for conservation planning in data-sparse areas. Recent global analyses for cold-water corals predict a high probability of occurrence along the slopes of continental margins, offshore banks and seamounts in the north-eastern Atlantic, but tend to overestimate the extent of the habitat and do not provide the detail needed for finer-scale assessments and protected area planning. Using *Lophelia pertusa* reefs as an example, this study integrates multibeam bathymetry with a wide range of environmental data to produce a regional high-resolution habitat suitability map relevant for marine spatial planning."

References:

Rengstorf, Anna M., Chris Yesson, Colin Brown, and Anthony J. Grehan. 2013. "High-Resolution Habitat Suitability Modelling Can Improve Conservation of Vulnerable Marine Ecosystems in the Deep Sea." *Journal of Biogeography* 40 (9): 1702–14. https://doi.org/10.1111/jbi.12123.

Rengstorf, Anna M; Yesson, Chris; Brown, Colin; Grehan, Anthony J (2013): Raster grids detailing habitat suitability for Lophelia pertusa reefs in the Irish continental margin. *PANGAEA*, https://doi.org/10.1594/PANGAEA.810467

See Figure 3.11-1 below

3.11 Habitat Suitability for Framework-Forming Scleractinian Corals

Abstract:

"Predictive habitat models are increasingly being used by conservationists, researchers and governmental bodies to identify vulnerable ecosystems and species' distributions in areas that have not been sampled. However, in the deep sea, several limitations have restricted the widespread utilisation of this approach. These range from issues with the accuracy of species presences, the lack of reliable absence data and the limited spatial resolution of environmental factors known or thought to control deep-sea species' distributions. To address these problems, global habitat suitability models have been generated for five species of framework-forming scleractinian corals by taking the best available data and using a novel approach to generate high resolution maps of seafloor conditions. High-resolution global bathymetry was used to resample gridded data from sources such as World Ocean Atlas to produce continuous 30-arc second (1 km^2) global grids for environmental, chemical and physical data of the world's oceans. The increased area and

resolution of the environmental variables resulted in a greater number of coral presence records being incorporated into habitat models and higher accuracy of model predictions. The most important factors in determining cold-water coral habitat suitability were depth, temperature, aragonite saturation state and salinity. Model outputs indicated the majority of suitable coral habitat is likely to occur on the continental shelves and slopes of the Atlantic, South Pacific and Indian Oceans. The North Pacific has very little suitable scleractinian coral habitat. Numerous small scale features (i.e., seamounts), which have not been sampled or identified as having a high probability of supporting cold-water coral habitat were identified in all ocean basins. Field validation of newly identified areas is needed to determine the accuracy of model results, assess the utility of modeling efforts to identify vulnerable marine ecosystems for inclusion in future marine protected areas and reduce coral bycatch by commercial fisheries."

References:
Davies AJ, Guinotte JM (2011) *Global Habitat Suitability for Framework-Forming Cold-Water Corals*. PLoS ONE 6(4): e18483. doi:10.1371/journal.pone.0018483

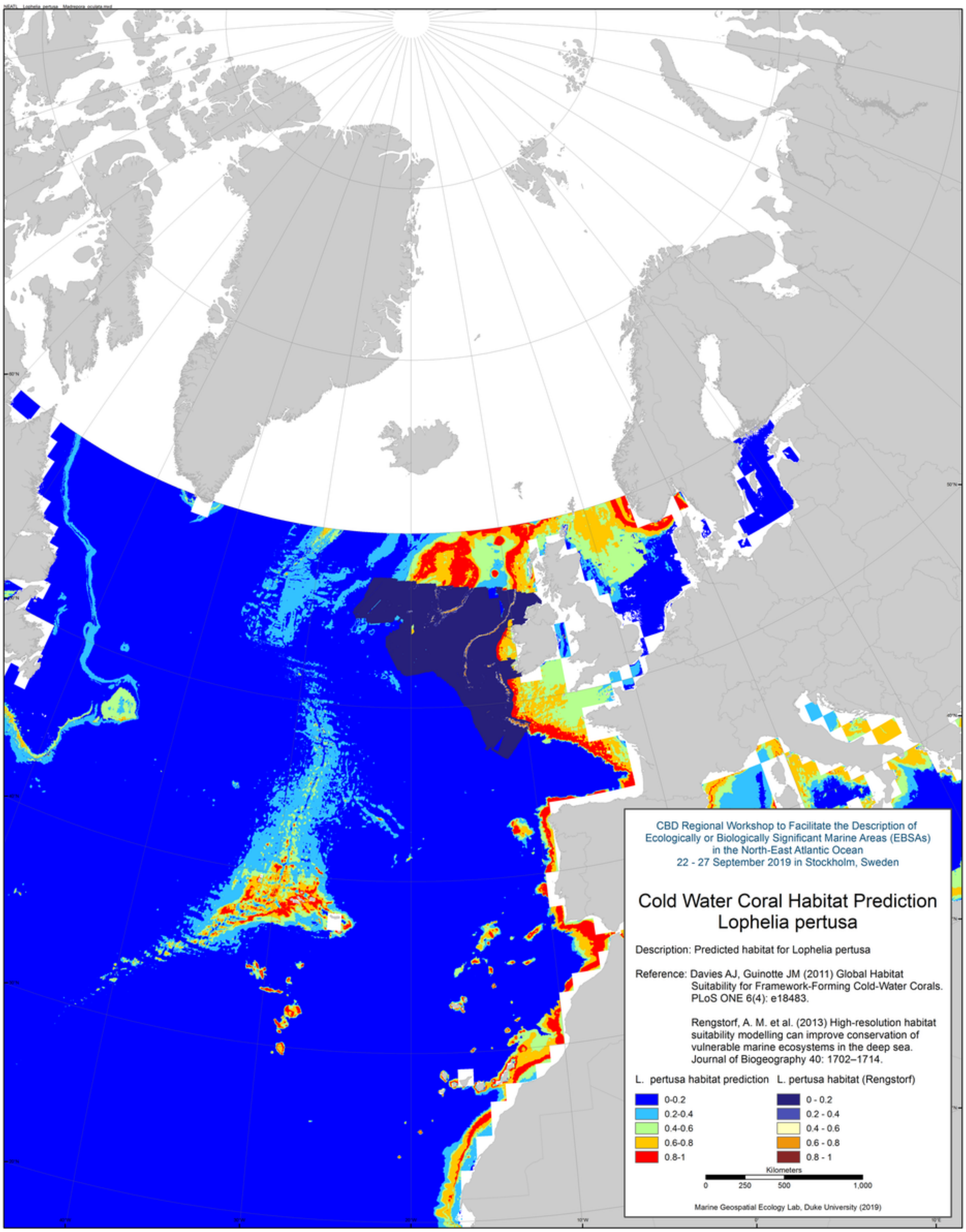

Figure 3.11-1 Habitat suitability for *Lophelia pertusa*

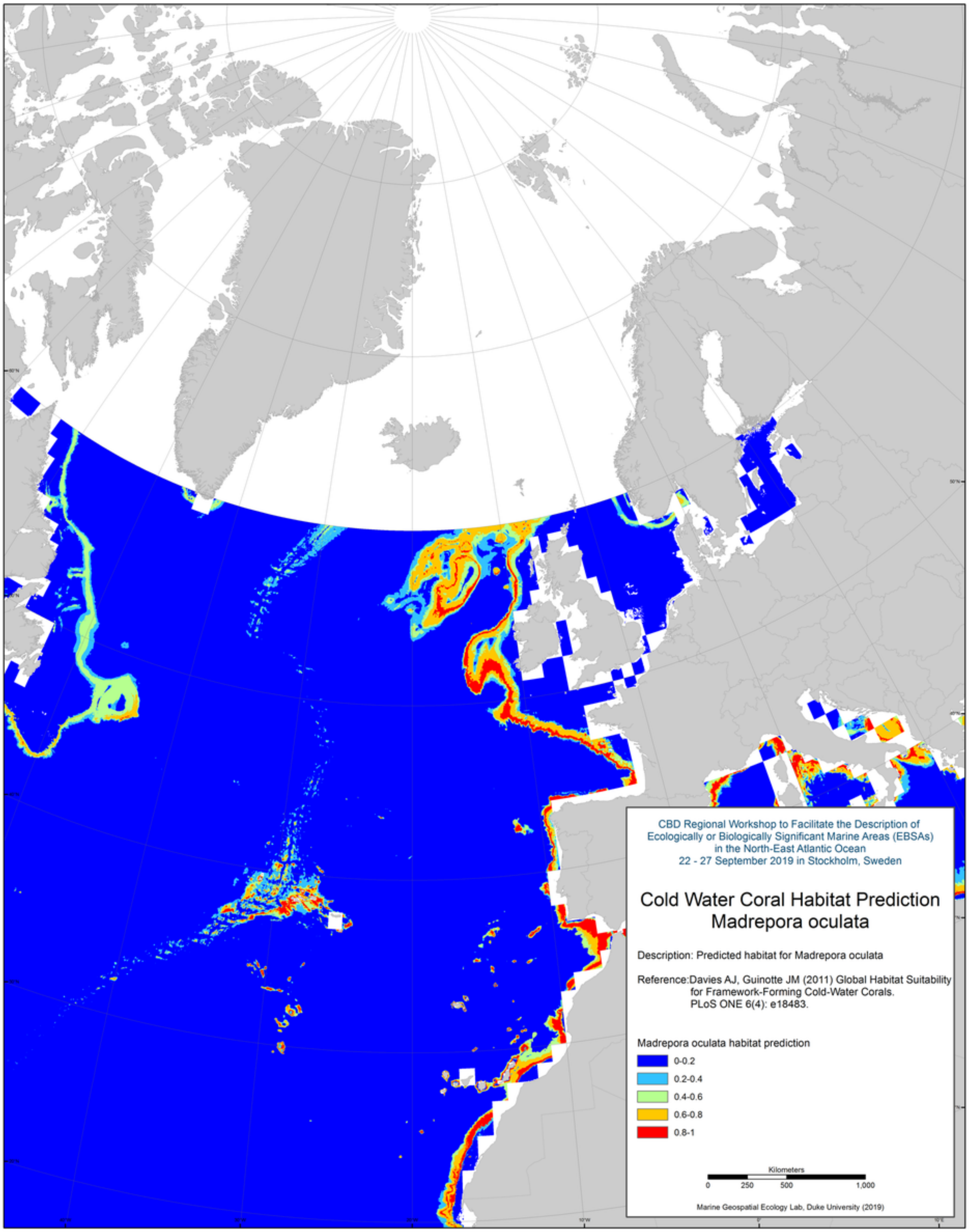

Figure 3.11-2 Habitat suitability for *Madrepora oculata*

3.12 Global Distribution of Deep-water Antipatharia Habitat

Abstract:
"Antipatharia are a diverse group of corals with many species found in deep water. Many Antipatharia are habitat for associates, have extreme longevity and some species can occur beyond 8500 m depth. As they are major constituents of 'coral gardens', which are Vulnerable Marine Ecosystems (VMEs), knowledge of their distribution and environmental requirements is an important prerequisite for informed conservation planning particularly where the expense and difficulty of deep-sea sampling prohibits comprehensive surveys.

This study uses a global database of Antipatharia distribution data to perform habitat suitability modelling using the Maxent methodology to estimate the global extent of black coral habitat suitability. The model of habitat suitability is driven by temperature but there is notable influence from other variables of topography, surface productivity and oxygen levels."

Reference:
Yesson, Chris, Faye Bedford, Alex D. Rogers, and Michelle L. Taylor. 2017. "The Global Distribution of Deep-Water Antipatharia Habitat." *Deep Sea Research Part II: Topical Studies in Oceanography*, Towards ecosystem based management and monitoring of the deep Mediterranean, North-East Atlantic and Beyond, 145 (November): 79–86. https://doi.org/10.1016/j.dsr2.2015.12.004.

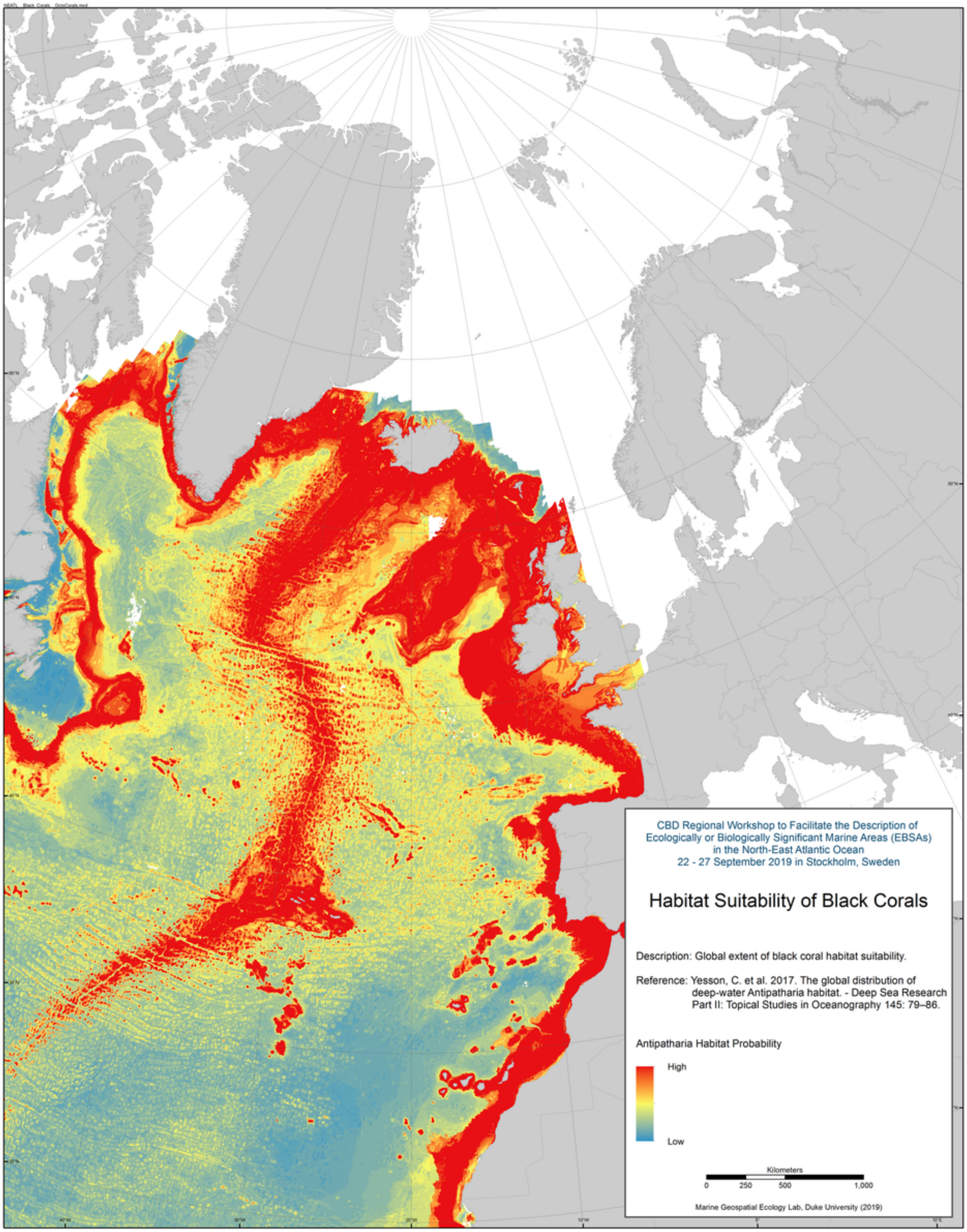

Figure 3.12-1 Habitat suitability for black corals

3.13 Seasonal Phytoplankton Bloom Magnitude and Frequency

Abstract:
"The North Atlantic Ocean contains diverse patterns of seasonal phytoplankton blooms with distinct internal dynamics. We analyzed blooms using remotely-sensed chlorophyll *a* concentration data and change point statistics. The first bloom of the year began during spring at low latitudes and later in summer at higher latitudes. In regions where spring blooms occurred at high frequency (i.e., proportion of years that a bloom was detected), there was a negative correlation between bloom timing and duration, indicating that early blooms last longer. In much of the Northeast Atlantic, bloom development extended over multiple seasons resulting in peak chlorophyll concentrations in summer. Spring bloom start day was found to be positively correlated with a spring phenology index and showed both positive and negative correlations to sea surface temperature and the North Atlantic Oscillation in different regions. Based on the characteristics of spring and summer blooms, the North Atlantic can be classified into two regions: a seasonal bloom region, with a well-defined bloom limited to a single season; and a multi-seasonal bloom region, with blooms extending over multiple seasons. These regions differed in the correlation between bloom start and duration with only the seasonal bloom region showing a significant, negative correlation. We tested the hypothesis that the near-surface springtime distribution of copepods that undergo diapause (*Calanus finmarchicus*, *C. helgolandicus*, *C. glacialis*, and *C. hyperboreus*) may contribute to the contrast in bloom development between the two regions. Peak near-surface spring abundance of the late stages of these *Calanoid* copepods was generally associated with areas having a well-defined seasonal bloom, implying a link between bloom shape and their abundance. We suggest that either grazing is a factor in shaping the seasonal bloom or bloom shape determines whether a habitat is conducive to diapause, while recognizing that both factors can re-enforce each other."

Reference:
Friedland, Kevin D., Nicholas R. Record, Rebecca G. Asch, Trond Kristiansen, Vincent S. Saba, Kenneth F. Drinkwater, Stephanie Henson, et al. 2016. "Seasonal Phytoplankton Blooms in the North Atlantic Linked to the Overwintering Strategies of Copepods." *Elem Sci Anth* 4 (0): 000099. https://doi.org/10.12952/journal.elementa.000099.

Data from Figures 2 A/B and 4 A/B are mapped below.

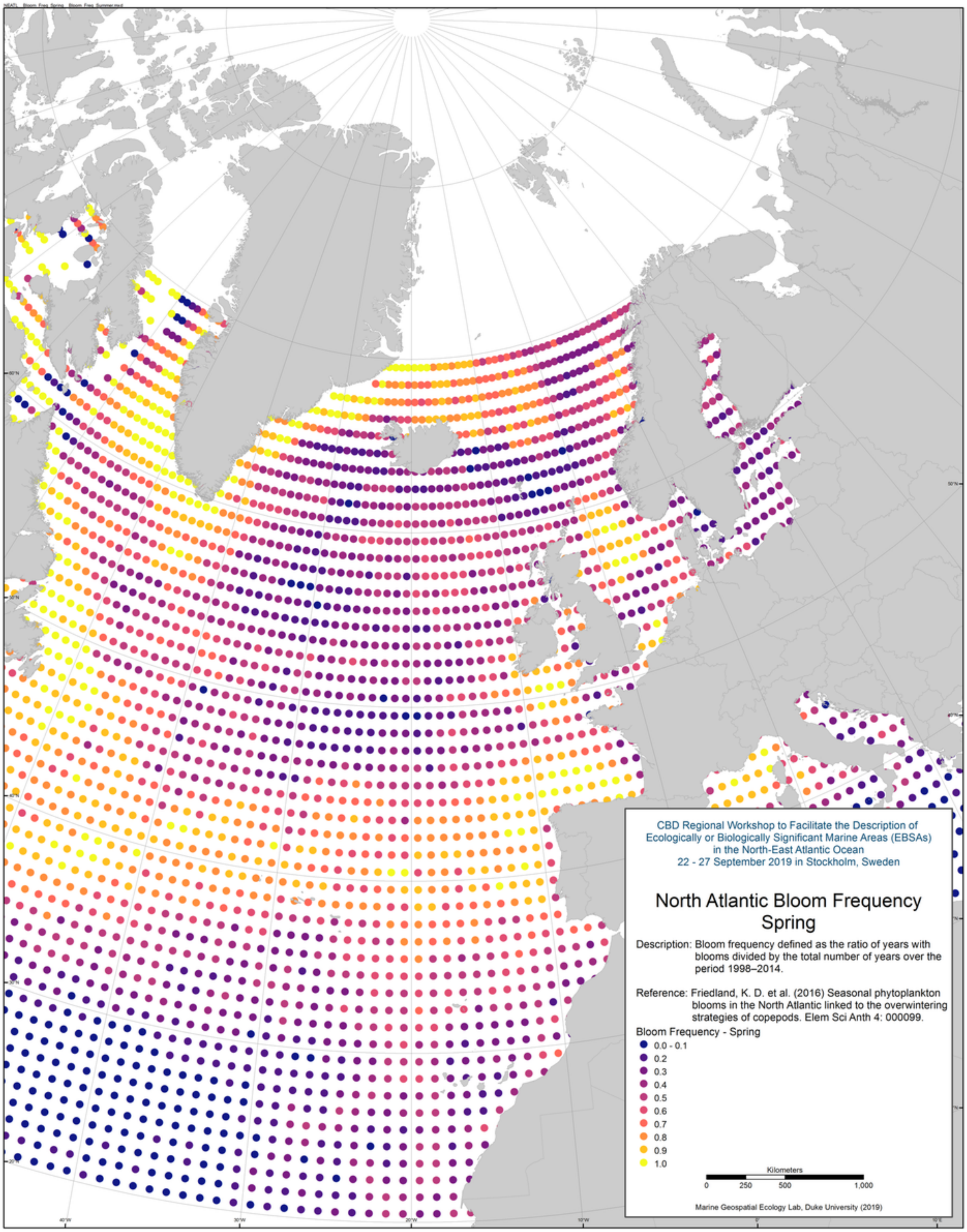

Figure 3.13-1 North Atlantic bloom frequency - Spring

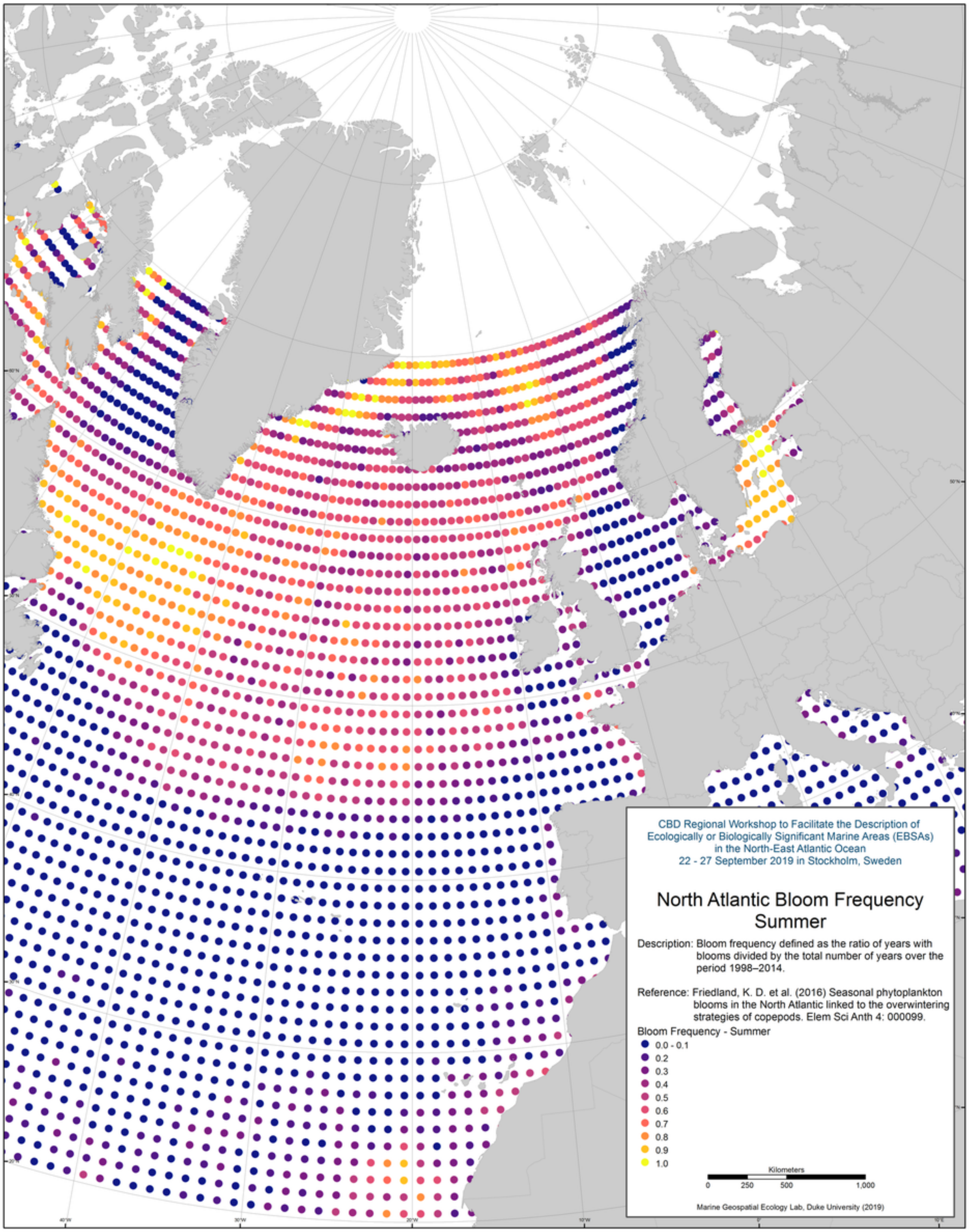

Figure 3.13-2 North Atlantic bloom frequency - Summer

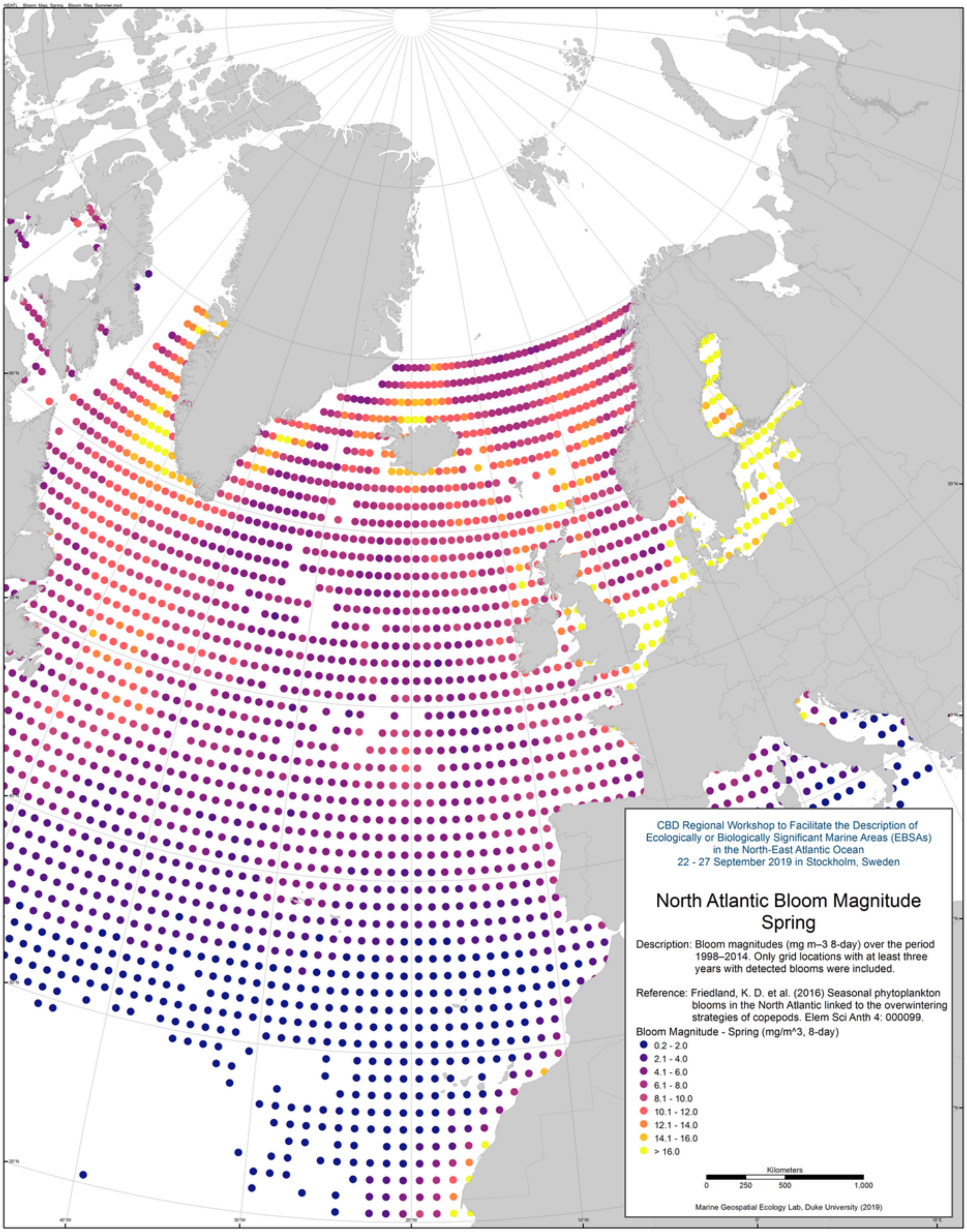

Figure 3.13-3 North Atlantic bloom magnitude - Spring

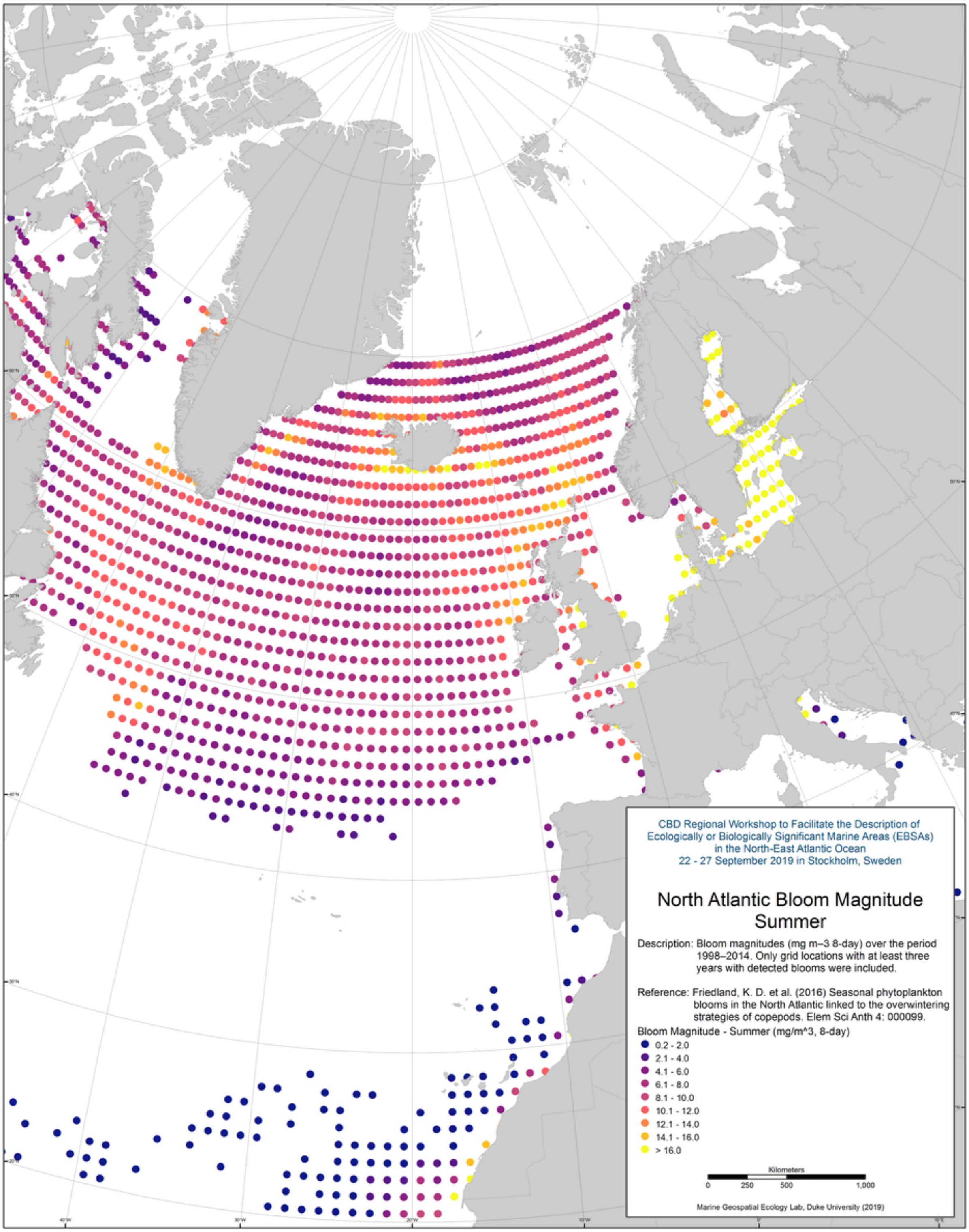

Figure 3.13-4 North Atlantic bloom magnitude - Summer

3.14 Net Primary Production of Biomass - Mercator Ocean Biogeochemical Model

"The Operational Mercator Ocean biogeochemical global ocean analysis and forecast system at 1/4 degree is providing 10 days of 3D global ocean forecasts updated weekly. The time series is aggregated in time, in order to reach a two full year's time series sliding window. This product includes daily and monthly mean files of biogeochemical parameters (chlorophyll, nitrate, phosphate, silicate, dissolved oxygen, dissolved iron, primary production, phytoplankton, PH, and surface partial pressure of carbon dioxide) over the global ocean. The global ocean output files are displayed with a 1/4 degree horizontal resolution with regular longitude/latitude equirectangular projection. 50 vertical levels are ranging from 0 to 5700 meters."

- NEMO version (v3.6_STABLE)
- Forcings: GLOBAL_ANALYSIS_FORECAST_PHYS_001_024 at daily frequency.
- Outputs mean fields are interpolated on a standard regular grid in NetCDF format.
- Initial conditions: World Ocean Atlas 2013 for nitrate, phosphate, silicate and dissolved oxygen, GLODAPv2 for DIC and Alkalinity, and climatological model outputs for Iron and DOC

Source: http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&view=details&product_id=GLOBAL_ANALYSIS_FORECAST_BIO_001_028

Dataset: GLOBAL_ANALYSIS_FORECAST_BIO_001_028
Variable: nppv [mg m-3 day-1], Net primary production of biomass expressed as carbon per unit volume in sea water

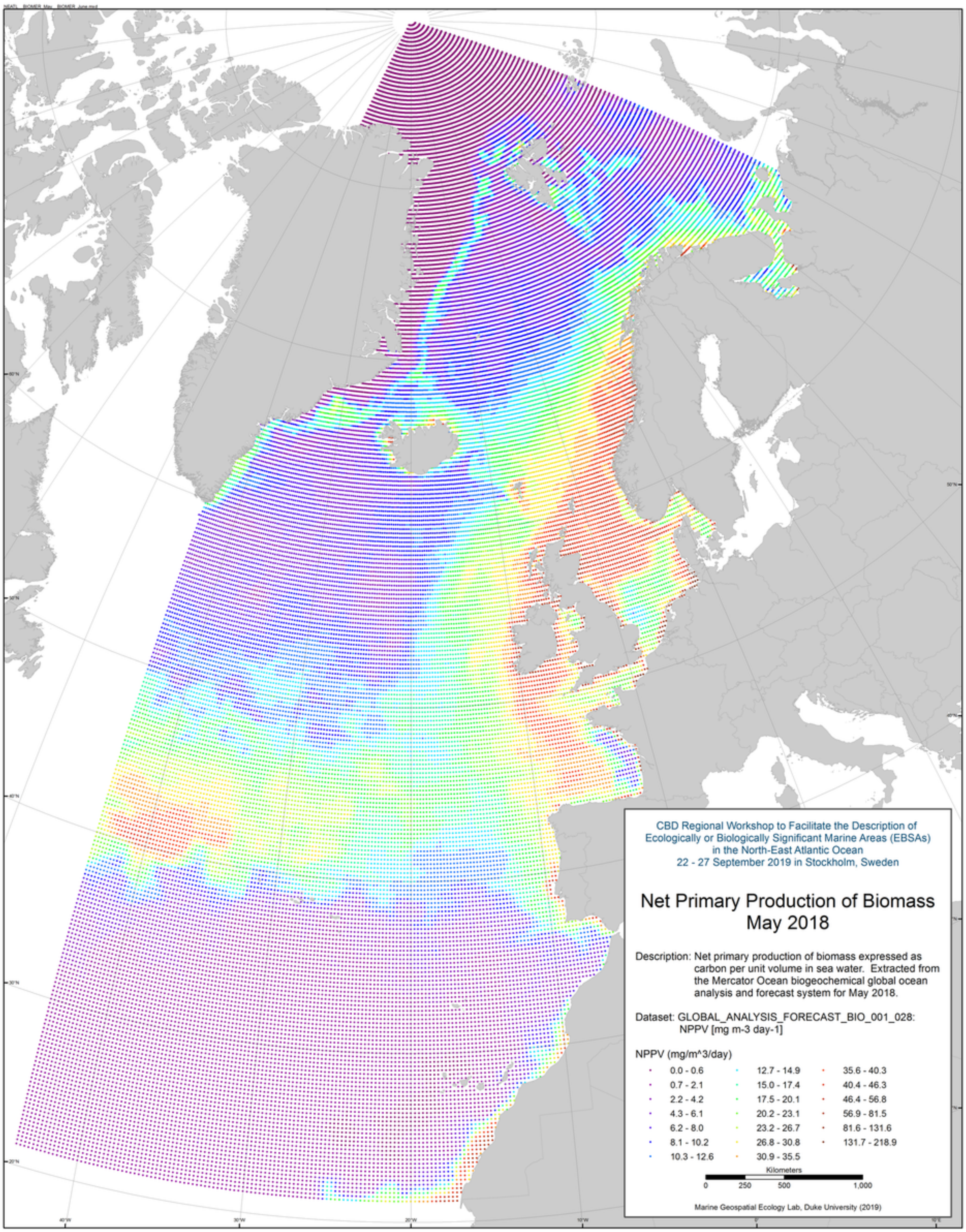

Figure 3.14-1 Net primary production of biomass – May 2018

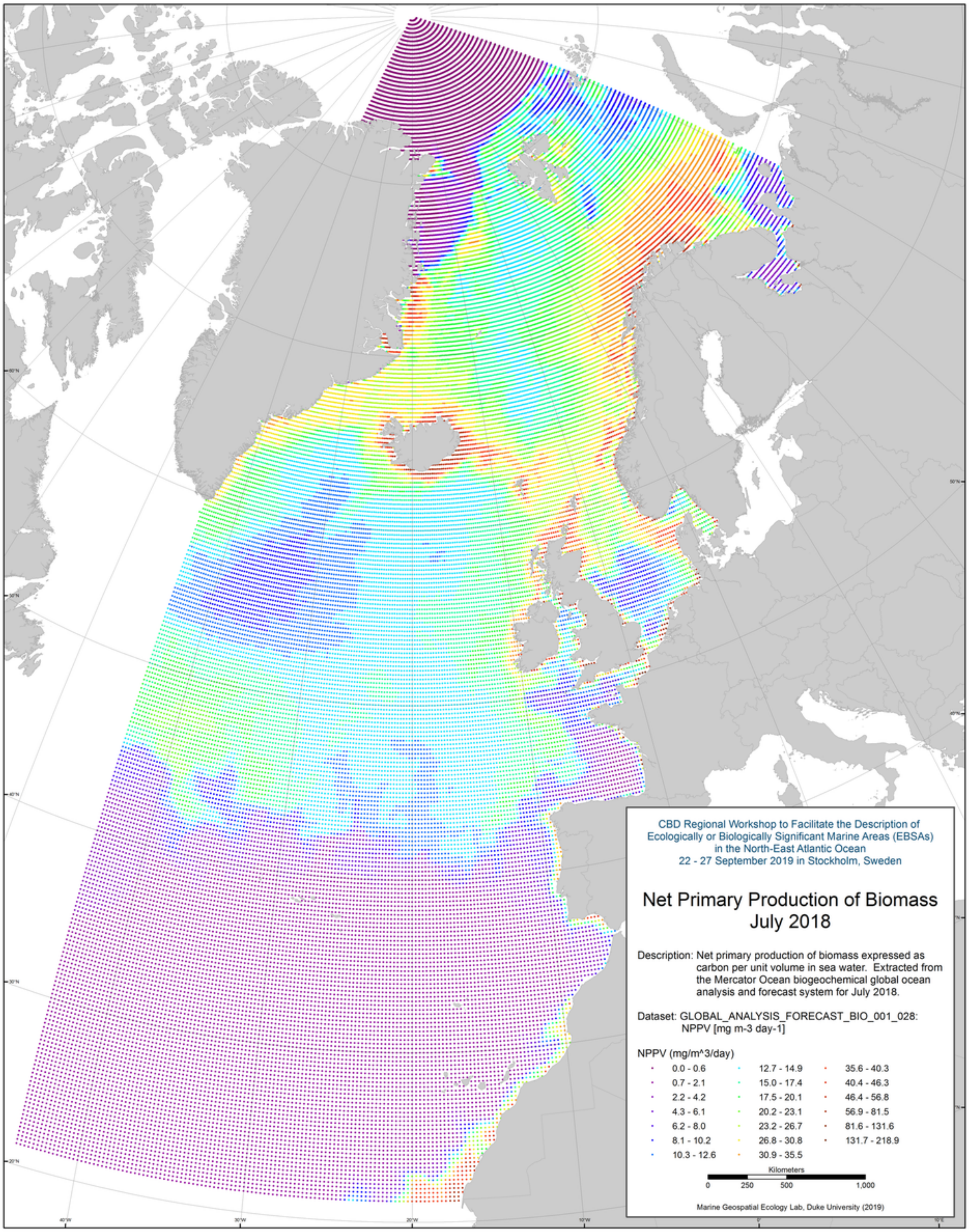

Figure 3.14-2 Net primary production of biomass – July 2018

3.15 Chlorophyll A Concentration Seasonal Climatologies

Seasonal cumulative chlorophyll A climatologies for 2009 - 2018 were created using the "Create Climatological Rasters for NASA OceanColor L3 SMI Product" tool in the Marine Geospatial Ecology Tools (MGET) for ArcGIS (Roberts et al., 2010). This tool uses data from the MODIS sensor on the Aqua satellite. One climatology was generated for each quarter: January – March, April – June, July – September, October - December.

Reference:

Roberts, Jason J., Benjamin D. Best, Daniel C. Dunn, Eric A. Treml, and Patrick N. Halpin. 2010. "Marine Geospatial Ecology Tools: An Integrated Framework for Ecological Geoprocessing with ArcGIS, Python, R, MATLAB, and C++." *Environmental Modelling & Software* 25 (10):1197–1207. https://doi.org/10.1016/j.envsoft.2010.03.029.

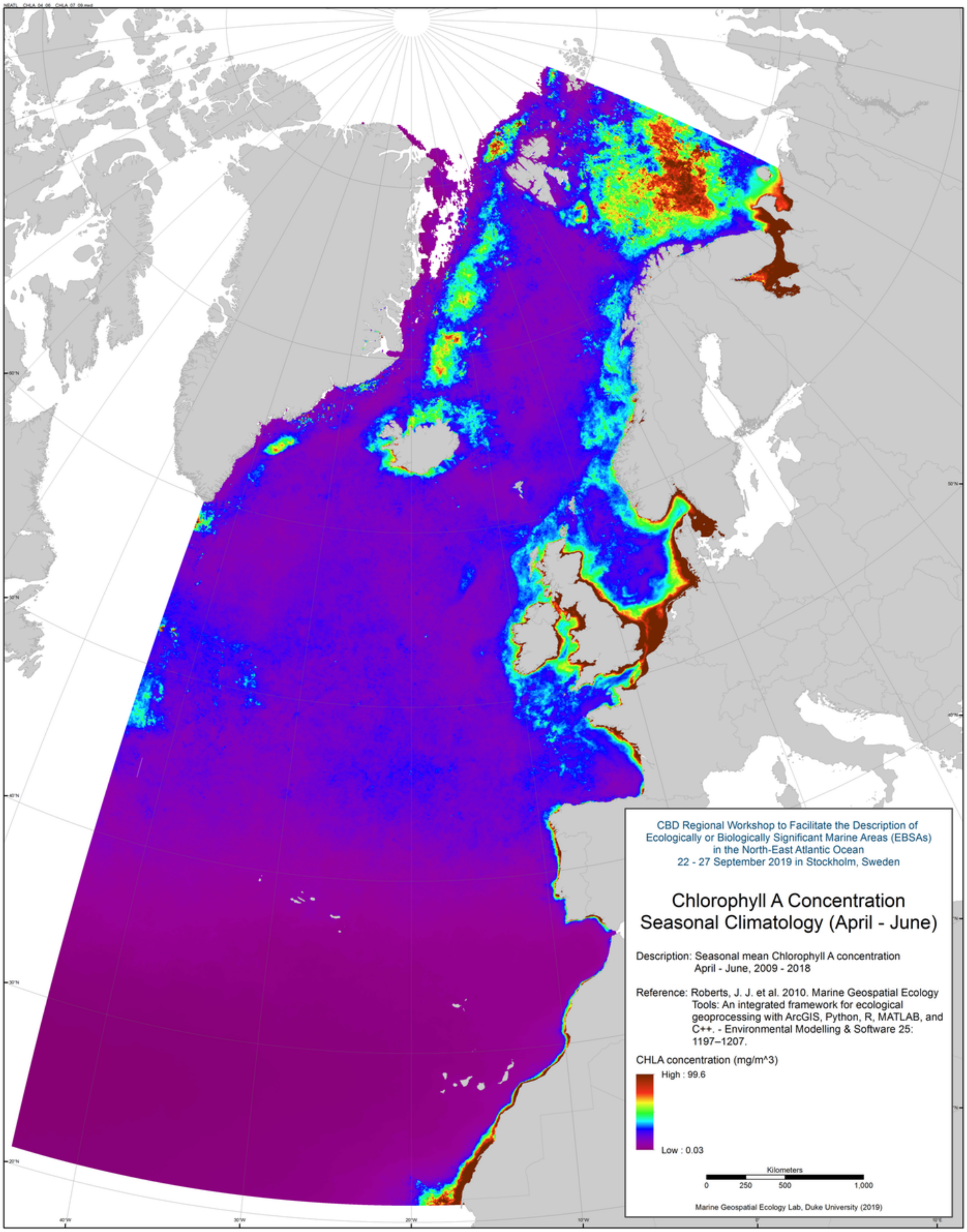

Figure 3.15-1 Chlorophyll A concentration seasonal climatology: April - June

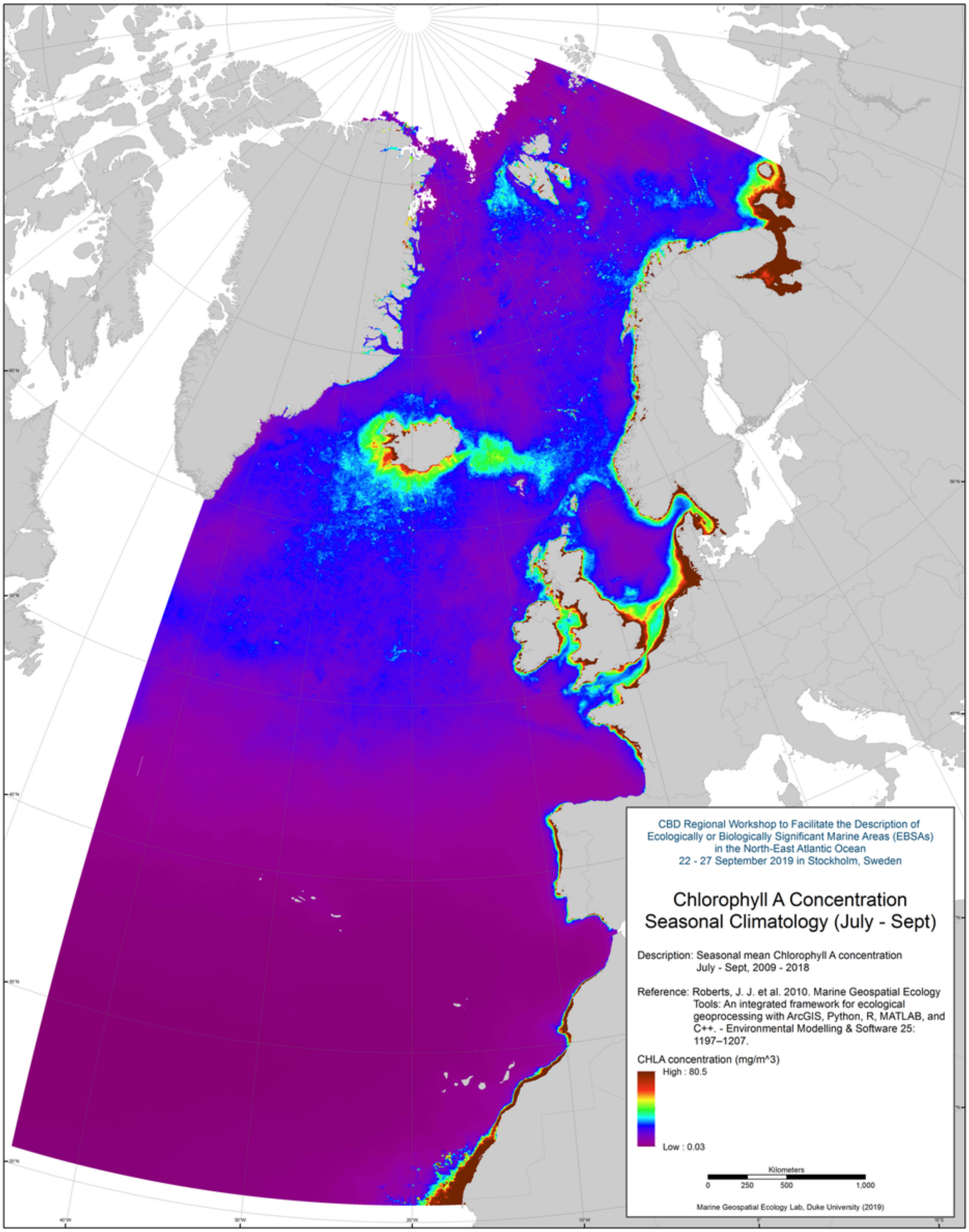

Figure 3.15-2 Chlorophyll A concentration seasonal climatology: July - September

3.16 ICES Trawl Survey Database

"DATRAS (the Database of Trawl Surveys) has been developed to collate and document the survey data, assure data quality, standardise data formats and calculations, and ease data handling and availability. With the possibility for instant remote access, the data from DATRAS are used for stock assessments and fish community studies by the ICES community and public users.

DATRAS stores data collected primarily from bottom trawl fish surveys coordinated by ICES expert groups. The survey data are covering the Baltic Sea, Skagerrak, Kattegat, North Sea, English Channel, Celtic Sea, Irish Sea, Bay of Biscay and the eastern Atlantic from the Shetlands to Gibraltar. At present, there are more than 45 years of continuous time series data in DATRAS, and survey data are continuously updated by national institutions.

DATRAS has an integrated quality check utility. All data, before entering the database, have to pass an extensive quality check. Data products (such as CPUE per area or indices) and raw data, can be freely downloaded according to the ICES Data policy."

Source:
http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx

Portal:
https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx

3.17 ICES Operational Oceanographic Products and Services - Gridded Copepod abundance data

"The International Council for the Exploration of the Sea (ICES), located in Copenhagen is an organisation providing scientific advice in the North Atlantic on the exploitation and stewardship of the marine ecosystem and marine living resources. Within this role, it is developing an integrated ecosystem advice at a regional level which will be appropriate to managers, policy developers and interested stakeholders. As part of this ICES has recently constructed "Ecosystem Overviews" which describe the trends in pressures and state of regional ecosystems. These advice processes require regular inputs of monitoring information on the oceanography and hydrology of the regions, called Operational Oceanographic Products and Services (OOPS).

This dataset consists of gridded abundance map of copepod species. This product was developed with DIVA (Data-Interpolating Variational Analysis). Data was provided by SAHFOS (Continuous Plankton Recorder (CPR) data (zooplankton) from the Sir Alister Hardy Foundation for Ocean Science (SAHFOS).)."

Reference:
Flanders Marine Institute (VLIZ); Sir Alister Hardy Foundation for Ocean Science (SAHFOS); Royal Netherlands Institute for Sea Research (NIOZ); (2015): OOPS - Copepods: ICES Operational Oceanographic Products and Services - Gridded Copepod abundance data; European Marine Observation Data Network (EMODnet) Biology project (www.emodnet-biology.eu), funded by the European Commission's Directorate - General for Maritime Affairs and Fisheries (DG MARE).

Data Portal:
http://gis.ices.dk/sf/index.html?widget=oops-z

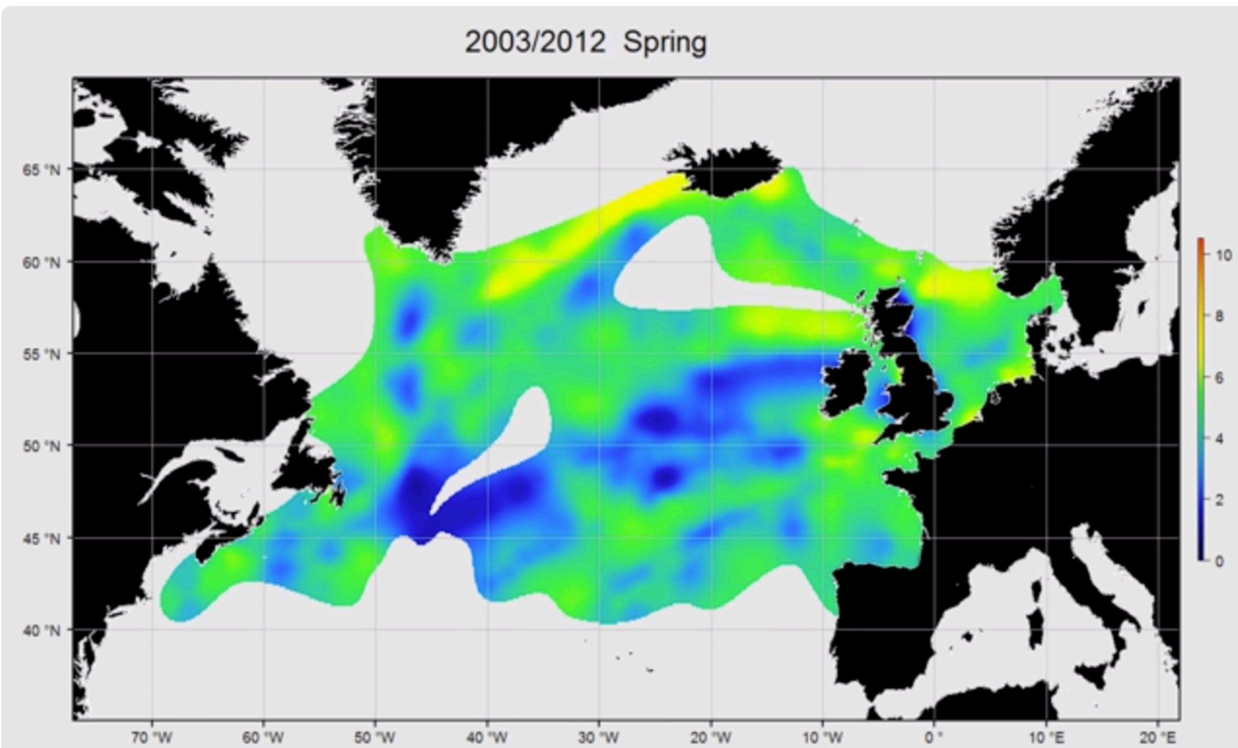

Figure 3.17-1 Copepod abundance, Spring 2012

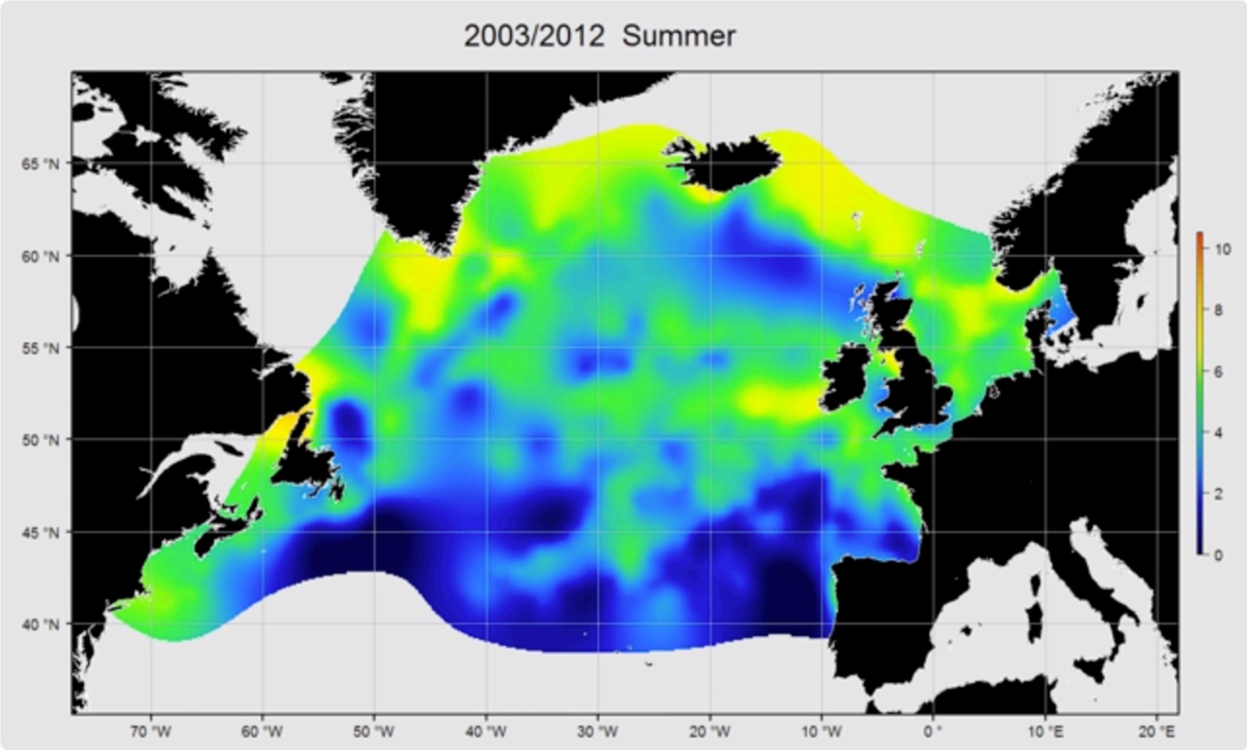

Figure 3.17-2 Copepod abundance, Summer 2012

3.18 ICES Fish Eggs & Larvae Data Portal

Unified portal to access data from ichthyoplankton surveys carried out in ICES areas
Fish egg and fish larvae data have been collected in the ICES area for a long time for use in stock assessments and fisheries management. The collection of the data is usually organized by international survey expert groups. The Eggs and Larvae database aims to store, and make available, data collected by ichthyoplankton surveys for use by ICES and the wider marine community. It provides an overview of available fish egg and larvae survey data, and a unified portal for access to the ichthyoplankton survey data.

Data Portal:
http://www.ices.dk/marine-data/data-portals/Pages/Eggs-and-larvae.aspx

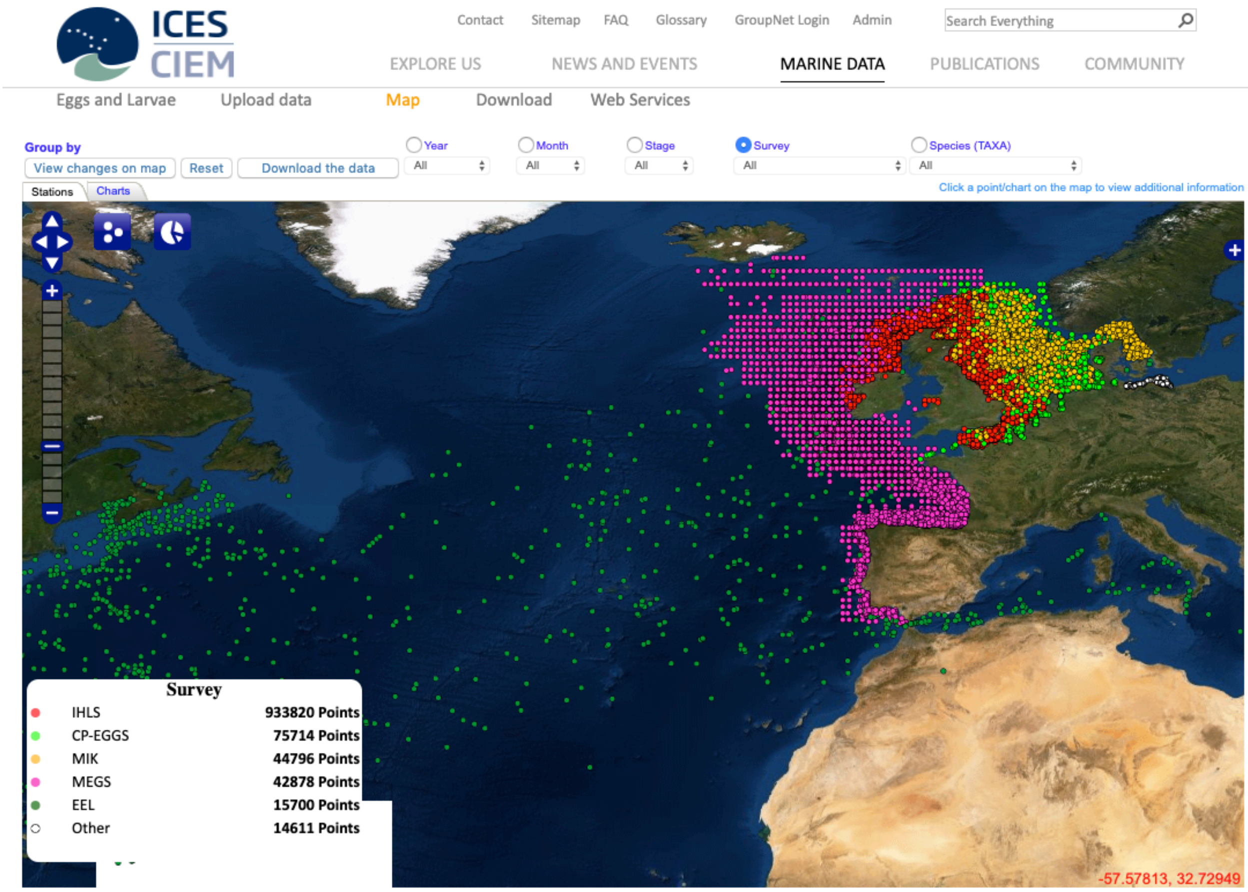

Figure 3.18-1 Survey locations in the Fish Egg and Larvae database

3.19 Bottom Fishing Intensity by ICES for OSPAR

A collection comprising the data products for OSPAR special request to produce updated spatial data layers on fishing intensity/ pressure within the Regions II and III of the OSPAR maritime used in the OSPAR advice: sr.2018.14

Source:
https://odims.ospar.org/maps/1467

Data download:
http://www.ices.dk/sites/pub/Publication%20Reports/Data%20outputs/ICES.2018.OSPAR-spatial-data-fishing-intensity.zip

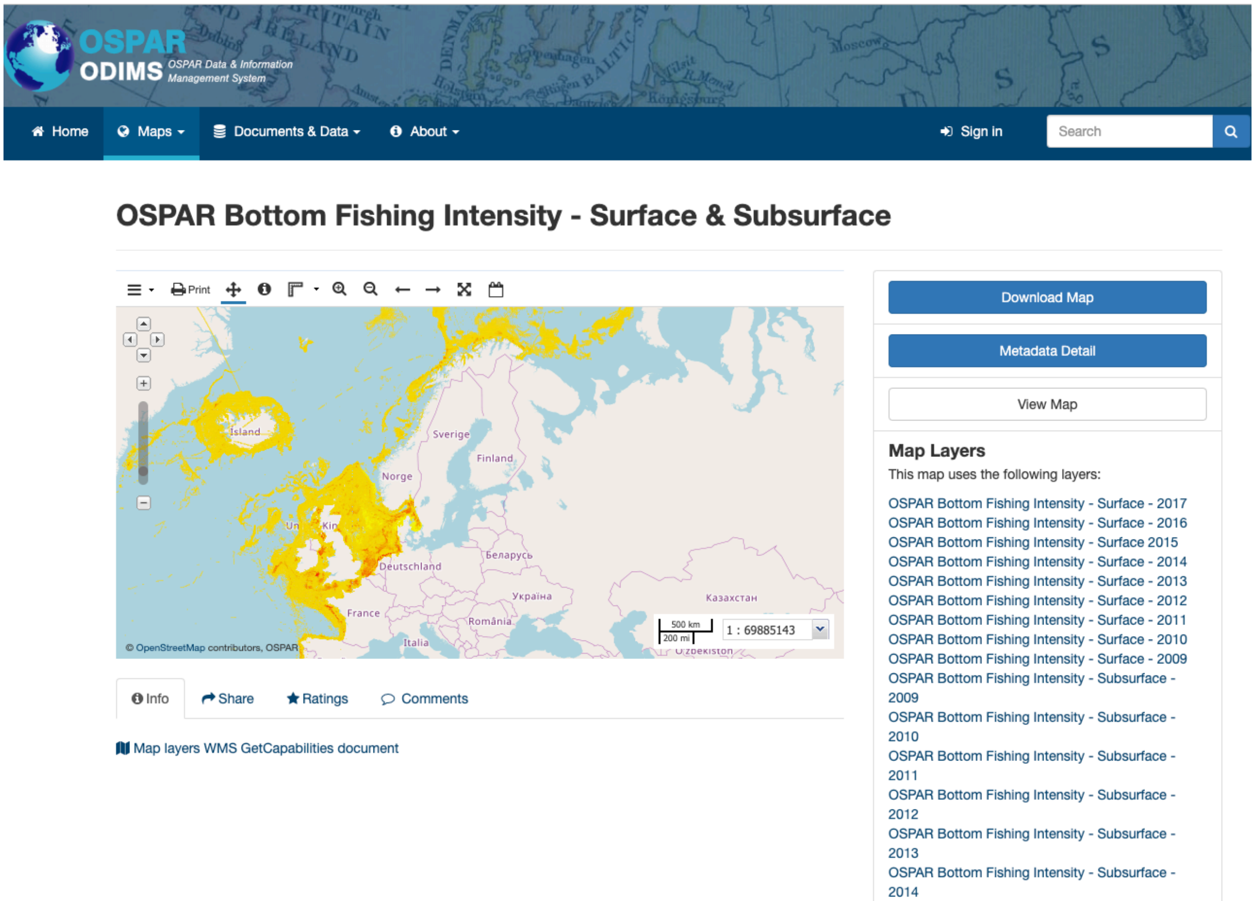

Figure 3.19-1 OSPAR bottom fishing intensity - surface & subsurface

4 Physical Data

4.1 EMODnet Digital Terrain Model (DTM) Bathymetry and Slope

"The EMODnet-Bathymetry portal is being developed in the framework of the European Marine Observation and Data Network (EMODnet) as initiated by the European Commission. It provides services for discovery and requesting access to bathymetric data (survey data sets and composite DTMs) as managed by an increasing number of data providers from government and research. The portal also provides a service for viewing and downloading a harmonised Digital Terrain Model (DTM) for the European sea regions that is generated by the EMODnet Bathymetry partnership on the basis of the gathered data sources."

Source:
http://www.emodnet-bathymetry.eu/

Reference:
EMODnet Bathymetry Consortium (2018). EMODnet Digital Bathymetry (DTM). EMODnet Bathymetry. http://doi.org/10.12770/c7b53704-999d-4721-b1a3-04ec60c87238

Slope derived from EMODnet Digital Terrain Model (DTM) bathymetry with ArcGIS 10.6.1.

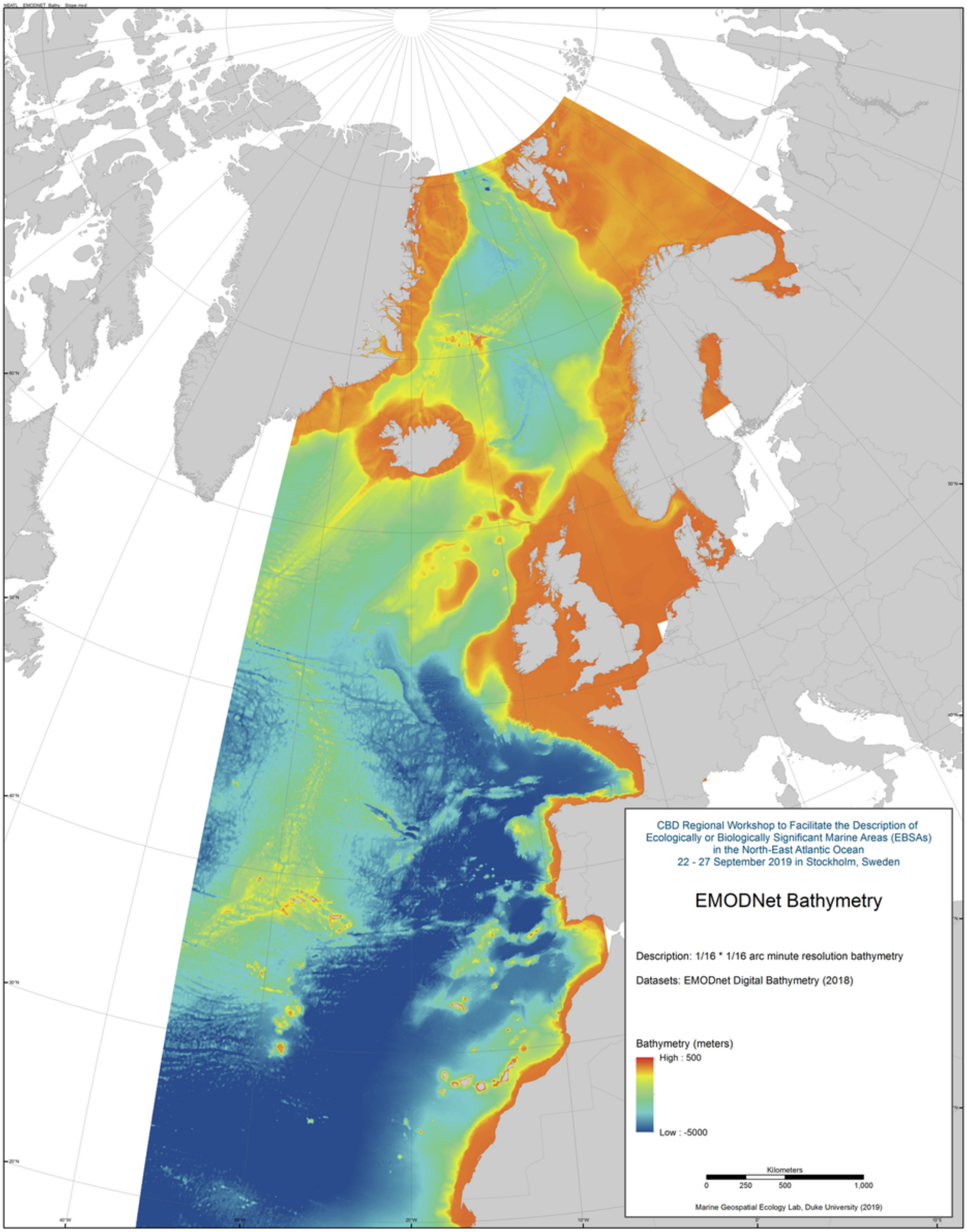

Figure 4.1-1 EMODnet Bathymetry

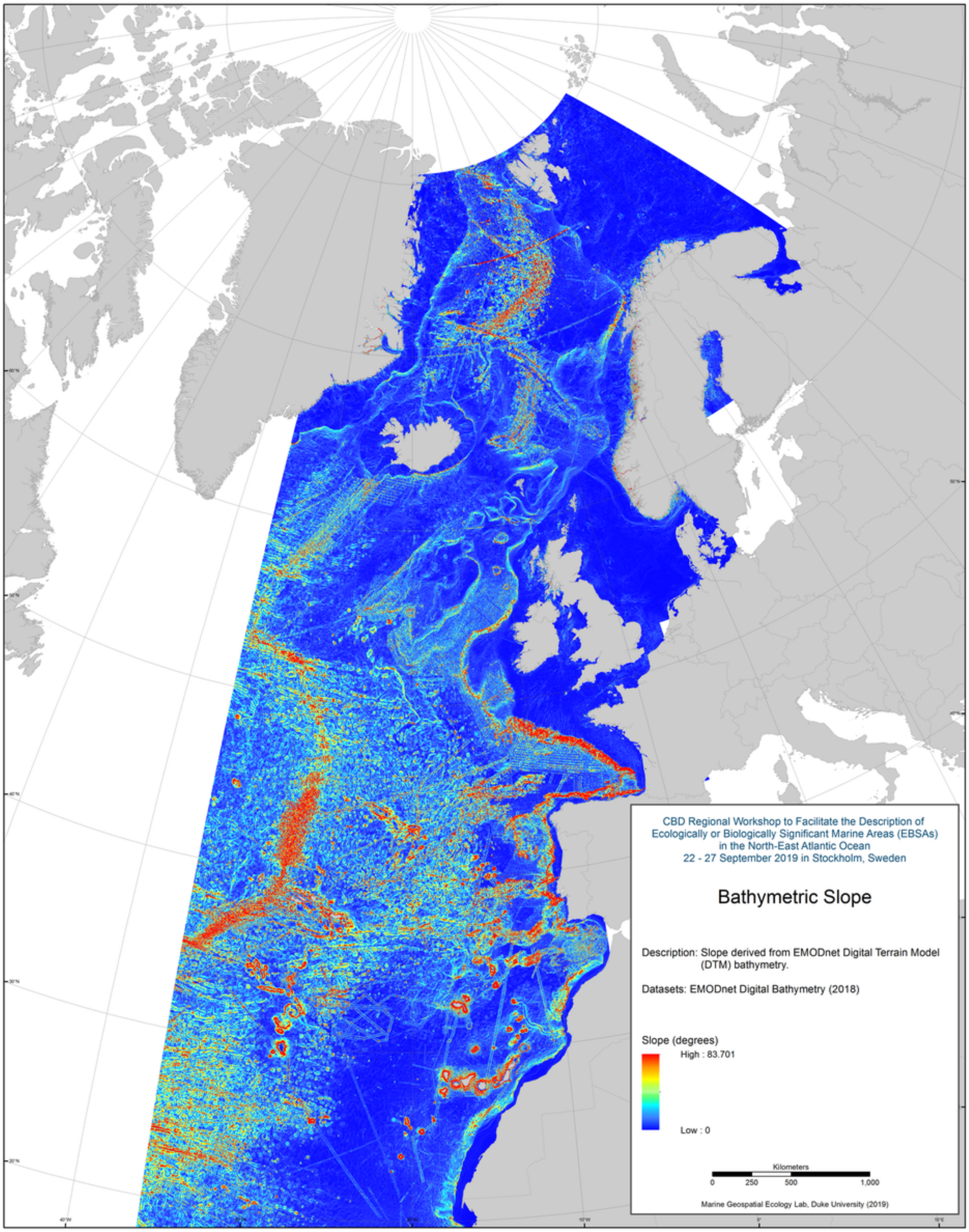

Figure 4.1-2 EMODnet Bathymetric Slope

4.2 GEBCO Bathymetry

GEBCO's gridded bathymetric data set, the GEBCO_2019 grid, is a global terrain model for ocean and land at 15 arc-second intervals.

The GEBCO_2019 Grid is the latest global bathymetric product released by the General Bathymetric Chart of the Oceans (GEBCO) and has been developed through the Nippon Foundation-GEBCO Seabed 2030 Project. This is a collaborative project between the Nippon Foundation of Japan and GEBCO. The Seabed 2030 Project aims to bring together all available bathymetric data to produce the definitive map of the world ocean floor and make it available to all.

The Nippon Foundation of Japan is a non-profit philanthropic organisation active around the world. GEBCO is an international group of mapping experts developing a range of bathymetric data sets and data products, operating under the joint auspices of the International Hydrographic Organization (IHO) and UNESCO's Intergovernmental Oceanographic Commission (IOC).

The GEBCO_2019 product provides global coverage, spanning 89° 59' 52.5''N, 179° 59' 52.5''W to 89° 59' 52.5''S, 179° 59' 52.5''E on a 15 arc-second grid. It consists of 86400 rows x 43200 columns, giving 3,732,480,000 data points. The data values are pixel-centre registered i.e. they refer to elevations at the centre of grid cells.

Source:
https://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_2019/gebco_2019_info.html

4.3 Hydrothermal Vents and Cold Seeps

ChEss (Chemosynthetic Ecosystem Science) was a field project of the Census of Marine Life programme (CoML). The main aim of ChEss was to determine the biogeography of deep-water chemosynthetic ecosystems at a global scale and to understand the processes driving these ecosystems. ChEss addressed the main questions of CoML on diversity, abundance and distribution of marine species, focusing on deep-water reducing environments such as hydrothermal vents, cold seeps, whale falls, sunken wood and areas of low oxygen that intersect with continental margins and seamounts. (source: http://www.coml.org/projects/biography-deep-water-chemosynthetic-ecosystems-chess.html)

ChEssBase is a dynamic relational database available online since December 2004. The aim of ChEssBase is to provide taxonomical, biological, ecological and distributional data of all species described from deep-water chemosynthetic ecosystems, as well as bibliography and information on the habitats. These habitats include hydrothermal vents, cold seeps, whale falls, sunken wood and areas of minimum oxygen that intersect with the continental margin or seamounts.

Since the discovery of hydrothermal vents in 1977 and of cold seep communities in 1984, over 500 species from vents and over 200 species from seeps have been described (Van Dover et al., 2002. Science 295: 1253-1257). The discovery of chemosynthetically fuelled communities on benthic OMZs and large organic falls to the deep-sea such as whales and wood have increased the number of habitats and fauna for investigation. New species are continuously being discovered and described from sampling programmes around the globe.
(source: http://www.noc.soton.ac.uk/chess/database/db_home.php)

ChEssBase: http://www.noc.soton.ac.uk/chess/database/db_home.php
Inter: http://www.interridge.org/irvents/maps

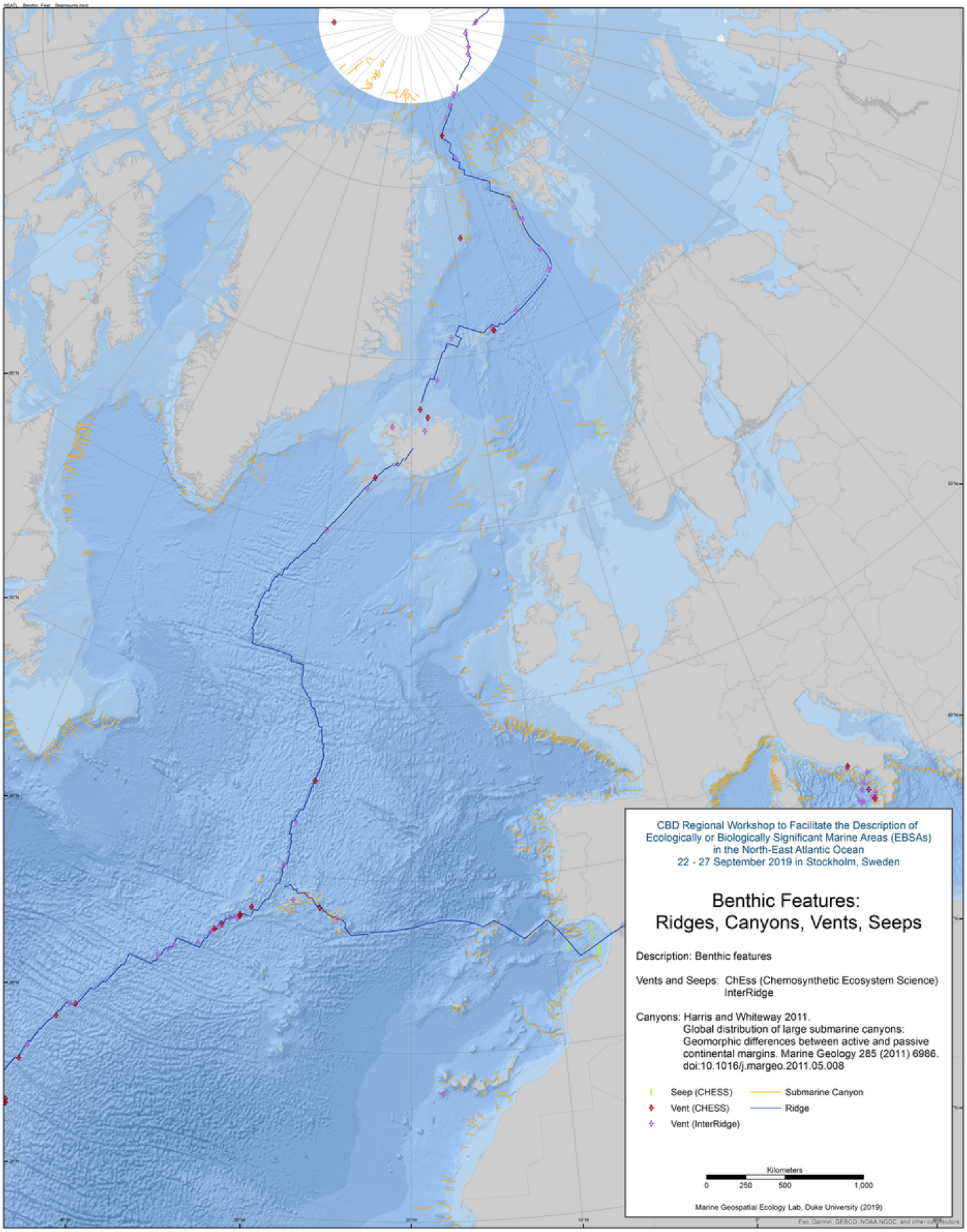

Figure 4.3-1 Benthic features: ridges, canyons, vents, seeps

4.4 Distribution of Large Submarine Canyons

Abstract:
"The aim of this study is to assess the global occurrence of large submarine canyons to provide context and guidance for discussions regarding canyon occurrence, distribution, geological and oceanographic significance and conservation. Based on an analysis of the ETOPO1 data set, this study has compiled the first inventory of 5849 separate large submarine canyons in the world ocean. Active continental margins contain 15% more canyons (2586, equal to 44.2% of all canyons) than passive margins (2244, equal to 38.4%) and the canyons are steeper, shorter, more dendritic and more closely spaced on active than on passive continental margins. This study confirms observations of earlier workers that a relationship exists between canyon slope and canyon spacing (increased canyon slope correlates with closer canyon spacing). The greatest canyon spacing occurs in the Arctic and the Antarctic whereas canyons are more closely spaced in the Mediterranean than in other areas."

Reference:
Harris and Whiteway 2011. Global distribution of large submarine canyons: Geomorphic differences between active and passive continental margins. Marine Geology 285 (2011) 6986. doi:10.1016/j.margeo.2011.05.008

See Figure 4.3-1 above.

4.5 Global Distribution of Seamounts

Abstract:
"Seamounts and knolls are 'undersea mountains', the former rising more than 1000 m from the seafloor. These features provide important habitats for aquatic predators, demersal deep-sea fish and benthic invertebrates. However most seamounts have not been surveyed and their numbers and locations are not well known. Previous efforts to locate and quantify seamounts have used relatively coarse bathymetry grids. Here we use global bathymetric data at 30 arc-second resolution to identify seamounts and knolls. We identify 33,452 seamounts and 138,412 knolls, representing the largest global set of identified seamounts and knolls to date. We compare estimated seamount numbers, locations, and depths with validation sets of seamount data from New Zealand and Azores. This comparison indicates the method we apply finds 94% of seamounts, but may overestimate seamount numbers along ridges and in areas where faulting and seafloor spreading creates highly complex topography. The seamounts and knolls identified herein are significantly geographically biased towards areas surveyed with shipbased soundings. As only 6.5% of the ocean floor has been surveyed with soundings it is likely that new seamounts will be uncovered as surveying improves. Seamount habitats constitute approximately 4.7% of the ocean floor, whilst knolls cover 16.3%. Regional distribution of these features is examined, and we find a disproportionate number of productive knolls, with a summit depth of o1.5 km, located in the Southern Ocean. Less than 2% of seamounts are within marine protected areas and the

majority of these are located within exclusive economic zones with few on the High Seas. The database of seamounts and knolls resulting from this study will be a useful resource for researchers and conservation planners."

Reference:
Yesson, C., et al., The global distribution of seamounts based on 30 arc seconds bathymetry data. Deep-Sea Research I (2011), doi:10.1016/j.dsr.2011.02.004

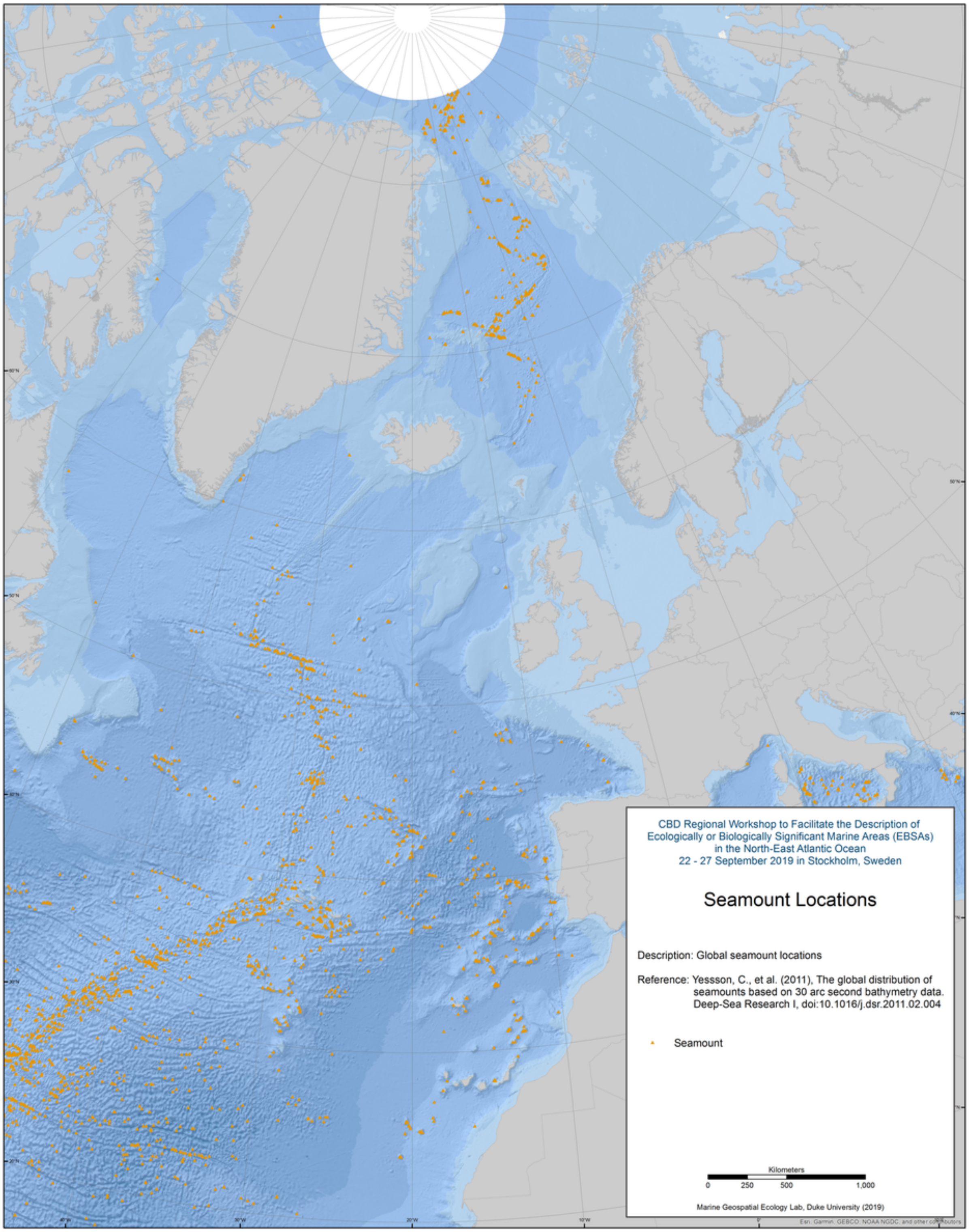

Figure 4.5-1 Seamount locations

4.6 Seafloor Geomorphology

Abstract:
"We present the first digital seafloor geomorphic features map (GSFM) of the global ocean. The GSFM includes 131,192 separate polygons in 29 geomorphic feature categories, used here to assess differences between passive and active continental margins as well as between 8 major ocean regions (the Arctic, Indian, North Atlantic, North Pacific, South Atlantic, South Pacific and the Southern Oceans and the Mediterranean and Black Seas). The GSFM provides quantitative assessments of differences between passive and active margins: continental shelf width of passive margins (88 km) is nearly three times that of active margins (31 km); the average width of active slopes (36 km) is less than the average width of passive margin slopes (46 km); active margin slopes contain an area of 3.4 million km^2 where the gradient exceeds 5°, compared with 1.3 million km^2 on passive margin slopes; the continental rise covers 27 million km^2 adjacent to passive margins and less than 2.3 million km^2 adjacent to active margins. Examples of specific applications of the GSFM are presented to show that: 1) larger rift valley segments are generally associated with slow-spreading rates and smaller rift valley segments are associated with fast spreading; 2) polar submarine canyons are twice the average size of non-polar canyons and abyssal polar regions exhibit lower seafloor roughness than non-polar regions, expressed as spatially extensive fan, rise and abyssal plain sediment deposits – all of which are attributed here to the effects of continental glaciations; and 3) recognition of seamounts as a separate category of feature from ridges results in a lower estimate of seamount number compared with estimates of previous workers."

Reference:
Harris PT, Macmillan-Lawler M, Rupp J, Baker EK Geomorphology of the oceans. Marine Geology. doi: 10.1016/j.margeo.2014.01.011

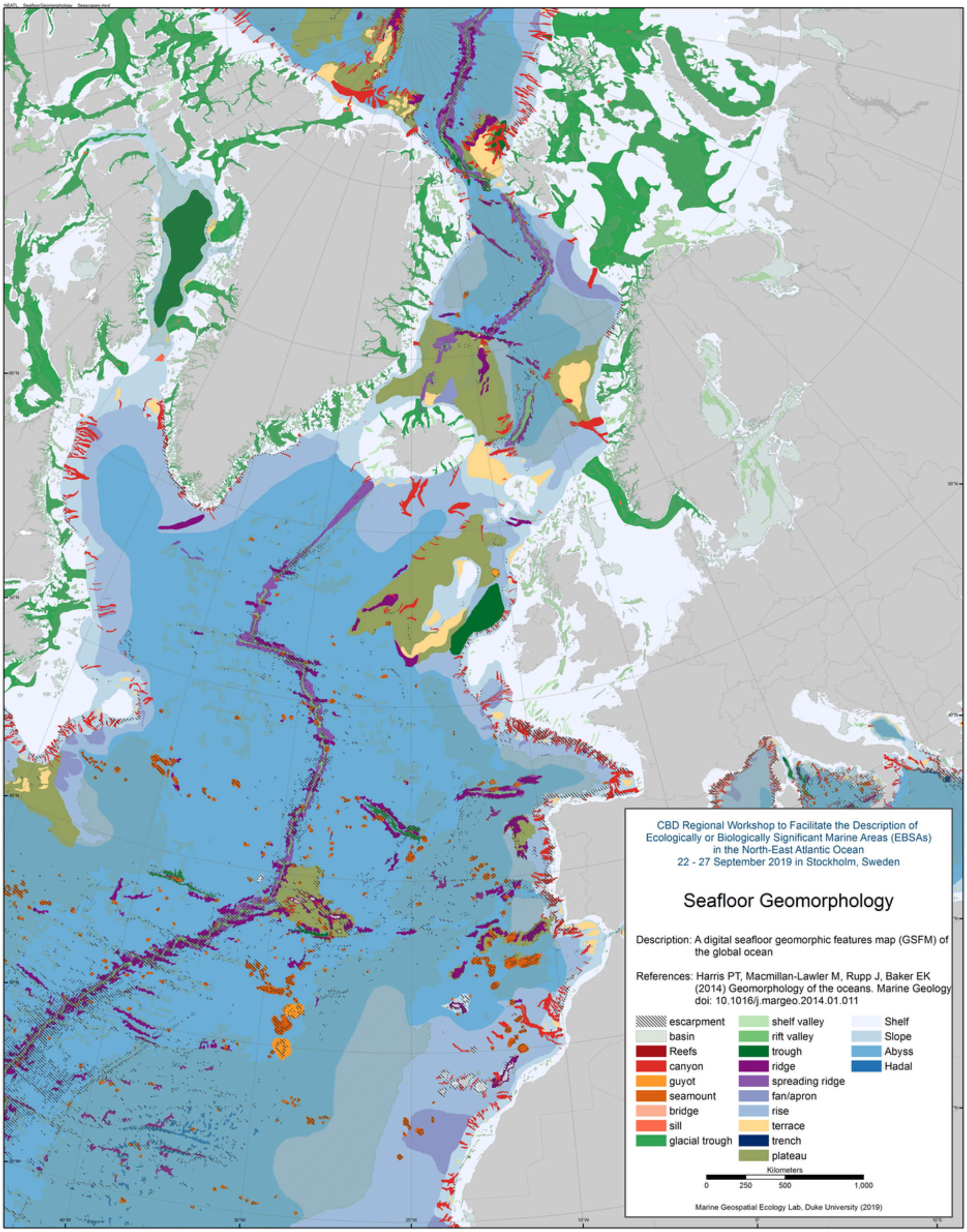

Figure 4.6-1 Seafloor geomorphology

4.7 Global Seascapes

Abstract:
"Designing a representative network of high seas marine protected areas (MPAs) requires an acceptable scheme to classify the benthic (as well as the pelagic) bioregions of the oceans. Given the lack of sufficient biological information to accomplish this task, we used a multivariate statistical method with 6 biophysical variables (depth, seabed slope, sediment thickness, primary production, bottom water dissolved oxygen and bottom temperature) to objectively classify the ocean floor into 53,713 separate polygons comprising 11 different categories, that we have termed "seascapes". A cross-check of the seascape classification was carried out by comparing the seascapes with existing maps of seafloor geomorphology and seabed sediment type and by GIS analysis of the number of separate polygons, polygon area and perimeter/area ratio. We conclude that seascapes, derived using a multivariate statistical approach, are biophysically meaningful subdivisions of the ocean floor and can be expected to contain different biological associations, in as much as different geomorphological units do the same. Less than 20% of some seascapes occur in the high seas while other seascapes are largely confined to the high seas, indicating specific types of environment whose protection and conservation will require international cooperation. Our study illustrates how the identification of potential sites for high seas marine protected areas can be accomplished by a simple GIS analysis of seafloor geomorphic and seascape classification maps. Using this approach, maps of seascape and geomorphic heterogeneity were generated in which heterogeneity hotspots identify themselves as MPA candidates. The use of computer-aided mapping tools removes subjectivity in the MPA design process and provides greater confidence to stakeholders that an unbiased result has been achieved."

Reference:
Harris, P. T. and Whiteway, T. 2009. High seas marine protected areas: Benthic environmental conservation priorities from a GIS analysis of global ocean biophysical data. - Ocean & Coastal Management 52: 22–38.

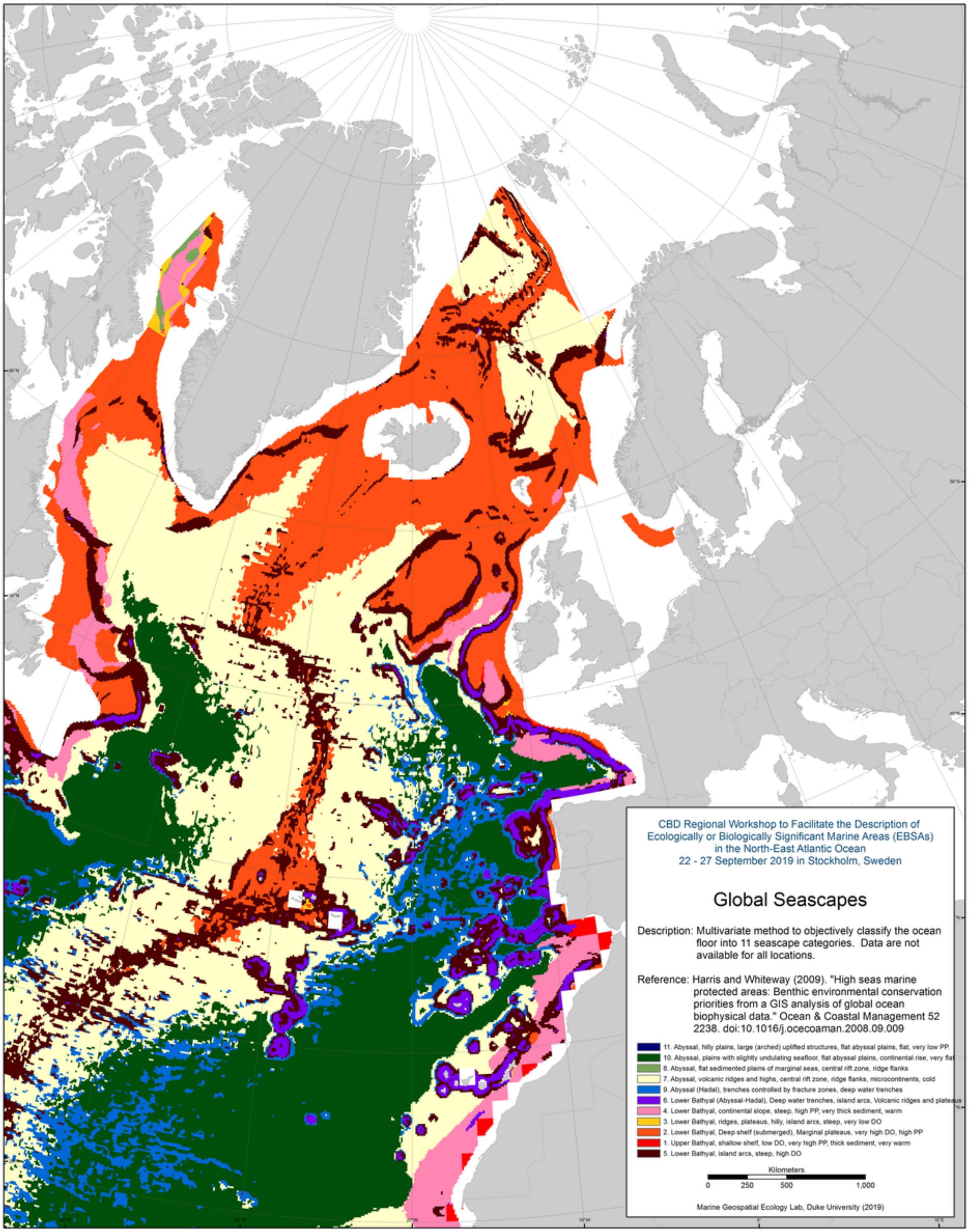

Figure 4.7-1 Global seascapes

4.8 EMODnet Seabed Habitats

Description:
"In the first phase of EMODnet Seabed Habitats (2009-2012) over two million square kilometres of European seabed were mapped using levels 3 and 4 of the EUNIS (European Nature Information System) classification system to produce the EMODnet broad-scale seabed habitat map for Europe (EUSeaMap). In phase 2 (2013-2016), the coverage of the maps has been extended to all European seas and the existing maps have been improved."

"Building on the highly successful INTERREG IIIB-funded MESH and BALANCE projects, phase 1 of EMODnet Seabed Habitats (2009-2012) improved and harmonised predictive benthic habitat layers across the Celtic Seas, Greater North Sea and Baltic Sea, as well as undertaking broad-scale mapping of the western Mediterranean for the first time. In phase 2 (2013-2016), the coverage of the maps has been extended to all European seas and the existing maps have been improved. The map is referred to as the EMODnet broad-scale seabed habitat map for Europe(AKA EUSeaMap)."

Source:
https://www.emodnet-seabedhabitats.eu/about/

Reference:
EMODnet Phase 2 Final Report - Seabed Habitats (2016)

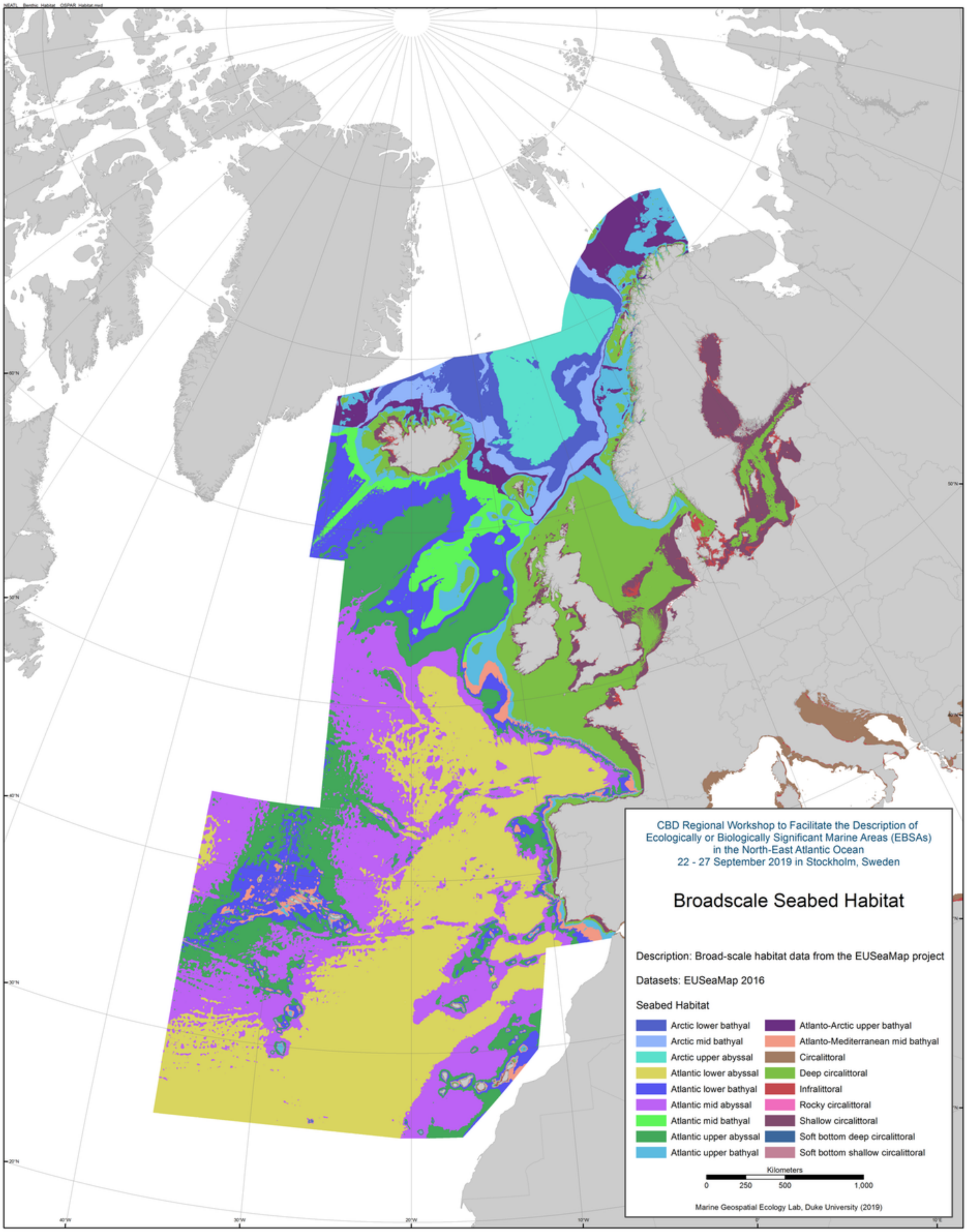

Figure 4.8-1 EMODnet broadscale seabed habitat

4.9 OSPAR Habitats in the North-East Atlantic Ocean

Description:
"This is a compilation of OSPAR habitat polygon data for the northeast Atlantic submitted by OSPAR contracting parties. The compilation is coordinated by the UK's Joint Nature Conservation Committee, working with a representative from each of the OSPAR coastal contracting parties.This public dataset does not contain records relating to sensitive species (e.g. Ostrea edulis) in specific areas, or where data are restricted from public release by the owner's use limitations.

This version (v2018) was published in July 2019."

Source:
http://gis.ices.dk/geonetwork/srv/eng/catalog.search#/metadata/9ae8cf2e-50c4-4106-b9da-e199e78aa4ac

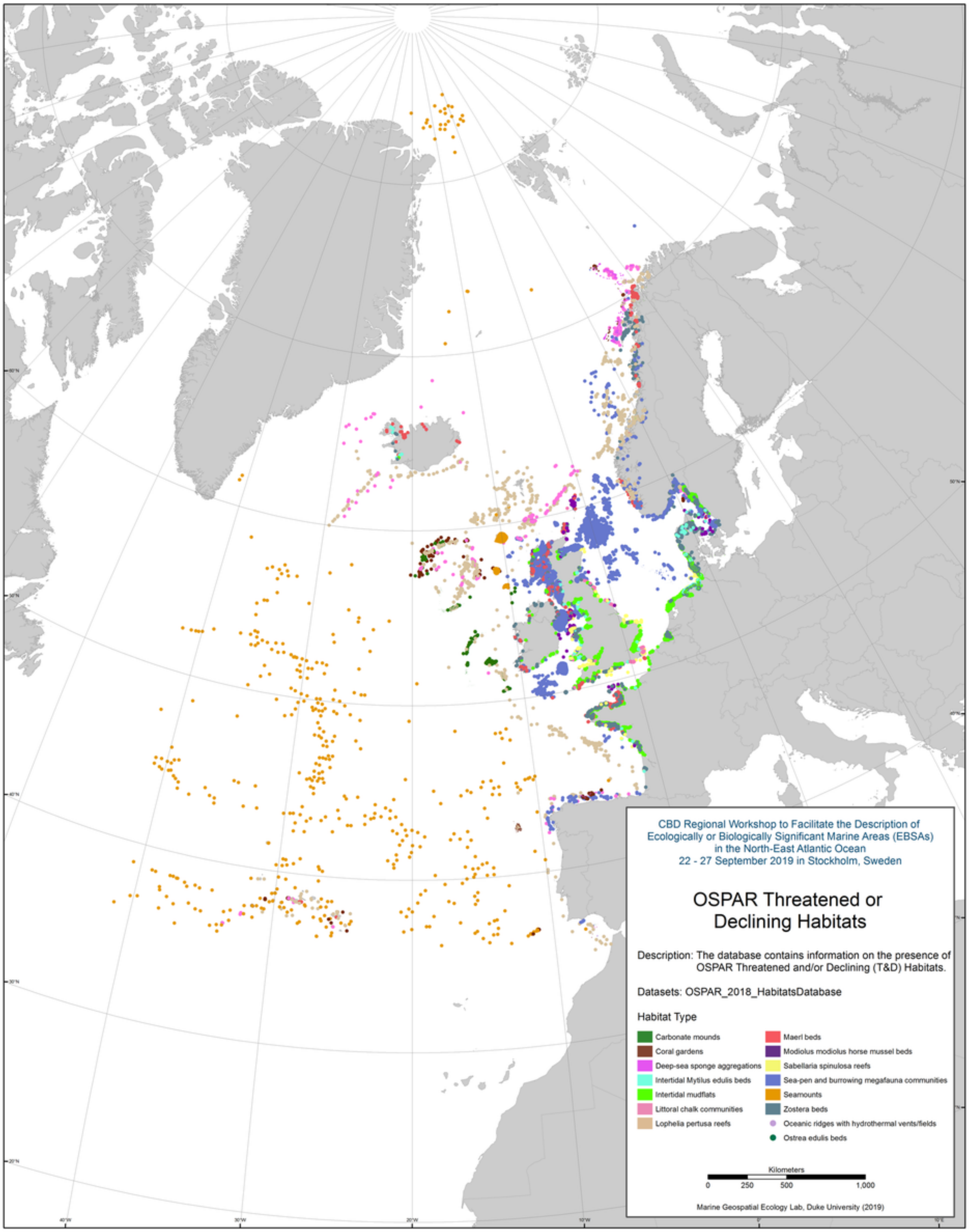

Figure 4.9-1 OSPAR threatened or declining habitats

4.10 Drifter Derived Surface Currents

Description:
"Satellite-tracked SVP drifting buoys (Sybrandy and Niiler, 1991; Niiler, 2001) provide observations of near-surface circulation at unprecedented resolution. In September 2005, the Global Drifter Array became the first fully realized component of the Global Ocean Observing System when it reached an array size of 1250 drifters. A drifter is composed of a surface float which includes a transmitter to relay data, a thermometer that reads temperature a few centimeters below the air/sea interface, and a submergence sensor used to detect when/if the drogue is lost. The surface float is tethered to a holey sock drogue, centered at 15 m depth. The drifter follows the flow integrated over the drogue depth, although some slip with respect to this motion is associated with direct wind forcing (Niiler and Paduan, 1995). This slip is greatly enhanced in drifters that have lost their drogues (Pazan and Niiler, 2000). Drifter velocities are derived from finite differences of their position fixes. These velocities, and the concurrent SST measurements, are archived at AOML's Drifting Buoy Data Assembly Center, where the data are quality controlled and interpolated to 1/4-day intervals (Hansen and Herman, 1989; Hansen and Poulain, 1996)."

Source:
https://www.aoml.noaa.gov/phod/gdp/mean_velocity.php

Reference:
Laurindo, L. C. et al. 2017. An improved near-surface velocity climatology for the global ocean from drifter observations. - Deep Sea Research Part I: Oceanographic Research Papers 124: 73–92.

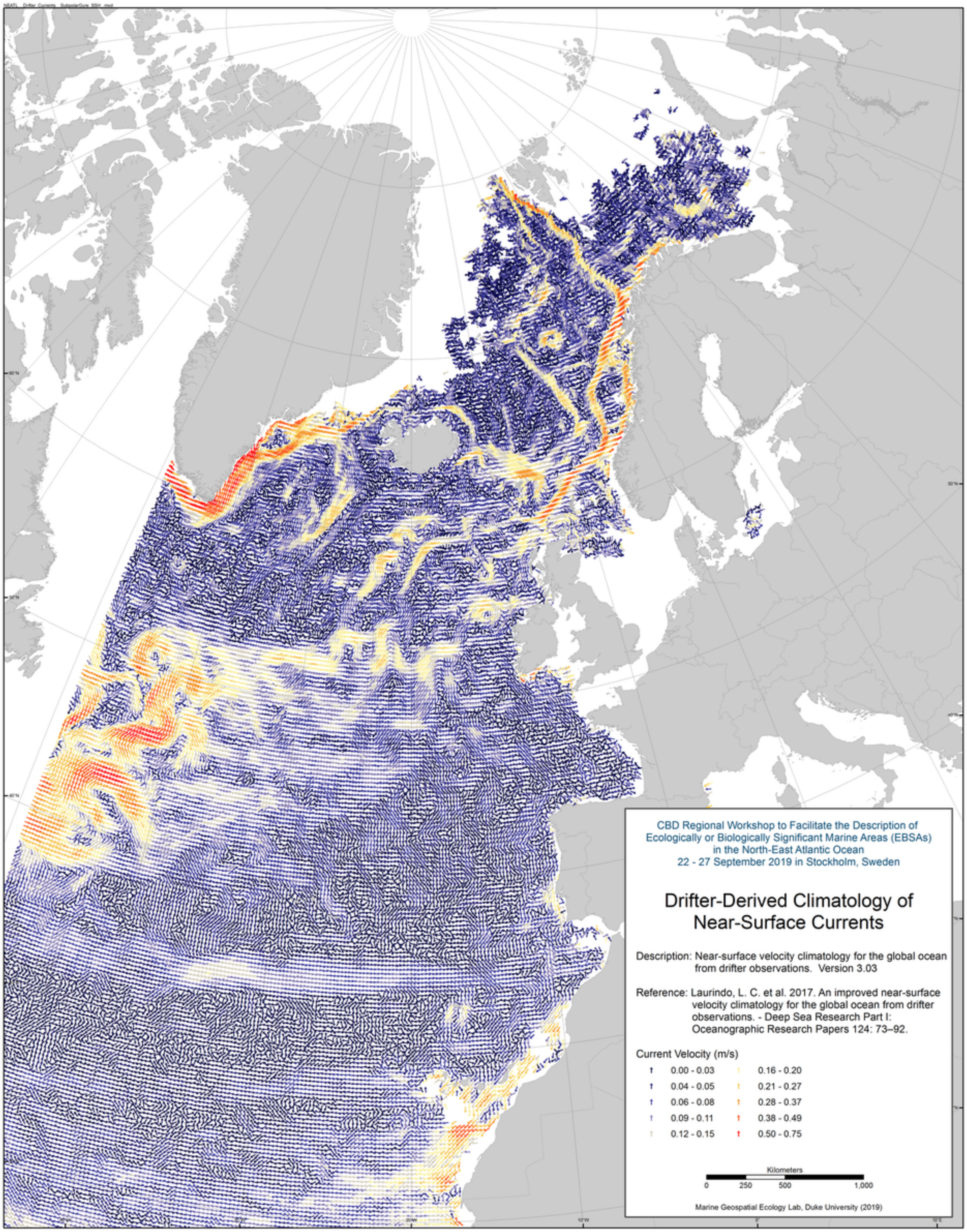

Figure 4.10-1 Drifter-derived climatology of near-surface currents

4.11 Mesoscale Eddies - Point Density and Occurrence Count

Description:
"The altimeter the Mesoscale Eddy Trajectory Atlas products were produced by SSALTO/DUACS and distributed by AVISO+ (http://www.aviso.altimetry.fr/) with support from CNES, in collaboration with Oregon State University with support from NASA. Eddies detected from the multimission altimetry datasets, with location each day for the whole altimetry period (1993-ongoing, in delayed-time), type (cyclonic/anticyclonic), speed, radius and associated metadata."

Source:
https://www.aviso.altimetry.fr/index.php?id=3280&L=1

Reference:
Mesoscale Eddy Trajectory Atlas Product Handbook, SALP-MU-P-EA-23126, issue 2.0
https://www.aviso.altimetry.fr/fileadmin/documents/data/tools/hdbk_eddytrajectory_2.0exp.pdf

Eddy point density and counts of distinct eddies over time were created for the North-East Atlantic region. The source data is the Mesoscale Eddy Trajectory Atlas (version 2.0exp).

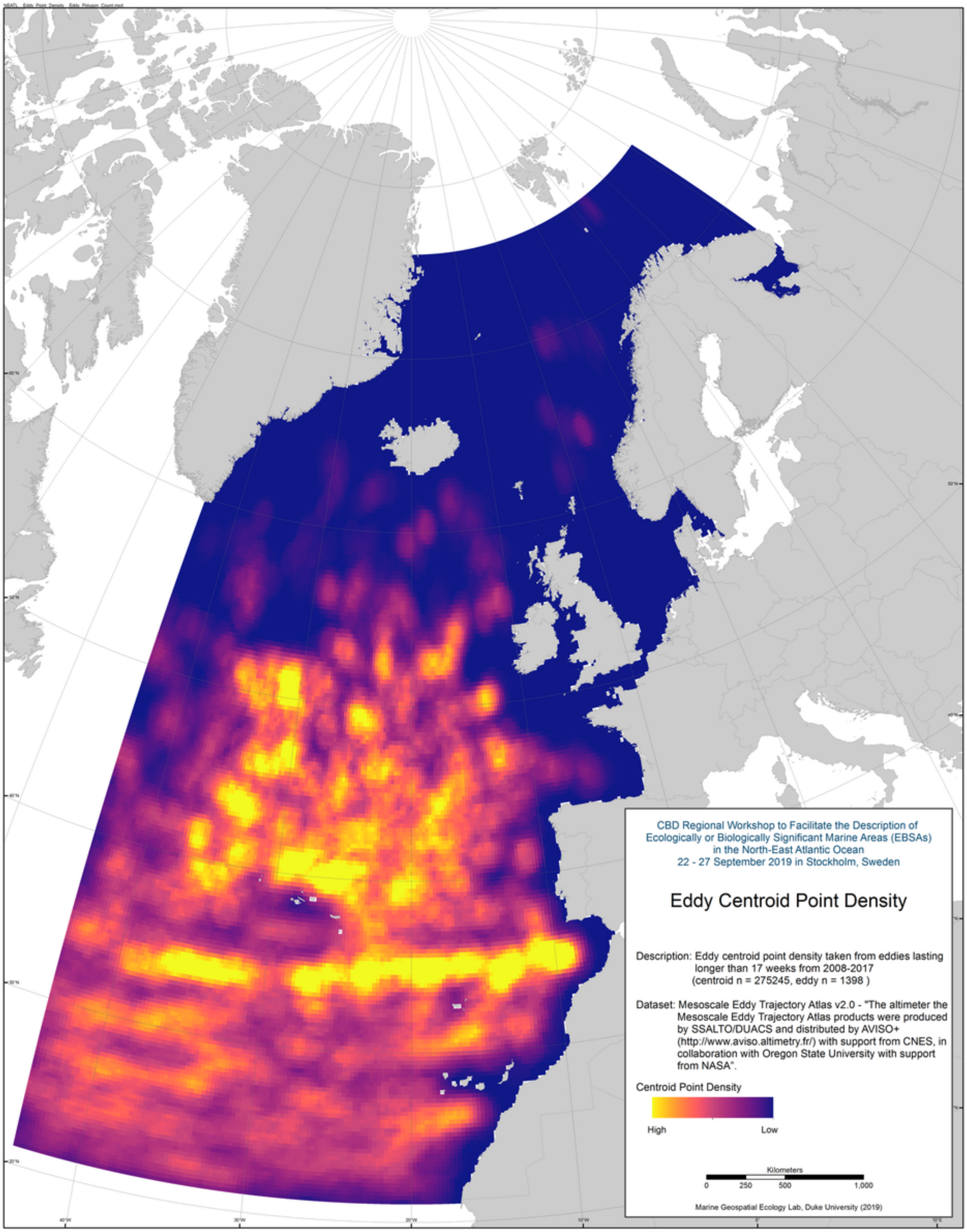

Figure 4.11-1 Eddy centroid point density

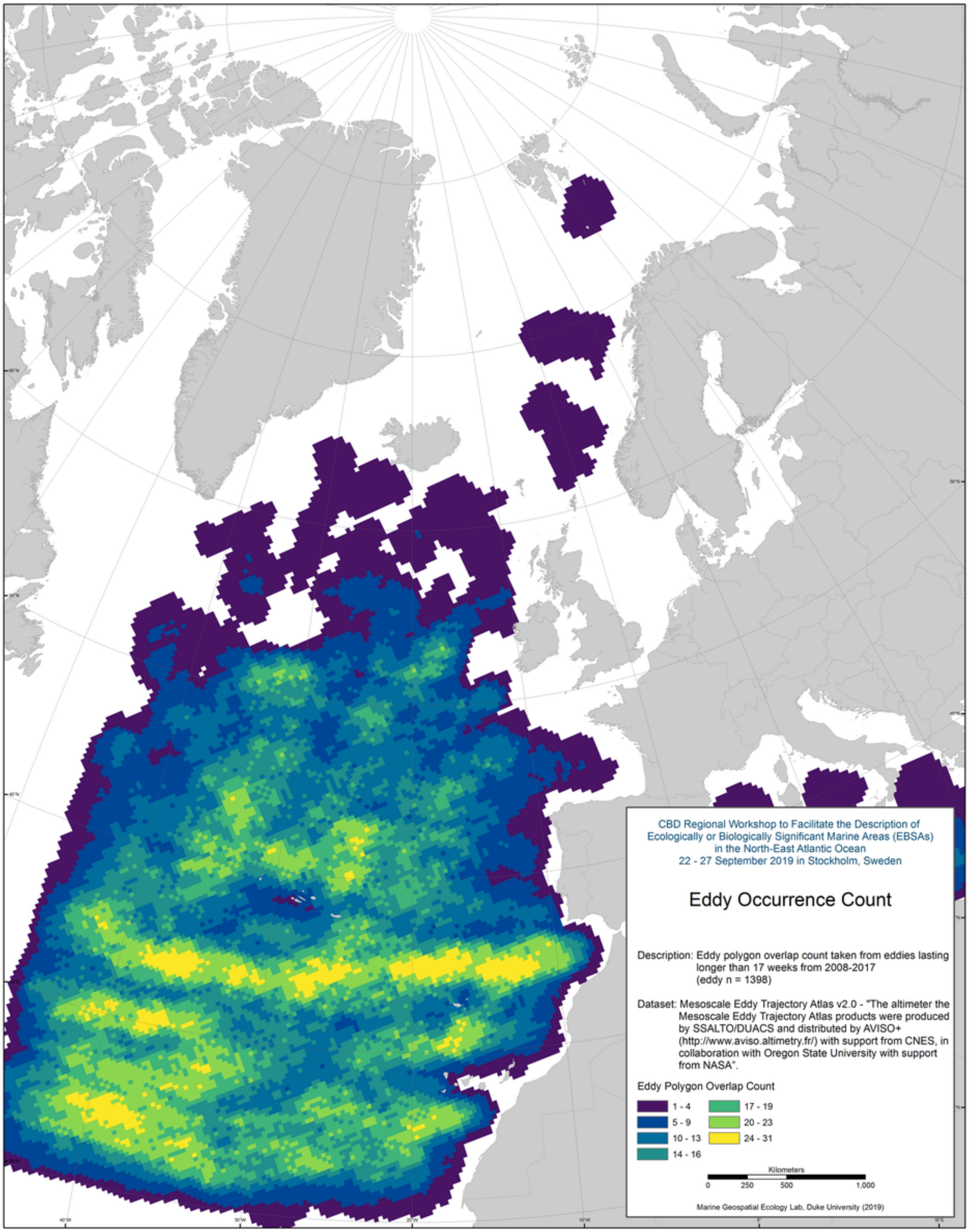

Figure 4.11-2 Eddy occurrence count

4.12 Sea Surface Temperature Seasonal Climatology

The 4km AVHHR Pathfinder dataset, published by the NOAA National Oceanographic Data Center (NODC), provides a global, long-term, high-resolution record of sea surface temperature (SST) using data collected by NOAA's Polar-orbiting Operational Environmental Satellites (POES).

For this effort, a cumulative climatology (2009 – 2018, inclusive) was created using the "Create Climatological Rasters for AVHHR Pathfinder V5 SST" tool in the Marine Geospatial Ecology Tools (MGET) for ArcGIS (Roberts et al., 2010).

References:
Roberts, J.J., B.D. Best, D.C. Dunn, E.A. Treml, and P.N. Halpin (2010). Marine Geospatial Ecology Tools: An integrated framework for ecological geoprocessing with ArcGIS, Python, R, MATLAB, and C++. Environmental Modelling & Software 25: 1197-1207.

Casey, K.S., T.B. Brandon, P. Cornillon, and R. Evans (2010). "The Past, Present and Future of the AVHRR Pathfinder SST Program", in Oceanography from Space: Revisited, eds. V. Barale, J.F.R. Gower, and L. Alberotanza, Springer

4.13 Sea Surface Temperature Front Climatology

The NASA Jet Propulsion Laboratory Physical Oceanography Distributed Active Archive Center (PO.DAAC) publishes sea surface temperature images from the Moderate Resolution Imaging Spectroradiometer (MODIS).

For this effort, SST fronts were detected using the "Find Cayula-Cornillon Fronts in PO.DAAC MODIS L3 SST" tool in the Marine Geospatial Ecology Tools (MGET) for ArcGIS (Roberts et al., 2010). The front threshold was set to 2 degrees Celsius, and the tool was run for every daily image available from 2009 – 2018 (inclusive). A custom Python script was then run to calculate the percentage of days with a temperature front over the full set of daily images. Data summaries were created seasonally, annually, and over the entire date range.

References:
Roberts, J.J., B.D. Best, D.C. Dunn, E.A. Treml, and P.N. Halpin (2010). Marine Geospatial Ecology Tools: An integrated framework for ecological geoprocessing with ArcGIS, Python, R, MATLAB, and C++. Environmental Modelling & Software 25: 1197-1207.

J.-F. Cayula, P. Cornillon (1992), Edge Detection Algorithm for SST Images, *Journal of Atmospheric and Oceanic Technology* 9, 67–80.

Two seasonal maps are shown below. All four seasons are available for use by workshop attendees.

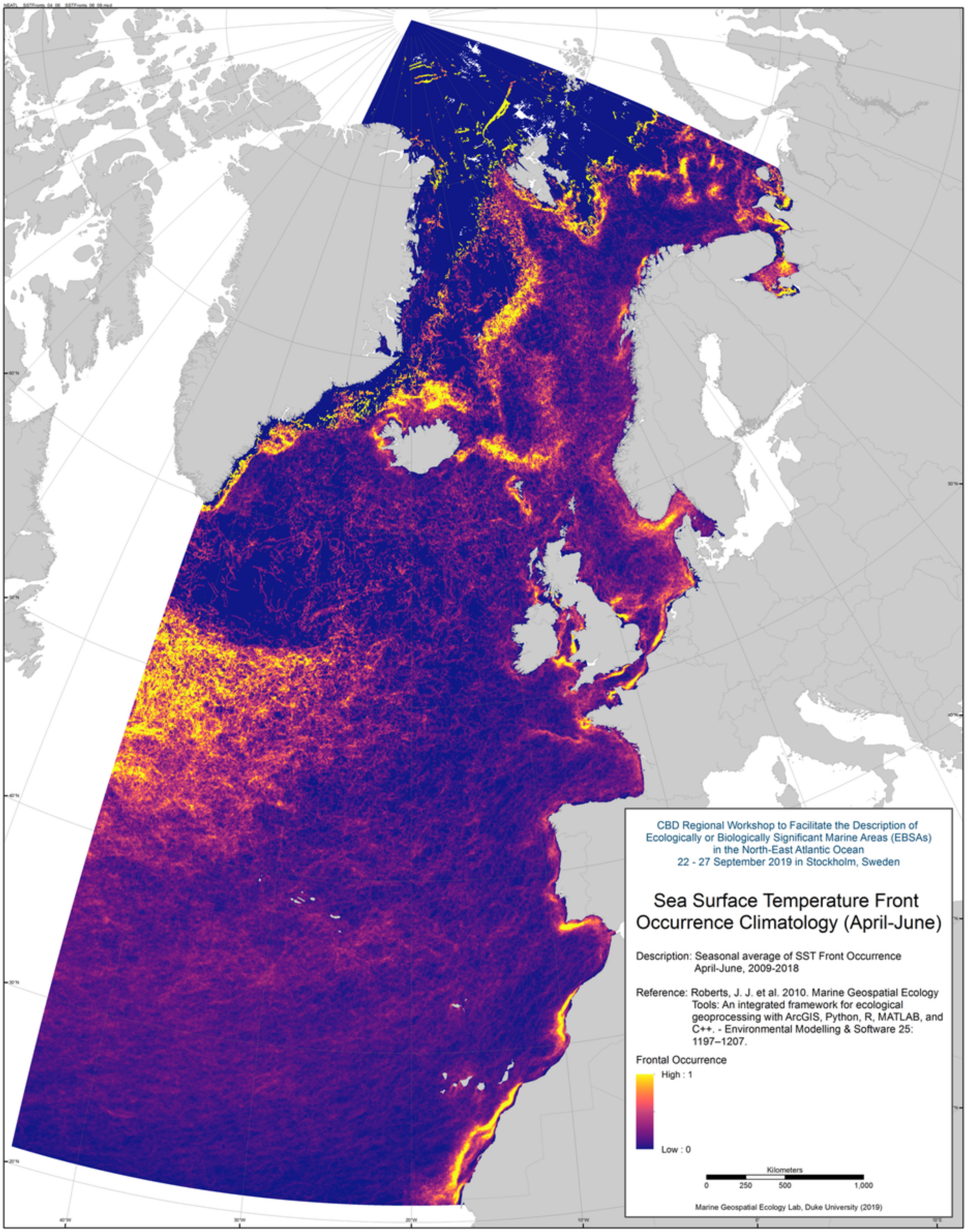

Figure 4.13-1 Sea surface temperature front climatology: April - June

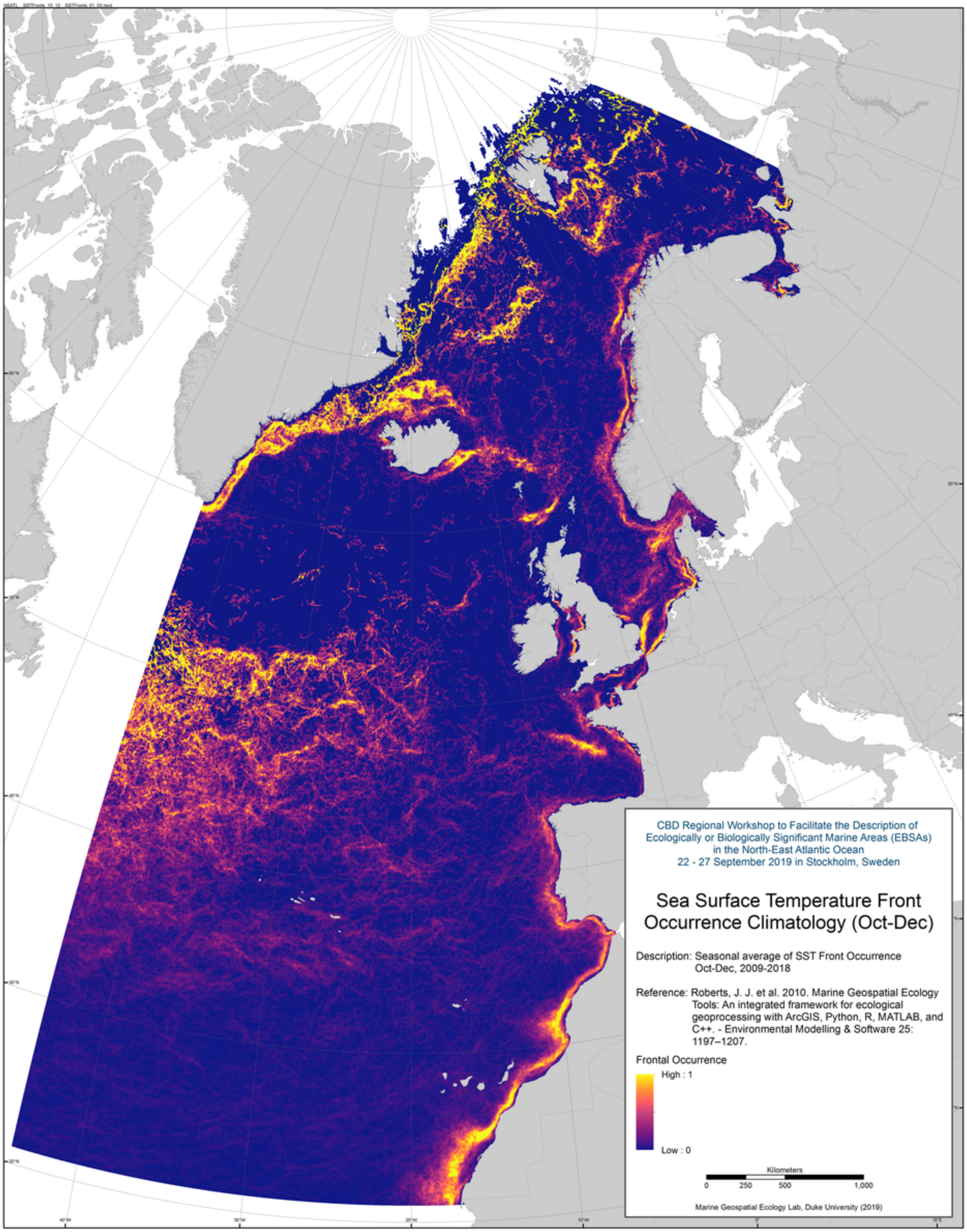

Figure 4.13-2 Sea surface temperature front climatology: October - December

4.14 HYCOM Surface Current Data

"The HYCOM consortium (https://hycom.org/about) is a multi-institutional effort sponsored by the National Ocean Partnership Program (NOPP), as part of the U.S. Global Ocean Data Assimilation Experiment (GODAE), to develop and evaluate a data-assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (called HYbrid Coordinate Ocean Model or HYCOM)."

Here, climatologies of the surface current velocity, magnitude and total kinetic energy were created using the "Create Climatological Rasters for HYCOM GLBu0.08 4D Variable" tool in the Marine Geospatial Ecology Tools (MGET) for ArcGIS (Roberts et al., 2010). This tool accesses a concatenation of several sequential HYCOM + NCODA Global 1/12 Degree "uniform" (GLBu0.08, Chassignet et al. 2009) datasets, treating them as a continuous virtual dataset running from late 1992 to the present day. This tool produces rasters showing the climatological average value (or other statistic) of a HYCOM GLBu0.08 4D variable from model runs output from 2014-2018. Quarterly data climatologies are available for Total Kinetic Energy (TKE) and Surface Current Magnitude and Direction.

References:
Chassignet, E. et al. 2009. US GODAE: Global Ocean Prediction with the HYbrid Coordinate Ocean Model (HYCOM). - Oceanog. 22: 64–75.

Roberts, J.J., B.D. Best, D.C. Dunn, E.A. Treml, and P.N. Halpin (2010). Marine Geospatial Ecology Tools: An integrated framework for ecological geoprocessing with ArcGIS, Python, R, MATLAB, and C++. Environmental Modelling & Software 25: 1197-1207.

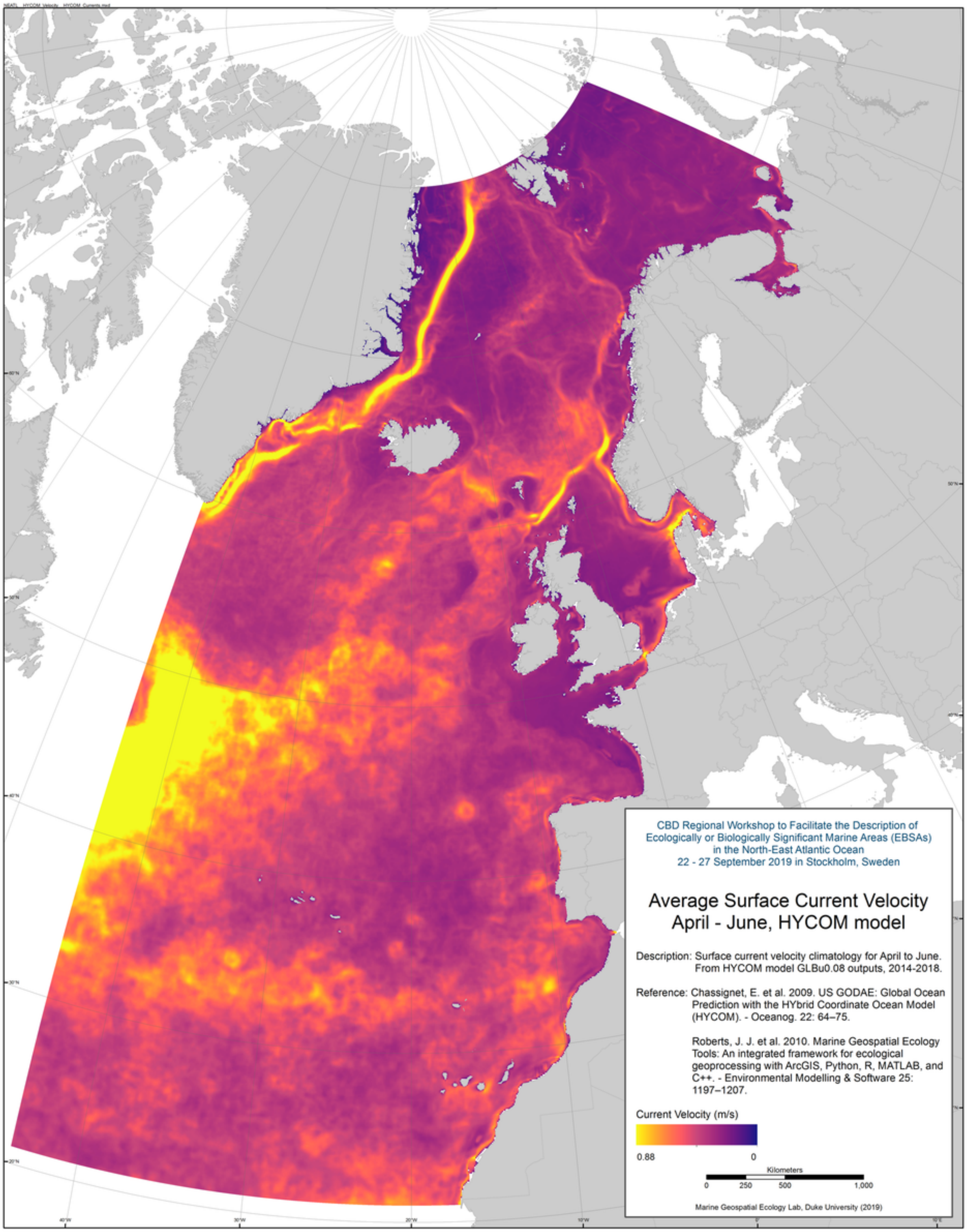

Figure 4.14-1 Average surface current velocity from HYCOM: April - June

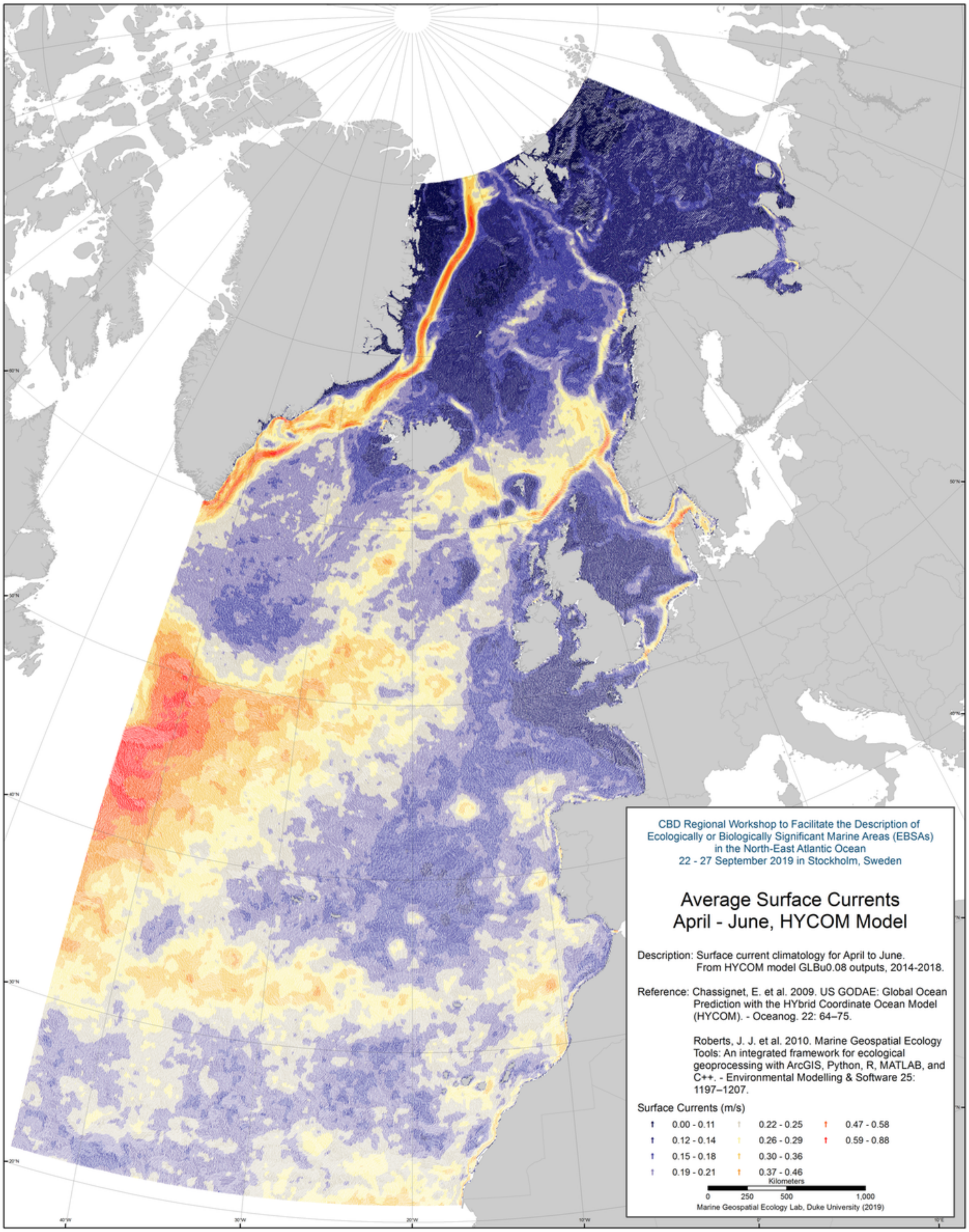

Figure 4.14-2 Average surface currents from HYCOM: April - June

4.15 Sea Surface Height Definition of the North Atlantic Subpolar Gyre

Following the approach outlined in Foukal and Lozier (2017) sea surface height (SSH) contours were created for selected dates. Contours were created using the Absolute Dynamic Topography (ADT) layer from the "Global Ocean Gridded L4 Sea Surface Heights And Derived Variables Reprocessed" dataset (DATASET-DUACS-REP-GLOBAL-MERGED-ALLSAT-PHY-L4). Contours were created using this method for Jan 1, April 1, July 1, and Oct 1 2018 to give a sense of the variability in the gyre boundary.

Data Source:
http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&view=details&product_id=SEALEVEL_GLO_PHY_L4_REP_OBSERVATIONS_008_047

Reference:

Foukal, N. P. and Lozier, M. S. 2017. Assessing variability in the size and strength of the North Atlantic subpolar gyre. - Journal of Geophysical Research: Oceans 122: 6295–6308.

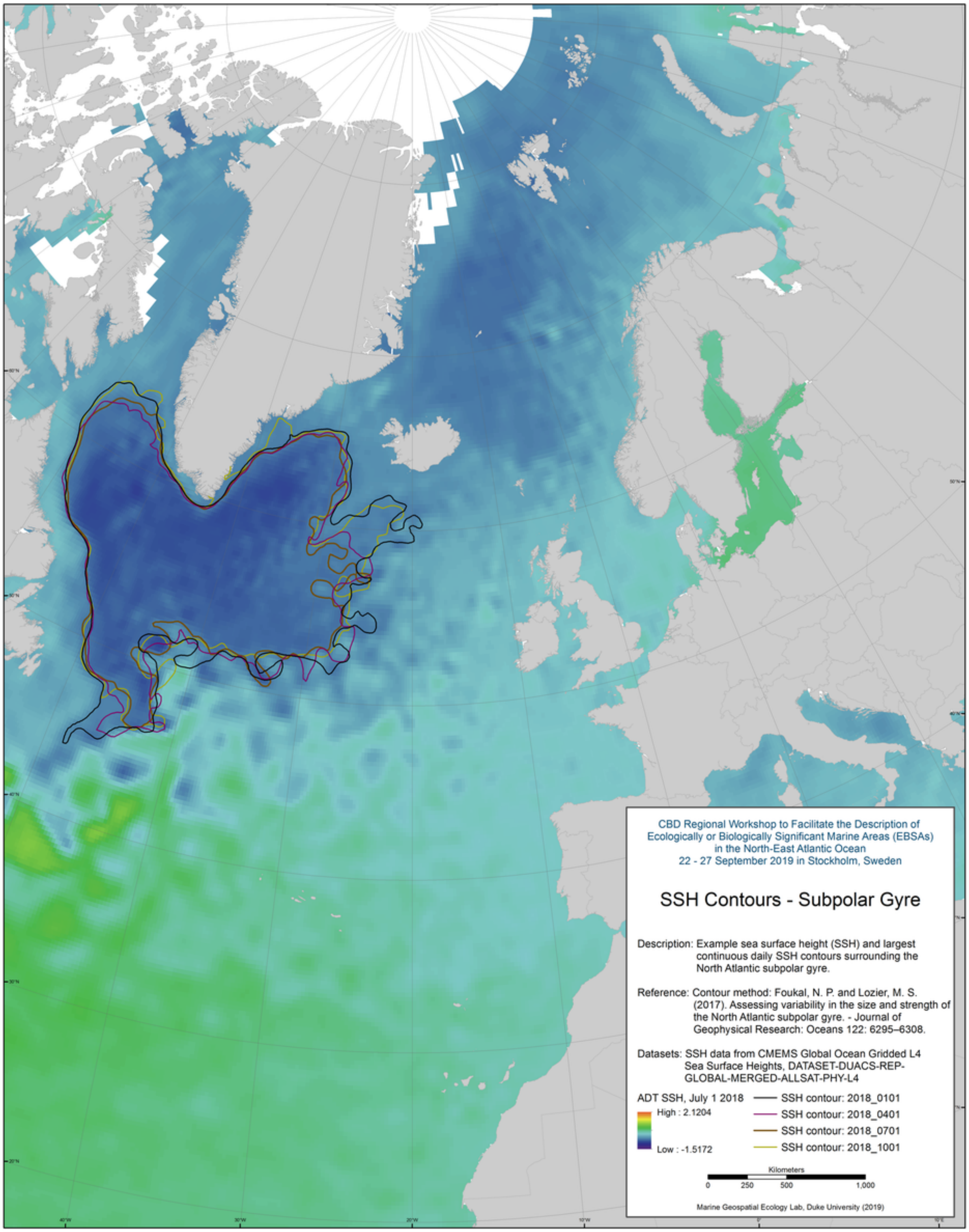

Figure 4.15-1 Sea surface height contours around the subpolar gyre

4.16 Arctic Ocean Physics Reanalysis - Sea Ice Coverage

"The Operational Ocean General Circulation Models describe routinely the 4D evolution of the physical ocean and sea ice variables, such as temperature, salinity, currents, sea level height, sea ice thickness and concentration. The TOPAZ reanalysis system assimilates available satellite and in situ observations available on the period 1991-2017.

The ARC-MFC V3 nominal system is the TOPAZ system based on an advanced sequential data assimilation method (the Ensemble Kalman Filter, EnKF) in its deterministic flavour (DEnKF, Sakov and Oke, 2009) and the Hybrid Coordinate Ocean Model (HYCOM version 2.2). This report describes the 27-years Arctic reanalysis product in the period 1991-2018 included. The variables delivered are all physical variables, including 3D currents, temperatures and salinities, 2D parameters for sea ice, mixed layer depth and sea surface heights. Sea surface temperature and sea surface heights are corrected for bias, with an online bias correction algorithm."

Data Source:
http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&view=details&product_id=ARCTIC_REANALYSIS_PHYS_002_003

Dataset : ARCTIC_REANALYSIS_PHYS_002_003

5 Important Areas

5.1 Marine Protected Areas

“Protected Planet is the most up to date and complete source of information on protected areas, updated monthly with submissions from governments, non-governmental organizations, landowners and communities. It is managed by the United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC) with support from IUCN and its World Commission on Protected Areas (WCPA).

It is a publicly available online platform where users can discover terrestrial and marine protected areas, access related statistics and download data from the World Database on Protected Areas (WDPA).”

Source: https://www.protectedplanet.net/c/world-database-on-protected-areas

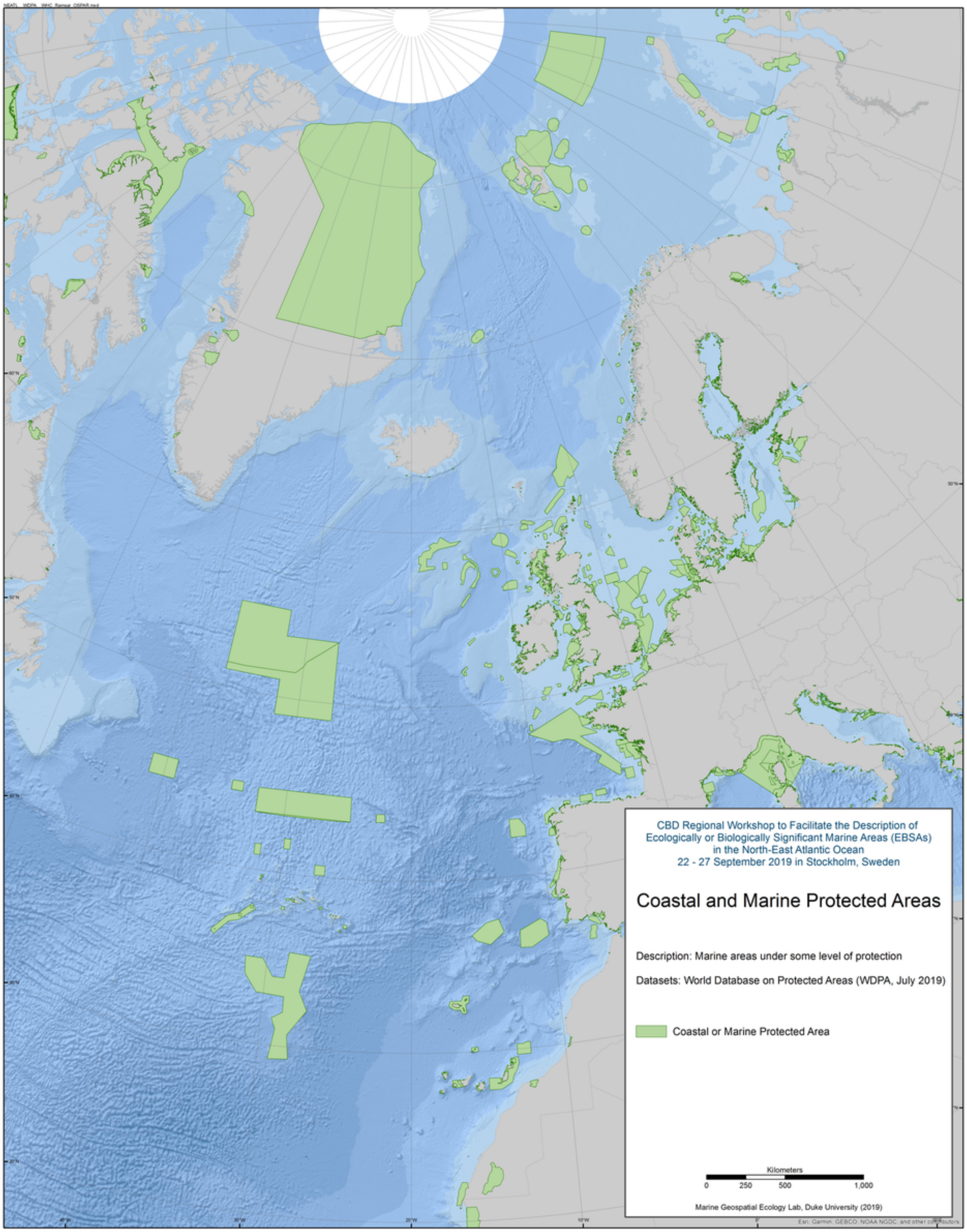

Figure 5.1-1 Coastal and marine protected areas

5.2 OSPAR Marine Protected Areas

“Within OSPAR, MPAs are understood as areas for which protective, conservation, restorative or precautionary measures have been instituted for the purpose of protecting and conserving species, habitats, ecosystems or ecological processes of the marine environment.

At the Ministerial Meeting in Sintra in 1998, OSPAR Ministers agreed to promote the establishment of a network of marine protected areas and, following a period of preparatory work, the 2003 OSPAR Ministerial Meeting in Bremen adopted Recommendation 2003/3 on a network of marine protected areas with the purpose of establishing an ecologically coherent network of MPAs in the North-East Atlantic that is well managed by 2016.The OSPAR network of MPAs aims:

- to protect, conserve and restore species, habitats and ecological processes which have been adversely affected by human activities;
- to prevent degradation of, and damage to, species, habitats and ecological processes, following the precautionary principle;
- to protect and conserve areas that best represent the range of species, habitats and ecological processes in the maritime area.

The progress made by Contracting Parties in identifying, selecting and establishing MPAs as components of the OSPAR network is summarised in the latest progress report on the network and a map describing the network”

Source: https://www.ospar.org/work-areas/bdc/marine-protected-areas

Dataset: WDPA July 2019 Marine, “name of designation” listed as “Marine Protected Area (OSPAR)”.

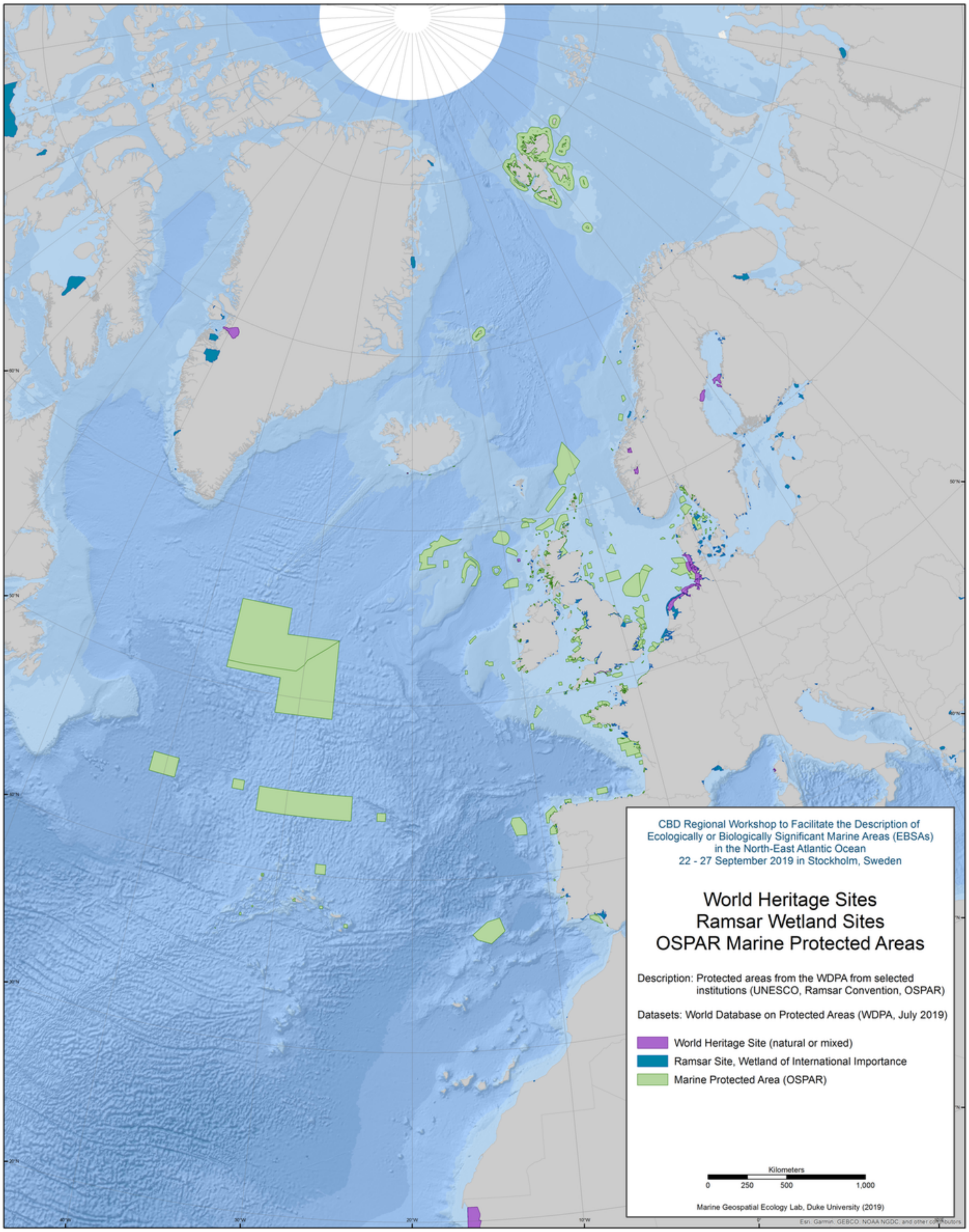

Figure 5.2-1 World Heritage Sites, Ramsar Sites, OSPAR Marine Protected Areas

5.3 Ramsar Wetlands of International Importance

"Under the Convention on Wetlands (Ramsar, 1971), each Contracting Party undertakes to designate at least one wetland site for inclusion in the List of Wetlands of International Importance (the "Ramsar List"). There are over 2,000 "Ramsar Sites" on the territories of over 160 Ramsar Contracting Parties across the world."

Source: https://www.ramsar.org/

Dataset: WDPA July 2019 Marine, "name of designation" listed as "Ramsar Site, Wetland of International Importance".

See figure 5.2-1 above.

5.4 UNESCO World Heritage Sites

"The United Nations Educational, Scientific and Cultural Organization (UNESCO) seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. This is embodied in an international treaty called the Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by UNESCO in 1972."

Source: https://whc.unesco.org

Dataset: WDPA July 2019 Marine, "name of designation" listed as "World Heritage Site (natural or mixed)".

See figure 5.2-1 above.

5.5 BirdLife International - Important Bird Areas

BirdLife Important Bird Areas (IBAs) have been used to inform the identification of EBSAs in previous EBSA regional workshops. Previously the data provided has been used to either support the designation of an EBSA for a range of taxa and habitats, or to identify EBSAs solely on the basis of bird data.

IBAs have been identified using several data sources:

1. Terrestrial seabird breeding sites are shown with point locality and species that qualifies at the IBA – see http://www.birdlife.org/datazone/site/search

2. Marine areas around breeding colonies have been identified based on literature review where possible, to guide the distance required by each species. Where literature is sparse or lacking, extensions have been applied on a precautionary basis. – see http://seabird.wikispaces.com/

3. Sites identified by satellite tracking data via kernel density analysis, first passage time analysis and bootstrapping approaches. - www.seabirdtracking.org

Together these IBAs form a network of sites of importance to coastal, pelagic, resident or migratory species. EBSA criteria of particular relevance are "important for life-history stages", "threatened species", "diversity" and "fragility". For further information, Google "IBAs vs EBSAs".

Dataset:
BirdLife International Marine E-Atlas, prepared by BirdLife International August 2019

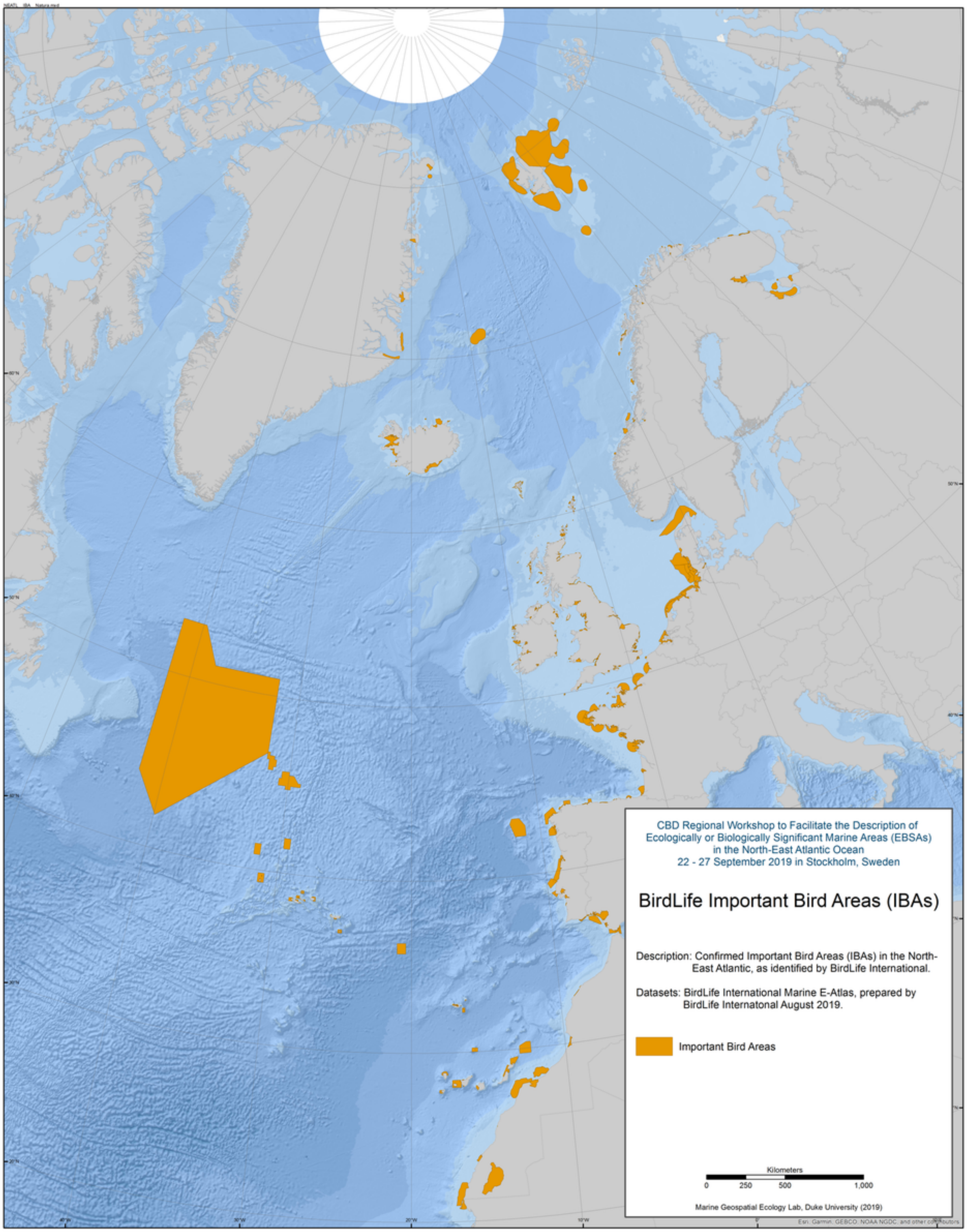

Figure 5.5-1 BirdLife important bird areas

5.6 Natura 2000 sites

"Natura 2000 is an ecological network composed of sites designated under the Birds Directive (Special Protection Areas, SPAs) and the Habitats Directive (Sites of Community Importance, SCIs, and Special Areas of Conservation, SACs).

The European database on Natura 2000 sites consists of a compilation of the data submitted by Member States to the European Commission. This European database is generally updated once per year, so as to take into account any updating of the content of the national databases by Member States. However, the release of a new EU-wide database does not necessarily entail that a particular national dataset has recently been updated.

The descriptive data in the European database are based on the information that national authorities have submitted, for each of the Natura 2000 sites, through a site-specific standard data form (SDF). Amongst other site-specific information, the standard data form provides the list of all species and habitat types for which a site is officially designated.

The spatial data (borders of sites) submitted by each Member State are validated by the European Environment Agency (EEA), including as regard their consistency with the descriptive data."

Sources:

https://www.eea.europa.eu/data-and-maps/data/natura-10

http://natura2000.eea.europa.eu/

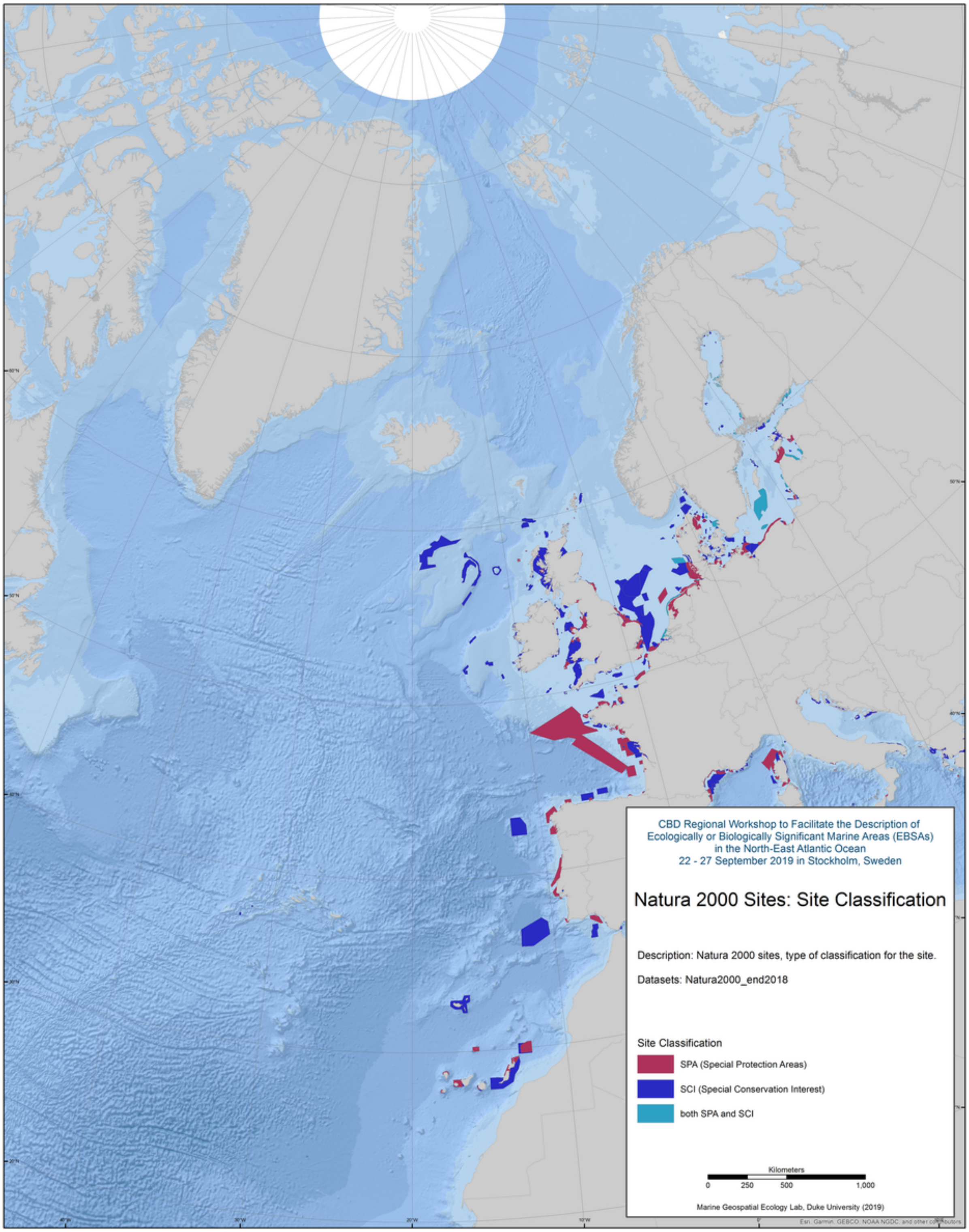

Figure 5.6-1 Natura 2000 Sites

5.7 ICES Vulnerable Marine Ecosystems (VMEs) Indicators

"VME data portal is a central portal for data on the distribution and abundance of Vulnerable Marine Ecosystems (VMEs), (and organisms considered to be indicators of VMEs) across the North Atlantic that has been set up by the Joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC) and is hosted by ICES. The database is comprised of 'VME habitats' and 'VME indicators' records. The VME database serves multiple purposes; ICES uses it for providing scientifically-robust advice on the distribution of VMEs and recommending possible management solutions such as bottom fishing closures within NEAFC (North East Atlantic Fisheries Commission) waters to protect VMEs."

Source:
http://gis.ices.dk/geonetwork/srv/eng/catalog.search#/metadata/50051026-435d-4554-9692-4cb2f62ab5f9

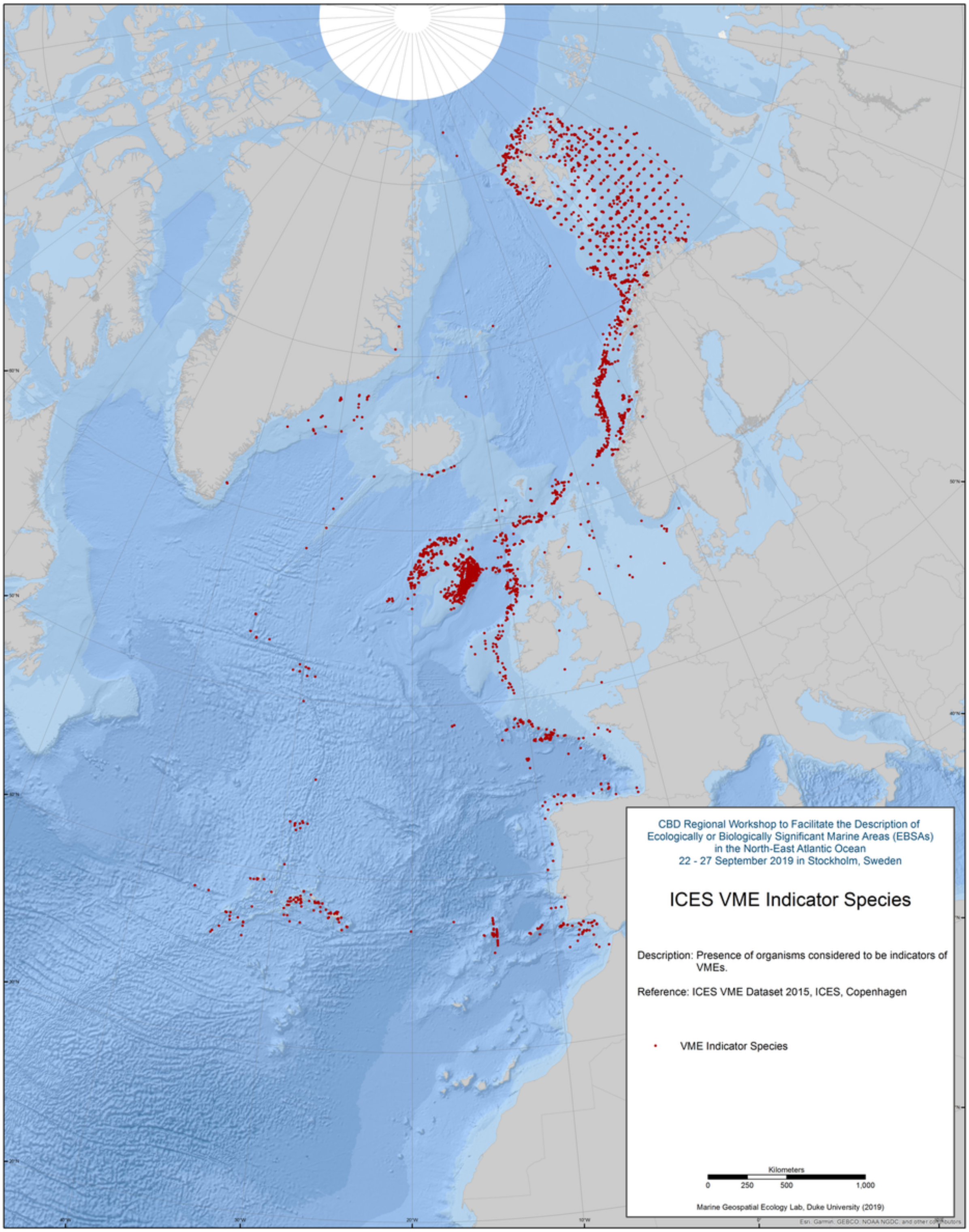

Figure 5.7-1 ICES vulnerable marine ecosystem indicator species

5.8 NEAFC Regulatory Areas, Bottom Fishing, & VME Closures

"This map shows areas defined as existing bottom fishing areas (in green). Any bottom fishing carried out within the NEAFC Regulatory Area other than in the bottom fishing areas, must comply with the conditions set out in the Exploratory Bottom Fishing Protocol for New Bottom Fishing Areas, details of which can be found in Recommendation 19:2014 as amended by Recommendation 09:2015 and Recommendation 10:2018 on the Protection of Vulnerable Marine Ecosystems." Areas in red are closed to bottom fisheries with no possibility of exploratory bottom fisheries.

"Details of the existing VME closures to bottom fishing are found in Recommendation 19:2014; Recommendation on the protection of vulnerable marine ecosystems in the NEAFC Regulatory Area. This binding Recommendation includes the lists of VME indicator species as well as the coordinates of all the existing closed areas."

https://www.neafc.org/system/files/Rec.19-2014_as_amended_by_09_2015_and_10_2018_fulltext-and-map.pdf

"NEAFC provides statistics to, and takes advice from, the International Council for the Exploration of the Sea (ICES) http://ices.dk. NEAFC also uses the areas defined by ICES for its maps. After taking advice and formal adoption, NEAFC may define protected Vulnerable Marine Ecosystems (VME) and set up Closures to ensure the sustainability of the fishing grounds."

Sources:
https://www.neafc.org/page/existingfishingareas
https://www.neafc.org/managing_fisheries

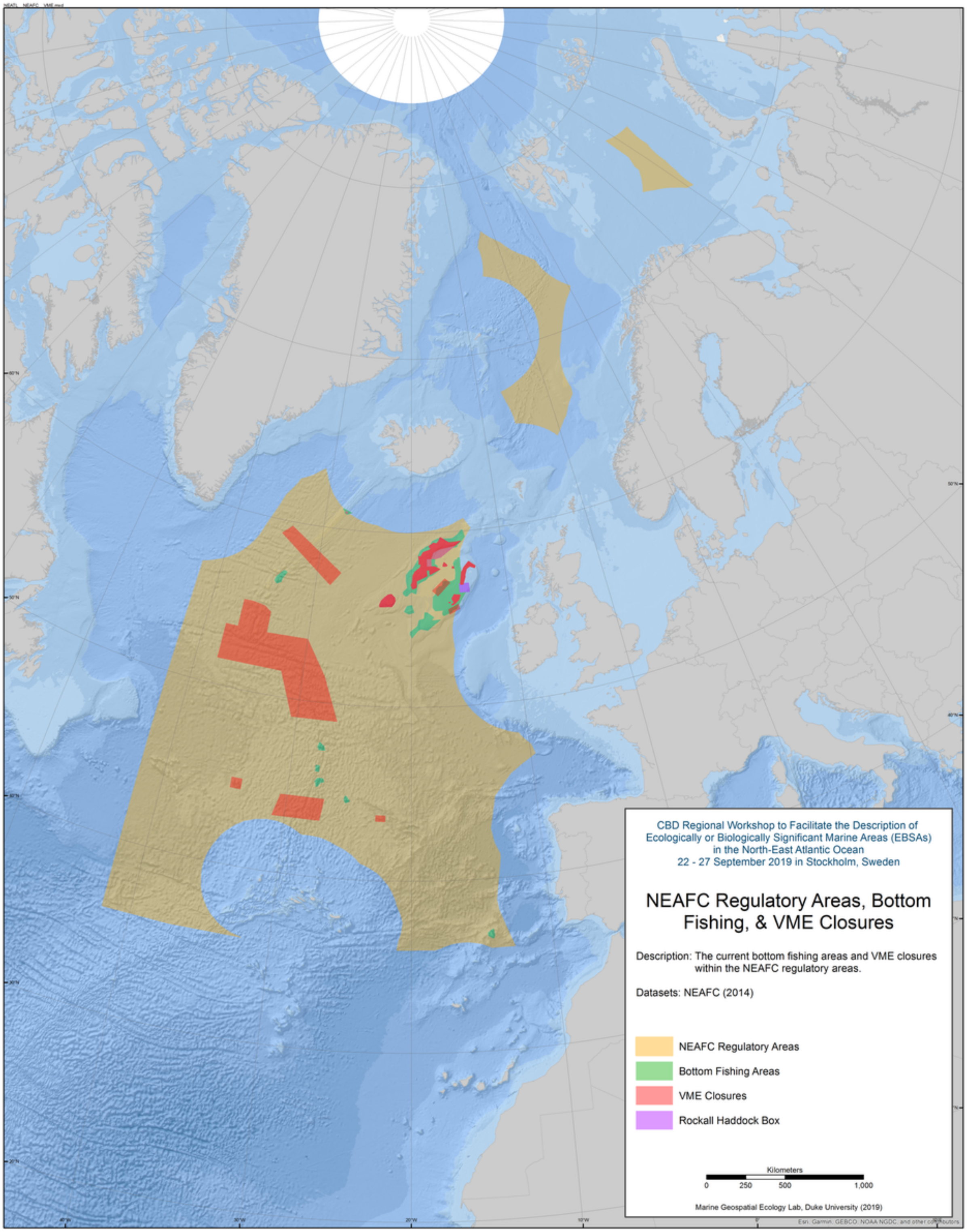

Figure 5.8-1 NEAFC regulatory areas, bottom fishing areas, and VME closures

6 Additional Literature, Data Reports and Data Portals

There are many data reports from ongoing scientific research programs and planning processes were recommended for review by workshop attendees. Additional literature, data reports and data portals from across the region were reviewed and summarized below.

6.1 Joint OSPAR/NEAFC/CBD Scientific Workshop on the Identification of Ecologically or Biologically Significant Marine Areas (EBSAs)

The OSPAR Commission and the North-East Atlantic Fisheries Commission (NEAFC) in collaboration with the Secretariat of the Convention on Biological Diversity, convened a regional workshop on Ecologically or Biologically Significant Areas (EBSAs) in Hyeres, France in 2011. The workshop aimed at the description of EBSAs in North East Atlantic, and resulted in description of ten areas meeting the EBSA criteria. The workshop was not convened through a formal process of the Convention on the Biological Diversity (CBD) and the scientific and technical preparation was not coordinated by the CBD Secretariat. Thus, the CBD Secretariat was not involved in the invitation of participants nor in the preparation of scientific information. Subsequently a request for ICES advice on workshop proposals was commissioned by OSPAR and NEAFC. The resultant interim advice was considered in 2013. OSPAR and NEAFC requested ICES to conclude their advice and prepare an updated proforma for the areas that were considered meeting the criteria. As a result, ICES produced revised advice and updated proforma.

In 2018, the OSPAR Commission agreed to approach NEAFC for a joint request for collaboration with the CBD to convene a regional workshop on EBSAs. It was agreed that such a process should consider the information collated for the previous EBSA process in 2011 and 2013, where this would be appropriate for the scope of the workshop. The 2011 workshop outputs and consecutive ICES advice are provided with the aim of making the previously collated information available.

Datasets that supported the 2011 workshop have been folded into the above data report. Here is a list of datasets that were made available for use at the 2011 workshop:

Jurisdictional boundaries:

- EEZs, territorial waters

- Extended continental shelf subject to submissions to the Commission of the Limits of the Continental Shelf under UNCLOS Article 76)
- Existing spatial management measures (OSPAR, NEAFC)
- Proposed spatial management measures (Submitted to this workshop)

Ecological and geographic data:

- Seamount base areas, Yesson et al 2011
- Aquamaps predictive species range maps for
    - all available species (>11‘500);
    - IUCN endangered + vulnerable;
    - OSPAR List of Threatened and Declining Species
- The Joint Nature Conservation Committee’s data on OSPAR Threatened and Declining Habitats
    - Seamounts, Hydrothermal Vents, Carbonate Mounds, Lophelia pertusa, Sponges
- Coral habitat suitability maps
    - Lophelia pertusa and Antipatharia (black corals)
- Octocorallia diversity maps

“Report of Joint OSPAR/NEAFC/CBD Scientific Workshop On EBSAs” (UNEP/CBD/SBSTTA/16/INF/5)

Source: https://www.cbd.int/doc/meetings/sbstta/sbstta-16/information/sbstta-16-inf-05-en.pdf

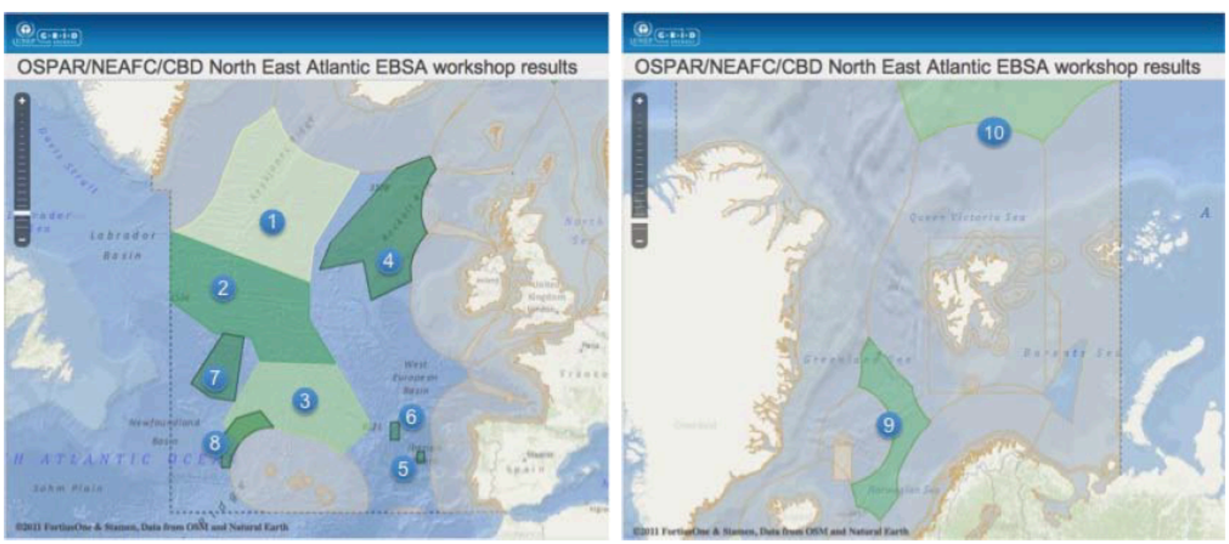

Figure 6.1-1 Map of Workshop EBSA proposals

(Figure 1 from the workshop report)

ICES Report of the Workshop to Review and Advise on EBSA Proposed Areas (WKEBSA)

"WKEBSA reviewed the ecological evidence supporting the ten proposed EBSAs from the OSPAR/NEAFC/CBD Workshop of September 2011, as presented in the proformas attached as Annexes to that Report. The review looked primarily at the references cited in the proformas, but often augmented those references with other publications and data sources. In nine of the ten proposed EBSAs, WKEBSA came to different conclusions than were contained in the OSPAR/NEAFC/CBC Workshop, with regard to the rankings on the CBD EBSA criteria."

Reference:
ICES. 2013. Report of the Workshop to Review and Advise on EBSA Proposed Areas (WKEBSA), 27 - 21 May 2013, ICES HQ, Copenhagen, Denmark. ICES CM 2013/ACOM:70. 127 pp.

ICES Advice 1.5.6.5: "OSPAR/NEAFC special request on review of the results of the Joint OSPAR/NEAFC/CBD Workshop on Ecologically and Biologically Significant Areas (EBSAs)"

"ICES reviewed the ecological evidence supporting the ten proposed ecologically and biologically significant areas (EBSAs) from the OSPAR/NEAFC/CBD Workshop of September 2011, as presented in the annexes to that report. The review applied standard ICES practices and used primarily the references cited in the relevant annexes, but augmented those references with other publications and data sources. In nine of the ten proposed EBSAs, ICES came to different conclusions than were contained in the OSPAR/NEAFC/CBD Workshop report, with regard to the rankings of the Convention on Biological Diversity (CBD) EBSA criteria."

Source:
https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2013/Special%20requests/OSPAR-NEAFC%20EBSA%20review.pdf

ICES Advice 1.5.6.7: "OSPAR/NEAFC special request on review and reformulation of four EBSA Proformas"

ICES provided advice to OSPAR and NEAFC in June 2013 (OSPAR/NEAFC special request on review of the results of the Joint OSPAR/NEAFC/CBD Workshop on Ecologically and Biologically Significant Areas (EBSAs) (ICES Advice 2013 Section 1.5.6.5).

Following discussion with OSPAR and NEAFC, ICES (using experts of the review group) agreed to reformulate and revise four of the proposed EBSAs and provide new updated maps. The material consists of scientifically updated Proformas for the following areas proposed as meeting the EBSA criteria:

- Mid-Atlantic Ridge North of the Azores and South of Iceland
- Charlie-Gibbs Fracture Zone (and the Sub-Polar Front)
- The Hatton and Rockall Banks and the Hatton-Rockall Basin
- The Arctic Ice habitat – multiyear ice, seasonal ice – marginal ice zone

Source:
http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2013/Special%20requests/OSPAR-NEAFC%20EBSA%202nd%20Round.pdf

6.2 ASCOBANS Conservation Plan for Harbour Porpoises in the North Sea

"Harbour porpoises (Phocoena phocoena, Linnaeus 1758) are widely distributed in shelf waters of the temperate North Atlantic and of the North Pacific Oceans and in some semienclosed seas, such as the Black and Baltic Seas. The North Sea is an important habitat for harbour porpoises in the North East Atlantic. Harbour porpoises are exposed to a number of anthropogenic pressures (e.g. Bjørge & Donovan 1995) and are listed as threatened or endangered in several international conservation instruments (e.g. EC Habitats and Species Directive 1992 (92/43/EEC), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), Convention on Migratory Species (Bonn Convention), IUCN Red List of Threatened Species).

The 5th International Conference for the Protection of the North Sea (Bergen, Norway, 20-21 March 2002) called for a recovery plan for harbour porpoises in the North Sea to be developed and adopted (Paragraph 30, Bergen Declaration). Germany volunteered in 2003 to draft a recovery plan1 within the framework of ASCOBANS and in association with Range State Norway.

This document builds upon considerable work by a number of people. It summarises the current state of knowledge about North Sea harbour porpoises and the risk factors affecting them; detailed information is given in Eisfeld & Kock (2006). The Conservation Plan aims at achieving and maintaining a favourable conservation status, specifically by suggesting a series of priority actions."

Authors:
Peter J.H. Reijnders, Greg P. Donovan, Arne Bjørge, Karl-Hermann Kock, Sonja Eisfeld, Meike Scheidat & Mark L. Tasker

6.3 SAMBAH Project Final Report on Harbour Porpoise

SAMBAH targeted the Baltic Sea population of harbour porpoise (Phocoena phocoena). This population is small and has been drastically reduced during the last decades. The species is listed in Annexes II and IV of the EC Habitats Directive as well as in the national red lists of several Member States. When SAMBAH started, the conservation status of the species in combination with a complex of threats necessitated improved methodologies for collecting data on population size and distribution, and fluctuations over time. The overall objective of the project has been to launch a best practice methodology for this purpose and to provide data for a reliable assessment of distribution and preferred habitats of the species. This would make possible an appropriate designation of SCIs for the species within the Natura 2000 network as well as the implementation of other relevant mitigation measures.

SAMBAH objective 1 has been to estimate densities, produce distribution maps and estimate abundances of harbour porpoises in the project area. Density and Abundance estimates have been produced by season for the whole study area and within country. Distribution maps showing probability of detection have been produced per month while maps showing the spatial variation in density have been produced per season.

SAMBAH objective 2 has been to identify hotspots, habitat preferences, and areas with higher risk of conflicts with anthropogenic activities for the Baltic Sea harbour porpoise. In Swedish waters, these results has been used to identify appropriate areas for protection, and within these areas to suggest appropriate management of anthropogenic activities with known or potential negative impact.

SAMBAH objective 3 has been to increase the knowledge about the Baltic Sea harbour porpoise among policymakers, managers, stakeholders, users of the marine environment and the general public, in the EU Member States bordering the Baltic Sea.

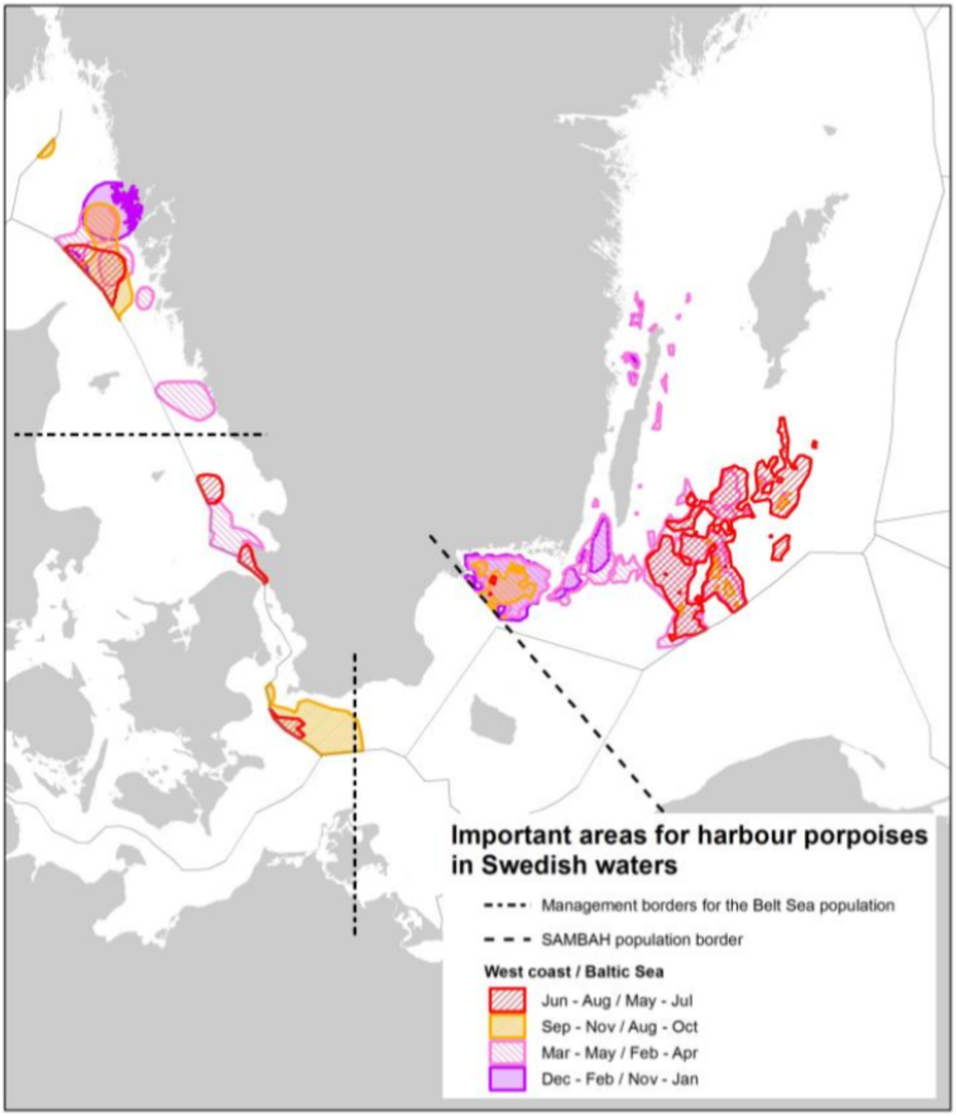

Figure 6.3-1 Important areas for harbour porpoises in Swedish waters

Original Caption: "Figure 10 Important areas for harbour porpoises in Swedish waters"

SAMBAH objective 4 has been to implement best practice methods for cost efficient, large-scale surveillance of harbour porpoises in a low density area. The implementation of coherent methods throughout the distribution range of the Baltic Sea harbour porpoise aimed at facilitating future monitoring actions in order to follow up the effects of conservations measurements taken on a local regional, national or transnational scale.

Report download: http://www.sambah.org/SAMBAH-Final-Report-FINAL-for-website-April-2017.pdf

6.4 Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) Final Report

"The aims of project CODA were to estimate the abundance and investigate the habitat use of cetacean species in European Atlantic waters beyond the continental shelf and to develop further a management framework (procedure) for determining safe bycatch limits and to provide indicative calculations for the common dolphin in European Atlantic waters. The results were intended to inform assessments of conservation status of all cetacean species, inform assessments of the impact of bycatch of common dolphin, and inform assessments of the impact of anthropogenic sound on deep-diving whales.

State-of-the-art visual survey methods were used on five survey ships to collect data for abundance estimation along 9,651 km of transects in a 968,000 km2 survey area off the continental shelves of Britain, Ireland, France and Spain in July 2007. Design-based and/or model-based estimation methods, appropriate to the data, were used to estimate abundance. Best estimates of abundance were: 116,709 (coefficient of variation = 0.34) common dolphins; 67,414 (0.38) striped dolphins; 19,295 (0.25) bottlenose dolphins; 25,101 (0.33) long-finned pilot whales; 2,077 (0.20) sperm whales; 6,765 (0.99) minke whales; 9,019 (0.11) fin whales; and 6,992 (0.25) beaked whales."

Final Report:
http://biology.st-andrews.ac.uk/coda/documents/CODA_Final_Report_11-2-09.pdf
http://biology.st-andrews.ac.uk/coda/

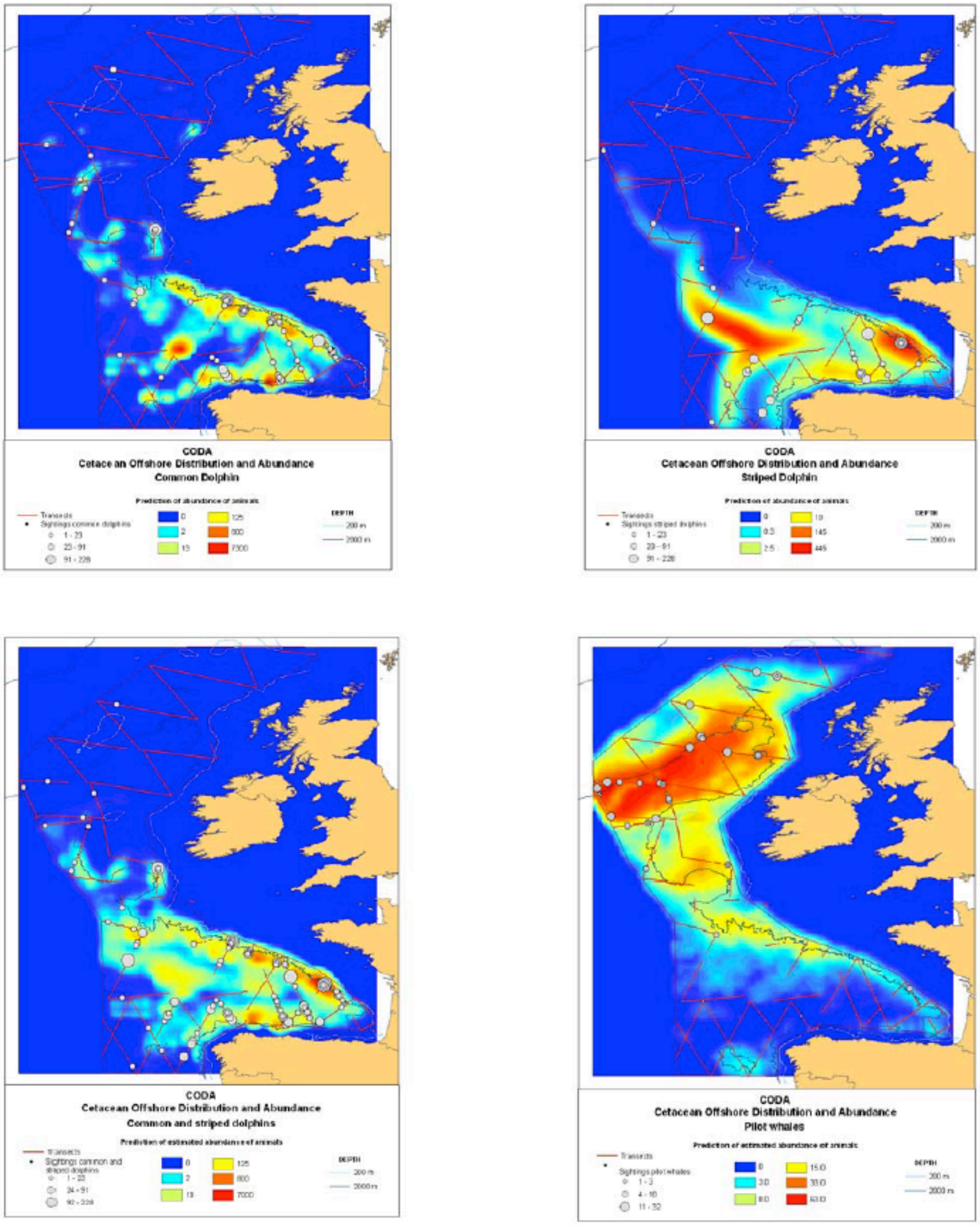

Figure 6.4-1 Surface maps of smoothed predicted abundance of animals of common dolphin, striped dolphin, common and striped dolphins combined, and long-finned pilot whales

Original Caption: "Figure 4: Surface maps of smoothed predicted abundance of animals of common dolphin, striped dolphin, common and striped dolphins combined, and long-finned pilot whales."

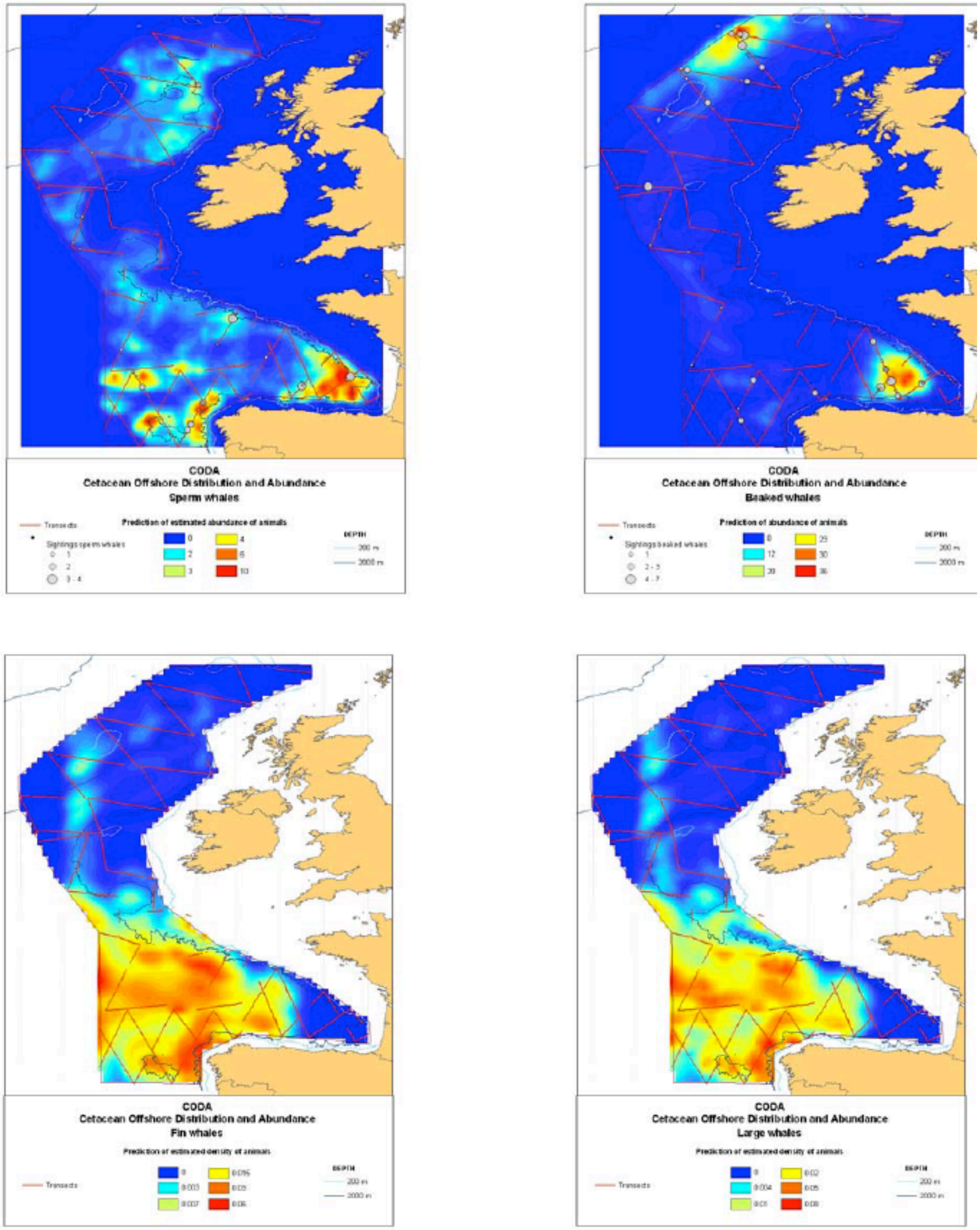

Figure 6.4-2 Surface map of smoothed predicted abundance of animals of sperm whales, beaked whales and fin whales, and large baleen whales.

Original Caption: Figure 5: Surface map of smoothed predicted abundance of animals of sperm whales, beaked whales and fin whales, and large baleen whales.

6.5 Marine Mammals and Megafauna in Irish Waters - Behaviour, Distribution and Habitat Use

"Irish waters are internationally important for cetaceans (whales, dolphins and porpoises), with 24 species recorded to date (Berrow, 2001). These range from the harbour porpoise, the smallest species in European waters, to the blue whale, the largest animal to ever have lived on Earth. Some species are relatively abundant and widespread while others are extremely rare and have never been sighted in Irish waters, only known from carcasses stranded on the Irish coast. At least 12 cetacean species are thought to calve within the Irish Exclusive Economic Zone (EEZ)1 (Berrow, 2001). Marine mammals, including cetaceans and seals, represent almost 50% of the Irish native mammal fauna and, thus, Ireland has a significant conservation obligation to them and their habitats. In 1991 the Irish government recognised the importance of Ireland for cetaceans by declaring all Irish waters within the EEZ a whale and dolphin sanctuary (Rogan and Berrow, 1995).

This diversity of cetacean species in Ireland reflects the range of marine habitats, which extend to 200 nautical miles (nmls) (370km) offshore and comprise an area of 453,000km2. This is a little over six times the area of the land of Ireland. These habitats range from shallow continental shelf waters to shelf slopes, deep-water canyons, offshore banks, carbonate mounds and associated deep water reef systems and abyssal waters."

Source:
https://oar.marine.ie/bitstream/handle/10793/869/No.%2014.%20PBA%20Precast%20WP1%20Report.pdf

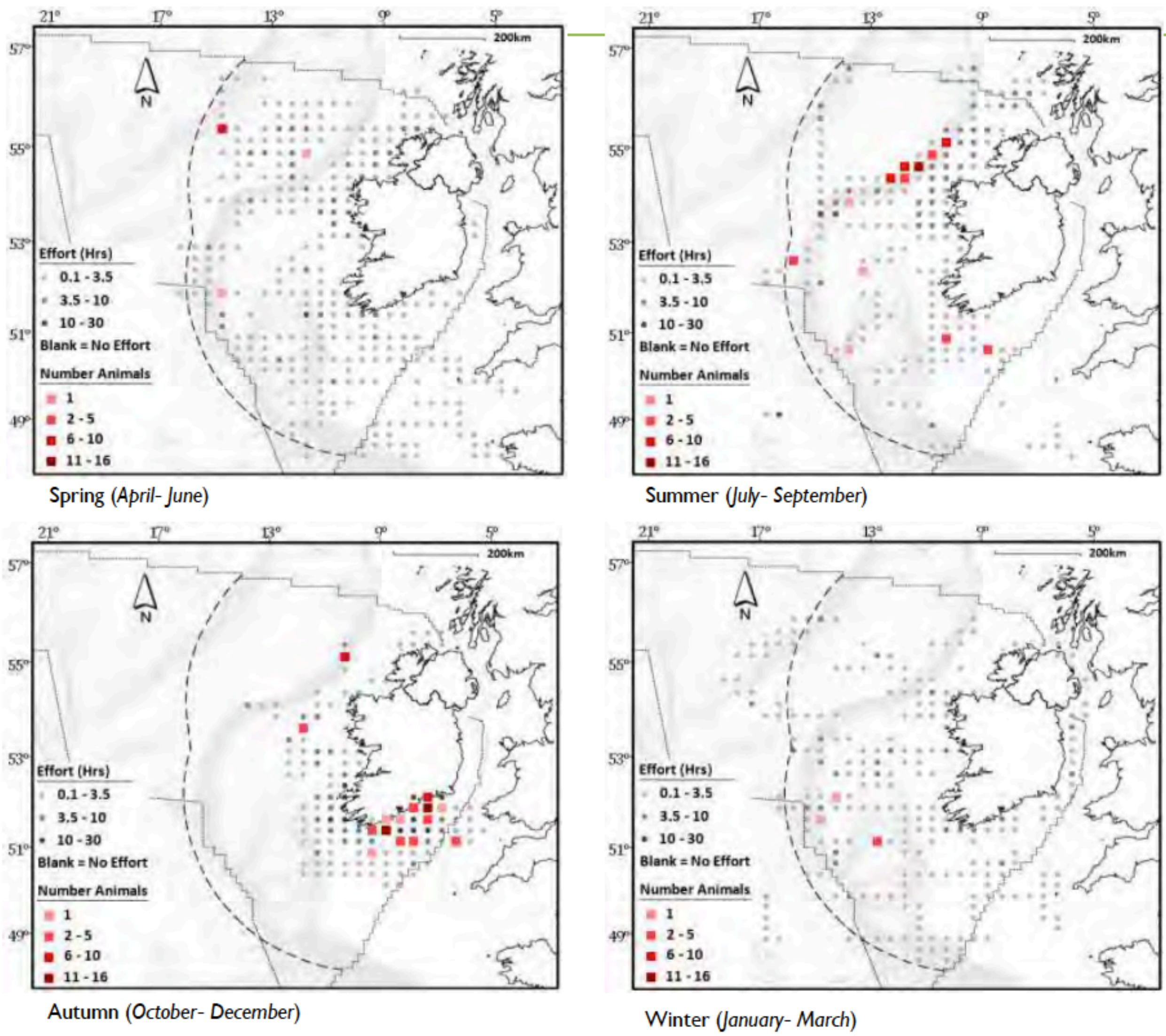

Figure 6.5-1 Seasonal sightings distribution and total numbers of individuals of fin whale

Original Caption: "Figure 4.3.4 Seasonal sightings distribution and total numbers of individuals of fin whale recorded on and off effort per 1/4 ICES statistical rectangle."

6.6 ICES Working Group on Marine Mammal Ecology reports

"ICES Working Group on Marine Mammal Ecology (WGMME) provides scientific advice in relation to marine mammals. Annually, WGMME examines any new information on population sizes, population/stock structure and management frameworks for marine mammals and assess how these can contribute to the regulatory requirements of

Contracting Parties. We also review information on anthropogenic impacts, including their mitigation, with a focus on bycatch (and in this respect linking with WGBYC) and, in particular, marine industries."

Source:
https://www.ices.dk/community/groups/Pages/WGMME.aspx

http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/EPDSG/2019/WGMME/wgmme_2019.pdf

Reference:
ICES (2019), Working Group on Marine Mammal Ecology (WGMME). ICES Scientific Reports. 1:22. 131 pp. http://doi.org/10.17895/ices.pub.4980

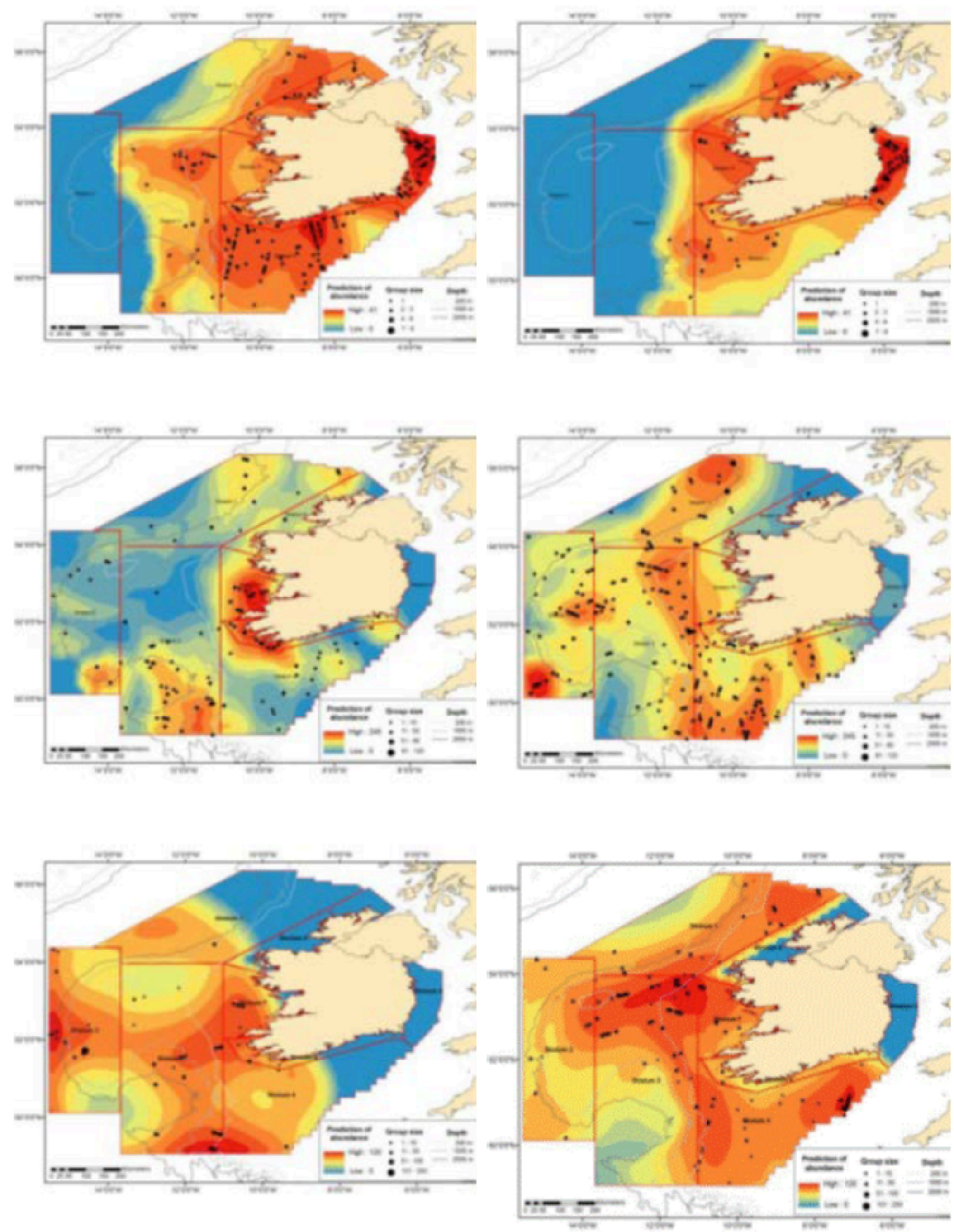

Figure 6.6-1 Predicted summer (left panel) and winter (right panel) distribution of harbour porpoise (top), bottlenose dolphin (middle), common+common/striped dolphin (bottom).

Original Caption: "Figure 19. Predicted summer (left panel) and winter (right panel) distribution of harbour porpoise (top), bottlenose dolphin (middle), common+common/striped dolphin (bottom). Note that scale on density estimates is a relative figure, which varies for each species and does not represent the absolute abundance of animals."

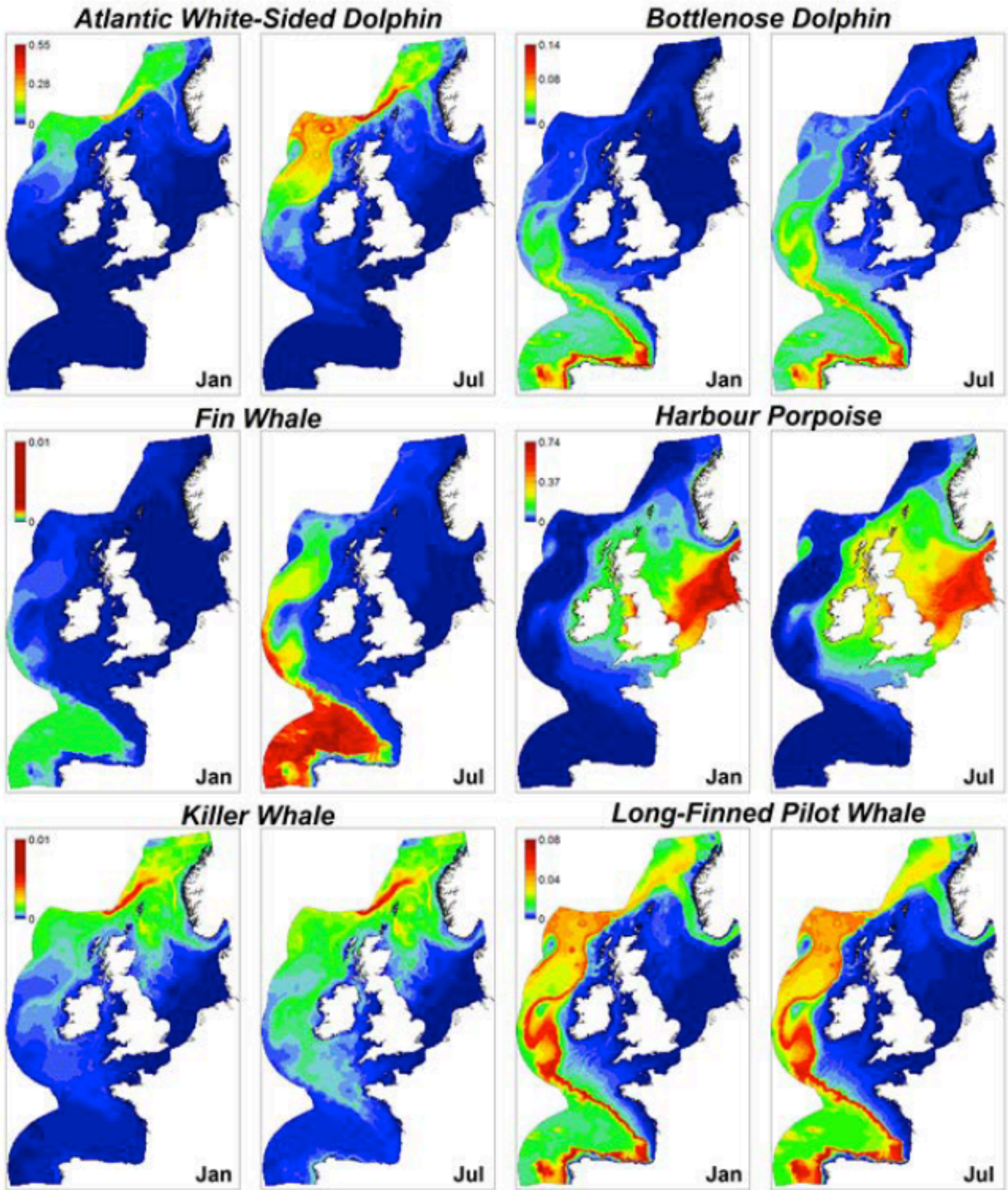

Figure 6.6-2 Predicted average January and July densities (animals per km2) for white-sided dolphin, bottlenose dolphin (offshore ecotype), fin whale, harbour porpoise, killer whale and long-finned pilot whale

Original Caption: "Figure 26. Predicted average January and July densities (animals per km2) for white-sided dolphin, bottlenose dolphin (offshore ecotype), fin whale, harbour porpoise, killer whale and long-finned pilot whale in the Northeastern North Atlantic. A different colour gradient is used for each species."

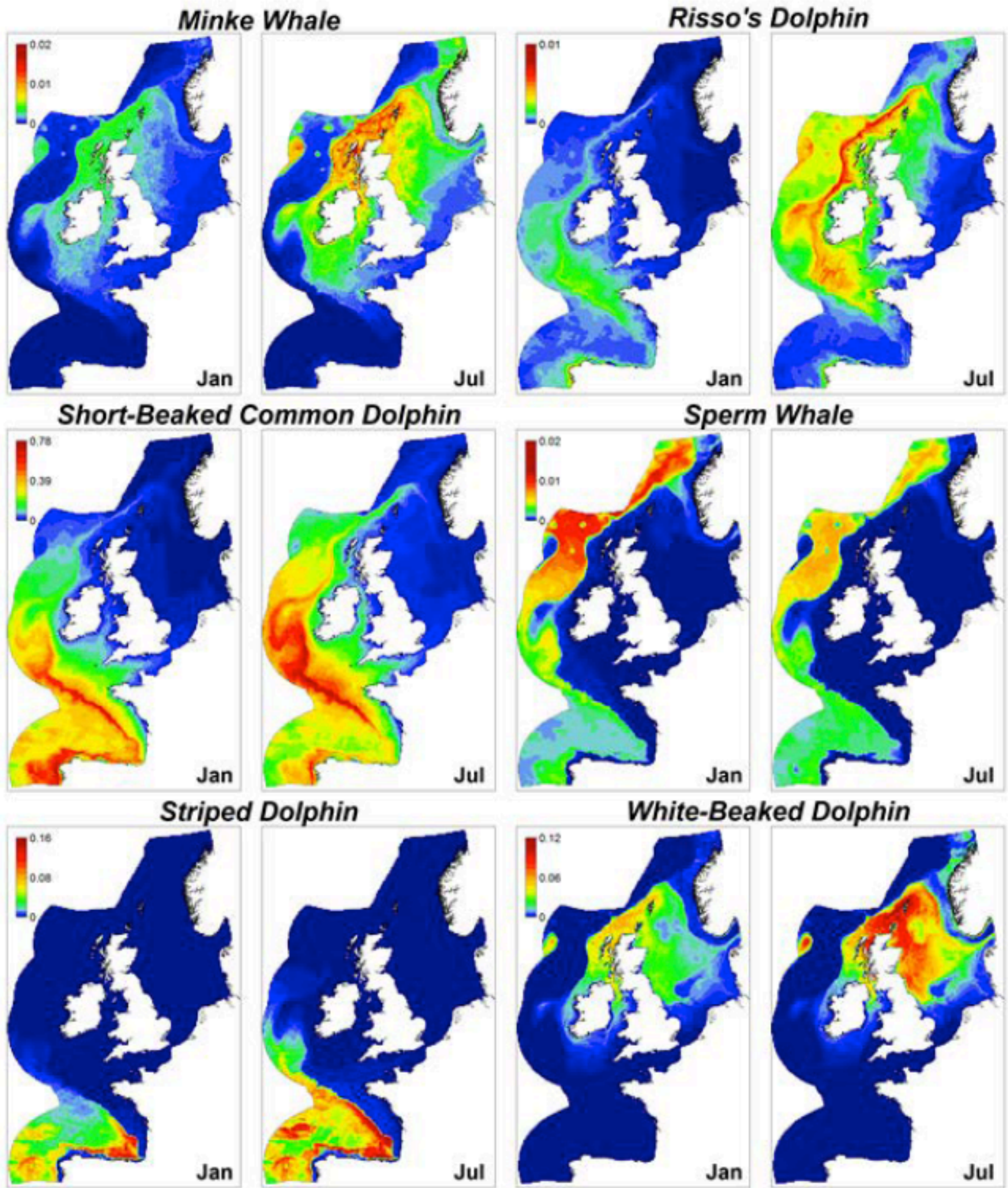

Figure 6.6-3 Predicted average January and July densities (animals per km2) for minke whale, Risso's dolphin, short-beaked common dolphin, sperm whale, striped dolphin and white-beaked dolphin

Original Caption: "Figure 27. Predicted average January and July densities (animals per km2) for minke whale, Risso's dolphin, short-beaked common dolphin, sperm whale, striped dolphin and white-beaked dolphin in the Northeastern North Atlantic. A different colour gradient is used for each species."

6.7 ICES Report on Ocean Climate (2017)

Introduction:
"ICES Report on Ocean Climate (IROC) combines decades of ocean observations across the North Atlantic ICES region to describe the current status of sea temperature and salinity and atmospheric conditions, as well as observed trends and recent variability.

The focus of the IROC is the observed variability of the upper ocean (the upper 1000 m). Information from the longest time-series is synthesized into an overview of changes across the ICES areas of the North Atlantic and Nordic seas. The introductory sections contain gridded fields constructed by optimal analysis of the Argo float data distributed by the Coriolis Data Centre in France. In addition to the temperature and salinity measurements, complementary datasets are included, such as sea level pressure (SLP), air temperature, and ice cover. An estimate of the Subpolar Gyre Index, included for the first time in 2016, is also provided. The main body of the report consists of short summaries of the variability in the intermediate and deep waters of the North Atlantic across regions."

Source:
http://prep.ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/CRR345.pdf

Reference:
González-Pola, C., Larsen, K. M. H., Fratantoni, P., and Beszczynska-Möller, A. (Eds). 2018. ICES Report on Ocean Climate 2017. ICES Cooperative Research Report No. 345. 119 pp. http://doi.org/10.17895/ices.pub.4625

6.8 ICES Ecosystem Overviews

These overviews provide a description of the ecosystems, identify the main human pressures, and explain how these affect key ecosystem components.

- Baltic Sea
- Barents Sea
- Bay of Biscay and the Iberian Coast
- Celtic Seas
- Greater North Sea
- Icelandic Waters
- Norwegian Sea

Source:
http://www.ices.dk/community/advisory-process/Pages/Ecosystem-overviews.aspx

6.9 ICES Fisheries Overviews

Fisheries overviews summarize fishing activities at ICES ecoregions, including which countries are catching what species, the various fishing methods being used, and how stocks are managed.

- Baltic Sea
- Celtic Seas
- Greater North Sea

Source:
https://www.ices.dk/community/advisory-process/Pages/fisheries-overviews.aspx

6.10 ICES Stock Assessment Database

The ICES ecosystem advice is based on assessment results that are presented in stock assessment standard graphs and data tables. Data and plots are available in ICES Stock Assessment Database.

The ICES Stock Assessment Database data are available for the analytically assessed ICES stocks from 2014 onwards. Plots and data from previous assessments will be made available when the data and settings have been quality controlled.

Source:
ICES Stock Assessment Database - http://standardgraphs.ices.dk
ICES Stock Information Database - http://sid.ices.dk/default.aspx
ICES Stock Assessment Mapper - http://gis.ices.dk/sf/index.html?widget=visa

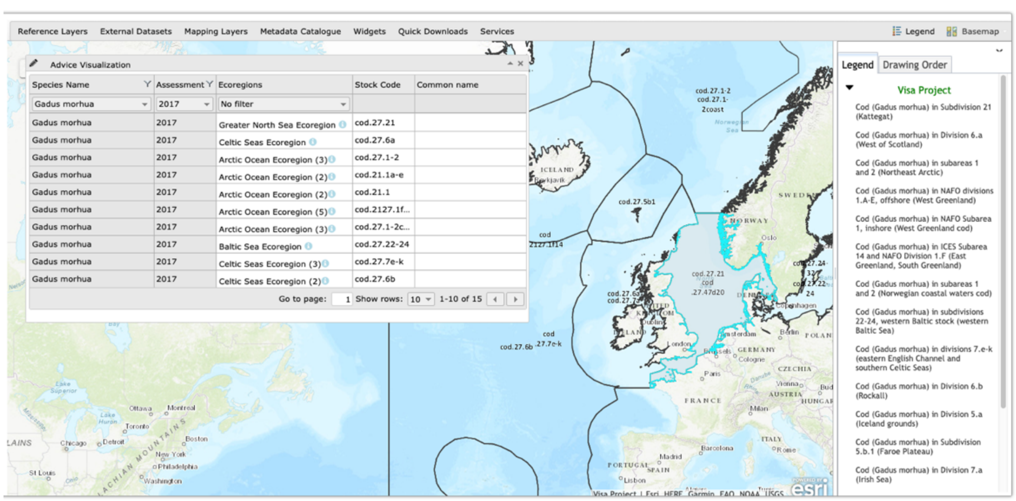

Figure 6.10-1 ICES stock assessment mapping tool

6.11 ICES Fish Predation

"Understanding species interactions is key to understanding more widely how marine ecosystems function. With the contents of fish stomachs, scientists can gain knowledge on what species are feeding on, which in turn can be used as input to multispecies and ecosystem models.

This data portal collates stomach data from the ICES year of the stomach:

- 1981, 1985-1986, - a few key commercial species in the North Sea.
- 1991 the 2nd year of the stomach ran

In addition, this portal now includes data collated under the EU Tender MARE/2012/02 which focused on the Baltic Sea Region and specifically Cod."

Portal:
https://www.ices.dk/marine-data/data-portals/Pages/Fish-stomach.aspx

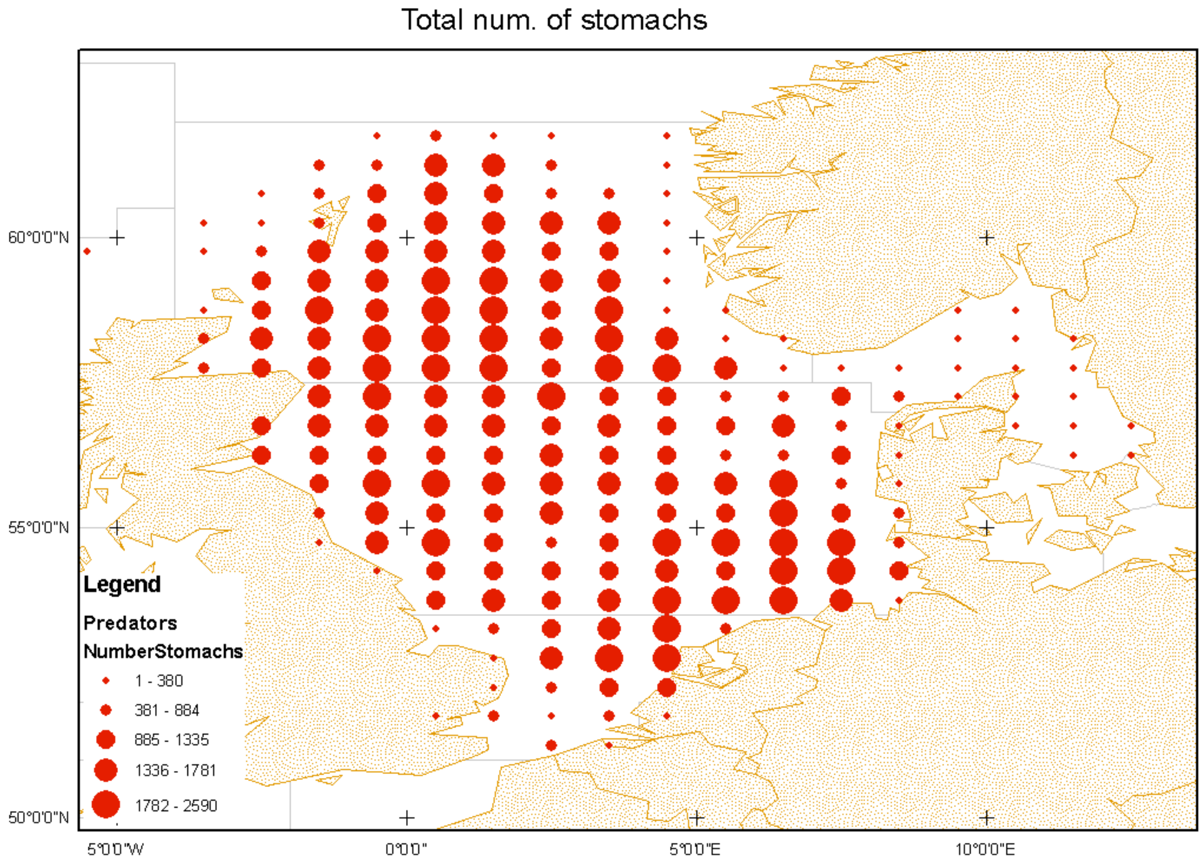

Figure 6.11-1 Geographical distribution of ICES fish stomach database samples

6.12 ICES Workshop on Ecological Valuing of Areas of the Barents Sea (WKBAR)

"ICES WKBAR met to provide the scientific basis to determine the ecological value of areas of the Barents Sea by formulating a definition of ecological value, developing criteria, and a framework to identify areas of special ecological value in the Barents Sea, and exemplify the potential for practical use in management."

Source:
http://ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/IEASG/2019/WKBAR%202019.pdf

Reference:
ICES (2019), Workshop on ecological valuing of areas of the Barents Sea (WKBAR). ICES Scientific Reports. 1:39. 34 pp. http://doi.org/10.17895/ices.pub.5444

6.13 ICES Report of the Working Group on Fish Distribution Shifts (WKFISHDISH)

"This report documents the work undertaken during the WKFISHDISH workshop which took place at ICES headquarters (Copenhagen) on November 22nd 25th 2016. The purpose of this workshop was to inform an answer to a request from the EU Commission about the distribution shifts of commercial fish stocks in relation to TAC management areas which ICES tackled in two consecutive steps: (1) data analysis carried out by the ICES secretariat (2) identify, based on both the results from the analysis and existing literature, changes in distribution and the associated drivers. This second step was done by the WKFISHDISH workshop participants. The workshop was chaired by Thomas Brunel (Netherlands), Alan Baudron (UK) and Jose Fernandes (UK)."

Sources:
http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2016/WKFISHDISH/01%20Report%20of%20WKFISHDISH%202016.pdf

https://www.eea.europa.eu/data-and-maps/indicators/fish-distribution-shifts

Reference:
ICES (2017). Report of the Working Group on Fish Distribution Shifts (WKFISHDISH), 22–25 November 2016, ICES HQ, Copenhagen, Denmark. ICES CM 2016/ACOM: 55. 197 pp.

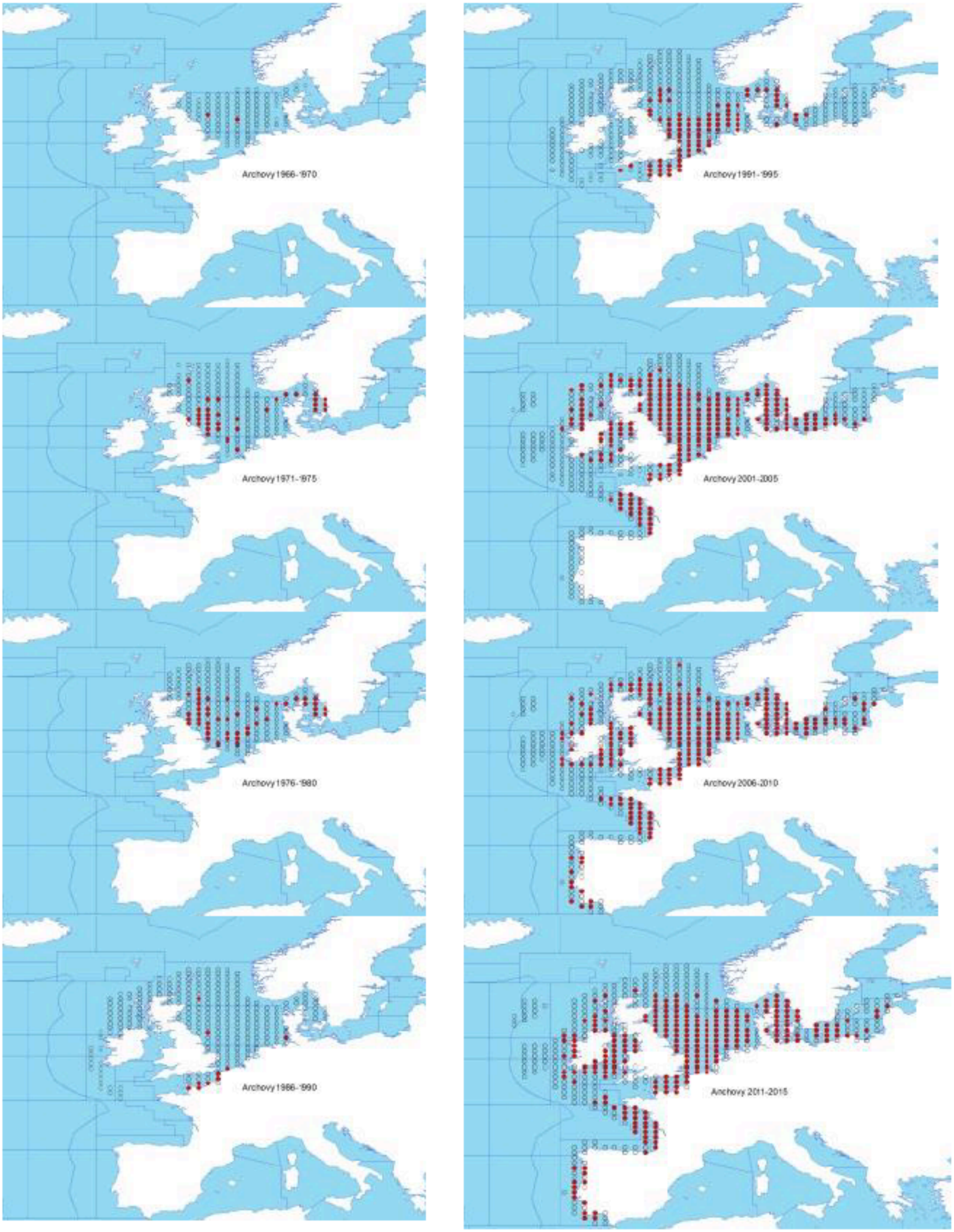

Figure 6.13-1 Map of anchovy presence through time

Original Caption: "Figure 3.1.2. Map of anchovy presence through time"

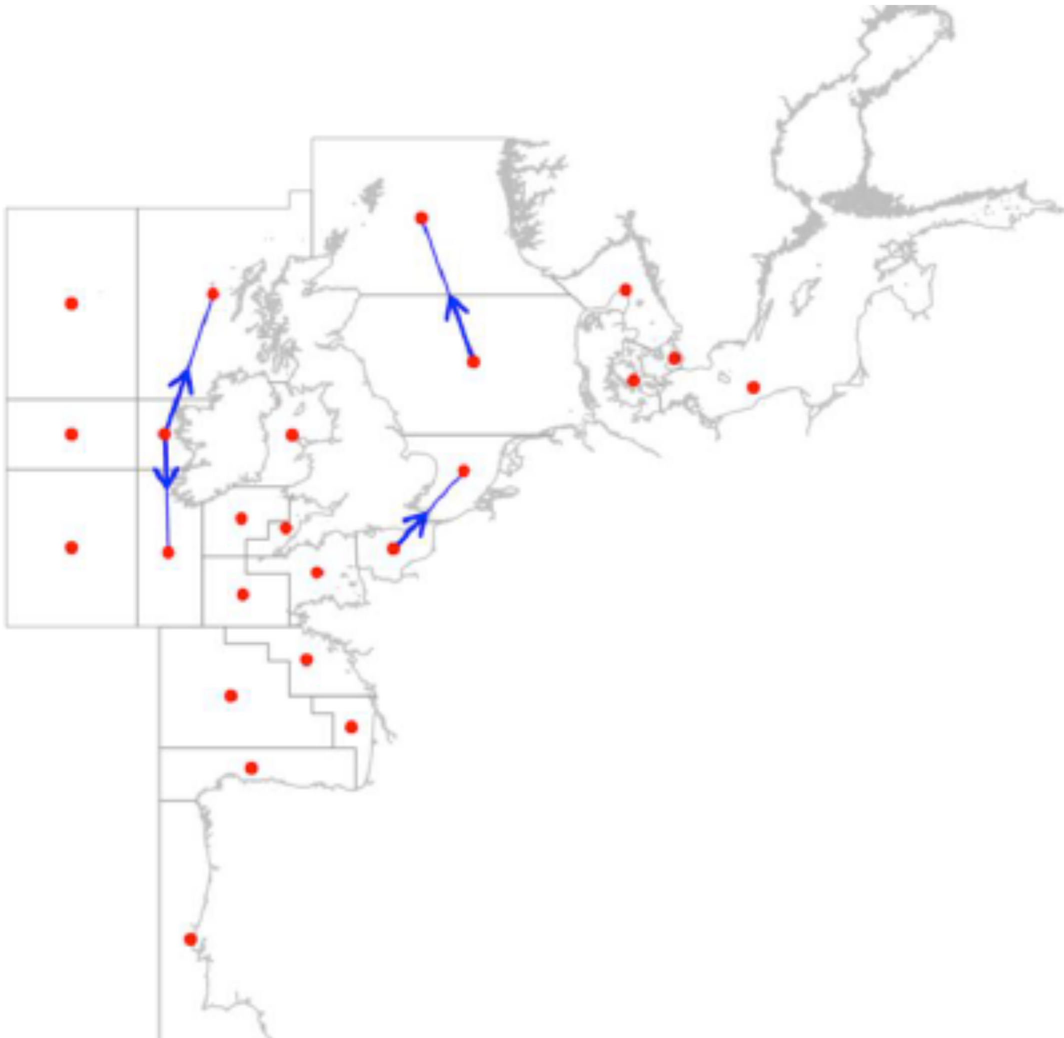

Figure 6.13-2 Significant trend maps. Centroids (red points) of ICES divisions and subdivisions (boxes) used in the analysis of relative changes in cod abundance

Original Caption: "Figure 3.4.4. Significant trend maps. Centroids (red points) of ICES divisions and subdivisions (boxes) used in the analysis of relative changes in cod abundance. Arrows show significant trends where the box at the beginning of the arrow has consistently lower relative change in abundance to the neighbouring box with the terminus of the arrow."

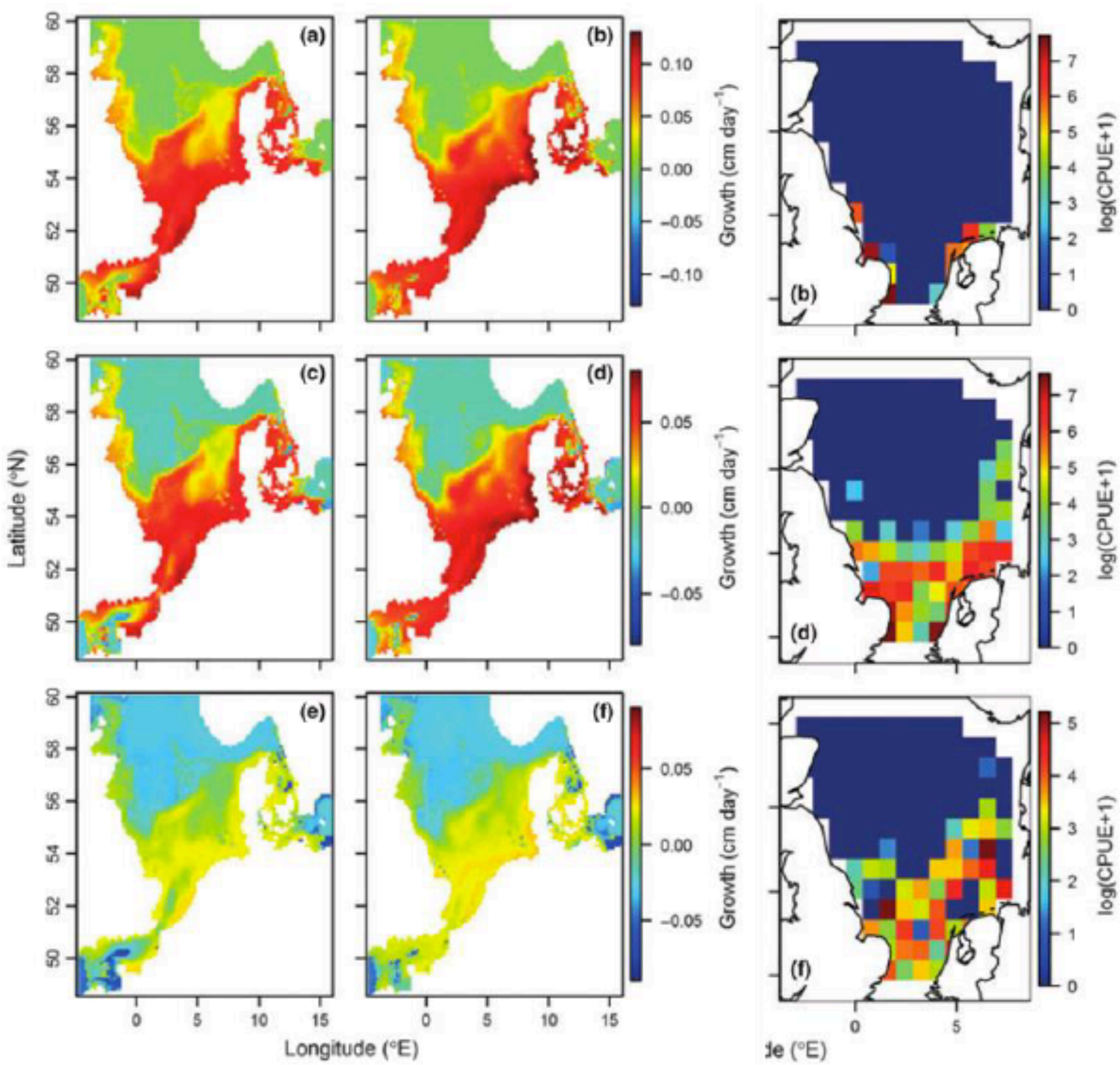

Figure 6.13-3 Maps of the North Sea including the English Channel to the Western Baltic showing maximum expected growth rate (Left two columns) from combined DEB and benthic productivity models for sole

Original Caption: "Figure 3.5.12 Maps of the North Sea including the English Channel to the Western Baltic showing maximum expected growth rate (Left two columns) from combined DEB and benthic productivity models for sole with starting lengths of 1.5cm (a, b), 20cm (c, d) and 40cm (e, f) in two different years: High nutrient, low temperature (a, c, e) and lower nutrient, higher temperature (b, d, f). The right panel shows average abundance of sole across the North Sea from 1990 – 2010 for size clas-ses 9-15cm (top), 19-25cm (middle), >35cm (bottom). Figures taken from Teal *et al.* (2012)."

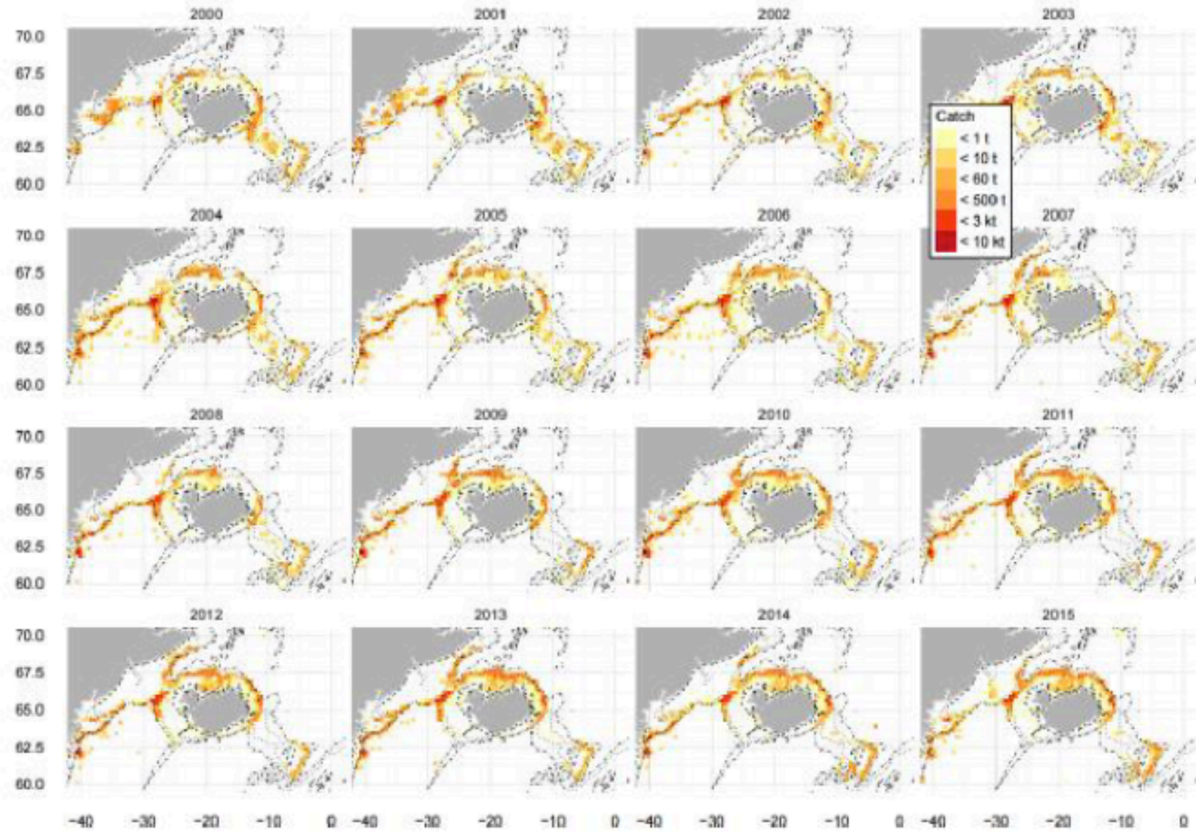

Figure 6.13-4 Greenland Halibut in subareas 5 and 14. Distribution of total catches in the fishery 2000-2015. Depth contours for 500 and 1000m shown

Original Caption: "Figure 3.6.1.2.1 Greenland Halibut in subareas 5 and 14. Distribution of total catches in the fishery 2000-2015. Depth contours for 500 and 1000m shown. Source: NWWG 2016."

6.14 State of the Arctic Marine Biodiversity Report

"The State of the Arctic Marine Biodiversity Report (SAMBR), is a product of the Circumpolar Biodiversity Monitoring Program (CBMP) of the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) Working Group. The SAMBR is a synthesis of the state of knowledge about biodiversity in Arctic marine ecosystems, detectable changes, and important gaps in our ability to assess state and trends in biodiversity across six Focal Ecosystem Components (FECs): sea ice biota, plankton, benthos, marine fishes, seabirds and marine mammals.

By compiling available information, this report provides an important first step to identify knowledge gaps in circumpolar biodiversity monitoring efforts. Current biodiversity monitoring is not sufficient to describe the status and trends for many of the FECs."

Source:

https://www.arcticbiodiversity.is/marine

Reference:
CAFF (2017). State of the Arctic Marine Biodiversity Report. Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland. 978-9935-431-63-9

Figure 6.14-1 Circumpolar map of known polynyas

Original Caption: "Figure 2.5 Circumpolar map of known polynyas. Note that polynyas are dynamic systems and some may no longer exist in the form known from their recent history. Adapted from Meltofte (2013) and based on Barber and Massom (2007)."

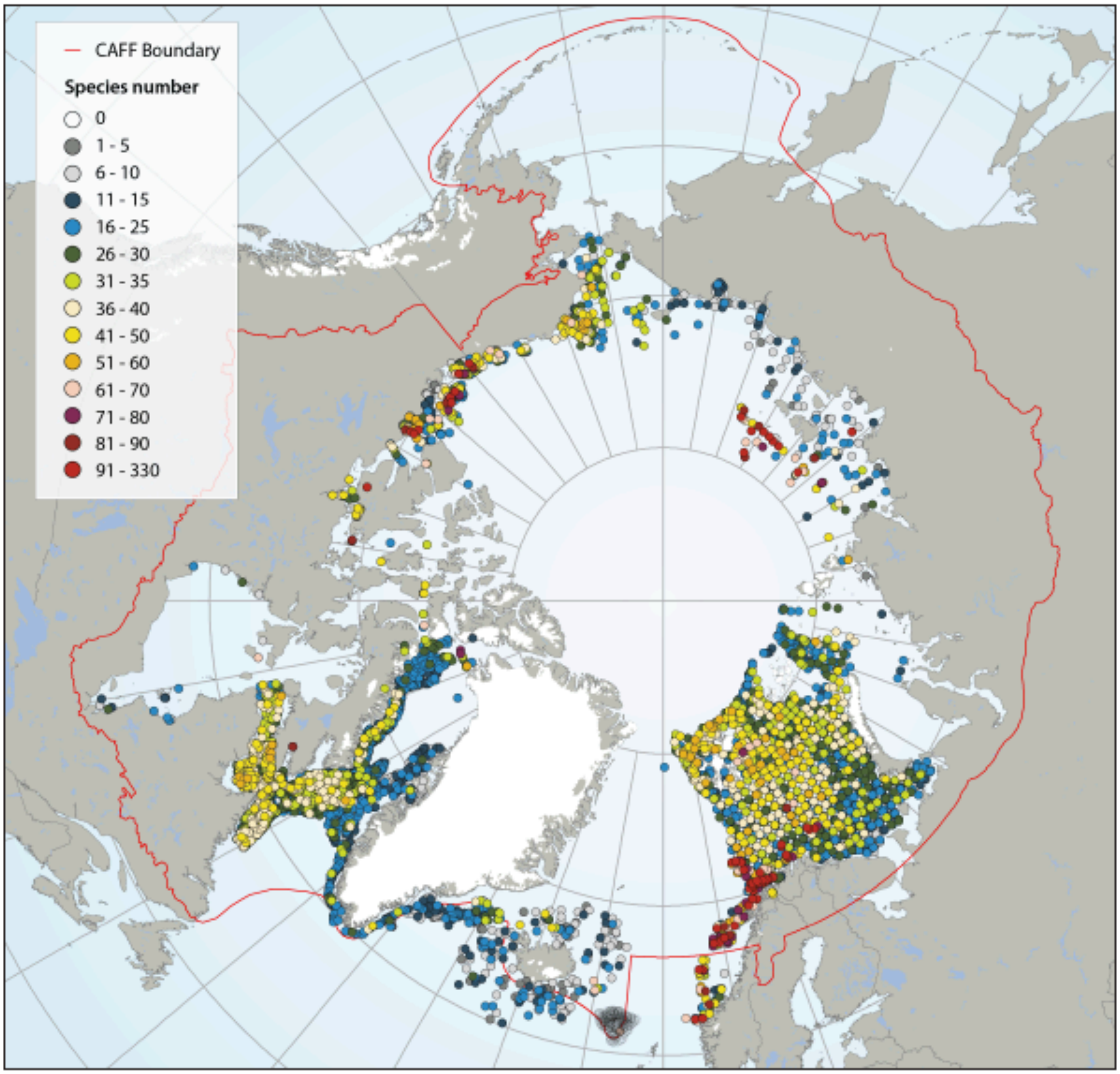

Figure 6.14-2 Number of megafauna species/taxa in the Arctic

Original Caption: "Box figure 3.3.2 Number of megafauna species/taxa in the Arctic (7,322 stations in total), based on recent trawl investigations. Stations with highest species/taxon number are sorted to the top, meaning that dense concentrations of stations (e.g. Eastern Canada, Barents Sea), with low species numbers are hidden behind stations with higher species numbers. Also note that species numbers are somewhat biased by differing taxonomic resolution between studies. Data from: Icelandic Institute of Natural History, Iceland; Marine Research Institute, Iceland; University of Alaska, Fairbanks, U.S.; Greenland Institute of Natural Resources, Greenland; Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia; Université du Québec à Rimouski, Canada; Fisheries and Oceans Canada; Institute of Marine Research, Norway; and Polar Research Institute of Marine Fisheries and Oceanography, Murmansk, Russia."

6.15 EMODnet Human Activities Data Portal

EMODnet Human Activities aims to facilitate access to existing marine data on activities carried out in EU waters, by building a single entry point for geographic information on 14 different themes. The portal makes available information such as geographical position, spatial extent of a series of activities related to the sea, their temporal variation, time when data was provided, and attributes to indicate the intensity of each activity. The data are aggregated and presented so as to preserve personal privacy and commercially-sensitive information. The data also include a time interval so that historic as well as current activities can be included.

The information provided through the portal is collated from a variety of sources, harmonised and made interoperable. Data are free and free of any restrictions, in such a way as to ensure their use from a multitude of stakeholders (policy makers, researchers, students, spatial planners, etc.).

Portal:
https://www.emodnet-humanactivities.eu/about-ha.php

Theme	Activity	Geographical Type	Attributes
Aggregate Extraction	Aggregate Extraction	Points	Gravel extracted per year, area of activity
Aquaculture	Finfish Production	Points	Species of fish and shellfish; production tonnage per year
	Shellfish Production	Points	Species of fish and shellfish; production tonnage per year
	Freshwater Production	Points	Species of fish; production tonnage per year
Cables	Telecommunication Cables (schematic routes)	Lines	Types of cable or pipeline, width
	Landing Stations	Points	
	Telecommunication Cables (actual route locations)	Lines	
Cultural Heritage	Ship Wrecks	Points	
	Lighthouses	Points	
	Submerged Prehistoric Archaeology and Landscapes	Points	
Dredging	Dredging	Points	Status (years operational), purpose
Environment	Protected Areas	Points and polygons	Legal basis for protection
	State of Bathing Waters	Points	
Fisheries	Fisheries zones	Polygons	ICES and FAO nomenclature
	Fish Catches	Polygons	
	Fish Sales	Points	
Hydrocarbon Extraction	Active Licenses	Polygons	Status (exploration, exploitation)
	Boreholes	Points	Status (exploration, exploitation)
	Ofshore Installations	Points	
Main Ports	Traffic	Points	Traffic
Ocean Energy Facility	Project Locations	Points	Type, status (planned, under construction, operational)
	Test Sites	Polygons	
Other Forms of Area Management/ Designation	Other Forms of Area Management/ Designation	Polygons	National or international basis
Pipelines	Pipelines	Lines	
Waste Disposal	Dredge Spoil Dumping	Points and polygons	Status (years operational), distance from coast
	Dumped Munitions	Points and polygons	Distance from coast, munition type
Wind Farms	Wind Farms	Points and polygons	Number of turbines, generation capacity, status (planned, under construction, operational)

Figure 6.15-1 Table of data themes in the EMODNet Human Activities Portal

6.16 OSPAR Intermediate Assessment

"The Intermediate Assessment 2017 further develops OSPAR's understanding of the marine environment of the North-East Atlantic and its current status. It demonstrates OSPAR's progress towards realising its vision of a clean, healthy and biologically diverse North-East Atlantic, used sustainably.

OSPAR's previous holistic assessment, the QSR 2010, was a culmination of ten years of joint assessment and monitoring by OSPAR Contracting Parties. Seven years on, and with the benefit of significant developments in monitoring and assessment methodology, the IA 2017 provides an update on the 2010 assessment as well as presenting some new indicators and assessment methodology. The actual time period for the range of assessments presented in the IA 2017 varies since the reporting period is parameter-specific. The objective has been to use the most recent data available. For hazardous substances the assessment period in the IA 2017 incorporates data up to 2015, inclusive. Eutrophication indicators, together with nutrient inputs, incorporate data up to 2014, inclusive. However, the reader is encouraged to note the period covered by the individual assessments.

Although this is an OSPAR Report, OSPAR Contracting Parties that are also EU Member States have the opportunity to use the information presented in the IA 2017 for their update in 2018 to the EU on the initial assessment (2012) for the MSFD. However, it should be noted that at this point in time, OSPAR IA 2017 indicator assessment values are not to be considered as equivalent to proposed EU MSFD criteria threshold values."

Reference:
OSPAR (2017). Intermediate Assessment 2017. Available at:
https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017

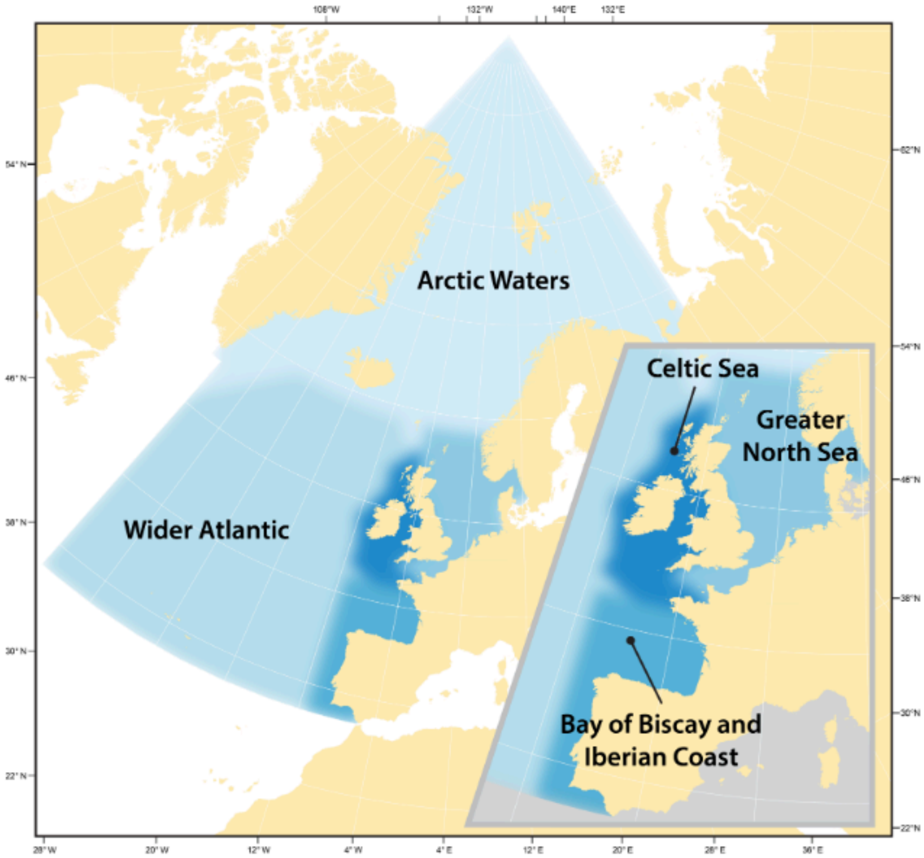

Figure 6.16-1 OSPAR Maritime Area sub-regions for assessment purposes

Original Caption: "Figure 1: The OSPAR Maritime Area is divided into five Regions (Table 1) for assessment purposes: Arctic Waters, Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Coast and Wider Atlantic

6.17 OSPAR Composition and Spatial Distribution of Litter on the Seafloor

"The distribution and abundance of marine litter on the seafloor in the OSPAR Maritime Area were investigated on the basis of data collected by trawl surveys from seven Contracting Parties (Figure 1). Benthic trawls are designed to capture marine biota on or near the seafloor over a range of different seafloor types. As a result, some trawl designs plough through the seafloor while others roll over the seafloor. The amount of litter captured during a survey is influenced by the type of interaction with the seafloor and the mesh size of the nets. Therefore, the sampled quantities are not absolute amounts, but 'relative' amounts. However, they still allow comparisons between regions sampled with similar gear. The number of stations monitored determines the confidence that can be applied to assessments and defines the time (number of years of data) needed to obtain an acceptable confidence level."

Source:
https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/marine-litter/composition-and-spatial-distribution-litter-seafloor/

Reference:
OSPAR (2017). Intermediate Assessment 2017. Available at:
https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017

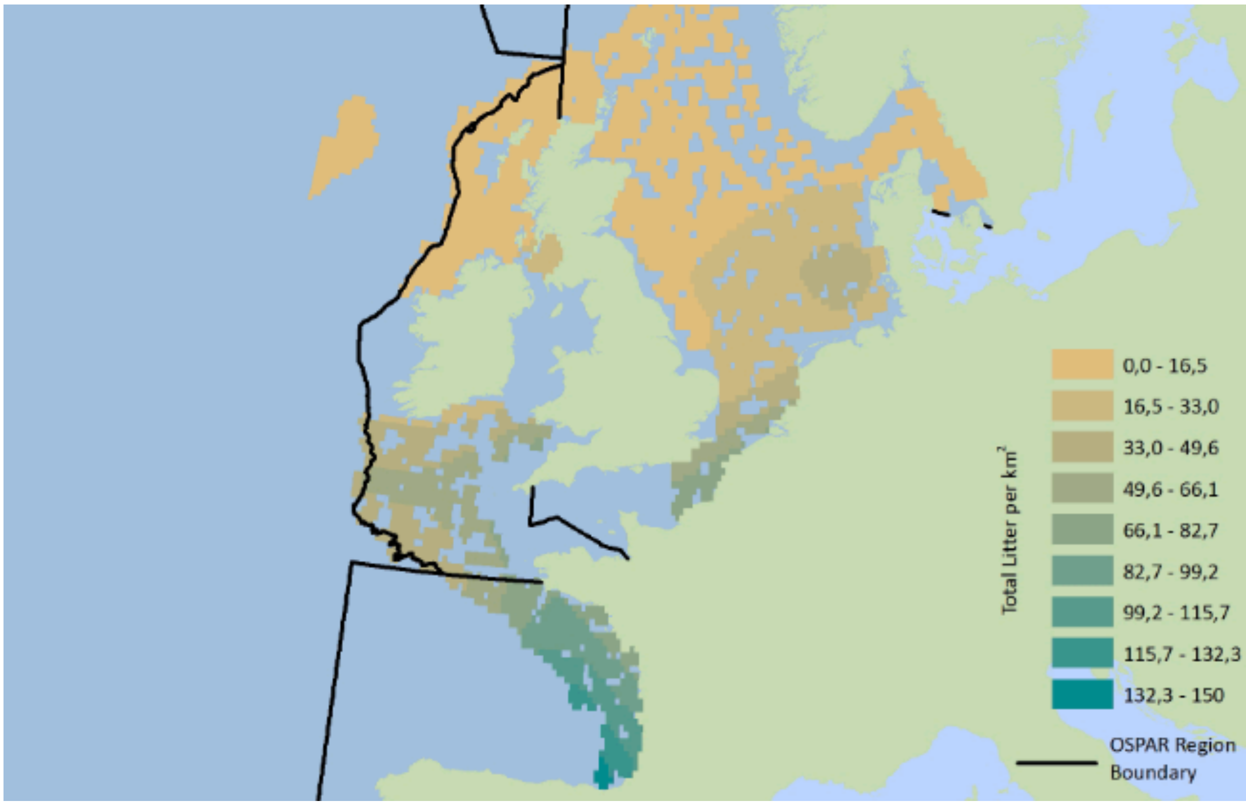

Figure 6.17-1 Relative number of litter items per km^2 seafloor

Original Caption: "Figure 2: Relative number of litter items per km2 seafloor across the Greater North Sea, Celtic Seas and the Eastern Bay of Biscay, based on the number of items caught as by-catch in fisheries trawls."

6.18 OSPAR Offshore Renewable Energy Developments

Details of the location and status of offshore renewable energy developments in the OSPAR region [Version 002].

Data:
https://odims.ospar.org/layers/geonode:ospar_offshore_renewables_2018_01_002

6.19 Multi-Beam Survey Data from the Alfred Wegener Institute

The Alfred Wegener Institute (AWI Germany) provided cruise tracks from multi-beam bathymetric surveys performed in the region from 1984 to 2018. High-resolution bathymetric data from these cruises can be provided to workshop attendees as needed.

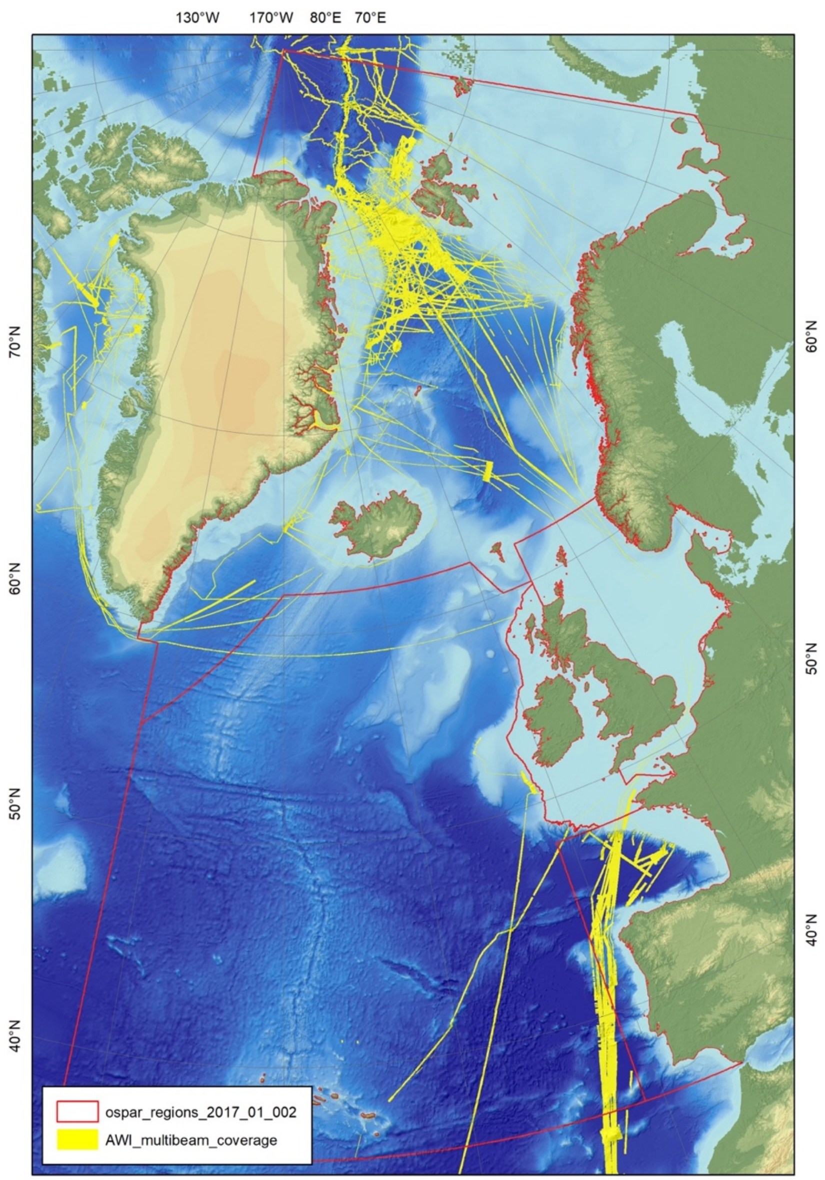

Figure 6.19-1 Multi-beam survey coverage from the Alfred Wegener Institute

6.20 The Baltic Sea scale inventory of benthic faunal communities

Abstract:
"This study provides an inventory of the recent benthic macrofaunal communities in the entire Baltic Sea. The analyses of soft-bottom benthic invertebrate community data based on over 7000 locations in the Baltic Sea suggested the existence of 10major communities based on species abundances and 17 communities based on species biomasses, respectively. The low-saline northern Baltic, characterized by silty sediments, is dominated by Monoporeia affinis, Marenzelleria spp., and Macoma balthica. Hydrobiidae, Pygospio elegans, and Cerastoderma glaucum dominate the community in sandy habitats off the Estonian west coast and in the southeastern and southern Baltic Sea. Deep parts of the Gulf of Finland and central Baltic Sea often experience hypoxia, and when oxygen levels in these regions recover, Bylgides sarsi was the first species to colonize. The southwestern Baltic Sea, with high salinity, has higher macrofaunal diversity compared with the northern parts. To spatially interpolate the distribution of the major communities, we used the Random Forest method. Substrate data, bathymetric maps, and modelled hydrographical fields were used as predictors. Model predictions were in good agreement with observations, quantified by Cohen's k of 0.90 for the abundance and 0.89 in the wet weight-based model. Misclassifications were mainly associated with uncommon classes in regions with high spatial variability. Our analysis provides a detailed baseline map of the distribution of benthic communities in the Baltic Sea to be used both in science and management."

Reference:

Mayya Gogina, Henrik Nygård, Mats Blomqvist, Darius Daunys, Alf B. Josefson, Jonne Kotta, Alexey Maximov, Jan Warzocha, Vadim Yermakov, Ulf Gräwe, Michael L. Zettler, The Baltic Sea scale inventory of benthic faunal communities, ICES Journal of Marine Science, Volume 73, Issue 4, March/April 2016, Pages 1196–1213, https://doi.org/10.1093/icesjms/fsv265

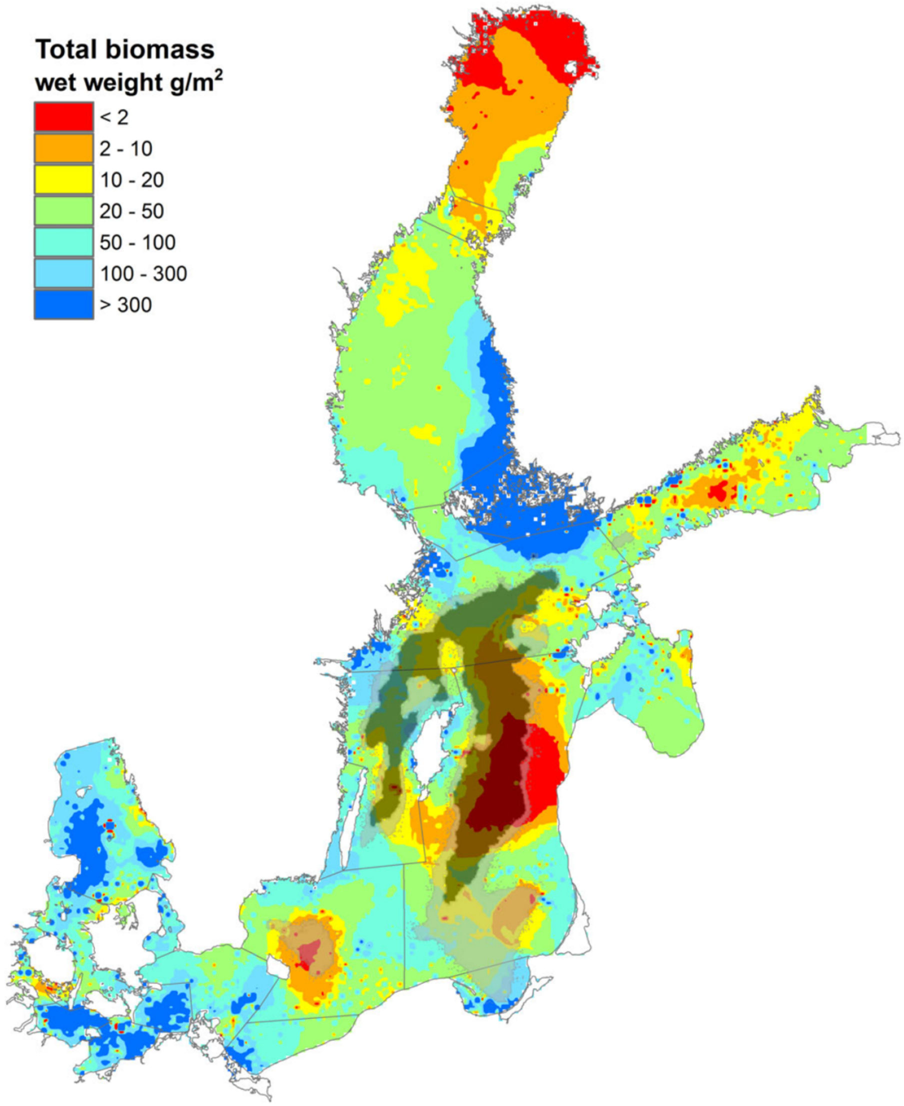

Figure 6.20-1 Distribution of interpolated total wet biomass

Original caption: "Figure 8. Distribution of interpolated total wet weight biomass, derived using ordinary kriging interpolation of available biomass data averaged per 5 Å~ 5 km grid cell. Transparent light grey and dark grey areas mask out the deep water hypoxic and anoxic oxygen conditions. Note that at the areas where biomass data are lacking interpolation artefacts are evident, for instance, values at the shallow parts of the Eastern Gotland Basin at the west coast off Latvia are presumably too low. "

6.21 Benthic Response to a Pelagic Front

Abstract:
"With the aim of studying the influence of pelagic front primary production on the benthic system underneath, biomarkers of benthic organic matter constituents and macrofaunal abundance and biomass were measured on stations in a grid extending through the area of the Skagerrak-Kattegat pelagic plume front. A time persistent pattern of chl a and phaeopigments in the surface sediment was observed, with chl a / chl a + phaeopigments ratios exceeding 0.5, suggesting high input of phytoplankton to the bottom near the front. Of the sediment variables chl a, phaeopigments, particulate organic nitrogen (PON), particulate organic carbon (POC) and biogenic silica (BSi), the pigments showed the highest correlation with benthic biomass and abundance. Chl a and phaeopigments together explained nearly half of the variation in benthic biomass and the non-polychaete fraction of abundance. C/N ratio showed the expected negative relationship with biomass but was not statistically significant. PON, BSi and POC were poor indicators of faunal variables. Results suggest that sediment chlorophyll and its breakdown products may be useful biomarkers of labile organic matter. The organic matter (OM) gradient significantly influenced faunal structure. Polychaete and echinoderm AFDW were positively correlated with chl a and with phaeopigments. A major part of the positive faunal response was due to the burrowing ophiuroid Amphiura filiformis and its commensal Mysella bidentata. While the host was best correlated with phaeopigments, the commensal correlated equally well with both chl a and phaeopigments. Faunal changes in composition suggested increased importance of subsurface feeding deep in the sediment in response to increased OM loading. Surface deposit-feeders did not respond to the high levels of labile OM in the middle of the area. Results indicate strong pelagic-benthic coupling near the front and in the area with a mixed water column and are consistent with the hypotheses that pelagic-benthic energy coupling is stronger in mixed areas compared to those which are stratified and that increased OM loading may increase subsurface dwelling and OM processing through benthic burrowing biomass."

Reference:
Josefson, A. B. and D. J. Conley. (1997). Benthic response to a pelagic front. Marine Ecology Progress Series 147: 49-62.

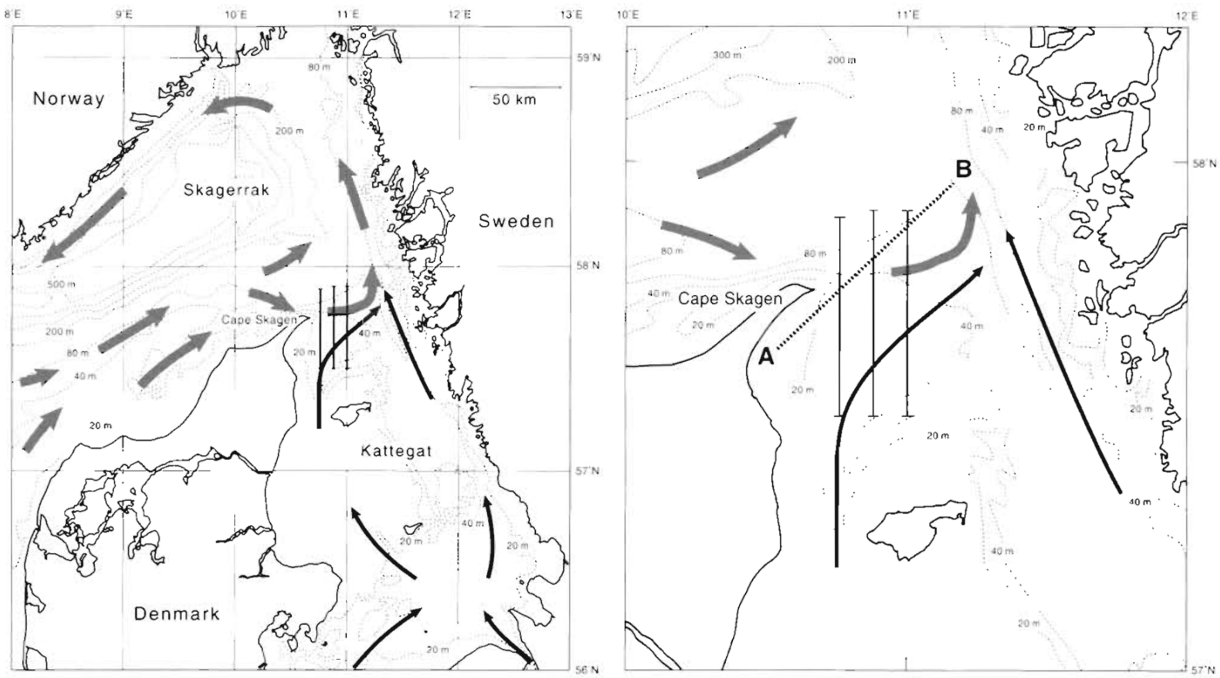

Figure 6.21-1 Transition area between Baltic and North Seas, where the Skagerrak-Kattegat front is present from May to August and contributes to strong benthic-pelagic coupling

Original caption: "Fig. 1. Investigated area with positions of the 3 benthic transects (vertical solid straight lines), bathymetry, and a simplified picture of surface currents (modified from Svansson 1975). Shaded arrows indicate circulation in the Skagerrak, and solid arrows the Baltic outflow. Line A-B in enlarged figure shows average position of the 29 PSU surface isohaline (Rodhe 1996), indicating the approximate position of the Skagerrak-Kattegat Front in the period May-August"

6.22 Habitat Models of Eelgrass in Danish Coastal Waters: Development, Validation and Management Perspectives

Abstract:
"During the last century, eutrophication significantly reduced the depth distribution and density of the habitat forming eelgrass meadows (Zostera marina) in Danish coastal waters. Despite large reductions in nutrient loadings and improved water quality, Danish eelgrass meadows are currently not as widely distributed as expected from improvements in water clarity alone. This point to the importance of other environmental conditions such as sediment quality, wave exposure, oxygen conditions and water temperature that may limit eelgrass growth and contribute to constraining current distributions. Recently, detailed local models have been set up to evaluate the importance of such regulating factors in selected Danish coastal areas, but nationwide maps of eelgrass

distribution and large-scale evaluations of regulating factors are still lacking. To provide such nationwide information, we applied a spatial habitat GIS modeling approach, which combines information on six key eelgrass habitat requirements (light availability, water temperature, salinity, frequency of low oxygen concentration, wave exposure, and sediment type) for which we were able to obtain national coverage. The modeled potential current distribution area of Danish eelgrass meadows was 2204 km2 compared to historical estimates of around 7000 km2, indicating a great potential for further distribution. While validating the modeled eelgrass distribution area in three areas (83–111 km2) that hold large eelgrass meadows, we found an agreement of 67% with in situ monitoring data and 77% for eelgrass areas as identified from summer orthophotos. The GIS model predicted higher coverage especially in shallow waters and near the depth limits. Areas of disagreement between GIS-modeled and observed coverage generally exhibited higher exposure level, mean summer temperature and salinity compared to areas of agreement. A sensitivity analysis showed that the modeled area distribution of eelgrass was highly sensitive to light conditions, with 18–38% increase in coverage following an increase in light availability of 20%. Modeled coverage of eelgrass was also sensitive to wave exposure and temperature conditions while less sensitive to changes in oxygen and salinity conditions. Large regional differences in habitat conditions suggest spatial variation in the factors currently limiting the recovery of eelgrass and, hence, variations in actions required for sustainable management."

Reference:

Staehr PA, Göke C, Holbach AM, Krause-Jensen D, Timmermann K, Upadhyay S and Ørberg SB (2019) Habitat Model of Eelgrass in Danish Coastal Waters: Development, Validation and Management Perspectives. Front. Mar. Sci. 6:175. doi: 10.3389/fmars.2019.00175

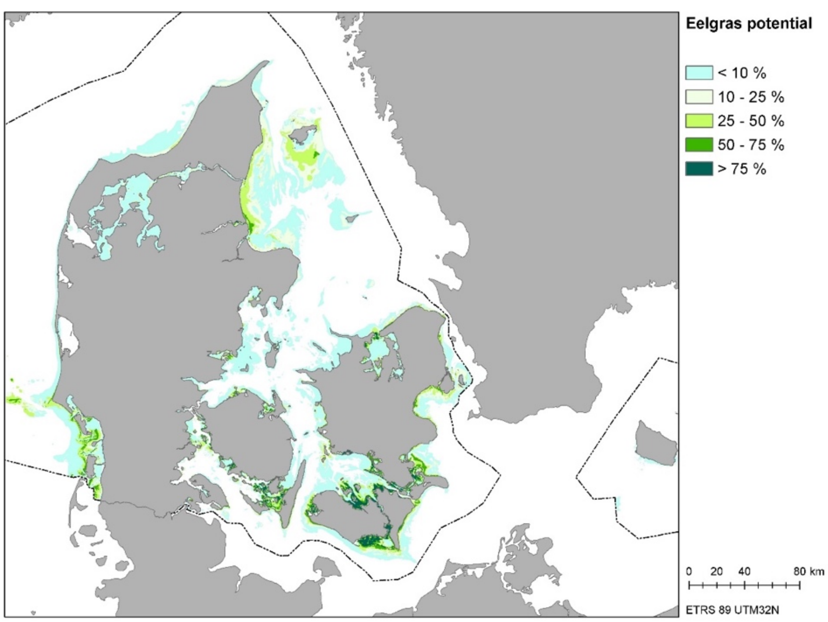

Figure 6.22-1 Map of potential eelgrass distribution

Original caption: "Figure 2. Map of eelgrass distribution potential area derived from spatial habitat modeling"

6.23 Maps and Data Submitted by Denmark

A range of maps and data reports were provided by Denmark for use at the North-East Atlantic workshop. Several example maps from these submissions appear below and the full datasets will be available for use by workshop attendees in Stockholm.

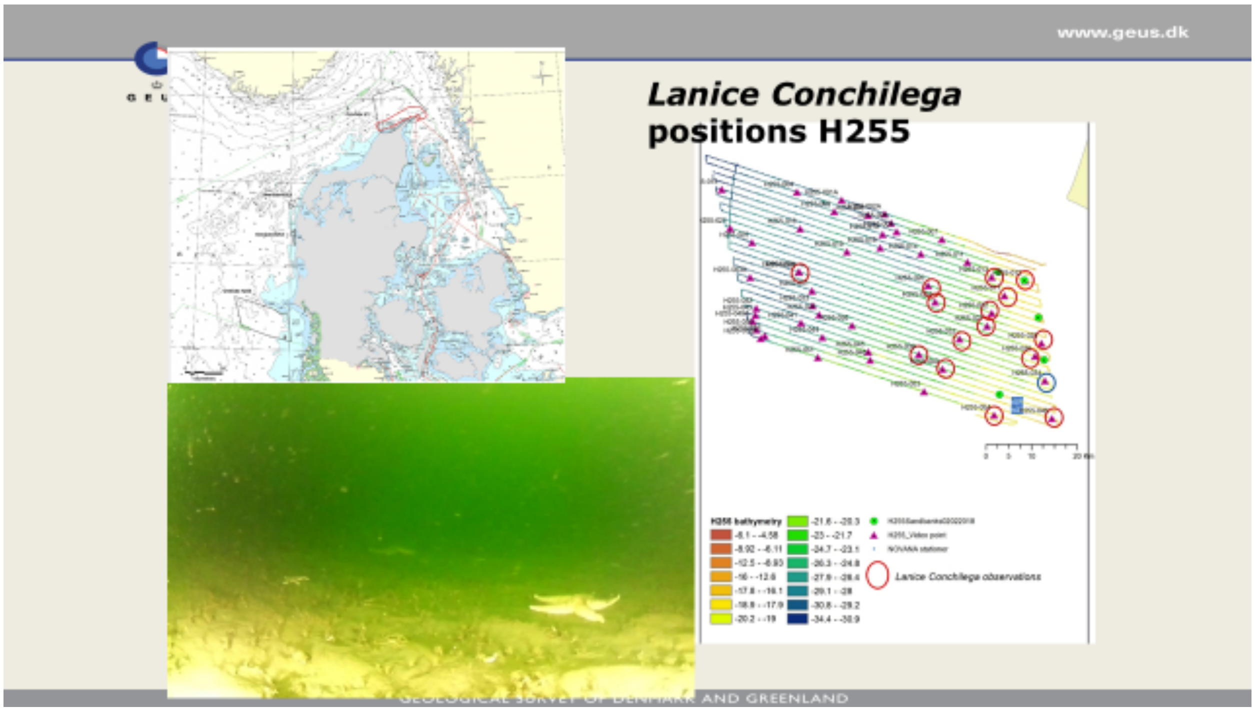

Figure 6.23-1 Observations of *Lanice conchilega* within Omrade H255

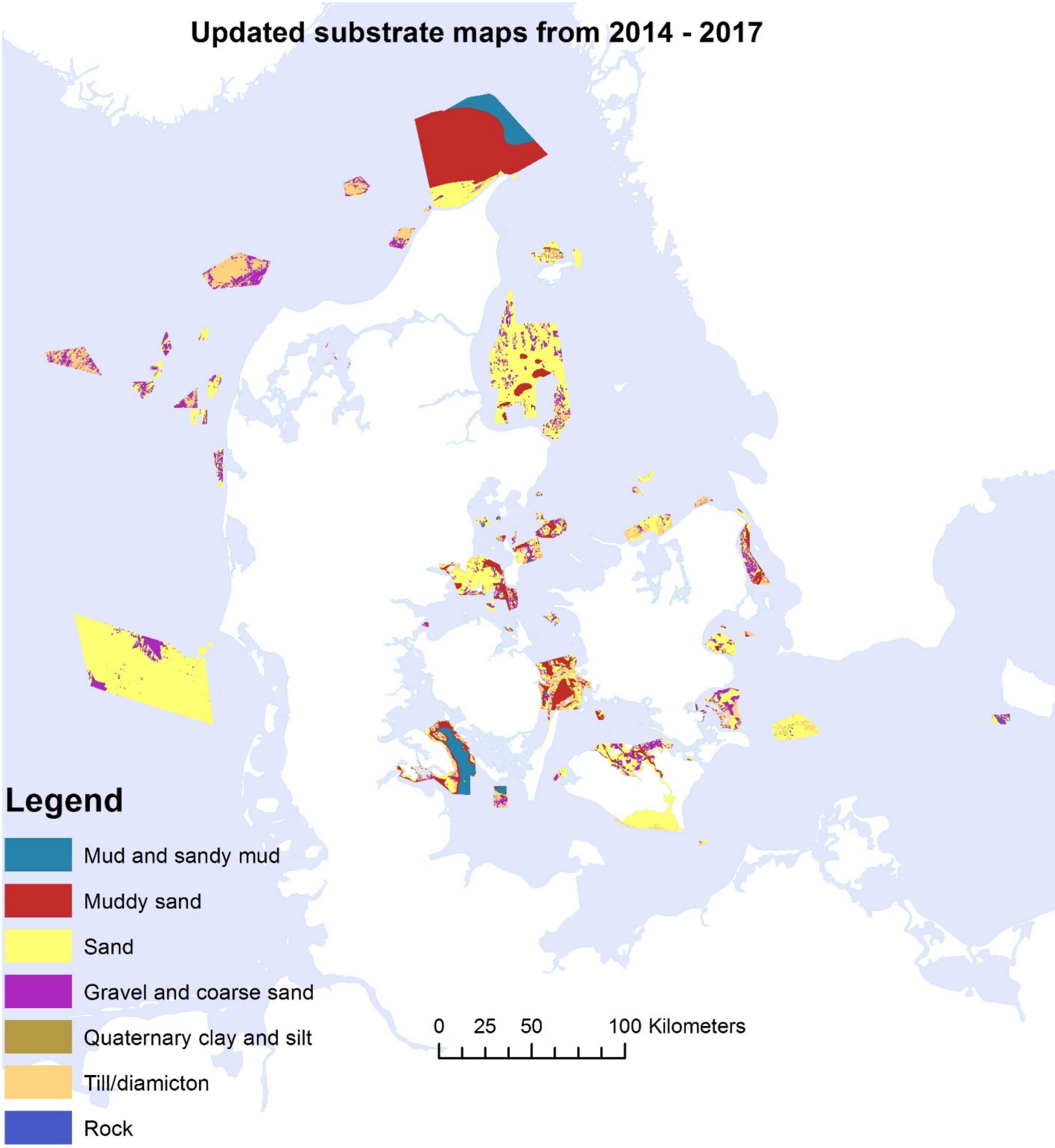

Figure 6.23-2 Substrate maps for Danish coastal waters

6.24 WWF Arctic Geographical Information System

WWF Arctic Geographical Information System is a free and interactive mapping platform that combines and integrates existing data about the environment and human activity in the Arctic. The wwfarcticmaps.org web-platform allows any user to download pre-made maps and videos, as well as developing customized maps on their own, using an interactive map service.

Source:
http://wwfarcticmaps.org/

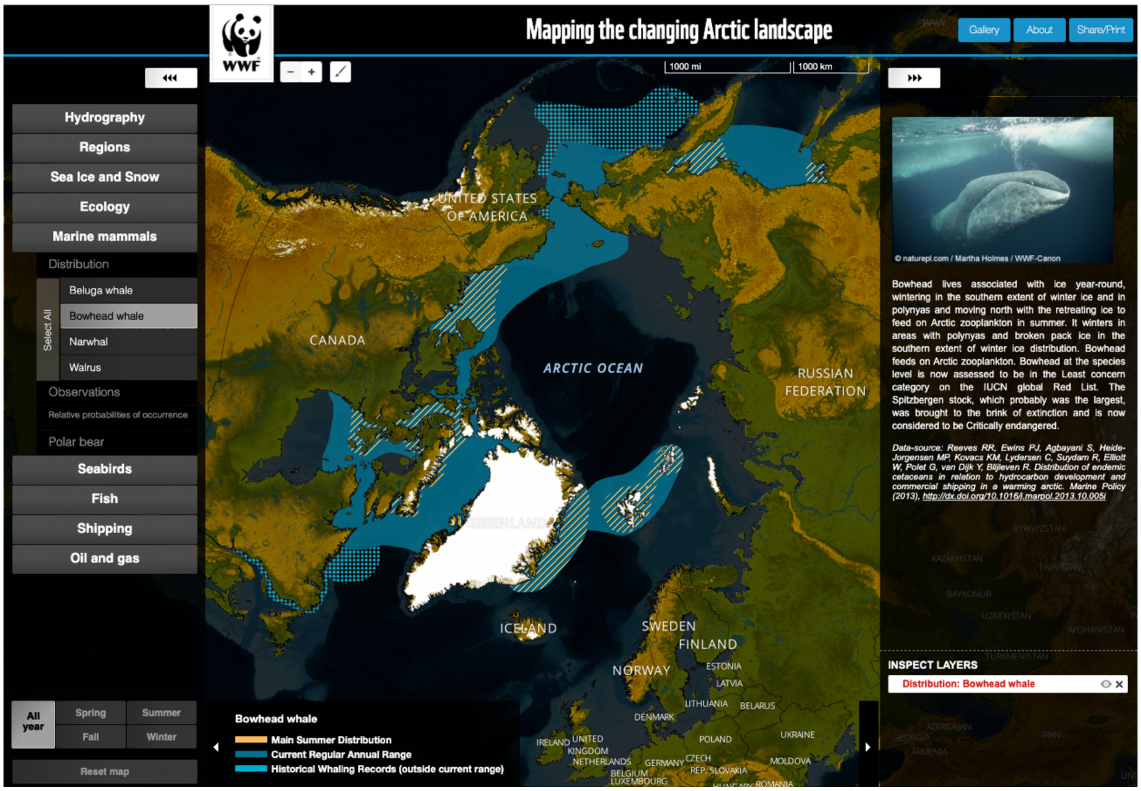

Figure 6.24-1 Bowhead whale distribution from WWF Arctic geographical information system

6.25 Meereisportal (Sea Ice Portal)

“The data and image archive of meereisportal.de provides sea ice data of the Arctic and Antarctic. In addition to graphic representations of the underlying verified data and derived data products it is also possible to download the information for further processing.”

Source:
https://www.meereisportal.de/en/

Reference:

Grosfeld, K.; Treffeisen, R.; Asseng, J.; Bartsch, A.; Bräuer, B.; Fritzsch, B.; Gerdes, R.; Hendricks, S.; Hiller, W.; Heygster, G.; Krumpen, T.; Lemke, P.; Melsheimer, C.; Nicolaus, M.; Ricker, R. and Weigelt, M. (2016), Online sea-ice knowledge and data platform <www.meereisportal.de>, Polarforschung, Bremerhaven, Alfred Wegener Institute for Polar and Marine Research & German Society of Polar Research, 85 (2), 143-155, doi:10.2312/polfor.2016.011.

Figure 6.25-1 Data products available in the Meereisportal

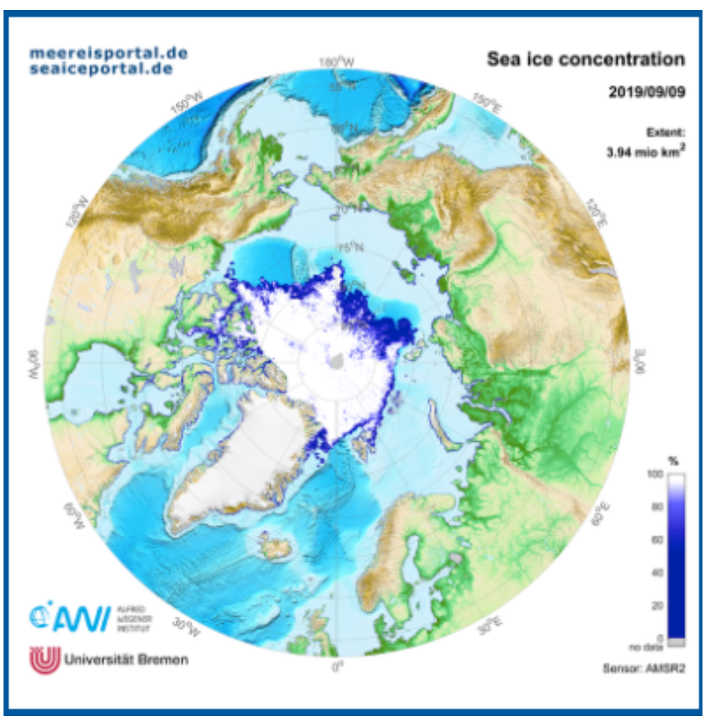

Figure 6.25-2 Near real-time sea ice concentration

6.26 International Seabed Authority Deep Data Portal

"The newly developed "ISA Deep Seabed and Ocean Database" (*DeepData*) was launched in July 2019 at the Authority's 25th Session. This database has been designed to serve as a spatial, internet-based data management system. Its main function is to host all deep-seabed activities related data and in particular, data collected by the contractors on their exploration activities as well as any other relevant environmental and resources related data for the Area.

DeepData contains information on mineral resource assessment (geological data) and environmental baseline/assessment data. However, only the environmental data will be accessible to the public. This will include biological, physical and geochemical parameters of the marine ecosystems from the seafloor to the ocean surface.

The Geographical Information System (GIS) is part of *DeepData* functionalities. As such, it allows visualization of contract areas, reserved areas and designated areas of particular environmental interest (APEIs). GIS information accessible through *DeepData* also include sampling locations containing biological, physical and/or geochemical parameters of the seabed sediments and water column."

Deep Data Portal: https://data.isa.org.jm/isa/map/

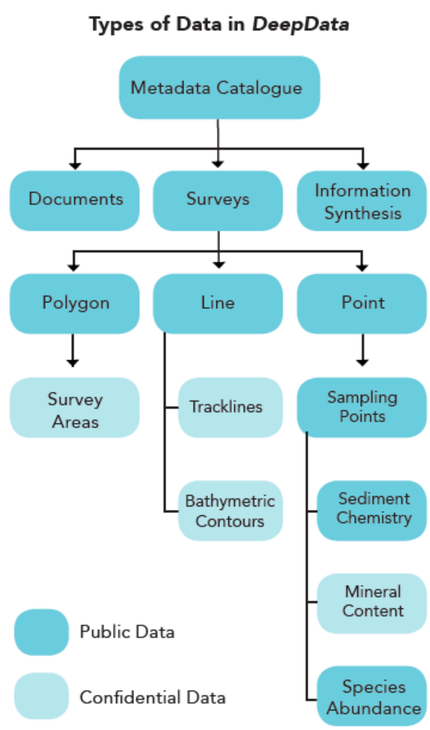

Figure 6.26-1 Chart of data types in Deep Data

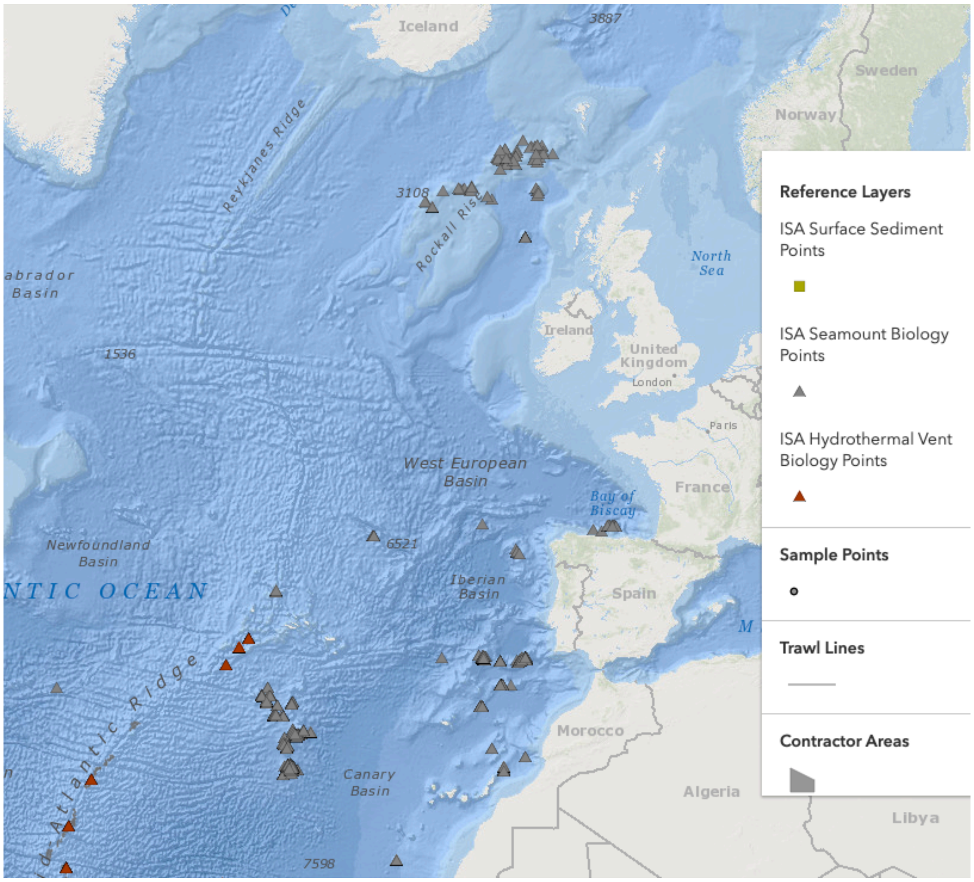

Figure 6.26-2 ISA Deep Data portal sampling points

7 Acknowledgments

The workshop will be hosted by the Government of Sweden and organized in collaboration with the OSPAR Commission and the North-East Atlantic Fisheries Commission (NEAFC), with financial support from the Governments of Sweden, Germany, France and Denmark.

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Darius Campbell - North-East Atlantic Fisheries Commission

Juan-Pablo Pertierra - European Commission, Directorate General for Environment

Pia Norling - Swedish Agency for Marine and Water Management

Ward Appletans, Pieter Provoost - Ocean Biogeographic Information System, UNESCO

Jihyun Lee – International Seabed Authority

Neil Holdsworth, Colin Millar, Sebastian Valanko, Mark Dicky-Collas, Eugene Nixon – International Council for the Exploration of the Sea (ICES)

Henning Von Nordheim, Dieter Boedeker, Matthias Steitz - Federal Agency for Nature Conservation, Germany

Cristina Garilao - GEOMAR Helmholtz Centre for Ocean Research Kiel

Tammy Davies, Maria Dias, Ana Carneiro - BirdLife International

Kevin Friedland – National Oceanic and Atmospheric Administration (NOAA), United States

Karsten Dahl - Aarhus University, Denmark

Tom Barry – Conservation of Arctic Flora and Fauna (CAFF)

Tim Packeiser – International WWF-Centre for Marine Conservation, WWF Germany

Nic Bax, Piers Dunstan, Mike Fuller - CSIRO Australia