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REGIONAL WORKSHOP TO FACILITATE THE DESCRIPTION OF ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS IN THE BLACK SEA AND THE CASPIAN SEA AND TRAINING SESSION ON ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS
Baku, 24-29 April 2017

DATA TO INFORM THE REGIONAL WORKSHOP TO FACILITATE THE DESCRIPTION OF ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS IN THE BLACK SEA AND THE CASPIAN SEA

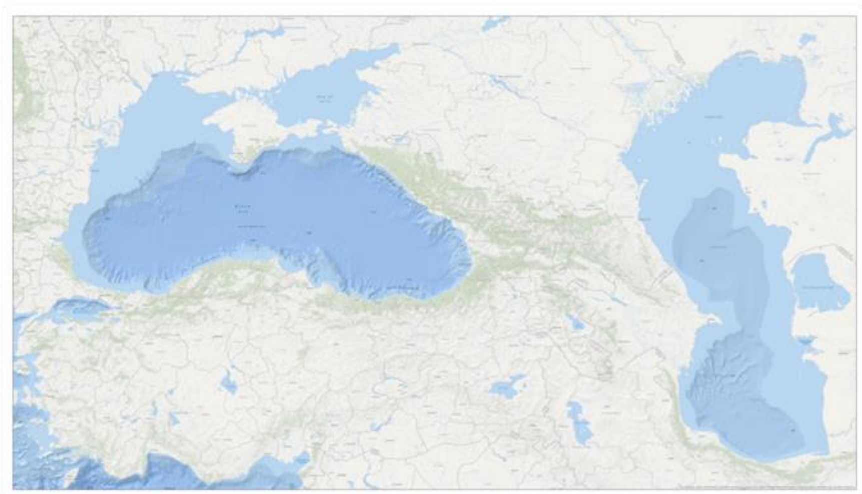
Note by the Executive Secretary

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 Black Sea and the Caspian Sea. This document was prepared by the Marine Geospatial Ecology Lab, Duke University, as commissioned by the Secretariat, 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 from the European Union.

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

Data to inform the CBD Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas in the Black Sea and Caspian Sea Region

24 April – 29 April 2017
Baku, Azerbaijan



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

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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 Black Sea and Caspian Sea. Biogeographic, biological and physical data sets are included. The data are intended to be used by the expert regional workshop convened by the CBD to aid in identifying EBSAs through application of scientific criteria in annex I of decision IX/20 as well as other relevant compatible and complementary nationally and inter-governmentally agreed scientific criteria. Each dataset may be used to meet one or more of the EBSA criteria.

Printed map posters and map books will be available for review at the workshop. Digital versions of these maps are also available online:
https://duke.box.com/s/22l75z868qwfmrtffh031izufzit6ei2

1.1 Data Collection Scope

Data and supporting documents for this report were collected and collated for the Black Sea, Caspian Sea and Marmara Sea. The exact geographic focus of the workshop will be established by the workshop attendees at the meeting.

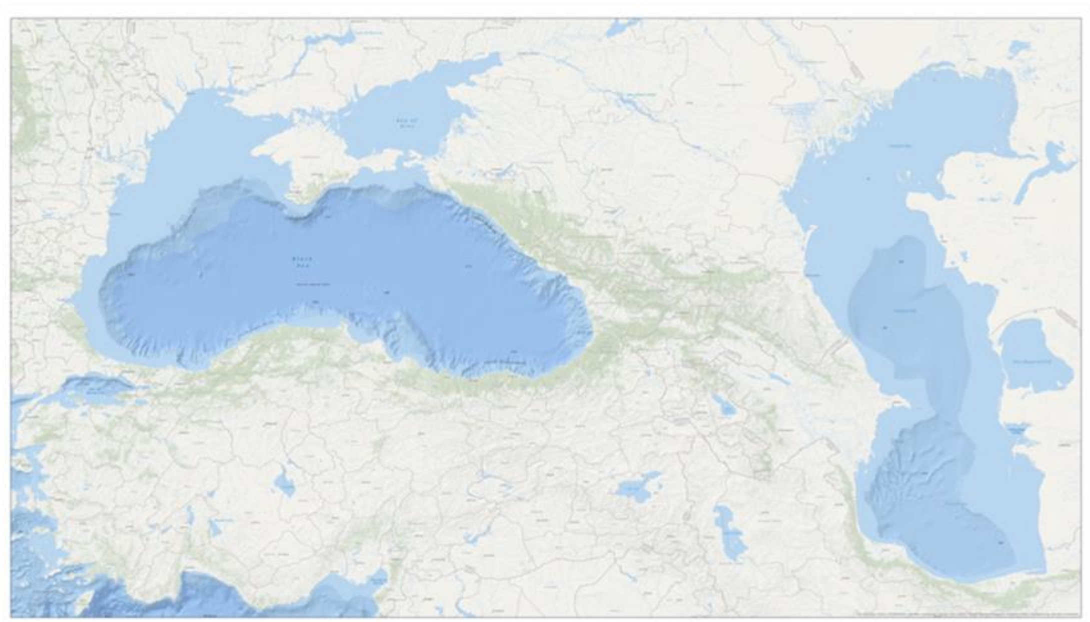

Figure 2.1.1-1 Data collection scope

2 Black Sea

2.1 Biological Data

2.1.1 Hexacorallia Observations

"The EMODnet biology data portal provides free access to data on temporal and spatial distribution of marine species and species traits from all European regional seas. EMODnet Biology is part of the EU funded European Marine Observation and Data Network and is built upon the World Register of Marine Species and the European Ocean Biogeographic Information System."

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

Datasets included in these observations of Hexacorallia and child taxa:

Wijsmans J. 1995: Spatial distribution in sediment characteristics and benthic activity on the northwestern Black Sea shelf: macrobenthos. Netherlands Institute of Ecology; Centre for Estuarine and Marine Ecology, Netherlands. Metadata available at http://data.nioo.knaw.nl/imis.php?module=dataset&dasid=1204

YugNIRO-1 - Macrozoobenthos data and accompanied environmental data from the Black Sea Regions.

Petrov A., Povchun A.S., Zolotrev P.N. Initial data set (1980-1989) on abundance and biomass of soft-bottom macrozoobenthos of Karkinitsky gulf, Western Crimea, Ukraine. Institute of Biology of Southern Seas, Ukraine.

Petrov, A; Milovidova, N. , Alyomov S., Shadrina L. Initial data set (1982-1992) on abundance and biomass of soft-bottom macrozoobenthos , key abiotic variables in near-bottom layers of Sevastopol bay, SW Crimea, Ukraine. Institute of Biology of Southern Seas, Ukraine.

Sezgin, M. 1999. Macrobenthos data from 1999. Sinop University Fisheries Faculty (SNU-FF).

Fautin, Daphne G. 2013. Hexacorallians of the World. Http://geoportal.kgs.ku.edu/hexacoral/anemone2/index.cfm

Hellenic Centre For Marine Research, MedOBIS - Mediterranean Ocean Biogeographic Information System. Hellenic Centre for Marine Research; Institute of Marine Biology and Genetics; Biodiversity and Ecosystem Management Department, Heraklion, Greece. Http://www.medobis.org/

Teaca A.; Begun T.; Gomoiu M.-T.; Secrieru; National Research and Development Institute for Marine Geology and Geoecology – GeoEcoMar, Romania (2016): Macrobenthos data from the Romanian part of the Black Sea between 2003 and 2011

Teaca, A.; Begun, T.; Muresan, M.; National Research and Development Institute for Marine Geology and Geoecology – GeoEcoMar, Romania (2016): Historical benthos data from the Romanian Black Sea Coast between 1954 and 1968

Teaca, A.; Begun, T.; Muresan, M.; National Research and Development Institute for Marine Geology and Geoecology – GeoEcoMar, Romania (2016): Historical benthos data from the Pre-deltaic Romanian Black Sea Coast in 1960

Petrov A. & N. Revkov, 1986: MegFeod-Black Sea dataset IBSS, Sevastopol. Institute of Biology of the Southern Seas (IBSS), Ukraine

Petrov A. & N. Revkov, 1993: Strelbay-Black Sea” dataset – IBSS, Sevastopol. Institute of Biology of the Southern Seas (IBSS), Ukraine

Petrov A. & Revkov N., 1986: Jalta-Black Sea dataset – IBSS, Sevastopol. Institute of Biology of the Southern Seas (IBSS), Ukraine

Nevrova H., Petrov A. & Revkov N., 1996: Laspibay-Black Sea dataset IBSS, Sevastopol. Institute of Biology of the Southern Seas (IBSS), Ukraine

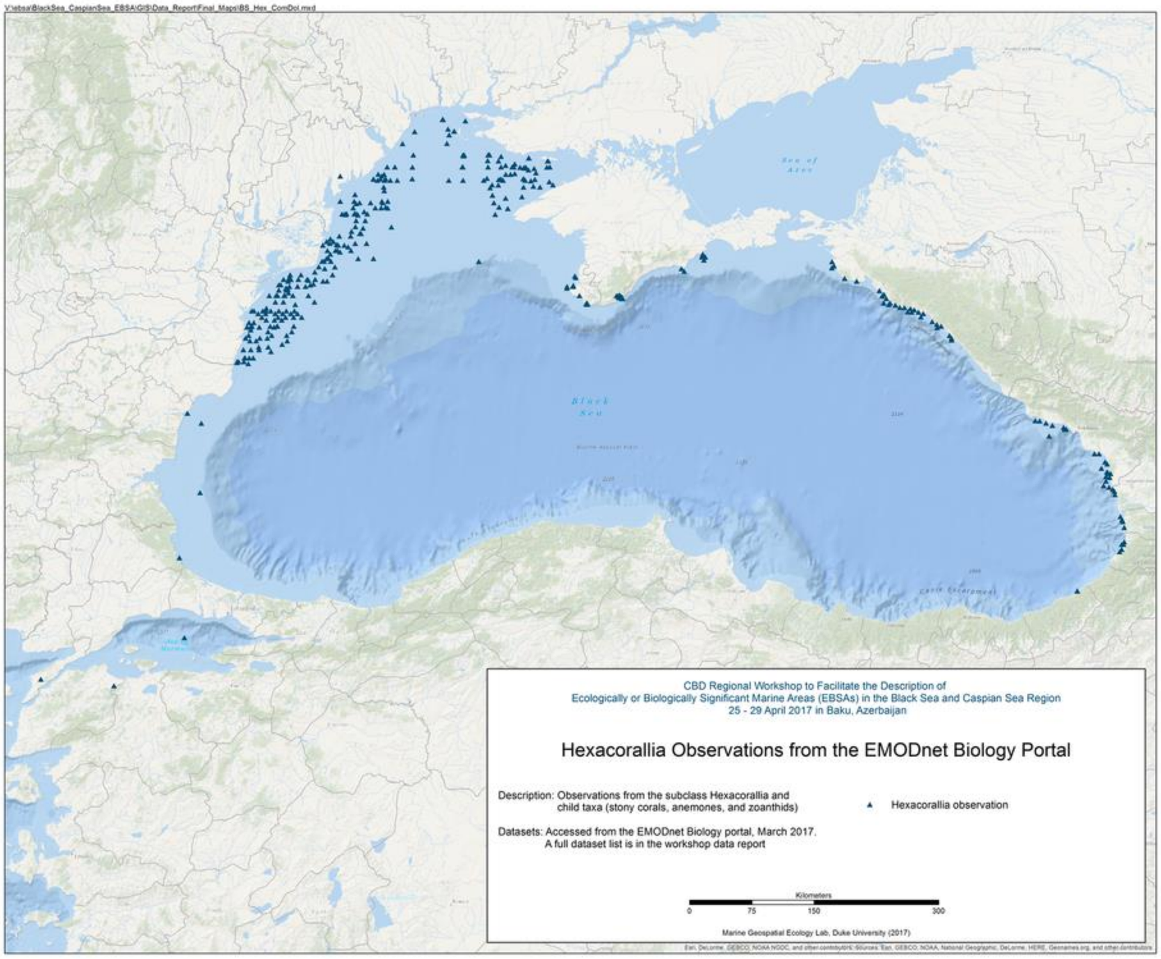

Figure 2.1.1-1 Hexacorallia observations from EMODnet

2.1.2 Common Dolphin Observations

"The EMODnet biology data portal provides free access to data on temporal and spatial distribution of marine species and species traits from all European regional seas. EMODnet Biology is part of the EU funded European Marine Observation and Data Network and is built upon the World Register of Marine Species and the European Ocean Biogeographic Information System."

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

Datasets included in these observations of Common Dolphin:

Marian Paiu, Eugen Anton, Mihaela Candea. 2012. Observation on dolphin sightings at the Romanian coast and measures to reduce accidental catches in fishing nets. Recherches Marines. nr. 42/149-158

Cetacean sightings in the Black Sea, Sea of Azov and Kerch Strait (CetSiBS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODNet.

Cetacean strandings in the northern Black Sea and the Sea of Azov (CeStraBS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODnet.

Paiu, M., Fujioka, E. 2011. Cetaceans along Romanian Black Sea Coast by boat 2010-2011. Mare Nostrum NGO.

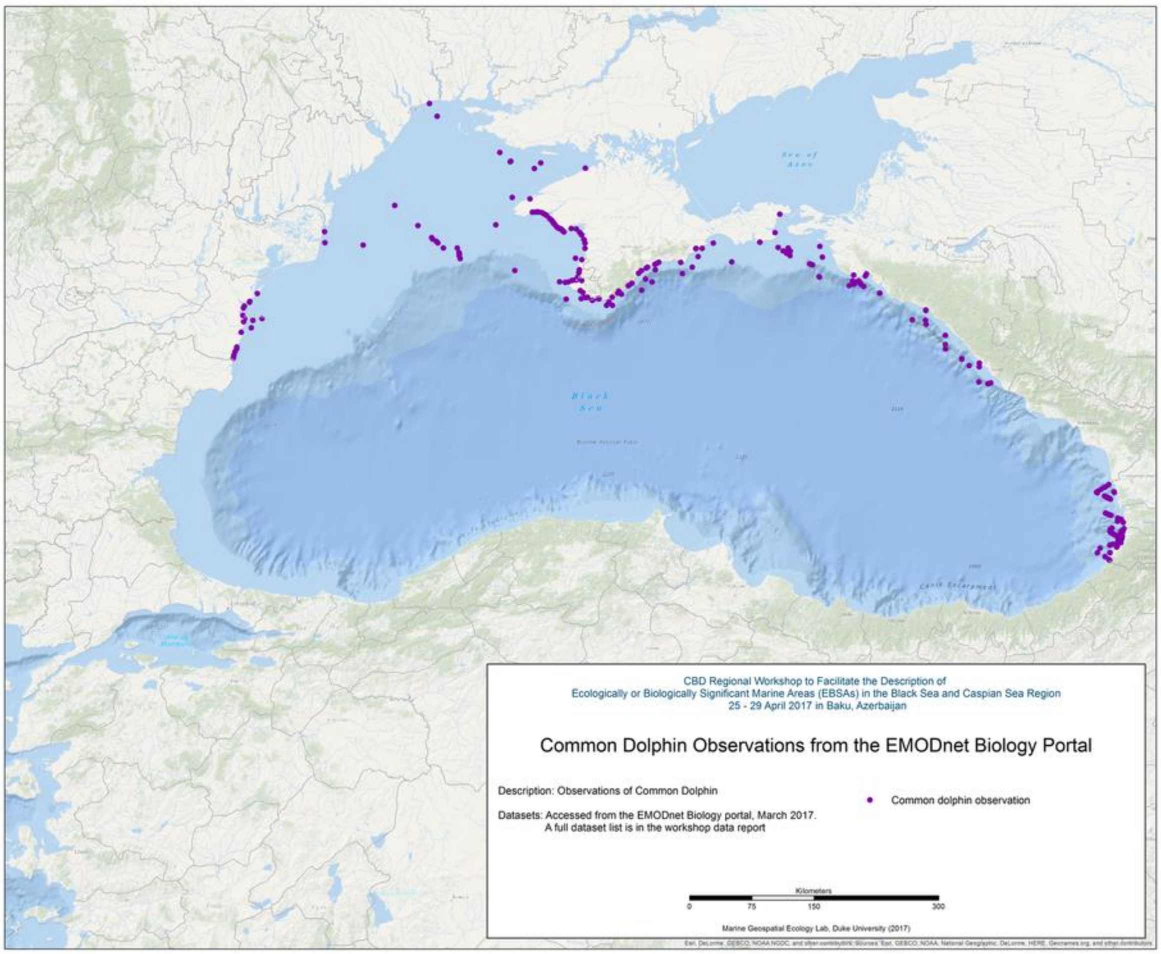

Figure 2.1.2-1 Common Dolphin observations from EMODnet

2.1.3 Harbour Porpoise Observations

"The EMODnet biology data portal provides free access to data on temporal and spatial distribution of marine species and species traits from all European regional seas. EMODnet

Biology is part of the EU funded European Marine Observation and Data Network and is built upon the World Register of Marine Species and the European Ocean Biogeographic Information System."

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

Datasets included in these observations of Harbour Porpoise:

Cetacean strandings in the northern Black Sea and the Sea of Azov (CeStraBS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODnet.

Cetacean bycatches in the northern Black Sea (CetByBlaS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODNet.

Cetacean sightings in the Black Sea, Sea of Azov and Kerch Strait (CetSiBS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODNet.

Paiu, M., Fujioka, E. 2011. Cetaceans along Romanian Black Sea Coast by boat 2010-2011. Mare Nostrum NGO.

Paiu, M., Fujioka, E. 2011. Cetaceans along Romanian Black Sea Coast from shore 2010-2011. Mare Nostrum NGO.

Marian Paiu, Eugen Anton, Mihaela Candea. 2012. Observation on dolphin sightings at the Romanian coast and measures to reduce accidental cathes in fishing nets. Recherches Marines. nr. 42/149-158

Marian Paiu, Eugen Anton, Mihaela Candea. 2012. Observation on dolphin sightings at the Romanian coast and measures to reduce accidental catches in fishing nets. Recherches Marines. nr. 42/149-158

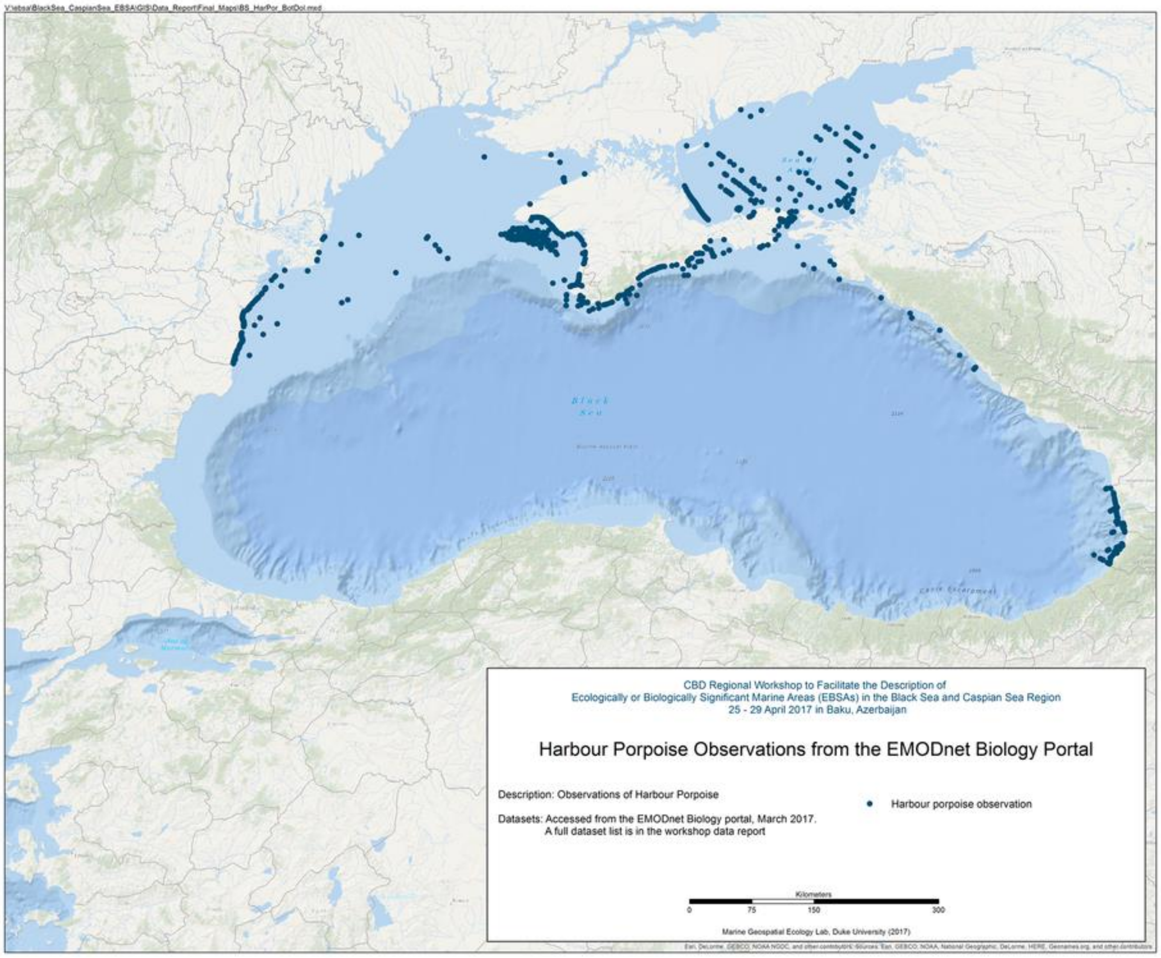

Figure 2.1.3-1 Harbour Porpoise observations from EMODnet

2.1.4 Bottlenose Dolphin Observations

"The EMODnet biology data portal provides free access to data on temporal and spatial distribution of marine species and species traits from all European regional seas. EMODnet Biology is part of the EU funded European Marine Observation and Data Network and is built upon the World Register of Marine Species and the European Ocean Biogeographic Information System."

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

Datasets included in these observations of Bottlenose Dolphin:
Cetacean strandings in the northern Black Sea and the Sea of Azov (CeStraBS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODnet.

Cetacean sightings in the Black Sea, Sea of Azov and Kerch Strait (CetSiBS). 2011. Dataset assembled by A. Birkun, Jr. and S. Krivokhizhin. EMODNet.

Paiu, M., Fujioka, E. 2011. Cetaceans along Romanian Black Sea Coast by boat 2010-2011. Mare Nostrum NGO.

Marian Paiu, Eugen Anton, Mihaela Candea. 2012. Observation on dolphin sightings at the Romanian coast and measures to reduce accidental catches in fishing nets. Recherches Marines. nr. 42/149-158

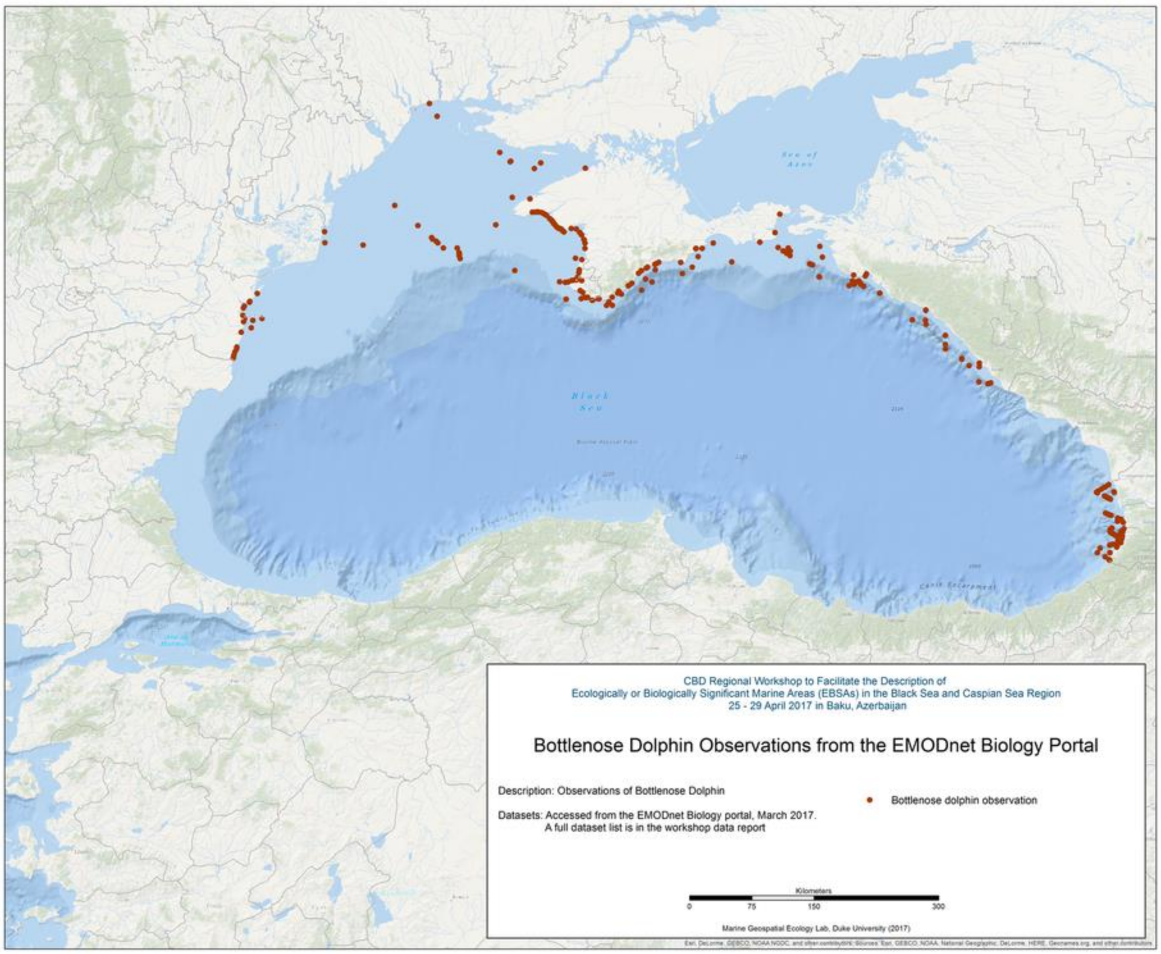

Figure 2.1.4-1 Bottlenose Dolphin observations from EMODnet

2.1.5 Non-Breeding Distribution for Yelkouan Shearwater

This map shows the non-breeding season distribution of the Yelkouan shearwater *Puffinus yelkouan*, a globally threatened seabird species classified as Vulnerable in the IUCN's red list of threatened species (BirdLife International 2017a).

Reference:

BirdLife International, 2017a. IUCN Red List for birds. Downloaded from http://www.birdlife.org on 10/03/2017

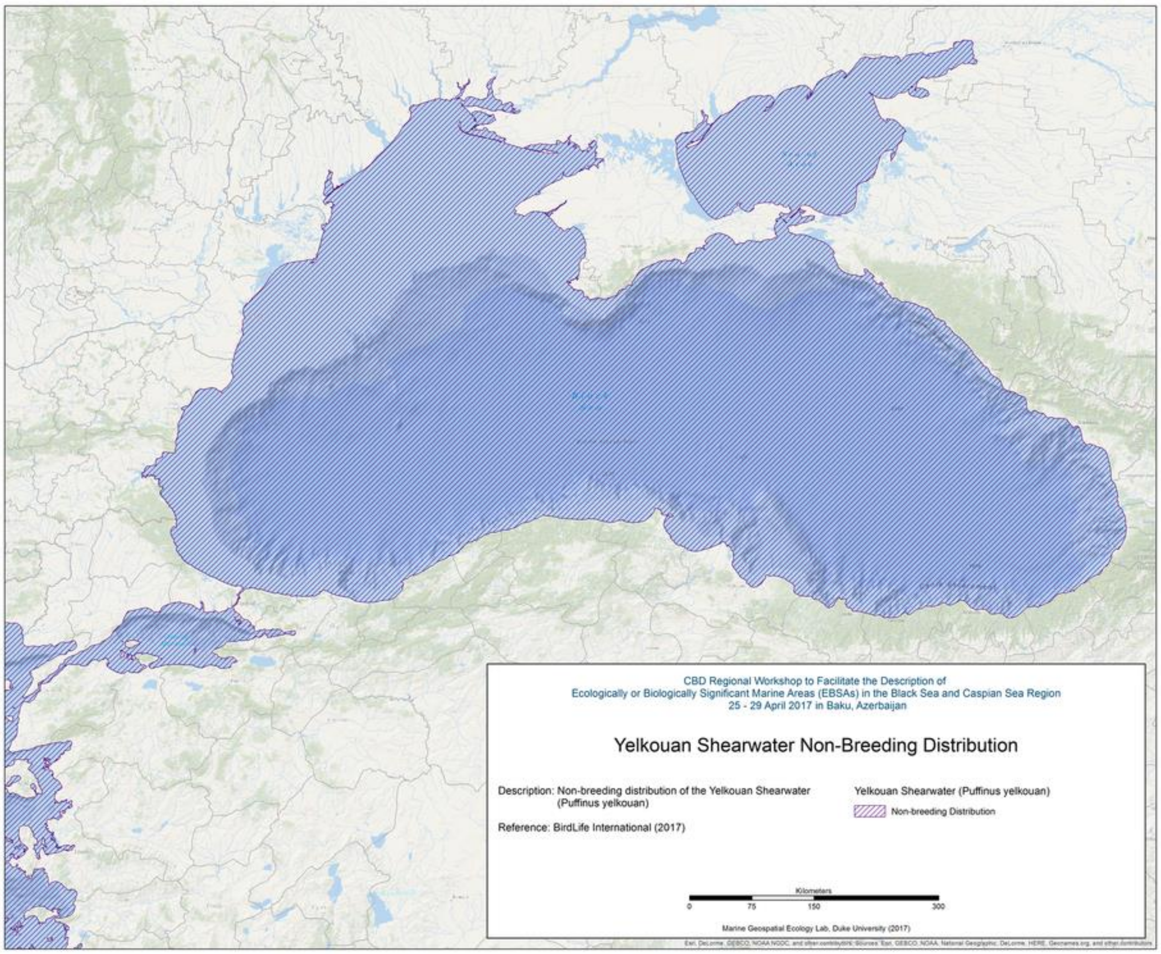

Figure 2.1.5-1 Non-Breeding Distribution for Yelkouan Shearwater

2.1.6 Non-Breeding Distribution for Velvet Scoter

This map shows the non-breeding season distribution of the Velvet Scoter *Melanitta fusca*, a globally threatened seabird species classified as Vulnerable in the IUCN's red list of threatened species (BirdLife International 2017a).

Reference:

BirdLife International, 2017a. IUCN Red List for birds. Downloaded from http://www.birdlife.org on 10/03/2017

Figure 2.1.6-1 Non-Breeding Distribution for Velvet Scoter

2.1.7 Non-Breeding Distribution for Horned Grebe

This map shows the non-breeding season distribution of the Horned Grebe *Podiceps auritus*, a globally threatened seabird species classified as Vulnerable in the IUCN's red list of threatened species (BirdLife International 2017a).

Reference:

BirdLife International, 2017a. IUCN Red List for birds. Downloaded from http://www.birdlife.org on 10/03/2017

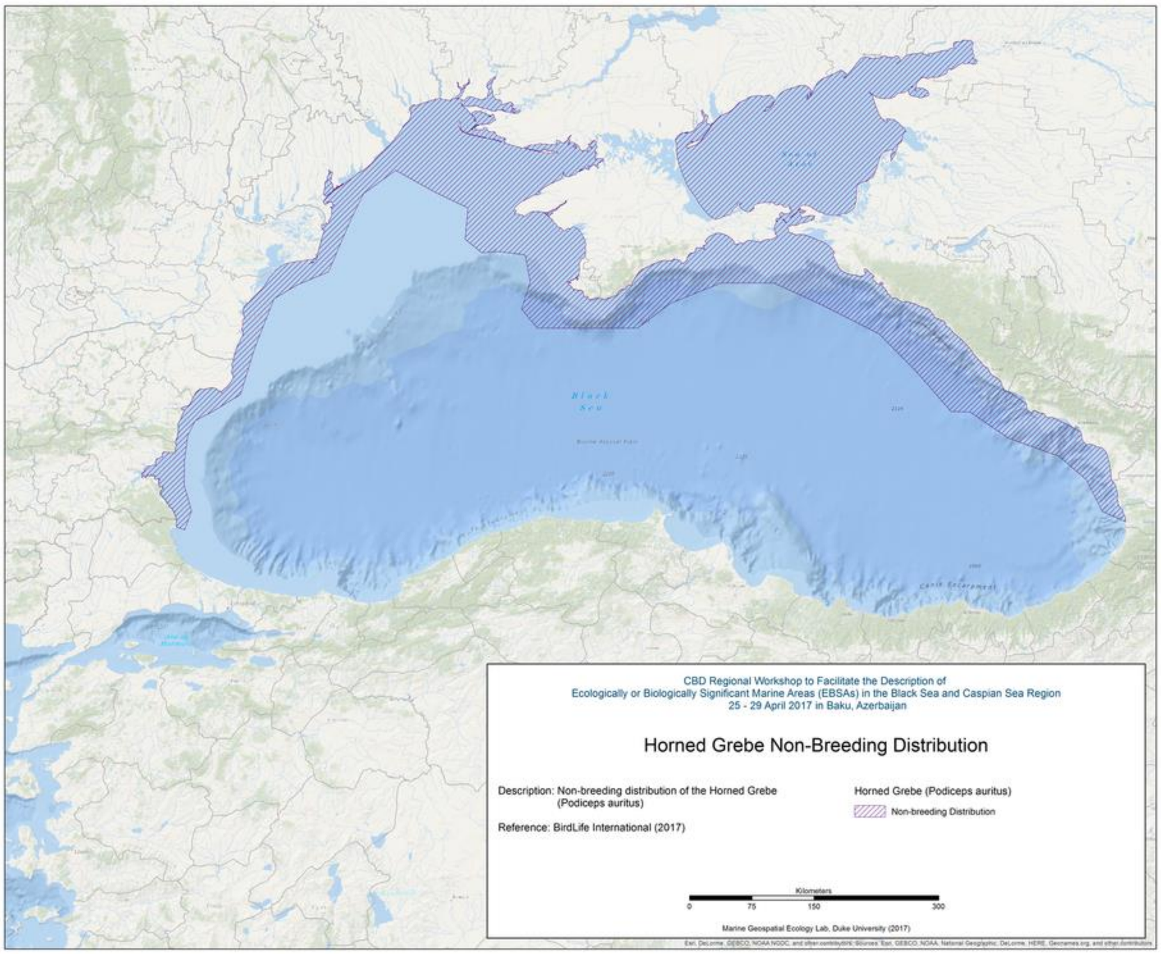

Figure 2.1.7-1 Non-Breeding Distribution for Horned Grebe

2.1.8 Ocean Biogeographic Information System (OBIS)

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:
http://www.iobis.org/about/index

The data provided here are summaries of available OBIS data. Species Richness and Hurlbert's Index (ES[50]) data summaries for 0.1 degree grids are provided for all species, mammals, shallow species (<100m depth), and deep species (>100m depth). Data gaps do exist in OBIS and thus these summaries are not exhaustive.

Reference:
Intergovernmental Oceanographic Commission (IOC) of UNESCO. The Ocean Biogeographic Information System. Web. http://www.iobis.org. (Consulted on 01/03/17)

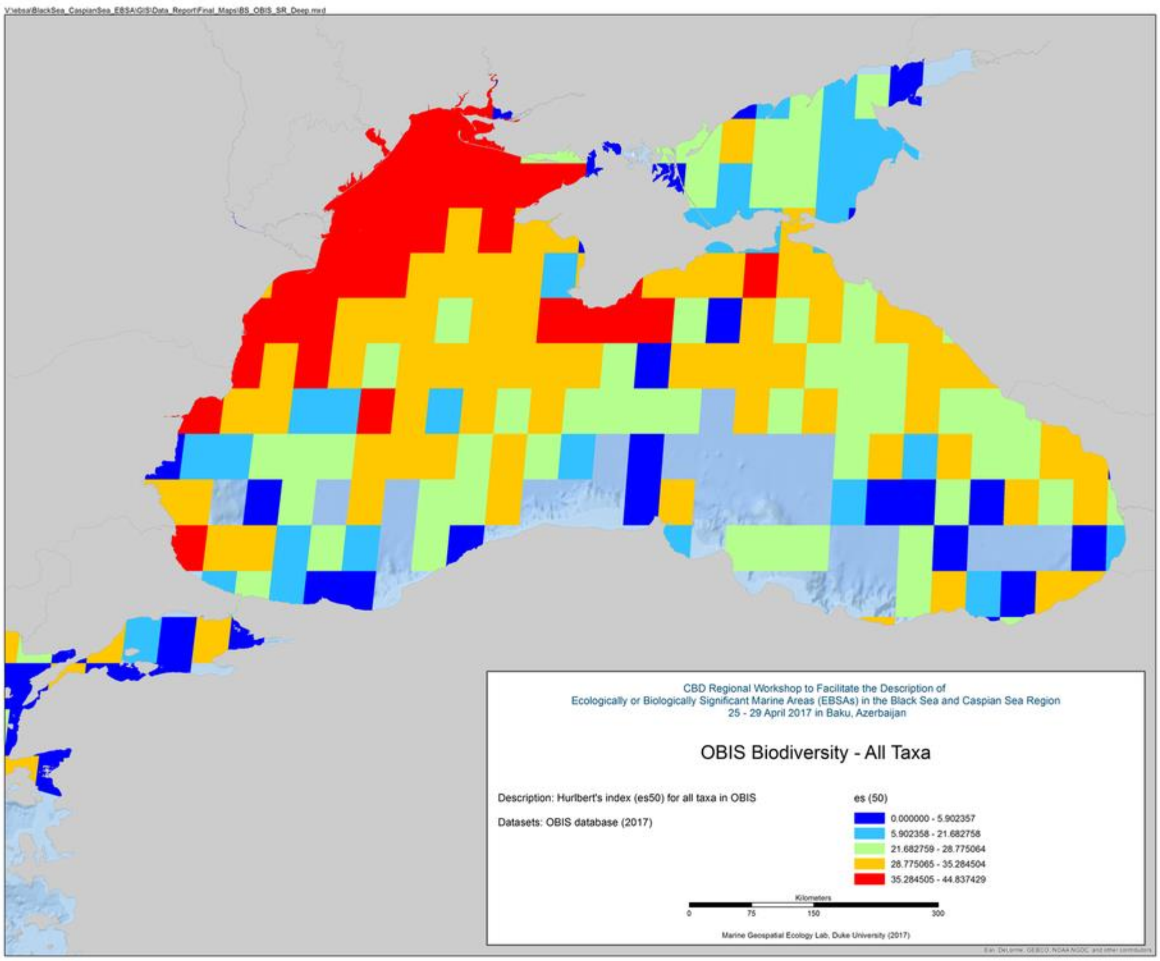

Figure 2.1.8-1 Biodiversity ES(50) for All Taxa

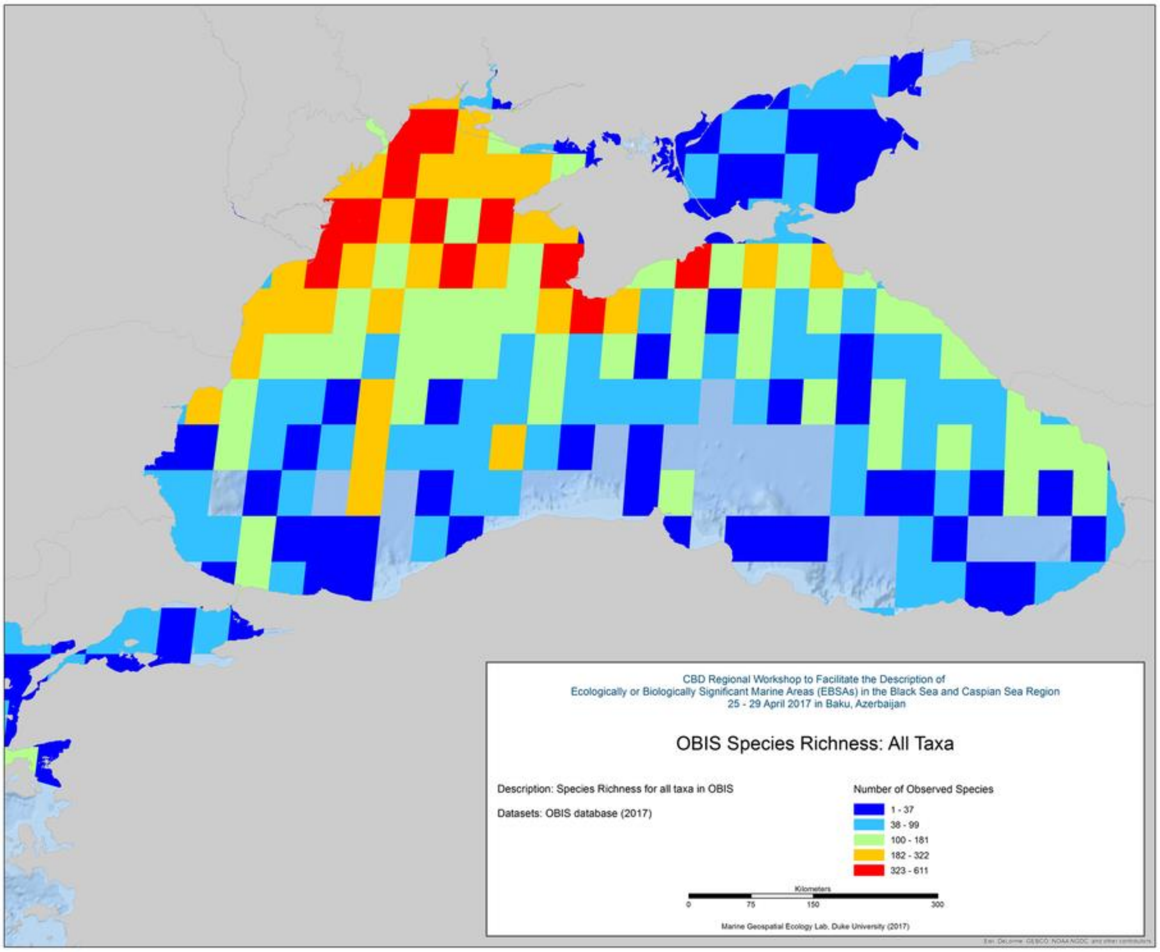

Figure 2.1.8-2 Species Richness for All Taxa

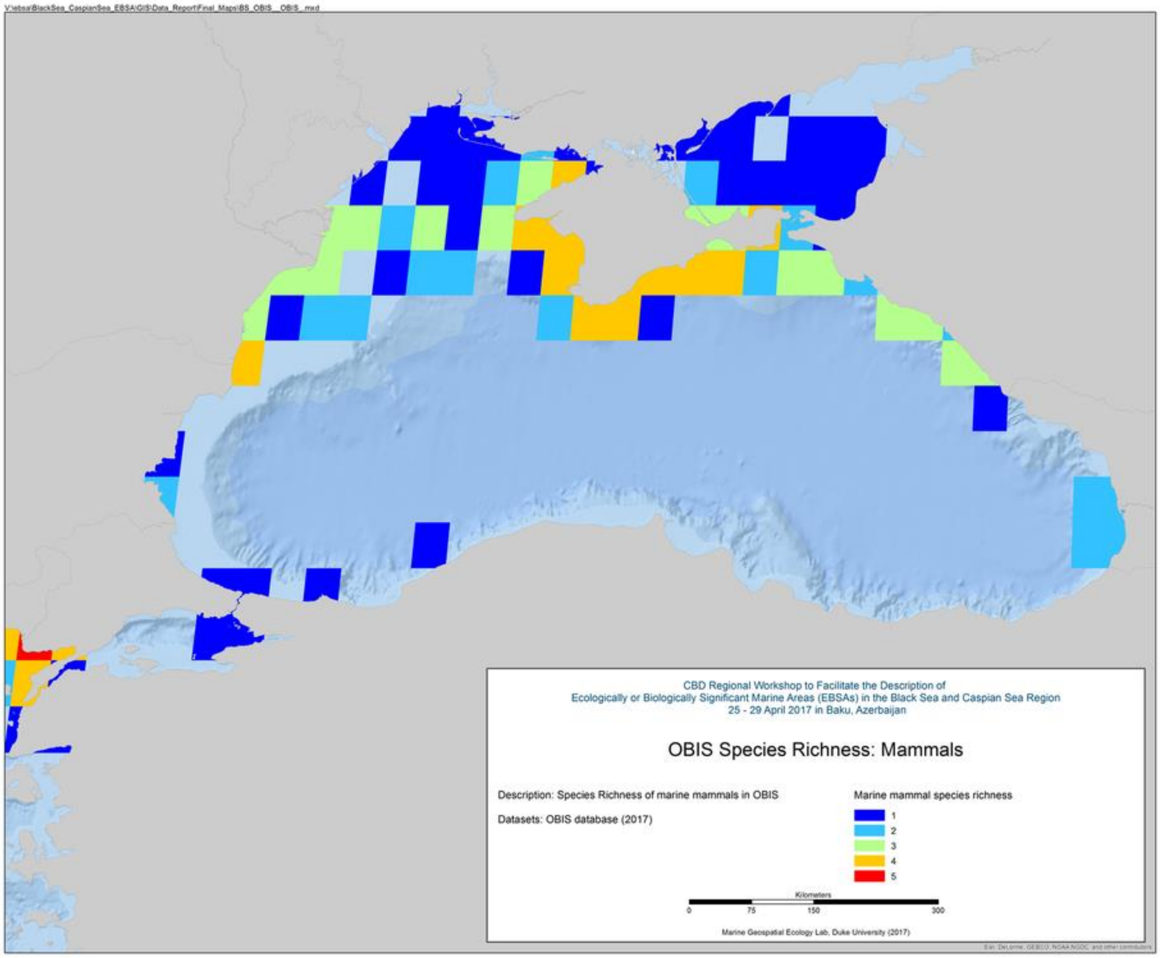

Figure 2.1.8-3 Species Richness for Marine Mammals

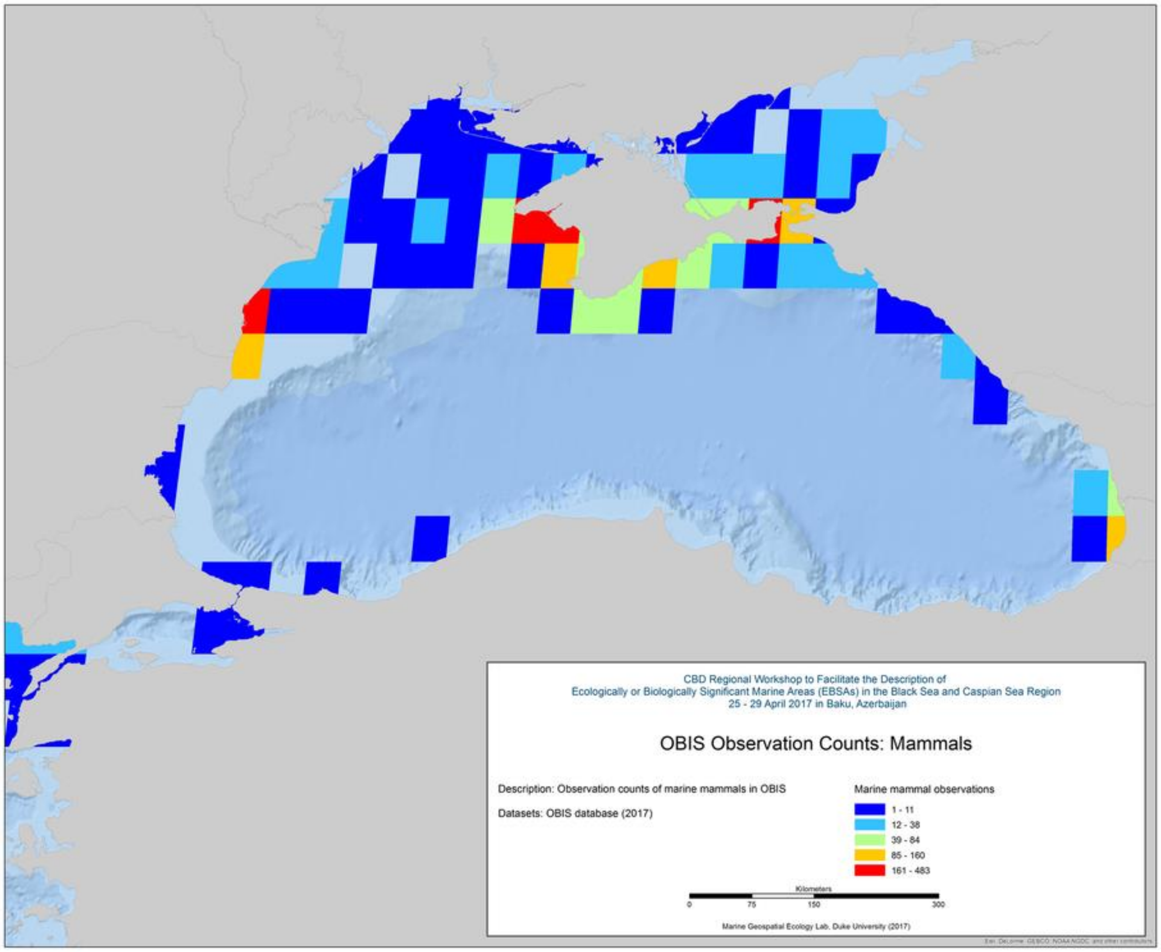

Figure 2.1.8-4 Observation count for Marine Mammals

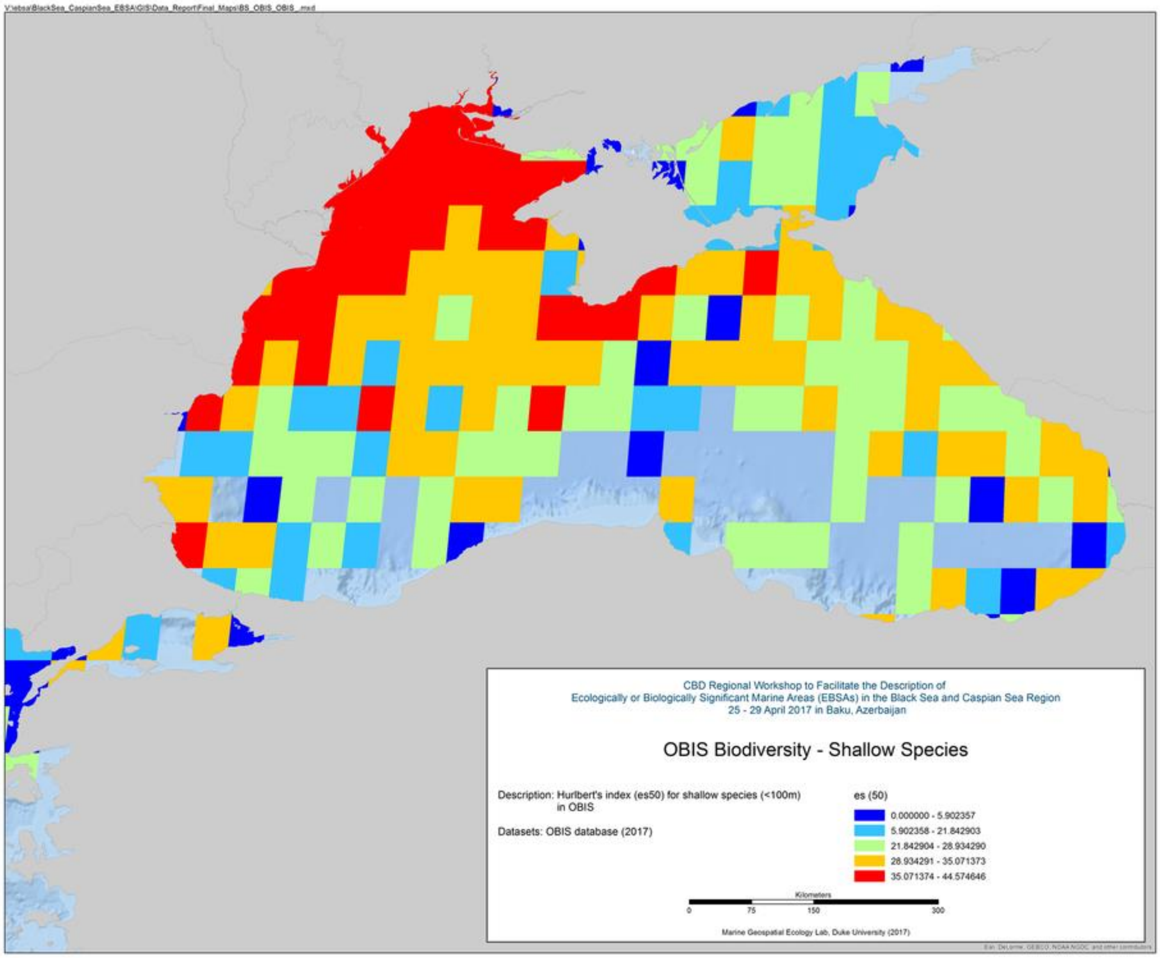

Figure 2.1.8-5 Biodiversity ES(50) for Shallow Species

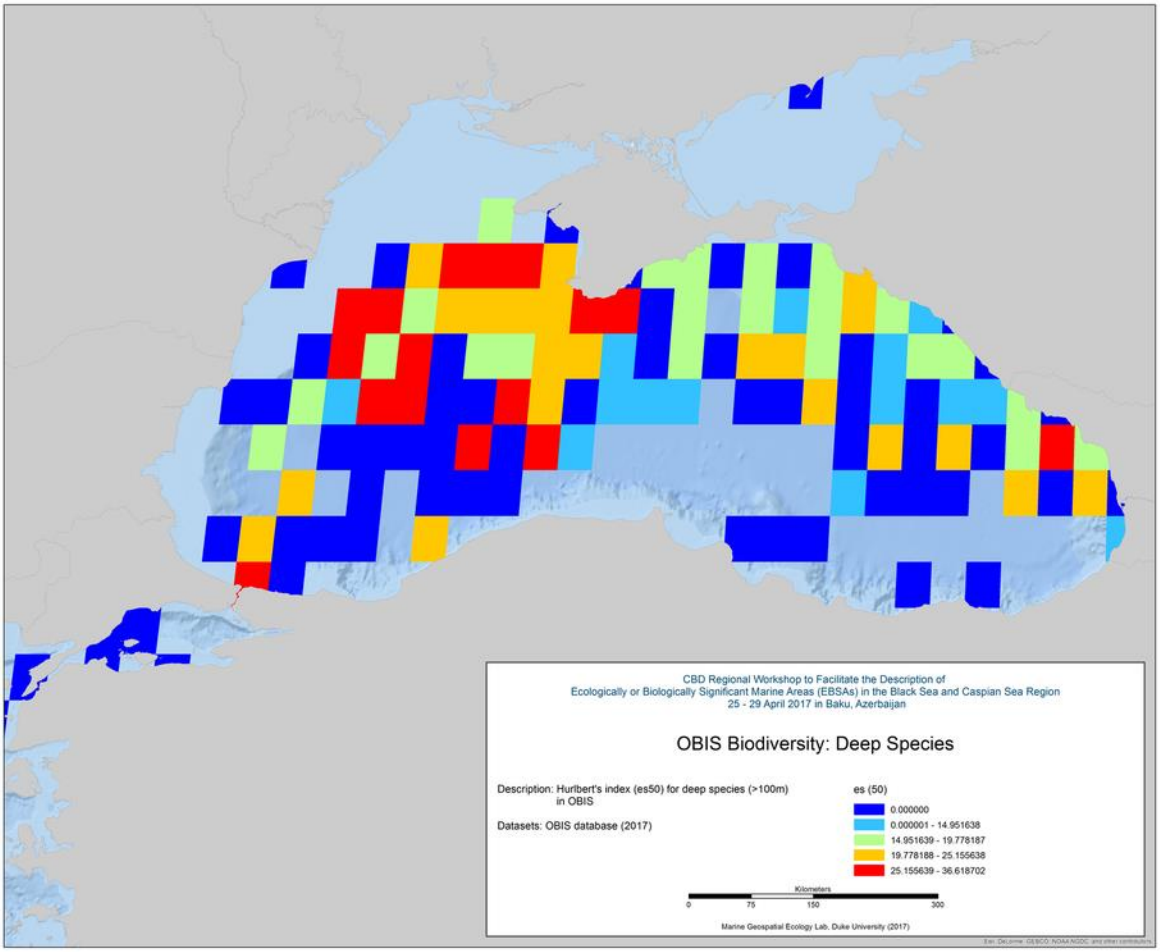

Figure 2.1.8-6 Biodiversity ES(50) for Deep Species

2.2 Physical Data

2.2.1 EMODnet Digital Terrain Model (DTM) Bathymetry and Slope

Abstract:
"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 (2016). EMODnet Digital Bathymetry (DTM). EMODnet Bathymetry. http://doi.org/10.12770/c7b53704-999d-4721-b1a3-04ec60c87238

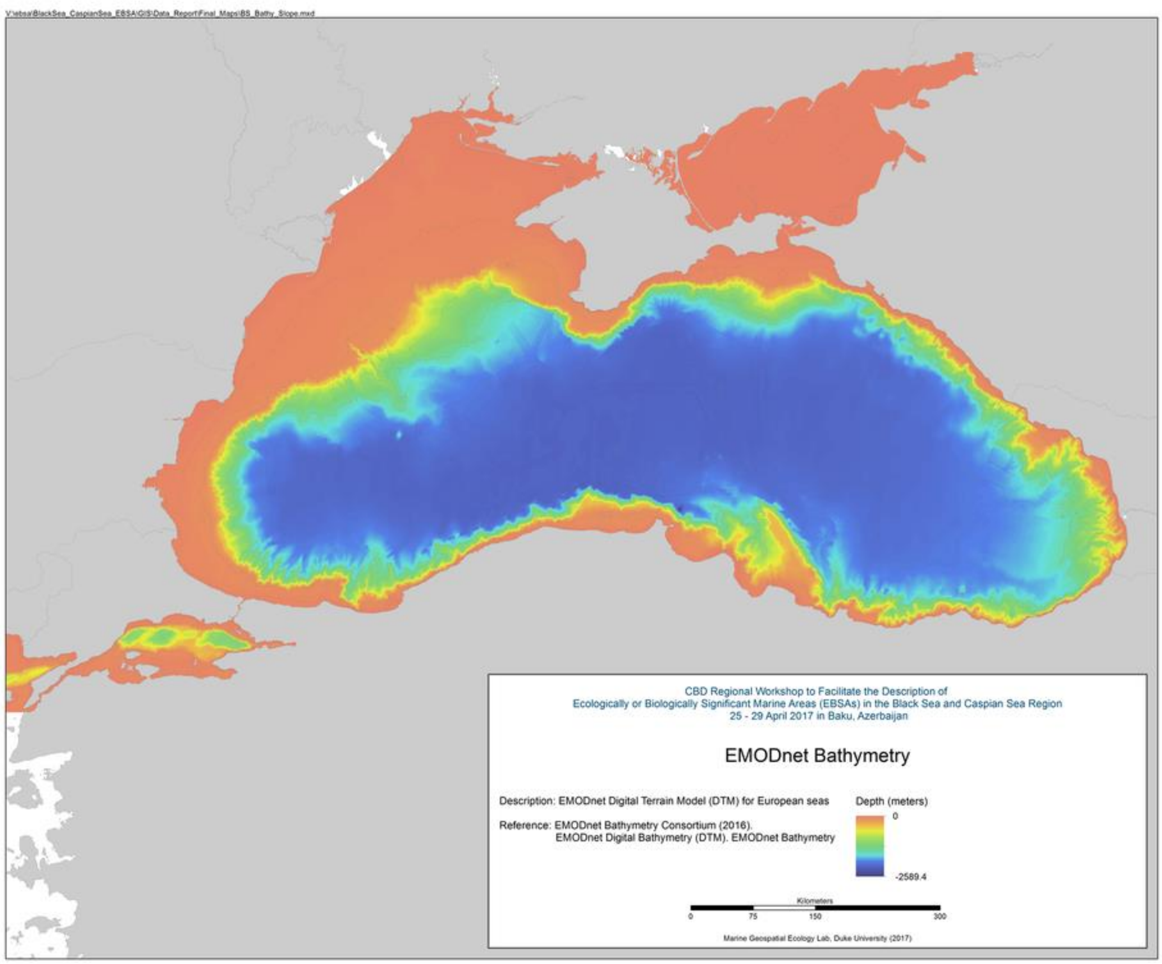

Figure 2.2.1-1 EMODnet Bathymetry

Slope derived from EMODnet Digital Terrain Model (DTM) bathymetry with ArcGIS 10.4.1.

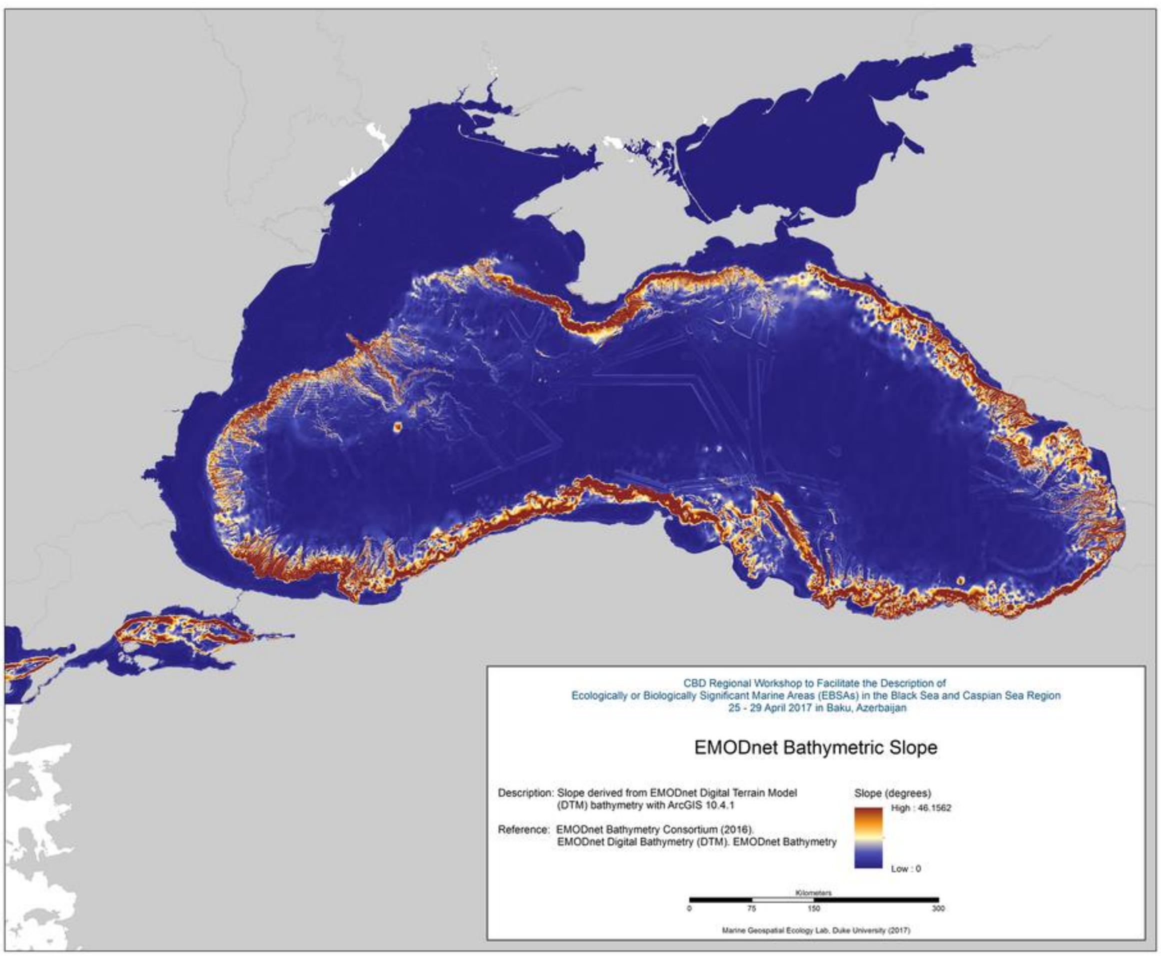

Figure 2.2.1-2 EMODnet Bathymetric Slope

2.2.2 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."

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."

Source:
http://www.noc.soton.ac.uk/chess/

Dataset:
http://www.noc.soton.ac.uk/chess/database/db_home.php

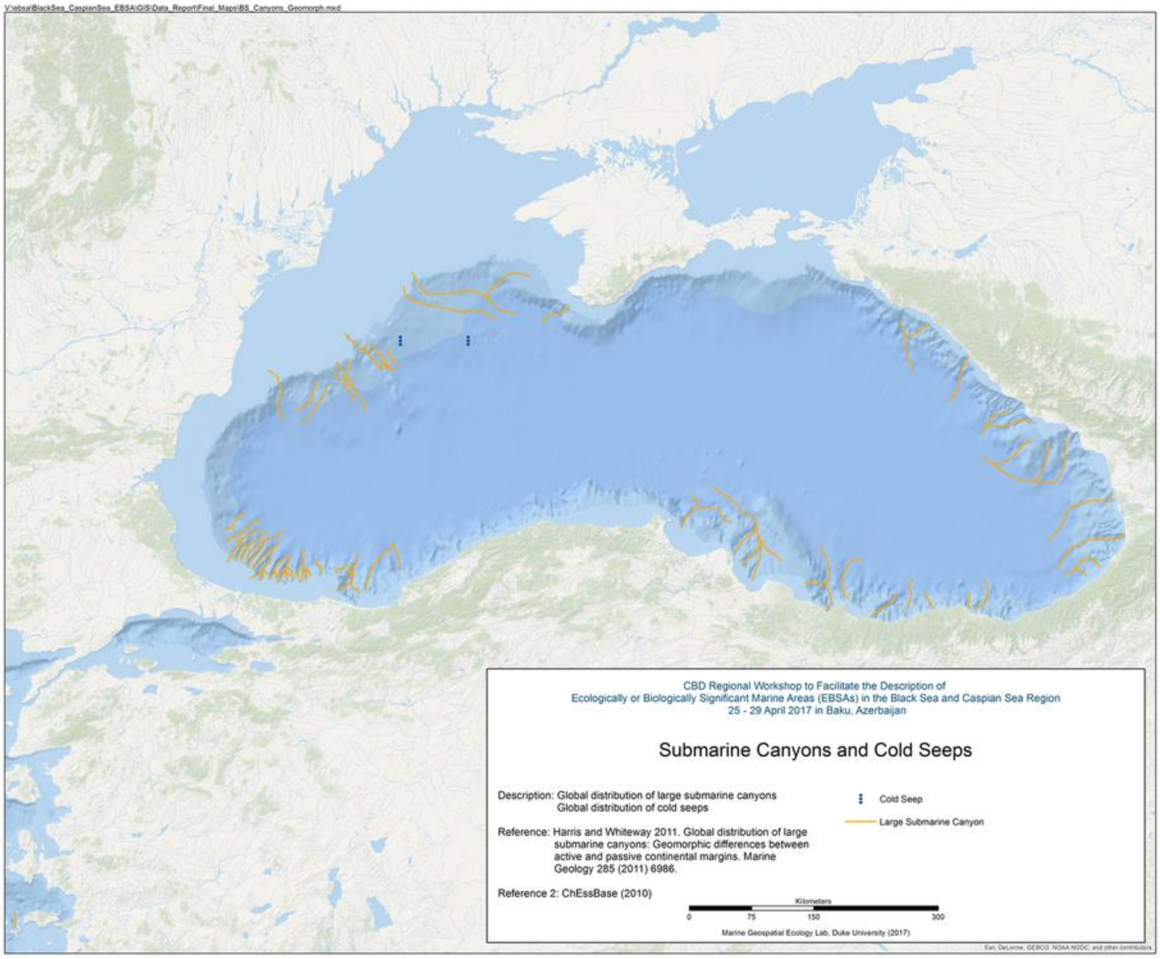

Figure 2.2.2-1 Submarine Canyons and Cold Seeps

2.2.3 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

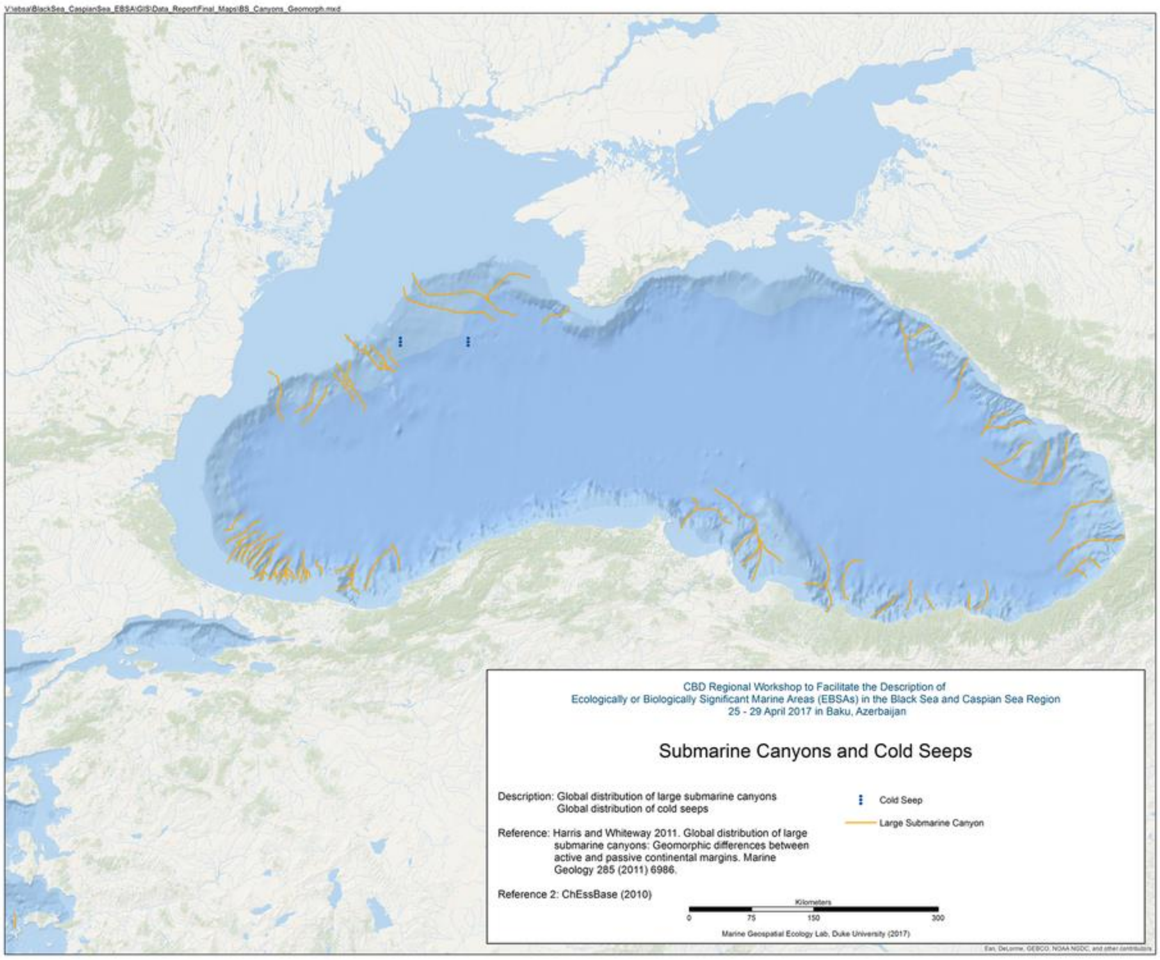

Figure 2.2.3-1 Submarine Canyons

2.2.4 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^2adjacent 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

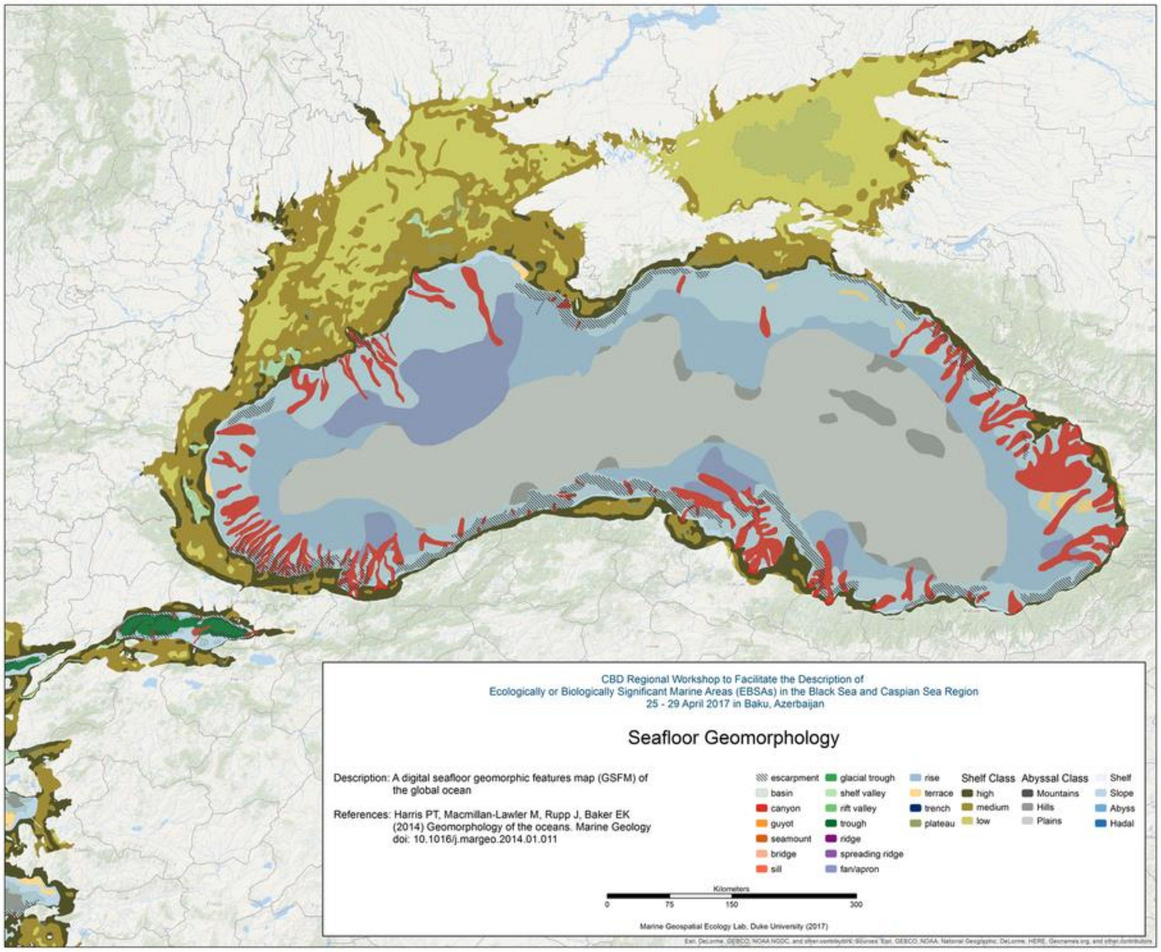

Figure 2.2.4-1 Seafloor Geomorphology

2.2.5 EMODnet Seabed Habitats

Overview:

"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:
http://www.emodnet-seabedhabitats.eu/default.aspx?page=2011)

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

Mapped below is the output of the 2016 EUSeaMap broad-scale predictive model, produced by EMODnet Seabed Habitats.

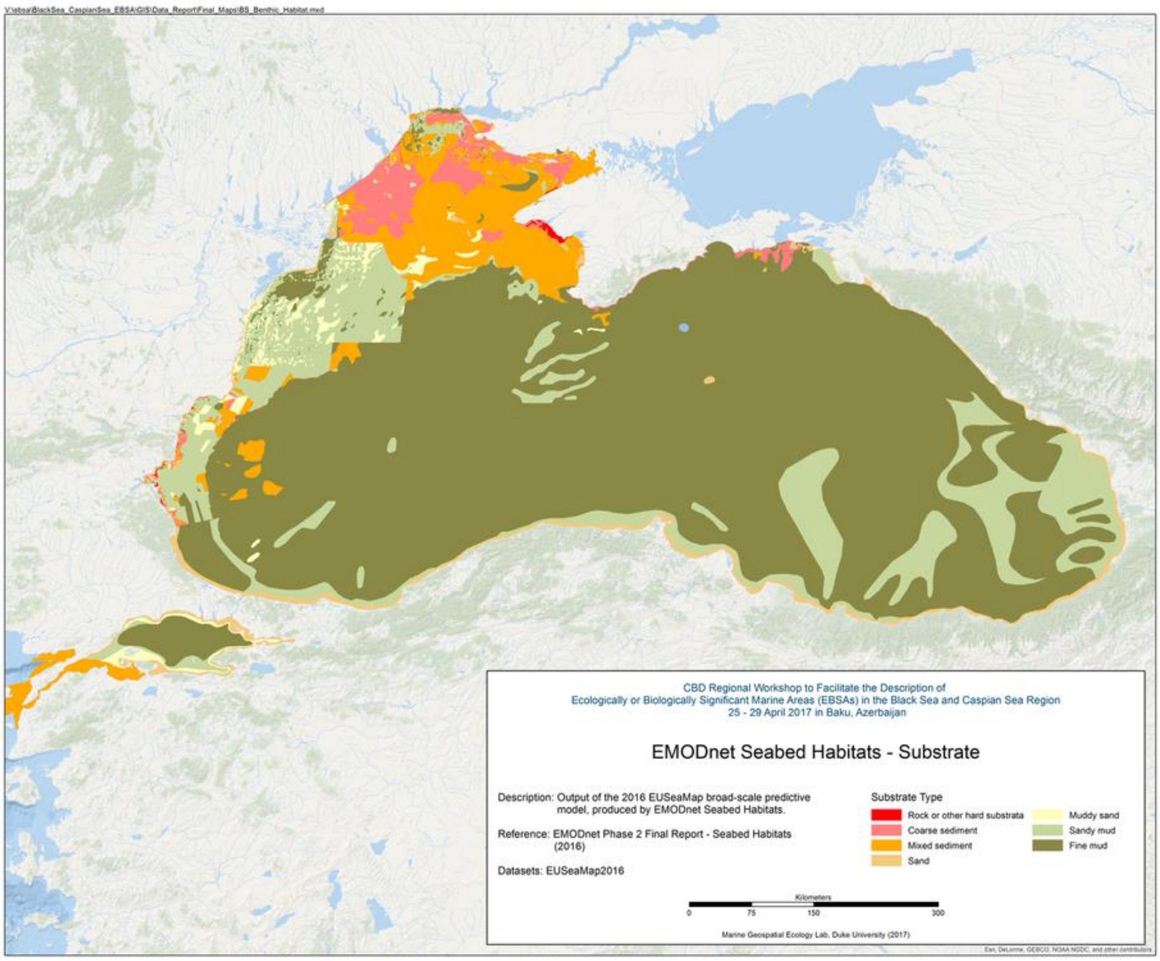

Figure 2.2.5-1 EMODnet Seabed Habitats - Substrate

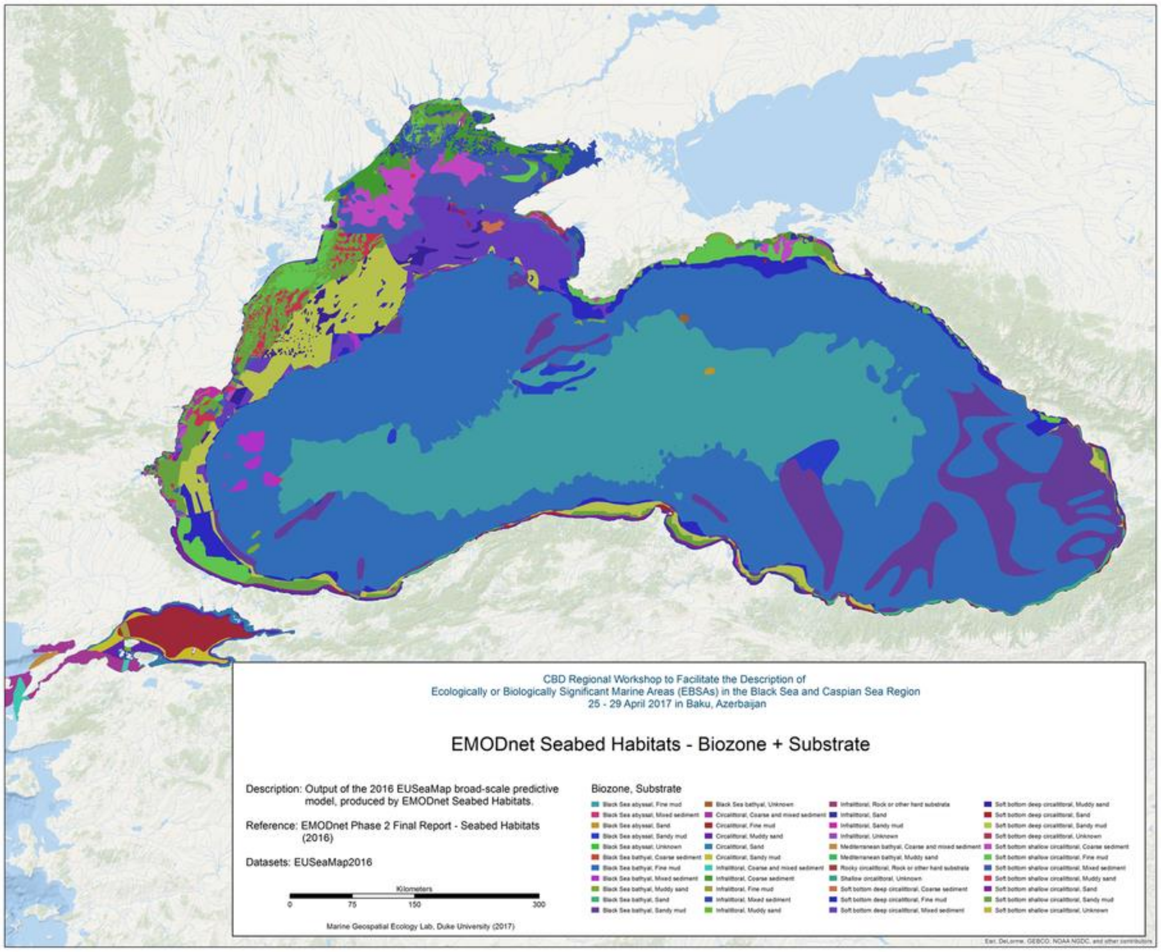

Figure 2.2.5-2 EMODnet Seabed Habitats – Biozone and Substrate

2.2.6 Sea Surface Temperature

The 4k 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 (2006 – 2016) 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:

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

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.

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

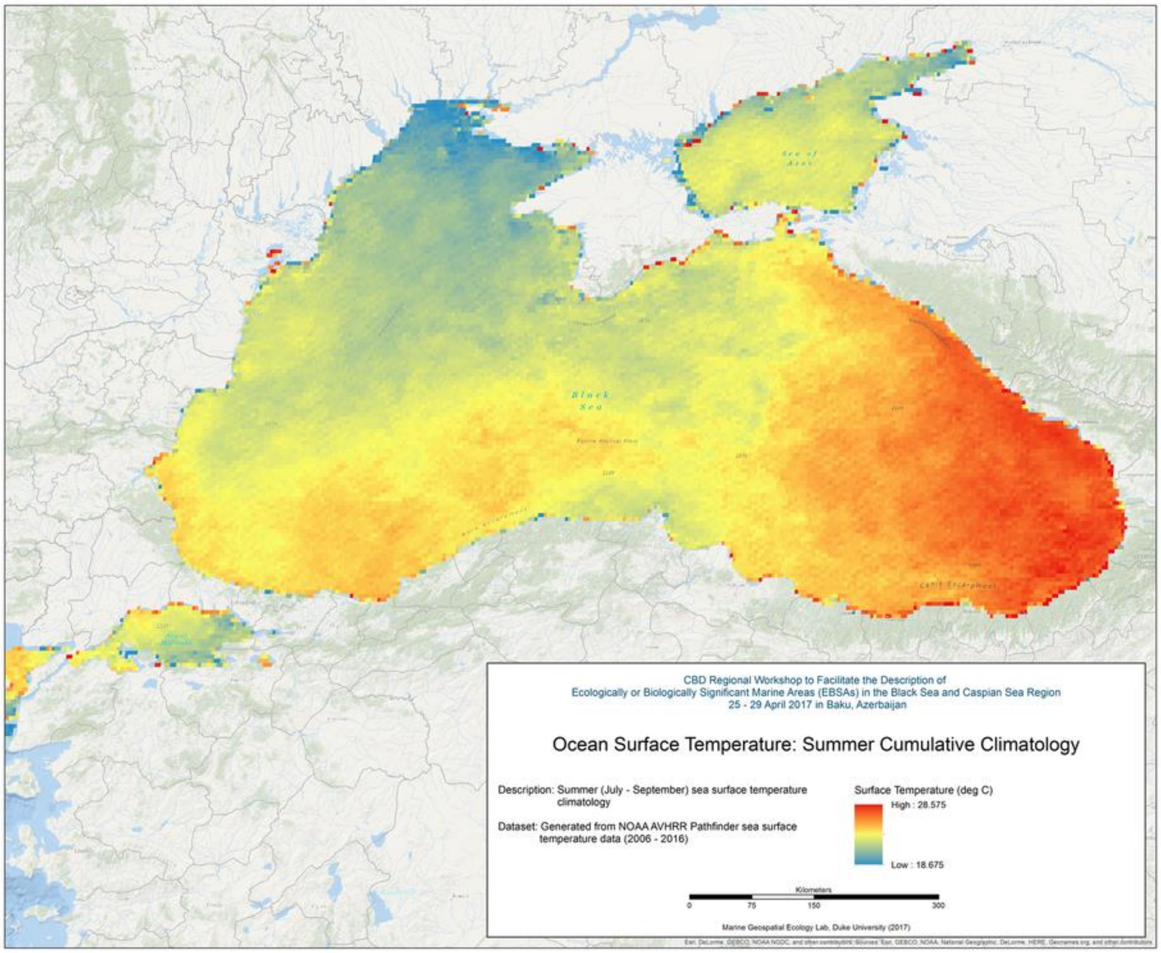

Figure 2.2.6-1 Sea Surface Temperature – Summer Cumulative Climatology

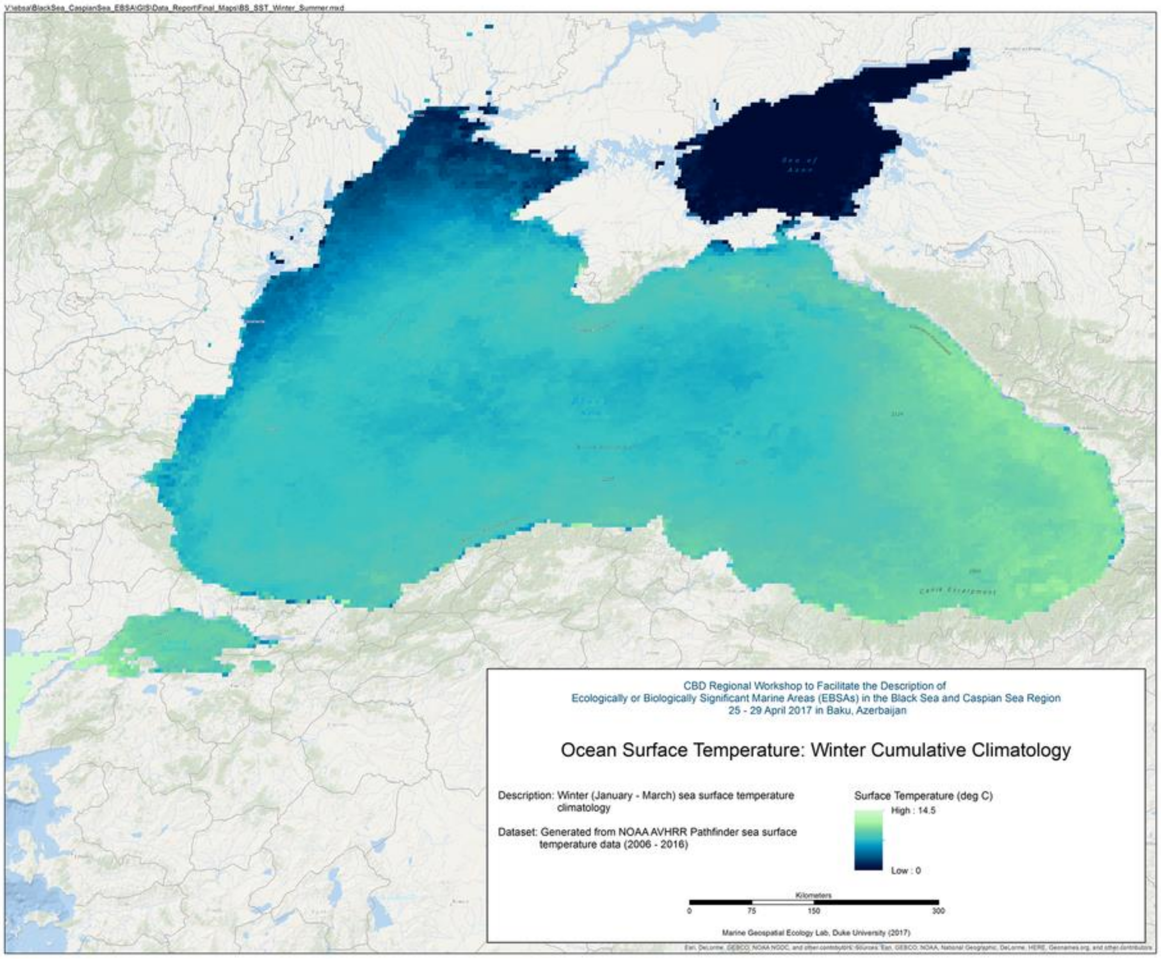

Figure 2.2.6-2 Sea Surface Temperature – Winter Cumulative Climatology

2.2.7 Chlorophyll A Climatology

Here, seasonal cumulative (2006-2016) chlorophyll A climatologies 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 4km monthly data from the MODIS Terra platform. One climatology was generated for each quarter: January – March, April – June, July – September, October - December.

Reference:

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.

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

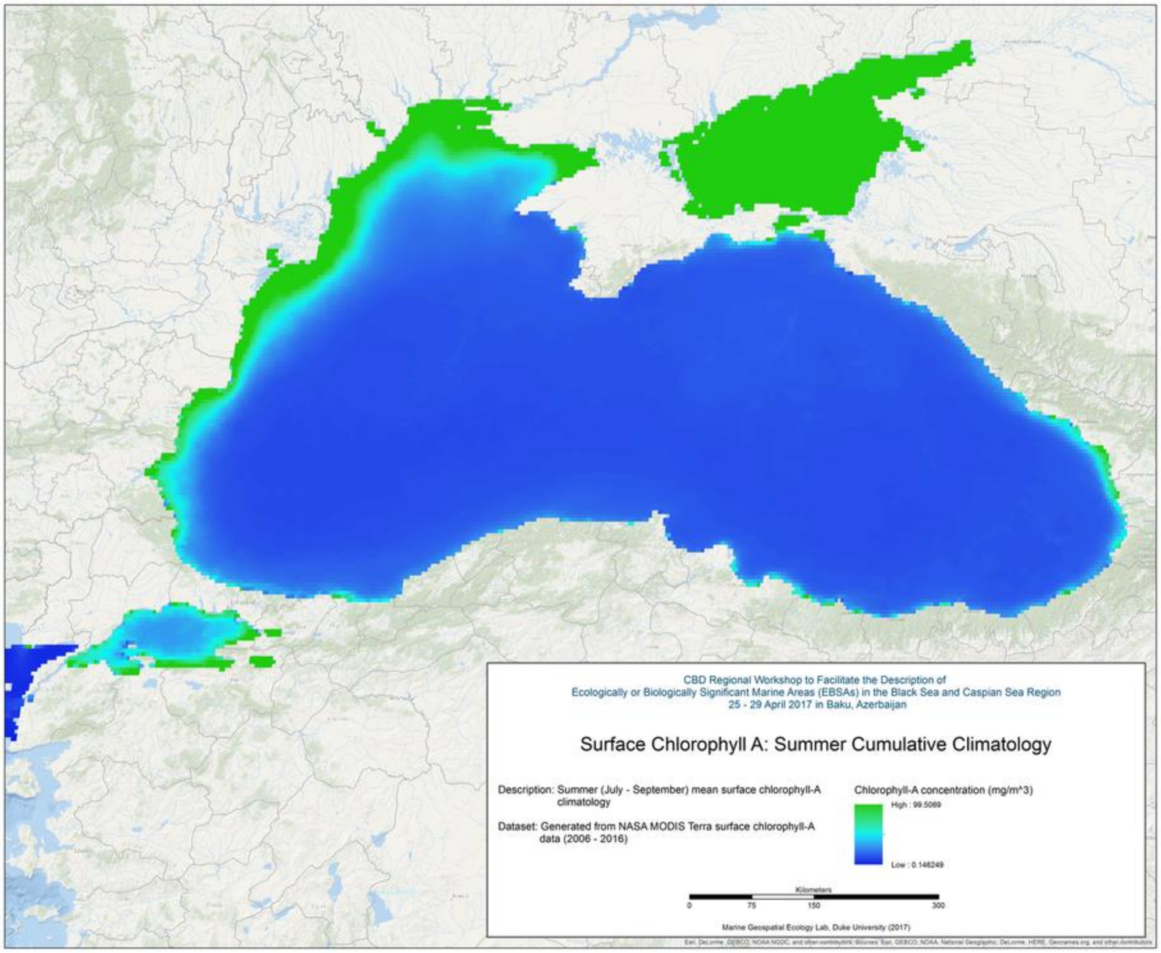

Figure 2.2.7-1 Chlorophyll A Concentration Summer Cumulative Climatology (July – September)

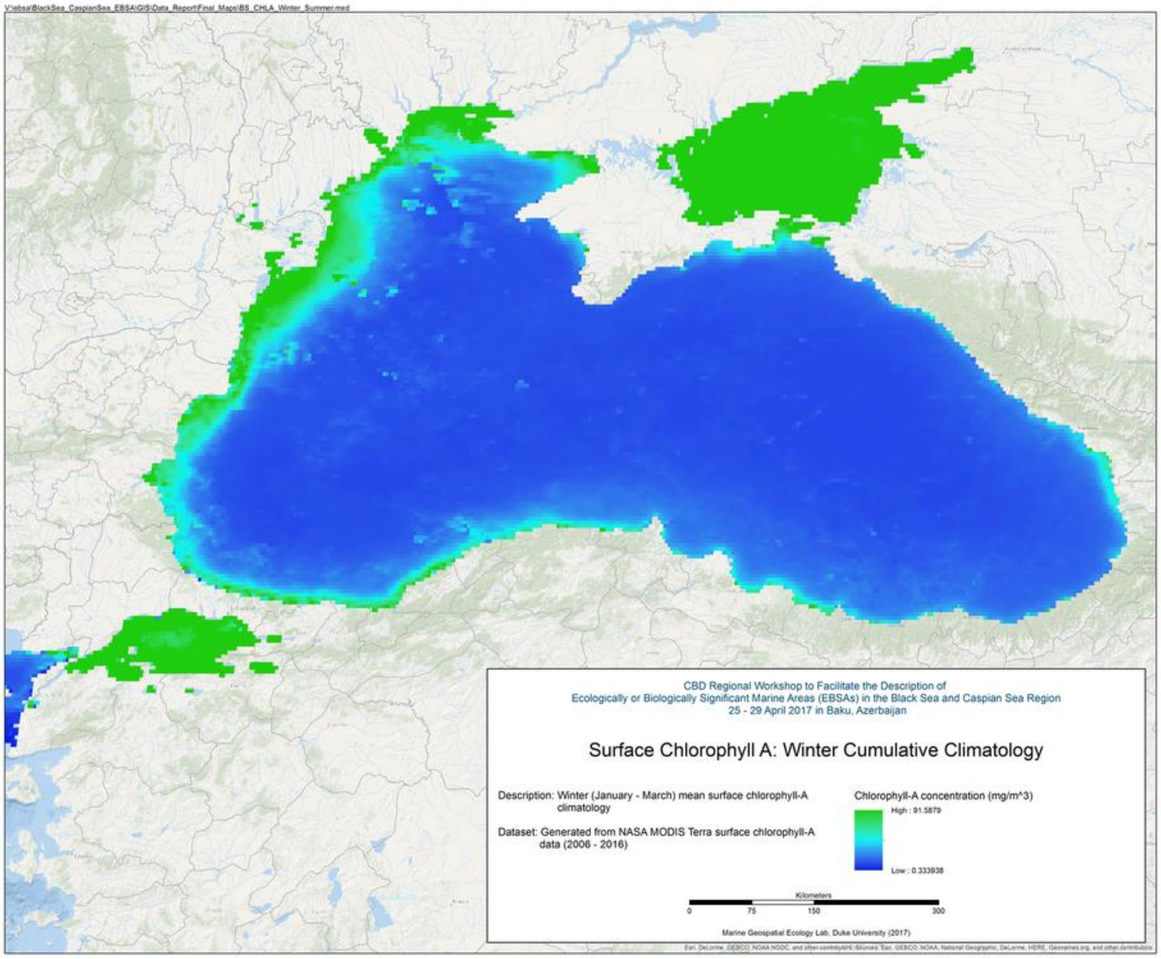

Figure 2.2.7-2 Chlorophyll A Concentration Winter Cumulative Climatology (January - March)

2.2.8 Vertically Integrated Net Primary Productivity Climatology

Abstract:

"The Black Sea biogeochemical model (BS-Biogeochemistry) is the Biogeochemical Model for Hypoxic and Benthic Influenced areas (BAMHBI, Gregoire et al., 2008; Capet et al., 2016). It describes the foodweb from bacteria to gelatinous carnivores through 24 state variables including three groups of phytoplankton: diatoms, small phototrophic flagellates and dinoflagellates, two zooplankton groups: micro- and mesozooplankton, two groups of gelatinous zooplankton: the omnivorous and carnivorous forms, an explicit representation of the bacterial loop: bacteria, labile and semi-labile dissolved organic matter, particulate organic matter. The model simulates oxygen, nitrogen, silicate and carbon cycling. In addition, an innovation of this model is that it explicitly represents processes in the anoxic layer.

Biogeochemical processes in anaerobic conditions have been represented using an approach similar to that used in the modelling of diagenetic processes in the sediments lumping together all the reduced substances in one state variable. In this way, processes in the upper oxygenated layer are fully coupled with anaerobic processes in the deep waters, allowing performing long term simulations. This fully coupling between aerobic, suboxic and anoxic processes is absolutely necessary for performing the long term reanalysis. Processes typical of low oxygen environments like denitrification, anaerobic ammonium oxidation (ANAMMOX), reduced decomposition efficiency have been explicitly represented (Gregoire et al., 2008). Moreover, the model includes a representation of diagenetic processes (Capet et al., 2016) using an efficient and economic representation as proposed by Soetaert et al., 2000. The incorporation of a benthic module allows to represent the impact of sediment processes on important biogeochemical processes such as sediment oxygen consumption (that is responsible for the generation of hypoxic conditions in summer), the active degradation of organic matter that determines the vigour of the shelf ecosystem (~30 % of the primary production produced in shelf waters is degraded in the sediment) and the intense consumption of nitrate by benthic denitrification that filters a substantial part (~50 %) of the nitrogen brought by the north-western shelf rivers (the Danube being the most important one) and modulates primary production in the deep basin. In addition to a representation of diagenesis, the biogeochemical model represents the transport of sediments by waves. This is an important feature that is necessary in order to sustain the primary production of the deep basin. From V0 to V3, the BS-Biogeochemistry model is online coupled with the GHER Ocean model and will be run with a horizontal resolution of 1/22° (5km) and 31 vertical levels using double-sigma terrain following coordinates."

Source:
http://sextant.ifremer.fr/en/geoportail/sextant#/metadata/326400c1-89a1-4e7f-aaa3-7fc411ccb69f

References:
Capet A., Meysman, F., Akoumianaki, I., Soetaert, K. and Grégoire, M. 2016. Integrating sediment biogeochemistry into 3D oceanic models: A study of benthic pelagic coupling in the Black Sea. Ocean Modelling, 101, 83-100.

Grégoire, M., Raick, C., & Soetaert, K. (2008). Numerical modeling of the deep Black Sea ecosystem functioning during the late 80's (eutrophication phase). Progress in Oceanography, 76(9), 286-333

Dataset:
BLKSEA_ANALYSIS_FORECAST_BIO_007_002 from GHER-BAMHBI

Processing:
Daily data from 2016 model output were created and averaged into seasonal climatologies. Two seasonal maps are shown below. All four seasons are available for use by workshop attendees.

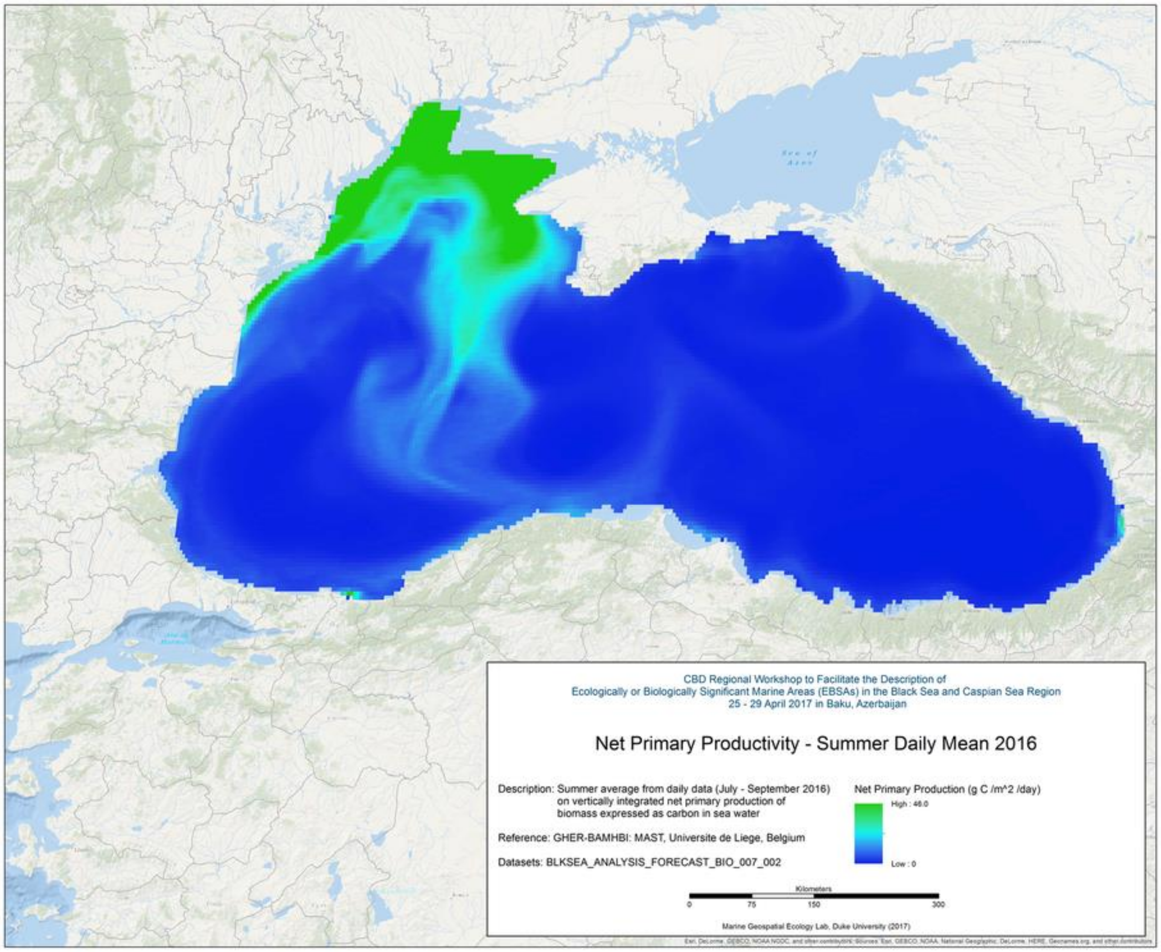

Figure 2.2.8-1 Net Primary Productivity – Summer daily mean 2016

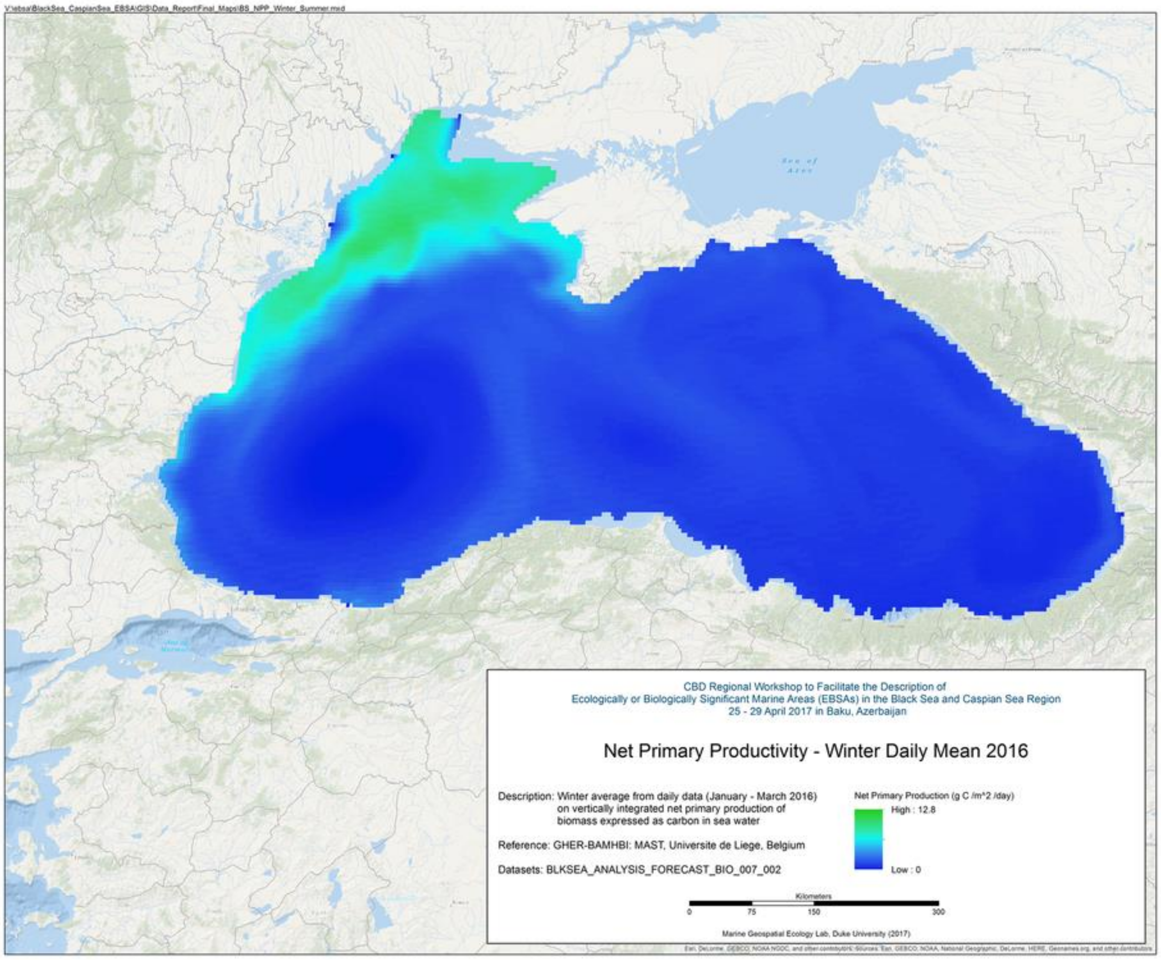

Figure 2.2.8-2 Net Primary Productivity – Winter daily mean 2016

2.2.9 Dissolved Oxygen Climatology

Abstract:
"Gridded product for visualization of water body dissolved oxygen concentration in the Black Sea generated by DIVA 4.6.11 using all EMODNET data from 1970 to 2014. Depth range (IODE standard depths): 0 – 250m. DIVA settings: signal-to-noise ratio and correlation length were estimated using data mean distance as a minimum (for L), and both parameters vertically filtered. Background field: the data mean value is subtracted from the data. Detrending of data: no. Advection constraint applied: no. Every year of the time dimension corresponds to a 10-year centred average for the season."

Source:
http://sextant.ifremer.fr/en/geoportail/sextant#/metadata/636541c0-27d0-11e6-9fd1-c996741cbd22

Reference:
DIVA 4D analysis of water body dissolved oxygen concentration. National Institute for Marine Research and Development “Grigore Antipa” (NIMRD)

Dataset:
DIVA 4.6.11 using all EMODNET data

Processing:
Surface data for the latest 10-year running average (2000-2010) were extracted from each of four seasonal data files. Two seasonal maps are shown below. All four seasons are available for use by workshop attendees.

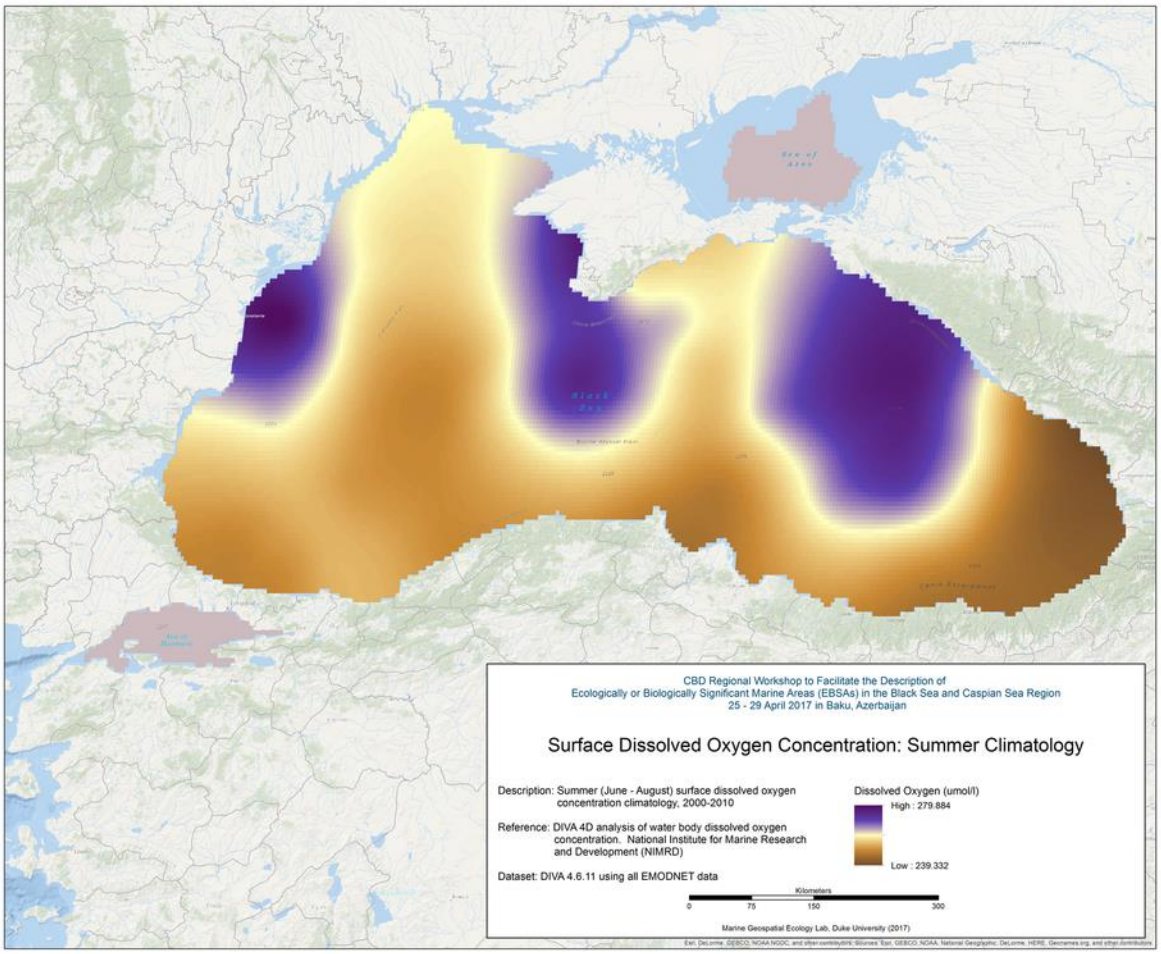

Figure 2.2.9-1 Surface Dissolved Oxygen Concentration: Summer Climatology

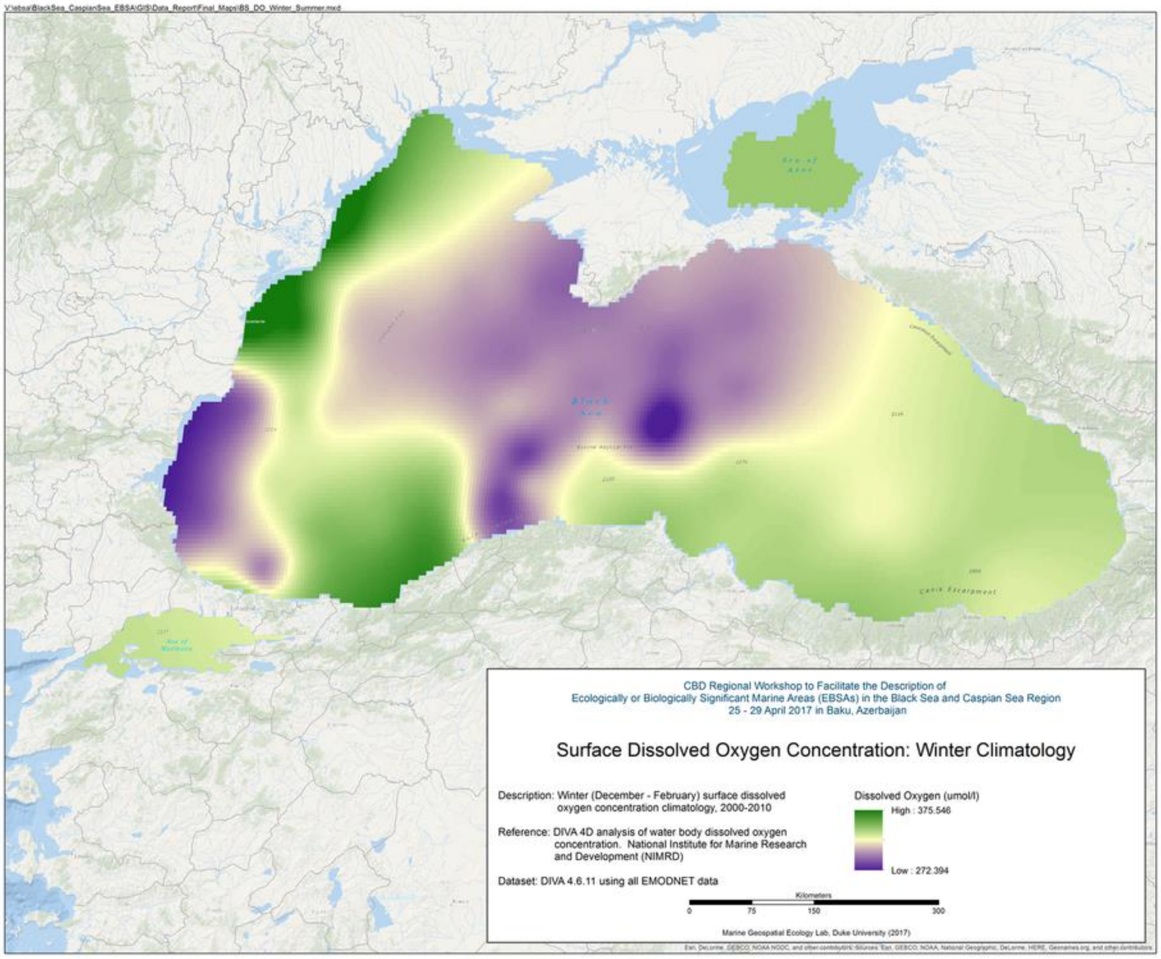

Figure 2.2.9-2 Surface Dissolved Oxygen Concentration: Winter Climatology

2.2.10 Black Sea Forecast System, Modeled Surface Currents

Abstract:

"The physical component of the Black Sea Forecasting System (BS-Currents) is a hydrodynamic model implemented over the whole Black Sea basin. The model horizontal grid resolution is 1/36° in zonal resolution, 1/27° in meridional resolution (ca. 3 km) and has 31 unevenly spaced vertical levels. The hydrodynamics are supplied by the Nucleus for European Modeling of the Ocean (NEMO, v3.4). The model solutions are corrected by the variational assimilation (based on a 3DVAR scheme), originally developed for the Mediterranean Sea and later extended for the global ocean. The observations assimilated in the BS-Currents includes in-situ profiles, along-track sea level anomalies (SLA) and gridded sea surface temperature (SST) provided by Copernicus TACs."

Source:

http://sextant.ifremer.fr/en/geoportail/sextant#/metadata/b09312b0-1b4d-4cac-b585-eeb4089ba8a1)

Reference:
Stefania Ciliberti, Andrea Storto, Sergio Creti, Francesca Macchia, G. Coppini (2016) PRODUCT USER MANUAL for Black Sea Physical Analysis and Forecast Product BLKSEA_ANALYSIS_FORECAST_PHYS_007_001,
http://cmems-resources.cls.fr/documents/PUM/CMEMS-BS-PUM-007-001.pdf

Dataset:
BLKSEA_ANALYSIS_FORECAST_PHYS_007_001

Processing:
Daily surface current vectors components were extracted from the 2016 data file. These daily files were combined into 2016 seasonal averages of direction and magnitude for each forecast cell. Two seasonal maps are shown below. All four seasons are available for use by workshop attendees.

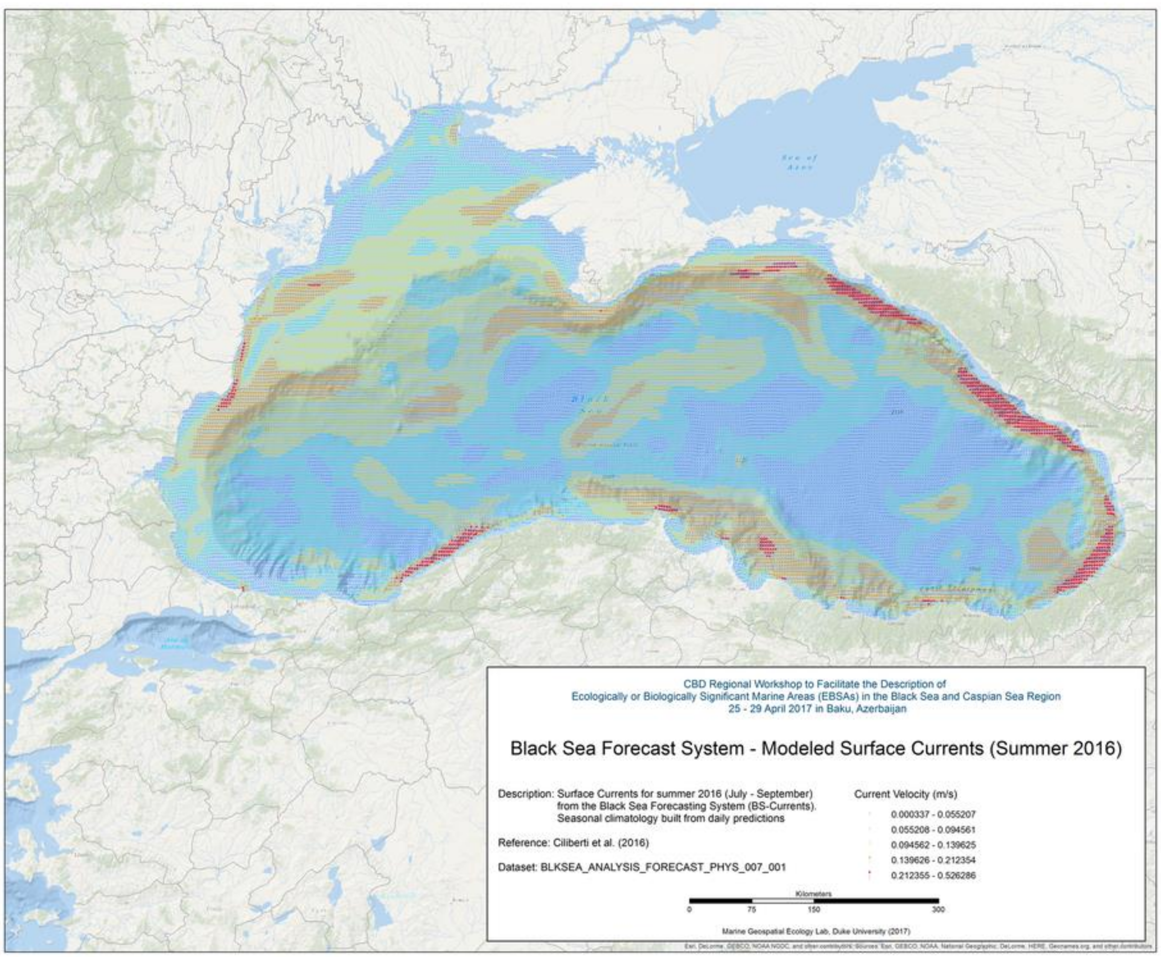

Figure 2.2.10-1 Black Sea Forecast System - Modeled Surface Currents (Summer 2016)

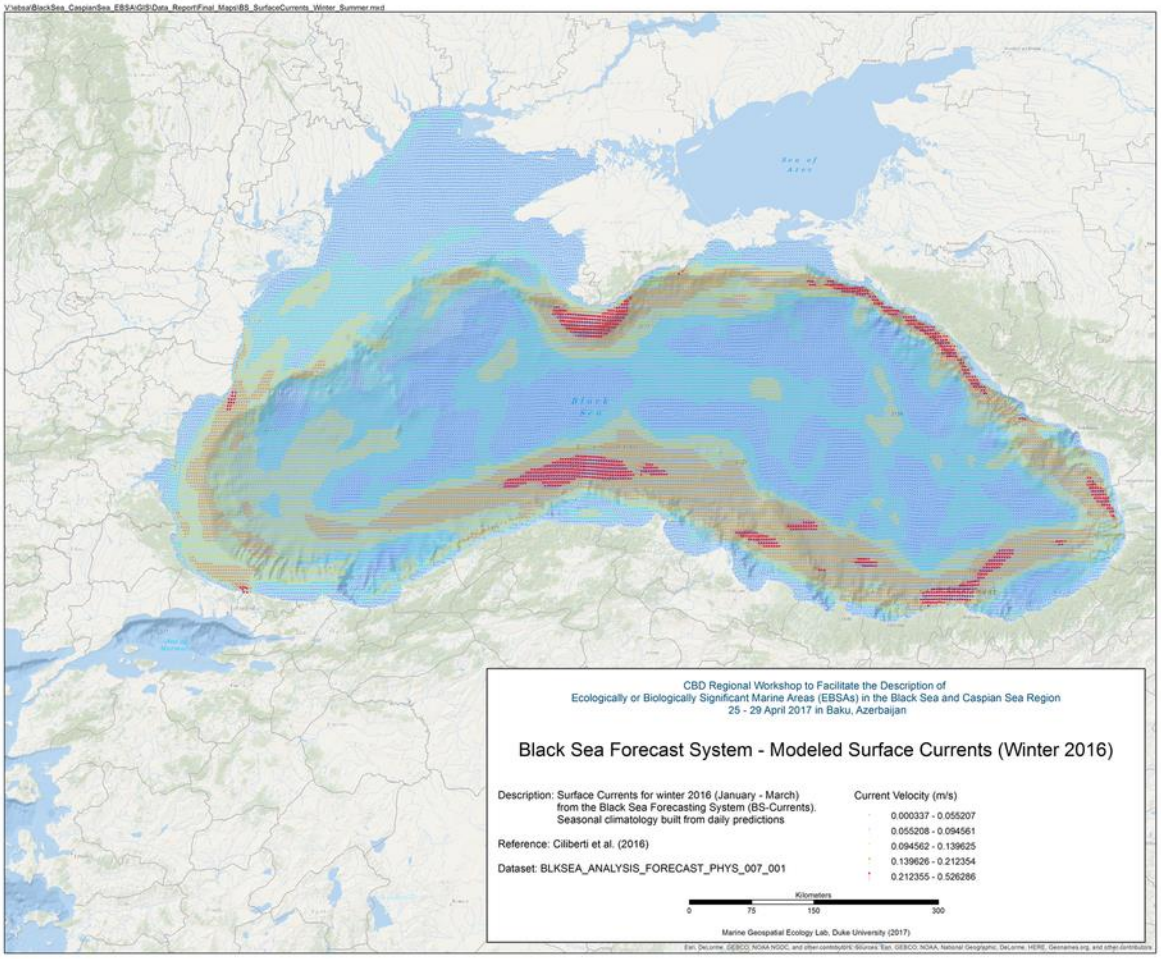

Figure 2.2.10-2 Black Sea Forecast System - Modeled Surface Currents (Winter 2016)

2.2.11 Mesoscale Eddy Density

Dudley B. Chelton and Michael G. Schlax maintain a database of trajectories of mesoscale eddies for the 18-year period October 1992 - January 2011. The eddies are based on the SSH fields in Version 3 of the AVISO Reference Series. Only eddies with lifetimes of 4 weeks or longer are retained; the trajectories are available at 7-day time steps.

Source:
http://cioss.coas.oregonstate.edu/eddies/

Processing:
A density raster of eddy centroids was created from the Chelton database (http://cioss.coas.oregonstate.edu/eddies/). First, the NetCDF file was converted to a SpatiaLite database using the MGET tool "Convert Mesoscale Eddies NetCDF to

SpatiaLite". Next, the "Extract Mesoscale Eddy Centroids from SpatiaLite" and "Extract Mesoscale Eddy Tracklines from SpatiaLite" tools were run specifying the date range (1993 - 2010) and the region of interest. The density raster was created from the Point Density ArcMap tool using 0.1 degree cell size and a 0.25 degree circular window.

References:

Chelton, D.B., M.G. Schlax, and R.M. Samelson (2011). Global observations of nonlinear mesoscale eddies. Progress in Oceanography 91: 167-216.

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.

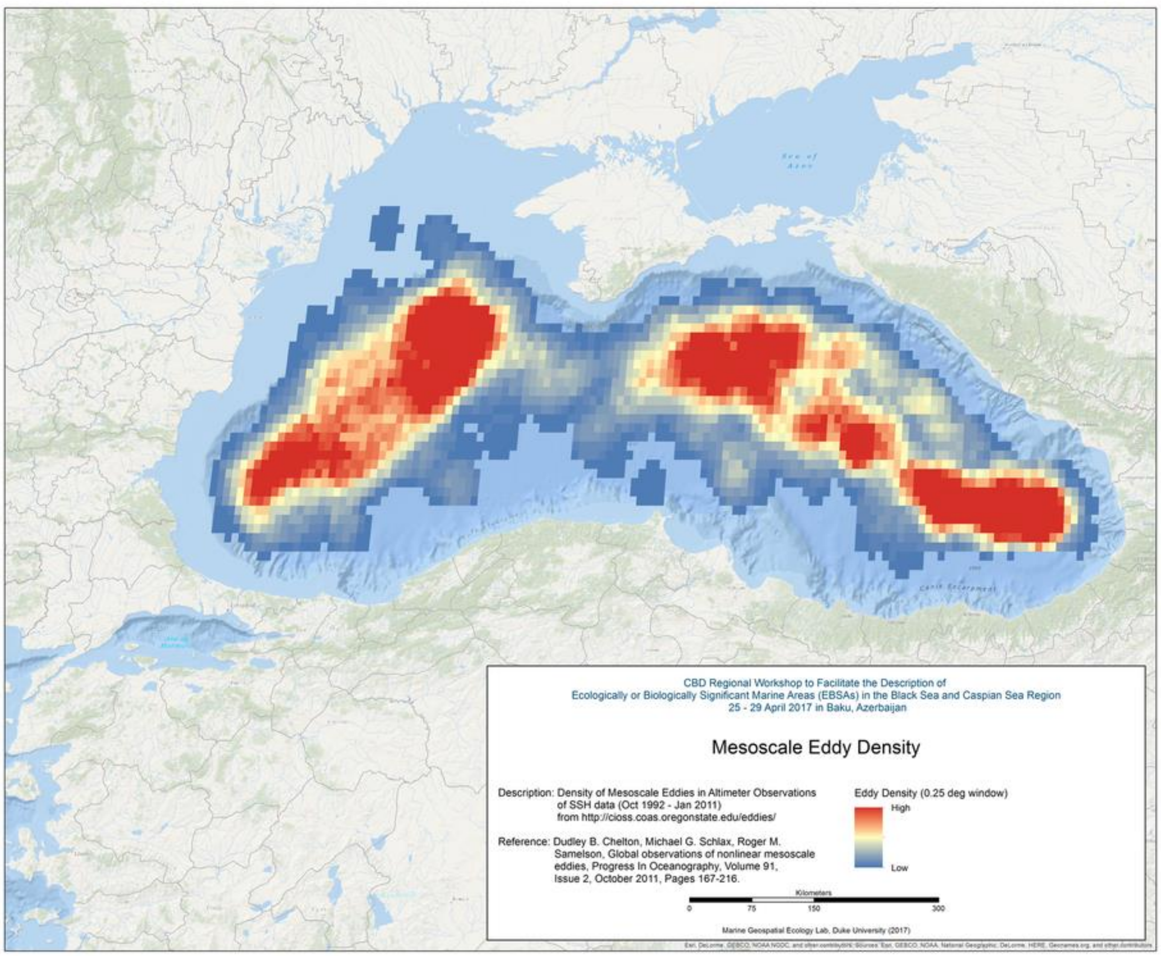

Figure 2.2.11-1 Mesoscale Eddy Density

2.3 Important Areas

2.3.1 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: http://www.wdpa.org/c/about

Dataset: WDPA Feb 2017

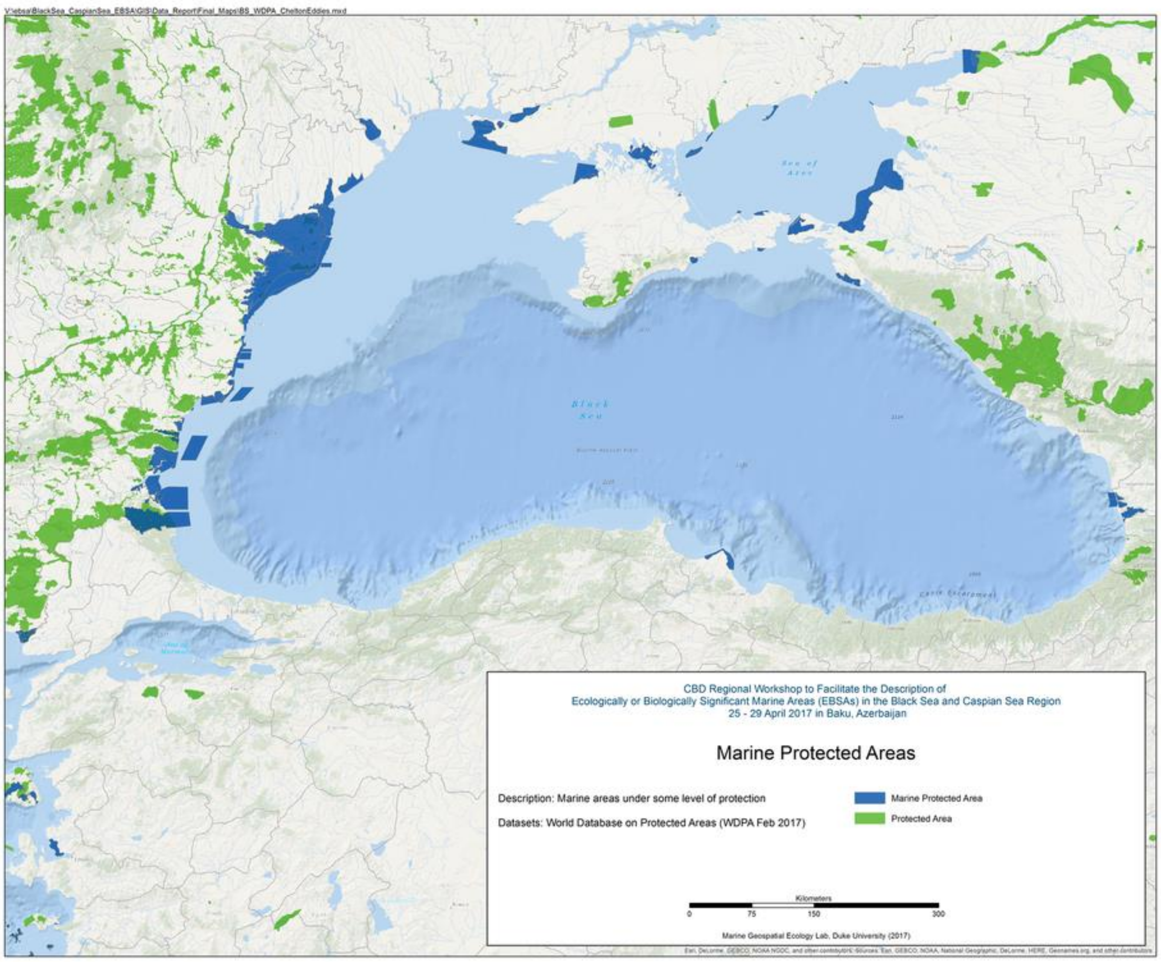

Figure 2.3.1-1 Marine Protected Areas

2.3.2 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.”

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

Reference:

Sundseth, K. and S. Barova (2009). *Natura 2000 in the Black Sea Region*. European Commission, Environment Directorate General. Luxembourg: Office for Official Publications of the European Communities.

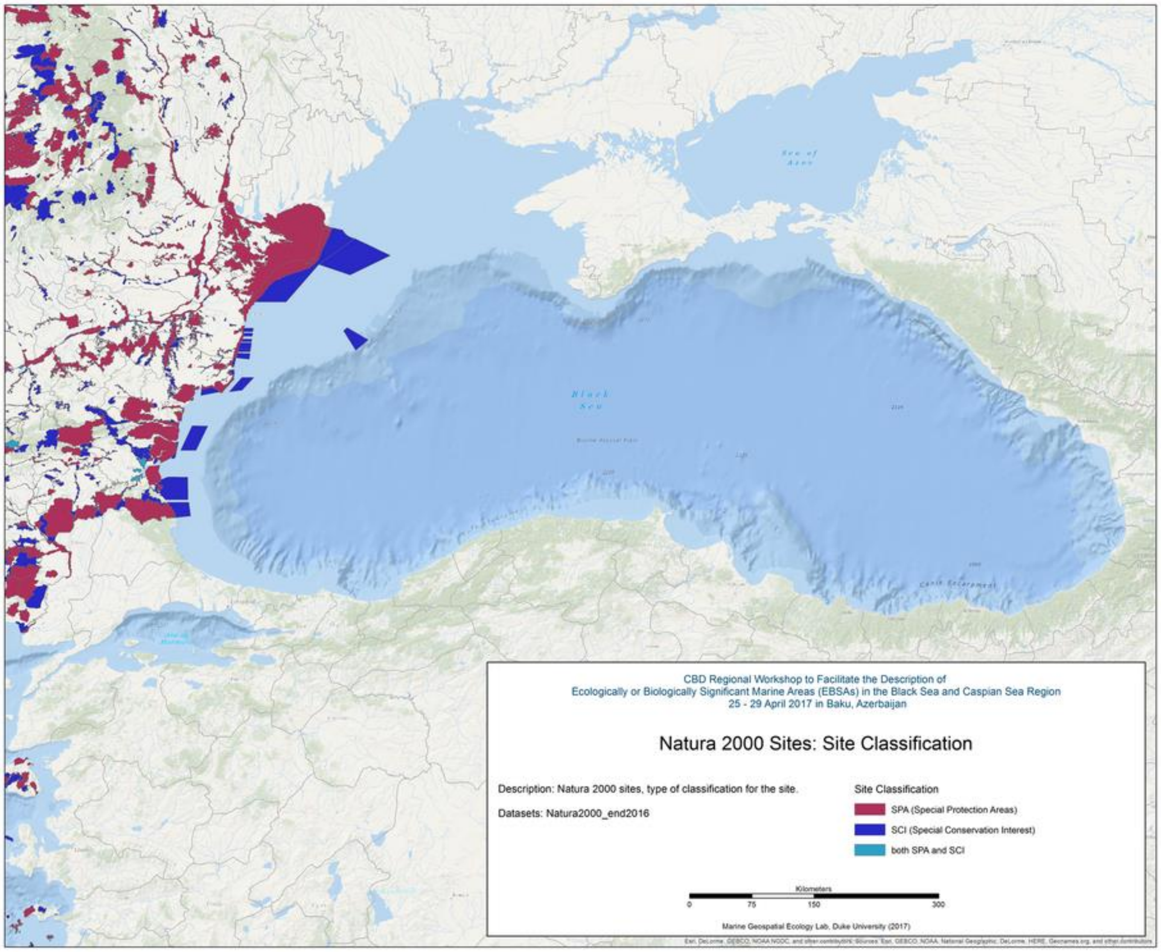

Figure 2.3.2-1 Natura 2000 Sites

2.3.3 ACCOBAMS Areas of Special Importance for Cetaceans

Areas of special importance for cetaceans in the ACCOBAMS area (ACCOBAMS Resolution 4.15, 2010)

Source:
http://www.accobams.org/index.php?option=com_content&view=article&id=1094&Itemid=147

http://sextant.ifremer.fr/en/geoportail/sextant#/metadata/ce7fbda2-90a6-45b9-b467-0dc2f0298938

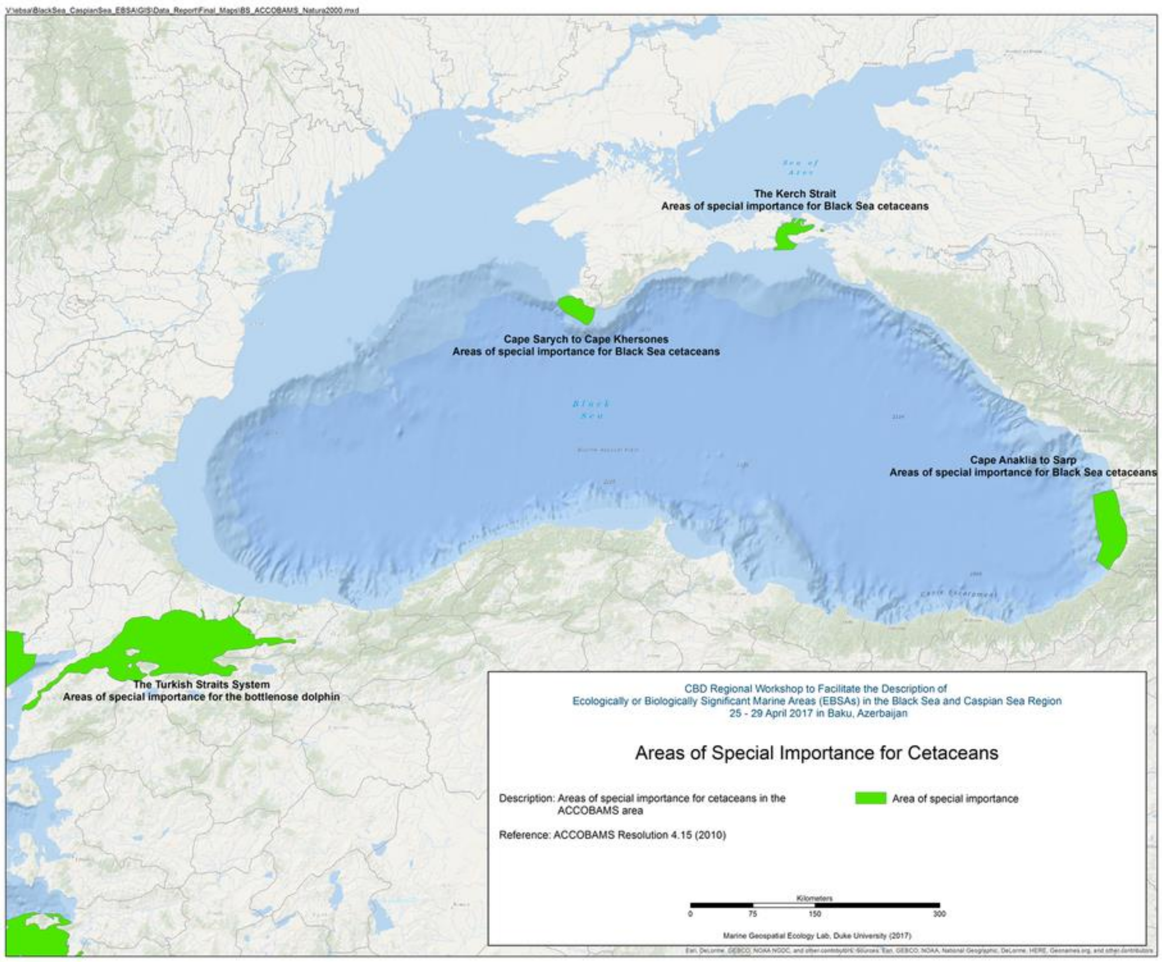

Figure 2.3.3-1 ACCOBAMS Areas of Special Importance for Cetaceans

2.3.4 BirdLife International Important Bird Areas (IBAs)

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 March 2017

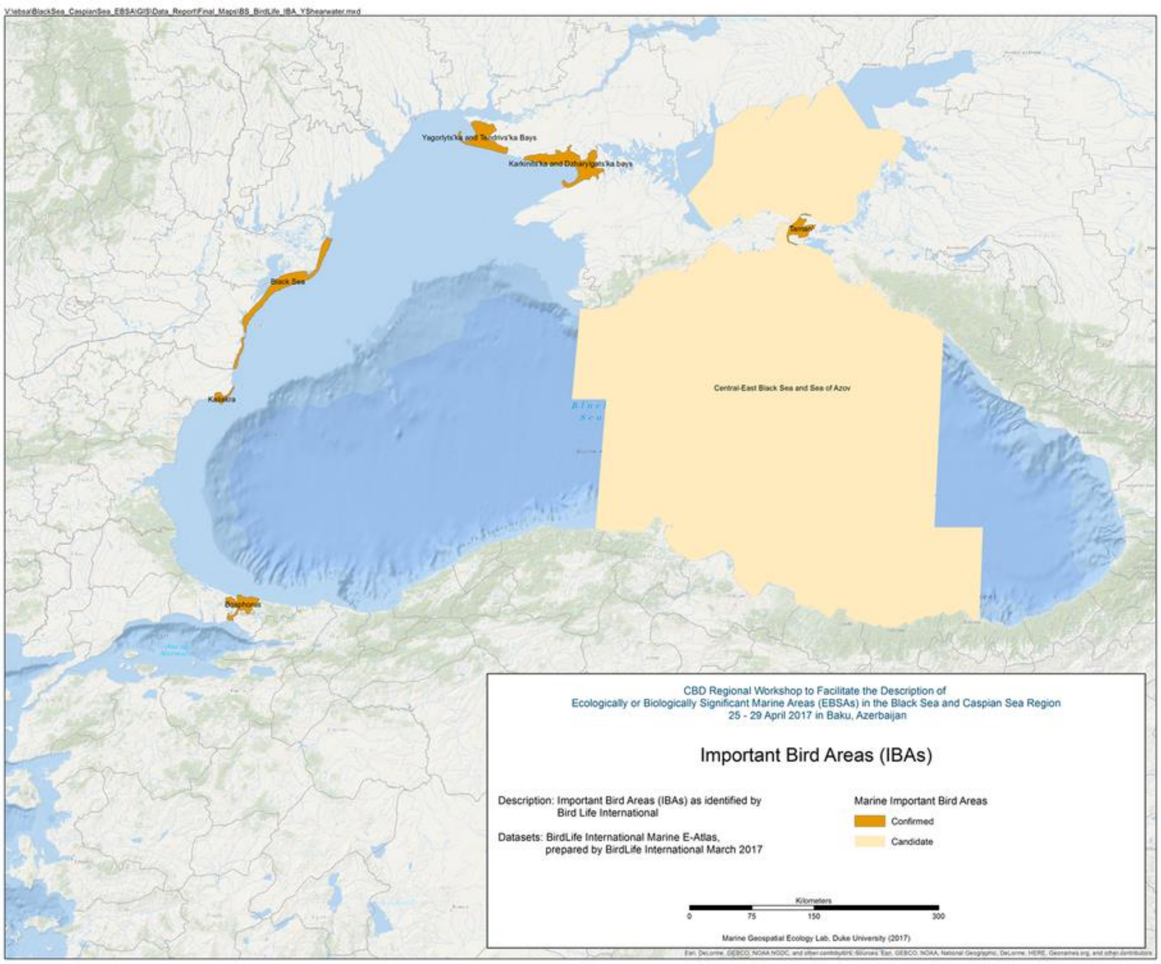

Figure 2.3.4-1 BirdLife International Important Bird Areas (IBAs)

2.4 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.

2.4.1 IFREMER Sextant Portal

"The geographical data present on Sextant derives from the research projects and scientific works at both Ifremer and its partner laboratories. This thematic data is aggregated and finalised, and some of it becomes benchmark data.

Marine Themes:

- Satellite, aerial and acoustic imaging
- the physical environment: bathymetry, sedimentology, morphology, hydrodynamics, climatology
- the biological environment: remarkable habitats, benthic populations, marine mammals, fisheries management, biogeochemistry, microbiology
- human use and activity: Commercial fishing, aquaculture, maritime navigation, tourism and sailing, surveillance networks
- regulatory data: zones Natura 2000, Znieff, OSPAR, etc.
- administrative boarders at sea: exclusive economic area, FAO areas, ICES statistical rectangles, etc."

Source:
http://sextant.ifremer.fr/en/presentation/missions

Black Sea Datasets:
http://sextant.ifremer.fr/en/geoportail/sextant#/search?fast=index&_content_type=json&sortBy=popularity&from=221&to=240&any=Black%20Sea

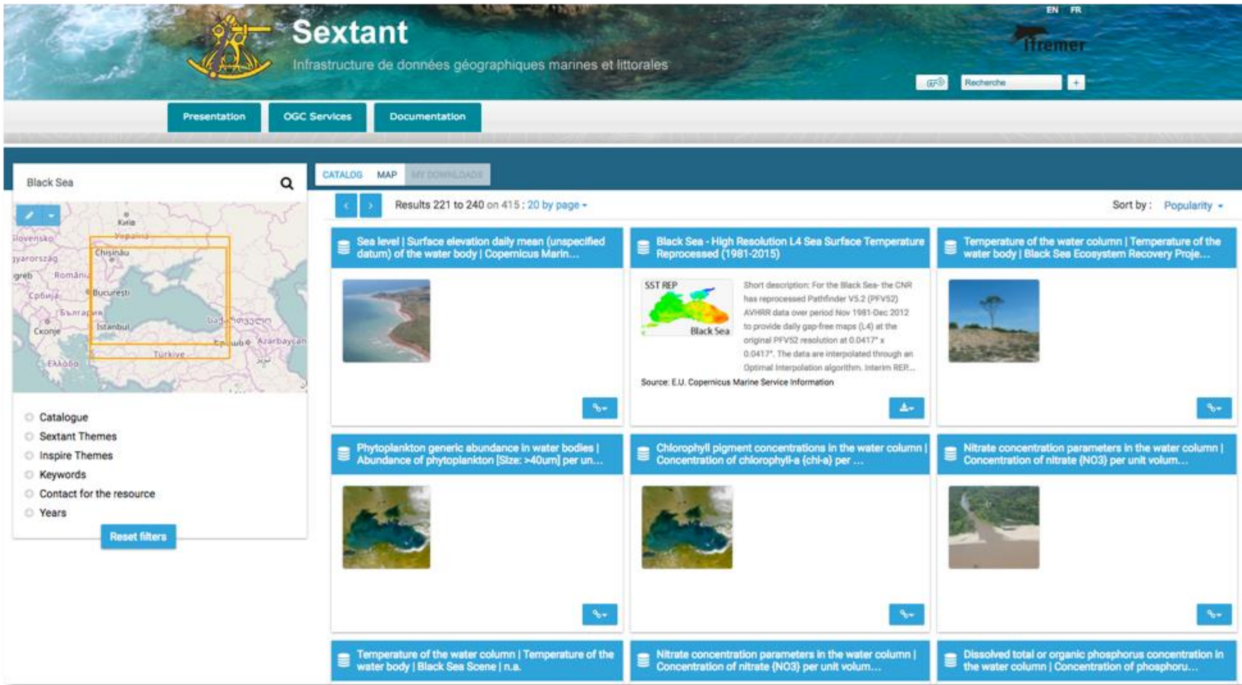

Figure 2.4.1-1 Subset of data from Sextant for the Black Sea

2.4.2 Black Sea SCENE Web Portal

The Black Sea Scene web portal collects regional mapping services in a one page application where oceanographic and contextual data can be compared. Example datasets include chlorophyll concentration, hydrocarbons in surface water, water temperature at depth, salinity, and protected areas.

Reference:
Retrieved April 6, 2017, from http://subsite.blackseascene.net/blackseascene/atlas.html

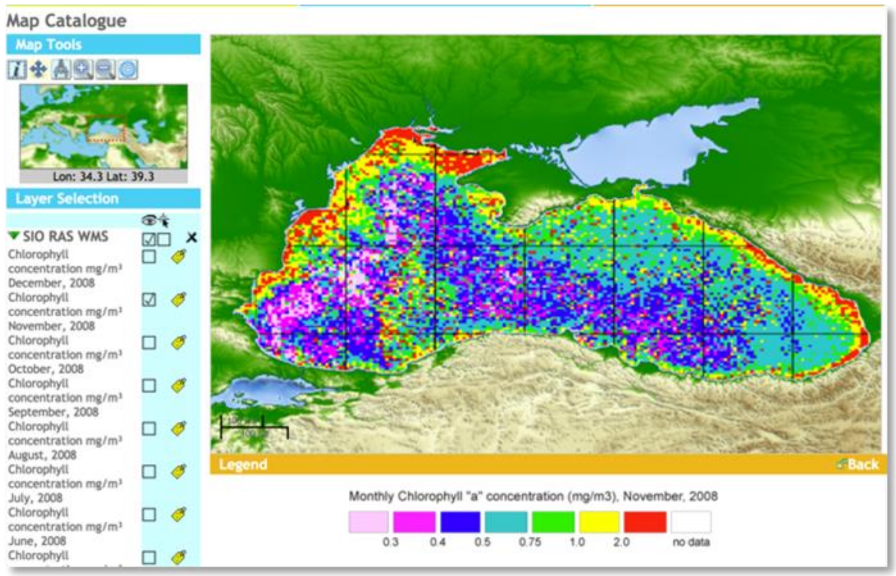

Figure 2.4.2-1 Chlorophyll concentration data from Shirshov Institute of Oceanology mapped in Black Sea Scene portal

Web Mapping Services in the application:

Demis WMS	Web Map Server provided by Demis presents geographic layers for Elevation, Hydrography, Cities, Roads	http://www.demis.nl/
IBSS WMS	This service is provided by Institute of Biology of the Southern Seas. Service provides some biological maps and measuring points.	http://www.ibss.iuf.net/
M.Nodia IG WMS	This service is provided by M. Nodia Institute of Geophysics of Georgia. The service provides forecast fields of temperature and salinity on different depths.	http://www.ig-geophysics.ge/
Metacarta WMS	Web Map Server provided by MetaCarta Inc	http://www.metacarta.com/
NODC of Ukraine MapServer	This service is provided by National Oceanographic Data Center of Ukraine.	http://ocean.nodc.org.ua/
SIO RAS WMS	This service is provided by P.P. Shirshov Institute of Oceanology, RAS. The service provides maps of oceanographic parameters (chorophyll concentration etc.).	http://www.ocean.ru/
SOI WMS	This service is provided by State Oceanographic Institute of Russian Federation. Service provides maps of content of oil hydrocarbons from 2001 to 2008 years of the Russian coast of the Black Sea.	http://www.oceanography.ru/
UkrSCES WMS	This service is provided by Ukrainian Scientific Center of Ecology of Sea.	http://www.sea.gov.ua/

2.4.3 SeaDataNet Common Data Index (CDI) V3

This data explorer portal aggregates data from all the global oceans, with search tools that can constrain data discovery to the Black Sea. Primarily in situ measurement, biological parameters available include:

- Alkalinity
- Ammonium and ammonia concentration parameters in water bodies
- Bacteria generic abundance in water bodies
- Bioluminescence parameters
- Biota lipid concentrations
- Chlorophyll pigment concentrations in water bodies
- Concentration of polychlorobiphenyls (PCBs) in biota
- Fish biomass in water bodies
- Metal concentrations in biota
- Phytoplankton generic biomass in water bodies
- Phytoplankton taxonomic abundance in water bodies
- Zoobenthos taxonomic abundance
- Zooplankton wet weight biomass

Reference:
Retrieved April 6, 2017, from http://seadatanet.maris2.nl/v_cdi_v3/search.asp

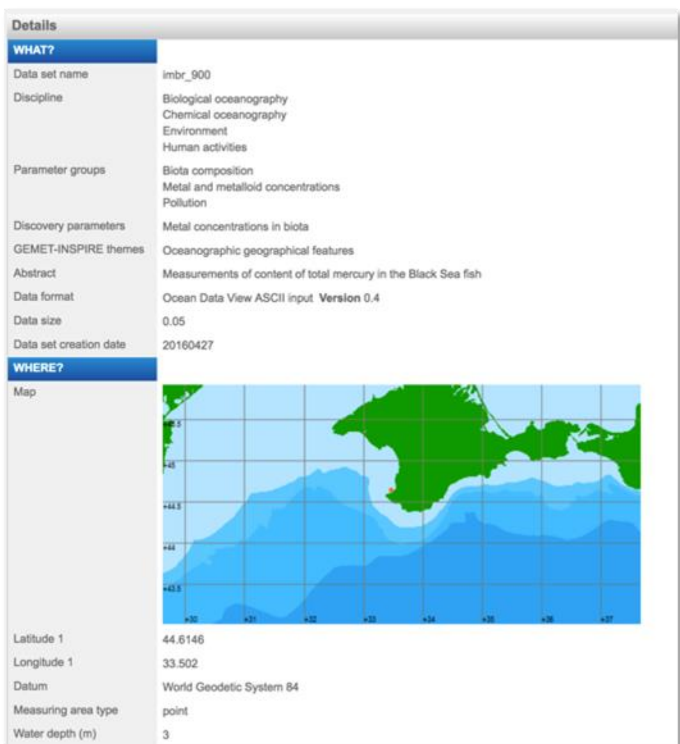

Figure 2.4.3-1 Example record retrieval from SeaDataNet

2.4.4 Commission on the Protection of the Black Sea Against Pollution

"Since the ratification of the Bucharest Convent by 1994, a substantial increase in sea-borne transportation of not only general goods and passengers, but also raw oil and refined petroleum products has taken place and is predicted to continue in the near future. This increase in sea-borne transportation enhances the risk of serious accidents at sea that could have dramatic impacts on the fragile marine environment of the Black Sea and the livelihood of the people living around it.

This increasing risk calls for the coastal states of the Black Sea to address the issue and urgently consider political, legal and operational initiatives that can improve the existing national and regional capacity on oil spill preparedness, response and co-operation.
A regional mechanism for exchange and dissemination of data and information related to shipping traffic, movement of oil & oil products, ongoing and future activities related to oil production, storage and transportation combined with up-to-date information on preparedness and response to oil spills would greatly reduce the risk of oil spills and its impact in the Black Sea region."

The Commission website has a repository for documents and resources related to the mission, and as well linking to Regional Euro-Asian Biological Invasions Center online GIS system. This tool allows searching and mapping of invasive species data, including those in the Black Sea and tributary rivers. (http://www.reabic.net/GIS_black.html)

Reference:
Retrieved April 6, 2017, from http://www.blacksea-commission.org/your-page.html

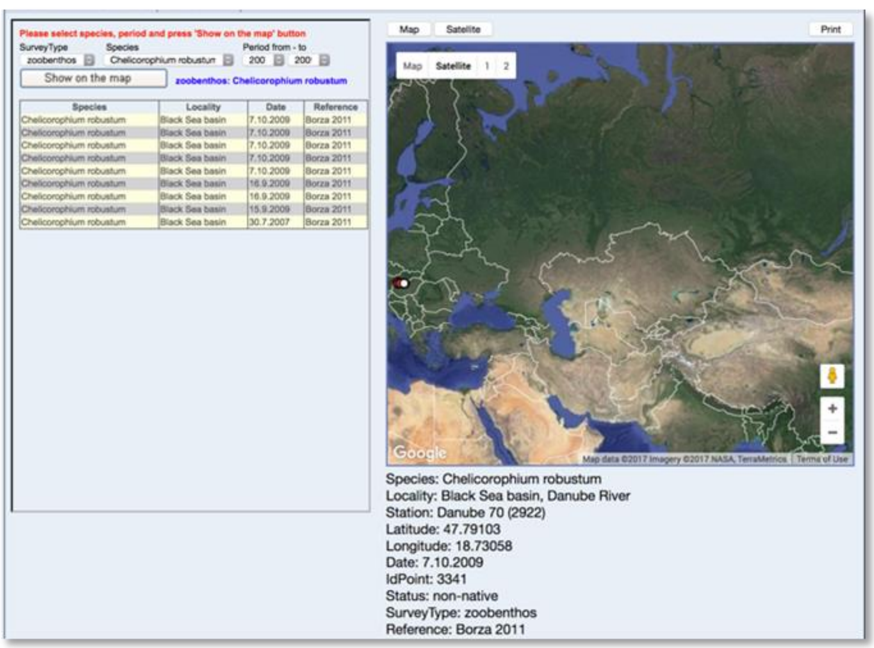

Figure 2.4.4-1 *Chelicorophium robustum* zooplankton in Danube part of the Black Sea Basin, retrieved from Regional Euro-Asian Biological Invasions Center

2.4.5 DEVOTES project portal

"DEVOTES is a Collaborative project funded for 4 years (2012-2016), with a total budget of €12 million, of which €9 million is from the 7th Framework Programme of the European Union.

The overall goal of DEVOTES is to better understand the relationships between pressures from human activities and climatic influences and their effects on marine ecosystems, including biological diversity, in order to support the ecosystem based management and fully achieve the Good Environmental Status (GES) of marine waters.

It involves 23 partners from 15 EU countries, including two non-EU partners (from Saudi Arabia and Ukraine) and four SMEs, along with two observers (EPA and NOAA) from the US. A panel of independent scientists form the Advisory Board (AB) which will provide strategic guidance and support the partnership to ensure that the project's results meet the objectives The AB will discuss the plans, progress and use of project results and recommend adjustment of the priorities of the project throughout the DEVOTES cycle.

DEVOTES main objectives are to: i) improve our understanding of the impact of human activities and climate change on marine biodiversity; ii) identify the barriers and bottlenecks that prevent Good Environmental Status from being achieved; iii) test indicators and develop new, innovative ones to assess biodiversity in a harmonized way throughout the 4 regional seas; iv) develop, test and validate innovative integrative modelling and monitoring tools to improve our understanding of ecosystem and biodiversity changes, for integration into a unique and holistic assessment; v) propose and disseminate strategies and measures for ecosystems' adaptive management, including the active role of industry and relevant stakeholders.

DEVOTES will address three main challenges in determining environmental status:
(i) assessment of anthropogenic pressures, including climate change, to which biodiversity responds; (ii) selection of appropriate indicators to assess the status; and
(iii) integration of those indicators across a number of ecological scales, into a unique biodiversity assessment.

DEVOTES objectives will be achieved through the activities carried out within seven operational workpackages, besides the management one: Human Pressures and Climate Change (WP1), Social-economic implications for achieving GES (WP2), Indicator testing and development (WP3) Innovative modelling tools (WP4); Innovative monitoring techniques (WP5); Integrative assessment of biodiversity (WP6); Outreach, stakeholder engagement and product dissemination (WP7)."

Source:
http://www.devotes-project.eu/

2.4.6 Black Sea First Data Adequacy Report

Executive Summary:
"This document illustrates the first Data Adequacy Report (DAR) of the EMODnet Black Sea Checkpoint project. The aim of the DAR is to assess the basin scale monitoring systems on the basis of input data sets for 11 prescribed Challenges. Nothing equivalent exists in the world. In fact, a completely new methodology has been developed based upon ISO standards, INSPIRE principles and a set of quality indicators…

This DAR includes the consolidated analysis of the needed characteristics required for the Challenge products and their input data sets. The Black Sea Checkpoint metadatabase now contains 452 input data sets describing 40 different characteristics categories. About half of these categories are used by more than one Challenge, and several input datasets are potentially capable of describing them for the Challenge products. Most of the Challenges involve several characteristics categories which will be potentially used to generate the required products. For each characteristics category there is large number of input data sets (50-100) mainly due to routine choices made by the Challenge experts."

Source:
https://webgate.ec.europa.eu/maritimeforum/en/node/3970

Reference:
BLACKSEA D15.2 First Data Adequacy Report.pdf. (2016). Retrieved March 23, 2017, from https://webgate.ec.europa.eu/maritimeforum/sites/maritimeforum/files/BLACKSEA%20D15.2%20First%20Data%20Adequacy%20Report.pdf

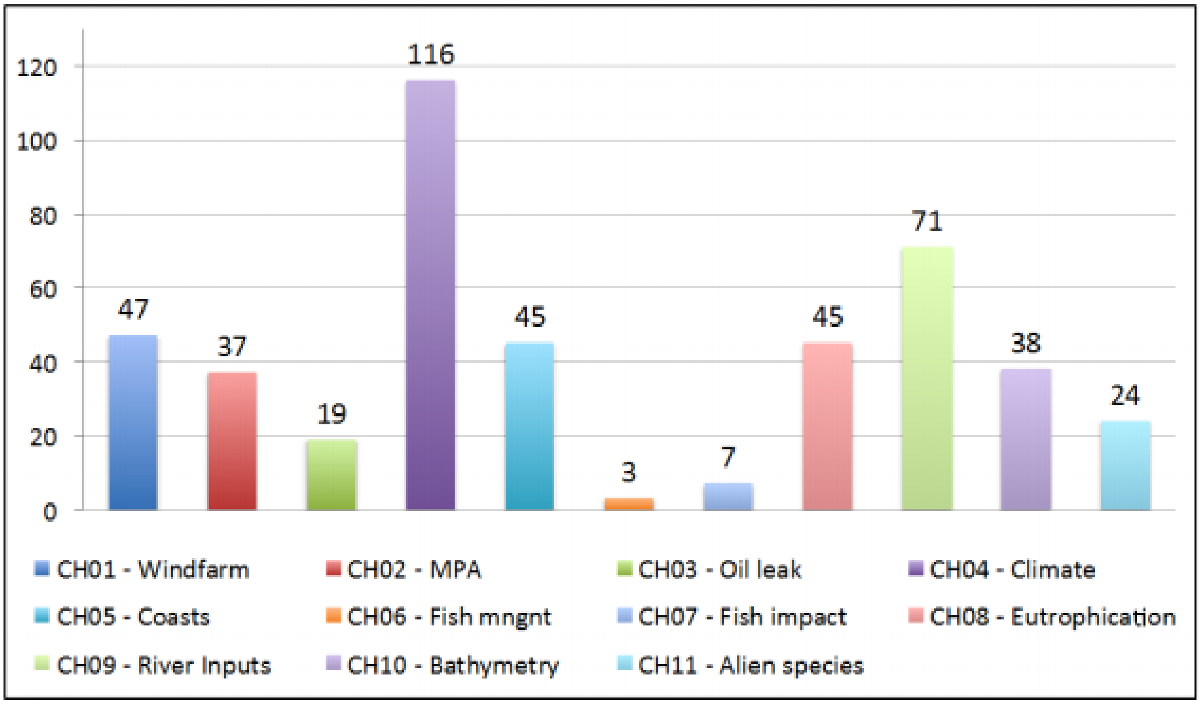

Figure 4.1: Number of input data sets for each challenge (visual representation of Table 4.1)

Figure 2.4.6-1 Number of data sets for each Challenge Area

2.4.7 Black Sea Commission State of Environment Report 2001 - 2006/7

Preface:
"More than 60 prominent scientists working on the Black Sea ecosystem have contributed to this report. Despite this is the most comprehensive report on the State of Environment of the Black Sea for the period 2001-2007, limitation in the systematically collected data and indicators, makes a conclusive inference difficult on the real state of the ecosystem of this sea.

Chapter 1, within two sub-chapters, presents introductory information on the Black Sea physico-chemical characteristics and geology/history. Chapter 2 deals with one of the most important problems of the Black Sea, the Eutrophication. Chapter 3, dealing with Chemical Pollution, has several subchapters of different pollutant groups. Radioactive pollution is dealt in Capter 4. States of phytoplankton, zooplankton, macrophytobenthos, zoobenthos are presented in Chapters 5, 6, 7 and 8, respectively. The fisheries is the subject of Chapter 9 and mammals of Chapter 10. Socio-economic pressures and impacts are included in Chapter 11. The overall assessment of the report summarizing all these issues is given in Chapter 12."

Source:
http://www.blacksea-commission.org/_publ-SOE2009.asp

2.4.8 Grid-Arendal: GIWA Black Sea graphics

"Illustration in a set of graphics prepared for a pilot assessment report on the Black Sea drainage basin, for the UNEP Global Impact on Waters Assessment (GIWA). All data and information were prepared in close collaboration with the GIWA Black Sea team and the GIWA secretariat. The graphics were not used in this form in the final report on the Black Sea, published in 2005. "

Source:
http://www.grida.no/resources/6558

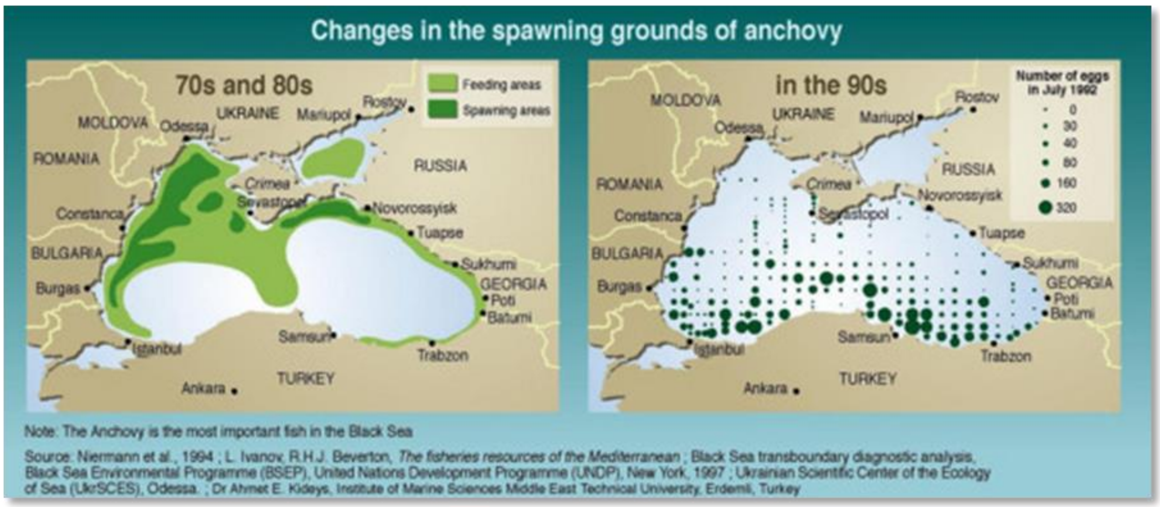

Figure 2.4.8-1 Changes in spawning grounds of Anchovy

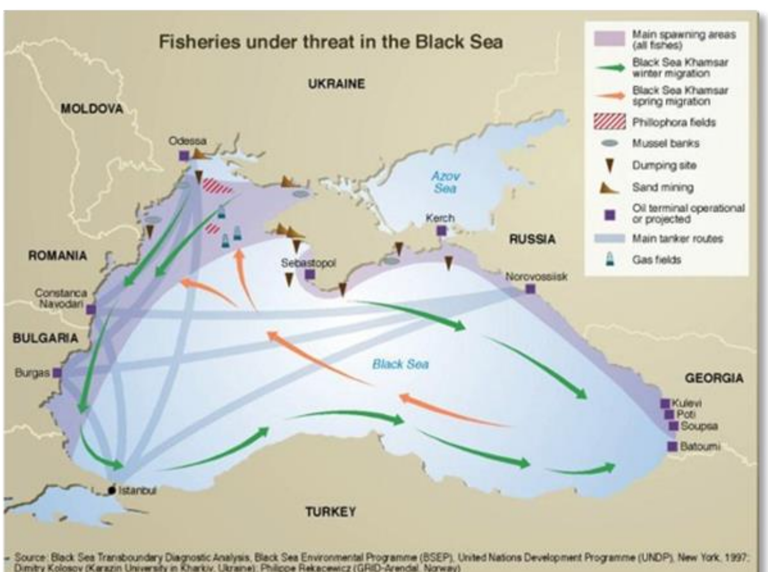

Figure 2.4.8-2 Fisheries under threat in the Black Sea

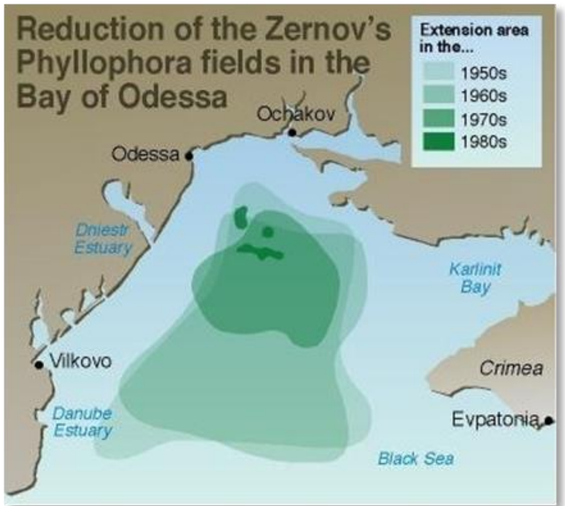

Figure 2.4.8-3 Reduction in the Zernov's Phyllophora fields in the Bay of Odessa

Figure 2.4.8-4 Sturgeon distribution in the Black Sea

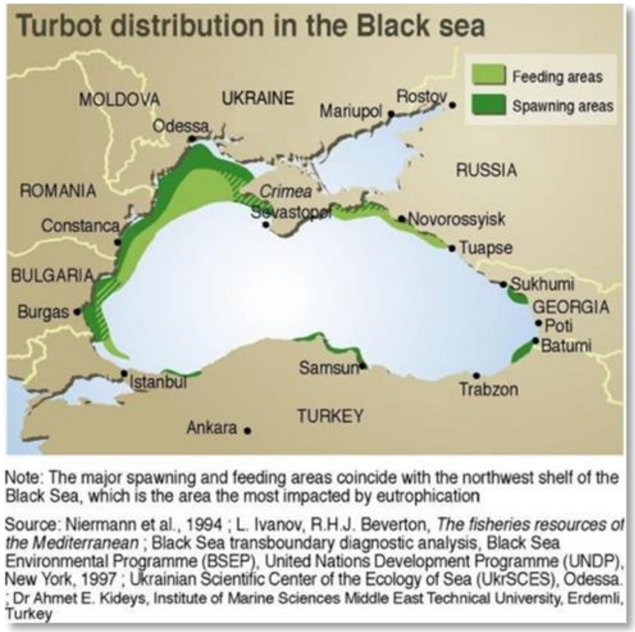

Figure 2.4.8-5 Turbot distribution in the Black Sea

2.4.9 Conserving Whales, Dolphins and Porpoises in the Mediterranean and Black Seas: an ACCOBAMS Status Report, 2010

This report provides presumed distribution maps of Black Sea cetacean species, with tables showing littoral presence.

Reference:

Nortarbartolo di Sciara, G., and A. Birkun Jr. "Conserving Whales, Dolphins and Porpoises in the Mediterranean and Black Seas: an ACCOBAMS Status Report, 2010." *ACCOBAMS, Monaco* (2010).

Fig. 18. Presumed distribution of *Tursiops truncatus ponticus* in the ACCOBAMS area. Red dots show two strandings of dead animals in the Azov Sea.

Figure 2.4.9-1 Presumed distribution of Black Sea bottlenose dolphin in the ACCOBAMS area

2.4.10 The Status and Distribution of Cetaceans in the Black Sea and Mediterranean Sea - Workshop Report, Monaco 5-7 March 2006

Methods:
"All cetacean species were assessed in 1996 against the 1994 criteria (Baillie and Groombridge 1996), and some species, subspecies and geographical populations ('subpopulations') have been reassessed since then against the 2001 criteria (see Reeves et al. 2003: their Table 1.1; also http://www.redlist.org). As explained in the Guidelines for Application of IUCN Red List Criteria at Regional Levels (http://www.iucn.org/themes/ssc/redlists/ regionalguidelines.htm; also see Gärdenfors et al. 2001), listing of a species at the global population level can differ from listings at the subspecies or 'subpopulation' level.

The scope of the present workshop was defined and delimited on a geographical basis, with the intent to assess the status of all cetaceans in the Mediterranean and Black Seas, some of which constitute endemic subspecies and others of which form geographically distinct 'subpopulations'. For some or many of the species considered, an uncertain amount of genetic and/or demographic interchange with populations in the North Atlantic was either known or suspected to occur. 'Units for assessment' were therefore considered on a species-by-species basis."

Reference:
Reeves R., Notarbartolo di Sciara G. (compilers and editors). 2006. The status and distribution of cetaceans in the Black Sea and Mediterranean Sea. IUCN Centre for Mediterranean Cooperation, Malaga, Spain. 137 pp.

Summary Documentation:

Short-beaked common dolphin (*Delphinus delphis ponticus*) Black Sea subspecies

Major Habitats:

- Open sea
- Circumlittoral area over the continental shelf (usually more than 6 m but less than 200 m deep) Shallow sea (usually less than 6 m deep; includes sea bays and straits)

Table 1 – Common dolphin abundance estimates in selected Black Sea areas

Surveyed area and observation effort	Observation platform	Research period	Uncorrected abundance estimates	References
Turkish Straits System (Bosphorus, Marmara Sea and Dardanelles)	vessel	October 1997	773 (292–2,059; 95% CI)	Dede (1999), cited after: IWC (2004)
Turkish Straits system (Bosphorus, Marmara Sea and Dardanelles)	vessel	August 1998	994 (390–2,531; 95% CI)	Dede (1999), cited after: IWC (2004)
NW, N and NE Black Sea within Ukrainian and Russian territorial waters, 31,780 km^2/2,230 km	vessel	September-October 2003	5,376 (2,898–9,972; 95% CI)	Birkun *et al.* (2004)
SE Black Sea within Georgian territorial waters, 2,320 km^2/211 km	vessel	January 2005	9,708 (5,009–18,814; 95% CI)	Birkun *et al.* (2006)
Central Black Sea beyond territorial waters of Ukraine and Turkey, 31,200km^2/660 km	vessel	September-October 2005	4,779 (1,433–15,945; 95% CI)	Krivokhizhin *et al.* (2006)

Figure 2.4.10-1 Common dolphin abundance estimates in selected Black Sea areas

Harbour porpoise (*Phocoena phocoena relicta*) Black Sea subspecies

Major Habitats:

- Circumlittoral area over the continental shelf (usually more than 6 m but less than 200 m deep). Open sea.
- Shallow sea (usually less than 6 m deep; includes sea bays and straits).
- Isolated instances are known of Black Sea harbour porpoises visiting estuaries of big rivers including their deltas, big rivers proper and their confluents, coastal brackish and saline lagoons, and freshwater lakes connected with the sea by rivers.

Table 1 – Line transect surveys and harbour porpoise abundance estimates in selected portions of the Black Sea

Surveyed area and observation effort	Observation platform	Year	Research period	Available uncorrected abundance estimates	References
Azov Sea in total, 40,280 Km^2/2,735 km	Aircraft	2001	July, 4 days	2,922 (1,333–6,403; 95% CI)	Birkun *et al.* (2002)
Southern Azov Sea (within above area), 7,560 km^2/413 km	Aircraft	2001	July, 2 days	871 (277–2,735; 95% CI)	Birkun *et al.* (2003)
Southern Azov Sea (the same area), 7,560 km^2/716 km	Aircraft	2002	August, 1 day	936 (436–2,009; 95% CI)	Birkun *et al.* (2003)
Kerch Strait in total, 890 km^2/353 km	Aircraft	2001	July, 1 day	not available (too small sample size: 5 sightings, 12 animals)	Birkun *et al.* (2002)
Kerch Strait in total, 890 km^2/353 km	Aircraft	2002	August, 1 day	not available (too small sample size: 4 sightings, 4 animals)	Birkun *et al.* (2003)
Kerch Strait, 862 km^2/310 km	Vessel	2003	August, 6 days	54 (12–245; 95% CI)	Birkun *et al.* (2004)
NE shelf area of the Black Sea, 7,960 km^2/791 km	Aircraft	2002	August, 3 days	not available (too small sample size: 8 sightings, 15 animals)	Birkun *et al.* (2003)
NW, N and NE Black Sea within Ukrainian and Russian territorial waters, 31,780 km^2/2,230 km	Vessel	2003	September-October, 18 days	1,215 (492–3,002; 95% CI)	Birkun *et al.* (2004)
SE Black Sea within Georgian territorial waters, 2,320 km^2/211 km	Vessel	2005	January, 3 days	3,565 (2,071–6,137; 95% CI)	Birkun *et al.* (2006)
Central Black Sea beyond territorial waters of Ukraine and Turkey, 31,200km^2/660 km	Vessel	2005	September-October, 8 days	8,240 (1,714–39,605; 95% CI)	Krivokhizhin *et al.* (2006)

Figure 2.4.10-2 Line transect surveys and harbour porpoise abundance estimates in selected portions of the Black Sea

Bottlenose dolphin (*Tursiops truncatus ponticus*) Black Sea subspecies

Major Habitats:

- Circumlittoral area over the continental shelf (usually more than 6 m but less than 200 m deep)
- Open sea
- Shallow sea (usually less than 6 m deep; includes sea bays and straits)
- A few instances of Black Sea bottlenose dolphins visiting big rivers are known. Sightings in some estuaries and coastal saline lagoons are not rare.

Table 1 – Bottlenose dolphin abundance estimates in the selected Black Sea areas

Surveyed area and observation effort	Observation platform	Research period	Uncorrected abundance estimates	References
Turkish Straits System (Bosphorus, Marmara Sea and Dardanelles)	Vessel	October 1997	495 (203–1,197; 95% CI)	Dede (1999), cited after: IWC (2004)
Turkish Straits System (Bosphorus, Marmara Sea and Dardanelles)	Vessel	August 1998	468 (184–1,186; 95% CI)	Dede (1999), cited after: IWC (2004)
Kerch Strait, 890 km^2/353 km	Aircraft	July 2001	76 (30–192; 95% CI)	Birkun *et al.* (2002)
Kerch Strait, 890 km^2/353 km	Aircraft	August 2002	88 (31–243; 95% CI)	Birkun *et al.* (2003)
Kerch Strait, 862 km^2/310 km	Vessel	August 2003	127 (67–238; 95% CI)	Birkun *et al.* (2004a)
NE shelf area of the Black Sea, 7,960 km^2/791 km	Aircraft	August 2002	823 (329–2,057; 95% CI)	Birkun *et al.* (2003)
NW, N and NE Black Sea within Ukrainian and Russian territorial waters, 31,780 km^2/2,230 km	Vessel	September-October 2003	4,193 (2,527–6,956; 95% CI)	Birkun *et al.* (2004a)
SE Black Sea within Georgian waters, 2,320 km^2/211 km	Vessel	January 2005	0	Birkun *et al.* (2006)
SE Black Sea within Georgian waters, 2,320 km^2/211 km	Vessel	May 2005	0	Komakhidze and Goradze (2005)
SE Black Sea within Georgian waters, 2,320 km^2/211 km	Vessel	August 2005	0	Komakhidze and Goradze (2005)
SE Black Sea within Georgian waters, 2,320 km^2/211 km	Vessel	November 2005	0	Irakli Goradze, 2006, pers. comm.
Central Black Sea beyond territorial waters of Ukraine and Turkey, 31,200km^2/660 km	Vessel	September-October 2005	0	Krivokhizhin *et al.* (2006)

Figure 2.4.10-3 Bottlenose dolphin abundance estimates in selected Black Sea areas

2.4.11 Cetaceans of the Mediterranean and Black Seas: State of Knowledge and Conservation Strategies

Summary:

"This report represents a compendium of the state of knowledge and of possible conservation strategies for cetaceans in the Mediterranean and Black Seas, to provide background information to the Contracting Parties to the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS).

Twenty-one species of cetaceans occur in various degrees of abundance in the Mediterranean Sea and in the Black Sea. However, the species that are represented by regularly occurring, resident populations are limited to three in the Black Sea (short-beaked common dolphin, common bottlenose dolphin, and harbour porpoise), and eight in

the Mediterranean Sea (fin whale, sperm whale, Cuvier's beaked whale, long-finned pilot whale, Risso's dolphin, common bottlenose dolphin, striped dolphin and short-beaked common dolphin). The status of the harbour porpoise in the Aegean Sea, where a small population unit may be existing, is still unclear. All other species occur occasionally, represented by vagrant individuals from North Atlantic and Red Sea populations. Each species is briefly described in this report, with a listing of its taxonomic position, the available common names in most of the Range States languages, and notes on distribution, habitat and ecology, and population data."

Reference:

Notarbartolo di Sciara G. 2002. Summary. In: G. Notarbartolo di Sciara (Ed.), Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies. A report to the ACCOBAMS Secretariat, Monaco, February 2002. Section 1, 5p.

Fig. 18.2 – Proposed Black Sea coastal and marine protected areas which are not established yet:

Figure 2.4.11-1 Proposed Black Sea Coastal and Marine Protected Area, which are not yet established (2002)

2.4.12 European Red List of Habitats: Part 1. Marine Habitats

Overview:
"The first ever European Red List of Habitats reviews the current status of all natural and semi-natural terrestrial, freshwater and marine habitats and highlights the pressures they face. Using a modified version of the IUCN Red List of Ecosystems categories and criteria, it covers the EU28, plus Iceland, Norway, Switzerland and the Balkan countries and their neighbouring seas. Over 230 terrestrial and freshwater habitats were assessed.
The European Red List of Habitats provides an entirely new and all embracing tool to review commitments for environmental protection and restoration within the EU2020 Biodiversity Strategy. In addition to the assessment of threat, a unique set of information underlies the Red List for every habitat: from a full description to distribution maps, images, links to other classification systems, details of occurrence and trends in each country and lists of threats with information on restoration potential. All of this is publicly available in PDF and database format (see links below), so the Red List can be used for a wide range of analysis."

Source:
http://ec.europa.eu/environment/nature/knowledge/redlist_en.htm

Back Sea Assessment Results:

"A total of 63 habitat types were assessed in the Black Sea and Sea of Marmara, an area defined as EU28+ (Table 3.5.1), while a total of 53 habitats were assessed for the EU28 (i.e. Bulgaria and Romania). As shown in Figure 3.5.3, for the EU28+ 86% of the habitats were Data Deficient (including nine habitat types only occurring in the Sea of Marmara), while for the EU28, 44 habitats (83%) were Data Deficient. The habitats assessed as threatened in either the EU28 and/or the EU28+ are set out in Box 3.5.1. The Red List categories for EU28 habitats are in all cases the same as, or higher than those in the EU28+. This is explained by the fact that the EU28 only includes 14% of the whole Black Sea coast and therefore space for habitats is more constrained.

Excluding Data Deficient habitats, 78% of Black Sea habitat types found in the EU28 are threatened (VU-CR) (11% of them Critically Endangered), while 67% of habitats in the EU28+ are threatened (11% Critically Endangered) (Figure 3.5.4)

For both the EU28 and EU28+, the circalittoral shows a somewhat higher level of threat. However, in the EU28 all habitat types are quite threatened with 67% or more being assessed as Endangered or Critically Endangered. Only the circalittoral habitats show the same level of threat in both the EU28 and EU28+ (Figure 3.5.5).

Within the EU28, habitats were frequently assessed as threatened under criterion B, reflecting the smaller area involved, as well as the greater knowledge of habitat status in Bulgaria and Romania following accession to the EU and the need to implement the Habitats Directive. In the EU28+, the main criteria under which habitats were assessed as threatened were A1, highlighting declines in extent, and C/D1, indicating a decline in quality.

Source:
http://ec.europa.eu/environment/nature/knowledge/pdf/Marine_EU_red_list_report.pdf

Reference:
S. Gubbay, N. Sanders, T. Haynes, J.A.M. Janssen, J.R. Rodwell, A. Nieto, M. García Criado, S. Beal, J. Borg, M. Kennedy, D. Micu, M. Otero, G. Saunders and M. Calix (2016) *European Red List of Habitats, Part 1 Marine Habitats*, European Commission. http://ec.europa.eu/environment/nature/knowledge/pdf/Marine_EU_red_list_report.pdf

Box 3.5.1 **Threatened Black Sea habitats (for more information refer to the full assessments).**

Critically Endangered
A5.xx Pontic circalittoral biogenic detritic bottoms with dead or alive mussel beds, shell deposits, with encrusting corallines (*Phymatolithon, Lithothamnion*) and attached foliose sciaphilic macroalgae

Endangered
A1.1xx Turf algae on Pontic moderately exposed lower mediolittoral rock
A1.44 Pontic mediolittoral caves and overhangs
A3.34 Fucales and other algae on Pontic sheltered upper infralittoral rock, well illuminated
A5.5w Seagrass meadows in Pontic lower infralittoral sands
A5.62 Mussel beds on Pontic circalittoral terrigenous muds

Vulnerable
A4.24 Invertebrate-dominated Pontic circalittoral rock

Figure 2.4.12-1 Threatened Black Sea Habitats

2.4.13 Cetacean Distribution in The Southern Black Sea: An Acoustic Approach

Abstract:
"Large numbers of small cetaceans (common dolphin, harbor porpoises and bottlenose dolphins) were hunted in the Black Sea until the hunting of cetaceans was banned in Turkey in 1983. Even though the practice of hunting cetaceans has ceased by Turkish fleets, ongoing threats such as viral infections, overfishing, by-catch, habitat loss, seismic surveys and the pressure of fishermen continue to persist. One of the most overwhelming reasons as to why overcoming these threats proves so difficult, is the insufficient data available for these populations.

This thesis study aims to evaluate the distribution and abundance of the Black Sea cetaceans for the future conservation of these species. To fulfill this role, i) hydro-acoustics, ii) passive acoustics and iii) visual observation methods were performed over transects during two one month cruises held in July and October 2014, covering up to 120 miles off the Black Sea coast of Turkey (approximately 150 000 km2). For the fisheries hydroacoustics, three scientific echo sounders (38 kHz, 120 kHz and 200 kHz, SIMRAD EK60) were operated continuously over the cruise transects. For the passive acoustics, C-POD (Chelonia Ltd., Cetacean Monitoring Systems) was deployed at up to the 93 stations. In addition, a new methodology for cetacean detection was developed. During the development of the new methodology, dolphin presence in fisheries hydroacoustic data, i.e. the "noise", was processed into the "data" by validation with cetacean observation data. C-POD data was used both for confirmation of cetacean species and characterization of cetacean vocalizations. Finally, the abundance of cetacean species in the Exclusive Economic Zone of Turkey were examined using the data generated by the three respective methodologies.

With the combination of these methods, the distribution of especially one vulnerable (IUCN) Black Sea cetacean, the short-beaked common dolphin (Delphinus delphis ssp. ponticus, Barabash-Nikiforov, 1935) was assessed. Results suggest that cetaceans, especially common dolphins, are concentrated mainly in the Eastern region of the Black Sea and harbor porpoises are distributed coastally in lesser numbers. Furthermore, bottlenose dolphins were scarcely observed in the study area. As a result of abundance estimations it was found that, common dolphins display the largest population size, followed by harbor porpoises and bottlenose dolphins, respectively. Additionally, comparisons with 11 years of past visual observation data demonstrated an overall decrease in Black Sea cetacean populations. Lastly, the methodology developed proved that the hydro-acoustical data collected for fisheries purposes can also be used in cetacean research."

Reference:
Saydam, Gulce. "Cetacean Distribution In The Southern Black Sea: An Acoustic Approach." Master's Thesis, Middle Eastern Technical University, Erdemli-Mersin, Turkey, Accessed March 23, 2017. http://etd.lib.metu.edu.tr/upload/12619339/index.pdf.

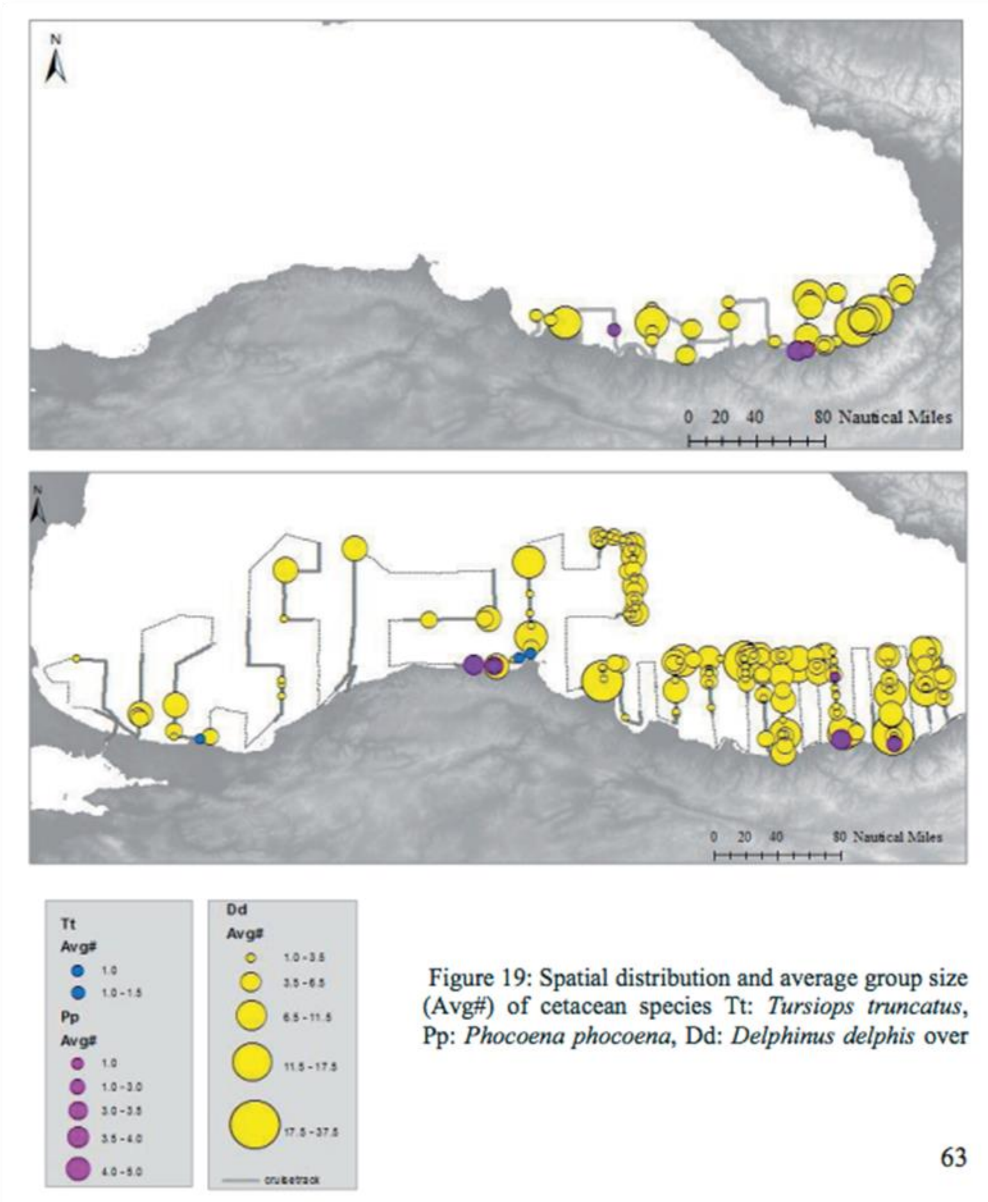

Figure 2.4.13-1 Spatial distribution and average group size (Avg#) of cetacean species Tt: Tursiops truncatus, Pp: Phocoena phocoena, Dd: Delphinus delphis over 64 the day-time cruise track of July 2014 (up) and October 2014 (down) cruises

2.4.14 Abundance and Summer Distribution of a Local Stock of Black Sea Bottlenose Dolphins, Tursiops truncatus (Cetacea, Delphinidae), in Coastal Waters near Sudak (Ukraine, Crimea)

Abstract:
"The first assessment of abundance of a local population of bottlenose dolphins in the Black Sea (near the Sudak coast) in 2011–2012 has been conducted: the results of a mark-recapture study of photo identified animals were complemented by a vessel line transect survey. The overall abundance of a population was estimated at between 621 ± 198 and 715 ± 267 animals (Chapman and Petersen estimates), and the majority of members of the population were recorded in the surveyed area. The summer range covered the area of a few hundred square kilometers, similar to migrating coastal stocks in other world regions. The greatest density of distribution was observed in August in sea 45–60 m deep; in addition, frequent approaches to the coastline are usual for dolphins of this stock. These trends in distribution may be partly explained by distribution of prey. Interaction with sprat trawling fisheries can be a factor shaping the local population structure. Coastal waters of Sudak and adjoining sea areas are an important habitat for bottlenose dolphins in the northern Black Sea, significant for their conservation."

Reference:
Gladilina, E. V., & Gol'din, P. E. (2016). Abundance and Summer Distribution of a Local Stock of Black Sea Bottlenose Dolphins, Tursiops truncatus (Cetacea, Delphinidae), in Coastal Waters near Sudak (Ukraine, Crimea). Vestnik Zoologii, 50(1), 49–56. https://doi.org/10.1515/vzoo-2016-0006

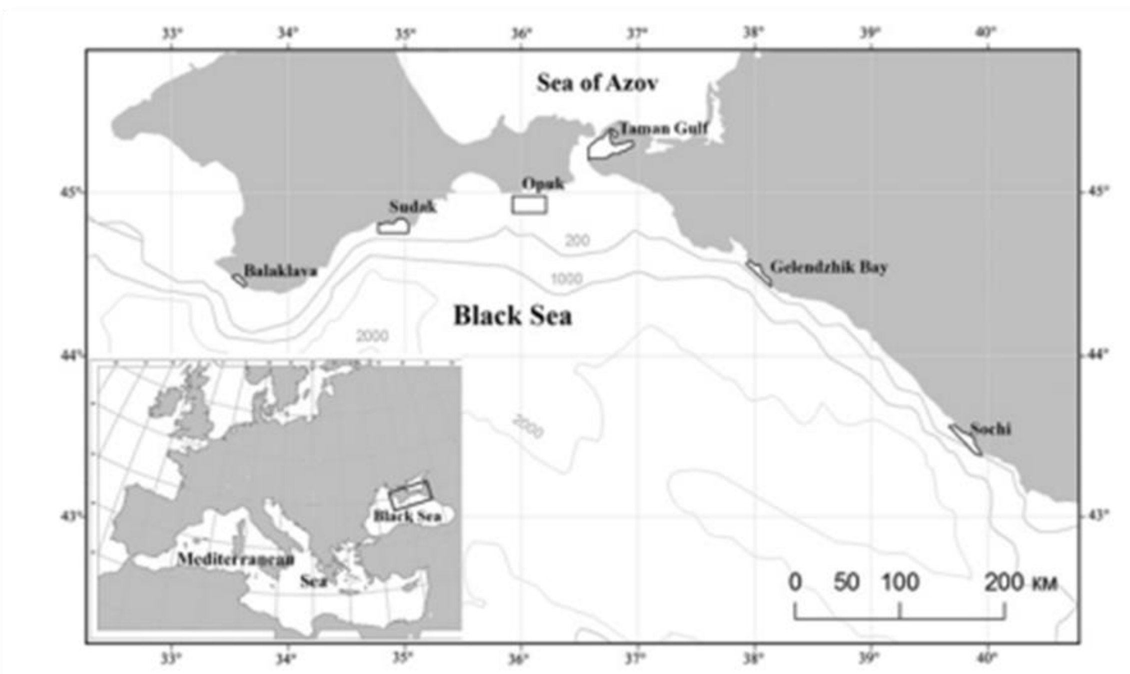

Figure 2.4.14-1 Areas of research of bottlenose dolphins in coastal waters of the northern and eastern Black Sea

Table 2. Resightings of bottlenose dolphins across the study areas: data for Marked + Left side subtly marked individuals (and separately for Marked individuals in parentheses).

Area	No. of identified dolphins	Sighted once	Resightings		Total resightings
			Within only the same year	In two or more years	
Balaklava	98 (68)	87 (58)	8 (7)	3 (3)	11 (10)
Sudak	71 (58)	56 (44)	3 (2)	12 (12)	15 (14)
Opuk	18 (12)	14 (11)	4 (1)	0 (0)	4 (1)
Taman	51 (39)	32 (23)	14 (11)	5 (5)	19 (16)
Gelendzhik	9 (9)	9 (9)	0 (0)	0 (0)	0 (0)
Sochi	103 (57)	61 (28)	24 (15)	18 (14)	42 (29)
Total	350 (243)	259 (173)	53 (36)	38 (34)	91 (70)

Figure 2.4.14-2 Re-sightings of bottlenose dolphins across the study areas

2.4.15 Selection of critical habitats for bottlenose dolphins (Tursiops truncatus) based on behavioral data, in relation to marine traffic in the Istanbul Strait, Turkey

Abstract:
"Marine traffic is a significant source of disturbance to the bottlenose dolphin population in the Istanbul Strait, Turkey. To determine the importance of this threat, behavioral data together with sighting data of both dolphins and marine vessels were assessed for 2012. The current study suggests that the Istanbul Strait is used mostly as a foraging ground for bottlenose dolphins. Nonetheless, in the same area there is intense marine traffic as well as increase of industrial fishing activities in autumn. The findings of this study indicated that high-speed ferries and high-speed boats were the most significant source of disturbance. Moreover, increased densities of fishing vessels resulted in a drastic decline of dolphin sightings. This study highlights that vessel type, speed, distance, and density have a cumulative negative effect on dolphins. In order to mitigate the impacts of vessels, it is necessary to establish managed areas in the Istanbul Strait. Such proposed areas should limit speed and density of marine traffic and have specific restrictions on vessel routes. We propose three different seasonal managed areas according to their values as critical habitat for bottlenose dolphins in the strait."

Reference:

Baş, A. A., Amaha Öztürk, A., & Öztürk, B. (2015). Selection of critical habitats for bottlenose dolphins (Tursiops truncatus) based on behavioral data, in relation to marine traffic in the Istanbul Strait, Turkey. Marine Mammal Science, 31(3), 979–997. https://doi.org/10.1111/mms.12202

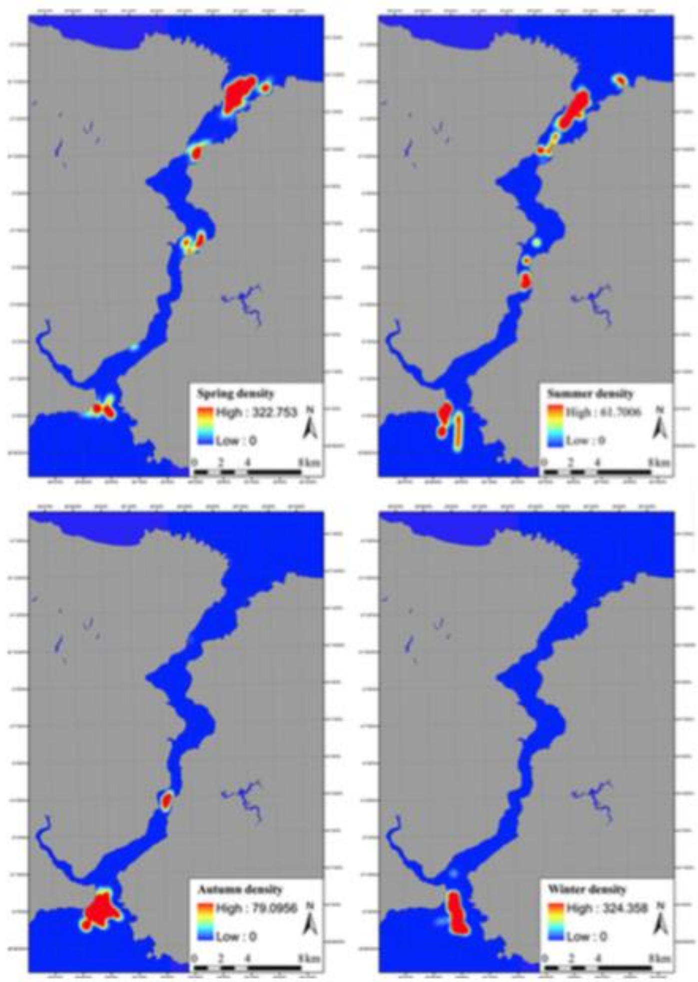

Figure 3. Bottlenose dolphin density per km^2 for each season: Spring (March, April, May), Summer (June, July, August), Autumn (September, October, November), and Winter (December, January, February).

Figure 2.4.15-1 Bottlenose dolphin density per km^2 for each season: Spring (March, April, May), Summer (June, July, August), Autumn (September, October, November), and Winter (December, January, February)

2.4.16 Predicting foraging hotspots for Yelkouan Shearwater in the Black Sea

Abstract:

The Yelkouan shearwater (*Puffinus yelkouan* Acerbi, 1827) is a vulnerable species endemic to the Mediterranean Region, but there is little information of its ecology particularly when at sea. In this study, we assessed the habitat use by Yelkouan shearwater in the Black Sea during the breeding (March-July) and non-breeding(August-February) periods of 2013, using boat-based surveys and shore-based counts. We created a species distribution model (SDM) based on the environmental variables that most accurately reflected the oceanographic habitat of this species in order to delineate foraging hotspots. Our habitat modelling analyses suggest that Yelkouan shearwaters respond to complex bio-physical coupling, as evidenced by their association with oceanographic variables. Foraging Yelkouan shearwaters mainly occurred on the western Black Sea continental shelf, indicating that Yelkouan shearwaters were foraging in shallow, cold and coastal waters. In the non-breeding period, Yelkouan Shearwater occurred beyond the Black Sea continental shelf, a wide pelagic extension of sea, indicating that shearwaters foraged in deep, warm and pelagic waters. These results are consistent with earlier studies, which identified the Black Sea as an important congregation site for Mediterranean Yelkouan shearwater populations outside the breeding season. This study demonstrates how the integration of boat-based survey data, shore-based counts and modelling can provide a wider understanding of the linkage between marine ecosystems that is mediated by marine megafauna such as pelagic seabirds.

Reference:

Ortega, M. P., & İsfendiyaroğlu, S. (n.d.). Predicting foraging hotspots for Yelkouan Shearwater in the Black Sea. *Deep Sea Research Part II: Topical Studies in Oceanography*. https://doi.org/10.1016/j.dsr2.2016.07.007

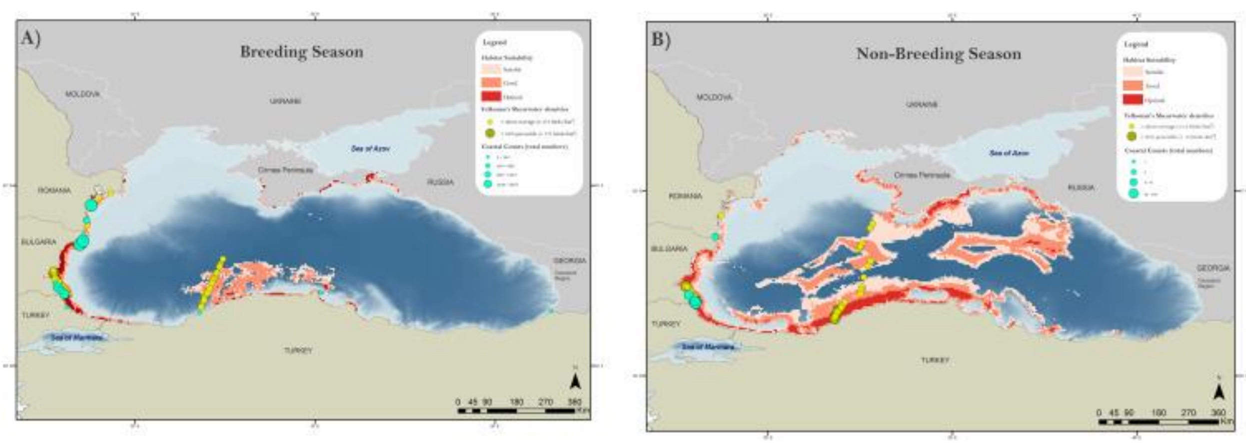

Figure 2.4.16-1 Yelkouan habitat suitability in breeding and non-breeding seasons

2.4.17 Migration strategies of the Yelkouan Shearwater (*Puffinus yelkouan*)

Abstract:
"Although the Yelkouan Shearwater *Puffinus yelkouan* is listed as near threatened on the International Union for Conservation of Nature Red List, with many populations in serious decline, there is little detailed information on the location of its key foraging areas during the non-breeding season. To address this knowledge gap, adult Yelkouan Shearwaters at a breeding colony in Malta were fitted with geolocators in 2 consecutive years. Of the 13 birds tracked (two of which were tracked in both years), the majority (n = 10; 76.9 %) migrated in June–July to spend most of the non-breeding period in the Black Sea (n = 5), Aegean Sea (n = 2), Black and Aegean seas (n = 2), or Black and Adriatic seas (n = 1). The final three birds remained within the central Mediterranean area and did not move beyond 500 km of the breeding colony. There was considerable variation among individuals in terms of timing of the outward and return migrations, duration and location of periods of residency in different areas, and migration routes. However, migration patterns (including routes and areas visited) were very consistent in the two individuals tracked in consecutive years. All birds returned in November or December to waters closer to the breeding colony, concentrating between the North African coast and the southern Adriatic. This study has identified key areas during the non-breeding season for Yelkouan Shearwaters from Malta which are also likely to be important for other populations. Given the continuing decline of this species throughout its range, this information represents an essential step for improving international conservation efforts. At-sea threats in the wintering regions include by-catch in long-line and trawl fisheries, impacts of over-fishing, illegal hunting (particularly in Maltese waters), ingestion of plastics, pollution, and the potential impact of off-shore wind farms. These threats need to be addressed urgently in the areas identified by this study to prevent further declines."

Reference:
Raine, A. F., Borg, J. J., Raine, H., & Phillips, R. A. (2013). Migration strategies of the Yelkouan Shearwater Puffinus yelkouan. Journal of Ornithology, 154(2), 411–422. https://doi.org/10.1007/s10336-012-0905-4

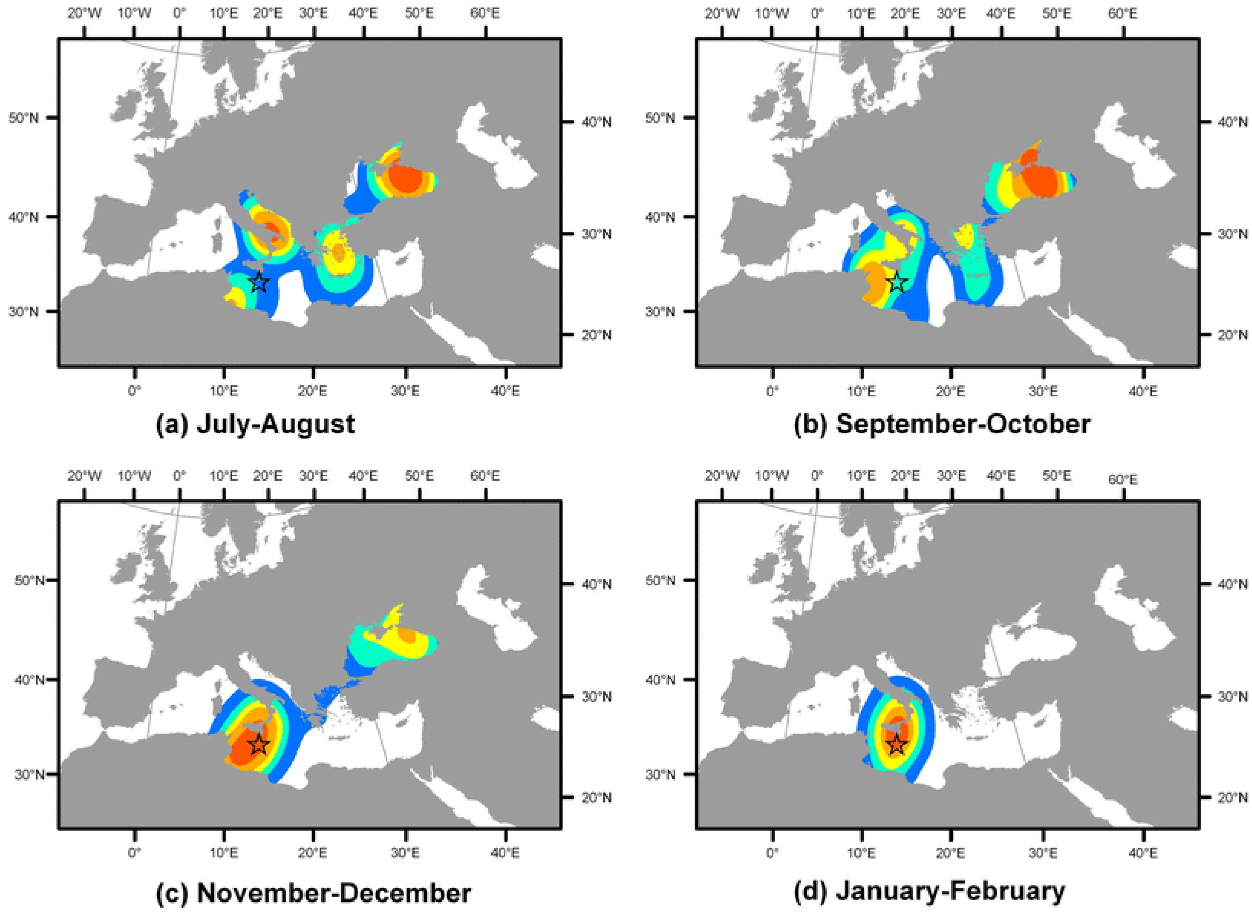

Figure 2.4.17-1 Seasonal changes in distribution of Yelkouan Shearwaters (Puffinus yelkouan) (n = 15) from Malta tracked during the non-breeding season (July–February) in 2008 and 2009

2.4.18 Defining Mediterranean and Black Sea Biogeochemical Subprovinces and Synthetic Ocean Indicators Using Mesoscale Oceanographic Features

Abstract:
"The Mediterranean and Black Seas are semi-enclosed basins characterized by high environmental variability and growing anthropogenic pressure. This has led to an increasing need for a bioregionalization of the oceanic environment at local and regional scales that can be used for managerial applications as a geographical reference. We aim to identify biogeochemical subprovinces within this domain, and develop synthetic indices of the key oceanographic dynamics of each subprovince to quantify baselines from which to assess variability and change. To do this, we compile a data set of 101 months (2002–2010) of a variety of both "classical" (i.e., sea surface temperature, surface chlorophyll-a, and bathymetry) and "mesoscale" (i.e., eddy kinetic energy, finite-size Lyapunov exponents, and surface frontal gradients) ocean features that we use to characterize the surface ocean variability. We employ a k-means clustering algorithm to objectively define biogeochemical subprovinces based on classical features, and, for the first time, on mesoscale features, and

on a combination of both classical and mesoscale features. Principal components analysis is then performed on the oceanographic variables to define integrative indices to monitor the environmental changes within each resultant subprovince at monthly resolutions. Using both the classical and mesoscale features, we find five biogeochemical subprovinces for the Mediterranean and Black Seas. Interestingly, the use of mesoscale variables contributes highly in the delineation of the open ocean. The first axis of the principal component analysis is explained primarily by classical ocean features and the second axis is explained by mesoscale features. Biogeochemical subprovinces identified by the present study can be useful within the European management framework as an objective geographical framework of the Mediterranean and Black Seas, and the synthetic ocean indicators developed here can be used to monitor variability and long-term change. “

Reference:

Nieblas, Anne-Elise, Kyla Drushka, Gabriel Reygondeau, Vincent Rossi, Hervé Demarcq, Laurent Dubroca, and Sylvain Bonhommeau. 2014. “Defining Mediterranean and Black Sea Biogeochemical Subprovinces and Synthetic Ocean Indicators Using Mesoscale Oceanographic Features.” *PLOS ONE* 9 (10): e111251. doi:10.1371/journal.pone.0111251.

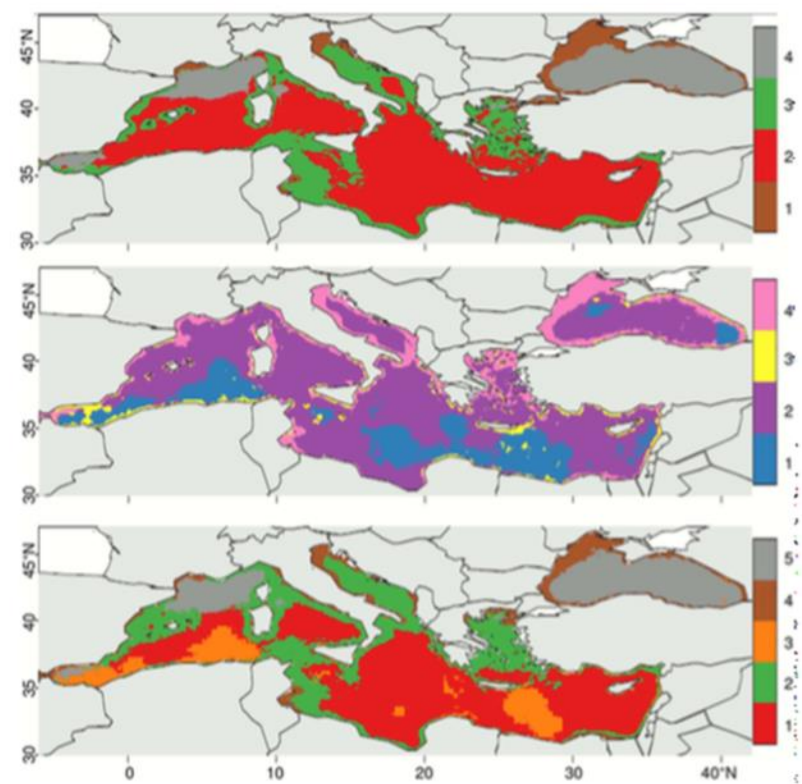

Figure 2. Biogeochemical subprovinces of the Mediterranean and Black Seas. Subprovinces for the (a) “classical”, (b) “mesoscale”, and (c) “full” multivariate arrays using a 5% threshold for the explained sum of squares to define the optimal number of subprovinces (see text). doi:10.1371/journal.pone.0111251.g002

Figure 2.4.18-1 Biogeochemical subprovinces of the Mediterranean and Black Seas

2.4.19 Seasonal, interannual, and mesoscale variability of the Black Sea upper layer circulation derived from altimeter data

Abstract:
"TOPEX/Poseidon and ERS altimeter data comprising the period from May 1992 to May 1999 are assimilated into a shallow water model for providing a dynamically consistent interpretation of the sea surface height variations and estimation of the temporal and spatial characteristics of the upper layer circulation in the Black Sea. These 7-year- long observations offer a new capability for interpretation of major transient and quasi-permanent features of the upper layer circulation. The instantaneous flow fields involve a complex, eddy-dominated system with different types of structural organizations in which the eddies and the gyres of the interior cyclonic cell interact continuously among themselves and with meanders, and filaments of the Rim Current. The circulation possesses a distinct seasonal cycle whose major characteristic features repeat every year with some year-to-year variability. An organized two-gyre winter circulation system disintegrates gradually into a series of interconnecting eddies in the summer and autumn months, which are also characterized by more pronounced and complex mesoscale activity in the peripheral flow system. Our analyses suggest a revised schematic circulation picture of the major quasi-permanent and recurrent elements of the Black Sea. "

Reference:
Korotaev, Gennady, T. Oguz, A. Nikiforov, and C. Koblinsky. 2003. "Seasonal, Interannual, and Mesoscale Variability of the Black Sea Upper Layer Circulation Derived from Altimeter Data." *Journal of Geophysical Research: Oceans* 108 (C4): 3122. doi:10.1029/2002JC001508.

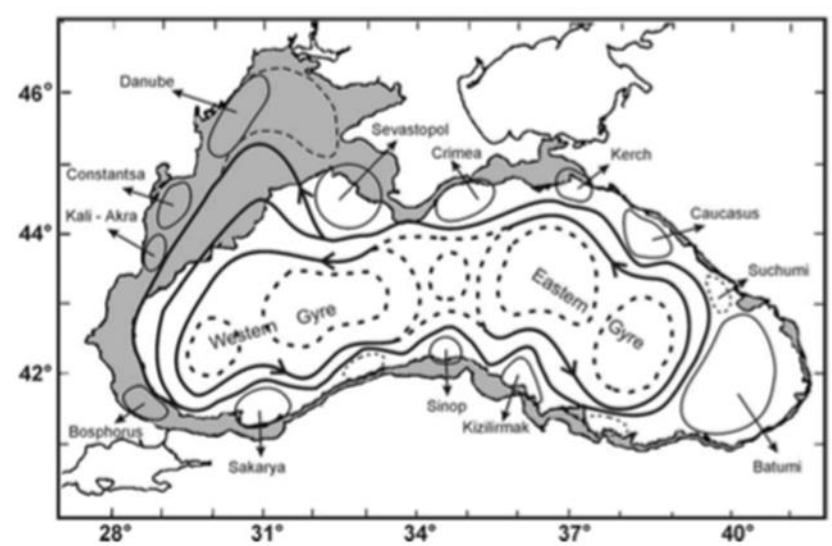

Figure 14. The revised schematic pattern including features derived from the analysis of the altimeter data.

Figure 2.4.19-1 Black Sea schematic circulation pattern

3 Caspian Sea

3.1 Biogeography

3.1.1 Biogeographic Classification of the Caspian Sea

Abstract:
"Like other inland seas, the Caspian Sea (CS) has been influenced by climate change and anthropogenic disturbance during recent decades, yet the scientific understanding of this water body remains poor. In this study, an eco- geographical classification of the CS based on physical in- formation derived from space and in situ data is developed and tested against a set of biological observations. We used a two-step classification procedure, consisting of (i) a data reduction with self-organizing maps (SOMs) and (ii) a synthesis of the most relevant features into a reduced number of marine ecoregions using the hierarchical agglomerative clustering (HAC) method. From an initial set of 12 potential physical variables, 6 independent variables were selected for the classification algorithm, i.e., sea surface temperature (SST), bathymetry, sea ice, seasonal variation of sea surface salinity (DSSS), total suspended matter (TSM) and its seasonal variation (DTSM). The classification results reveal a robust separation between the northern and the middle/southern basins as well as a separation of the shallow nearshore waters from those offshore. The observed patterns in ecoregions can be attributed to differences in climate and geochemical factors such as distance from river, water depth and currents. A comparison of the annual and monthly mean Chl a concentrations between the different ecoregions shows significant differences (one-way ANOVA, $P < 0.05$). In particular, we found differences in phytoplankton phenology, with differences in the date of bloom initiation, its duration and amplitude between ecoregions. A first qualitative evaluation of differences in community composition based on recorded presence–absence patterns of 25 different species of plankton, fish and benthic invertebrate also confirms the relevance of the ecoregions as proxies for habitats with common biological characteristics."

Reference:
Fendereski, F., Vogt, M., Payne, M. R., Lachkar, Z., Gruber, N., Salmanmahiny, A., & Hosseini, S. A. (2014). Biogeographic classification of the Caspian Sea. Biogeosciences, 11(22), 6451–6470. https://doi.org/10.5194/bg-11-6451-2014

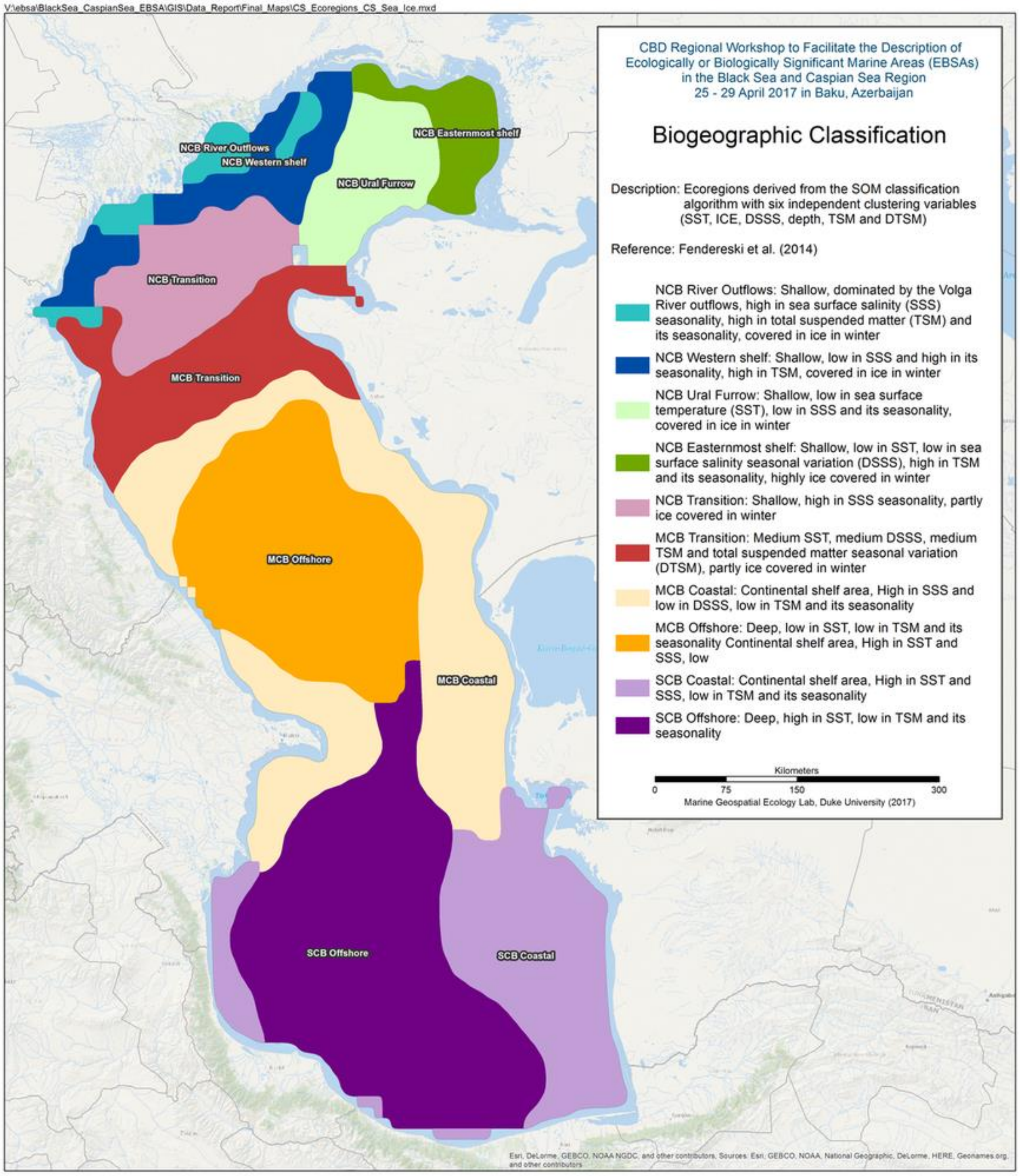

Figure 3.1.1-1 Biogeographic Classification of the Caspian Sea

3.2 Biological Data

3.2.1 Caspian Seal seasonal movement

Abstract:
"Marine mammal satellite telemetry studies can provide important tests of movement and foraging theory. Here we present the first satellite tracking study of Caspian seals Pusa caspica, an endangered, ice-breeding phocid seal, endemic to the Caspian Sea. The Caspian Sea is one of the most variable habitats inhabited by any pinniped species, and lacks competing large piscivores. Under such conditions foraging theory predicts that individual variation in foraging strategy may develop to reduce intra-species competition. We deployed 75 Argos satellite tags from 2009 to 2012 on adult seals of both sexes, and used state-space modelling to describe movement, and behavioural states. During winter in all years most individuals were mobile within the icepack, making repeated trips into open water outside the ice field, with only brief stationary periods that may have been related to breeding activity. During summer 2011, 60% of tagged animals migrated into the mid and southern Caspian, while the remainder spent the ice-free season in the north. Summer foraging locations were not restricted by proximity to haul-out sites, with animals spending more than 6 months at sea. Maximum dive depths exceeded 200 m, and maxi- mum duration was greater than 20 min, but 80% of dives were shallower than 15 m and shorter than 5 min. Hierarchical cluster analysis identified 3 distinct groups of summer dive behaviour, comprising shallow, intermediate and deep divers, which were also spatially exclusive, suggesting potential niche partitioning and individual specialisation on prey or habitat types. The results can contribute to assessment of impacts from anthropogenic activities and to designation of protected areas encompassing critical habitats."

Reference:
Dmitrieva, L., Jüssi, M., Jüssi, I., Kasymbekov, Y., Verevkin, M., Baimukanov, M., … Goodman, S. J. (2016). Individual variation in seasonal movements and foraging strategies of a land-locked, ice-breeding pinniped. Marine Ecology Progress Series, 554(10.3354/meps11804), 241–256.

The satellite telemetry results revealed that Caspian seal habitat area included almost the whole North and Middle Caspian and the eastern part of the Southern Caspian. The North Caspian is suggested to be a very important habitat area for the species which provides breeding ice-habitat in winter, a foraging habitat for transiting seals travelling to the south in spring and returning north in autumn, and for the large portion that stay in the North Caspian for the whole ice-free period. The shallow areas in the north-east Caspian, from Komsomoletz Bay to the Ural delta, are used by seals for transit, foraging and resting. Komsomolskiy Bay is an important moulting area where tens of thousands of seals gather every spring after ice disappears (see Photo below). Other important haul-out locations in the North Caspian include Ziud-West island, Malyj Zhemchuzhnyj island (Russia) and Rybachij island.

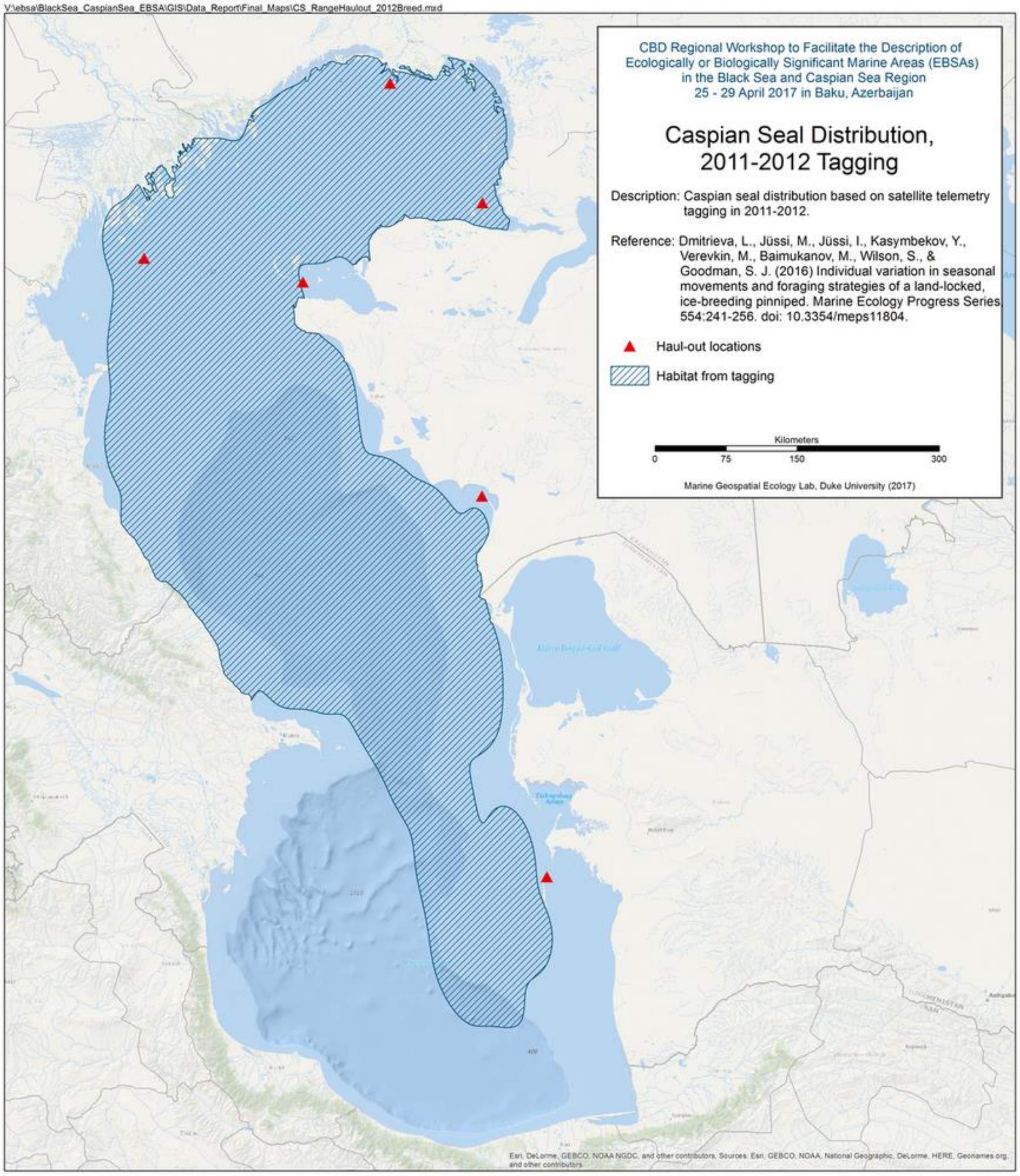

Figure 3.2.1-1 Caspian seal distribution based on satellite telemetry tagging in 2011-2012

3.2.2 Caspian Seal breeding distribution

Caspian seals tend to give birth far from the shore in the close-ridged ice stable enough to provide reliable platforms and shelter from weather and predators for the pup until weaning. The differences in breeding area location are mainly determined by the ice areas accessible for females in the pupping time.

References:

Dmitrieva, L., Härkönen, T., Baimukanov, M., Bignert, A., Jüssi, I., Jüssi, M., … Goodman, S. (2015). Inter-year variation in pup production of Caspian seals Pusa caspica 2005–2012 determined from aerial surveys. Endangered Species Research, 28(3), 209–223. https://doi.org/10.3354/esr00689

Harkonen, T., Jüssi, M., Baimukanov, M., Bignert, A., Dmitrieva, L., Kasimbekov, Y., … Goodman, S. J. (2008). Pup Production and Breeding Distribution of the Caspian Seal (Phoca caspica) in Relation to Human Impacts. AMBIO: A Journal of the Human Environment, 37(5), 356–361. https://doi.org/10.1579/07-R-345.1

Maps below show Caspian seal breeding areas in relation to the ice conditions in different years.

In years with normal ice cover (e.g. in 2006), the main breeding area was located in an area to the north-east of ‘The Saddle”, which lies at the boundary between the mid- and northern Caspian basins, between E49.8°–51.0°.

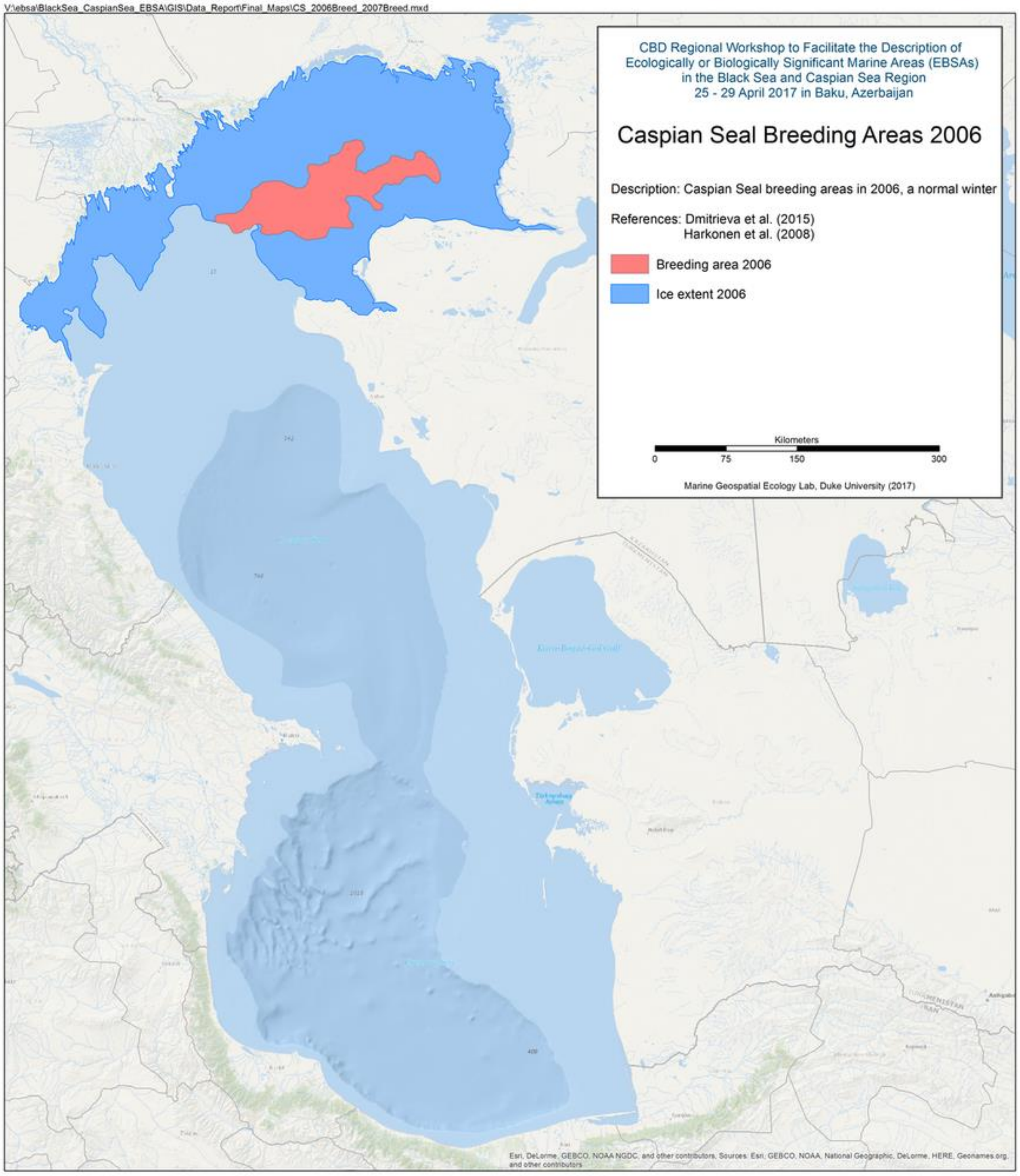

Figure 3.2.2-1 Caspian seal breeding area in 2006 (normal winter)

In mild winters (e.g. in 2007) there is no ice available in the areas normally used by breeding seals. In 2007 the ice was limited to a strip along the north-eastern Caspian coastline to very shallow waters of 1–3m. Therefore all seals were concentrated in the extreme easterly section. Mild winters could enhance pup mortality as loss of the ice-breeding platform before weaning and moulting is fatal for Caspian seal pups.

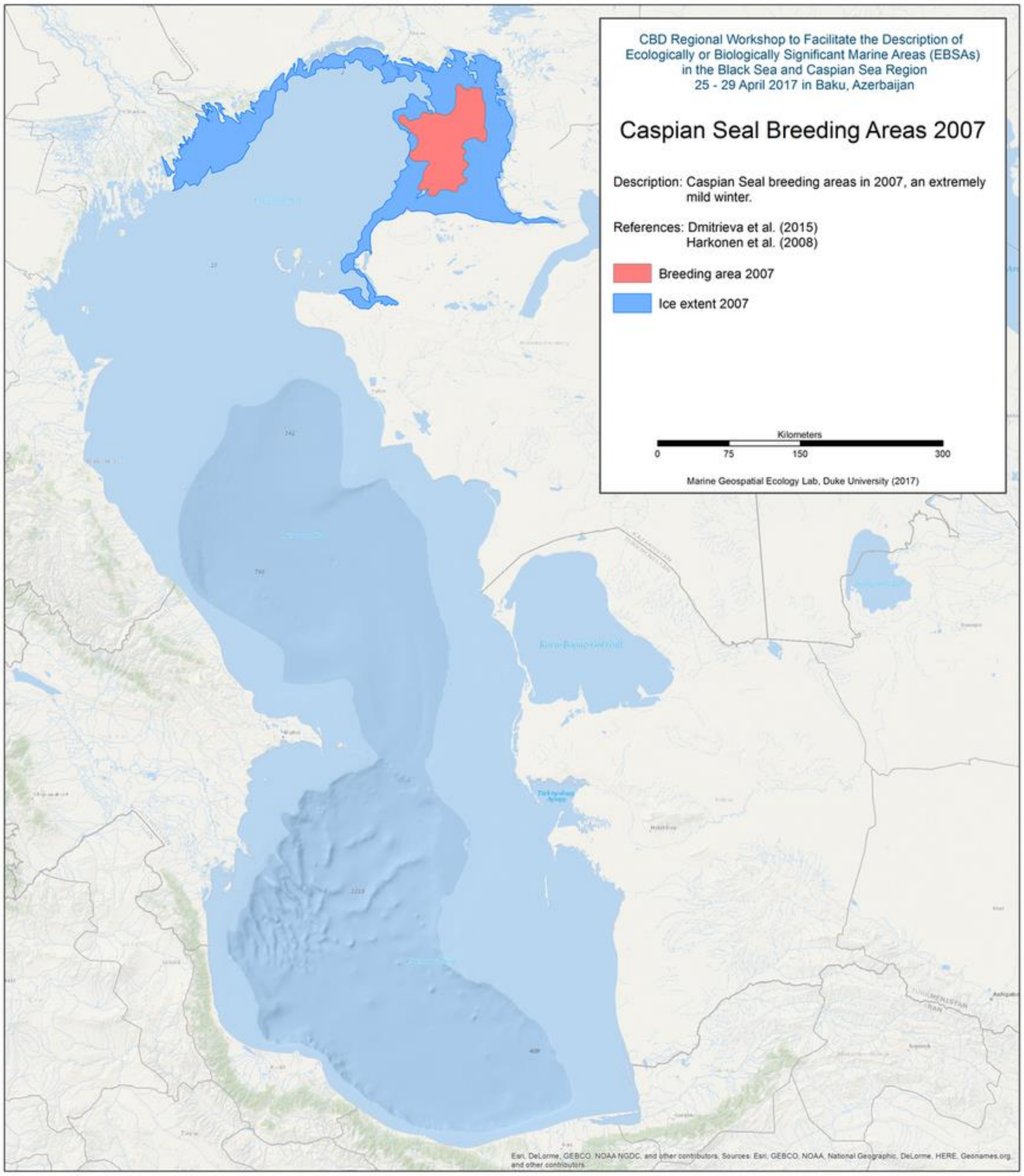

Figure 3.2.2-2 Caspian seal breeding area in 2007 (extremely mild winter)

The extensive ice coverage in severe winters (e.g. in 2012) determines the location of pupping areas which can be distributed further south and west compared to other years.

Main breeding area in 2012 was located in the Saddle area, and close to the ice edge between Maly Zhemchuzhnyj and Kulaly islands

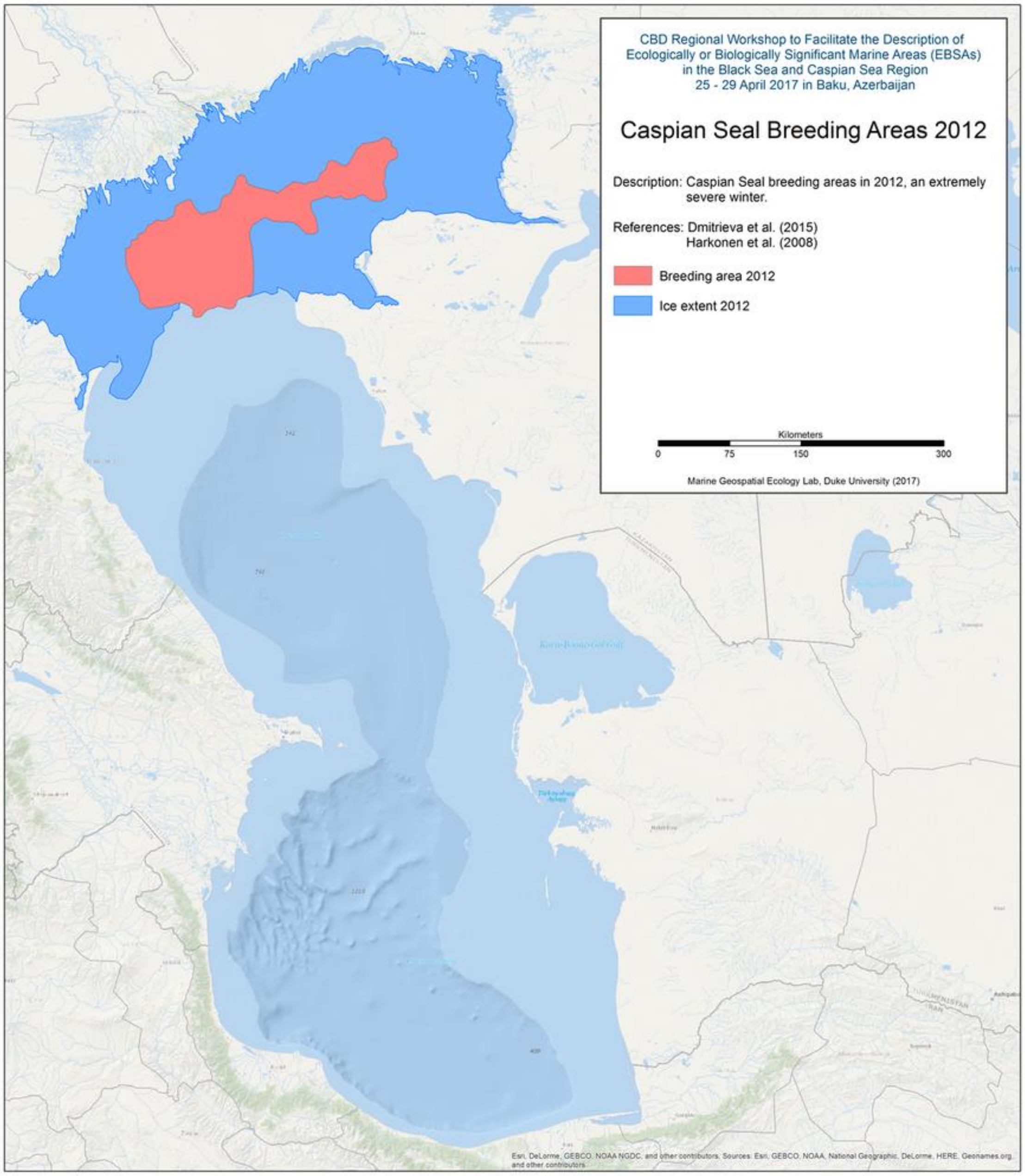

Figure 3.2.2-3 Caspian seal breeding area in 2012 (extremely severe winter)

3.2.3 Non-Breeding Distribution for Velvet Scoter

This map shows the non-breeding season distribution of the Velvet Scoter *Melanitta fusca*, a globally threatened seabird species classified as Vulnerable in the IUCN's red list of threatened species (BirdLife International 2017a).

Reference:

BirdLife International, 2017a. IUCN Red List for birds. Downloaded from http://www.birdlife.org on 10/03/2017

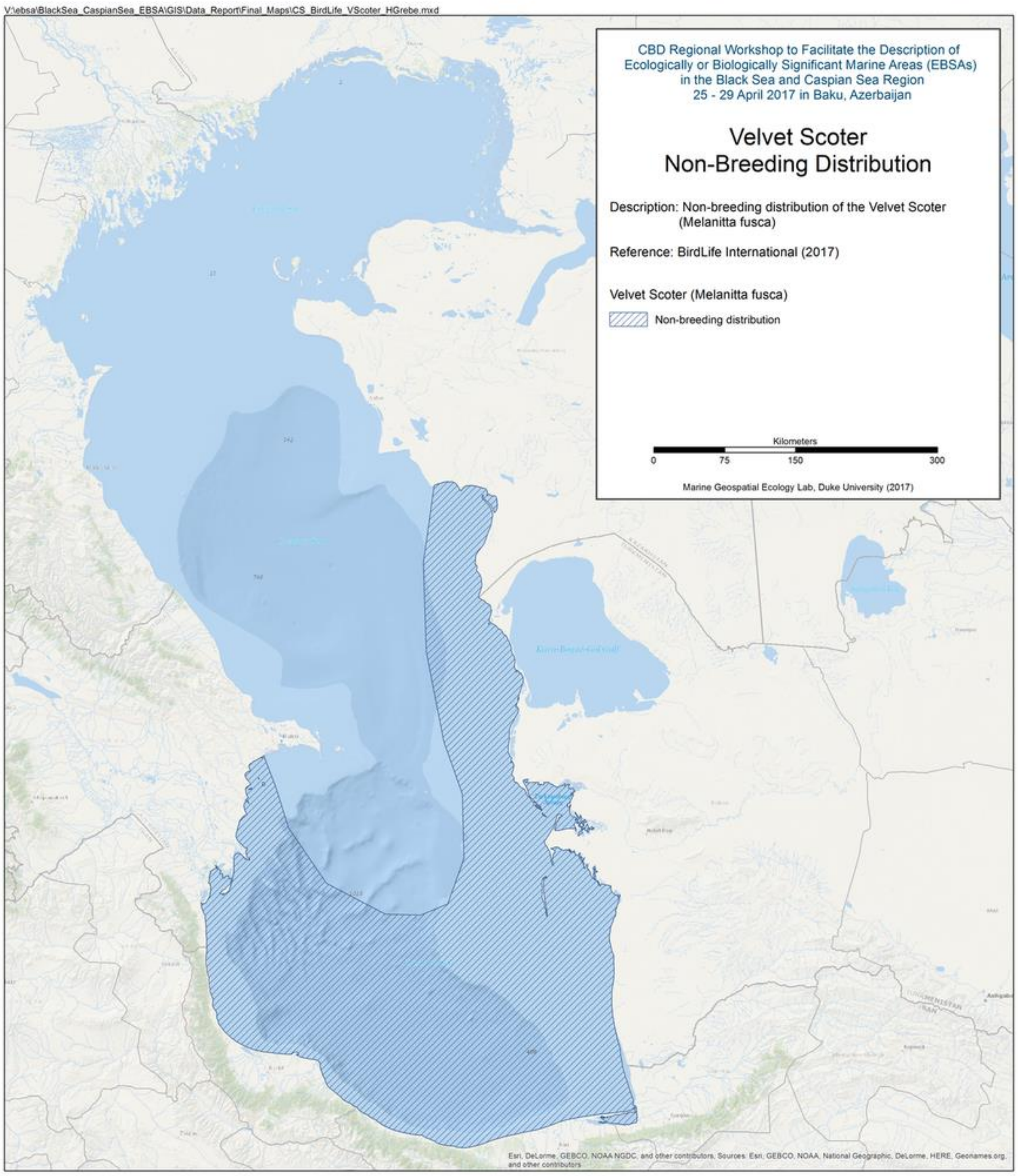

Figure 3.2.3-1 Non-Breeding Distribution for Velvet Scoter

3.2.4 Non-Breeding Distribution for Horned Grebe

This map shows the non-breeding season distribution of the Horned Grebe *Podiceps auritus*, a globally threatened seabird species classified as Vulnerable in the IUCN's red list of threatened species (BirdLife International 2017a).

Reference:

BirdLife International, 2017a. IUCN Red List for birds. Downloaded from http://www.birdlife.org on 10/03/2017

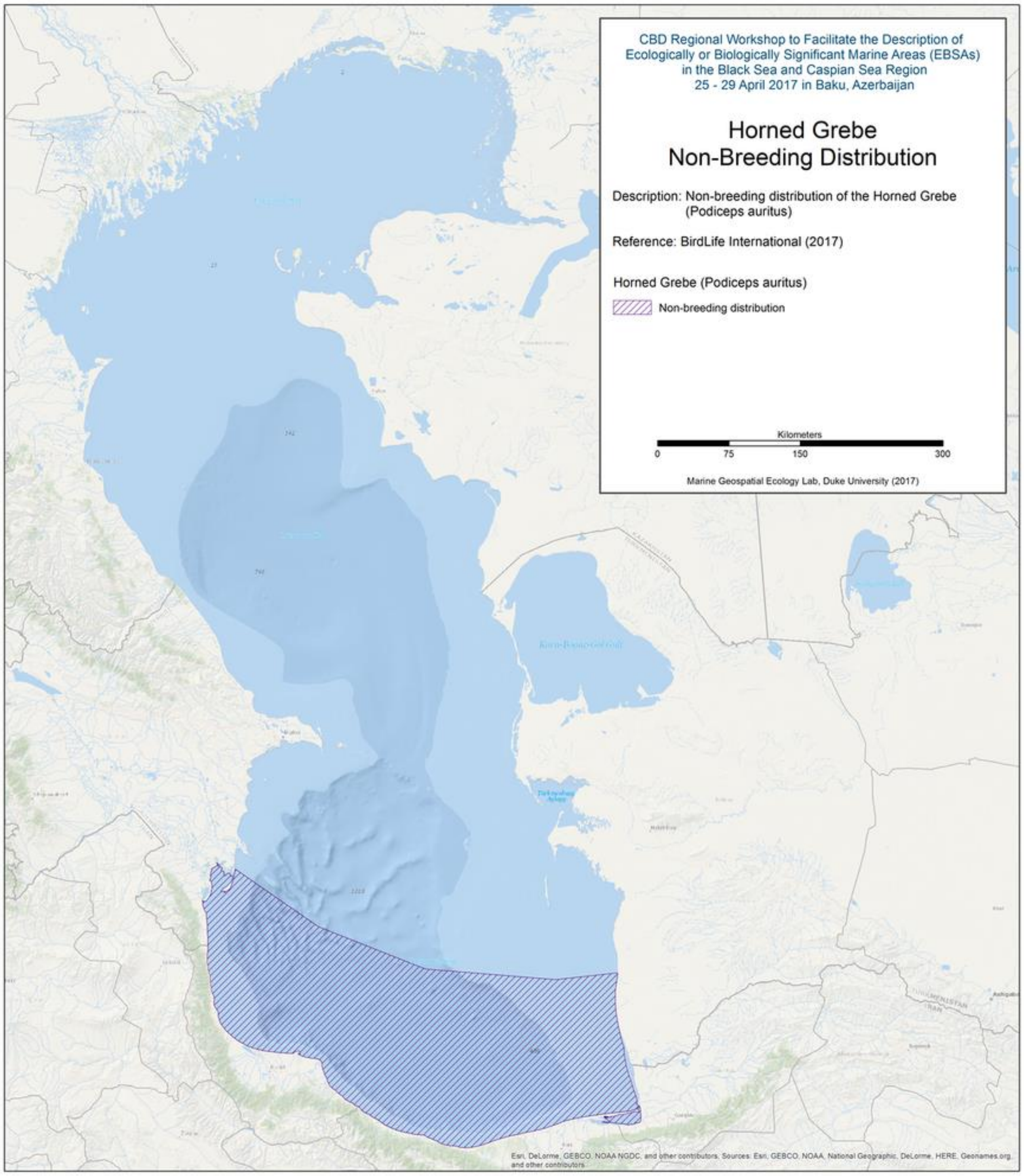

Figure 3.2.4-1 Non-Breeding Distribution for Horned Grebe

3.3 Physical Data

3.3.1 General Bathymetric Chart of the Oceans (GEBCO) Bathymetry and Slope

Abstract:
"General Bathymetric Chart of the Oceans (GEBCO) has released the GEBCO_2014 grid, a new digital bathymetric model of the world ocean floor merged with land topography from publicly available digital elevation models. GEBCO_2014 has a grid spacing of 30 arc sec and updates the 2010 release (GEBCO_08) by incorporating new versions of regional bathymetric compilations from the International Bathymetric Chart of the Arctic Ocean, the International Bathymetric Chart of the Southern Ocean, the Baltic Sea Bathymetry Database, and data from the European Marine Observation and Data network bathymetry portal, among other data sources. Approximately 33% of ocean grid cells (not area) have been updated in GEBCO_2014 from the previous version, including both new interpolated depth values and added soundings. These updates include large amounts of multibeam data collected using modern equipment and navigation techniques, improving portrayed details of the world ocean floor. Of all nonland grid cells in GEBCO_2014, approximately 18% are based on bathymetric control data, i.e., primarily multibeam and single-beam soundings or preprepared grids which may contain some interpolated values. The GEBCO_2014 grid has a mean and median depth of 3897 m and 3441 m, respectively. Hypsometric analysis reveals that 50% of the Earth's surface is composed of seafloor located 3200 m below mean sea level and that ~900 ship years of surveying would be needed to obtain complete multibeam coverage of the world's oceans."

Reference:
Weatherall, Pauline, K. M. Marks, Martin Jakobsson, Thierry Schmitt, Shin Tani, Jan Erik Arndt, Marzia Rovere, Dale Chayes, Vicki Ferrini, and Rochelle Wigley. 2015. "A New Digital Bathymetric Model of the World's Oceans." *Earth and Space Science* 2 (8): 2015EA000107. doi:10.1002/2015EA000107.

Dataset:
The GEBCO_2014 Grid, version 20150318, www.gebco.net

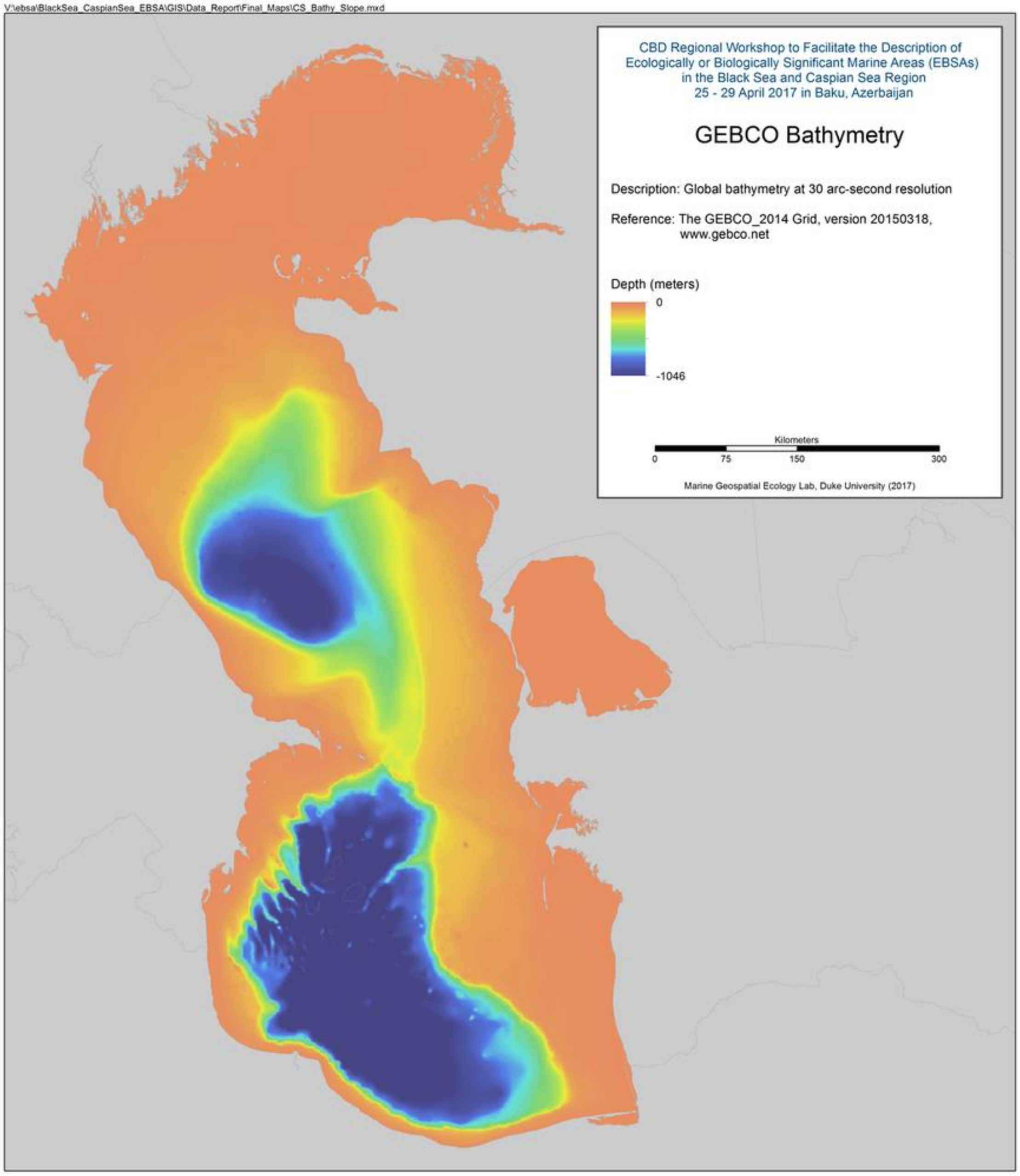

Figure 3.3.1-1 GEBCO 30 Arc-second Bathymetry

Slope derived from General Bathymetric Chart of the Oceans (GEBCO) bathymetry with ArcGIS 10.4.1.

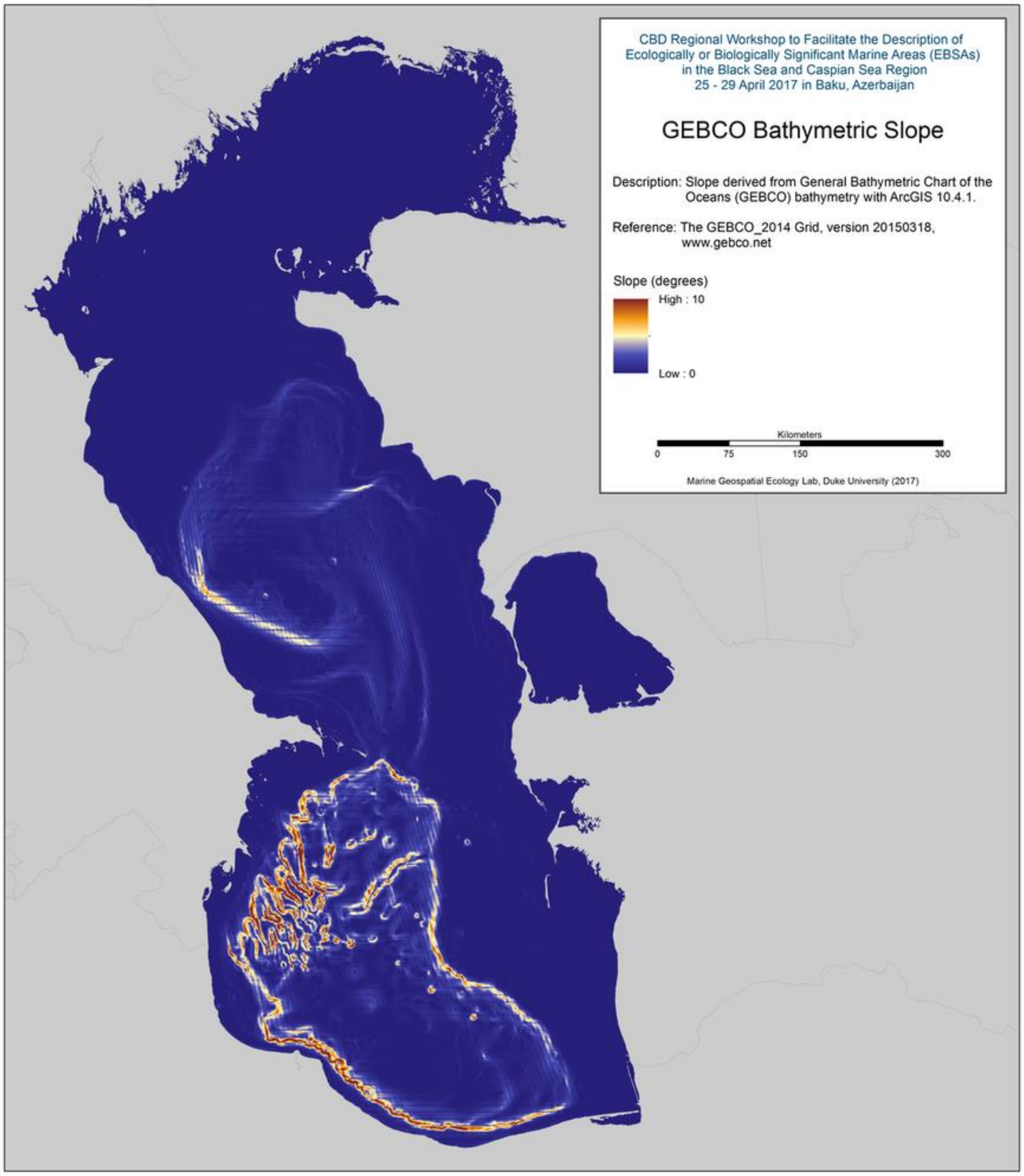

Figure 3.3.1-2 GEBCO Bathymetric Slope

3.3.2 Sea Surface Temperature

The 4k 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 (2006 - 2016) 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:

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

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.

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

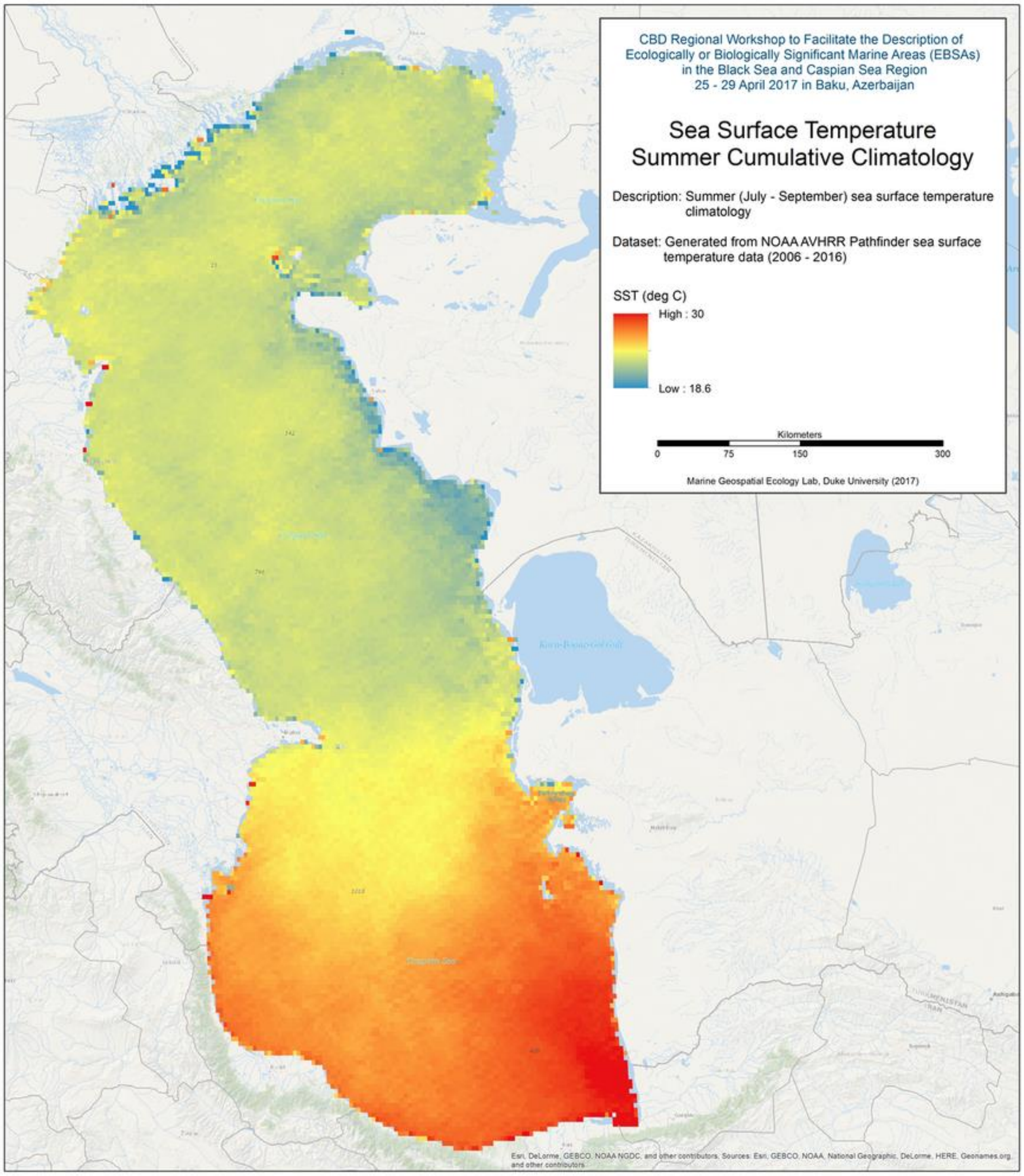

Figure 3.3.2-1 Sea Surface Temperature – Summer Cumulative Climatology

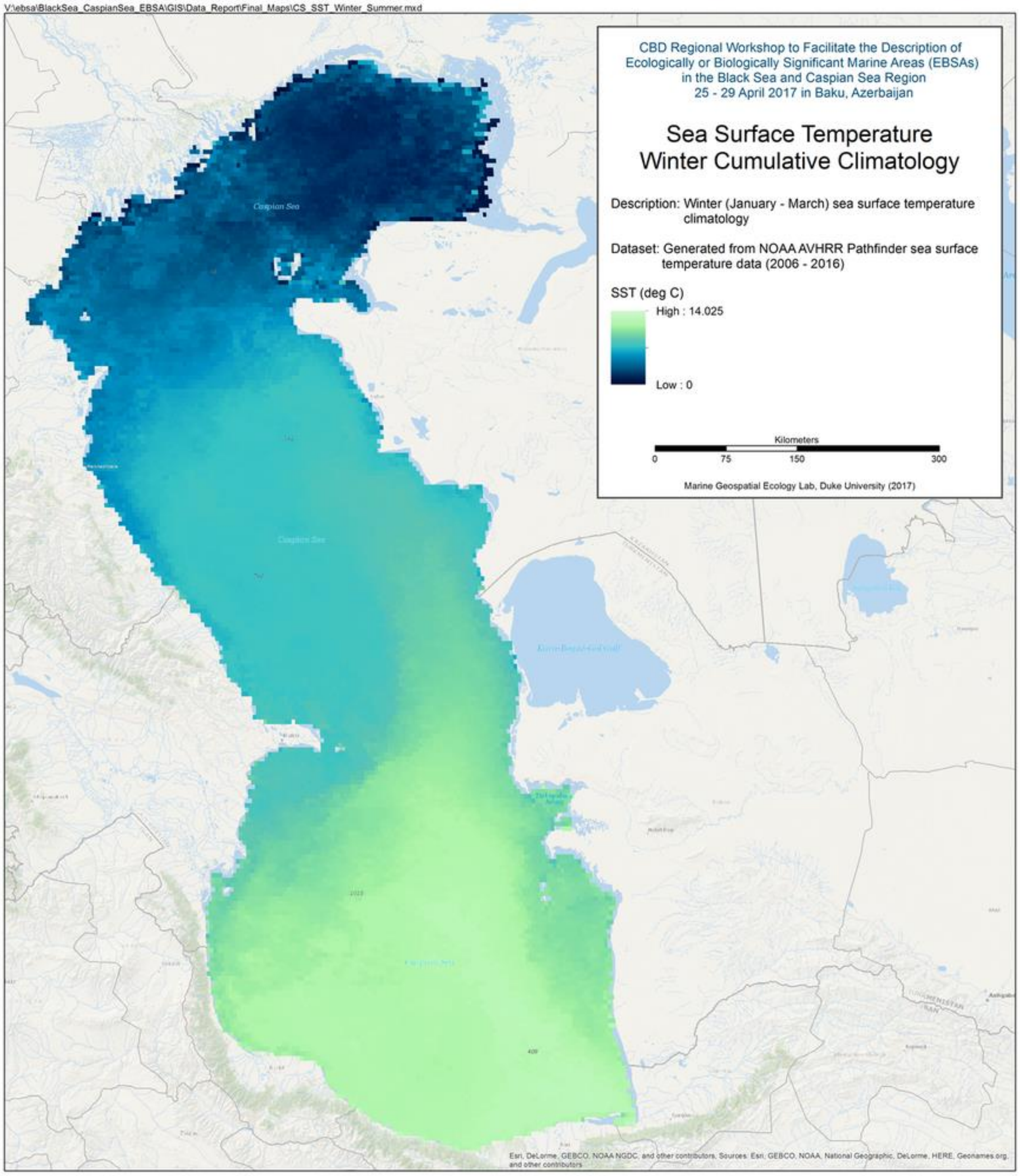

Figure 3.3.2-2 Sea Surface Temperature – Winter Cumulative Climatology

3.3.3 Sea Surface Temperature Front Occurrence

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 image available from 2006 – 2015. A custom Python script was then run to sum all the fronts seasonally and then average fronts detected.

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, Edge Detection Algorithm for SST Images, *Journal of Atmospheric and Oceanic Technology* **9**, 67–80 (1992).

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

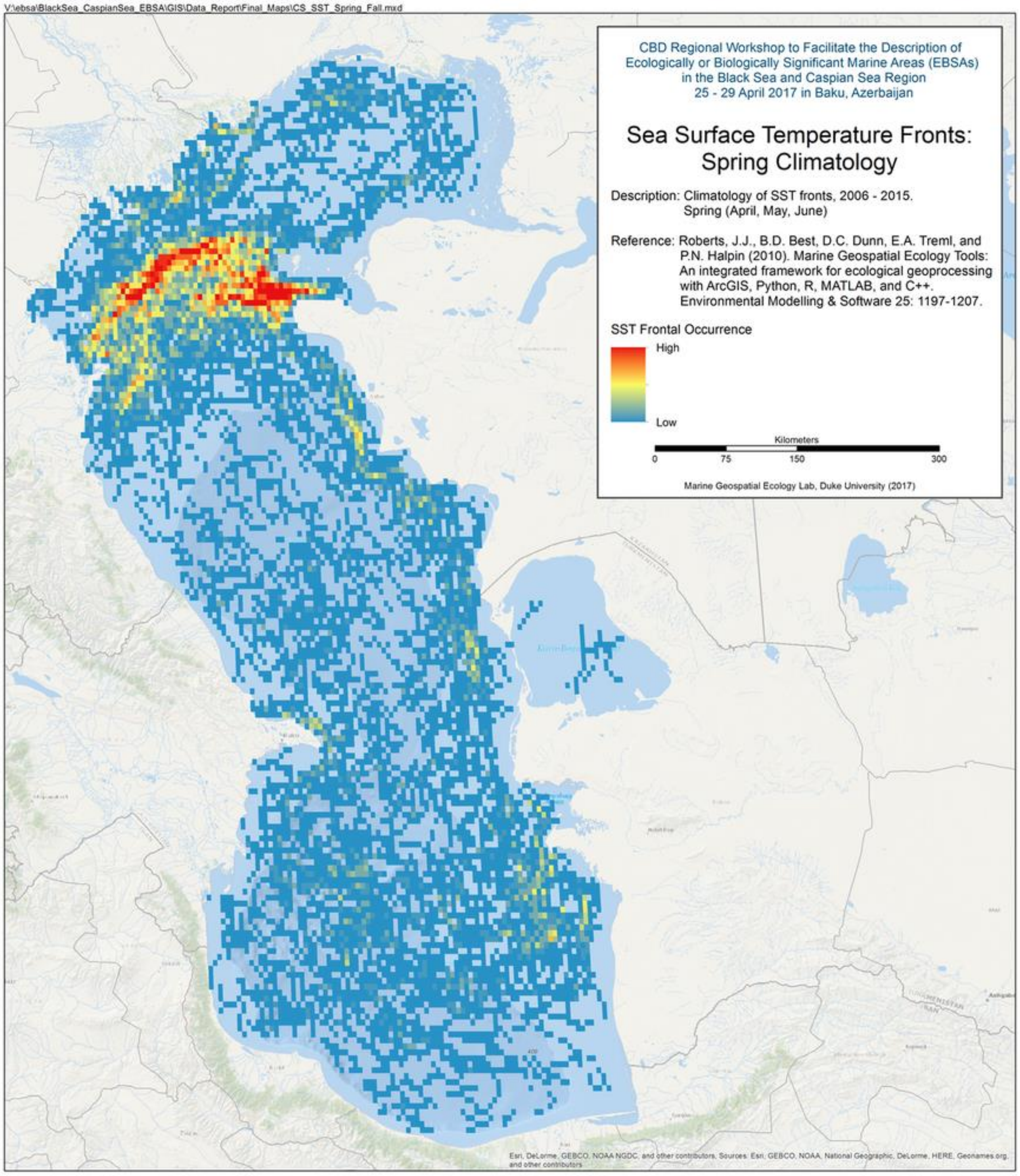

Figure 3.3.3-1 Sea Surface Temperature Front Occurrence: Spring Climatology

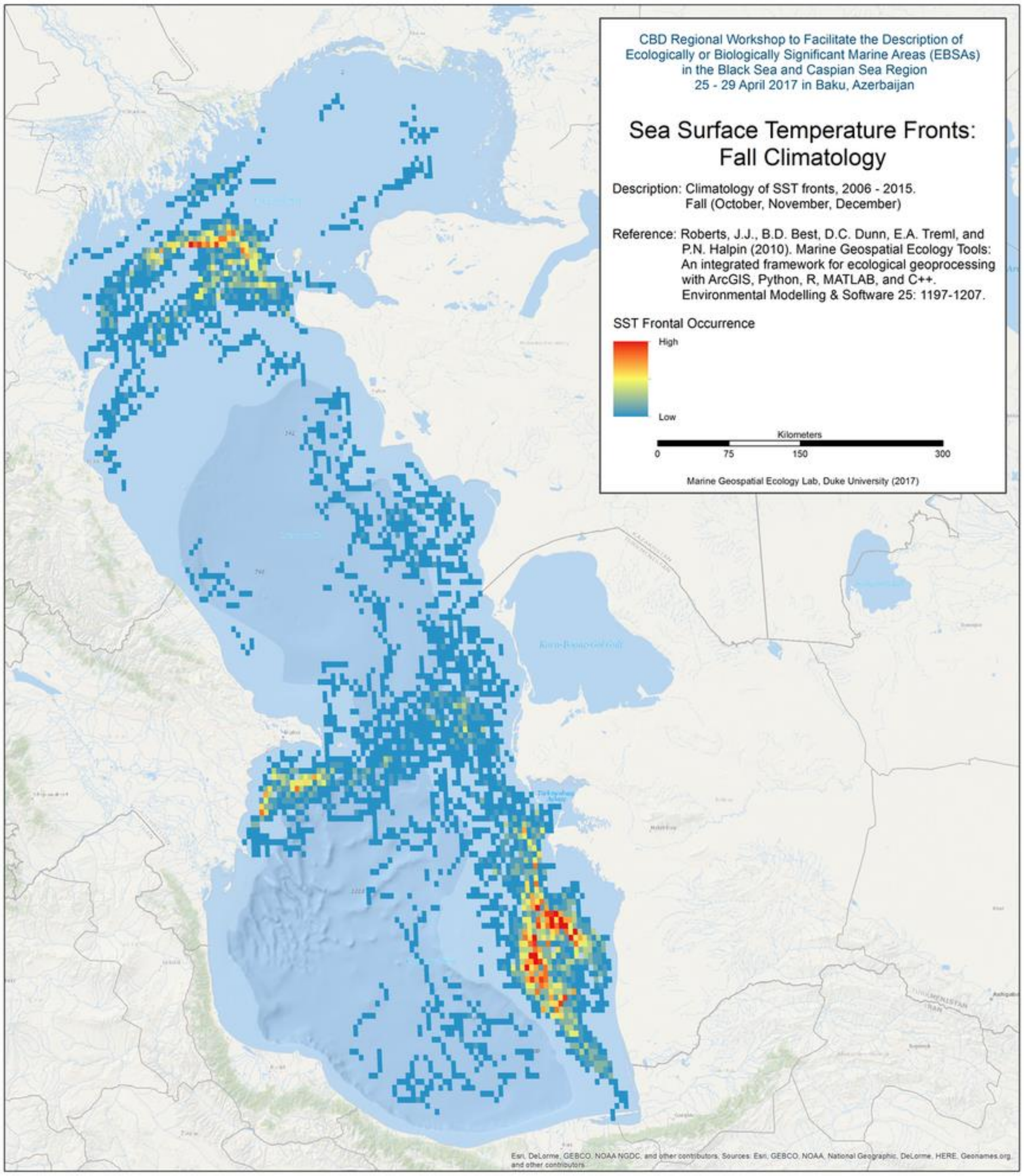

Figure 3.3.3-2 Sea Surface Temperature Front Occurrence: Fall Climatology

3.3.4 Chlorophyll A Climatology

Here, seasonal cumulative (2006 - 2016) chlorophyll A climatologies 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 Terra platform. One climatology was generated for each quarter: January – March, April – June, July – September, October - December.

Reference:

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.

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

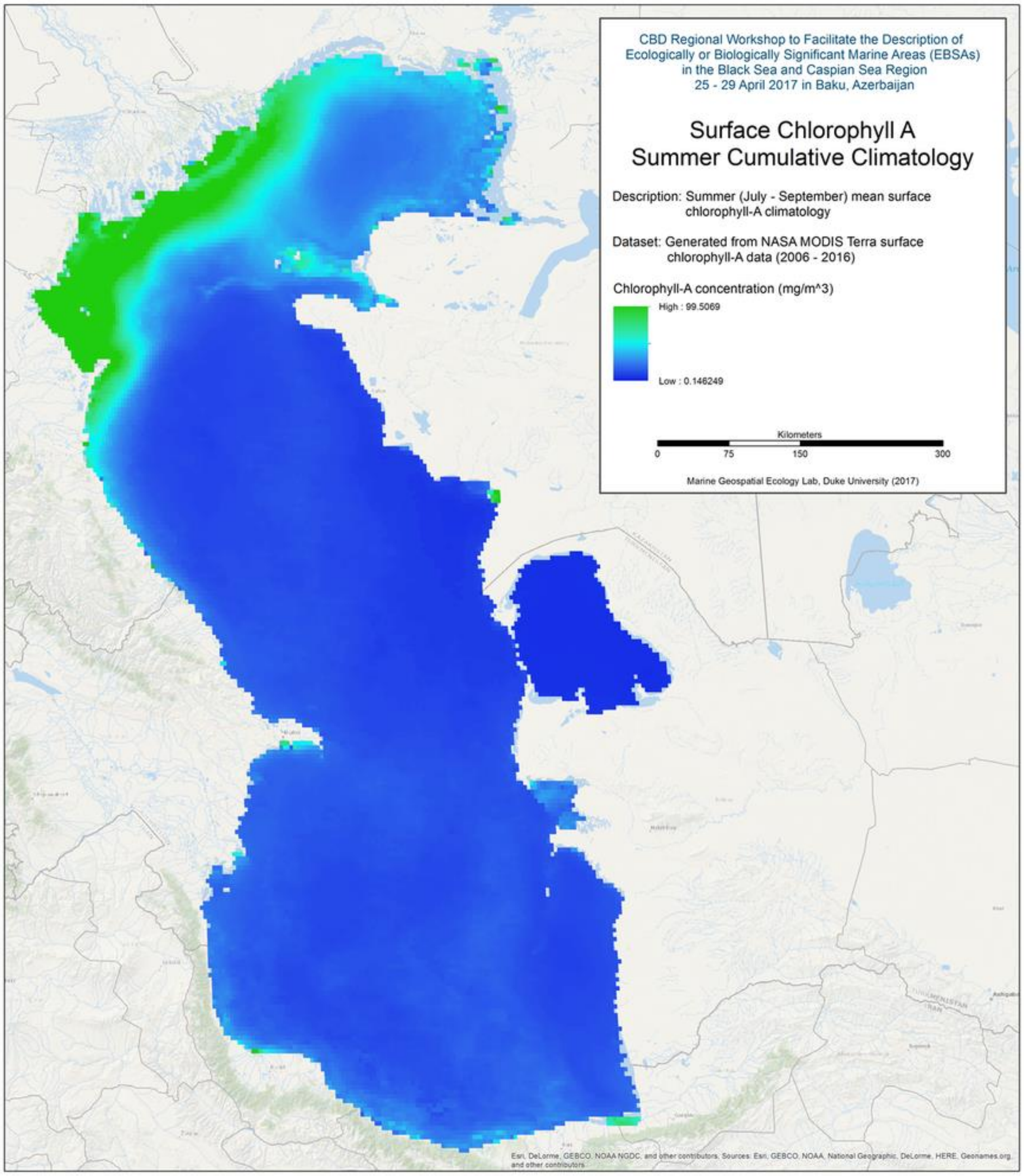

Figure 3.3.4-1 Chlorophyll A Concentration Summer Cumulative Climatology (May – October)

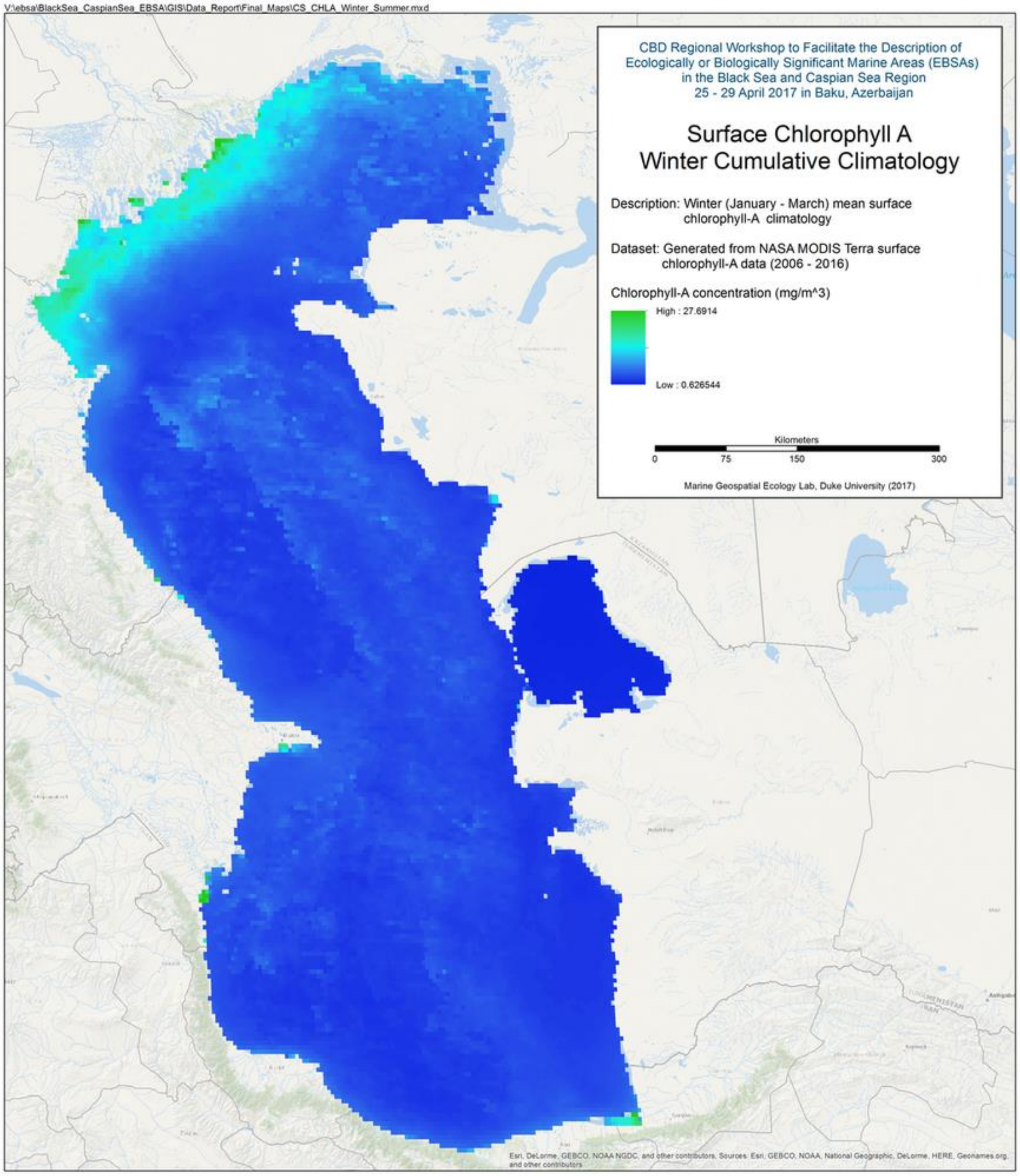

Figure 3.3.4-2 Chlorophyll A Concentration Winter Cumulative Climatology (January - March)

3.3.5 Sea Ice Temporal Coverage

"Sea ice data, provided by the Centre for Ice Hydrometeorological Information at the Arctic and Antarctic Research Institute in St. Petersburg (AARI), were used to create maps of percentage of sea ice coverage throughout the year (2004 to 2012)."

Data Source:
http://wdc.aari.ru/datasets/

Reference:
Fendereski, F., Vogt, M., Payne, M. R., Lachkar, Z., Gruber, N., Salmanmahiny, A., & Hosseini, S. A. (2014). Biogeographic classification of the Caspian Sea. *Biogeosciences*, *11*(22), 6451–6470. https://doi.org/10.5194/bg-11-6451-2014

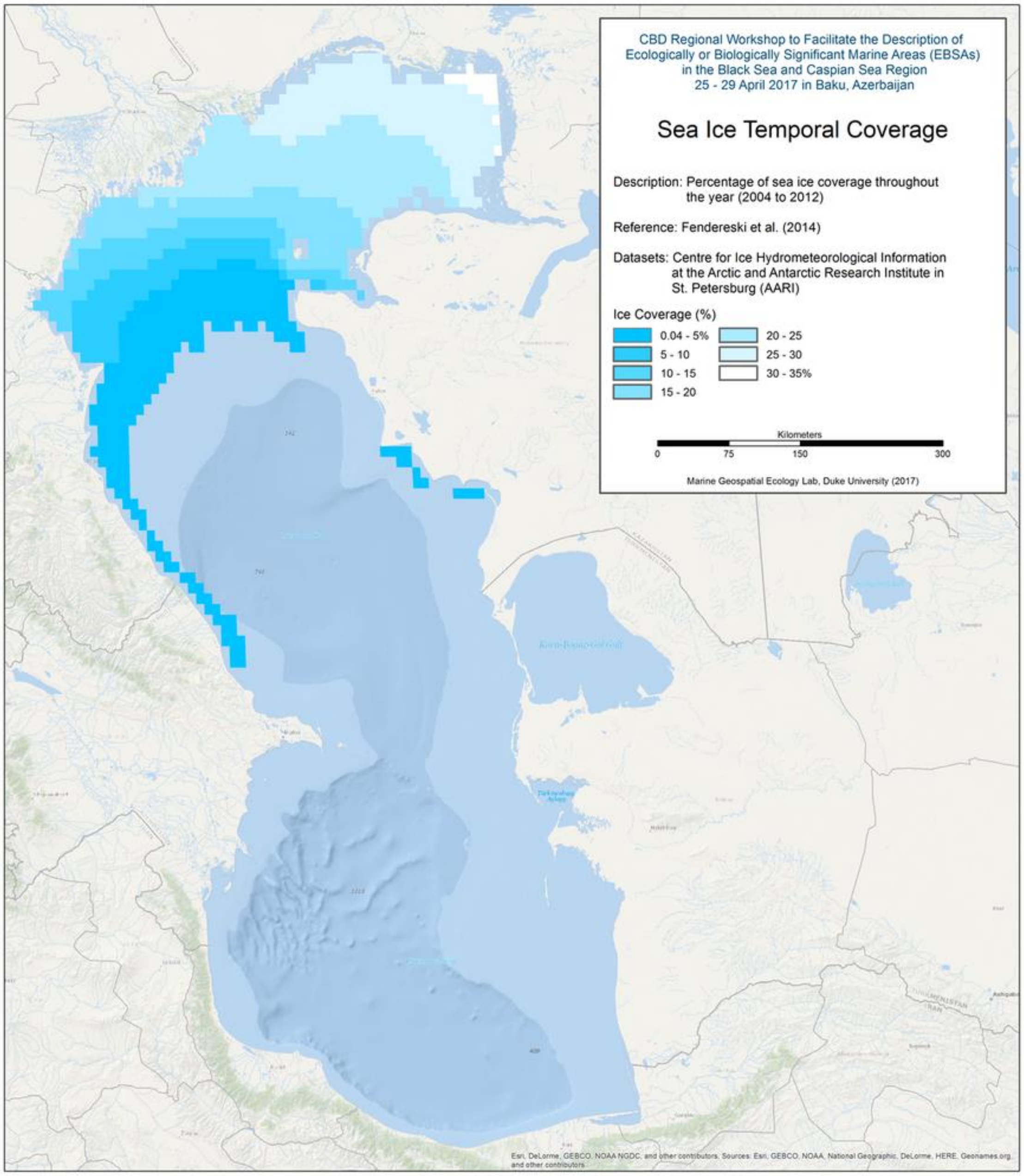

Figure 3.3.5-1 Sea Ice Temporal Coverage

3.3.6 Sea Surface Salinity

"We digitized monthly surface isohaline data of the CS to create sea surface salinity (SSS) maps (Kosarev and Tuzhilkin, 1995)."

Data Source: http://caspcom.com

Reference:
Fendereski, F., Vogt, M., Payne, M. R., Lachkar, Z., Gruber, N., Salmanmahiny, A., & Hosseini, S. A. (2014). Biogeographic classification of the Caspian Sea. *Biogeosciences*, *11*(22), 6451–6470. https://doi.org/10.5194/bg-11-6451-2014

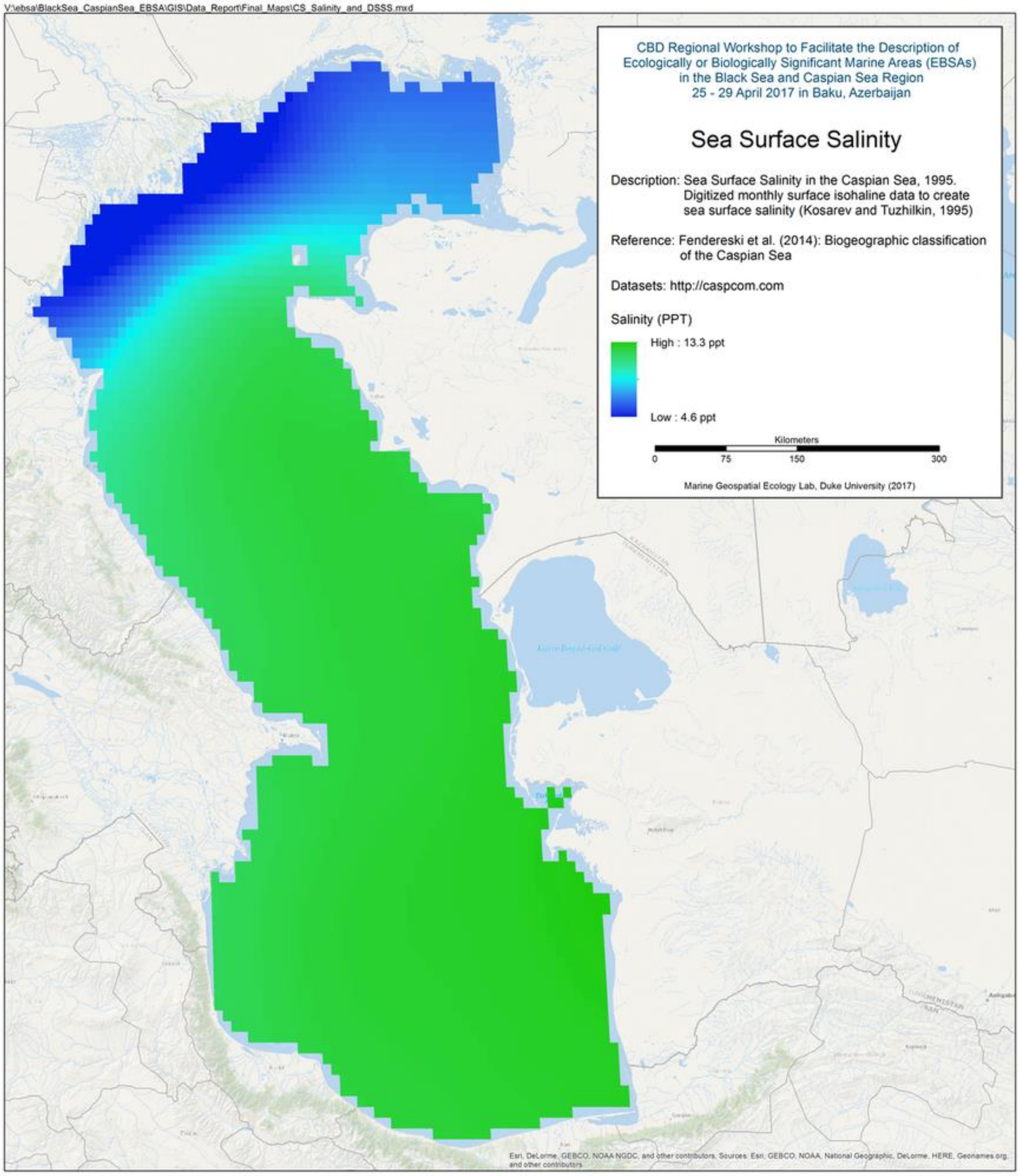

Figure 3.3.6-1 Sea Surface Salinity

3.3.7 Annual Change in Sea Surface Salinity

"Seasonal changes in salinity were computed by subtracting average values of the summer months (June, July, August) from those of the winter months (December, January, February)."

Data Source: http://caspcom.com

Reference:

Fendereski, F., Vogt, M., Payne, M. R., Lachkar, Z., Gruber, N., Salmanmahiny, A., & Hosseini, S. A. (2014). Biogeographic classification of the Caspian Sea. *Biogeosciences*, *11*(22), 6451–6470. https://doi.org/10.5194/bg-11-6451-2014

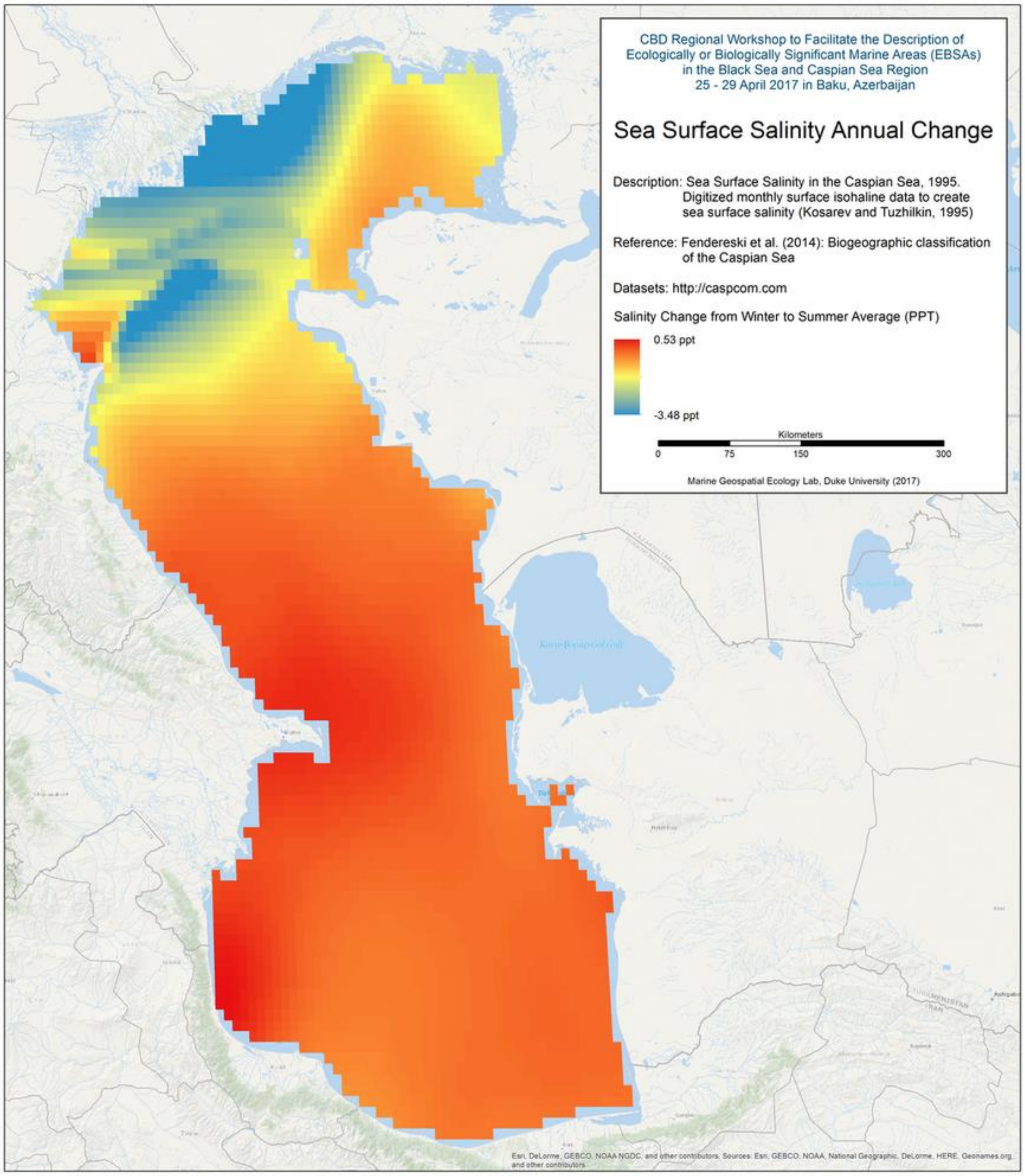

Figure 3.3.7-1 Annual Change in Sea Surface Salinity

3.3.8 Mesoscale Eddy Density

Dudley B. Chelton and Michael G. Schlax maintain a database of trajectories of mesoscale eddies for the 18-year period October 1992 - January 2011. The eddies are based on the SSH fields in Version 3 of the AVISO Reference Series. Only eddies with lifetimes of 4 weeks or longer are retained; the trajectories are available at 7-day time steps.

Source:
http://cioss.coas.oregonstate.edu/eddies/

Processing:
A density raster of eddy centroids was created from the Chelton database (http://cioss.coas.oregonstate.edu/eddies/). First, the NetCDF file was converted to a SpatiaLite database using the MGET tool "Convert Mesoscale Eddies NetCDF to SpatiaLite". Next, the "Extract Mesoscale Eddy Centroids from SpatiaLite" and "Extract Mesoscale Eddy Tracklines from SpatiaLite" tools were run specifying the date range (1993 - 2010) and the region of interest. The density raster was created from the Point Density ArcMap tool using 0.1 degree cell size and a 0.25 degree circular window.

References:
Chelton, D.B., M.G. Schlax, and R.M. Samelson (2011). Global observations of nonlinear mesoscale eddies. Progress in Oceanography 91: 167-216.

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.

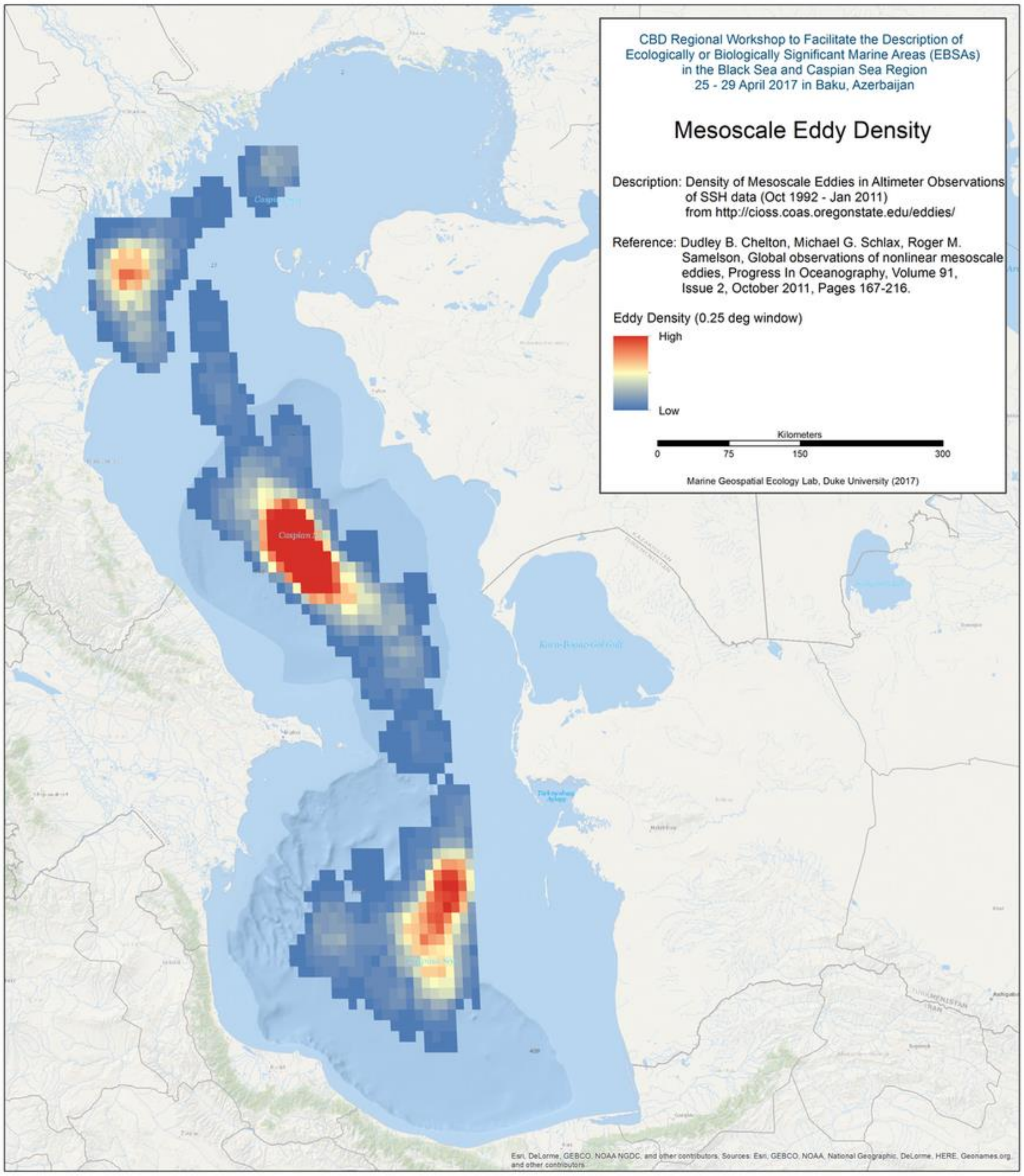

Figure 3.3.8-1 Mesoscale Eddy Density

3.4 Important Areas

3.4.1 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:
http://www.wdpa.org/c/about

Dataset:
World Database on Protected Areas (WDPA Feb 2017)

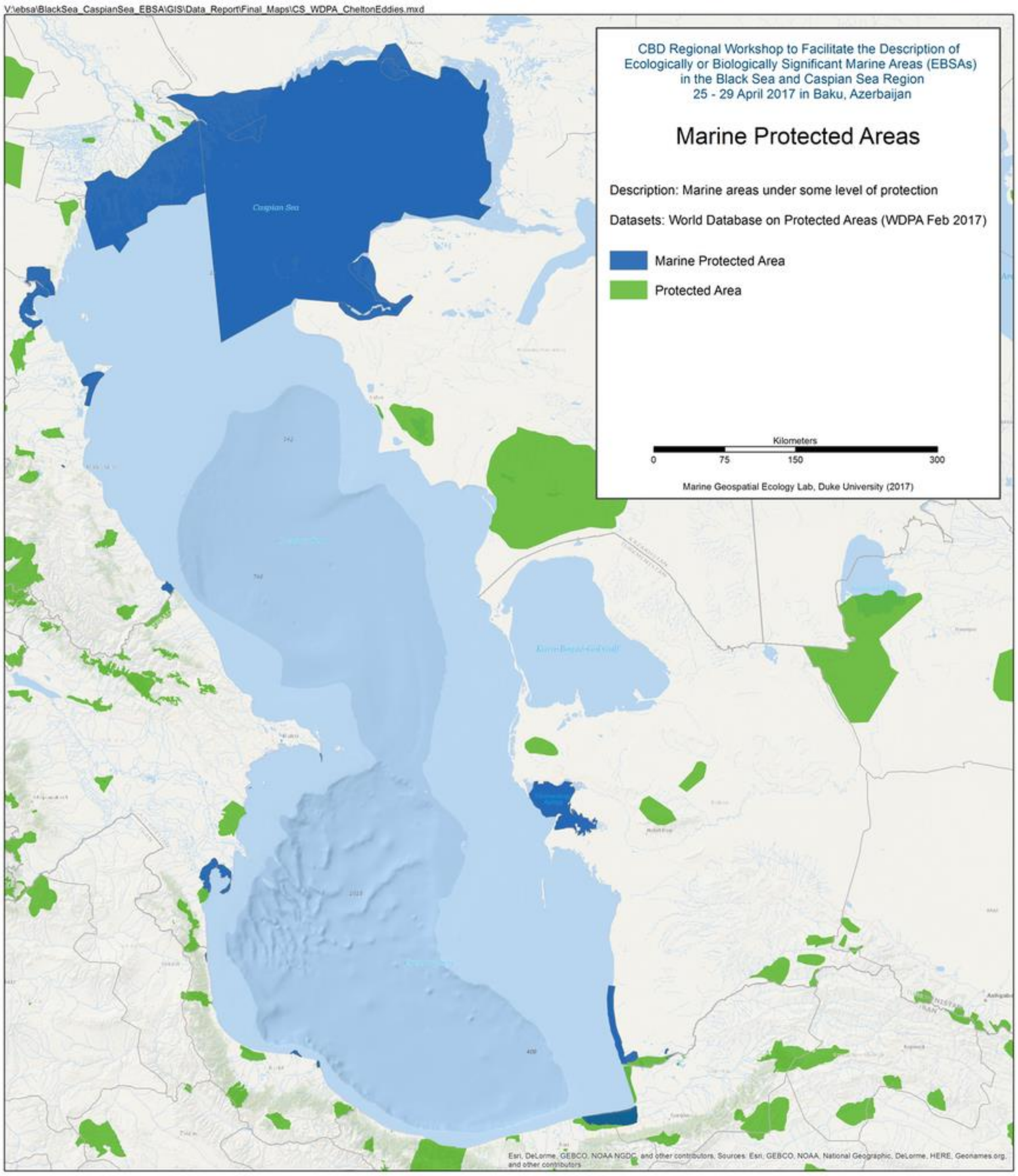

Figure 3.4.1-1 Marine Protected Areas

3.5 Additional Literature, Data Reports and Data Portals

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

3.5.1 CaspInfo Data Portal

Primarily in situ data, CaspInfo dispays summarized data in an online map application. Some datasets can be downloaded directly, while other data require an approval process through SeaDataNet (http://www.seadatanet.org/)

"EDMED is a comprehensive reference to the marine data sets and collections held within European research laboratories. It provides marine scientists, engineers and policy makers with a simple mechanism for their identification. EDMED covers datasets from a wide range of disciplines including:

- marine meteorology;
- physical, chemical and biological oceanography;
- sedimentology;
- marine biology and fisheries;
- environmental quality;
- coastal and estuarine studies;
- marine geology and geophysics, etc.

Data sets are described in EDMED factsheets irrespective of their format (e.g. digital databases or files, analogue records, paper charts, hard-copy tabulations, photographs and videos, geological samples, biological specimens etc). Currently, full EDMED describes more than 3.500 data sets, held at over 700 Data Holding Centres across Europe. Caspian Sea EDMED describes more than 30 datasets held at Caspian Sea researching organisations."

Source:
http://www.caspinfo.net/v_cdi_v3/browse_step.asp

3.5.2 Caspianenvironment.org Biodiversity website cache

A cache of the currently unavailable biodiversity database will be available at the EBSA workshop. The pages contain distribution maps of many Caspian fish, plankton and benthic species, including:

Alosa kessleri kessleri
Alosa saposchnikowii
Atherina boyeri caspia
Clupeonella cultriventris caspia
Clupeonella engrauliformis
Liza aurata
Salmo trutta caspius
Stenodus leucichthys leucichthys

Stenodus leucichthys
abramis brama
benthophylus
cyprinus carpio
huso huso
lisa auratus
lisa saliens
rutilus frissi kutum
rutilus rutilus

Source: Thanks to Forough Fendereski for providing the website cache.

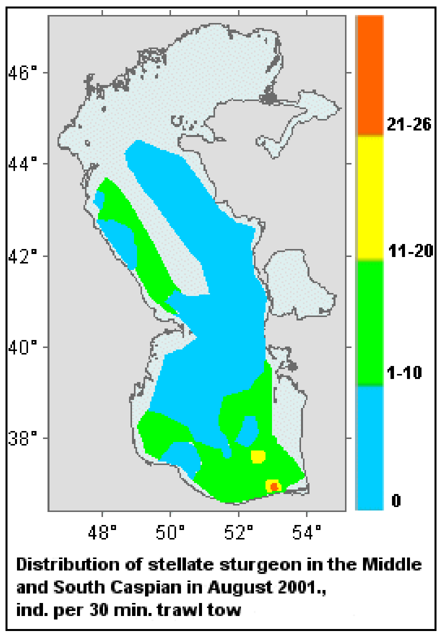

Figure 3.5.2-1 Stellate sturgeon sampling in the Middle and South Caspian

3.5.3 Caspian Sea Biodiversity Project under umbrella of Caspian Sea Environment Program (online report)

"The present book addresses the biological diversity of the Caspian Sea. We tried to inform readers of the surprising world of inhabitants of the Caspian, we described the history of studies of these inhabitants and threats posed by human activities.

This book describes in-depth history of the development of the Caspian Sea, the physical environment of the water bodies and major habitats and species ranging there. Special attention will be paid to commercial species and also to both rare and endangered animals and plants."

Source:
http://www.zin.ru/projects/caspdiv/biodiversity_report.html

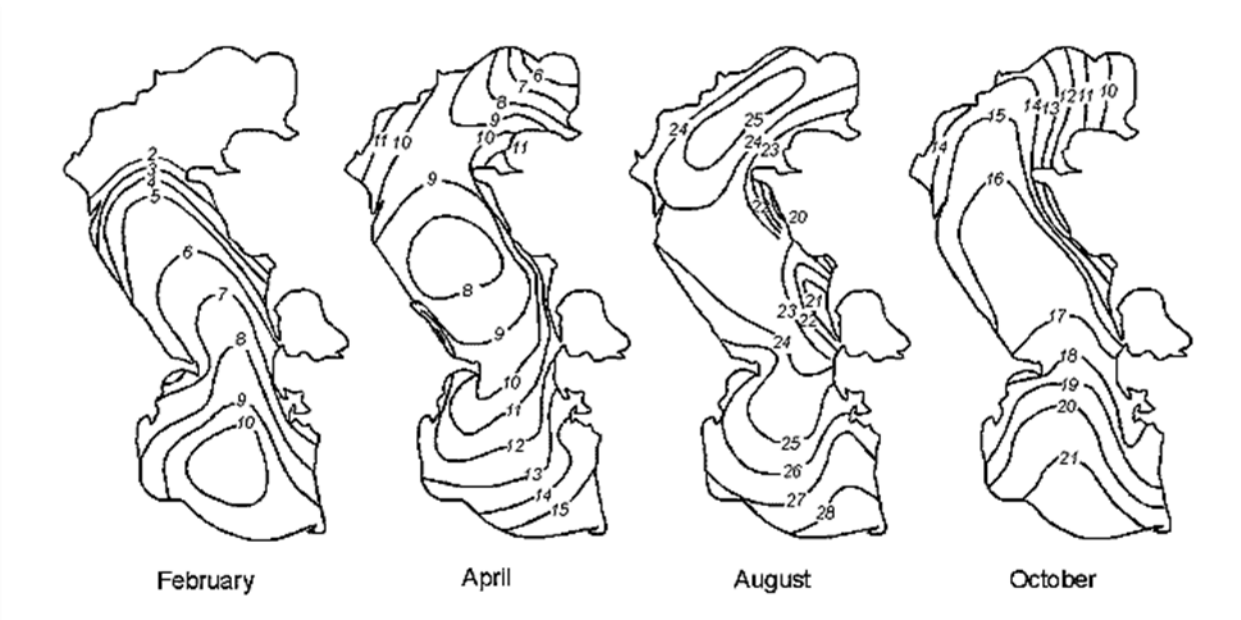

Figure 3.5.3-1 Mean temperature (˚C) on the surface in the Caspian Sea: February, April, August, October

3.5.4 Environment and Security Initiative: The Case of the Eastern Caspian Region

"Of all the economic activities in the eastern Caspian region, oil and gas exploration and extraction are probably causing the greatest concern among the local population and authorities regarding the current and future environmental situation and potential risks. The problems related to poor environmental practice in the past, as well as several mass fish and seal die-offs in recent years, have been on the agenda of governments, experts, mass media and public organisations addressing the energy sector's present and future.

Lack of knowledge about the actual state of marine ecosystems and their vulnerability to pollution, coupled with inadequate environ- mental monitoring, also fuel concern and uncertainty for the future."

Source:
http://www.envsec.org/publications/ENVSEC.%20Transforming%20risks%20into%20cooperation.%20The%20case%20of%20the%20Eastern%20Caspian%20Region_English.pdf

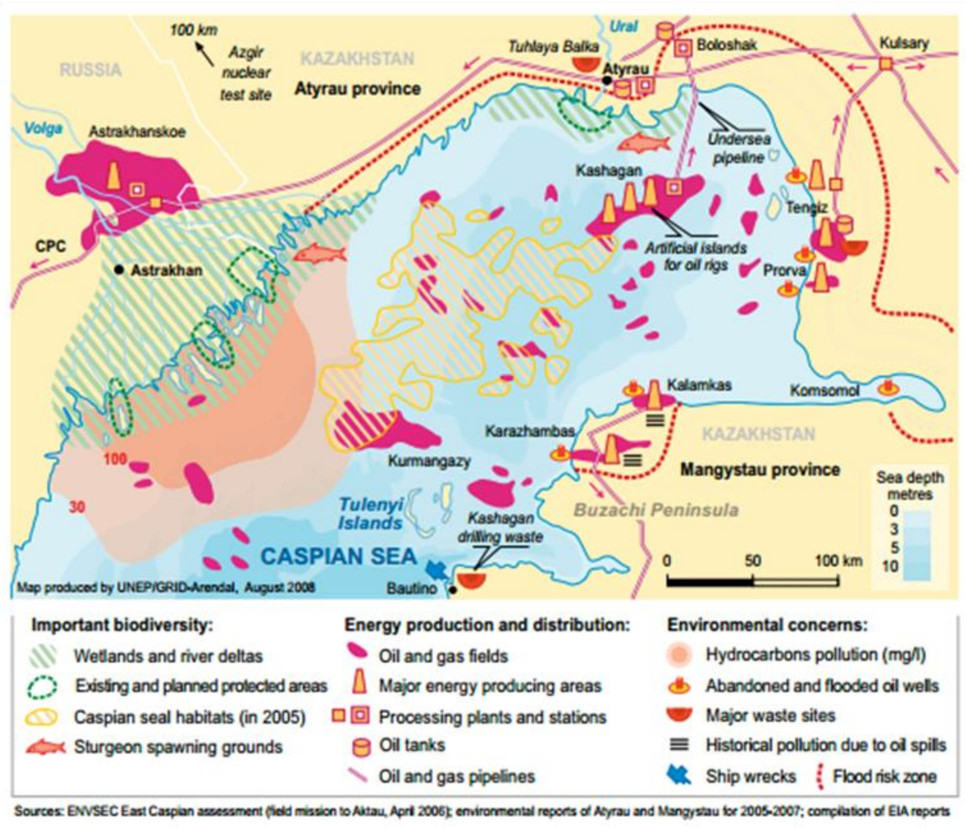

Figure 3.5.4-1 Environmental issues in the north Caspian Sea

Figure 3.5.4-2 Environmental issues around the Cheleken Peninsula, Turkmenistan

3.5.5 GIWA Regional Assessment 23 Caspian Sea

Executive Summary:

"This report presents the results of the Global International Waters Assessment of the Caspian Sea drainage basin (GIWA region 23)... The assessment has been carried out by a multidisciplinary, international expert team that included representatives from each littoral country. Regional scientific centres, such as the Russian Academy of Sciences, the Iranian National Center for Oceanography, the Academy of Science of Kazakhstan, were involved in the assessment….

Assessments of the current situation and the historical trends of each GIWA concern determined that Habitat and community modification exerted the greatest impacts on the Caspian Sea region and was prioritised for Causal chain analysis and Policy option analysis."

Reference:
UNEP, 2006. Stolberg, F., Borysova, O., Mitrofanov, I., Barannik, V. and Eghtesadi, P. Caspian Sea, GIWA Regional assessment 23. University of Kalmar, Kalmar, Sweden.

Table 6 Scoring table for the Caspian Sea region.

Assessment of GIWA concerns and issues according to scoring criteria (see Methodology chapter).
0 No known impact; 1 Slight impact; 2 Moderate impact; 3 Severe impact

The arrow indicates the likely direction of future changes.
↗ Increased impact; → No changes; ↘ Decreased impact

Caspian Sea	Environmental impacts	Economic impacts	Health impacts	Other community impacts	Overall Score**	Priority***
Freshwater shortage	1.3* ↗	2.0 →	2.0 →	1.8 →	2.0	4
Modification of stream flow	1					
Pollution of existing supplies	2					
Changes in the water table	1					
Pollution	1.4* ↗	2.0 →	2.0 →	2.0 →	2.0	3
Microbiological pollution	1					
Eutrophication	2					
Chemical	2					
Suspended solids	1					
Solid waste	1					
Thermal	1					
Radionuclide	1					
Spills	2					
Habitat and community modification	2.0* ↗	2.4 ↗	2.4 →	2.3 →	2.6	1
Loss of ecosystems	2					
Modification of ecosystems	2					
Unsustainable exploitation of fish	2.2* ↗	2.0 →	2.0 →	2.4 →	2.2	2
Overexploitation	3					
Excessive by-catch and discards	2					
Destructive fishing practices	2					
Decreased viability of stock	2					
Impact on biological and genetic diversity	2					
Global change	1.0* ↗	1.5 →	1.5 →	1.0 →	1.2	5
Changes in hydrological cycle	1					
Sea level change	2					
Increased UV-B radiation	1					
Changes in ocean CO_2 source/sink function	0					

* This value represents an average weighted score of the environmental issues associated to the concern. For further details see Detailed scoring tables (Annex II).

** This value represents the overall score including environmental, socio-economic and likely future impacts. For further details see Detailed scoring tables (Annex II).

*** Priority refers to the ranking of GIWA concerns.

Figure 3.5.5-1 Scoring Table for the Caspian Sea region

3.5.6 GRID-Arendal: Vital Caspian Graphics, 2nd ed.

From the Forward:
"These vital graphics are a reader friendly publication which present lesser-known aspects of the region while covering the broader picture in an attractive format…"

From section 6:
"Ecosystems: Soviet industrial practice and disregard for the external effects of an aggressive market economy have significantly jeopardized the lives of plants and animals in and around the Caspian Sea. The steep decline in fish resources due to overfishing, pollution and other human-related factors, such as the introduction of alien species, is negatively affecting the balance of ecosystems and threatening several species."

Reference:
Rucevska, I., & Simonett, O. (2011). Vital Caspian Graphics 2 - Opportunities, Aspirations and Challenges, 2012 GRID-Arendal. Zoï Environment Network and GRID-Arendal.

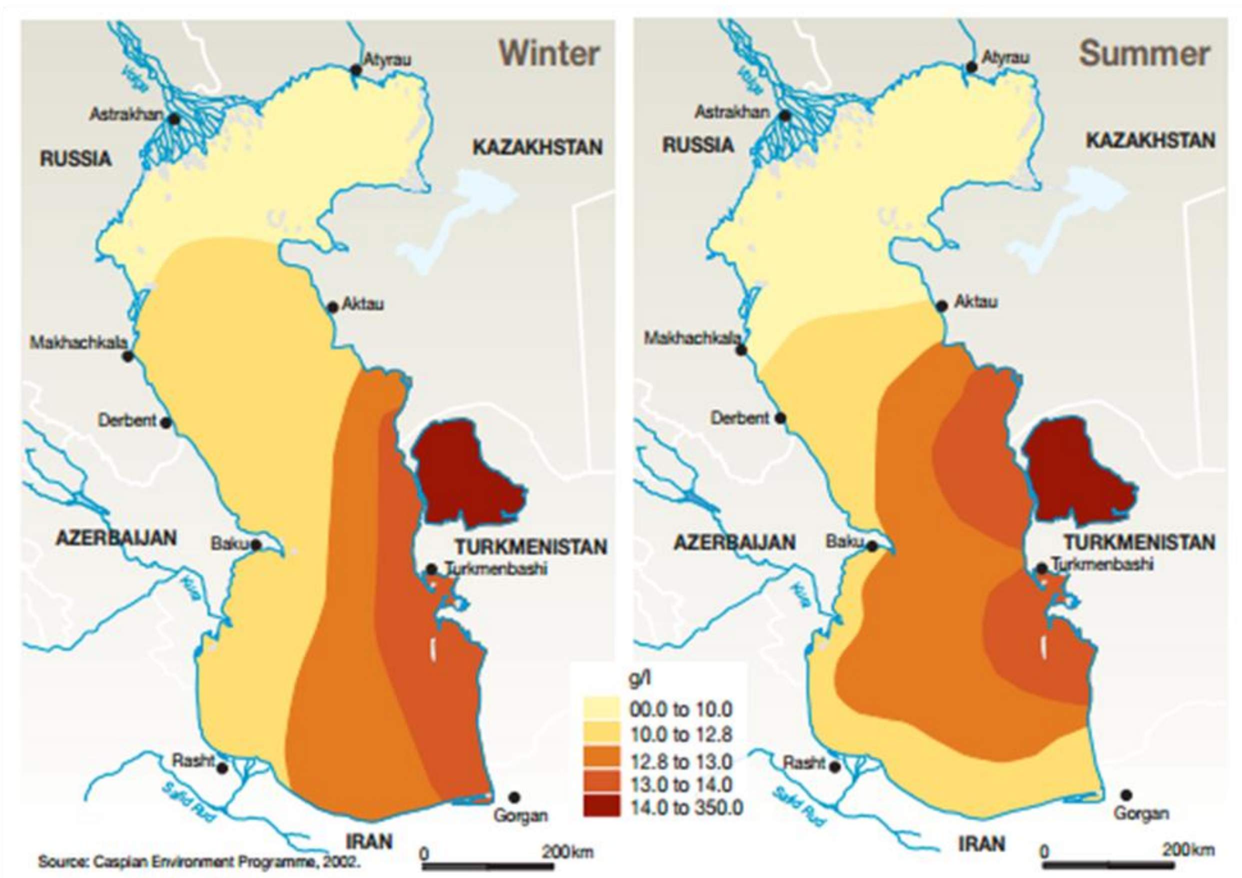

Figure 3.5.6-1 Sea Surface Salinity

3.5.7 State of the Environment of the Caspian Sea

"The State of the Environment of the Caspian Sea Report is based on existing documents developed in the context of the Caspian Environment Programme, which is supported by the Global Environment Facility, and through other major projects, including the first and the second editions of the Transboundary Diagnostic Analyses (TDA), the Regional Water Quality Monitoring and Pollution Plans developed with the support of the EU, the Rapid Assessment of Pollution Sources (RAPS), and the Strategic (Tehran) Convention Action Programme. The report summarizes the findings of the different assessments and includes existing updated figures. It is based on the latest information on policy and legislative measures, institutional set- up, stakeholder engagement, future challenges and barriers to the improvement of the state of the environment in the region, provided by the governments through a questionnaire."

Reference:
Interim Secretariat of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea. (2010). *Caspian Sea State of the Environment 2011* (p. 103). CaspEco Project.

Figure 3.5.7-1 Protected Areas of the Caspian Basin

3.5.8 Individual variation in seasonal movements and foraging strategies of a land-locked, ice-breeding pinniped

Abstract:
“Marine mammal satellite telemetry studies can provide important tests of movement and foraging theory. Here we present the first satellite tracking study of Caspian seals (Pusa caspica), an endangered, ice-breeding phocid seal, endemic to the Caspian Sea. The Caspian Sea is one of the most variable habitats inhabited by any pinniped species, and lacks competing large piscivores. Under such conditions foraging theory predicts individual variation in foraging strategy may develop to reduce intra-species competition. We deployed 75 Argos satellite tags 2009-2012 on adult seals of both sexes, and used State Space Modelling to describe movement, and behavioural states. During winter in all years most individuals were mobile within the icepack, making repeated trips into open water outside the ice field, with only brief stationary periods that may be related to breeding activity. During summer 2011, 60% of tagged animals migrated into the mid and southern Caspian, while the remainder spent the ice free season in the north. Summer foraging locations were not restricted by proximity to haul out sites, with animals spending more than 6 months at sea. Maximum dive depths exceeded 200m, and maximum duration was greater than 20 minutes, but 80% of dives were shallower than 15m and shorter than 5 minutes. Hierarchical cluster analysis identified 3 distinct groups of summer dive behaviour, comprising shallow, intermediate and deep divers, which were also spatially exclusive, suggesting potential niche partitioning and individual specialisation on prey or habitat types. The results can contribute to assessment of impacts from anthropogenic activities and to designation of protected areas encompassing critical habitats.”

Reference:
Dmitrieva, L., Jüssi, M., Jüssi, I., Kasymbekov, Y., Verevkin, M., Baimukanov, M., … Goodman, S. J. (2016). Individual variation in seasonal movements and foraging strategies of a land-locked, ice-breeding pinniped. Marine Ecology Progress Series, 554(10.3354/meps11804), 241–256.

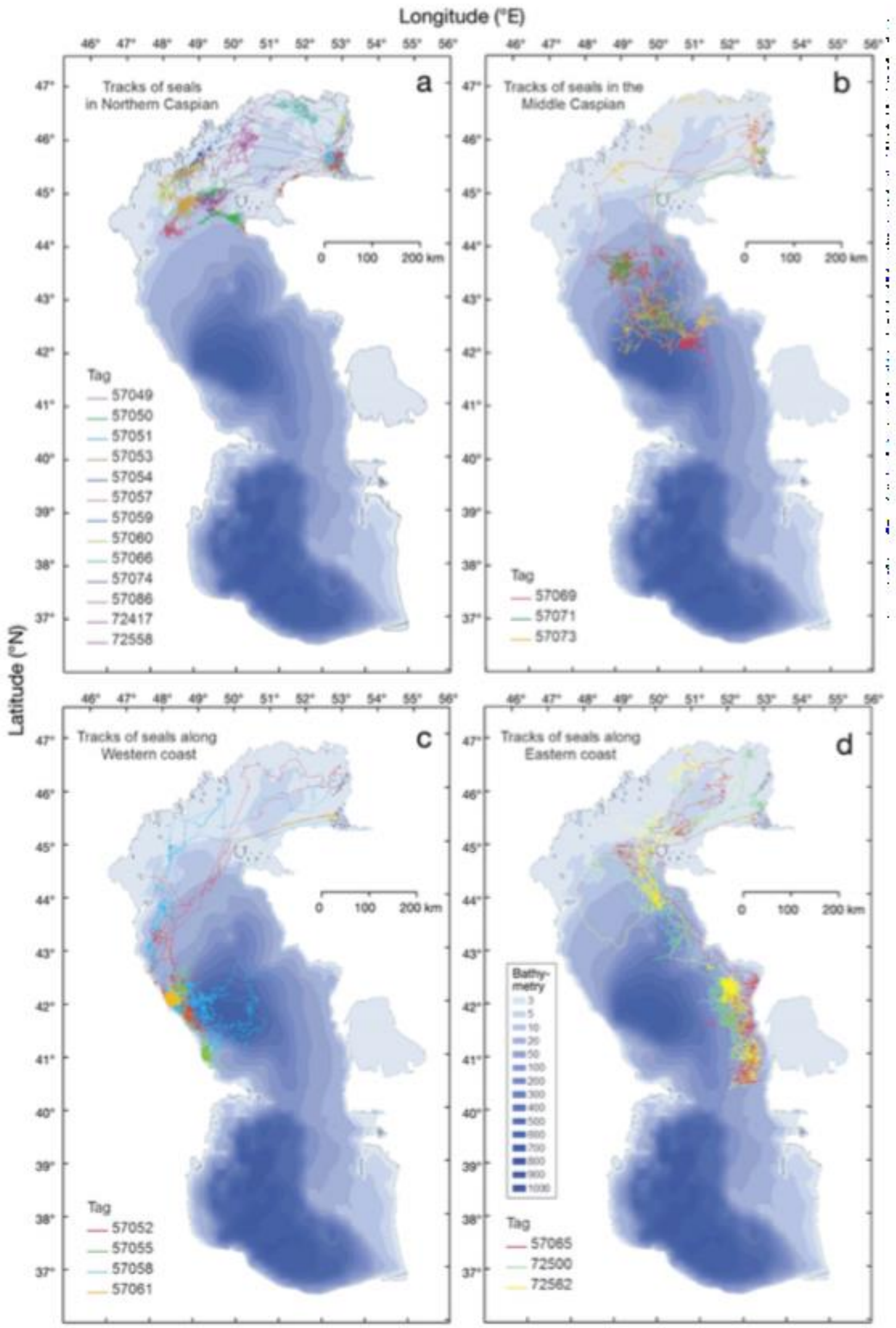

Fig. 2. Movement patterns for Caspian seals tagged in April 2011 and tracked in the (a) northern and (b) mid Caspian Sea, and along the (c) western and (d) eastern coasts. (e) Tracks of seals that moved to the southern Caspian Sea. (f) Representative tracks from autumn deployments. (g) All locations where tags were 'dry' (i.e. out of the water) for 25 to 50% and (h) > 50% of each 24 h period

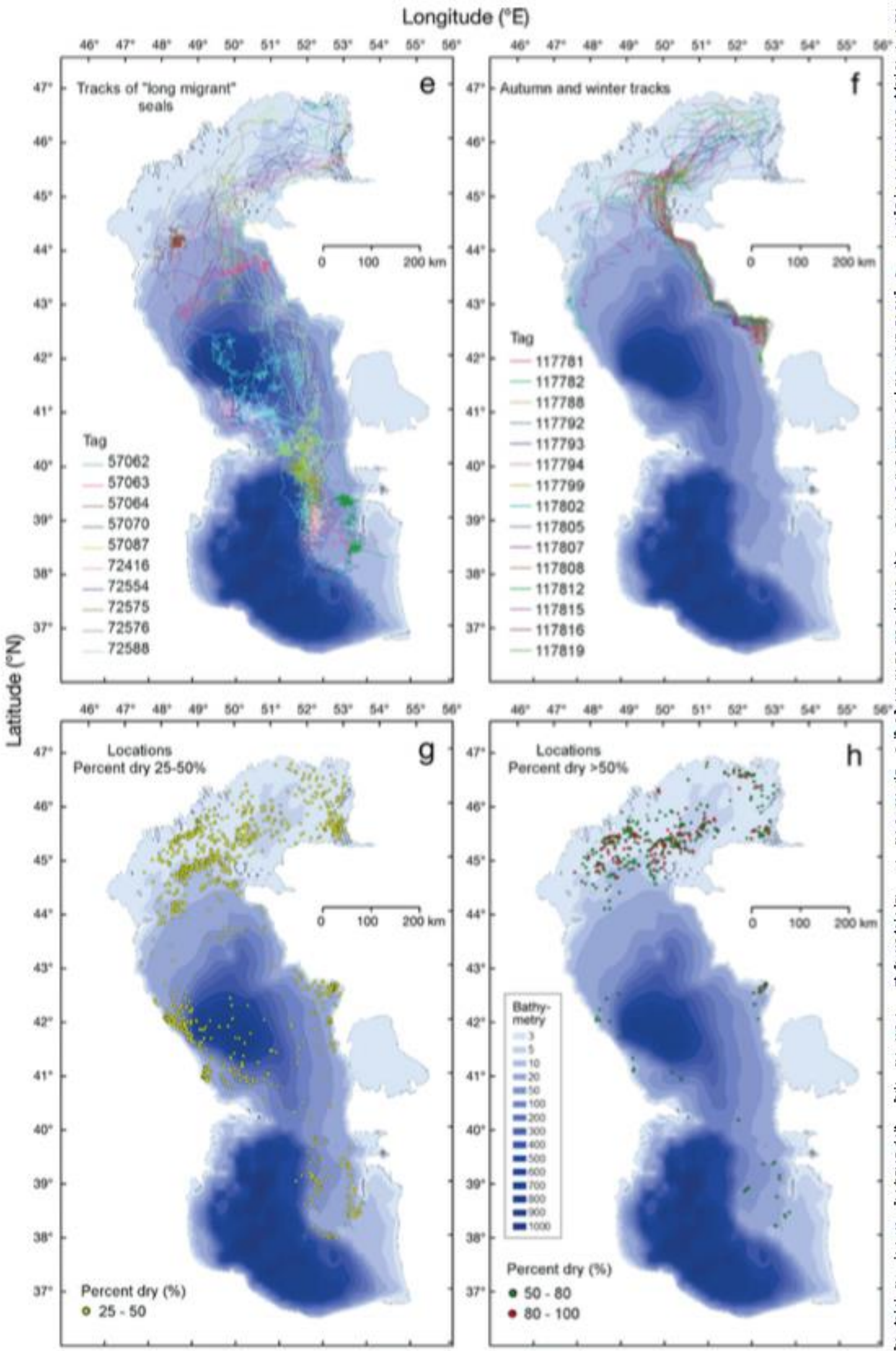

Fig. 2 (continued)

Figure 3.5.8-1 Movement patterns for Caspian Seals tagged in April 2011

3.5.9 Pup Production and Breeding Distribution of the Caspian Seal (Phoca caspica) in Relation to Human Impacts

Abstract:
"Aerial surveys of Caspian seals on the winter ice field in Kazakhstan territorial waters were carried out in February 2005 and 2006 to assess the annual pup production for the species and natural predation on newborn pups. Estimated pup production was 21063 in 2005 and 16 905 in 2006 (including an estimated figure for pups born in Russian territory in each year). The breeding population size of approximately 20000 females is much less than published estimates from the late 1980s. Eagles were the principal natural predators of pups. Commercial icebreaker routes passed through areas of dense pup concentrations in 2006, although not in 2005. Our findings have important implications for the development of conservation strategies for the species. Natural mortality, loss to predators, and, more important, the current hunting quota substantially exceed the recruitment of the Caspian seal population. Anthropogenic sources of mortality should be managed to avoid further declines in the species."

Reference:
Härkönen, T., Jüssi, M., Baimukanov, M., Bignert, A. Dmitrieva, L., Kasimbekov, Y., Verevkin, M., Wilson, S. and Goodman, S. 2008. *Pup production and breeding distribution of the Caspian seal (Phoca caspica) in relation to human impacts.* Ambio 37:356-361

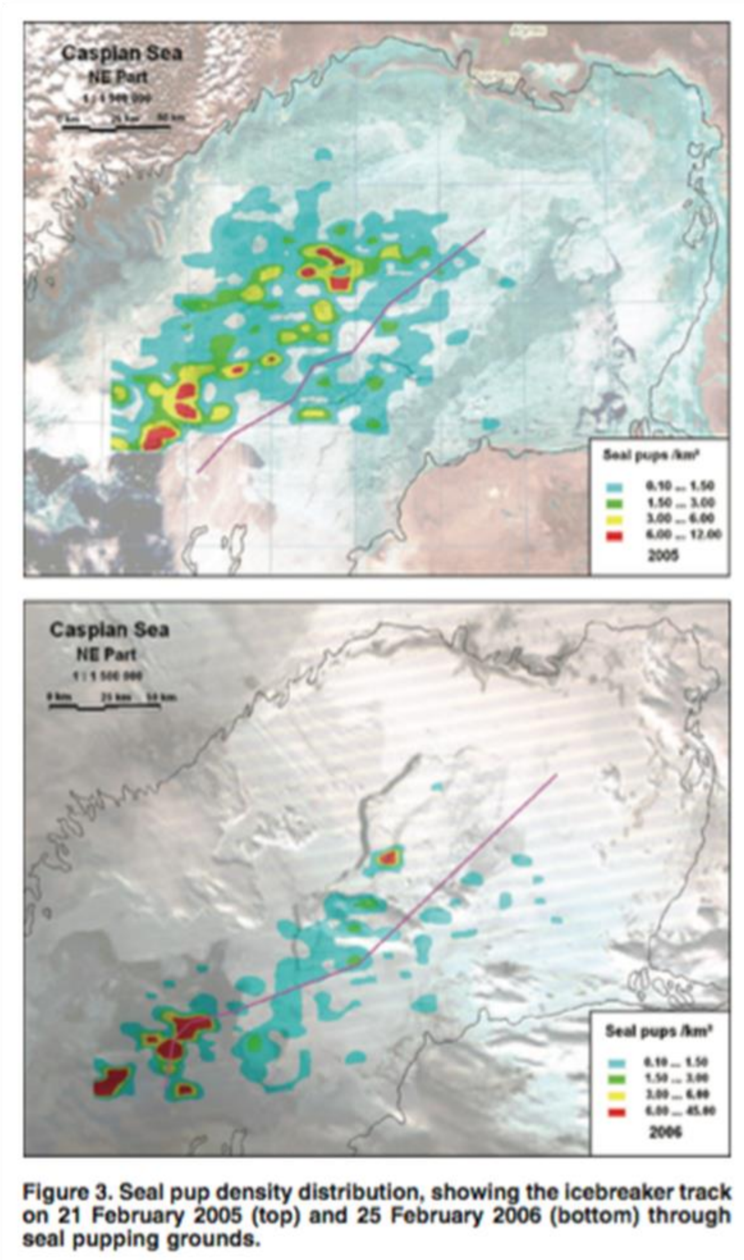

Figure 3.5.9-1 Seal pup density distribution

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