Draft Data Report:
Produced as a background document for the Workshop on the Development of a Regional Environmental Management Plan for the Area of the Northwest Pacific

Online Workshop
26 October 2020 - 06 November 2020

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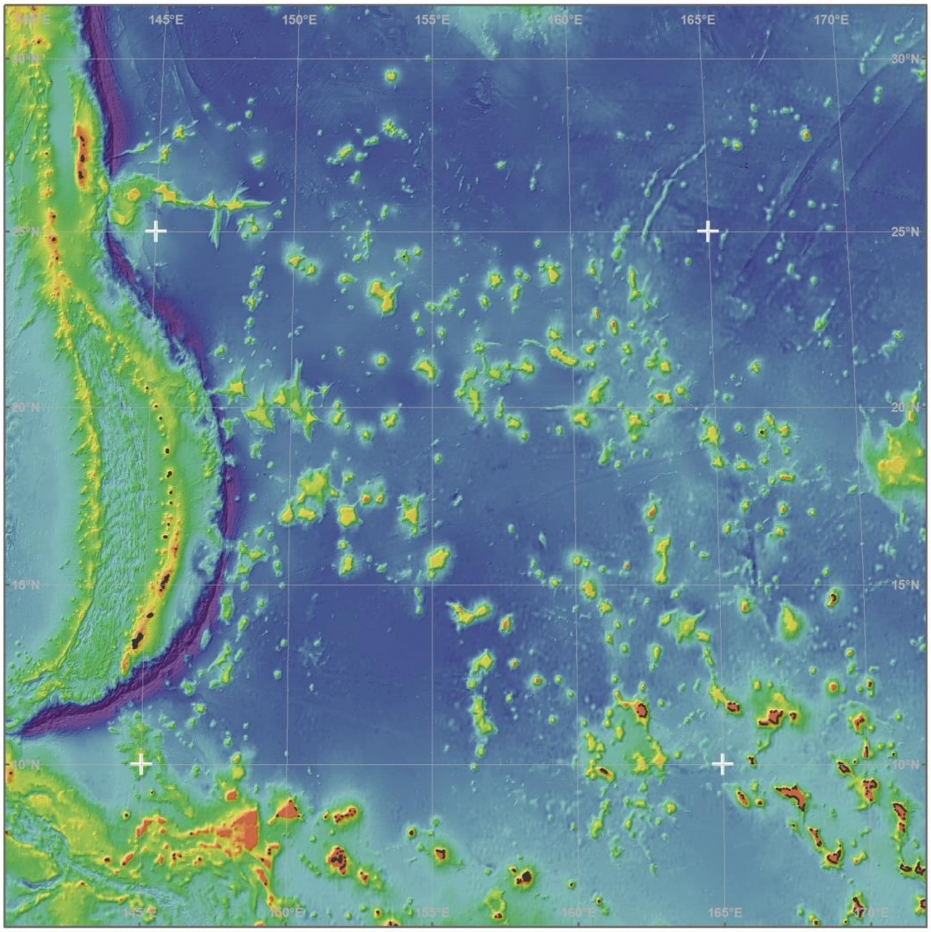

The preparation of this report was financially supported by the Ministry of Oceans and Fisheries of the Republic of Korea, through the commissioning of a consultancy by the ISA secretariat.

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Citation:
Cleary, J., S. DeLand, E. Menini, P.N. Halpin (2020) “Data Report: Workshop on the Development of a Regional Environmental Management Plan for the Area of the Northwest Pacific”, 140 pp.

Maps
Digital versions of individual maps herein are also available online at https://duke.box.com/s/z4350xkl2cer07x8eh9z5dojgb1kk3mu

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1 Context

The Marine Geospatial Ecology Lab at Duke University was contracted to provide data discovery and mapping support for experts attending the "Workshop on the Development of a Regional Environmental Management Plan for the Area of the Northwest Pacific" (Online, from 26 October 2020 – 06 November 2020). This workshop is convened by the Secretariat of International Seabed Authority in collaboration with the Ministry of Oceans and Fisheries of the Republic of Korea and the Korea Institute of Ocean Science and Technology. The preparation of this report was financially supported by the Ministry of Oceans and Fisheries of the Republic of Korea, through the commissioning of a consultancy by the ISA secretariat.

As part of this support, a large number of datasets and analyses pertaining to the Area of the Northwest Pacific have been collected and mapped. These datasets and supporting references have been compiled into this draft data report, an annotated catalog of available spatial data and selected publications to brief workshop participants and aid with data discovery.

This draft data report accompanies a draft report on Regional Environmental Assessment that provides an aggregation and synthesis of existing information relating to the Area of the Northwest Pacific, including geomorphology, physical characteristics and biological communities.

The datasets described herein will be available during the online workshop supported by live GIS and mapping capabilities. Workshop participants will be able to request simple map overlays and analyses be performed during the workshop that will aid in their discussions. The results of the mapping work performed at the workshop will be included in the subsequent ISA workshop report.

1.1 Geographical area to be addressed in this report

For the purposes of this data report on the Area of the Northwest Pacific, data were collected or generated for areas between 40°N and 1°N and 132°E to 179°E. The area to be included in the draft REMP will be discussed in the ISA workshop and will not necessarily coincide with the area covered by this data report.

EEZ Data Source - VLIZ v11, http://www.marineregions.org/eez.php
ECS Data Source - http://continentalshelf.org/onestopdatashop/6350.aspx

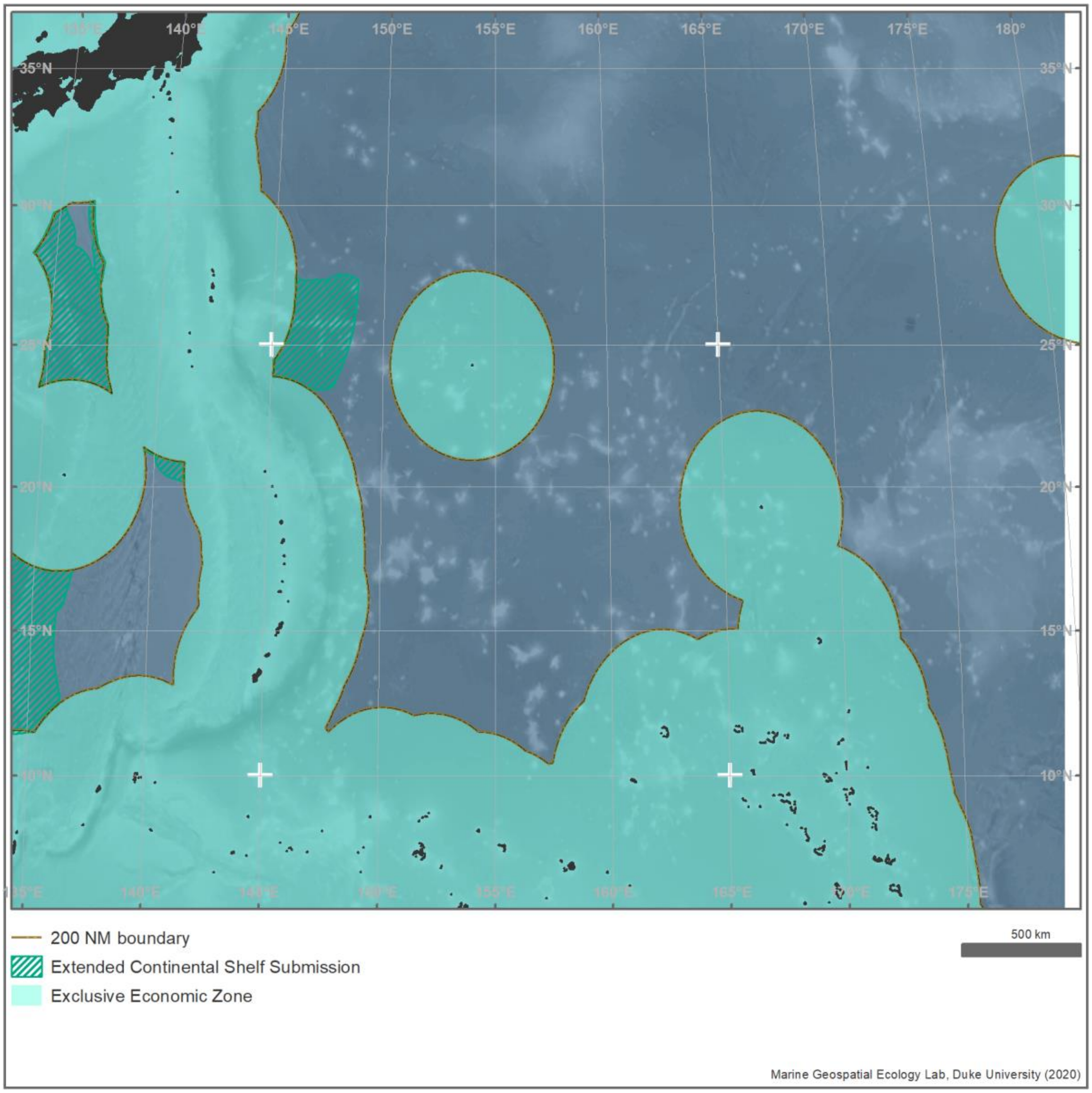

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Figure 1.1-1 Data collection scope and boundary context

2 Environmental Data

2.1 GEBCO Bathymetry

GEBCO's gridded bathymetric data set, the GEBCO_2019 grid, is a global terrain model for ocean and land at 15 arc-second intervals. The GEBCO_2019 Grid is the latest global bathymetric product released by the General Bathymetric Chart of the Oceans (GEBCO) and has been developed through the Nippon Foundation-GEBCO Seabed 2030 Project.

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

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

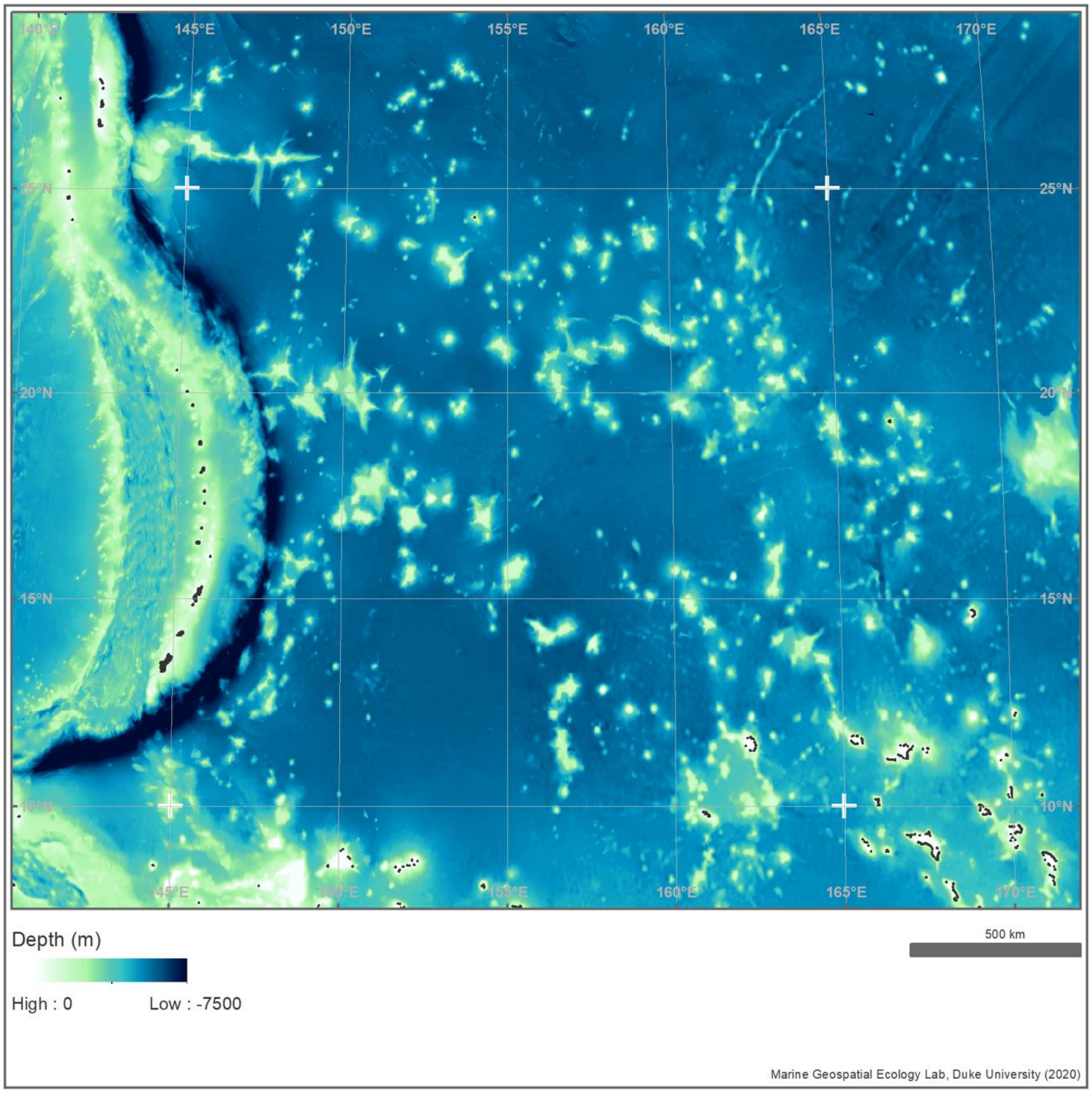

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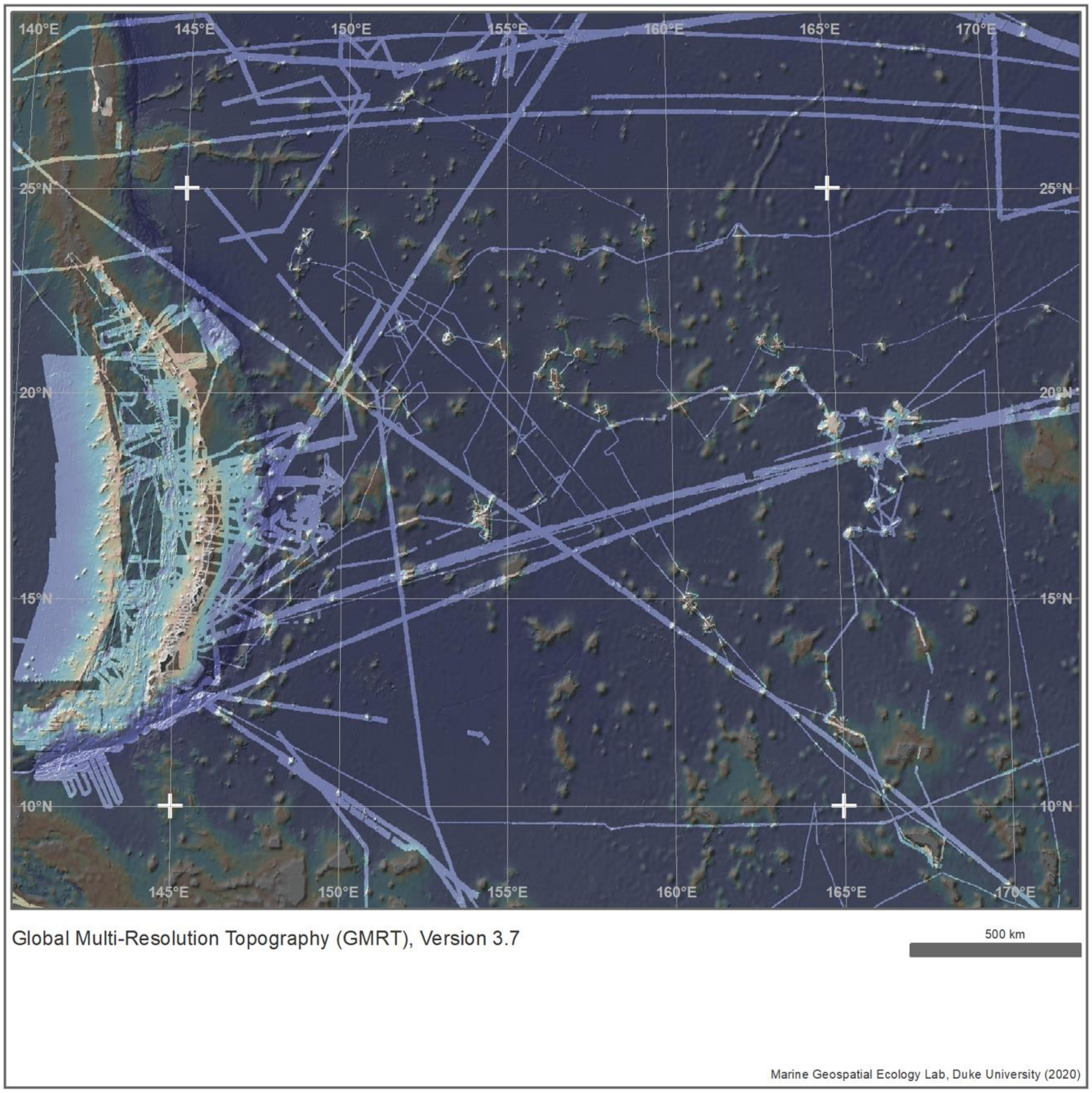
Figure 2.1-1 GEBCO Bathymetry

2.2 Global Multi-Resolution Topography (GMRT), Version 3.7

“The Global Multi-Resolution Topography (GMRT) Synthesis is maintained as a multi-resolution gridded global Digital Elevation Model (DEM) that includes cleaned processed ship-based multibeam sonar data at their full spatial resolution (~100m in the deep sea). Multibeam bathymetry data are unique among the marine geophysical data types in their relevance for a broad range of scientific investigations and non-academic uses, providing fundamental characterization of the physical environment and serving as primary base maps for multidisciplinary programs. While specialist expertise is needed to access, quality control and process multibeam bathymetry data files to generate high-quality bathymetric maps, the GMRT Synthesis provides free open access to bathymetric images and gridded bathymetric data for specialist and non-specialist users alike. Details about the tiling method and procedures used for creating and serving the GMRT synthesis is available in Ryan et al., 2009.”

Link: https://www.gmrt.org/about/index.php
Web Services: https://www.gmrt.org/services/index.php

Reference:
Ryan, William B. F., Suzanne M. Carbotte, Justin O. Coplan, Suzanne O’Hara, Andrew Melkonian, Robert Arko, Rose Anne Weissel, et al. 2009. “Global Multi-Resolution Topography Synthesis.” Geochemistry, Geophysics, Geosystems 10 (3). https://doi.org/10.1029/2008GC002332.



Global Multi-Resolution Topography (GMRT), Version 3.7

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Figure 2.2-1 Global multi-resolution topography

2.3 Multibeam Bathymetric Survey Tracklines

“The Multibeam Bathymetry Database (MBBDB) at NCEI collects and archives multibeam data from the earliest commercial installations (circa 1980) through today's modern high-resolution collections. Data are acquired from both U.S. and international government and academic sources (see individual cruise metadata records for source information) and consist of the raw (as collected) sonar data files. Datasets may also include processed or edited versions of the sonar data, ancillary data (i.e., sound velocity data), derived products (i.e., grids), and/or metadata for the data collection. The MBBDB provides data that span the globe and are discoverable and accessible via map interface or text-only search options. This map service shows ship tracks for multibeam bathymetric surveys archived at NCEI.“
Source: https://www.ngdc.noaa.gov/mgg/bathymetry/multibeam.html

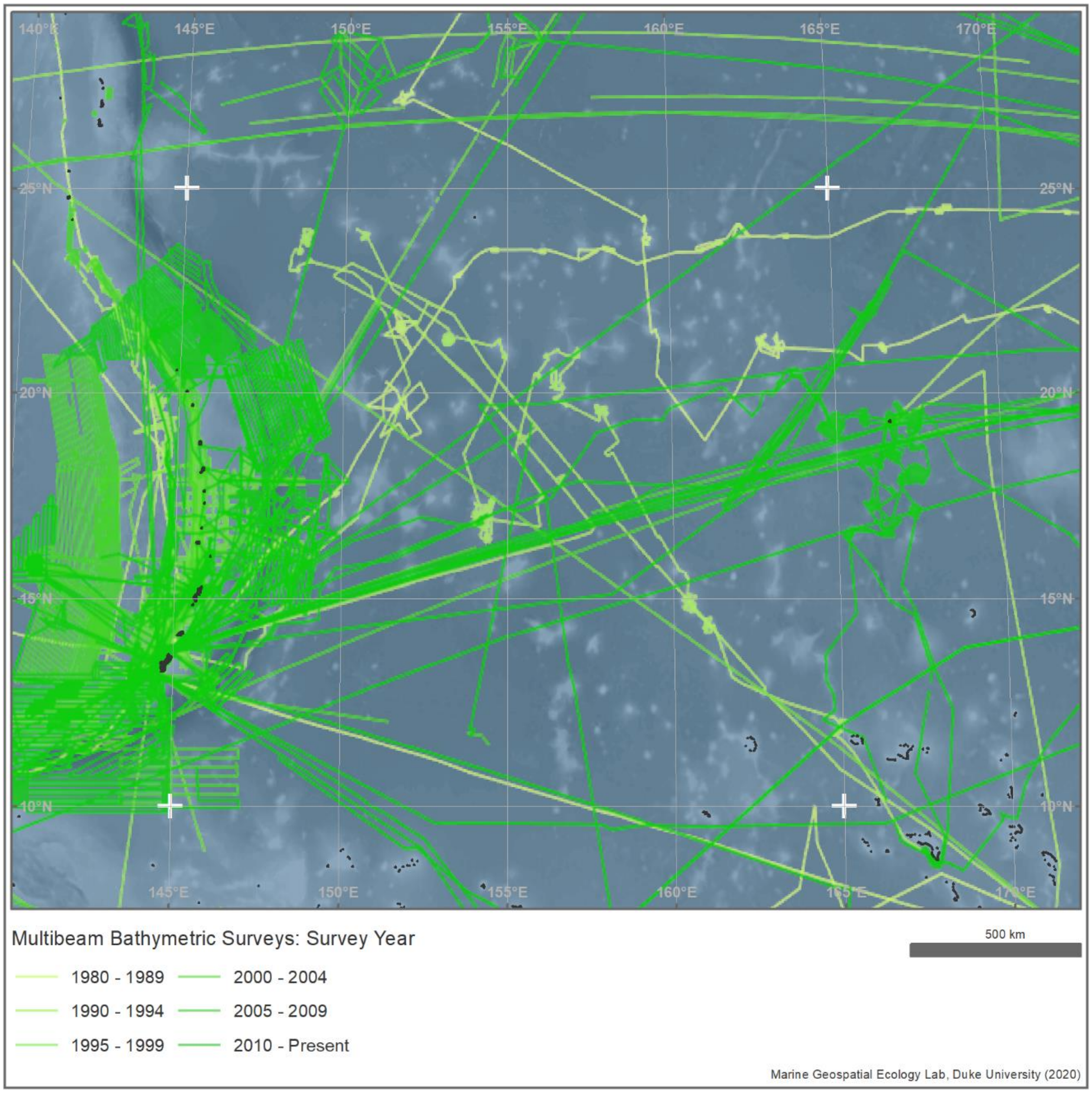

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Figure 2.3-1 Multibeam bathymetry survey tracklines

2.4 InterRidge Vents Database

"The InterRidge Global Database of Active Submarine Hydrothermal Vent Fields, hereafter referred to as the InterRidge Vents Database, is available online as the authoritative source for locations of hydrothermal vent fields worldwide (linked to InterRidge homepage: http://www.interridge.org). The InterRidge Vents Database was developed to provide a comprehensive list of active submarine hydrothermal vent fields for use in academic research and education."

Source: http://vents-data.interridge.org/, database version 3.4

Reference:
Beaulieu, S. E., E. T. Baker, C. R. German, and A. Maffei (2013), An authoritative global database for active submarine hydrothermal vent fields, Geochem. Geophys. Geosys., 14, 4892–4905, doi:10.1002/2013GC004998.

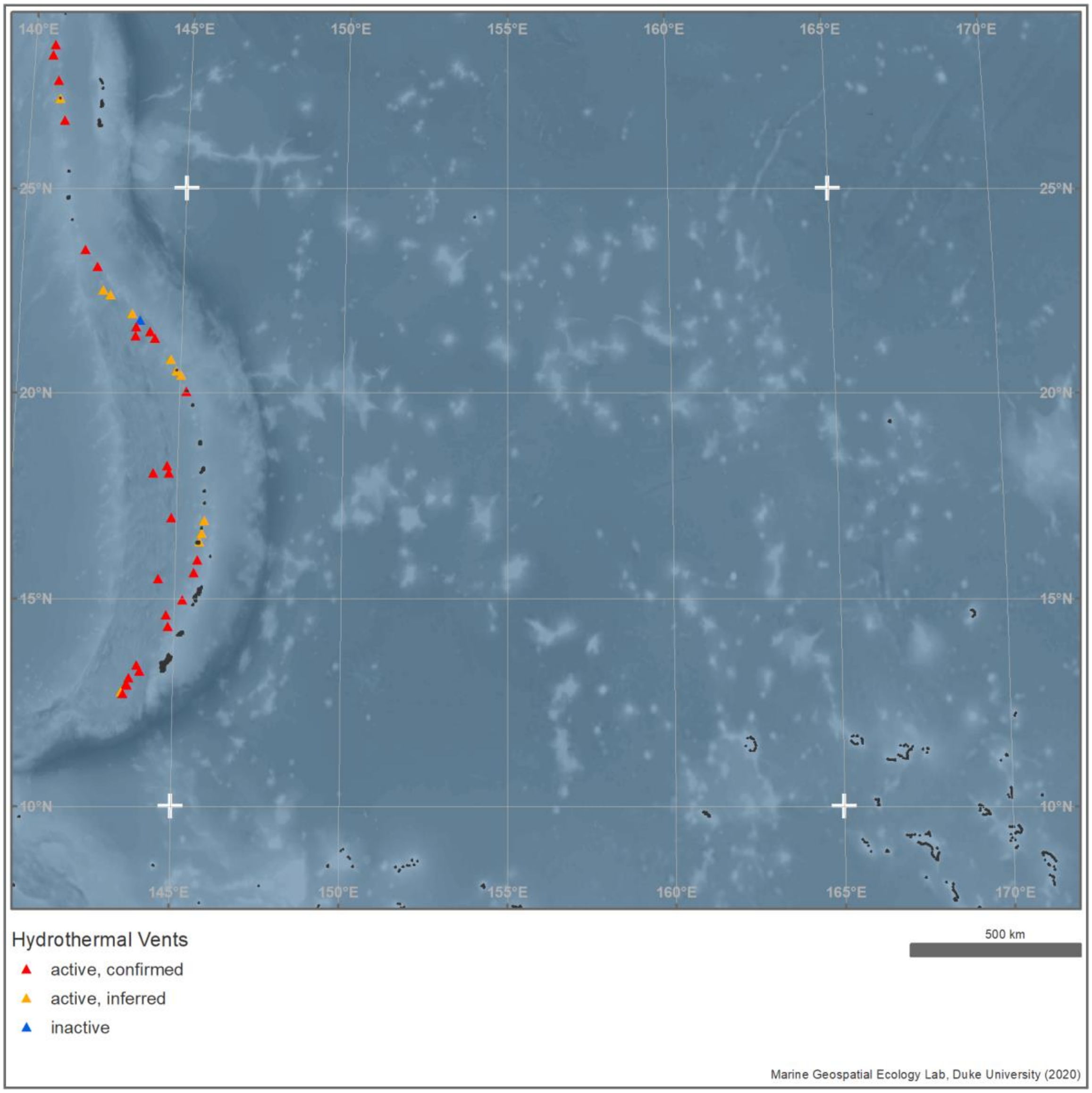

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Figure 2.4-1 Hydrothermal vents

2.5 GEBCO Undersea Features Gazetteer

“The GEBCO Sub-Committee on Undersea Feature Names (SCUFN) maintains and makes available a digital gazetteer of the names, generic feature type and geographic position of features on the seafloor.

The gazetteer is available to view and download via a web map application, hosted by the International Hydrographic Organization Data Centre for Digital Bathymetry (IHO DCDB) co-located with the US National Centers for Environmental Information (NCEI).
The data are available in a number of formats including spreadsheet, shapefile, KML, WMS and ArcGIS layer and can be accessed as a REST-style API.

Name proposals can be submitted to SCUFN for consideration for inclusion in the gazetteer.”

Source: https://www.gebco.net/data_and_products/undersea_feature_names/

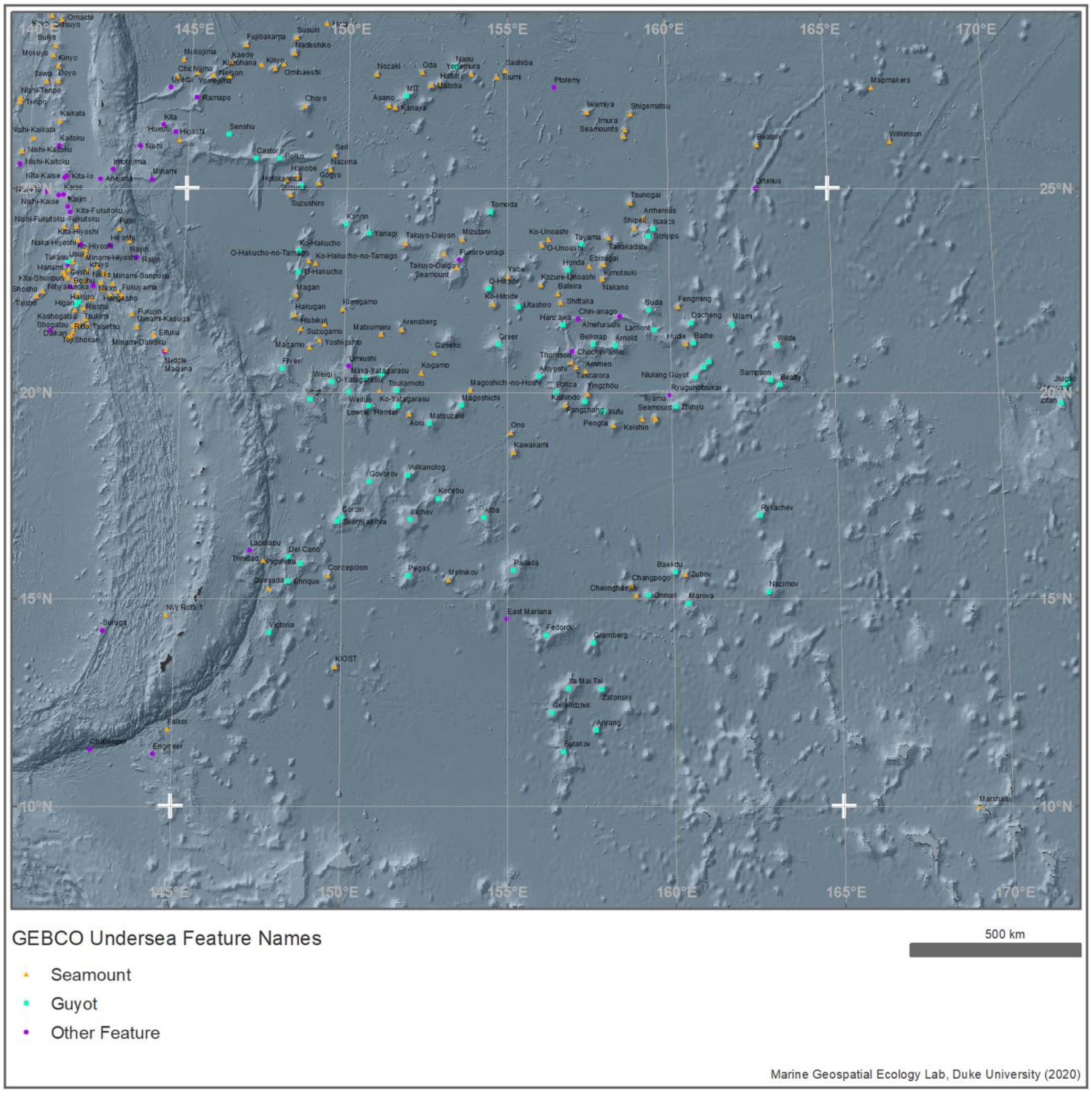

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Figure 2.5-1 Undersea features names

2.6 Seafloor Geomorphic Features

Abstract (Harris et al. 2014):
“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 km2 where the gradient exceeds 5°, compared with 1.3 million km2 on passive margin slopes; the continental rise covers 27 million km2 adjacent to passive margins and less than 2.3 million km2 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 (2014), Geomorphology of the oceans. Marine Geology. doi: 10.1016/j.margeo.2014.01.011

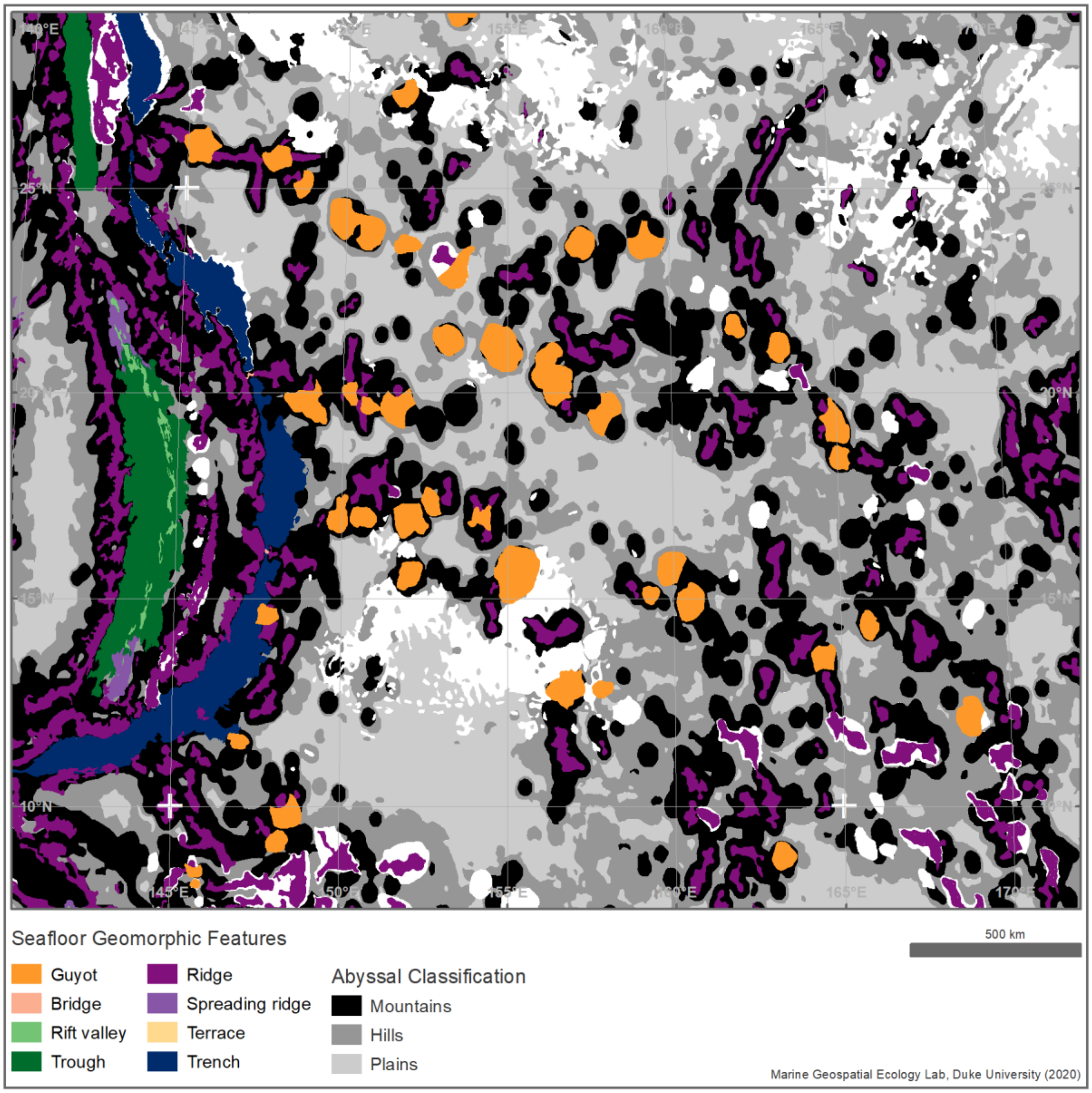

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Figure 2.6-1 Seafloor geomorphic features

2.7 Global Distribution of Seamounts

Abstract (Yesson et al. 2011):
"Seamounts and knolls are 'undersea mountains', the former rising more than 1000 m from the seafloor. These features provide important habitats for aquatic predators, demersal deep-sea fish and benthic invertebrates. However most seamounts have not been surveyed and their numbers and locations are not well known. Previous efforts to locate and quantify seamounts have used relatively coarse bathymetry grids. Here we use global bathymetric data at 30 arc-second resolution to identify seamounts and knolls. We identify 33,452 seamounts and 138,412 knolls, representing the largest global set of identified seamounts and knolls to date. We compare estimated seamount numbers, locations, and depths with validation sets of seamount data from New Zealand and Azores. This comparison indicates the method we apply finds 94% of seamounts, but may overestimate seamount numbers along ridges and in areas where faulting and seafloor spreading creates highly complex topography. The seamounts and knolls identified herein are significantly geographically biased towards areas surveyed with ship-based soundings. As only 6.5% of the ocean floor has been surveyed with soundings it is likely that new seamounts will be uncovered as surveying improves. Seamount habitats constitute approximately 4.7% of the ocean floor, whilst knolls cover 16.3%. Regional distribution of these features is examined, and we find a disproportionate number of productive knolls, with a summit depth of o1.5 km, located in the Southern Ocean. Less than 2% of seamounts are within marine protected areas and the majority of these are located within exclusive economic zones with few on the High Seas. The database of seamounts and knolls resulting from this study will be a useful resource for researchers and conservation planners."

Reference:
Yesson, C., Clark, M. R., Taylor, M. L., & Rogers, A. D. (2011). The global distribution of seamounts based on 30 arc seconds bathymetry data. Deep Sea Research Part I: Oceanographic Research Papers, 58(4), 442-453. doi: 10.1016/j.dsr.2011.02.004

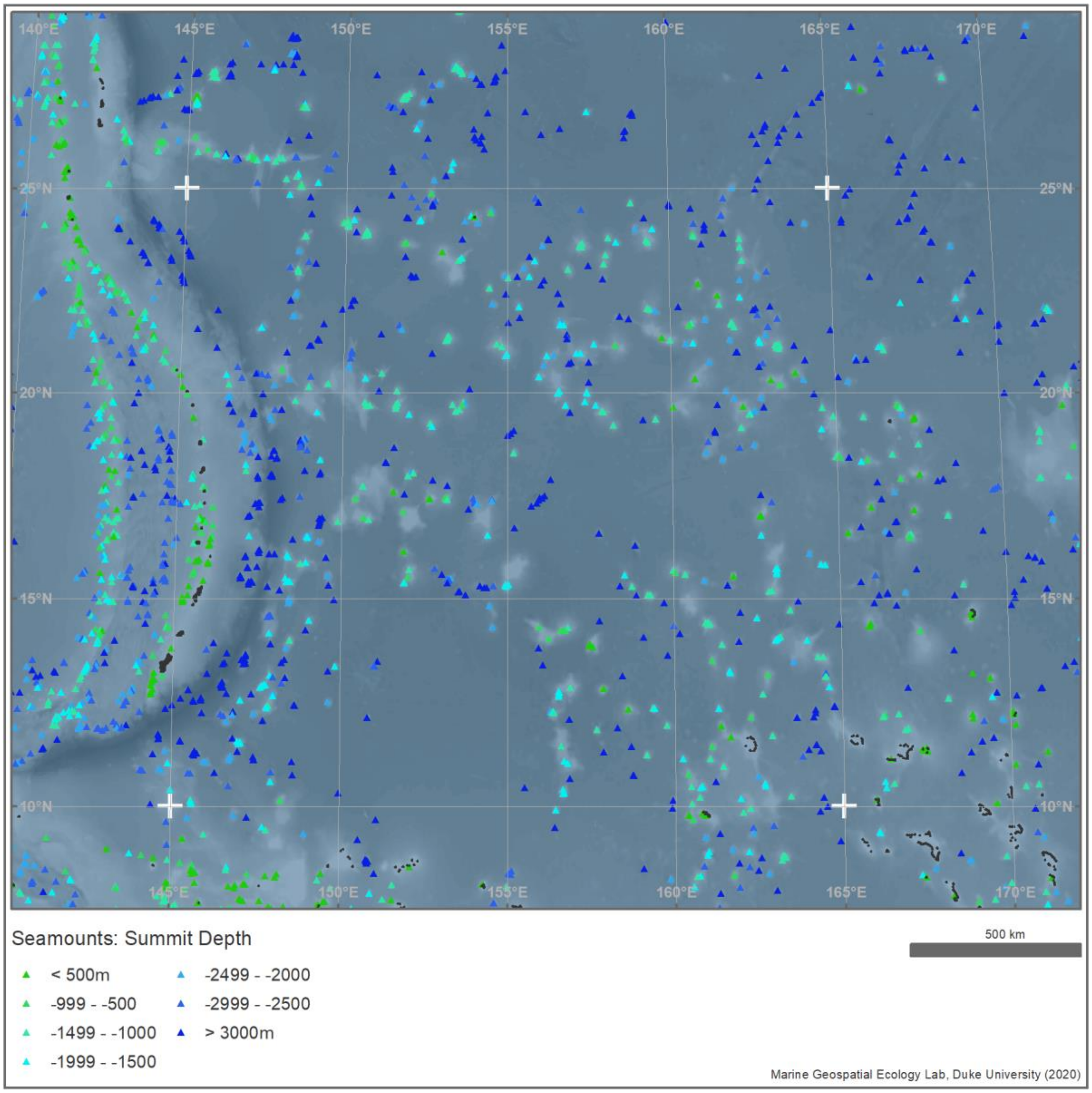

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Figure 2.7-1 Seamount summit depths

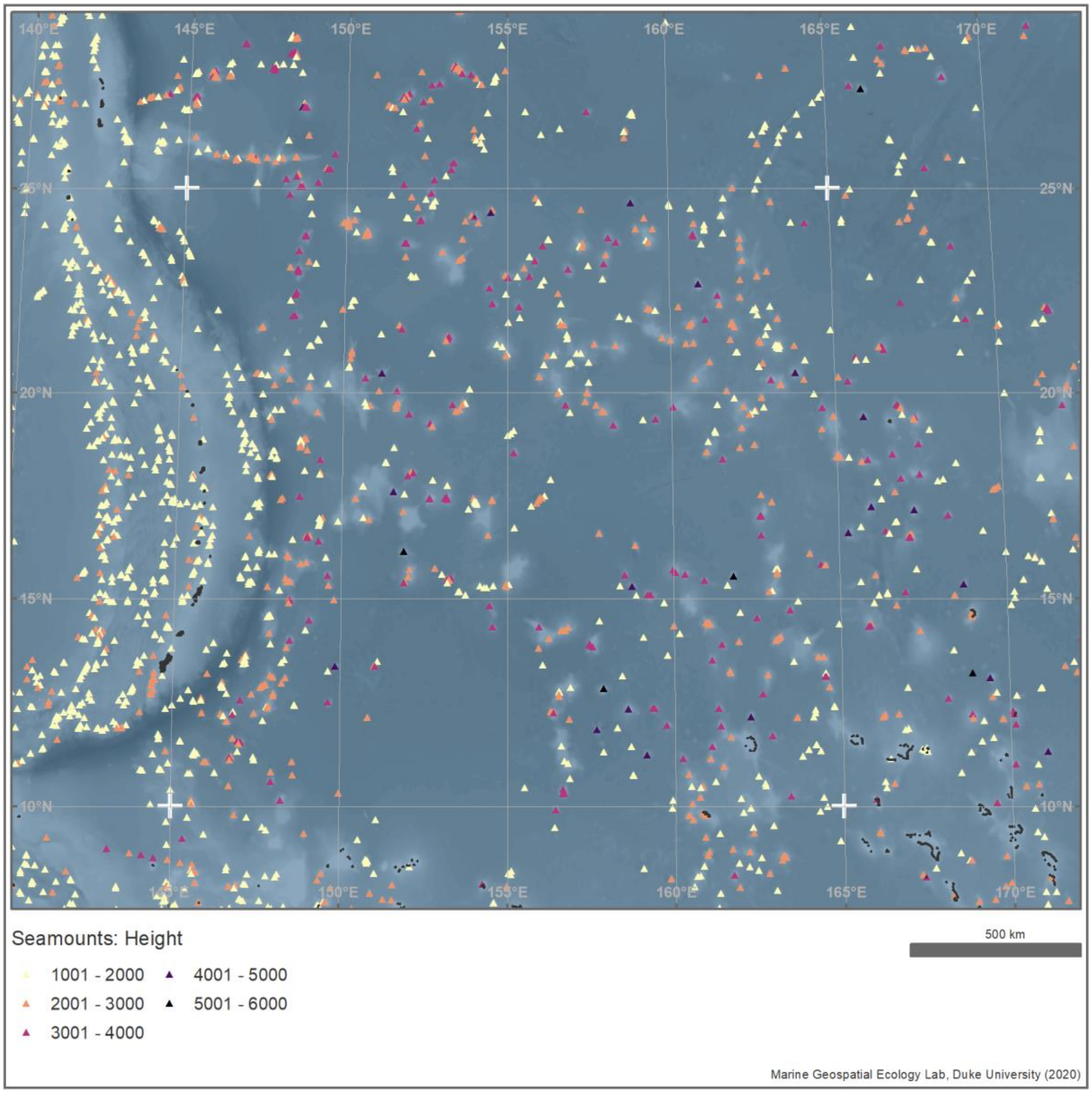

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Figure 2.7-2 Seamount height

2.8 Global Seamount Classification

Abstract (Clark et al. 2011):
“Seamounts are prominent features of the world’s seafloor, and are the target of deep-sea commercial fisheries, and of interest for minerals exploitation. They can host vulnerable benthic communities, which can be rapidly and severely impacted by human activities. There have been recent calls to establish networks of marine protected areas on the High Seas, including seamounts. However, there is little biological information on the benthic communities on seamounts, and this has limited the ability of scientists to inform managers about seamounts that should be protected as part of a network. In this paper we present a seamount classification based on “biologically meaningful” physical variables for which global-scale data are available. The approach involves the use of a general biogeographic classification for the bathyal depth zone (near-surface to 3500 m), and then uses four key environmental variables (overlying export production, summit depth, oxygen levels, and seamount proximity) to group seamounts with similar characteristics. This procedure is done in a simple hierarchical manner, which results in 194 seamount classes throughout the world’s oceans. The method was compared against a multivariate approach, and ground-truthed against octocoral data for the North Atlantic. We believe it gives biologically realistic groupings, in a transparent process that can be used to either directly select, or aid selection of, seamounts to be protected.”

Reference:
Clark, Malcolm R., Les Watling, Ashley A. Rowden, John M. Guinotte, and Craig R. Smith. "A global seamount classification to aid the scientific design of marine protected area networks." Ocean & Coastal Management 54, no. 1 (2011): 19-36. doi: 10.1016/j.ocecoaman.2010.10.006

Source: http://seamounts.sdsc.edu/

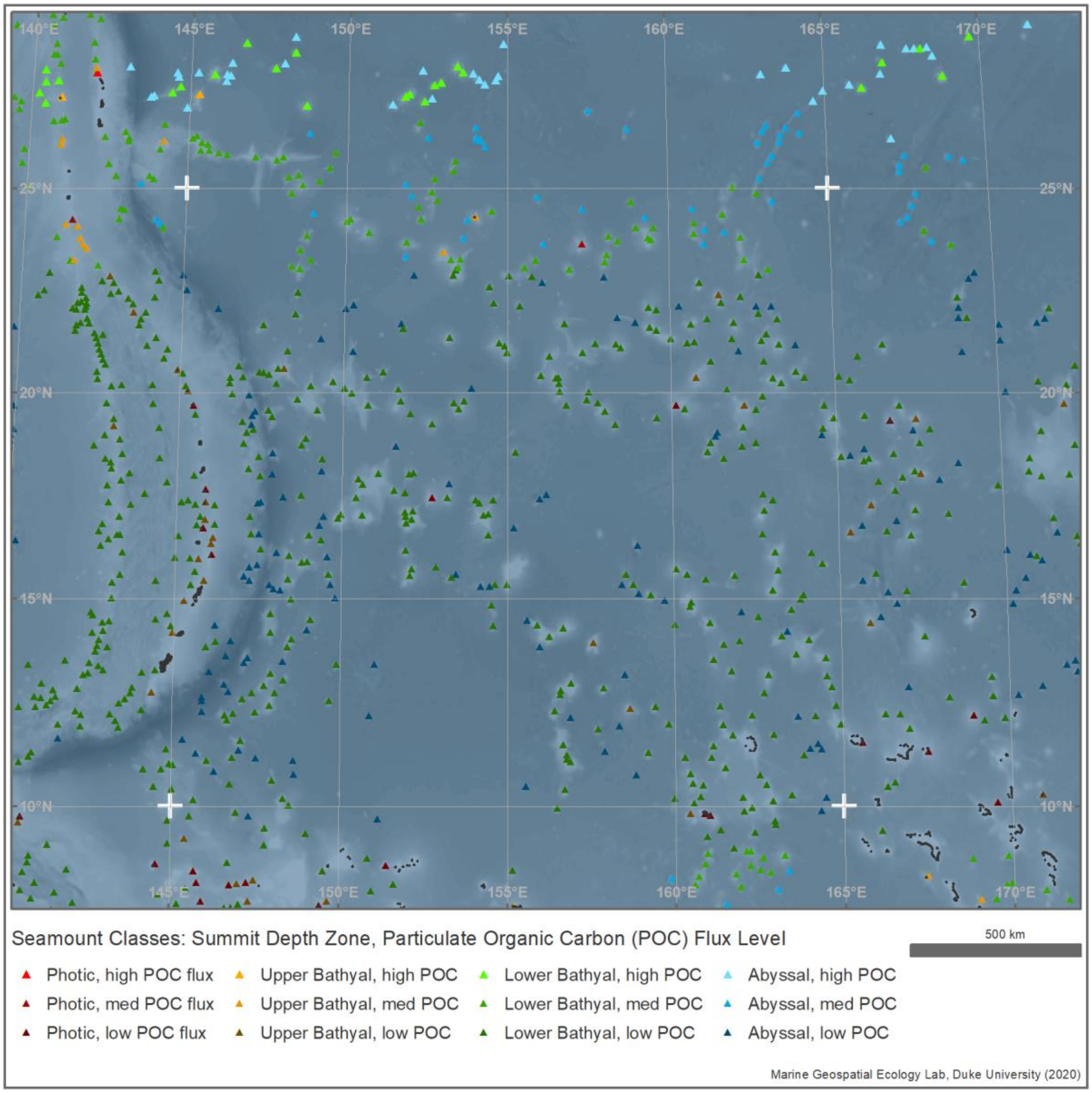

Figure 2.8-1 Global seamount classification, Depth Zone and POC Flux

2.9 Total Sediment Thickness of the World’s Oceans & Marginal Seas

“NCEI's global ocean sediment thickness grid of Divins (2003) updated by Whittaker et al. (2013) has been updated again for the NE Atlantic, Arctic, Southern Ocean, and Mediterranean regions. The new global 5-arc-minute total sediment thickness grid, GlobSed, incorporates new data and several regional oceanic sediment thickness maps, which have been compiled and published for the, (1) NE Atlantic (Funck et al., 2017; Hopper et al., 2014), (2) Mediterranean (Molinari & Morelli, 2011), (3) Arctic (Petrov et al., 2016), (4) Weddell Sea (Huang et al., 2014), and (5) the Ross Sea, Amundsen Sea, and Bellingshausen Sea sectors off West Antarctica (Lindeque et al., 2016; Wobbe et al., 2014). This version also includes updates in the White Sea region based on the VSEGEI map of Orlov and Fedorov (2001). GlobSed covers a larger area than NCEI’s previous global grids (Divins, 2003; Whittaker et al. 2013), and the new updates results in a 29.7% increase in estimated total oceanic sediment volume.”

Source: https://www.ngdc.noaa.gov/mgg/sedthick/

Reference:
Straume, E.O., Gaina, C., Medvedev, S., Hochmuth, K., Gohl, K., Whittaker, J. M., et al. (2019). GlobSed: Updated total sediment thickness in the world's oceans. Geochemistry, Geophysics, Geosystems, 20. DOI: 10.1029/2018GC008115

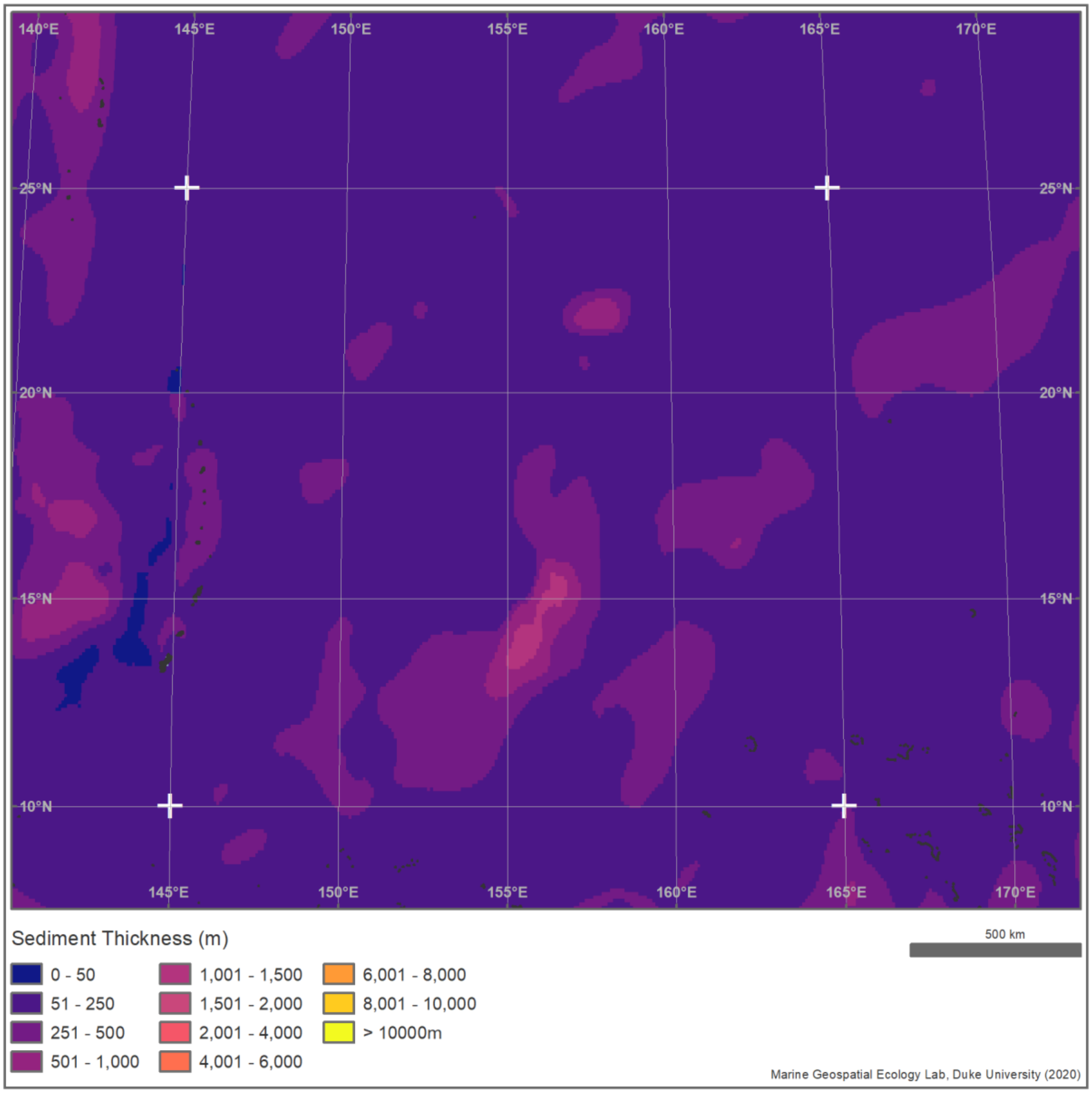

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Figure 2.9-1 Sediment thickness

2.10 Seafloor Lithology

Abstract (Dutkiewicz et al. 2015)
"Knowing the patterns of distribution of sediments in the global ocean is critical for understanding biogeochemical cycles and how deep-sea deposits respond to environmental change at the sea surface. We present the first digital map of seafloor lithologies based on descriptions of nearly 14,500 samples from original cruise reports, interpolated using a support vector machine algorithm. We show that sediment distribution is more complex, with significant deviations from earlier hand-drawn maps, and that major lithologies occur in drastically different proportions globally. By coupling our digital map to oceanographic data sets, we find that the global occurrence of biogenic oozes is strongly linked to specific ranges in sea-surface parameters. In particular, by using recent computations of diatom distributions from pigment-calibrated chlorophyll-*a* satellite data, we show that, contrary to a widely held view, diatom oozes are not a reliable proxy for surface productivity. Their global accumulation is instead strongly dependent on low surface temperature (0.9–5.7 °C) and salinity (33.8–34.0 PSS, Practical Salinity Scale 1978) and high concentrations of nutrients. Under these conditions, diatom oozes will accumulate on the seafloor regardless of surface productivity as long as there is limited competition from biogenous and detrital components, and diatom frustules are not significantly dissolved prior to preservation. Quantifying the link between the seafloor and the sea surface through the use of large digital data sets will ultimately lead to more robust reconstructions and predictions of climate change and its impact on the ocean environment."

Reference:
Dutkiewicz, A., R. Müller, S. O'Callaghan, and H. Jónasson. 2015. "Census of Seafloor Sediments in the World's Ocean." *Geology* 43 (9): 795–98. https://doi.org/10.1130/G36883.1.

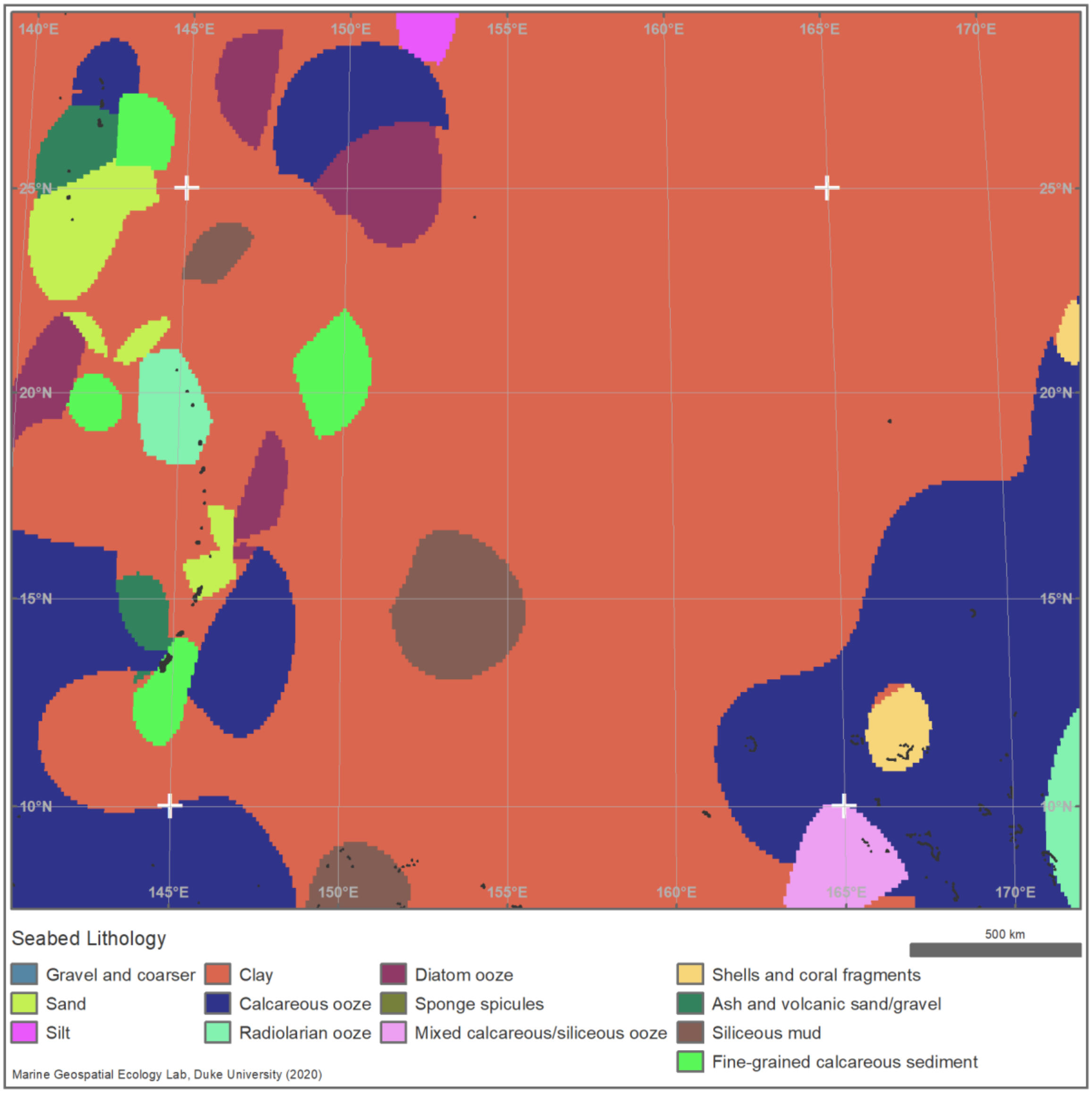

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Figure 2.10-1 Global seabed lithology

2.11 World Ocean Atlas – Dissolved Oxygen

“The WOA18 updates previous versions of the World Ocean Atlas to include approximately 3 million new oceanographic casts added to the World Ocean Database and renewed quality control. This final version of WOA18 published in July, 2019 is replacing a prereleased version made available in September, 2018. The changes between the versions include:

- For the first time the Animal mounted pinniped temperature profiles (APB) have been added improving coverage in high latitude areas.
- A different Expendable Bathythermograph (XBT) correction (Cheng et al., 2014) has been employed.
- A double XBT correction has been detected in pre-release version and fixed in final version.
- All temperature and salinity climatological fields were re-calculated to account for these adjustments.”

Source: https://www.nodc.noaa.gov/OC5/woa18/
https://www.nodc.noaa.gov/cgi-bin/OC5/woa18/woa18oxnu.pl

Reference:
Locarnini, R. A., A. V. Mishonov, O. K. Baranova, T. P. Boyer, M. M. Zweng, H. E. Garcia, J. R. Reagan, D. Seidov, K. Weathers, C. R. Paver, and I. Smolyar, 2018. *World Ocean Atlas 2018, Volume 1: Temperature.* A. Mishonov Technical Ed.; NOAA Atlas NESDIS 81, 52 pp.

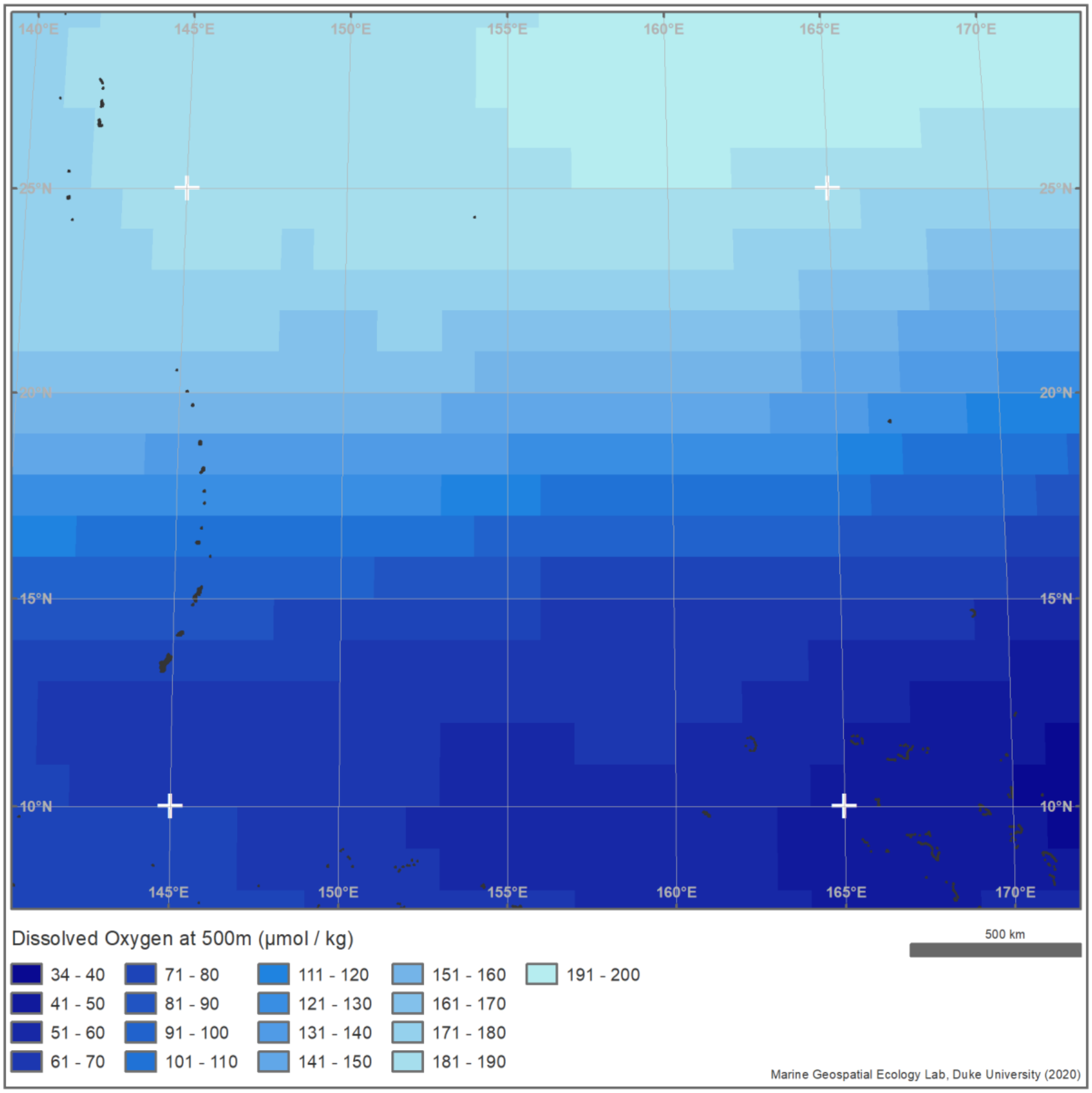

Figure 2.11-1 Dissolved oxygen, 500m

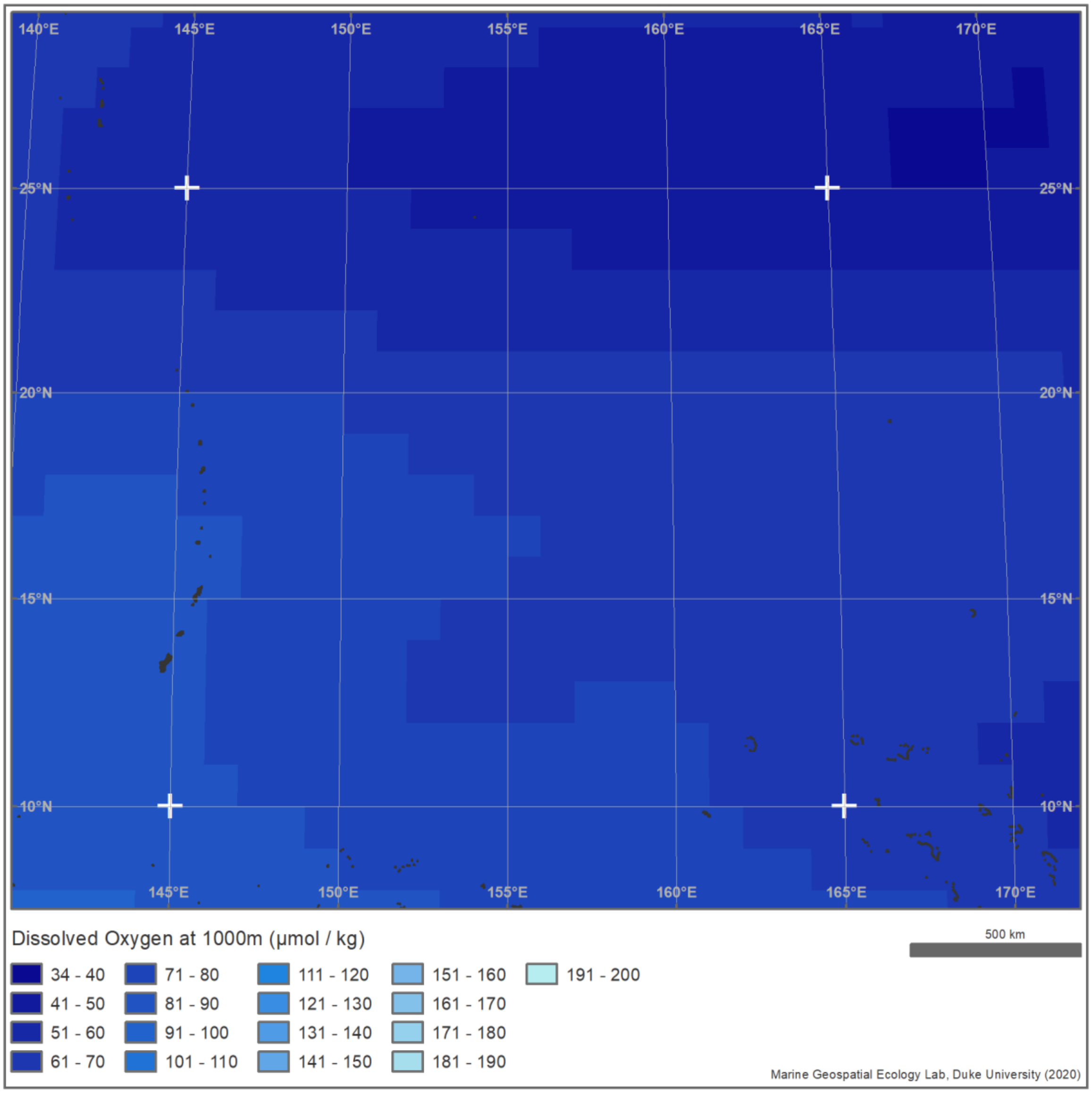

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Figure 2.11-2 Dissolved oxygen, 1000m

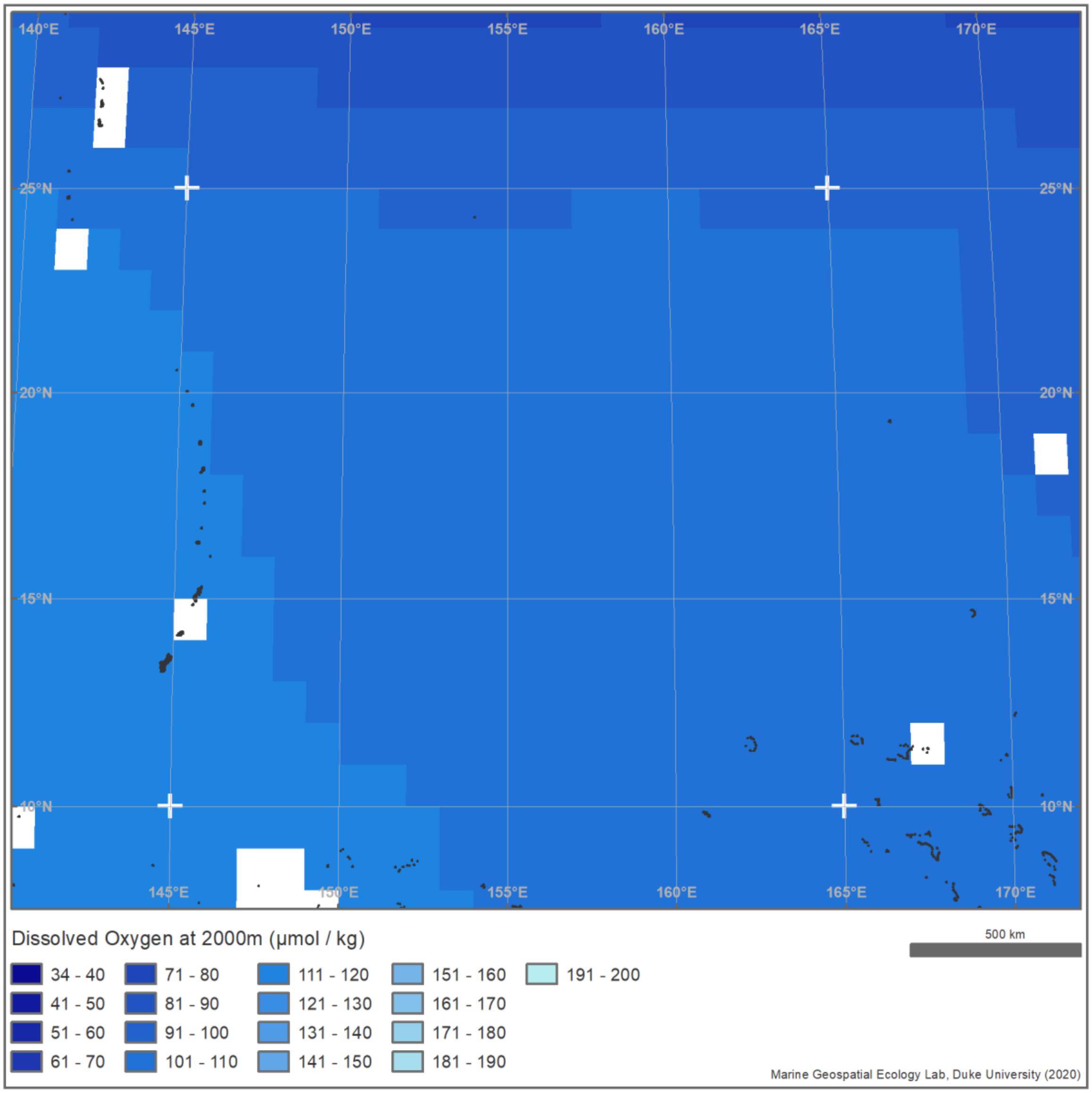

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Figure 2.11-3 Dissolved oxygen, 2000m

2.12 Hybrid Coordinate Ocean Model (HYCOM) Data

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

Here, climatologies of the current velocity (surface, 500m, 1500m, 2500m, bottom) and bottom temperature (January, July) were created using the “Create Climatological Rasters for HYCOM GLBu0.08 4D Variable” tool in the Marine Geospatial Ecology Tools (MGET) for ArcGIS (Roberts et al., 2010). This tool uses data from the Hybrid Coordinate Ocean Model (HYCOM) model GLBu0.08 (Chassignet et al. 2009). This tool produces rasters showing the climatological average value (or other statistic) of a HYCOM GLBu0.08 4D variable. Given a desired variable, a statistic, and a climatological bin definition, this tool downloads daily images for each depth layer of the variable, classifies them into bins, and produces a single raster for each bin. Each cell of the raster is produced by calculating the statistic on the values of that cell extracted from all of the rasters in the bin. This tool accesses a concatenation of several sequential HYCOM + NCODA Global 1/12 Degree "uniform" (GLBu0.08) datasets, treating them as a continuous virtual dataset running from late 1992 to the present day using the OPeNDAP protocol.

Data were summarized for single months in 2018 and can also be summarized into other climatologies as needed.

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

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

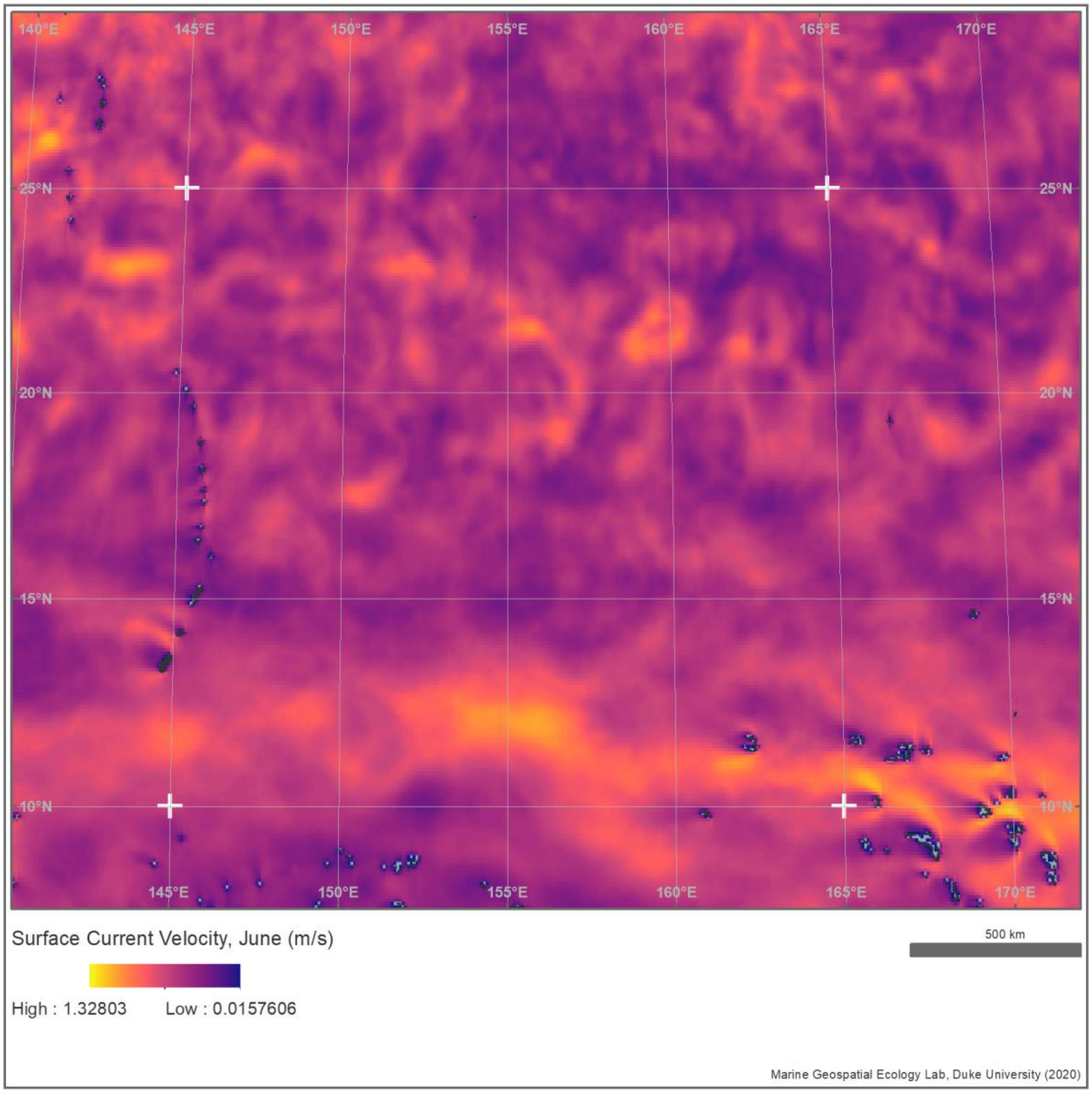

Figure 2.12-1 Current velocity, surface, June 2018

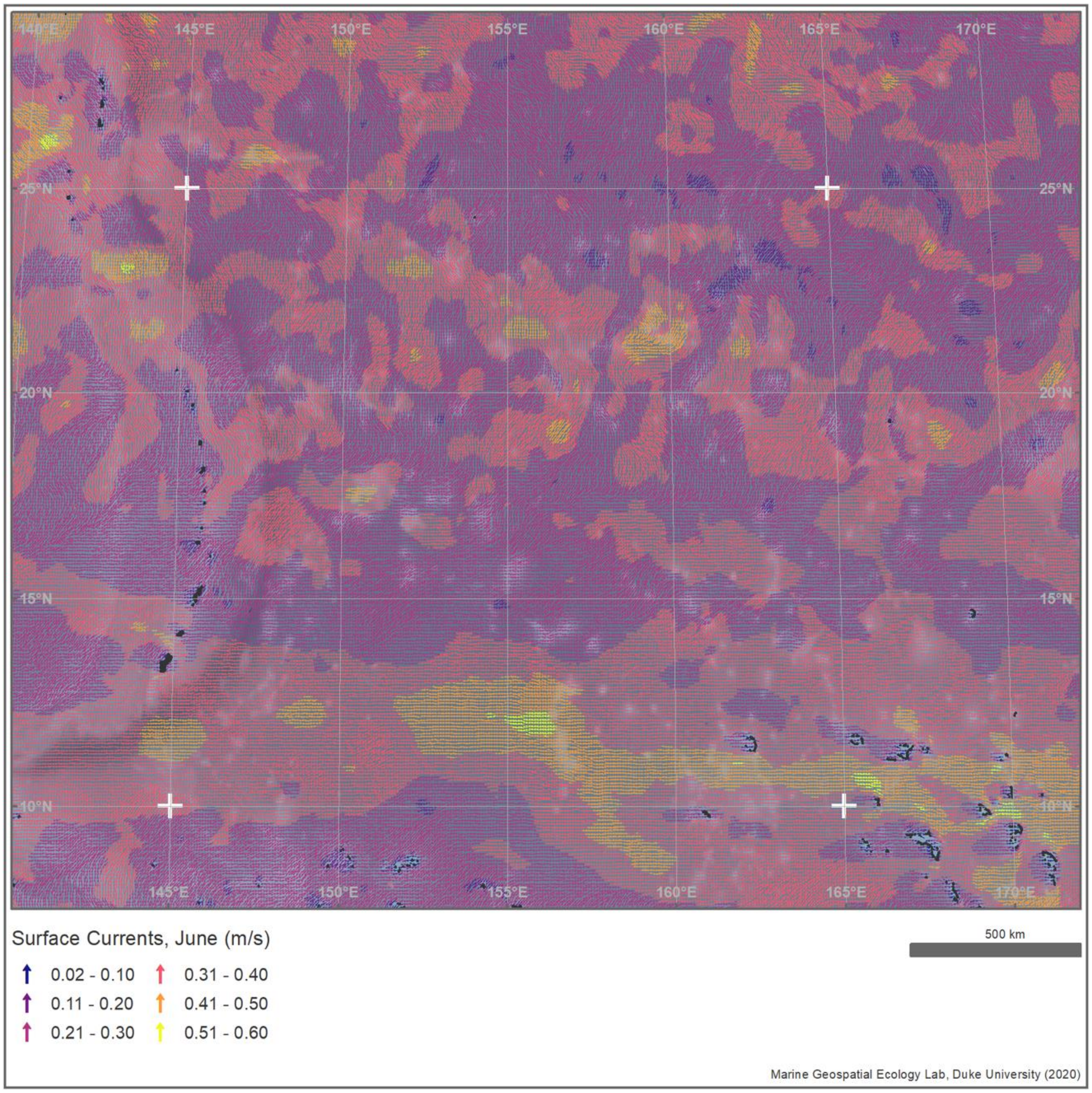

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Figure 2.12-2 Current velocity vectors, surface, June 2018

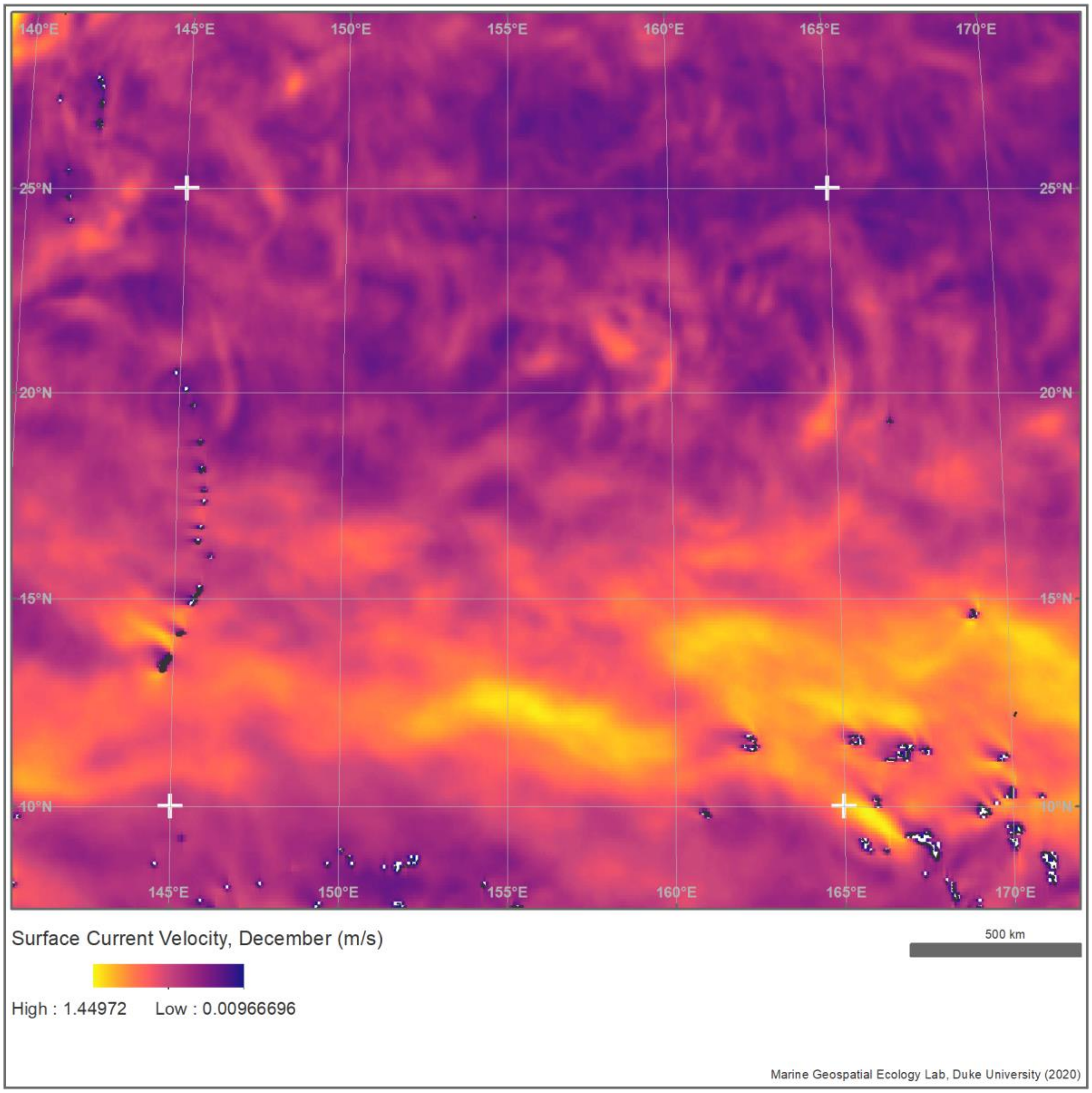

Figure 2.12-3 Current velocity, surface, December 2018

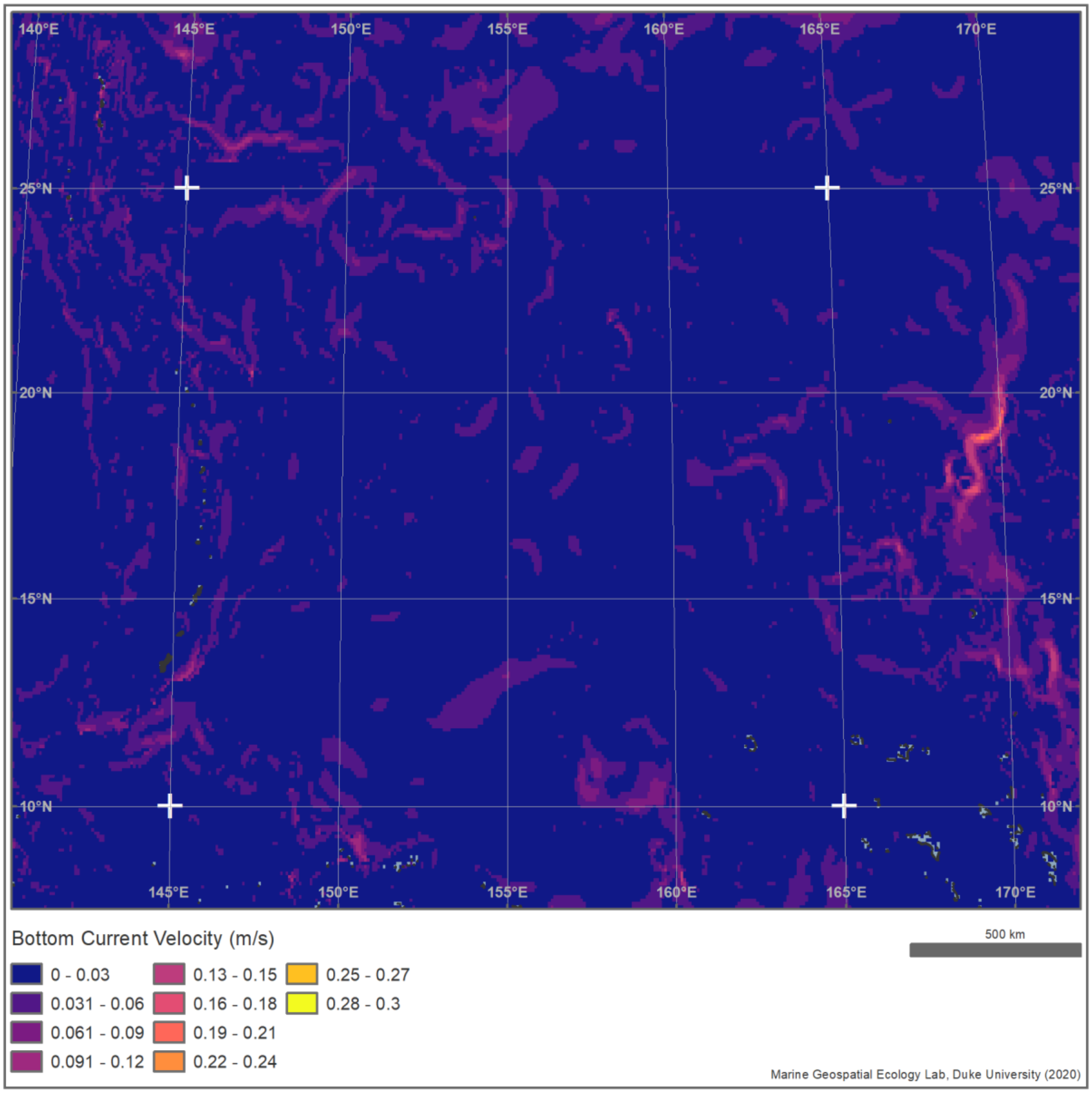

Figure 2.12-4 Current velocity, bottom, June 2018

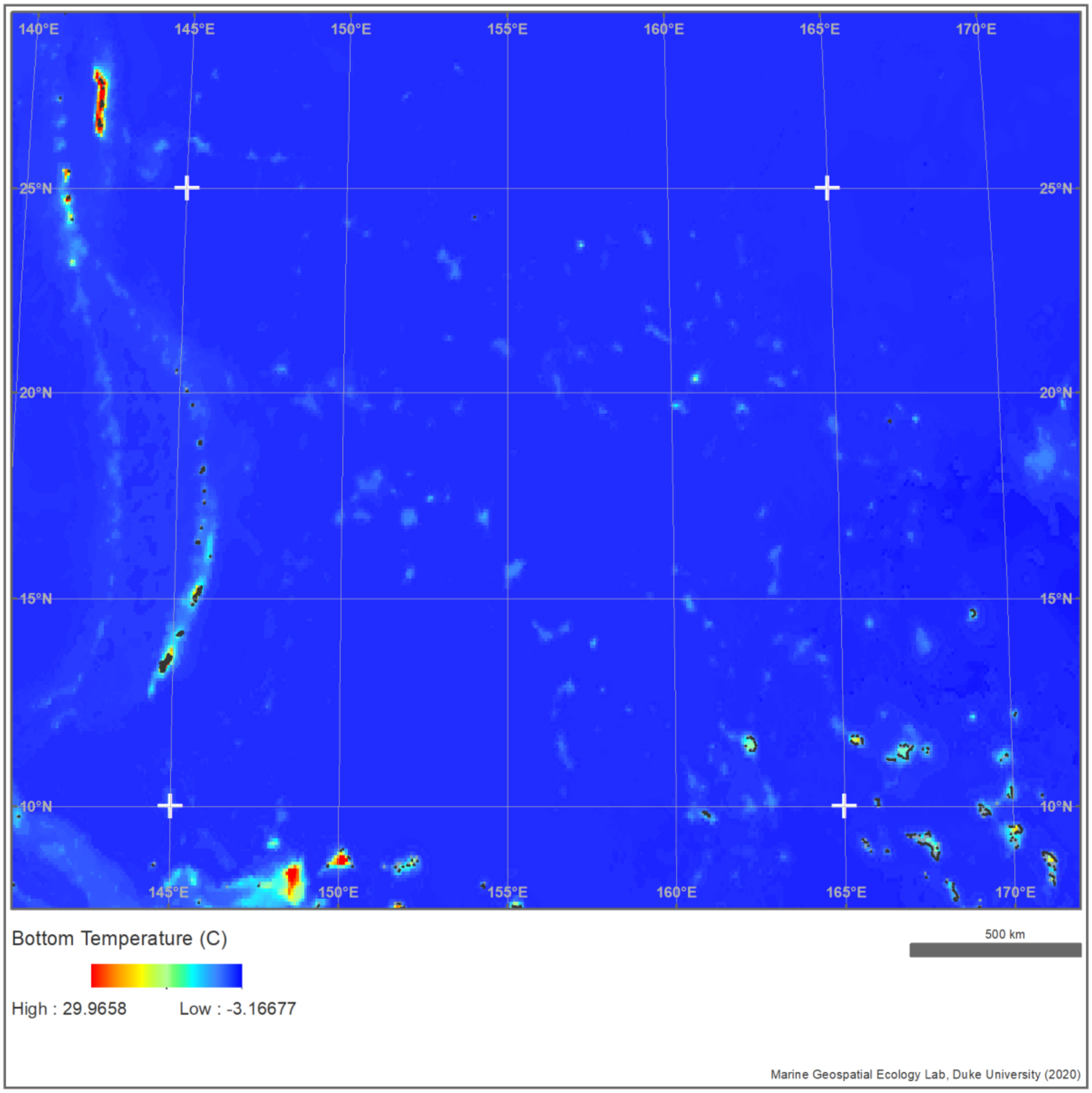

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Figure 2.12-5 Bottom temperature, June 2018

2.13 Sea Surface Temperature Front Climatology

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

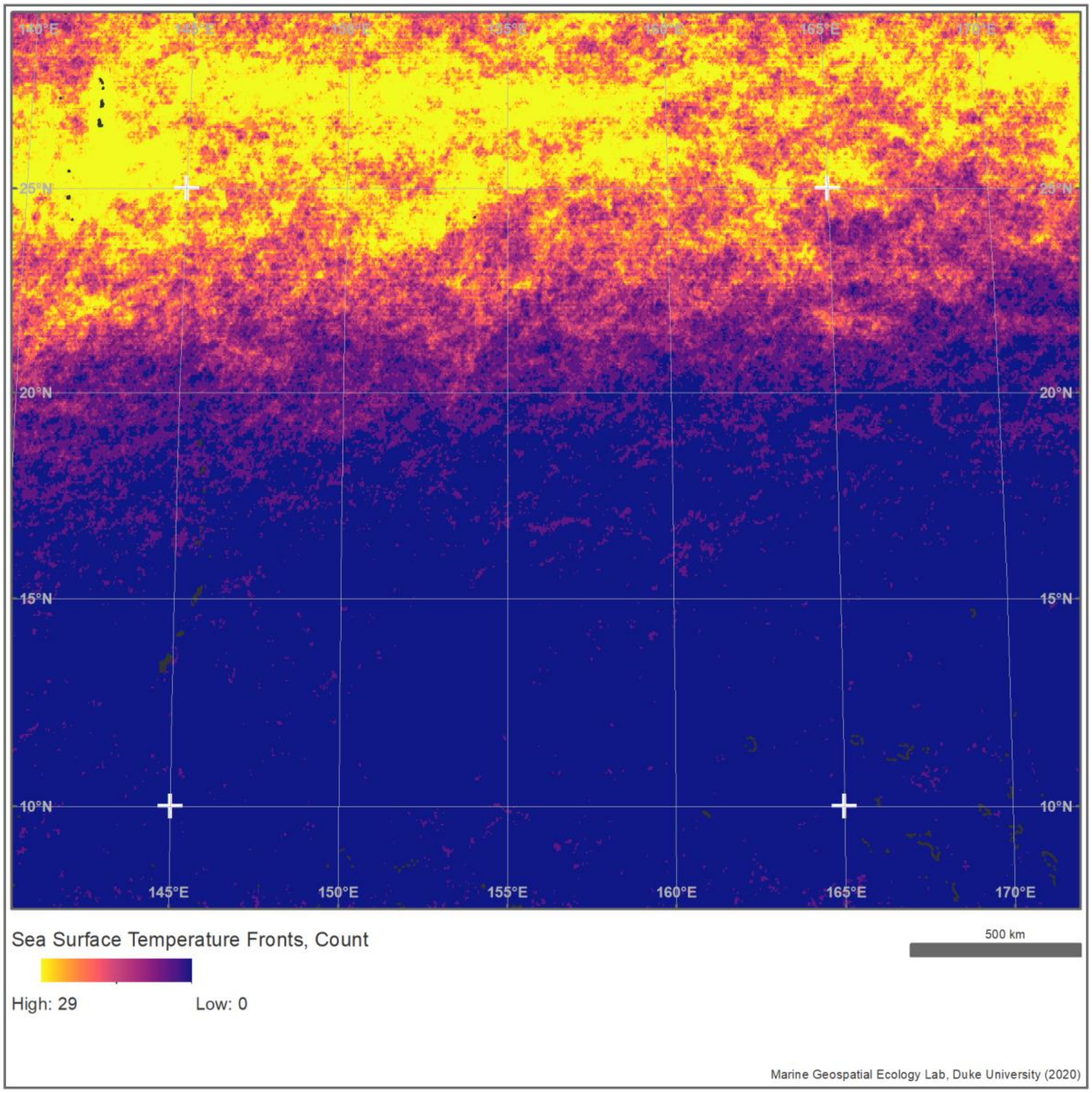
For this effort, SST fronts were detected using the "Find Cayula-Cornillon Fronts in PO.DAAC MODIS L3 SST" tool in the Marine Geospatial Ecology Tools (MGET) for ArcGIS (Roberts et al., 2010). The front threshold was set to 1 degree Celsius, and the tool was run for every daily image available from 2015 – 2019 (inclusive). A custom Python script was then run to calculate the percentage of days with a temperature front over the full set of daily images. Data summaries were created monthly, annually, and over the entire date range.

References:

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

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

An overall mean is shown below.



Marine Geospatial Ecology Lab, Duke University (2020)

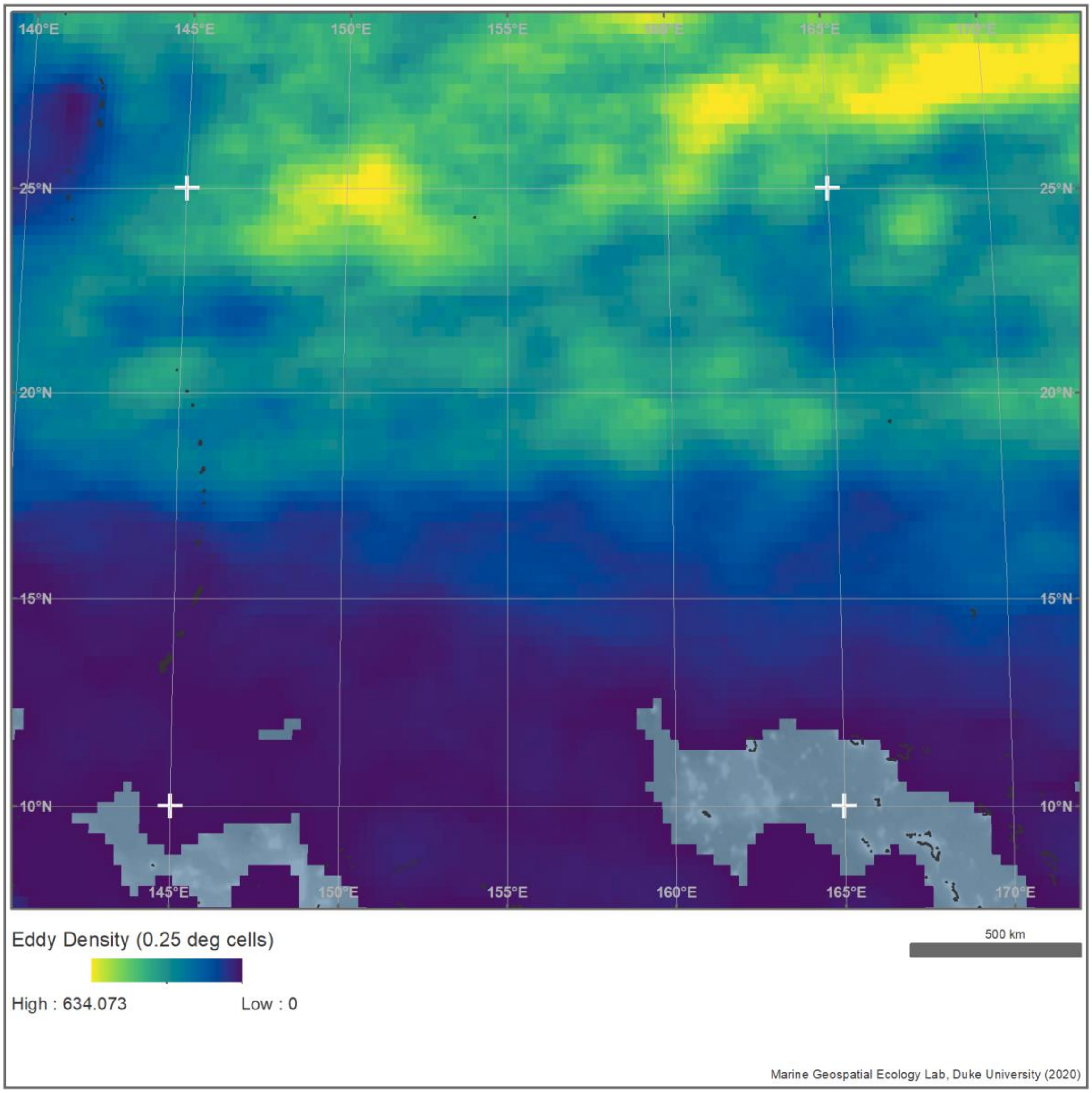
Figure 2.13-1 Sea surface temperature front climatology

2.14 Mesoscale Eddy Climatology

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

Source: Mesoscale Eddy Trajectory Atlas, version 2.0exp,
https://www.aviso.altimetry.fr/index.php?id=3280&L=1

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



Marine Geospatial Ecology Lab, Duke University (2020)

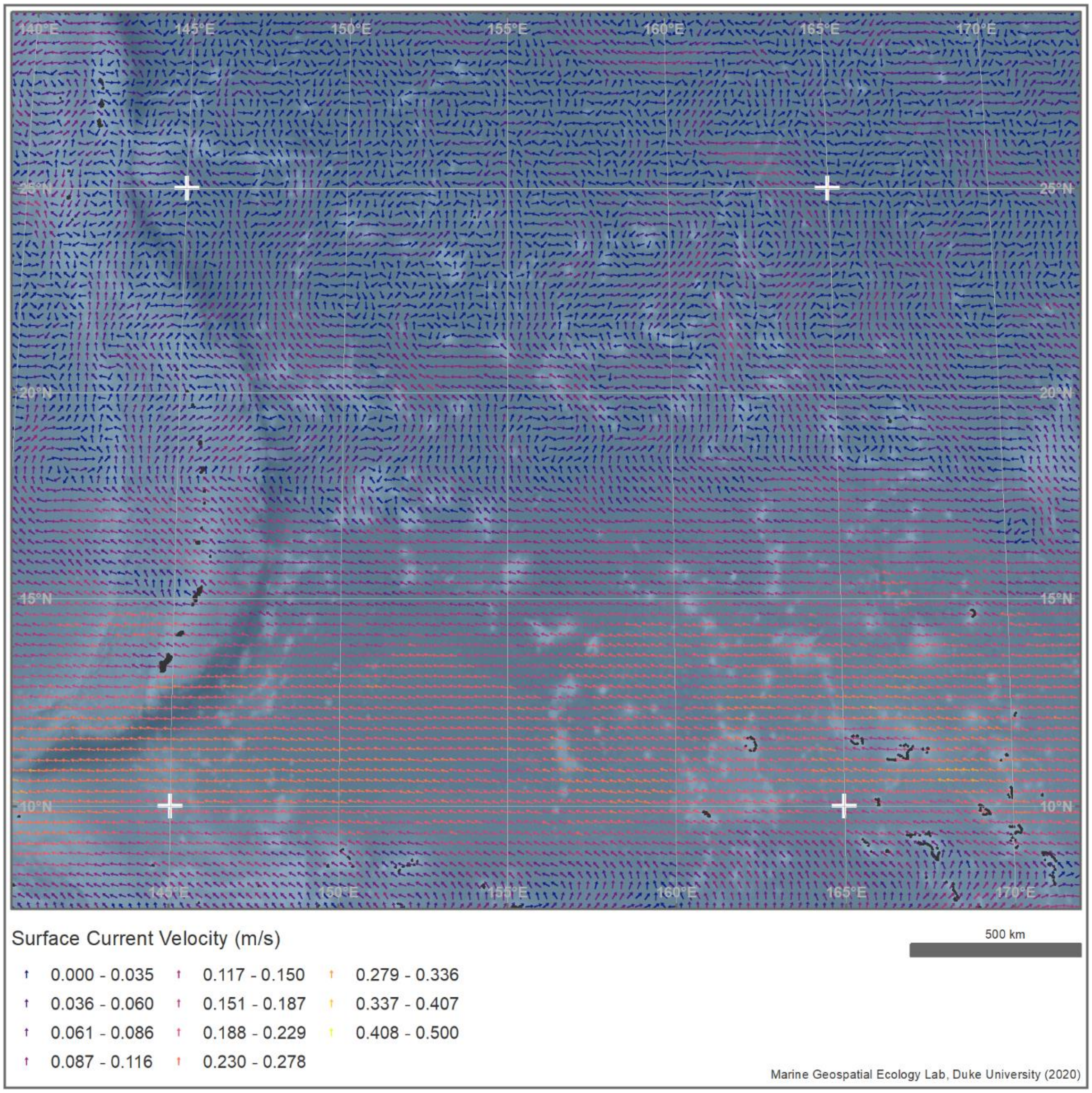
Figure 2.14-1 Mesoscale eddy density

2.15 Drifter Climatology of Near-Surface Currents

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

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

Reference:
Laurindo, L. C., Mariano, A. J., & Lumpkin, R. (2017). An improved near-surface velocity climatology for the global ocean from drifter observations. Deep Sea Research Part I: Oceanographic Research Papers, 124, 73-92. doi: 10.1016/j.dsr.2017.04.009



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 2.15-1 Drifter-derived climatology of near-surface currents

2.16 Chlorophyll A Concentration Monthly Climatologies

Monthly cumulative Chlorophyll A climatologies were created from Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua data for 2015-2019 (inclusive). These data were created by a script processing the “Ocean Color SMI: Standard Mapped Image MODIS Aqua Data” dataset in Google Earth Engine.

“This level 3 product includes ocean color and satellite ocean biology data produced or collected under EOSDIS. This dataset may be used for studying the biology and hydrology of coastal zones, changes in the diversity and geographical distribution of coastal marine habitats, biogeochemical fluxes and their influence in Earth's oceans and climate over time, and finally the impact of climate and environmental variability and change on ocean ecosystems and the biodiversity they support.”

Source:
https://developers.google.com/earth-engine/datasets/catalog/NASA_OCEANDATA_MODIS-Aqua_L3SMI#description

Reference:
NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group. Moderate-resolution Imaging Spectroradiometer (MODIS) Aqua Ocean Color Data, NASA OB.DAAC, Greenbelt, MD, USA.

While these datasets were created at a monthly time step, other temporal averages could be created as needed.

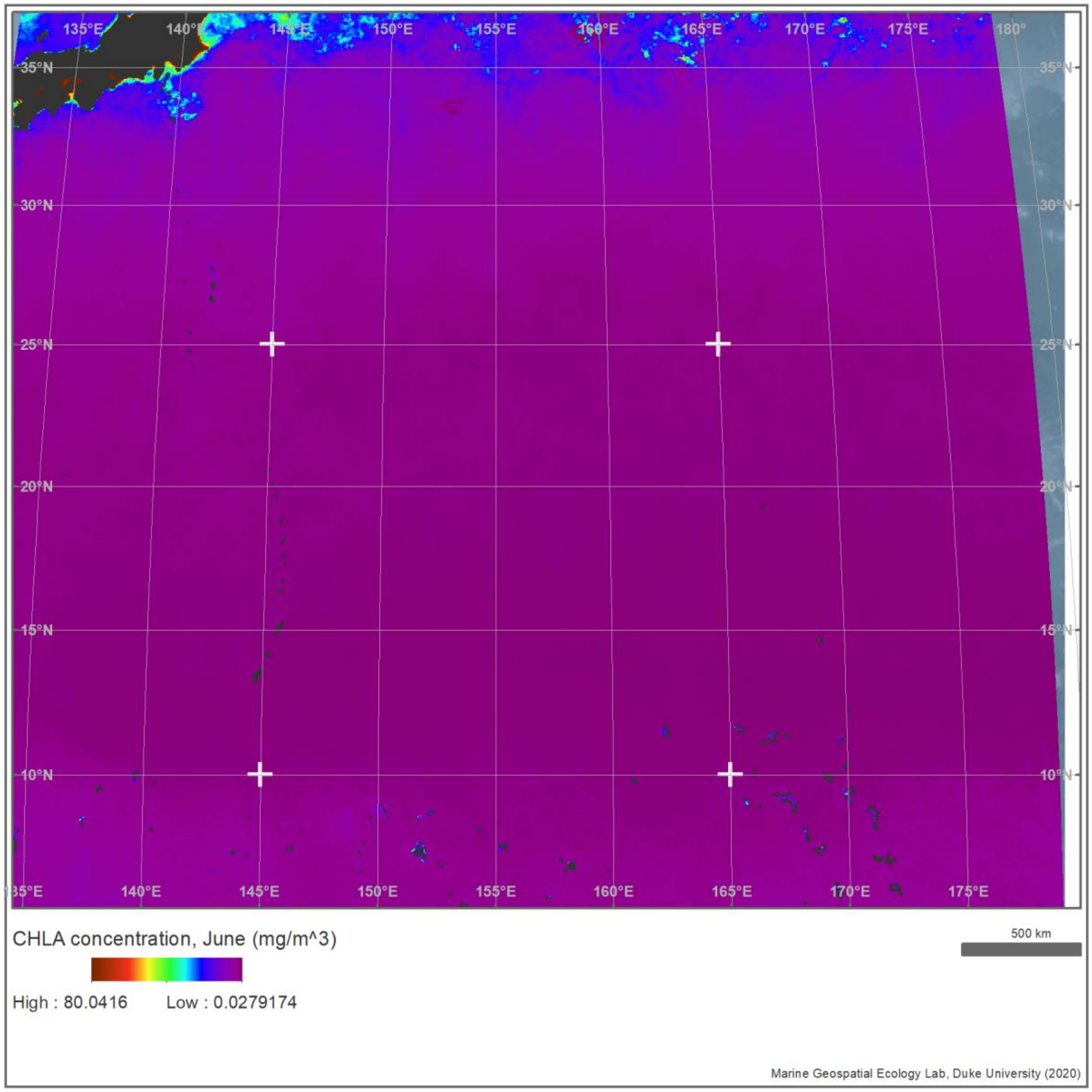


Figure 2.16-1 Chlorophyll A concentration climatology: June

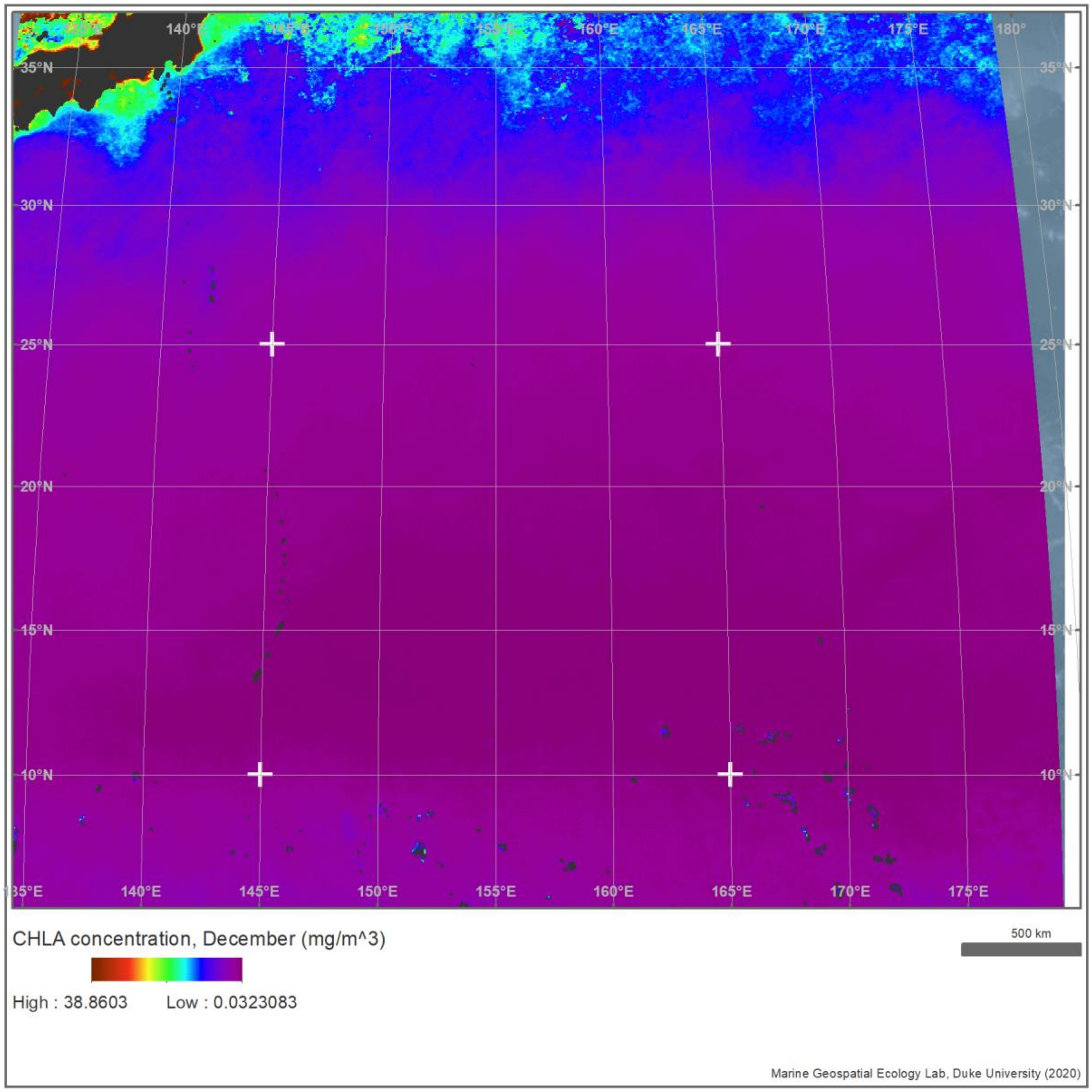


Figure 2.16-2 Chlorophyll A concentration climatology: December

2.17 Vertically Generalized Production Model (VGPM) Primary Productivity

Description:
“Standard Ocean Productivity Products are based on the original description of the Vertically Generalized Production Model (VGPM) (Behrenfeld & Falkowski 1997), MODIS surface chlorophyll concentrations (Chl_{sat}), MODIS 11-micron daytime sea surface temperature data (SST), and MODIS cloud-corrected incident daily photosynthetically active radiation (PAR). Euphotic depths are calculated from Chl_{sat} following Morel and Berthon (1989).”

For this effort, a cumulative climatology was created from Standard VGPM data derived from MODIS data from 2015-2019 (inclusive).

Reference:
Behrenfeld MJ, Falkowski PG (1997) Photosynthetic rates derived from satellite-based chlorophyll concentration. Limonology And Oceanography 42:1–20.

Source:
http://sites.science.oregonstate.edu/ocean.productivity/standard.product.php

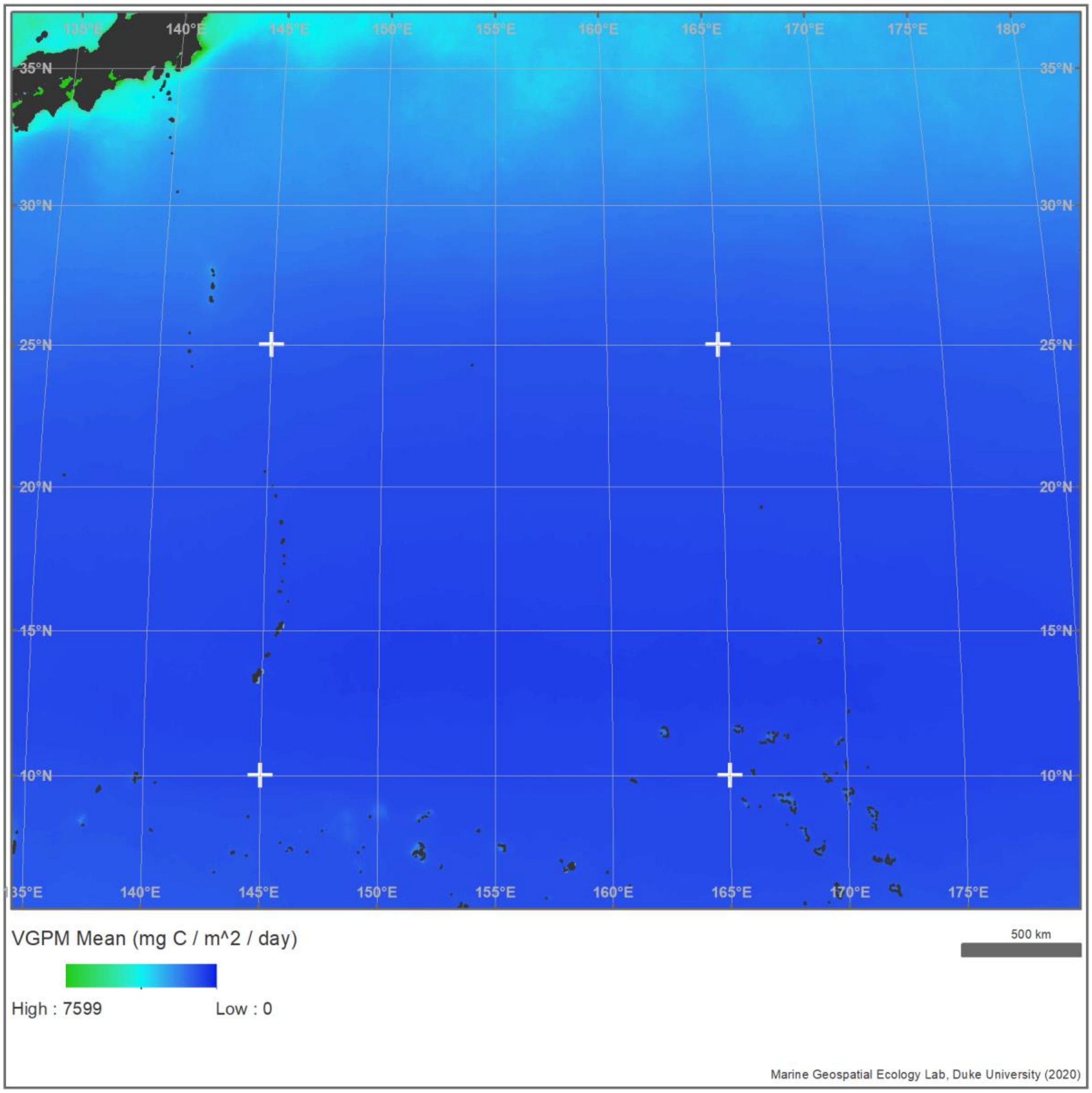
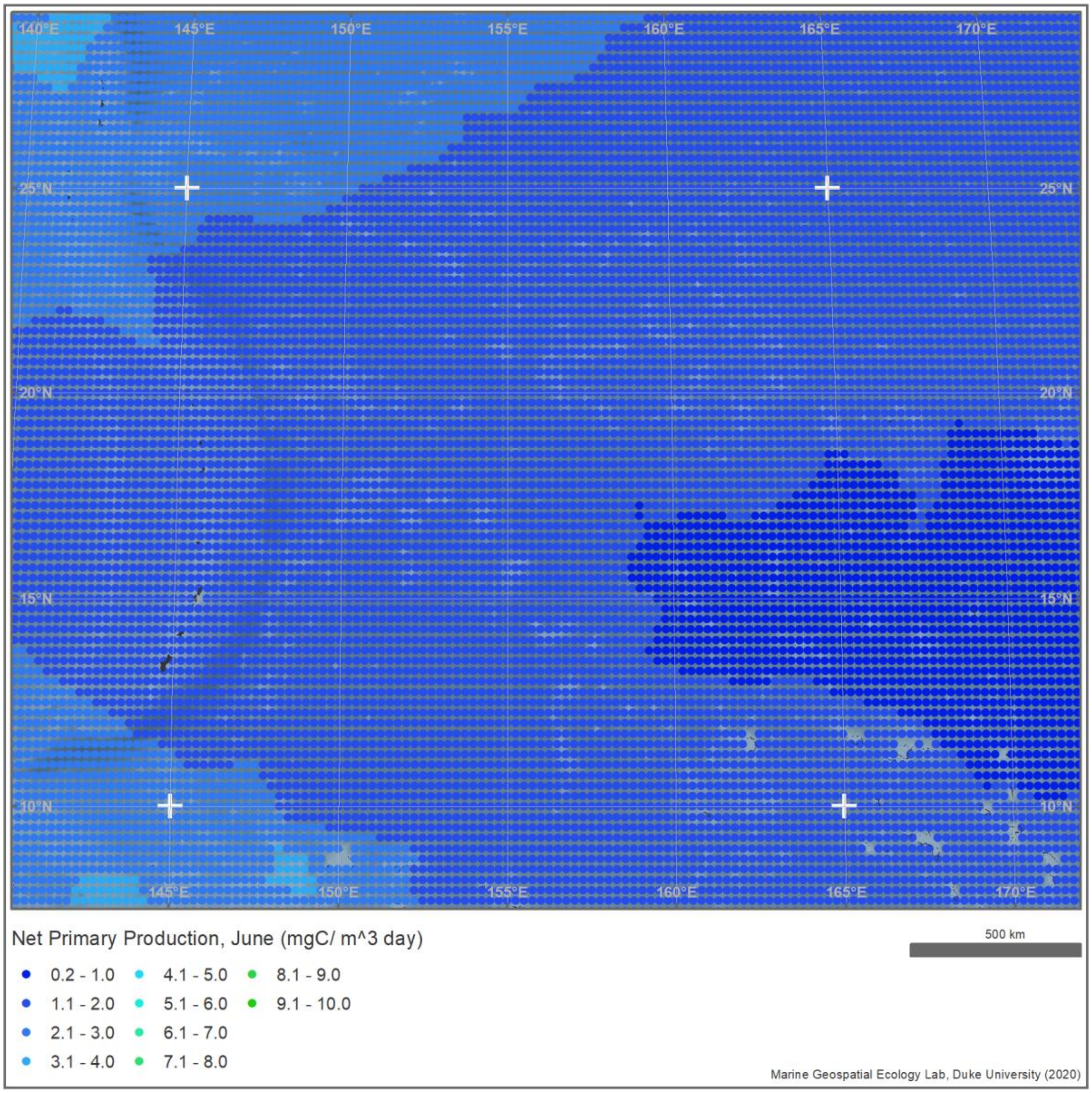


Figure 2.17-1 Vertically generalized production model - primary productivity climatology

2.18 Net Primary Productivity - Operational Mercator Ocean Biogeochemical Global Ocean Analysis and Forecast System

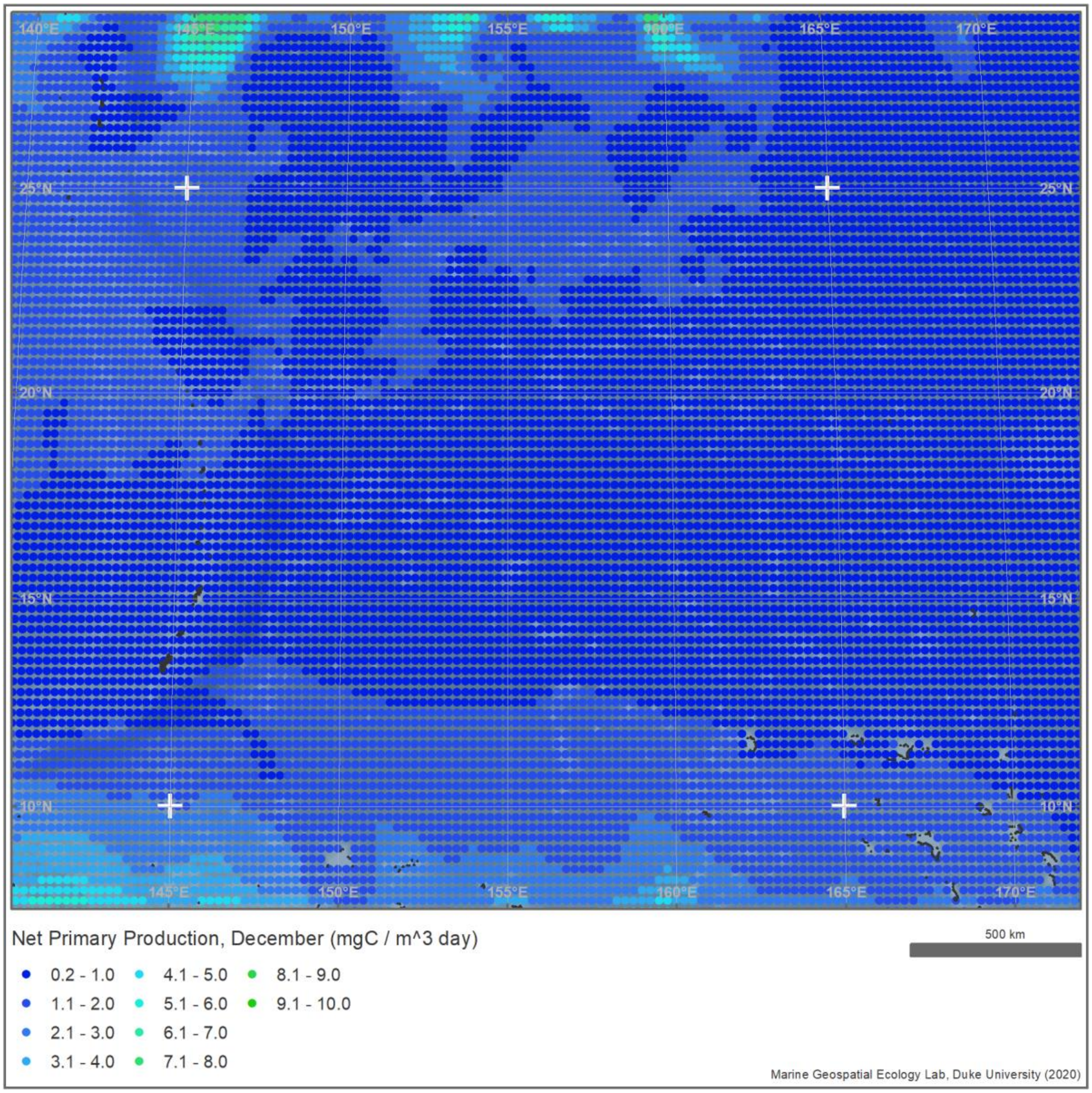
Description:
“The Operational Mercator Ocean biogeochemical global ocean analysis and forecast system at 1/4 degree is providing 10 days of 3D global ocean forecasts updated weekly. The time series is aggregated in time, in order to reach a two full year’s time series sliding window. This product includes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

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



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 2.18-1 Net primary production of biomass, June 2018



Net Primary Production, December (mgC / m^3 day)

Marine Geospatial Ecology Lab, Duke University (2020)

Figure 2.18-2 Net primary production of biomass, December 2018

2.19 Global Ocean Low and Mid Trophic Levels Biomass Hindcast

Description:
“The low and mid-trophic levels (LMTL) reanalysis for global ocean is produced at (https://www.cls.fr) (Toulouse, France). It provides 2D fields of _ass and six groups of micronekton biomass for the time period 1998-2016 at 1/4 degree and weekly time resolution. It uses the LMTL component of dynamical population model (http://www.seapodym.eu/). No data assimilation in this product.

- Latest SEAPODYM LMTL version (2.1.03) http://www.seapodym.eu/

Forcings:

- Ocean currents and ocean temperature from FREEGLORYS2V4 ocean physics produced at Mercator-Ocean
- Net Primary Production (NPP) computed from chlorophyll, Sea Surface Temperature (SST) and Photosynthetically Active Radiation (PAR) satellite observation and model
- daily SST from NOAA NCEI AVHRR-only (Reynolds (https://www.ncdc.noaa.gov/oisst)) and PAR from https://apps.ecmwf.int/datasets/data/interim-full-daily/levtype=sfc”

Source: http://marine.copernicus.eu/services-portfolio/access-to-products/?option=com_csw&view=details&product_id=GLOBAL_REANALYSIS_BIO_001_033

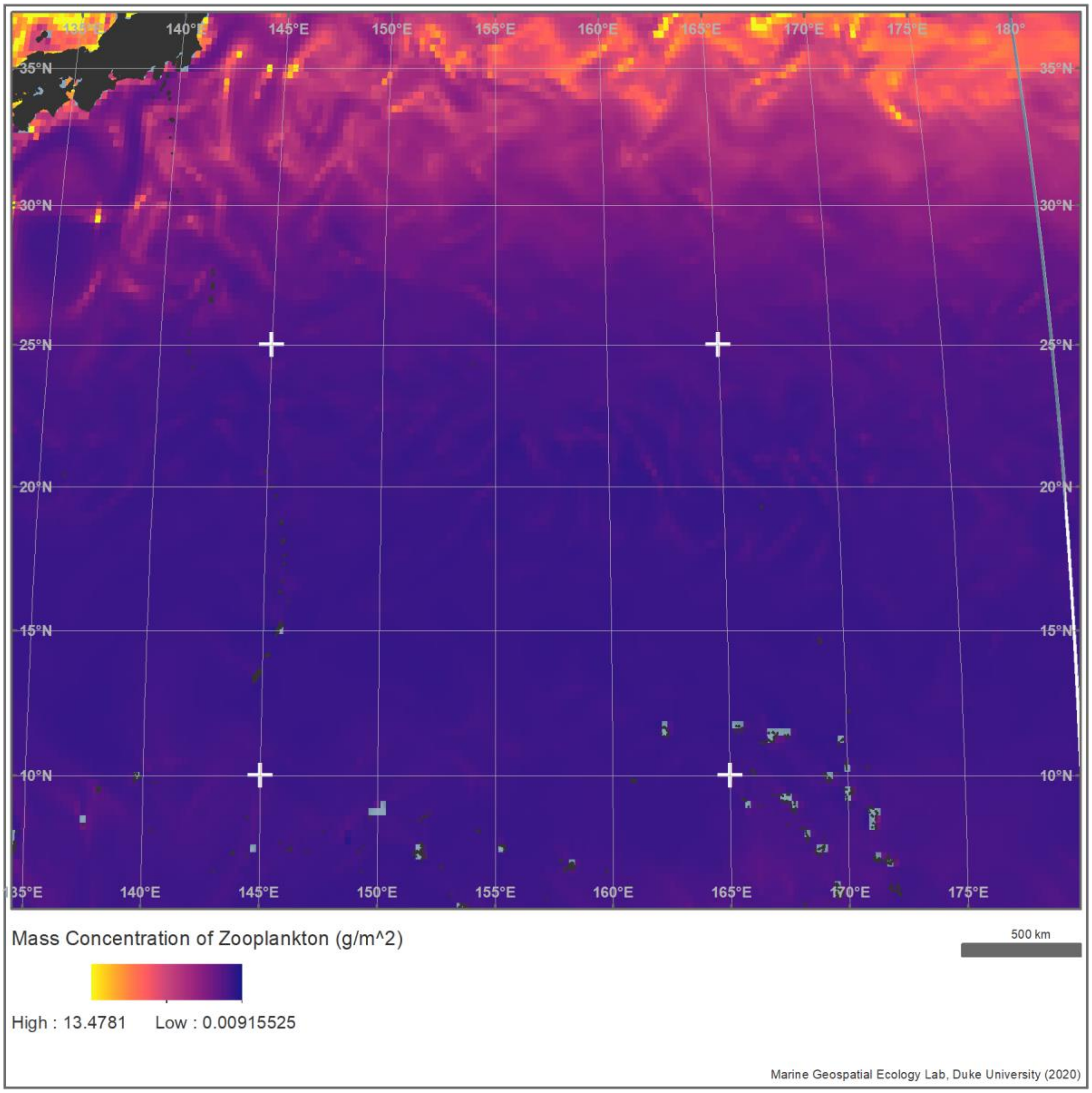


Figure 2.19-1 Zooplankton biomass, June 2018

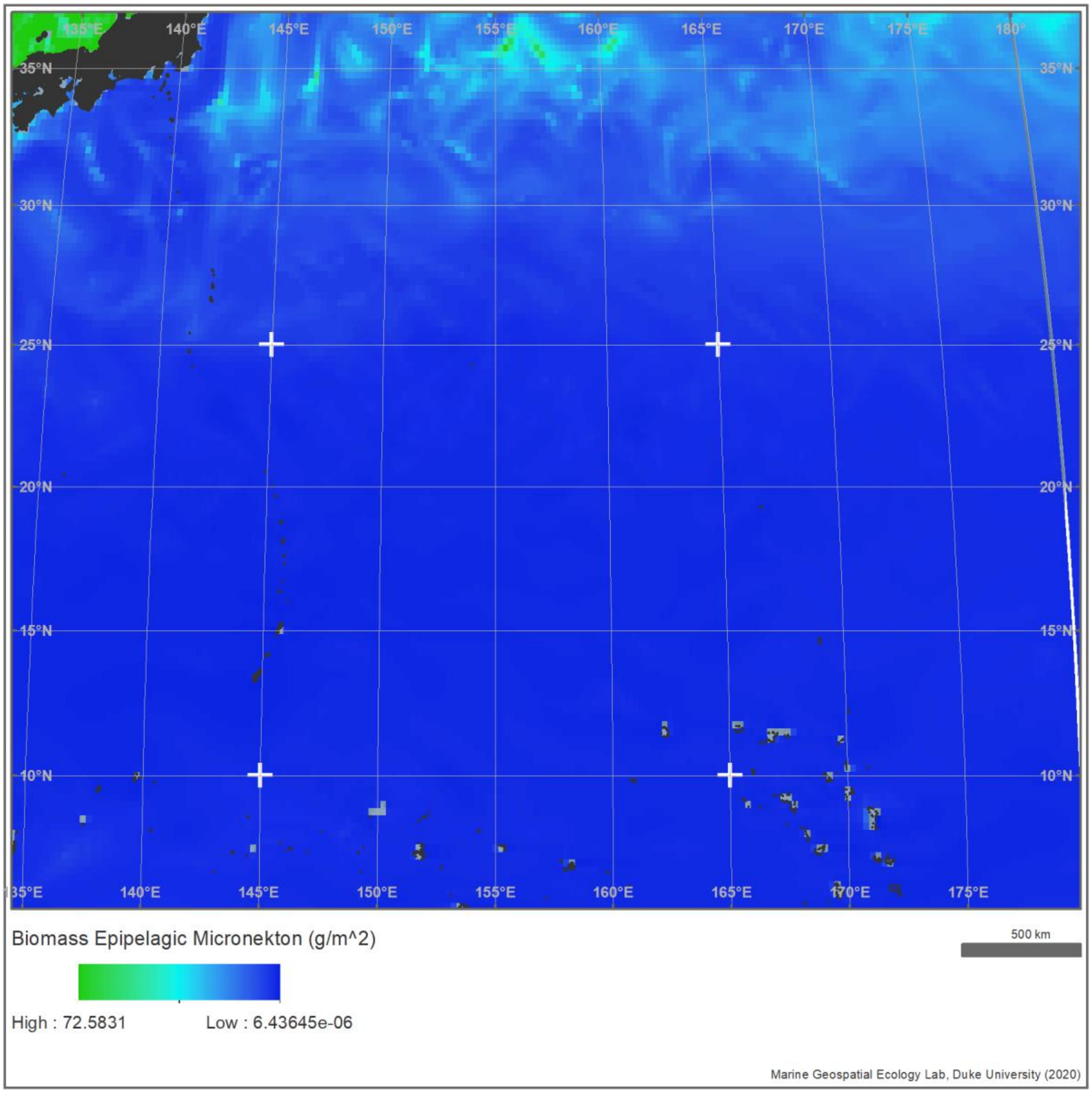


Figure 2.19-2 Epipelagic micronekton biomass, June 2018

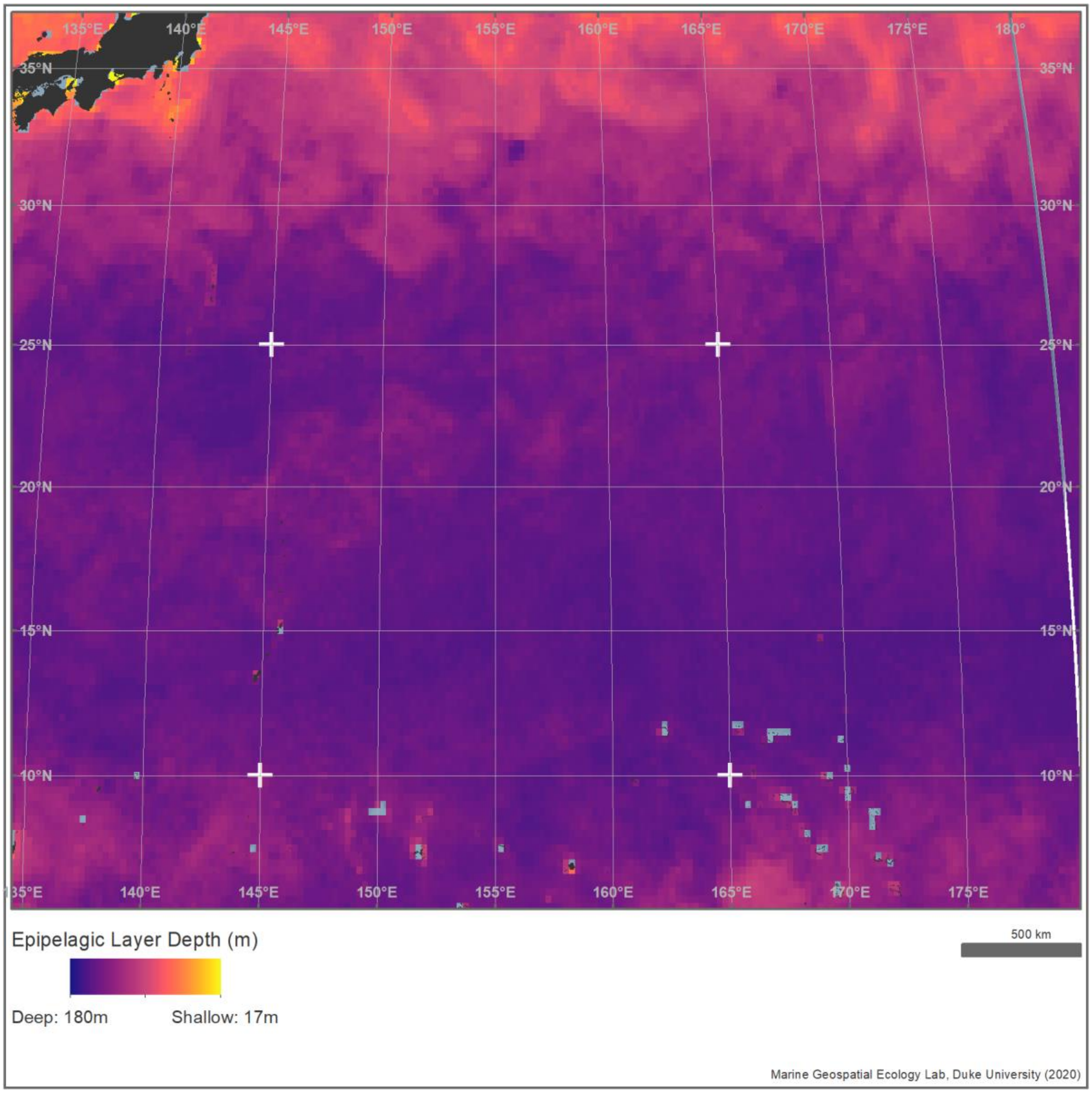


Figure 2.19-3 Epipelagic layer depth, June 2018

2.20 Seafloor Particulate Organic Carbon (POC) Flux

Abstract (Lutz et al. 2007):
"We investigate the functioning of the ocean's biological pump by analyzing the vertical transfer efficiency of particulate organic carbon (POC). Data evaluated include globally distributed time series of sediment trap POC flux, and remotely sensed estimates of net primary production (NPP) and sea surface temperature (SST). Mathematical techniques are developed to compare these temporally discordant time series using NPP and POC flux climatologies. The seasonal variation of NPP is mapped and shows regional- and basin-scale biogeographic patterns reflecting solar, climatic, and oceanographic controls. Patterns of flux are similar, with more high-frequency variability and a subtropical-subpolar pattern of maximum flux delayed by about 5 days per degree latitude increase, coherent across multiple sediment trap time series. Seasonal production-to-flux analyses indicate during intervals of bloom production, the sinking fraction of NPP is typically half that of other seasons. This globally synchronous pattern may result from seasonally varying biodegradability or multiseasonal retention of POC. The relationship between NPP variability and flux variability reverses with latitude, and may reflect dominance by the large-amplitude seasonal NPP signal at higher latitudes. We construct algorithms describing labile and refractory flux components as a function of remotely sensed NPP rates, NPP variability, and SST, which predict POC flux with accuracies greater than equations typically employed by global climate models. Globally mapped predictions of POC export, flux to depth, and sedimentation are supplied. Results indicate improved ocean carbon cycle forecasts may be obtained by combining satellite-based observations and more mechanistic representations taking into account factors such as mineral ballasting and ecosystem structure."

Reference:

Lutz, M. J., Caldeira, K., Dunbar, R. B., & Behrenfeld, M. J. (2007). Seasonal rhythms of net primary production and particulate organic carbon flux to depth describe the efficiency of biological pump in the global ocean. Journal of Geophysical Research: Oceans, 112(C10). doi:10.1029/2006JC003706.

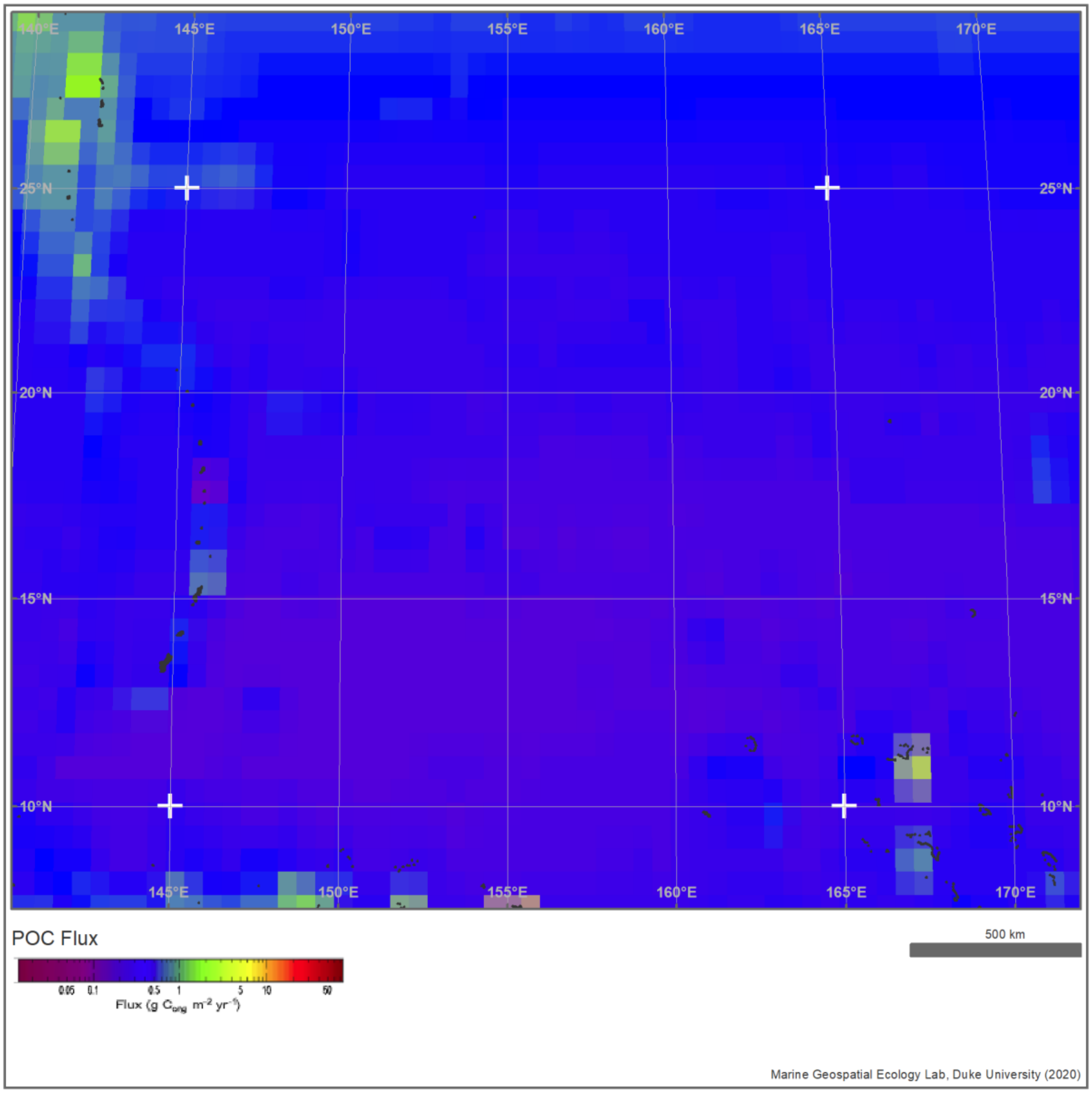


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Figure 2.20-1 Particulate organic carbon flux to the seafloor

Original Caption: Figure 14, “Annual average particulate organic carbon (d) flux to the seafloor (g Corg m−2 yr−1)”

2.21 NOAA Climate Change Portal

“A key approach for examining climate, especially how it will change in the future, uses complex computer models of the climate system that includes atmosphere, ocean, sea ice and land components. Some models also include additional aspects of the earth system, including chemistry and biology. The Climate Change Portal is a web interface developed by the NOAA ESRL Physical Sciences Division to access and display the immense volumes of climate and earth system model output that informed the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). The webtool makes climate change information more accessible to natural resource managers, decision makers and educators.”

Link: https://www.esrl.noaa.gov/psd/ipcc/ocn/

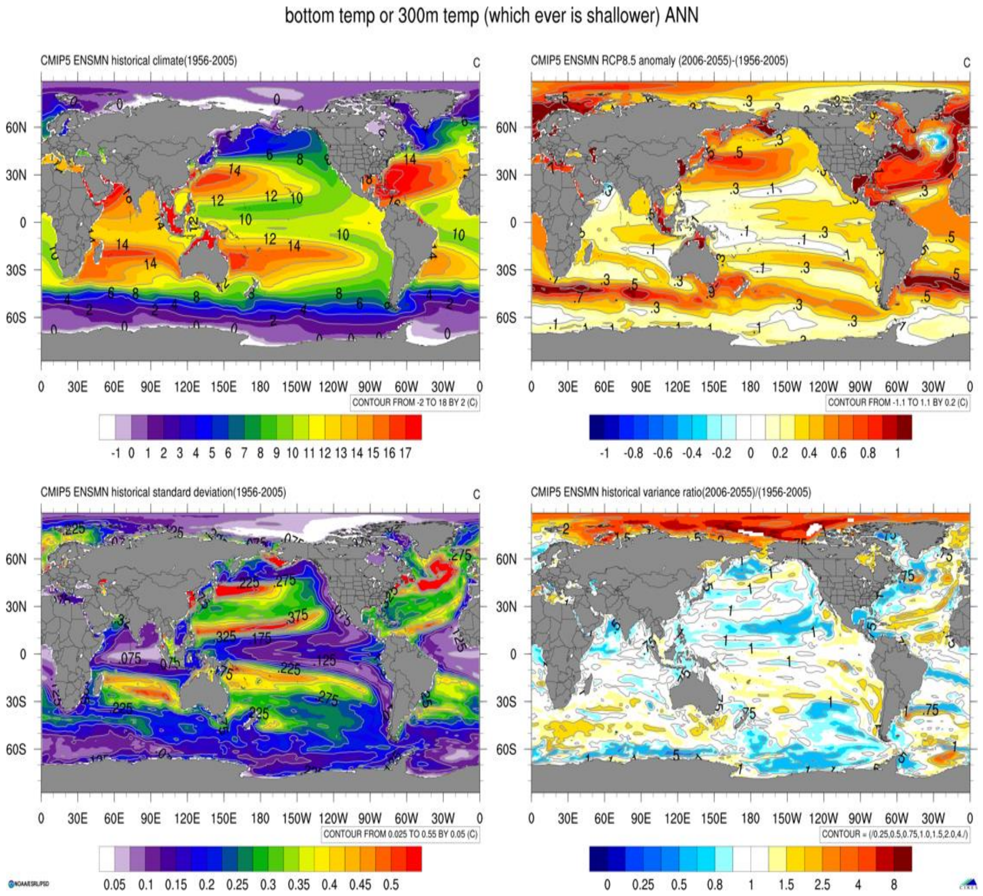


Figure 2.21-1 Climate change variables from CMIP5 data

2.22 Dynamic Seascape Pelagic Habitat Classification

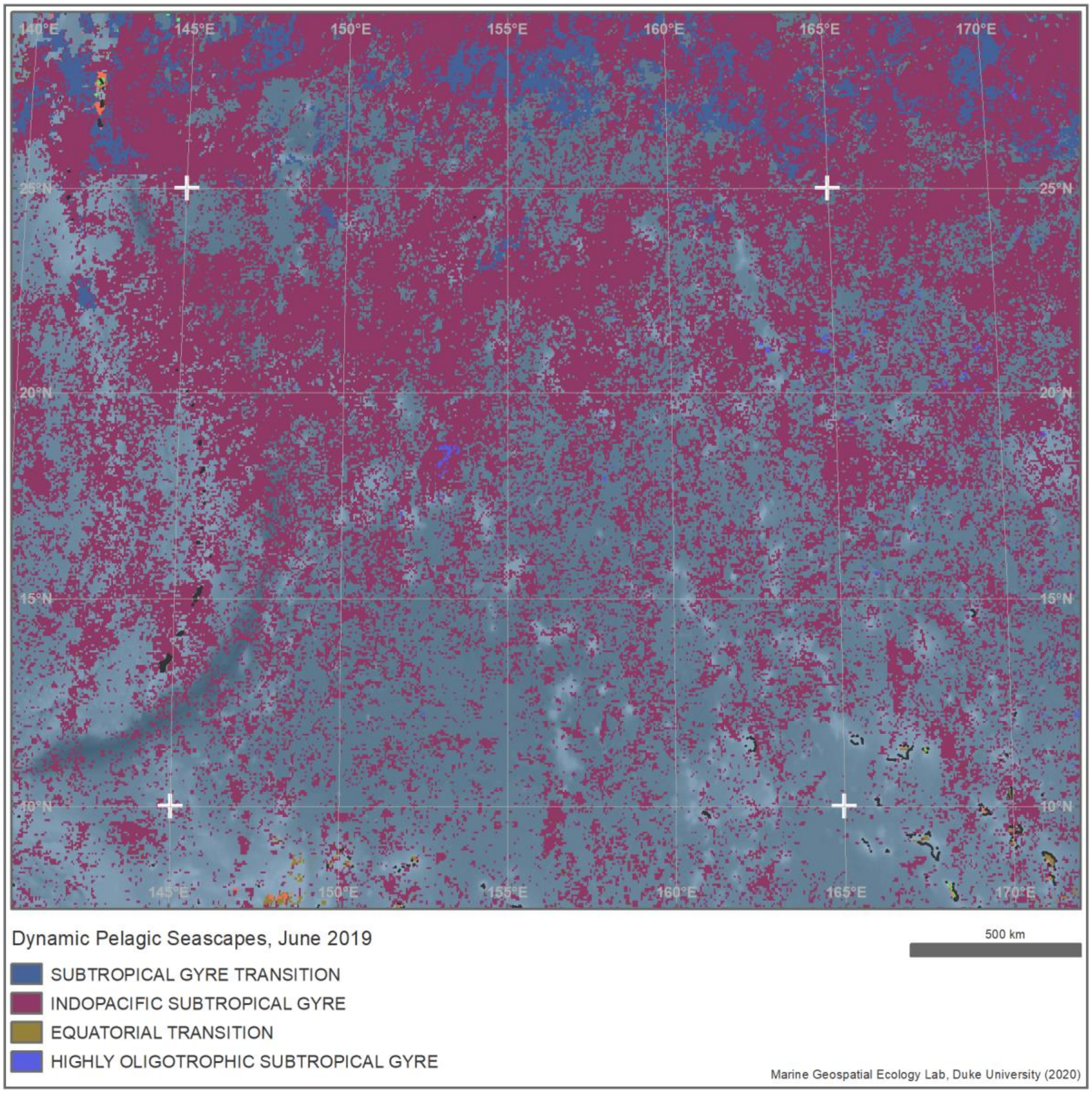
"The CoastWatch Seascape Pelagic Habitat Classification product (CW Seascapes) identifies spatially explicit water masses with particular biogeochemical features using a model and satellite-derived measurements. The seascape product is generated as monthly and 8-day composites at 5 km spatial resolution.

US and global Marine Biodiversity Observation Network (MBON) partnered with US Integrated Ocean Observation System (IOOS), NOAA/OAR/AOML and NOAA/NESDIS/STAR to develop and routinely generate "seascapes" products and to make them available on CoastWatch. Derived from dynamic fields of satellite and modelled data, seascapes are classified and used as a biogeographical framework to describe dynamic, changing ocean habitats for MBON and other applications. CW Seascapes provide information about the quality and extent of different oceanographic habitats or features and can be used to assess and predict the different planktonic and fisheries communities that reside within seascapes. Current CW Seascapes products include monthly and 8-day time steps at 5 km resolution. High resolution (1 km) case studies are planned on a case by case basis as through cooperation with US and global MBON partners."

Data are available at 8-day and monthly timesteps back to January 2003:
https://coastwatch.noaa.gov/cw/satellite-data-products/multi-parameter-models/seascape-pelagic-habitat-classification.html

Reference:
Kavanaugh, Maria T., Matthew J. Oliver, Francisco P. Chavez, Ricardo M. Letelier, Frank E. Muller-Karger, and Scott C. Doney. 2016. "Seascapes as a New Vernacular for Pelagic Ocean Monitoring, Management and Conservation." *ICES Journal of Marine Science* 73 (7): 1839–50. https://doi.org/10.1093/icesjms/fsw086.

Region - Seascape Class ID and Name:
3, TROPICAL SUBTROPICAL TRANSITION
5, SUBTROPICAL GYRE TRANSITION
8, INDOPACIFIC SUBTROPICAL GYRE
9, EQUATORIAL TRANSITION
10, HIGHLY OLIGOTROPHIC SUBTROPICAL GYRE
11, TROPICAL/SUBTROPICAL UPWELLING
13, SUBTROPICAL GYRE MESOSCALE INFLUENCED
15, TROPICAL SEAS
17, SUBTROPICAL TRANSITION LOW NUTRIENT STRESS
20, SUBTROPICAL, FRESH INFLUENCED COASTAL
21, WARM, BLOOMS, HIGH NUTS



Dynamic Pelagic Seascapes, June 2019

Marine Geospatial Ecology Lab, Duke University (2020)

Figure 2.22-1 Dynamic pelagic seascapes – June 2019

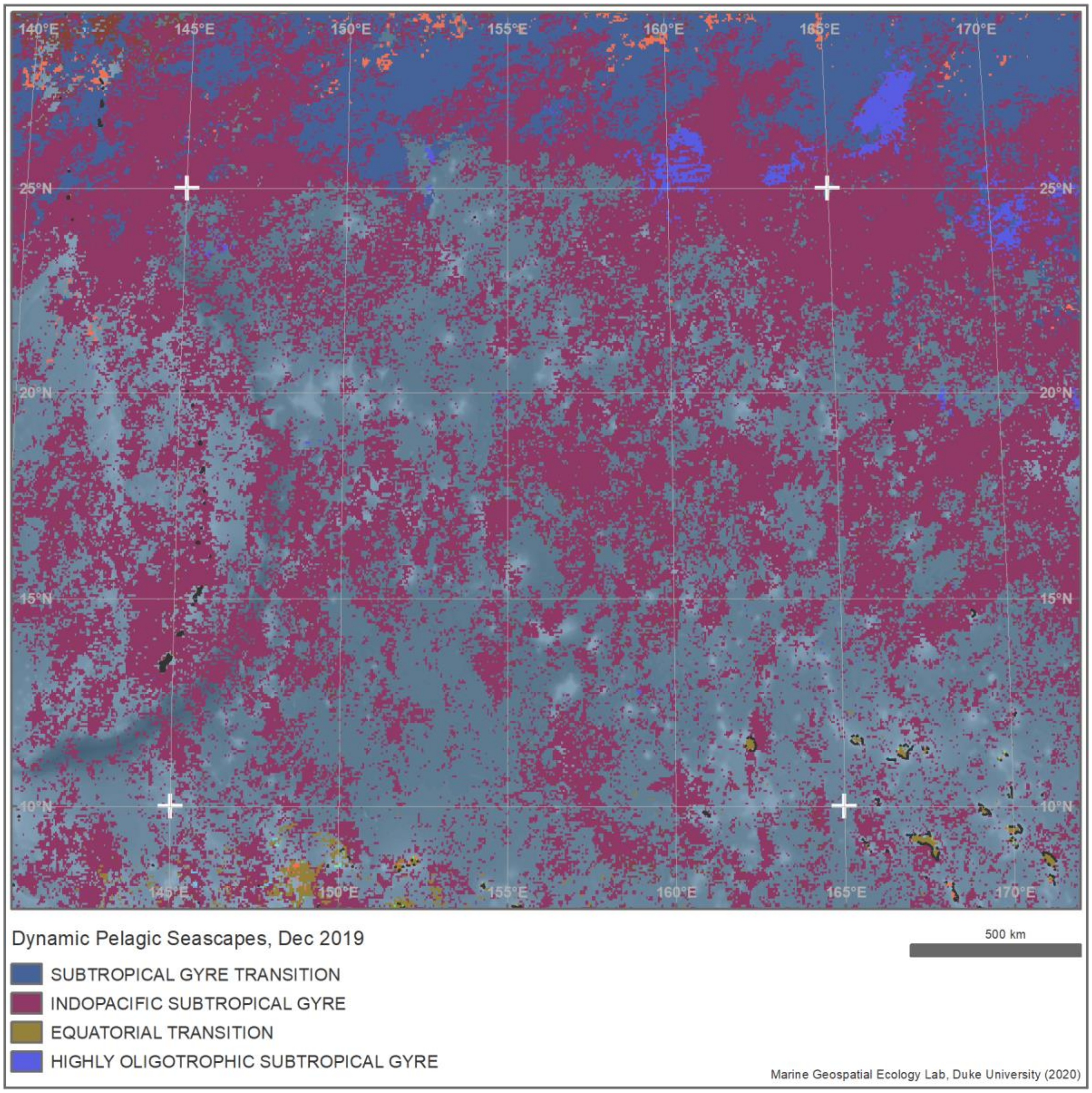


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Figure 2.22-2 Dynamic pelagic seascapes – December 2019

2.23 Ecological Marine Units

Abstract:

"In response to an intergovernmental commission for a high resolution and data-derived global marine ecosystems map, distinct marine physical and chemical volumetric regions were characterized in an environmental stratification of the global ocean. The stratification produced 37 ecological marine units (EMUs) at a base resolution of ¼° (approximately 27 kilometers at the equator). The EMUs were objectively derived from non-supervised statistical clustering of over 52 million points from NOAA's World Ocean Atlas 2013 (WOA) database, an authoritative 57-year archive of global water column data. We organized the WOA data into a 3D ocean point mesh which represents a standardized geospatial framework for organizing physical, chemical, and biological data that characterize ocean composition and processes. The points are currently attributed with values for temperature, salinity, dissolved oxygen, nitrate, phosphate, and silicate, the six input values used in the stratification. The data represent the most accurate, current, globally comprehensive, and finest spatial resolution data available for each of the six inputs organized in a standardized geospatial framework for improved understanding of ocean environments. While the methodology and initial findings are reported elsewhere, we provide herein a more detailed description of the open data geospatial resources and associated tool development. We present the EMU Explorer as a web-based query application that allows for the exploration of both the modeled EMUs as volumetric regions, and the comprehensive point data from the WOA."

Reference:

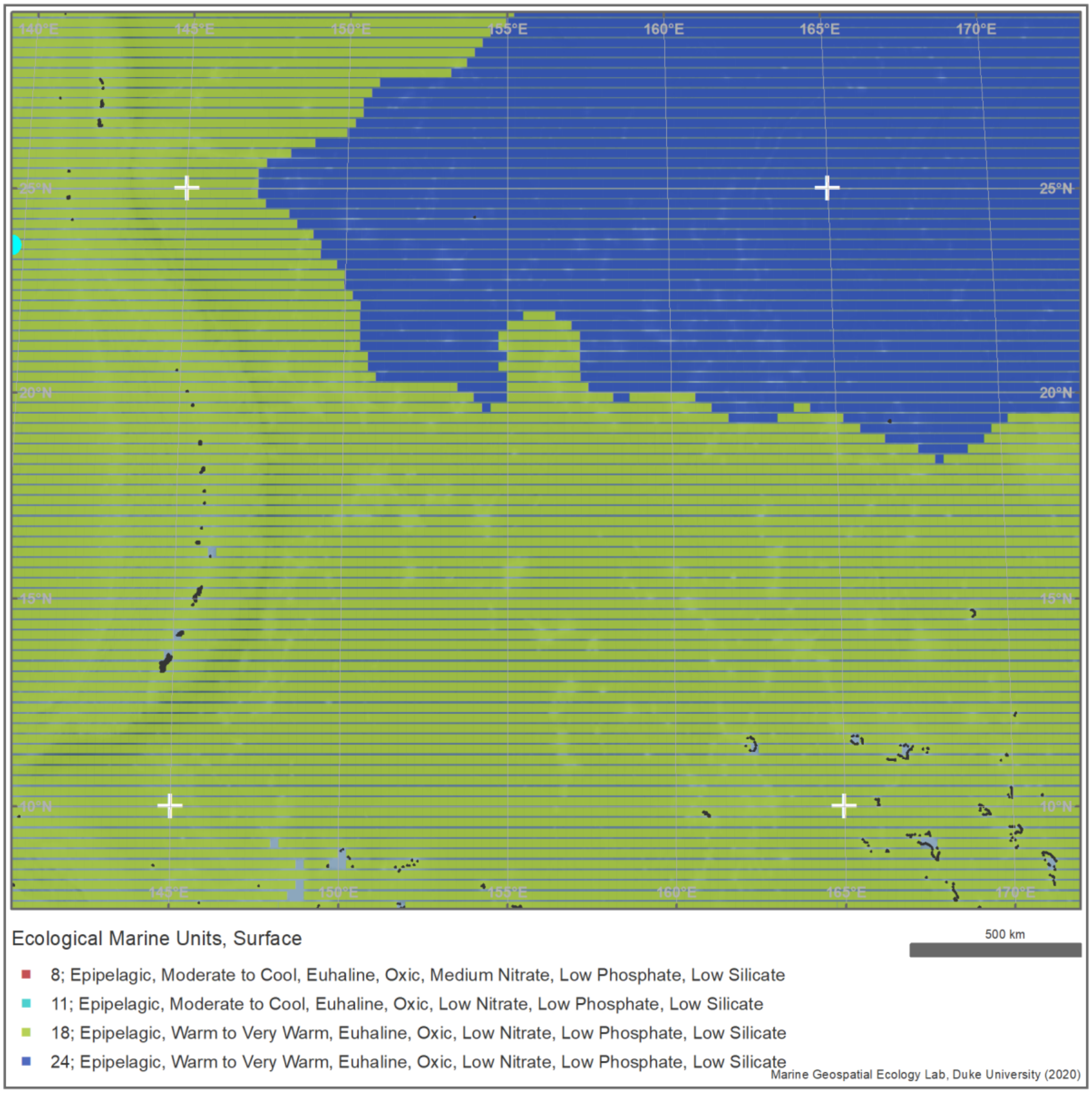
Sayre R, Dangermond J, Wright D, Breyer S, Butler K, Graafeiland K, Costello M, Harris P, Goodin K, Kavanaugh M, Cressie N, Guinotte J, Basher Z, Halpin P, Monaco M, Aniello P, Frye C, Stephens D, Valentine P, Convis C (2017) A New Map of Global Ecological Marine Units – An Environmental Stratification Approach. American Association of Geographers AAG Special Publication:36 p.

Data Access:

Ecological Marine Units V1, Atlantic Ocean
https://esri.maps.arcgis.com/home/item.html?id=8d3465c047324eb290b0acb79be72dd2

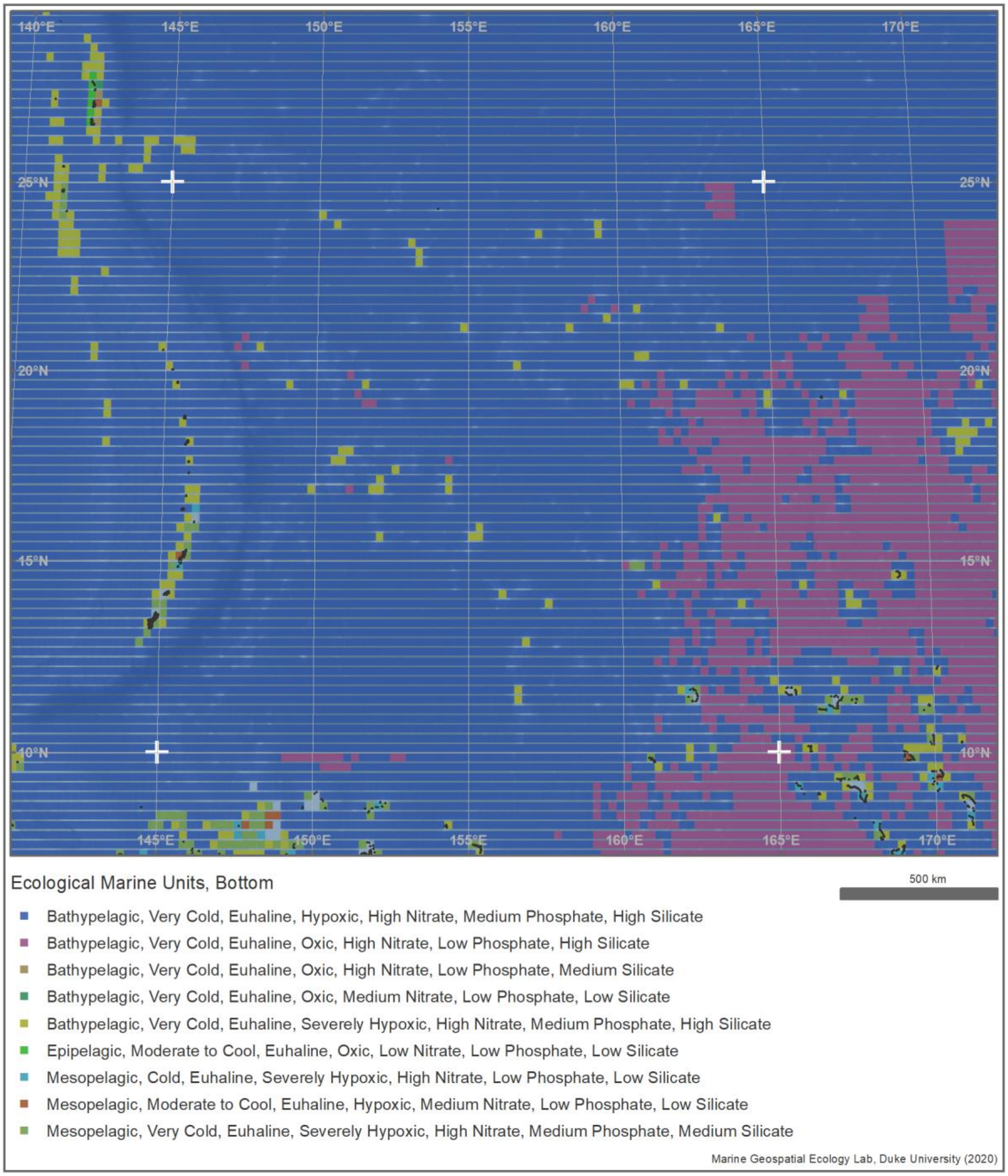
3D Mapper:

http://livingatlas.arcgis.com/emu



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 2.23-1 Ecological marine units - surface



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 2.23-2 Ecological marine units - bottom

3 Biological Data

3.1 Ocean Biogeographic Information System (OBIS) Data Summaries

“The Ocean Biodiversity 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.”

The data provided here are summaries of available OBIS data. Observation counts, Species Richness, Hurlbert’s Index (ES[50]), and Shannon Diversity data summaries for hexagons are provided for all species. Observation locations are provided for VME taxa. Data gaps do exist in OBIS and thus these summaries are not exhaustive.

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

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

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

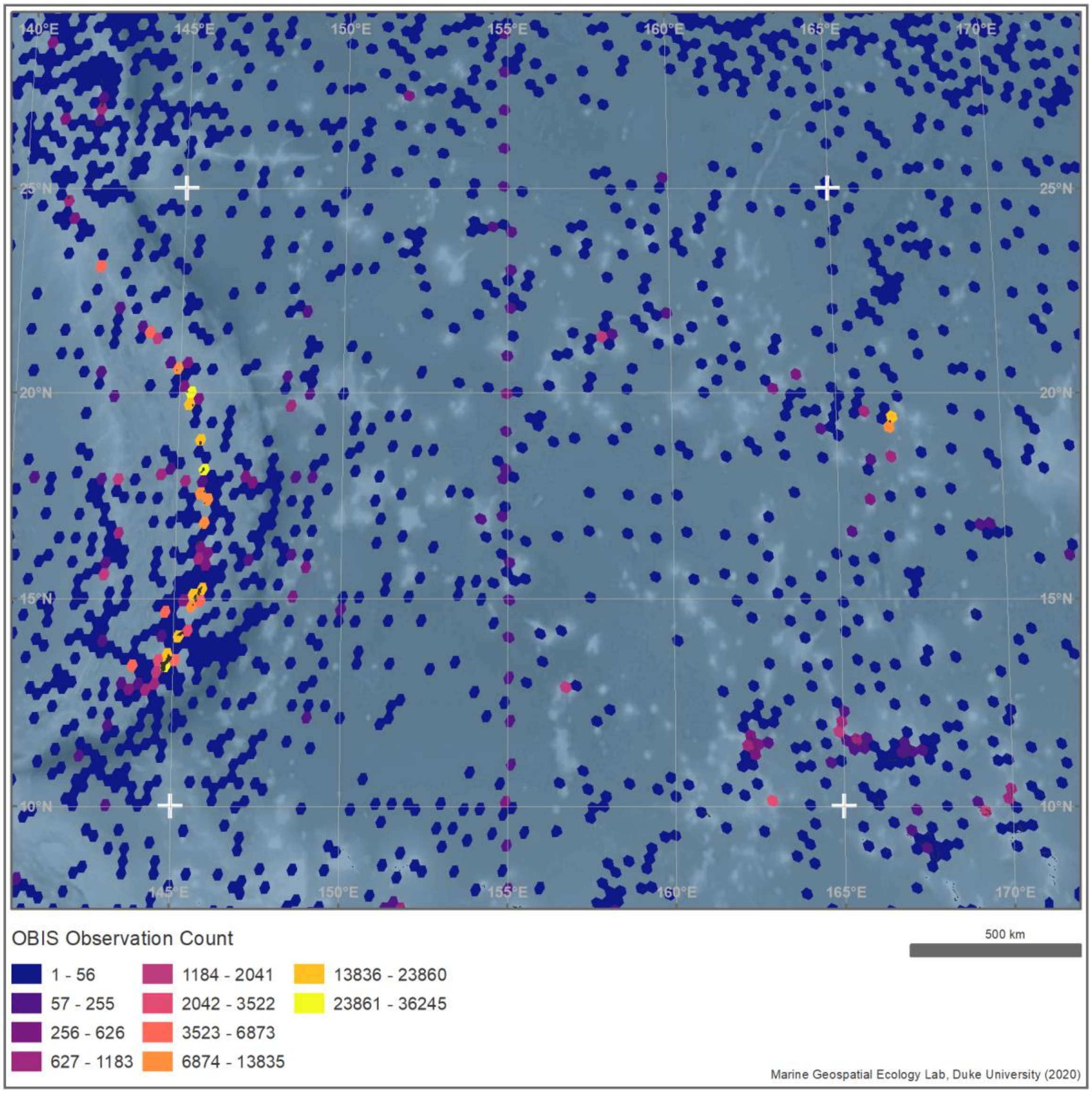


Figure 3.1-1 Observation count – all taxa

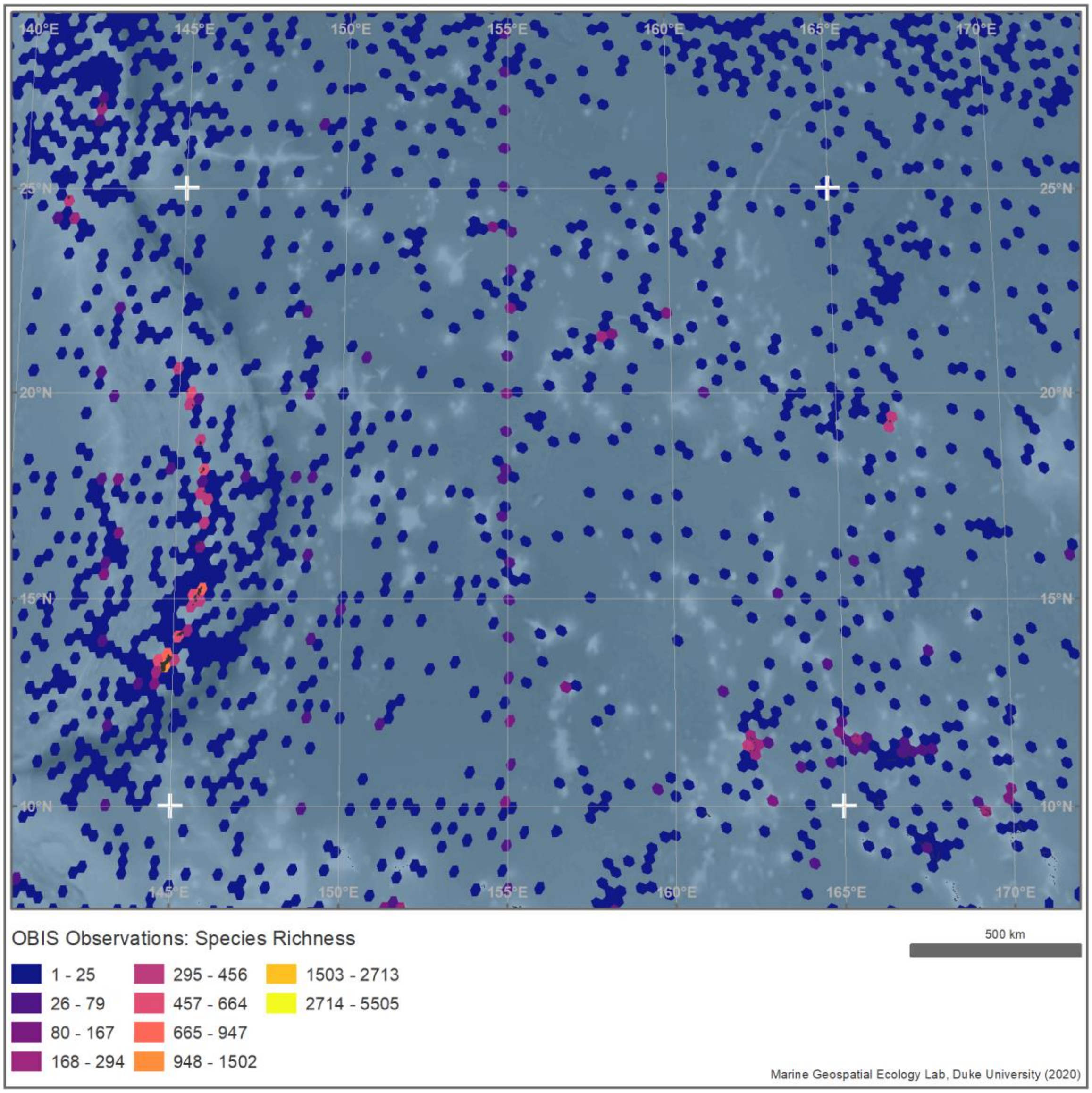
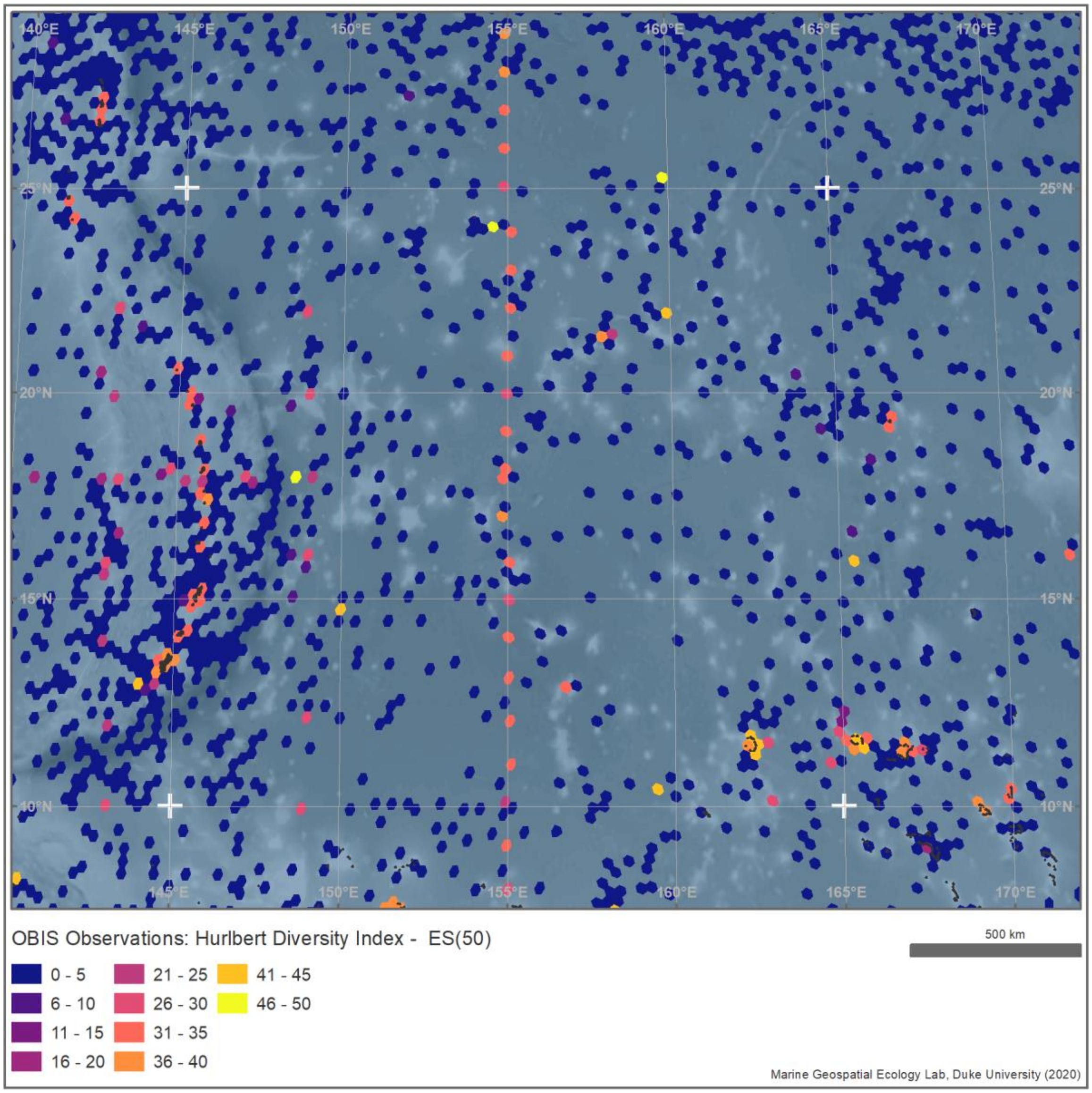


Figure 3.1-2 Species richness for all taxa



Marine Geospatial Ecology Lab, Duke University (2020)

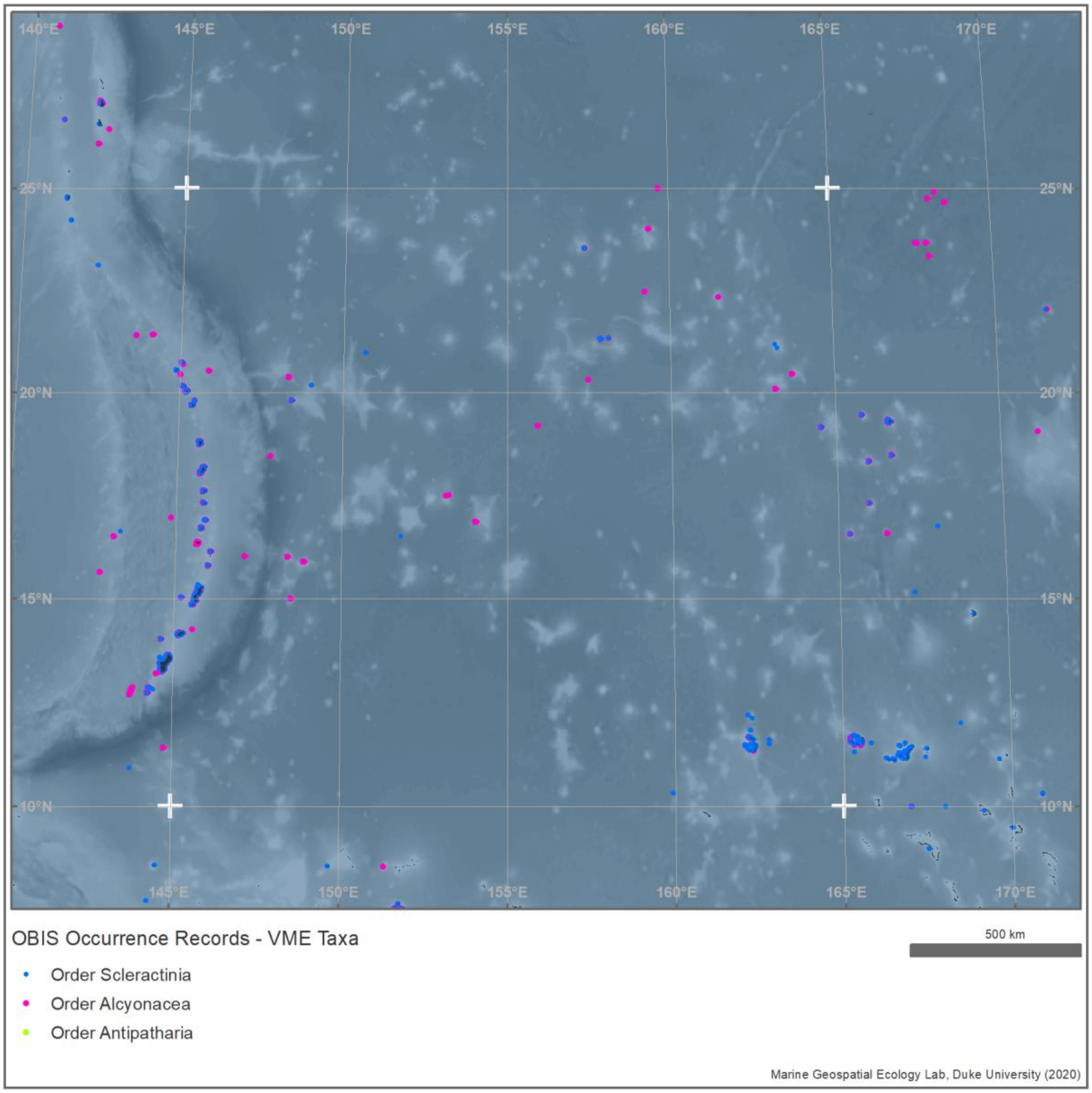
Figure 3.1-3 Hurlbert diversity index for all taxa, es(50)

3.2 OBIS Vulnerable Marine Ecosystems (VMEs) Indicator Taxa

The Food and Agriculture Organization (FAO) of the United Nations International Guidelines for the Management of Deep-sea Fisheries in the High Seas (FAO, 2009) provide general tools and considerations for the identification of vulnerable marine ecosystems (VMEs). They include a set of criteria that should be used, individually or in combination, for the identification process. Specifically: Uniqueness or rareness, Functional significance of the habitat, Fragility, Life-history of species make recovery difficult, and Structural complexity.

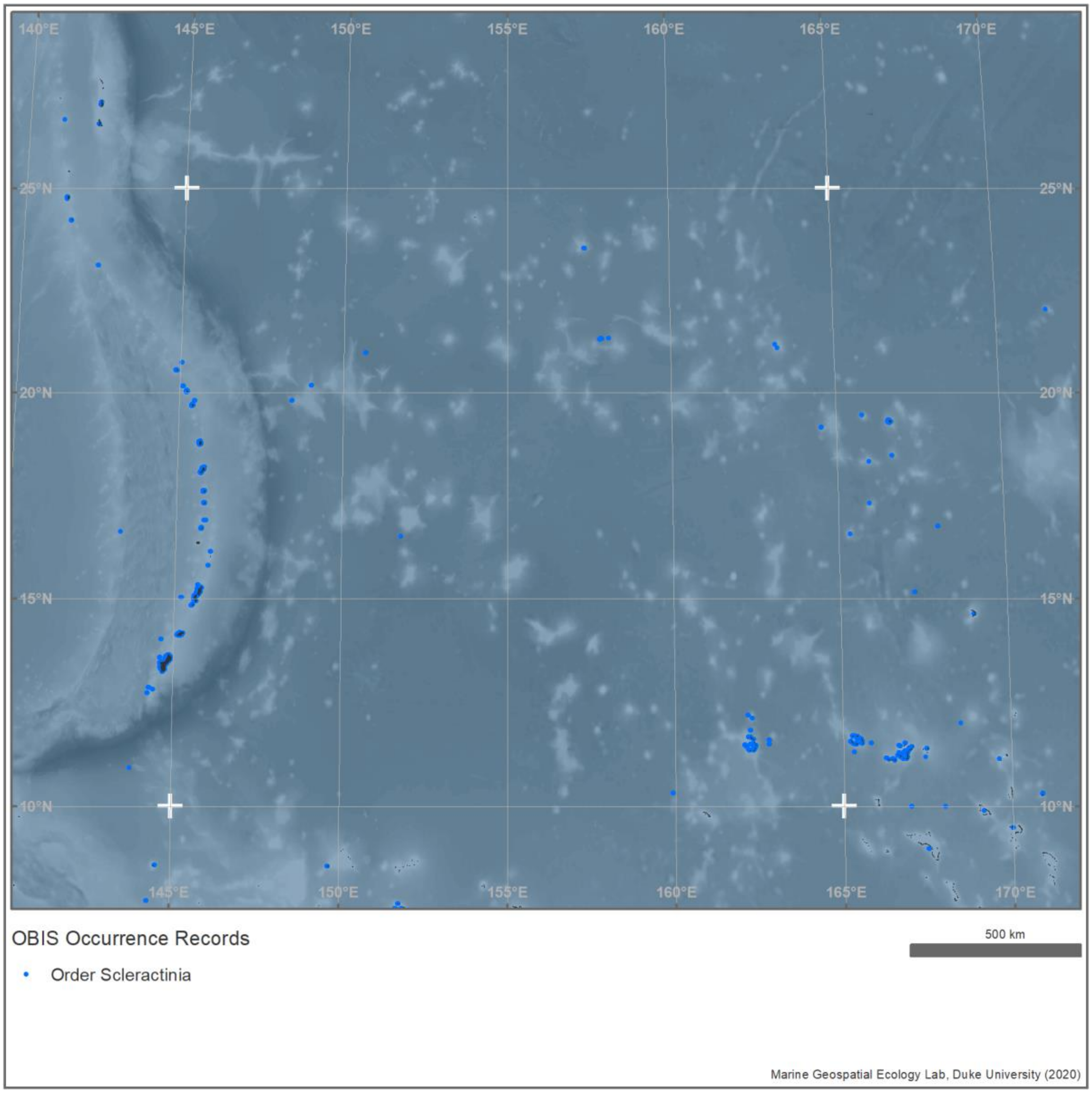
VME Indicator taxa from the North Pacific Fisheries Commission (NPFC) are:

Scientific name	Taxonomical level
Scleractinia	Order
Antipatharia	Order
Alcyonacea	Order



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.2-1 OBIS records for VME taxa



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.2-2 OBIS records of *Scleractinia*

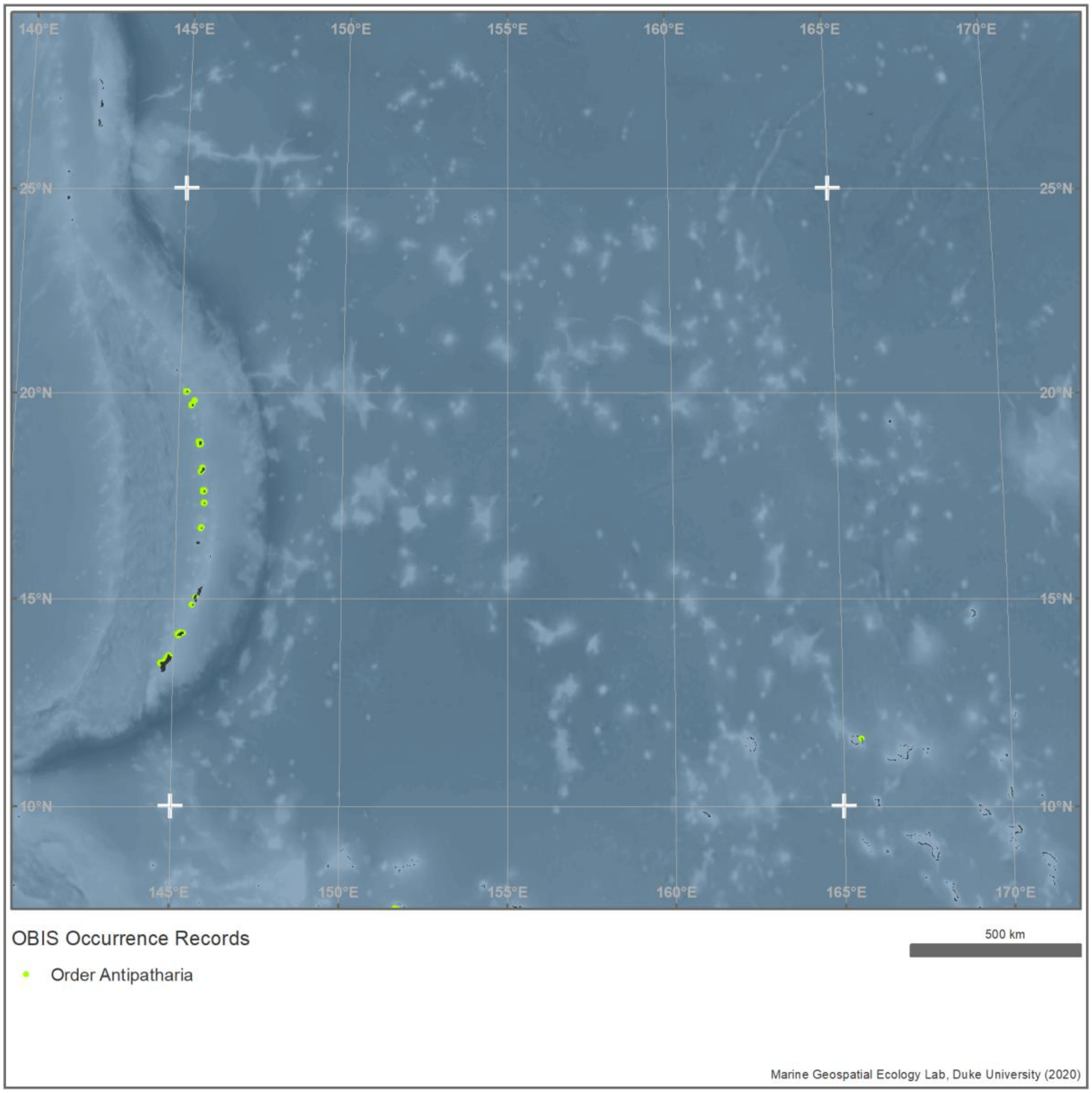
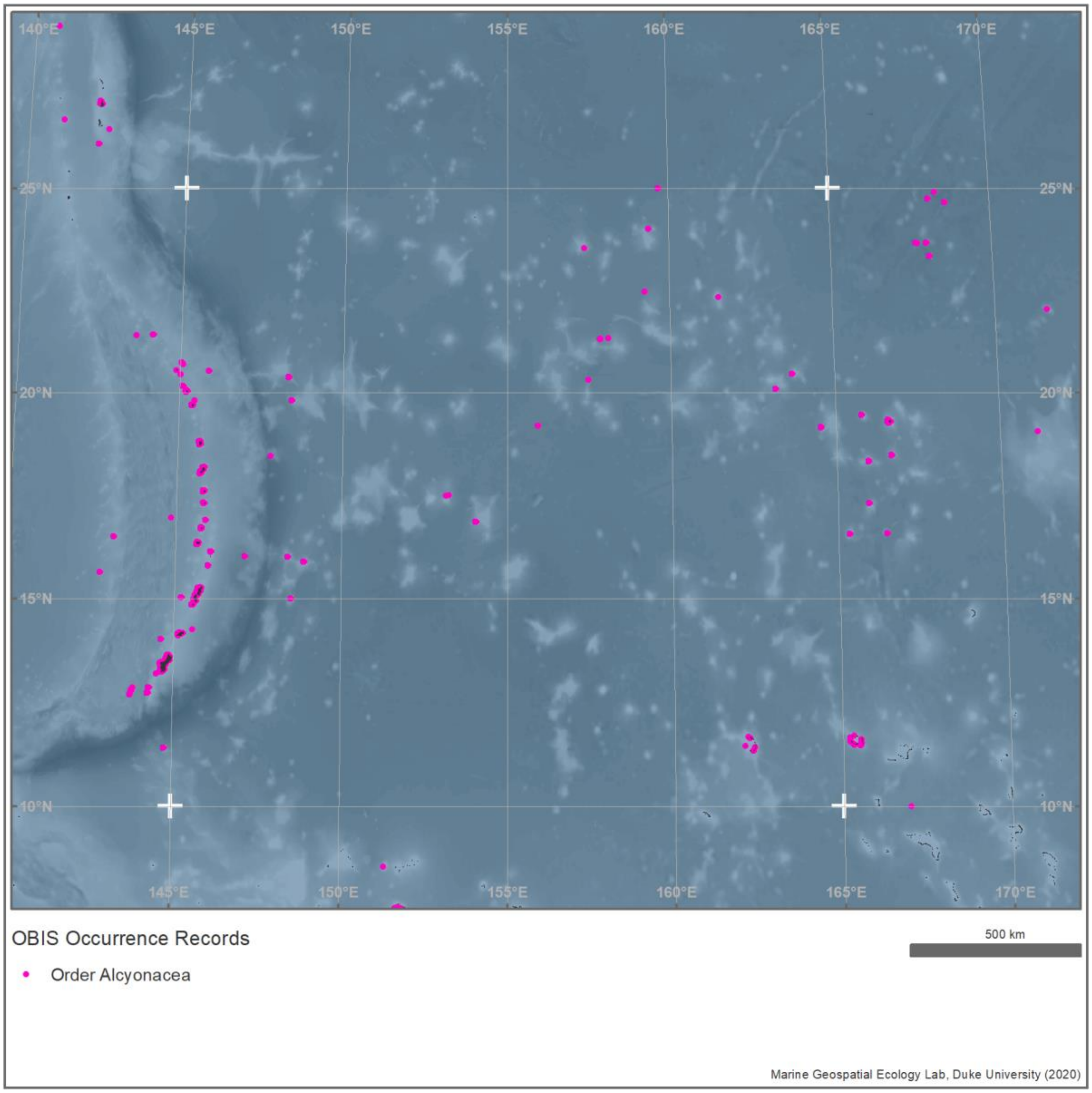


Figure 3.2-3 OBIS records of *Antipatharia*



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.2-4 OBIS records of *Alcyonacea*

3.3 International Seabed Authority *DeepData* Portal

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

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

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

DeepData Portal: https://data.isa.org.jm/isa/map/

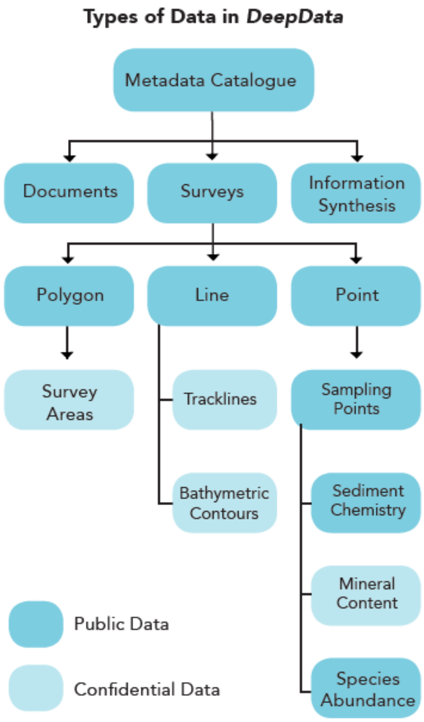


Figure 3.3-1 Chart of data types in *DeepData*

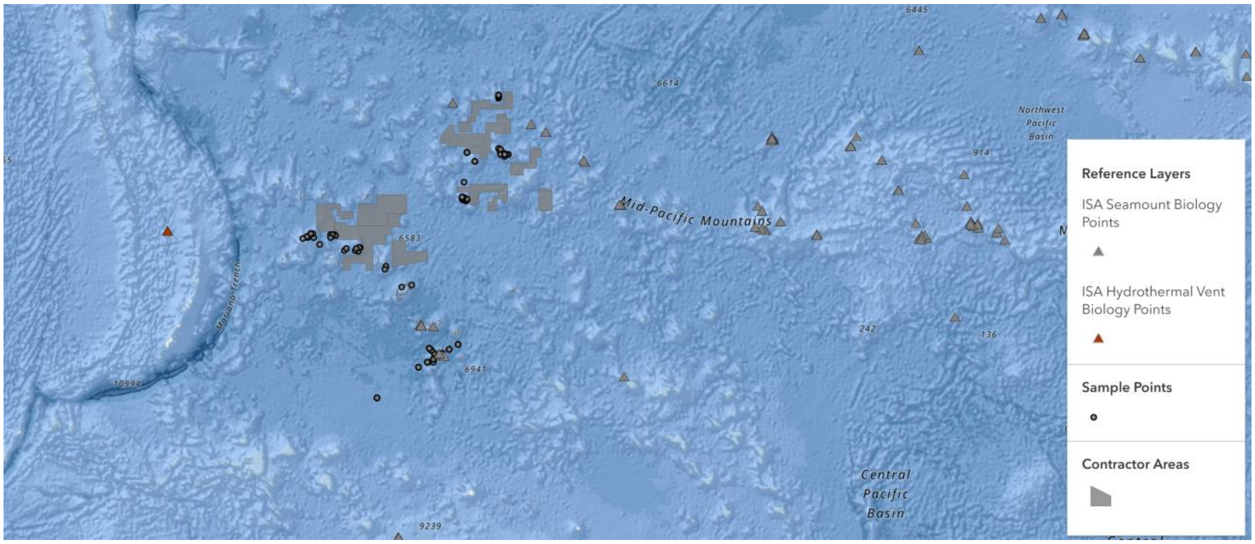


Figure 3.3-2 ISA *DeepData* portal sampling points

3.4 Species Richness from Aquamaps Models

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

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

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

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

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

Species Richness maps are available for 27 taxonomic groups (class or order level) via the AquaMaps website. For a full list see https://www.aquamaps.org/MultiSpeciesMapsList.php?what=orig

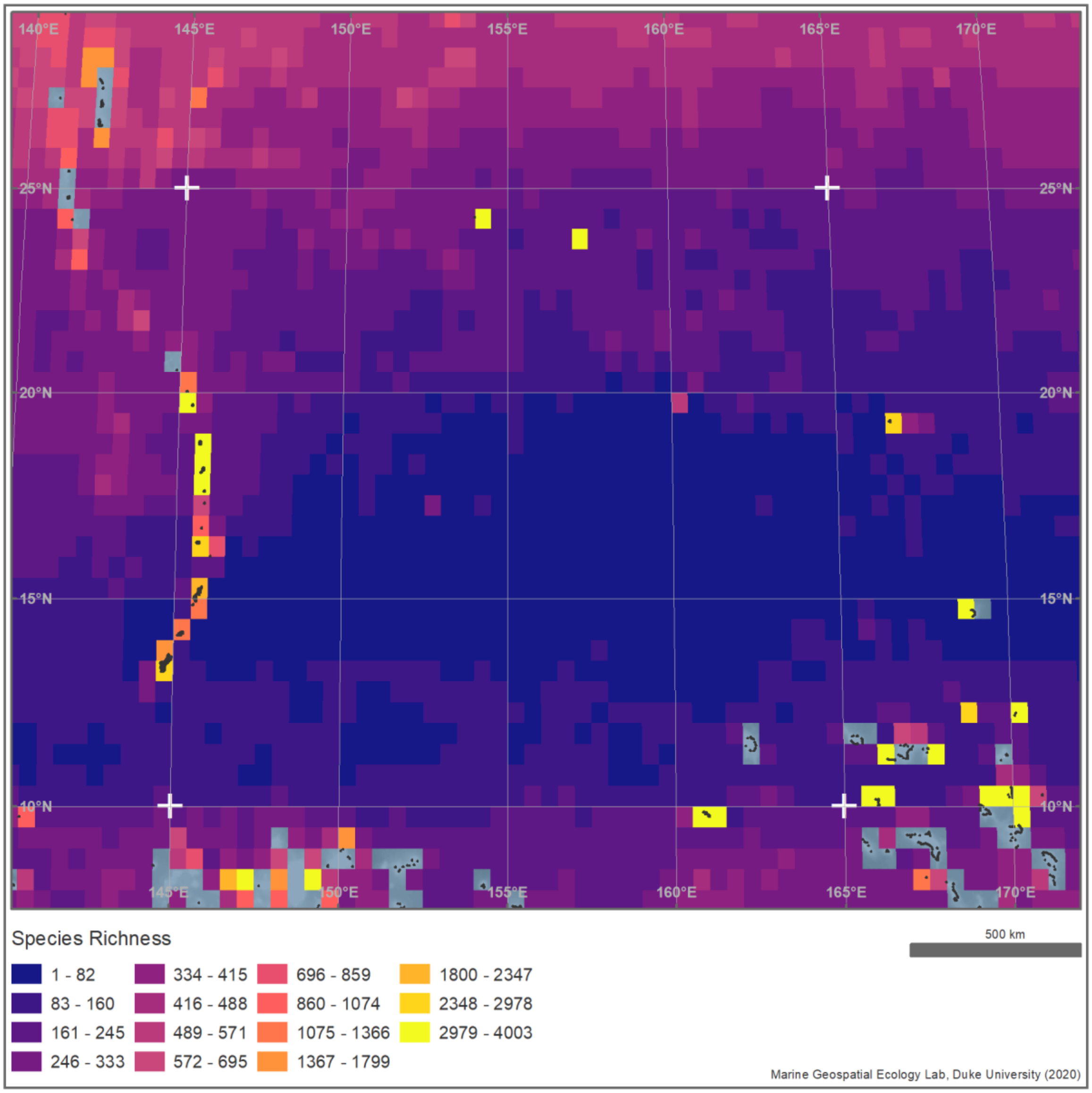


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Figure 3.4-1 AquaMaps species richness for all modeled species

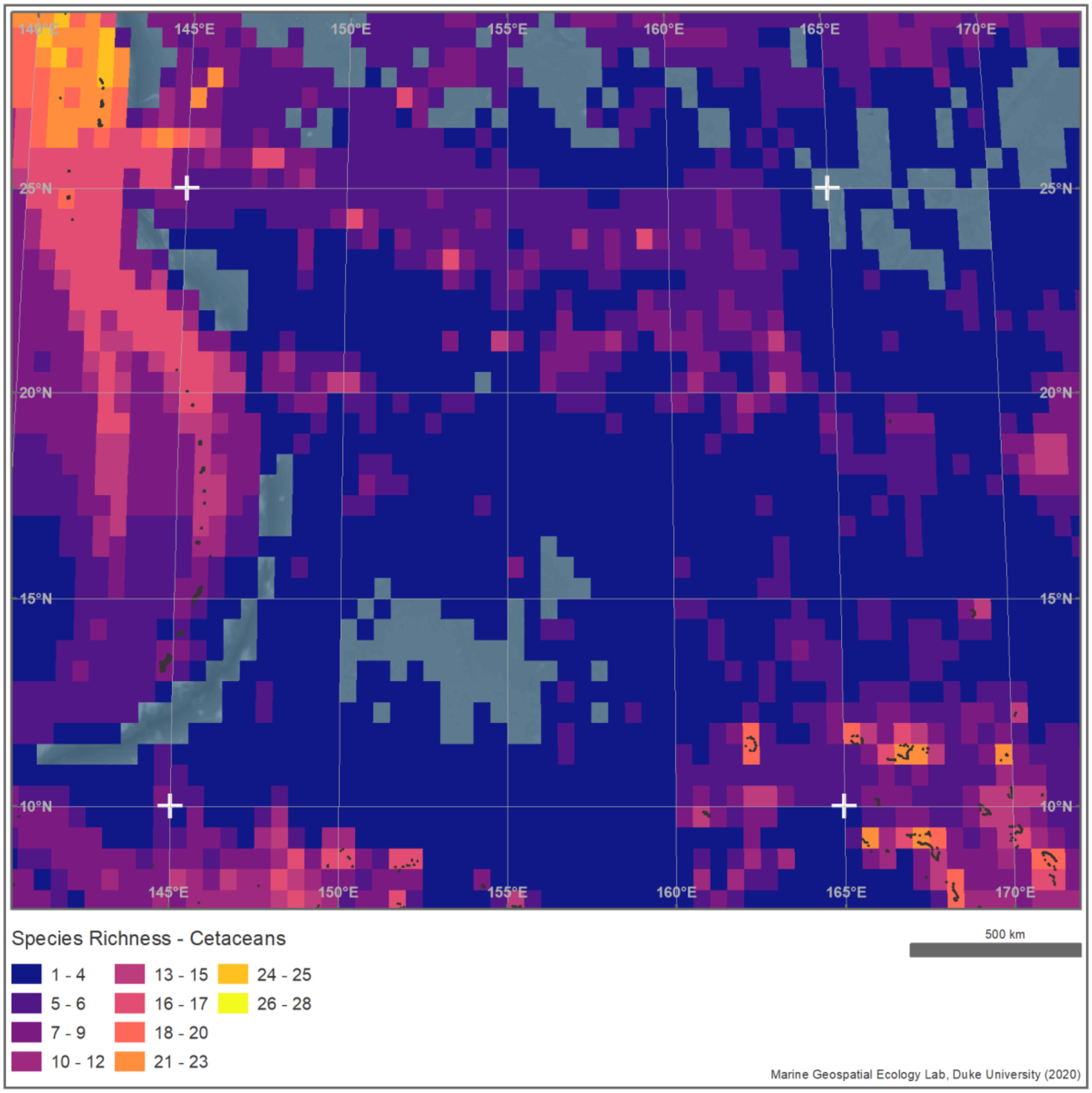

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Figure 3.4-2 AquaMaps species richness for Cetaceans

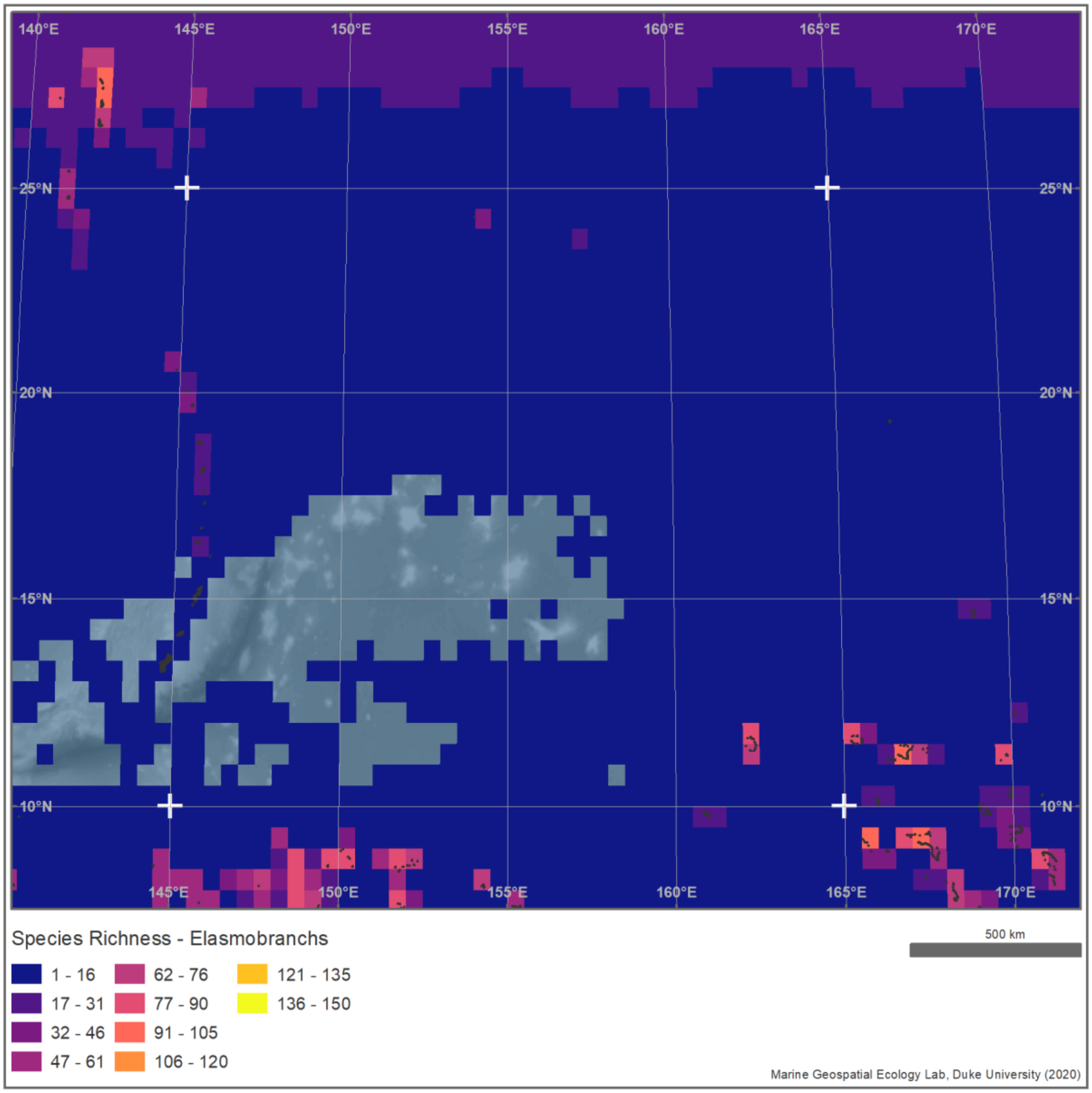

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Figure 3.4-3 AquaMaps species richness for Elasmobranchs

3.5 Cetacean data aggregated by OBIS-SEAMAP

OBIS-SEAMAP (http://seamap.env.duke.edu/), Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, is a spatially referenced online database, aggregating marine mammal, seabird and sea turtle observation data from across the globe. Data from several turtle tracking efforts were extracted from OBIS-SEAMAP data center for the study area and displayed on a per species basis.

Reference:

Halpin P, Read A, Fujioka E, Best B, Donnelly B, Hazen L, Kot C, Urian K, LaBrecque E, Dimatteo A, Cleary J, Good C, Crowder L, Hyrenbach K (2009) OBIS-SEAMAP The World Data Center for Marine Mammal, Sea Bird, and Sea Turtle Distributions. OCEANOGRAPHY 22:104–115.

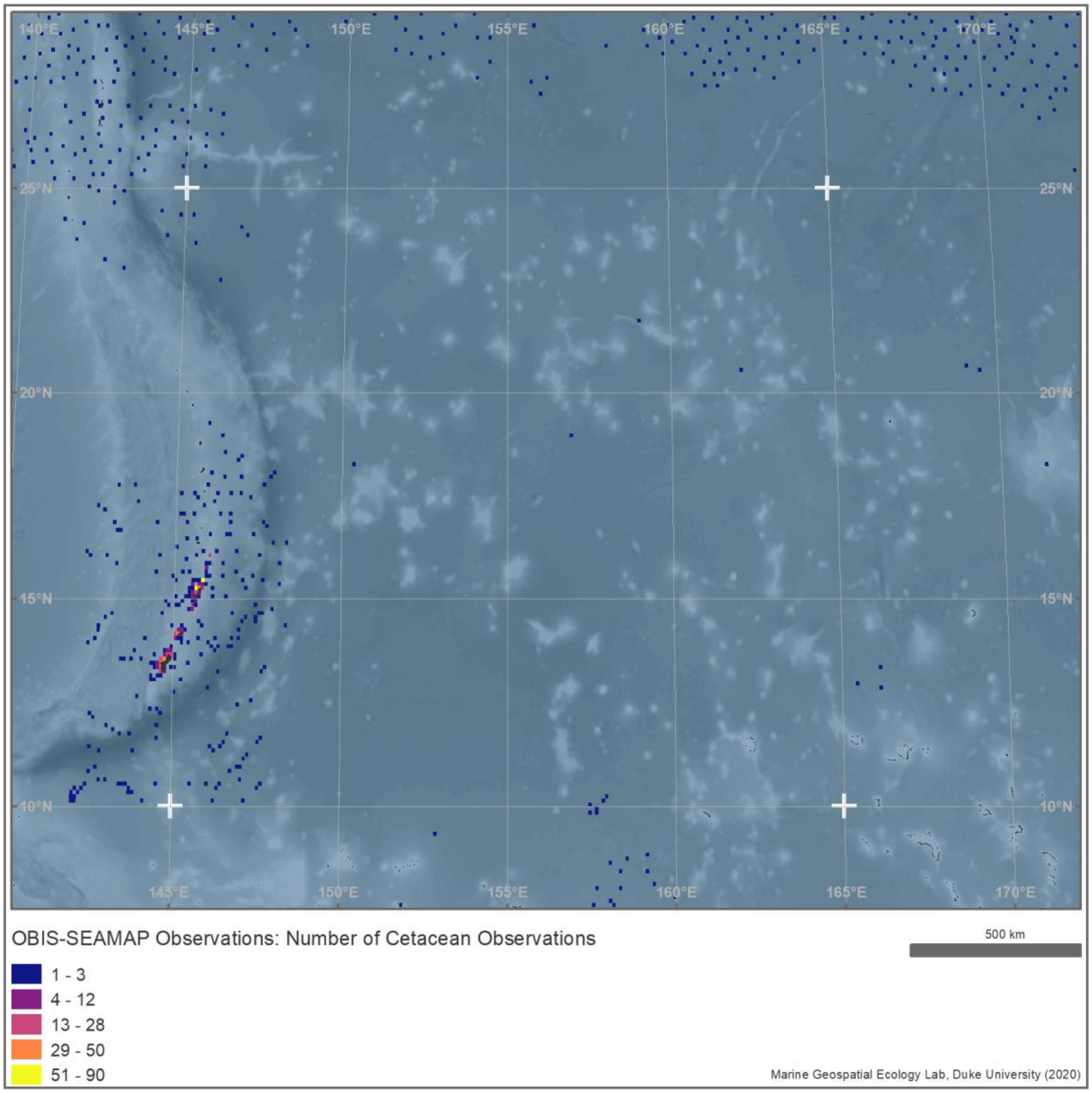

Figure 3.5-1 Cetacean observations from OBIS-SEAMAP

3.6 Turtle data aggregated by OBIS-SEAMAP

OBIS-SEAMAP (http://seamap.env.duke.edu/), Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations, is a spatially referenced online database, aggregating marine mammal, seabird and sea turtle observation data from across the globe. Data from several turtle tracking efforts were extracted from OBIS-SEAMAP data center for the study area and displayed on a per species basis.

Reference:
Halpin P, Read A, Fujioka E, Best B, Donnelly B, Hazen L, Kot C, Urian K, LaBrecque E, Dimatteo A, Cleary J, Good C, Crowder L, Hyrenbach K (2009) OBIS-SEAMAP The World Data Center for Marine Mammal, Sea Bird, and Sea Turtle Distributions. OCEANOGRAPHY 22:104–115.

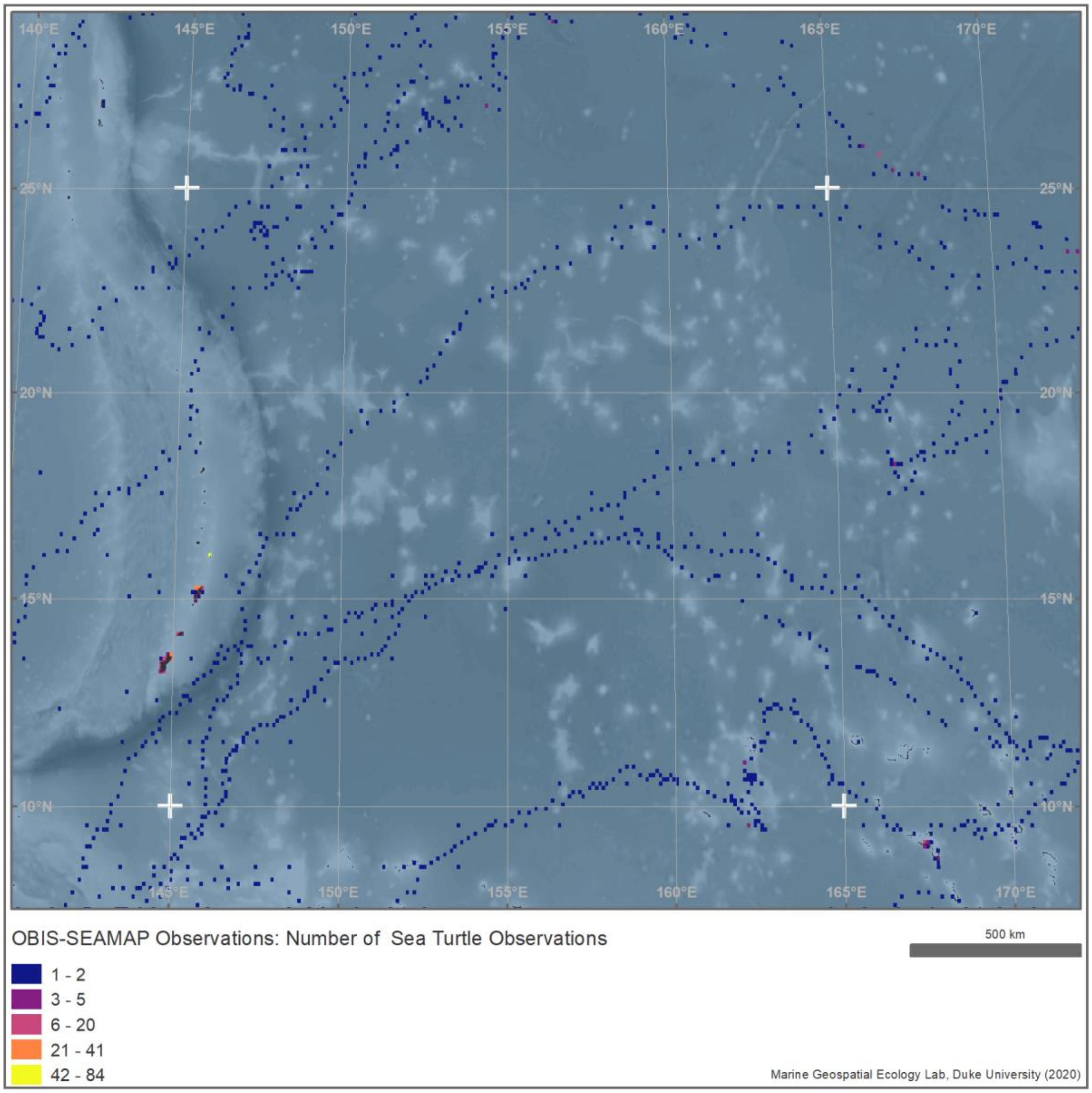

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Figure 3.6-1 Sea turtle observations from OBIS-SEAMAP

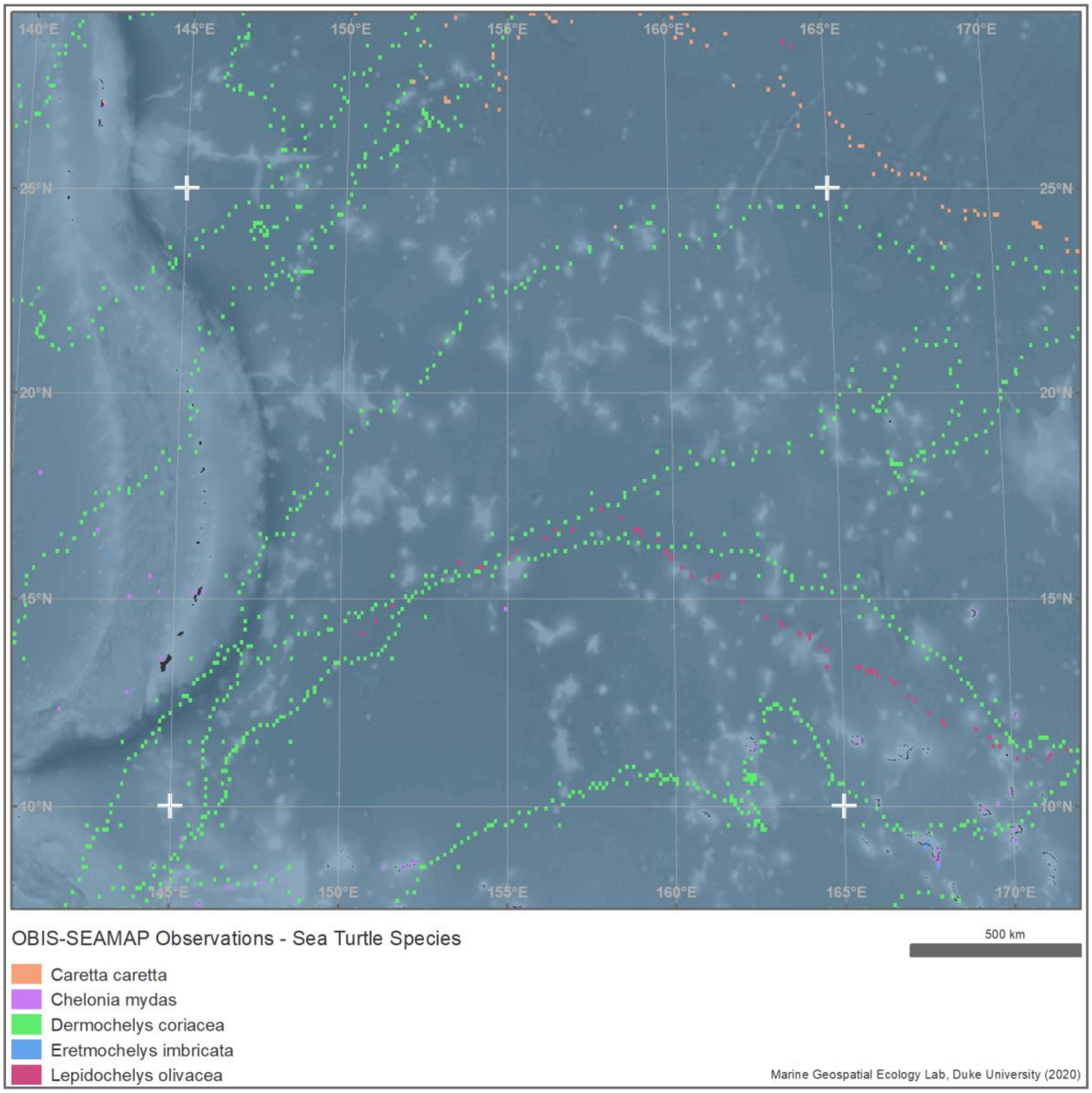

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Figure 3.6-2 Sea turtle species data from OBIS-SEAMAP

3.7 Important Bird Areas (IBAs)

BirdLife Important Bird Areas (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 (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 (http://seabird.wikispaces.com/), and 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 and or migratory species.

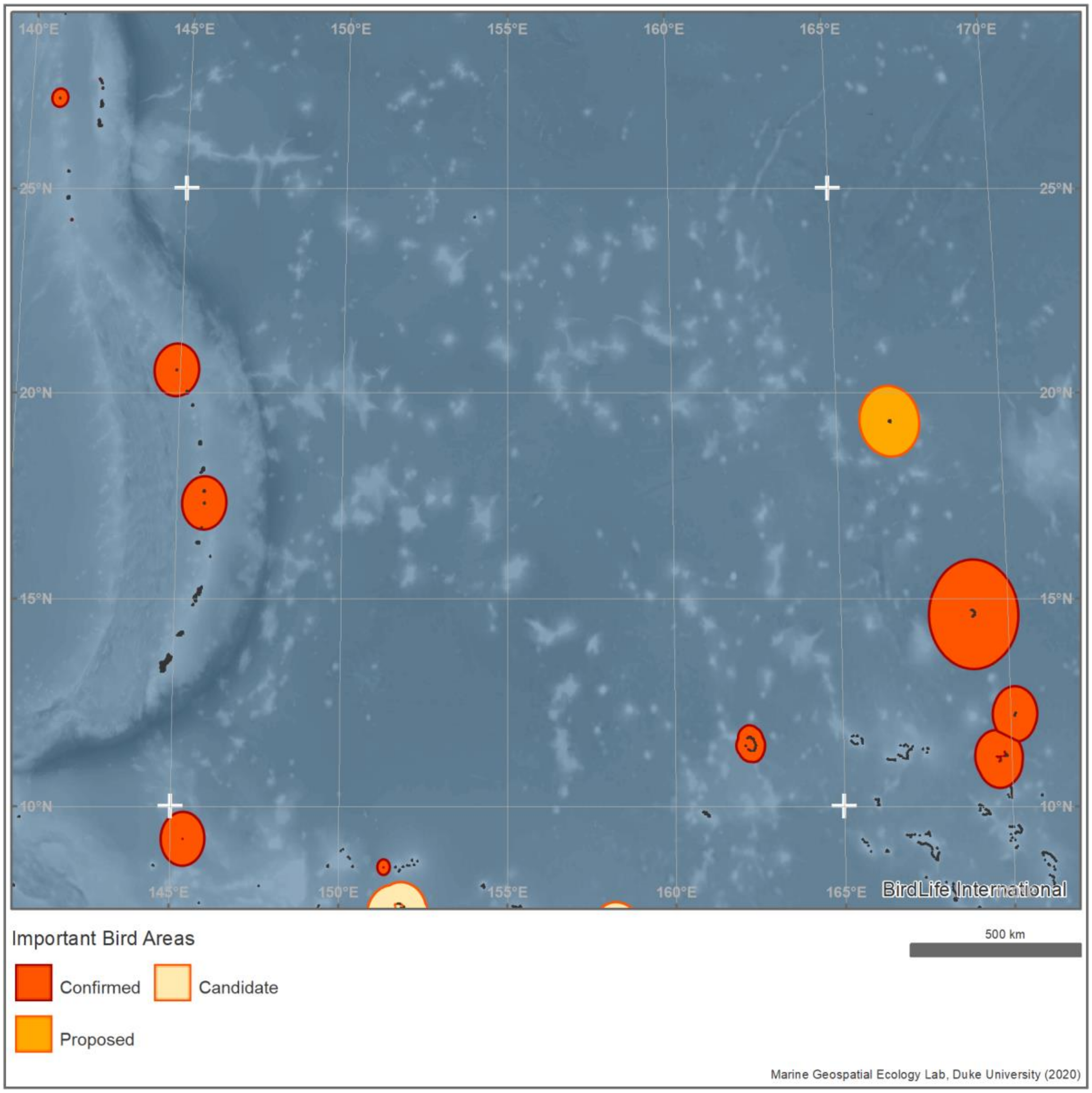


Figure 3.7-1 Important Bird Areas (BirdLife)

3.8 Global Distribution of Deep-Water *Antipatharia* Habitat

Abstract (Yesson et al. 2017)

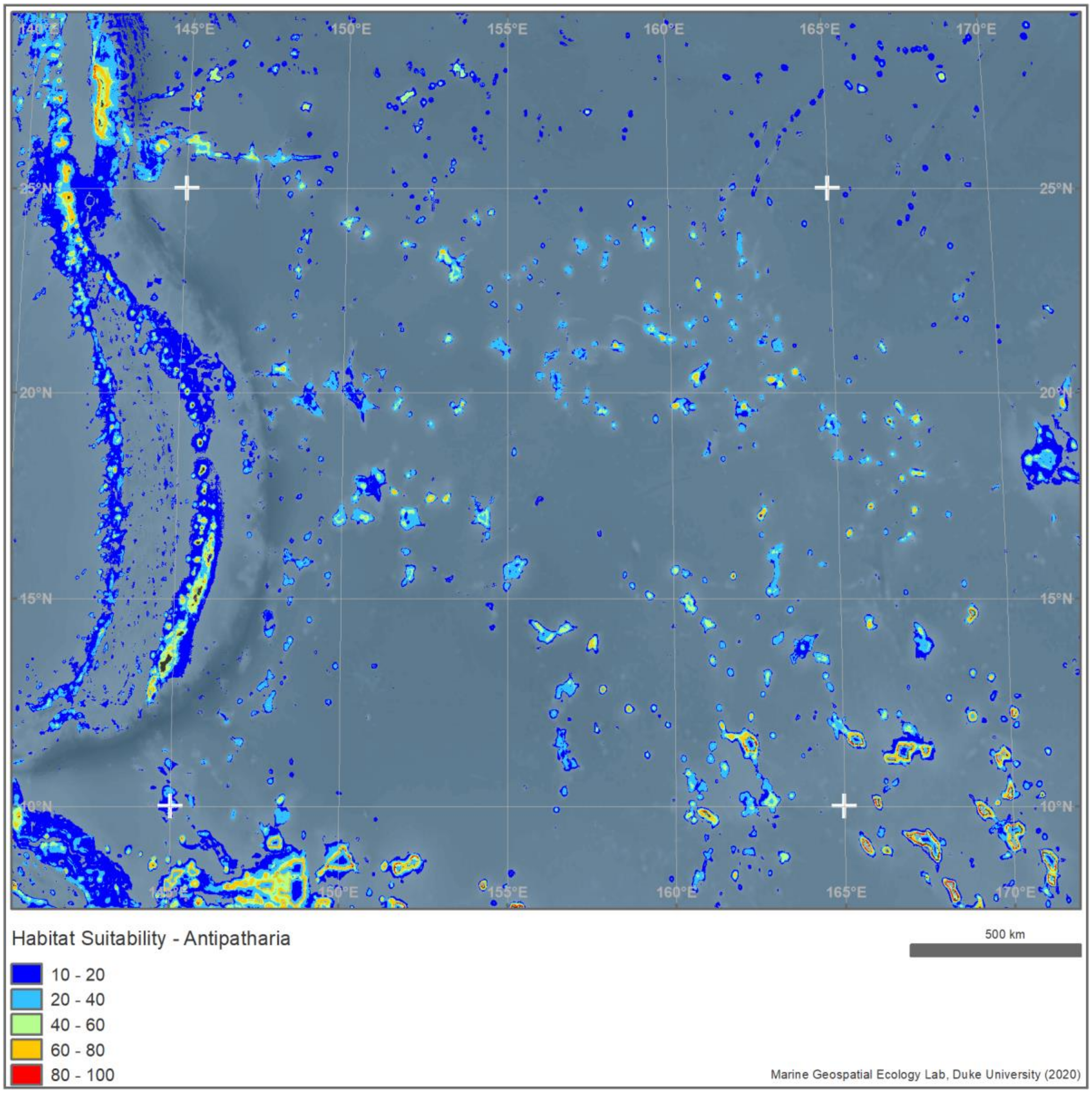
"Antipatharia are a diverse group of corals with many species found in deep water. Many Antipatharia are habitat for associates, have extreme longevity and some species can occur beyond 8500 m depth. As they are major constituents of 'coral gardens', which are Vulnerable Marine Ecosystems (VMEs), knowledge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

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

This model can be used to predict areas of suitable habitat, which can be useful for conservation planning. The global distribution of Antipatharia habitat suitability shows a marked contrast with the distribution of specimen observations, indicating that many potentially suitable areas have not been sampled, and that sampling effort has been disproportionate to shallow, accessible areas inside marine protected areas (MPAs). Although 25% of Antipatharia observations are located in MPAs, only 7-8% of predicted suitable habitat is protected, which is short of the Convention on Biological Diversity target to protect 10% of ocean habitats by 2020."

Reference:

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


Habitat Suitability - Antipatharia

Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.8-1 Deep-Water *Antipatharia* Habitat

3.9 Predictions of Habitat Suitability for Cold-Water Octocorals

Abstract (Yesson et al. 2012):
“Three-quarters of Octocorallia species are found in deep waters. These cold- water octocoral colonies can form a major constituent of structurally complex habitats. The global distribution and the habitat requirements of deep-sea octocorals are poorly understood given the expense and difficulties of sampling at depth. Habitat suitability models are useful tools to extrapolate distributions and provide an understanding of ecological requirements. Here, we present global habitat suitability models and distribution maps for seven suborders of Octocorallia: Alcyoniina, Calcaxonia, Holaxonia, Scleraxonia, Sessiliflorae, Stolonifera and Subselliflorae.”

Reference:
Yesson C, Taylor ML, Tittensor DP, Davies AJ, Guinotte J, Baco A, Black J, Hall-Spencer JM, Rogers AD (2012) Global habitat suitability of cold-water octocorals. Journal of Biogeography 39:1278–1292. Doi: 10.1111/j.1365-2699.2011.02681.x

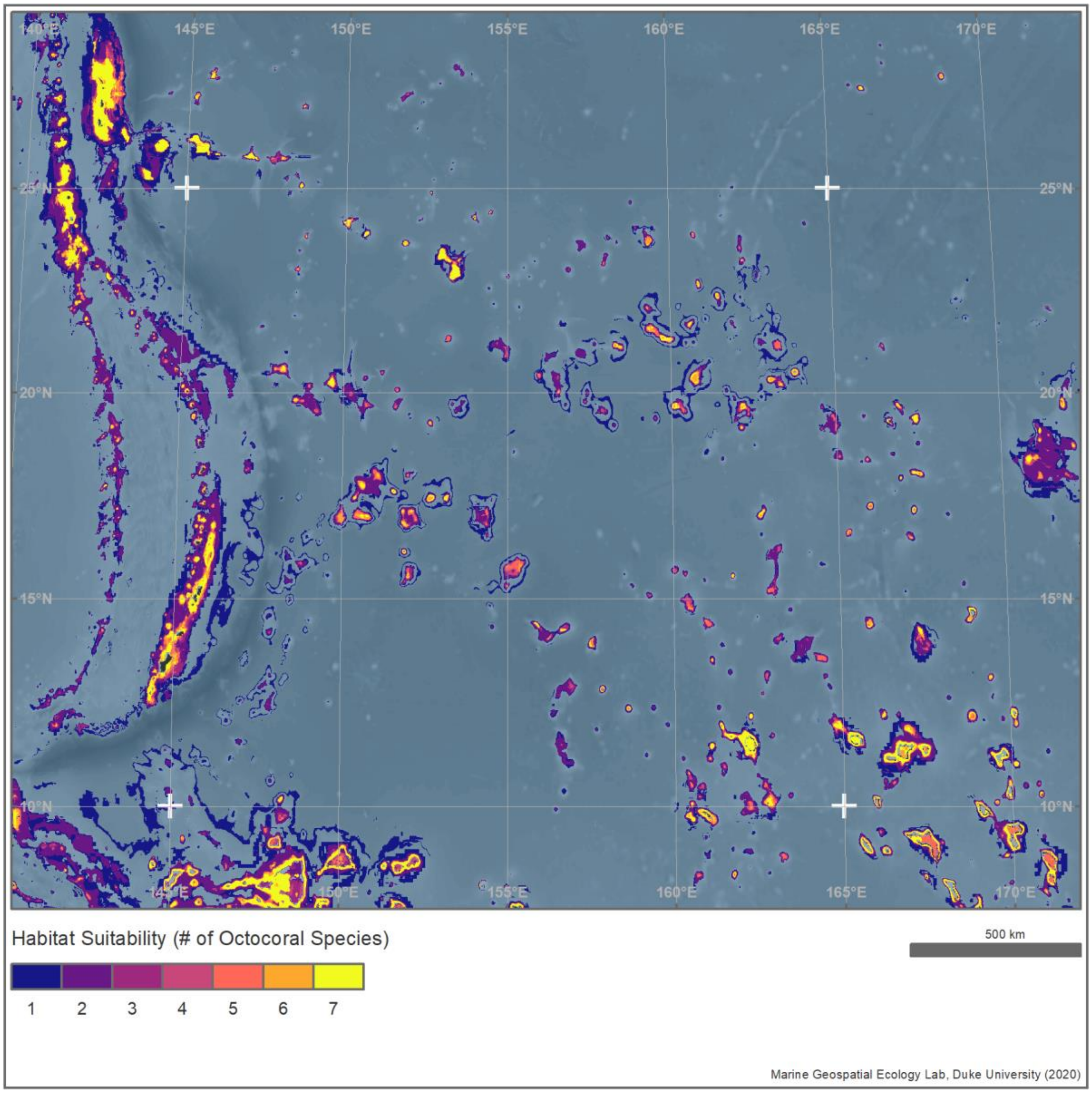
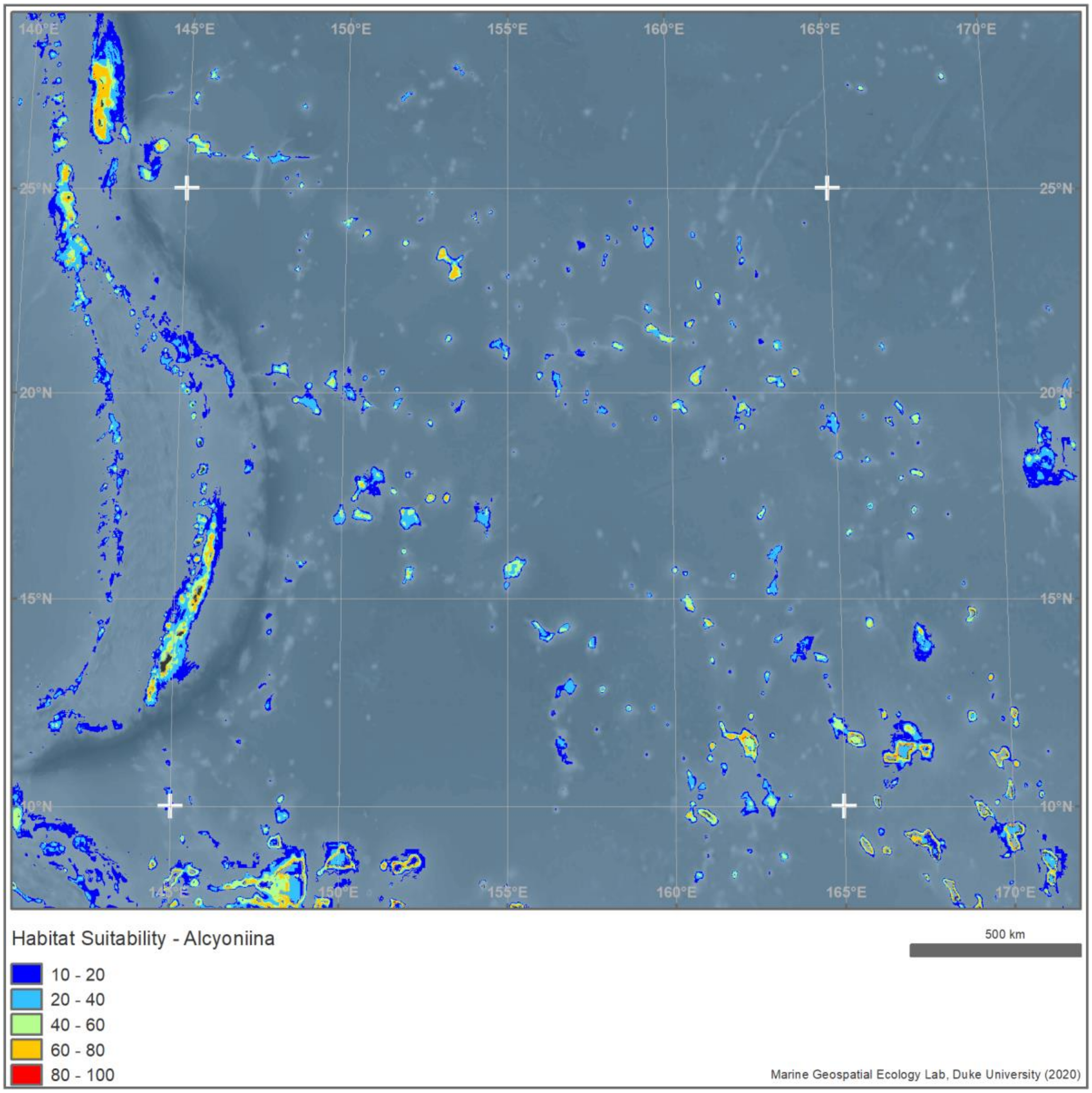
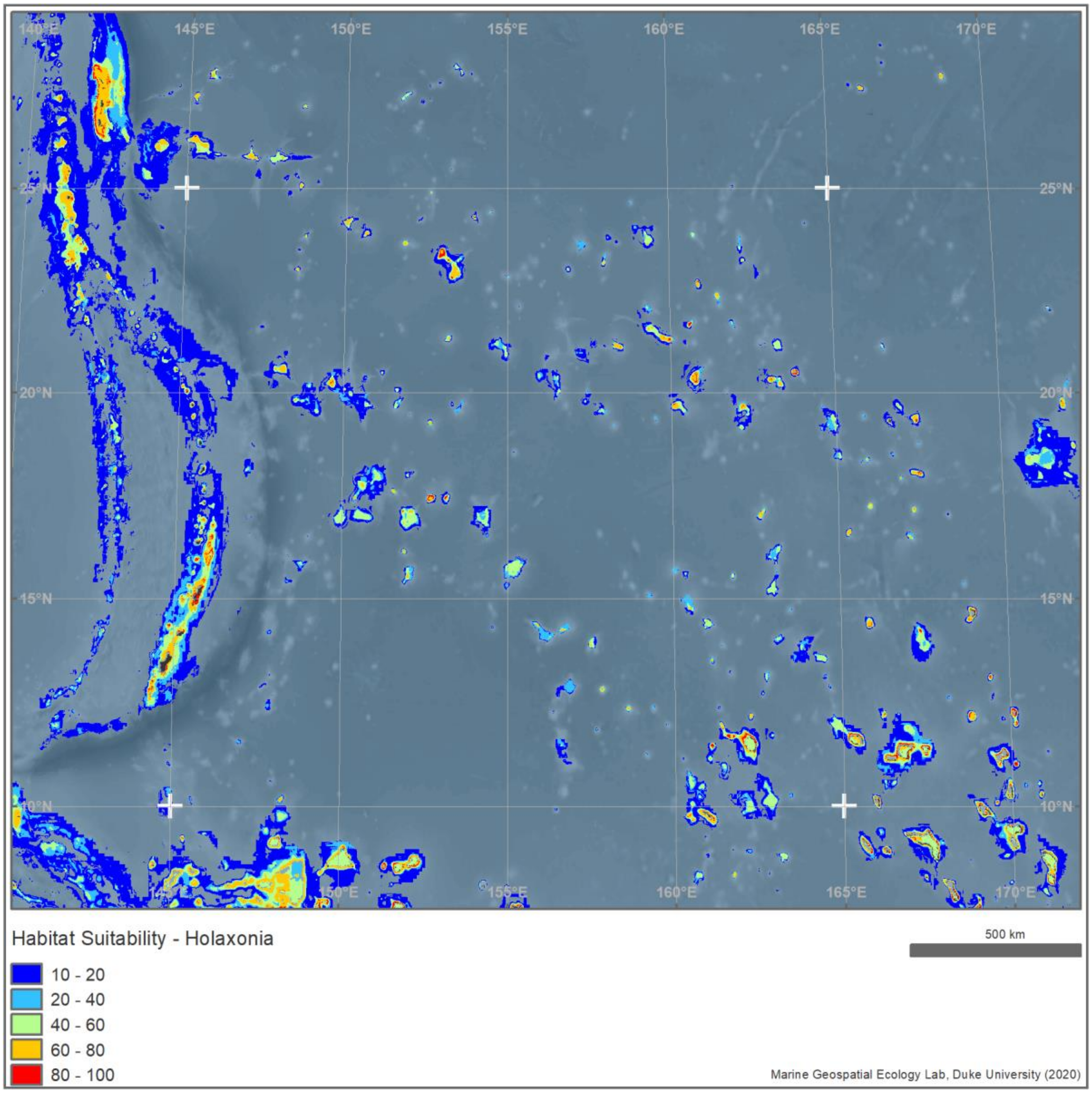


Figure 3.9-1 Deep-Sea octocoral habitat suitability – consensus



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.9-2 Deep-Sea octocoral habitat suitability - *Alcyoniina*



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.9-3 Deep-Sea octocoral habitat suitability - *Holaxonia*

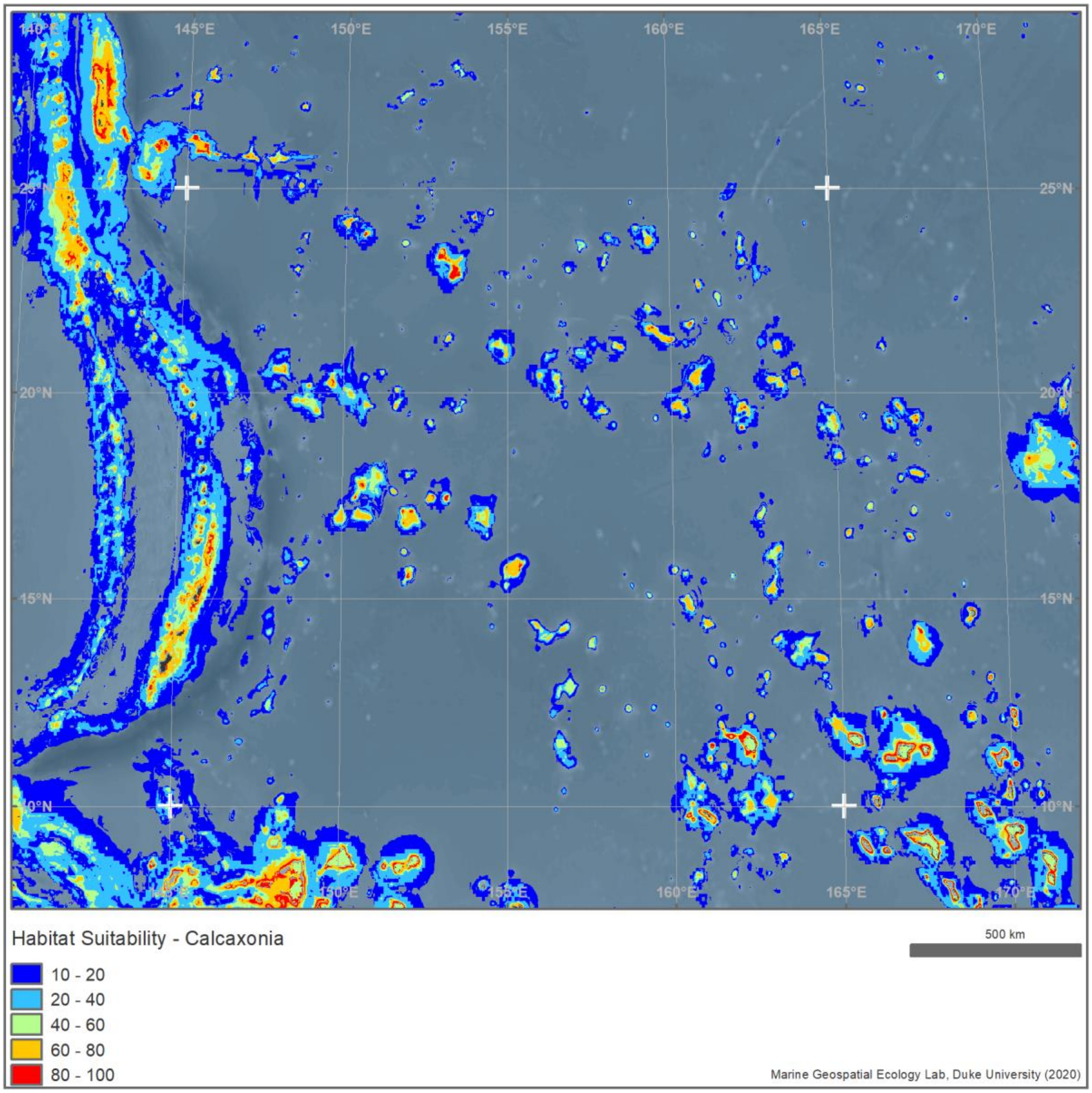


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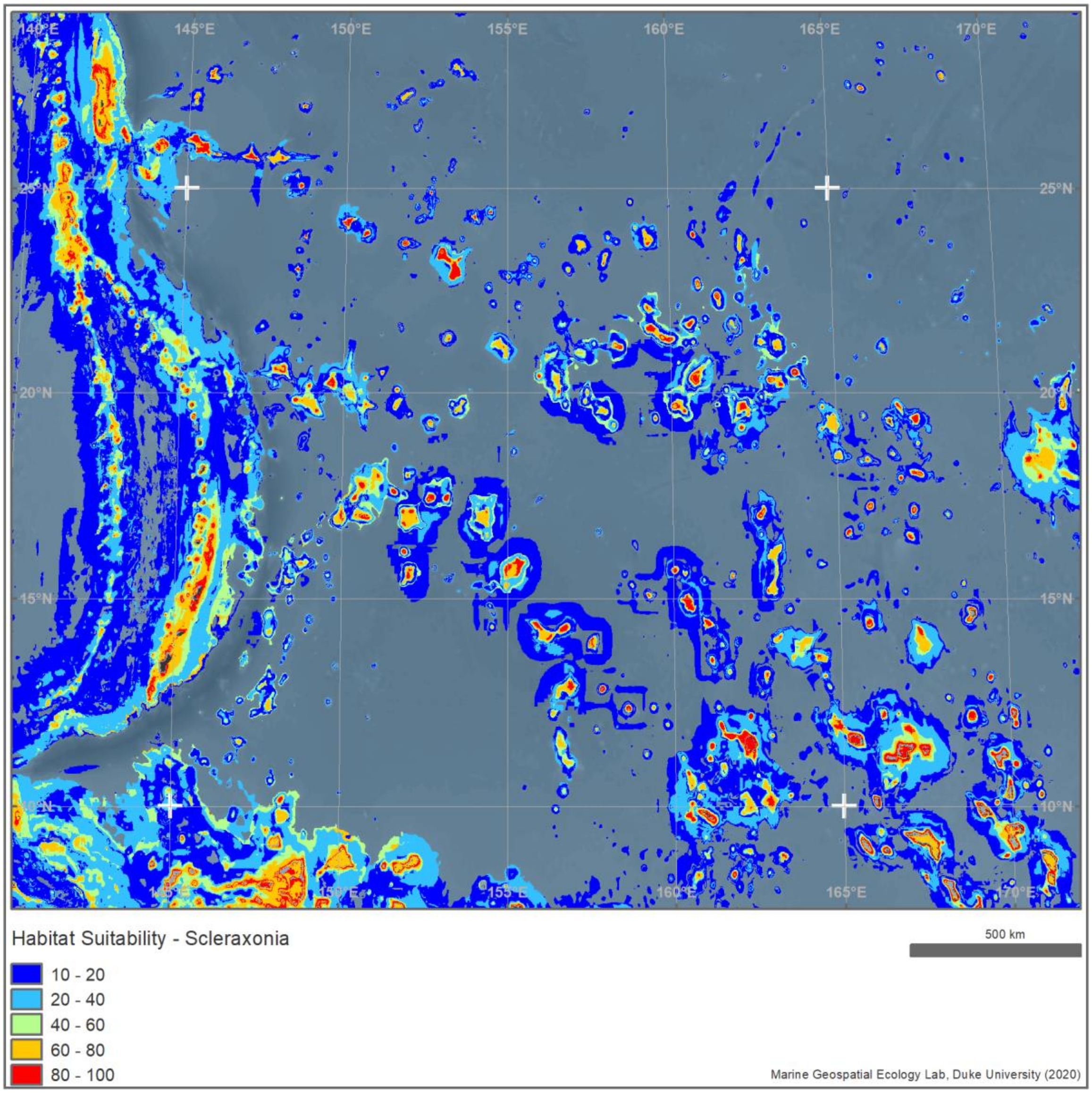
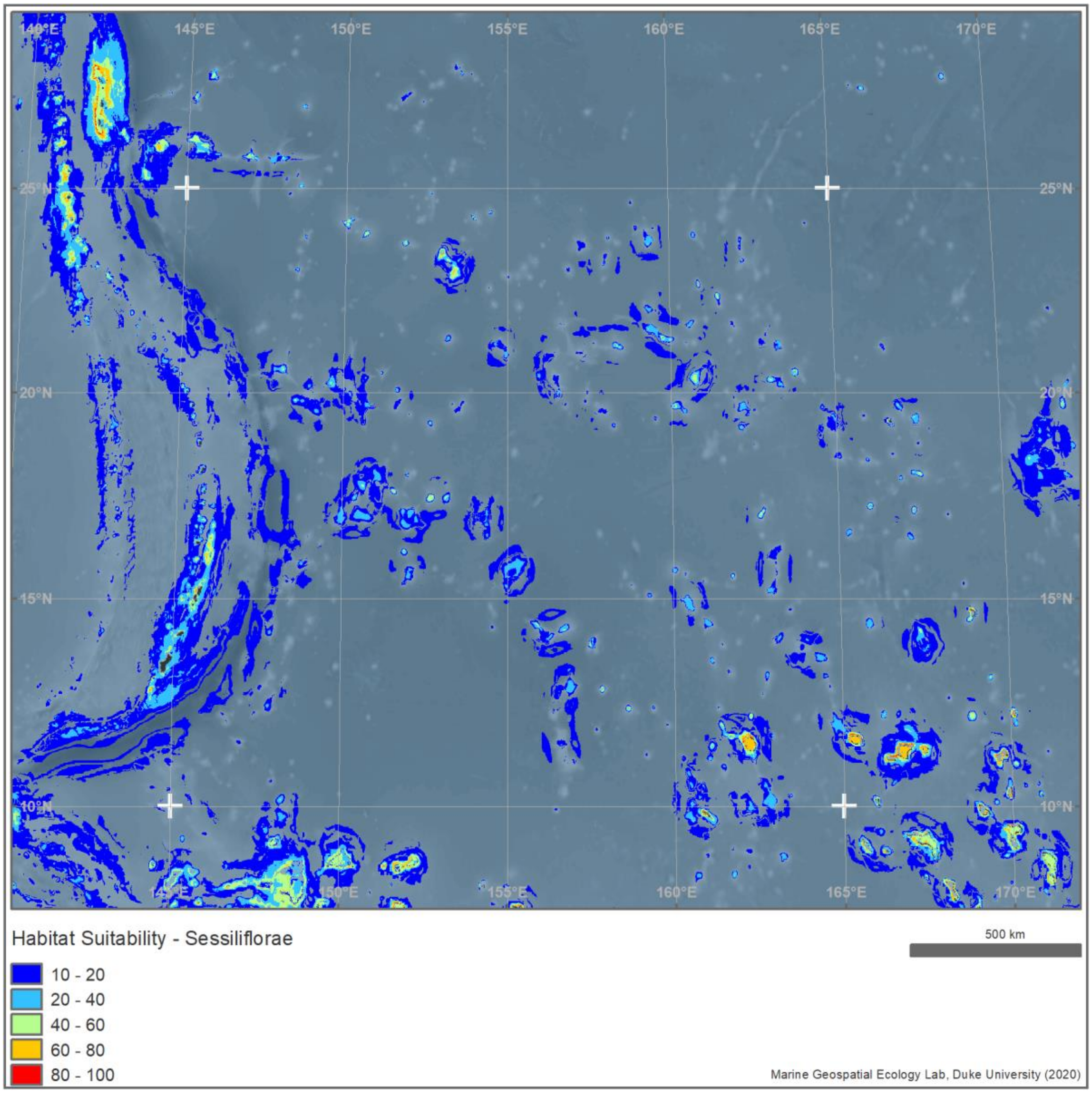
Figure 3.9-4 Deep-Sea octocoral habitat suitability - *Calcaxonia*



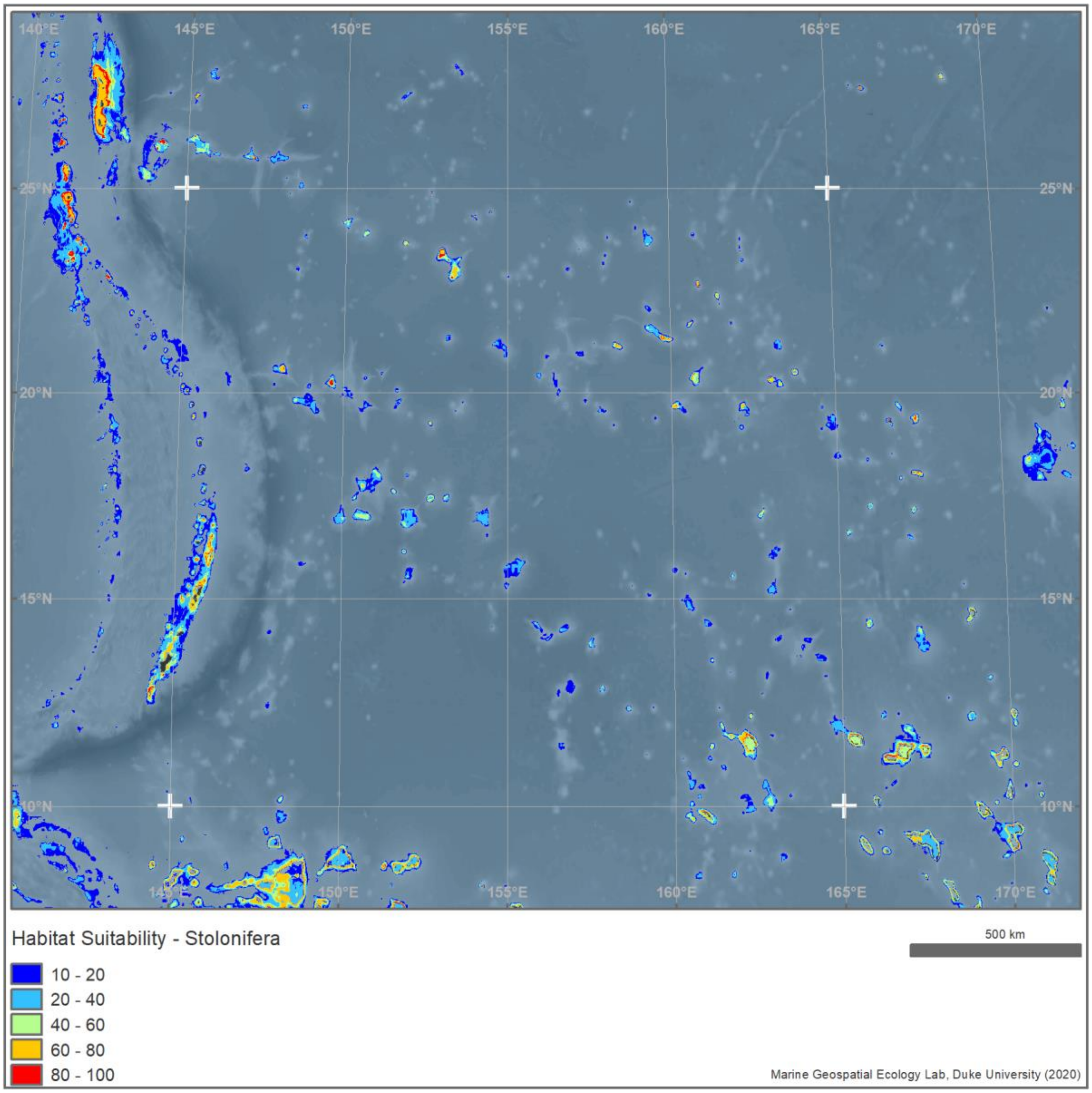
Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.9-5 Deep-Sea octocoral habitat suitability - ***Scleraxonia***



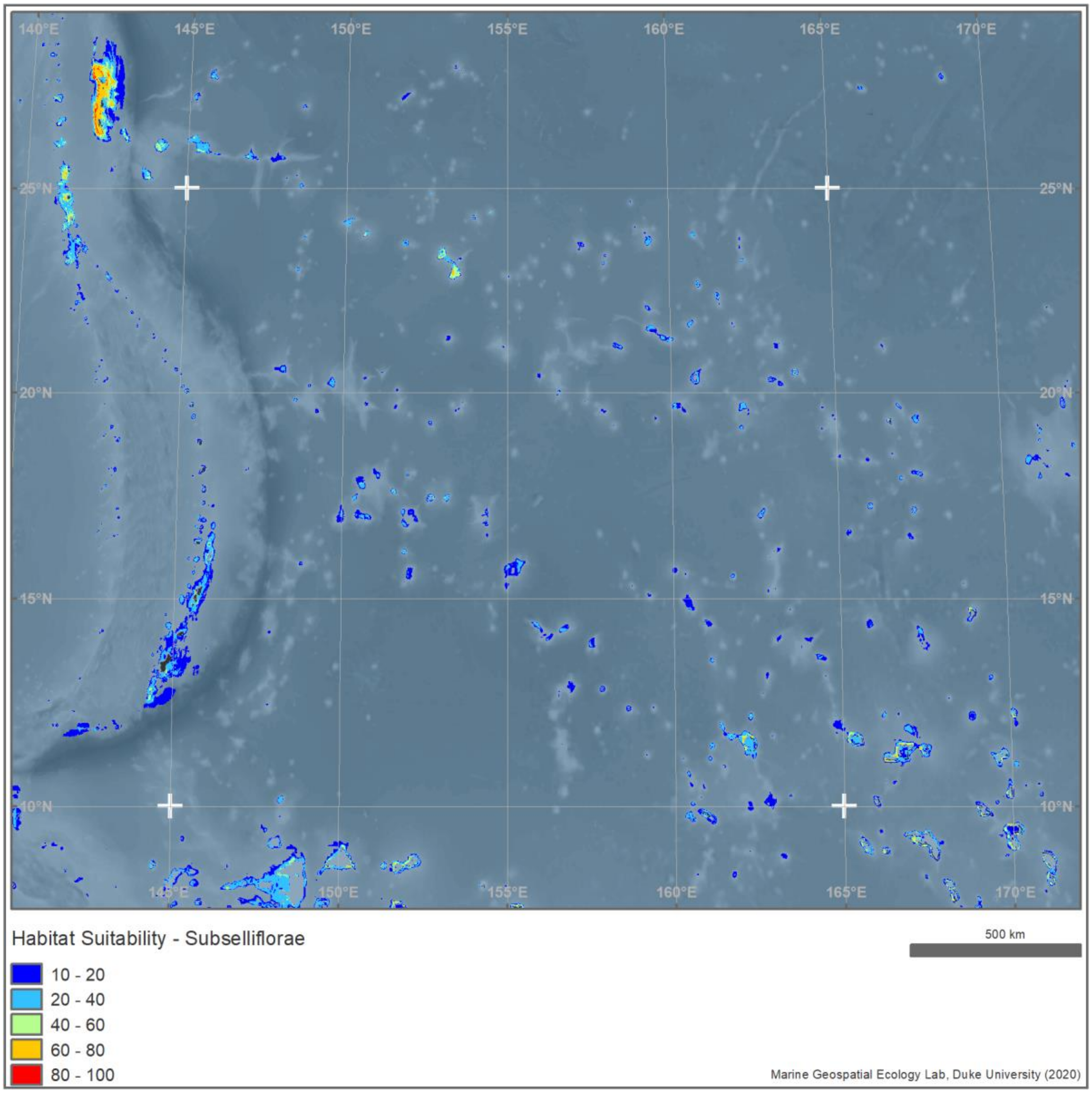
Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.9-6 Deep-Sea octocoral habitat suitability - *Sessiliflorae*



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.9-7 Deep-Sea octocoral habitat suitability - *Stolonifera*



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.9-8 Deep-Sea octocoral habitat suitability - *Subselliflorae*

3.10 Predictions of Habitat Suitability for Framework-Forming Scleractinian Corals

Abstract (Davies & Guinotte 2011):
“Predictive habitat models are increasingly being used by conservationists, researchers and governmental bodies to identify vulnerable ecosystems and species’ distributions in areas that have not been sampled. However, in the deep sea, several limitations have restricted the widespread utilisation of this approach. These range from issues with the accuracy of species presences, the lack of reliable absence data and the limited spatial resolution of environmental factors known or thought to control deep-sea species’ distributions. To address these problems, global habitat suitability models have been generated for five species of framework-forming scleractinian corals by taking the best available data and using a novel approach to generate high resolution maps of seafloor conditions. High-resolution global bathymetry was used to resample gridded data from sources such as World Ocean Atlas to produce continuous 30-arc second (1 km^2) global grids for environmental, chemical and physical data of the world’s oceans. The increased area and resolution of the environmental variables resulted in a greater number of coral presence records being incorporated into habitat models and higher accuracy of model predictions. The most important factors in determining cold-water coral habitat suitability were depth, temperature, aragonite saturation state and salinity. Model outputs indicated the majority of suitable coral habitat is likely to occur on the continental shelves and slopes of the Atlantic, South Pacific and Indian Oceans. The North Pacific has very little suitable scleractinian coral habitat. Numerous small scale features (i.e., seamounts), which have not been sampled or identified as having a high probability of supporting cold-water coral habitat were identified in all ocean basins. Field validation of newly identified areas is needed to determine the accuracy of model results, assess the utility of modeling efforts to identify vulnerable marine ecosystems for inclusion in future marine protected areas and reduce coral bycatch by commercial fisheries.”

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

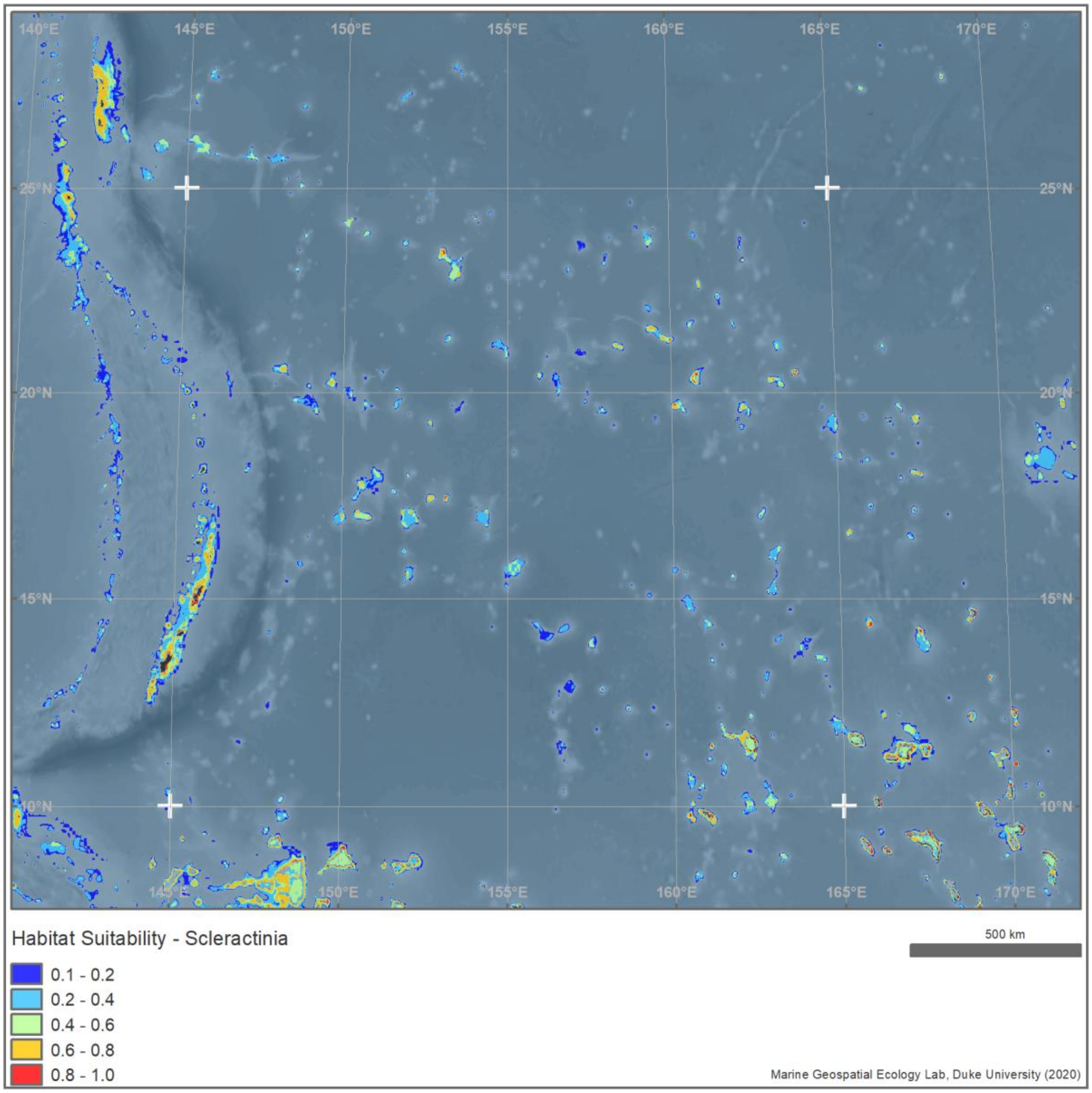


Figure 3.10-1 Deep-Sea *Scleractinia* habitat suitability – all five framework forming species

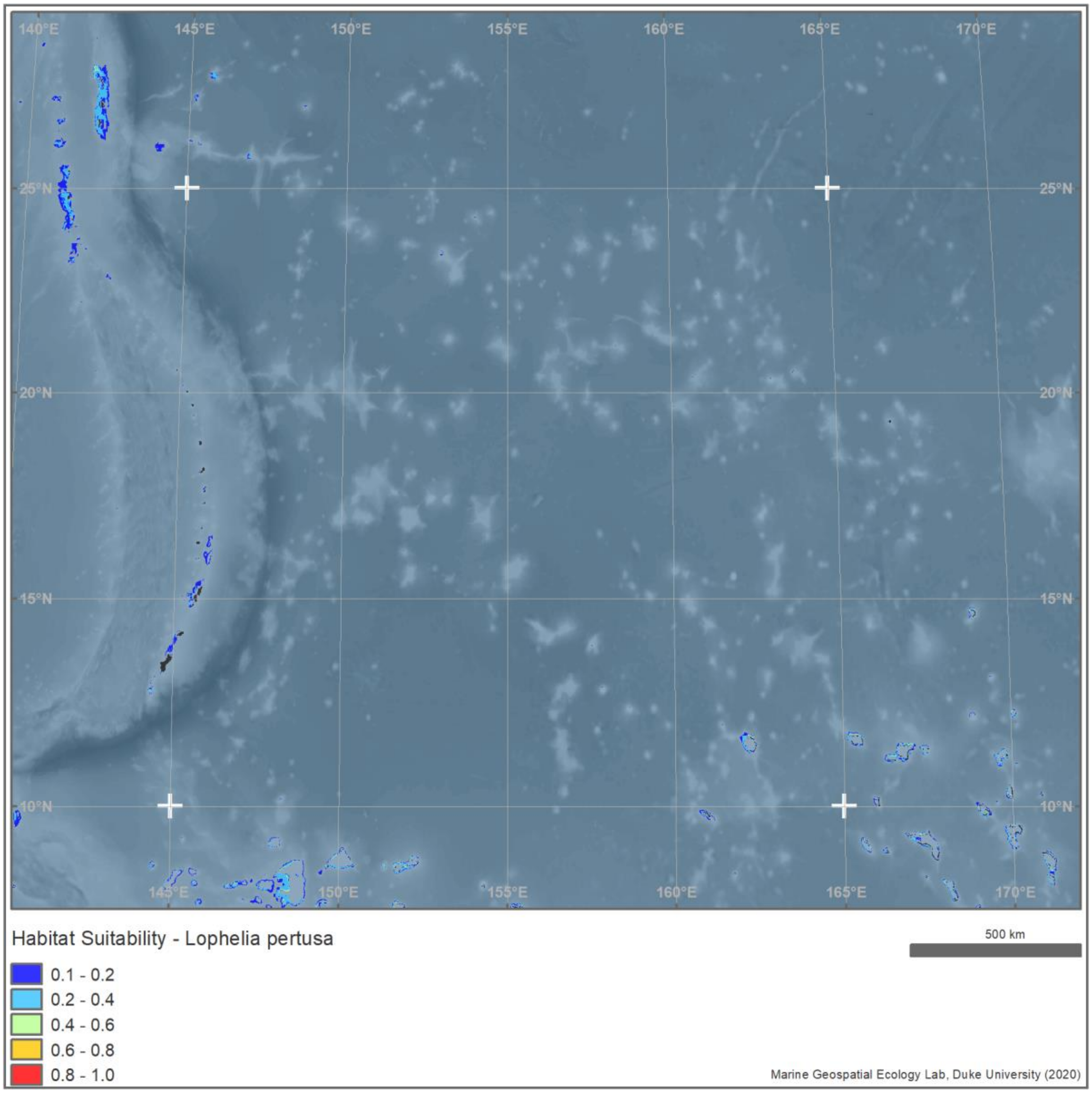


Figure 3.10-2 Deep-Sea *Scleractinia* habitat suitability – *Lophelia pertusa*

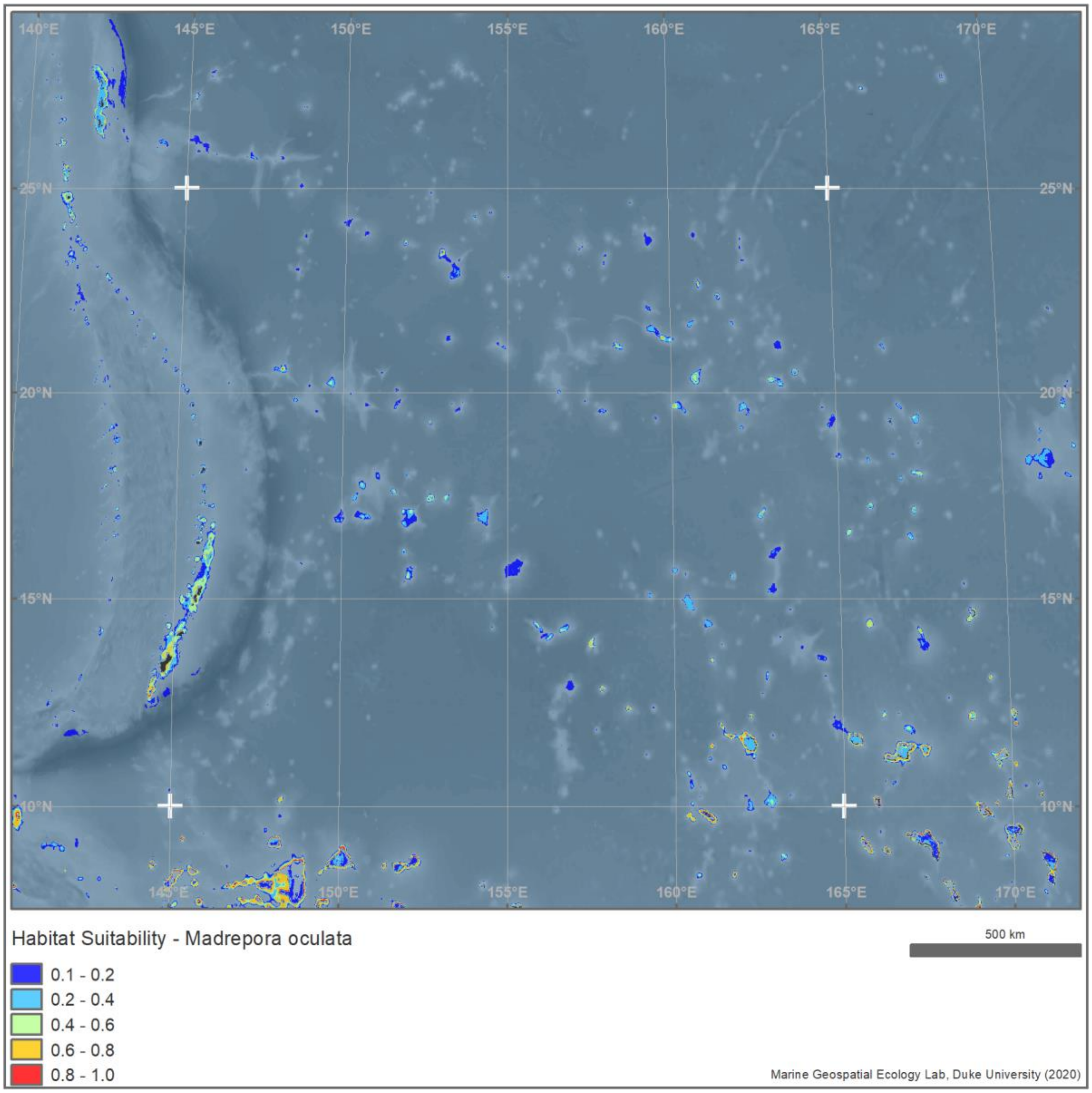


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Figure 3.10-3 Deep-Sea *Scleractinia* habitat suitability – *Madrepora oculata*

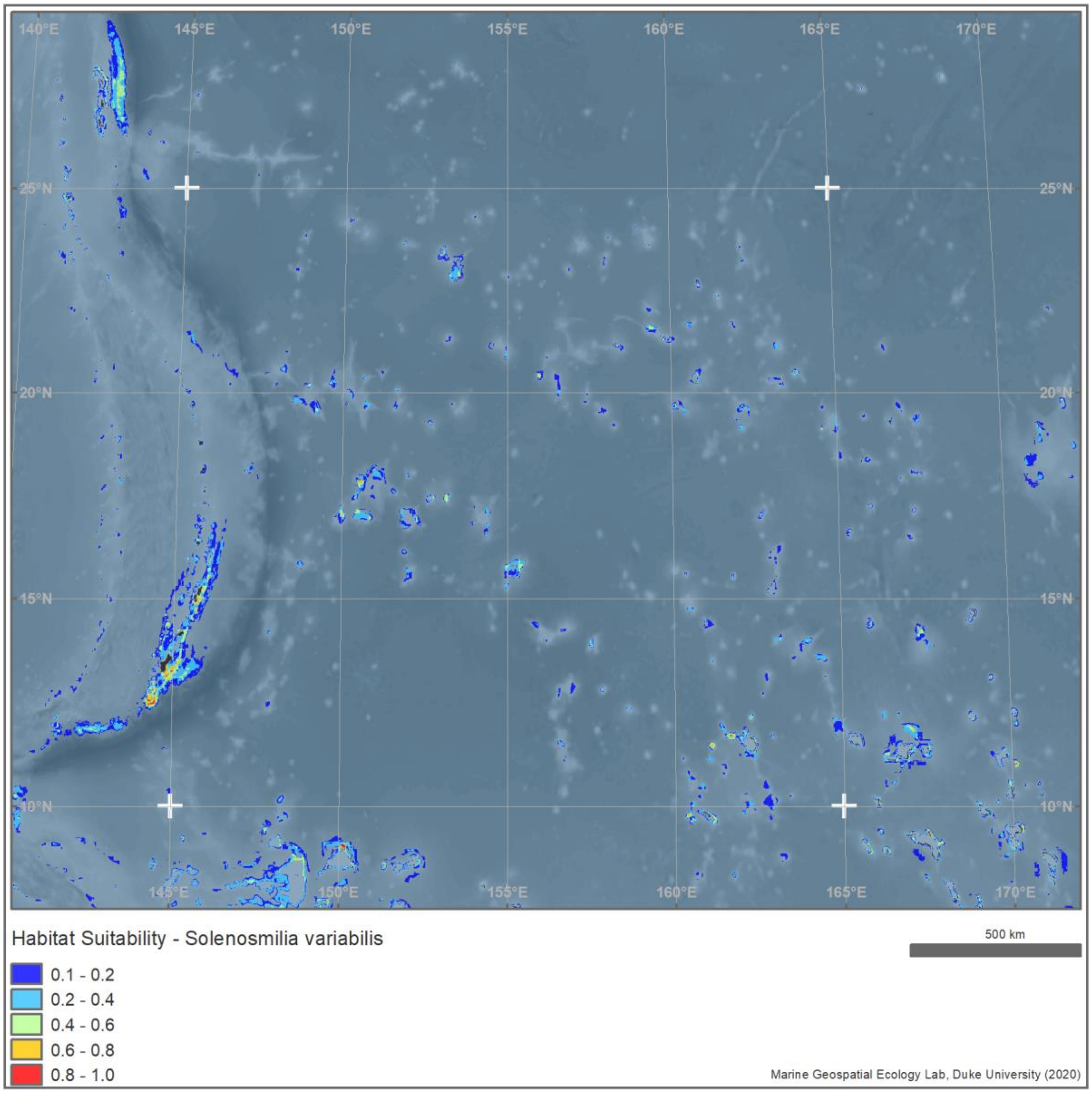

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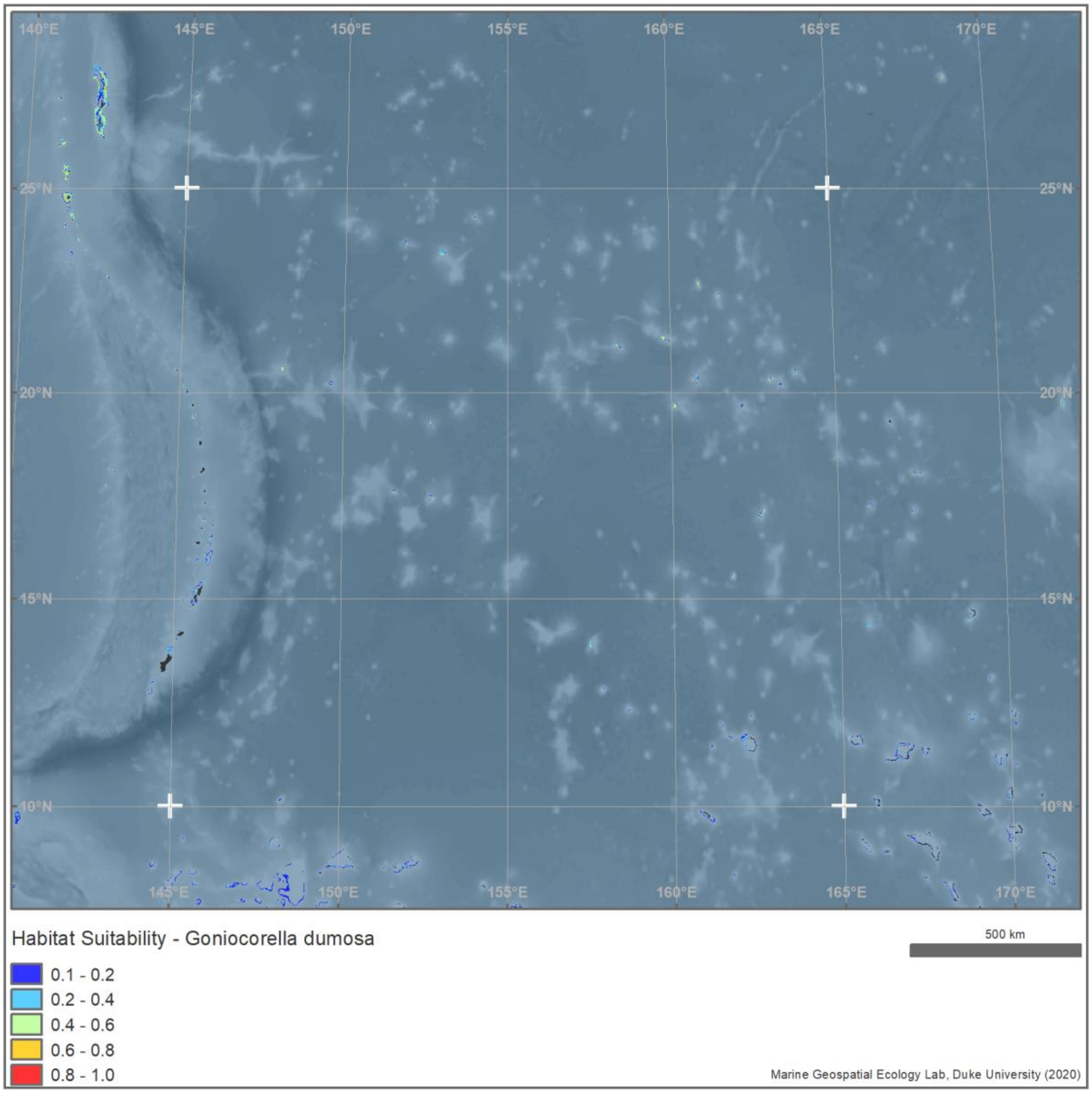
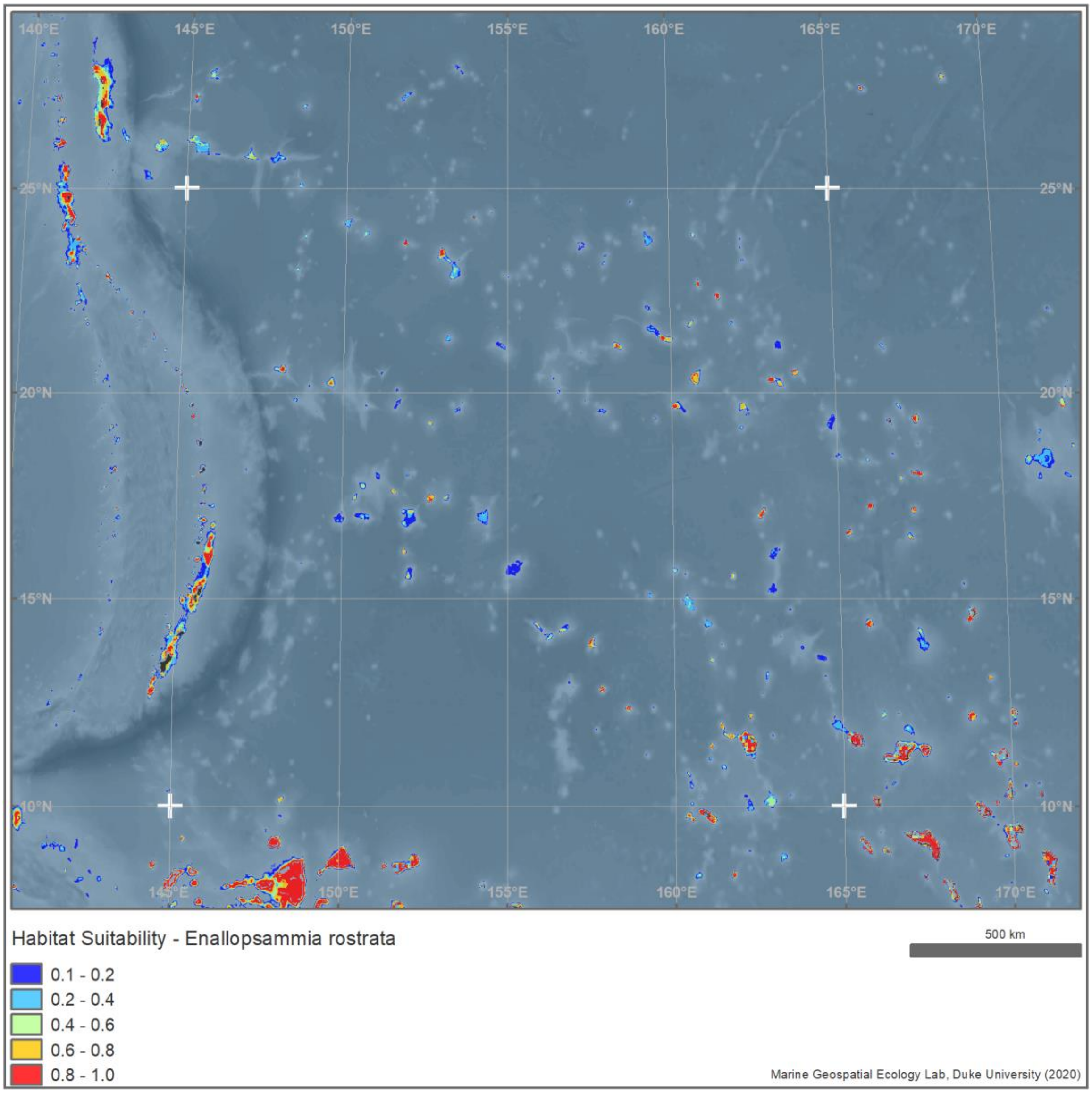
Figure 3.10-4 Deep-Sea *Scleractinia* habitat suitability – *Solenosmilia variabilis*



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.10-5 Deep-Sea *Scleractinia* habitat suitability – *Goniocorella dumosa*



Marine Geospatial Ecology Lab, Duke University (2020)

Figure 3.10-6 Deep-Sea *Scleractinia* habitat suitability – *Enallopsammia rostrata*

3.11 Global Patterns in Benthic Biomass

Abstract (Yool et al. 2017):
"Deep-water benthic communities in the ocean are almost wholly dependent on near-surface pelagic ecosystems for their supply of energy and material resources. Primary production in sunlit surface waters is channelled through complex food webs that extensively recycle organic material, but lose a fraction as particulate organic carbon (POC) that sinks into the ocean interior. This exported production is further rarefied by microbial breakdown in the abyssal ocean, but a residual ultimately drives diverse assemblages of seafloor heterotrophs. Advances have led to an understanding of the importance of size (body mass) in structuring these communities. Here we force a size-resolved benthic biomass model, BORIS, using seafloor POC flux from a coupled ocean-biogeochemistry model, NEMO-MEDUSA, to investigate global patterns in benthic biomass. BORIS resolves 16 size classes of metazoans, successively doubling in mass from approximately 1 μg to 28 mg. Simulations find a wide range of seasonal responses to differing patterns of POC forcing, with both a decline in seasonal variability, and an increase in peak lag times with increasing body size. However, the dominant factor for modelled benthic communities is the integrated magnitude of POC reaching the seafloor rather than its seasonal pattern. Scenarios of POC forcing under climate change and ocean acidification are then applied to investigate how benthic communities may change under different future conditions. Against a backdrop of falling surface primary production (-6.1%), and driven by changes in pelagic remineralization with depth, results show that while benthic communities in shallow seas generally show higher biomass in a warmed world (+3.2%), deep-sea communities experience a substantial decline (-32%) under a high greenhouse gas emissions scenario. Our results underscore the importance for benthic ecology of reducing uncertainty in the magnitude and seasonality of seafloor POC fluxes, as well as the importance of studying a broader range of seafloor environments for future model development."

Reference:
Yool, Andrew, Adrian P. Martin, Thomas R. Anderson, Brian J. Bett, Daniel OB Jones, and Henry A. Ruhl. "Big in the benthos: Future change of seafloor community biomass in a global, body size-resolved model." Global change biology 23, no. 9 (2017): 3554-3566.doi: 10.1111/gcb.13680

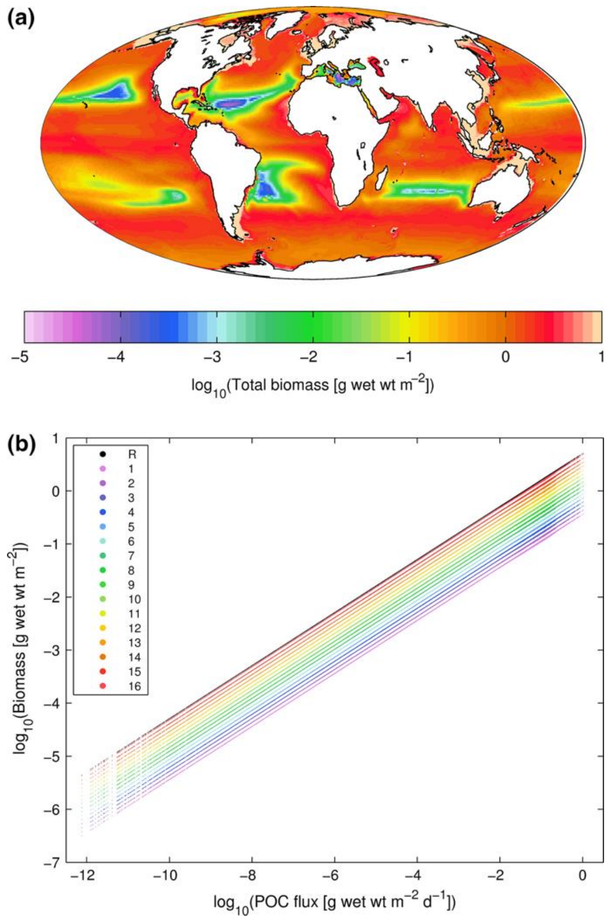


Figure 3.11-1 Mean annual field of total modelled seafloor biomass

4 Biogeographic Classification

4.1 Global Open Ocean and Deep Seabed (GOODS) biogeographic classification

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

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

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

References:

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

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

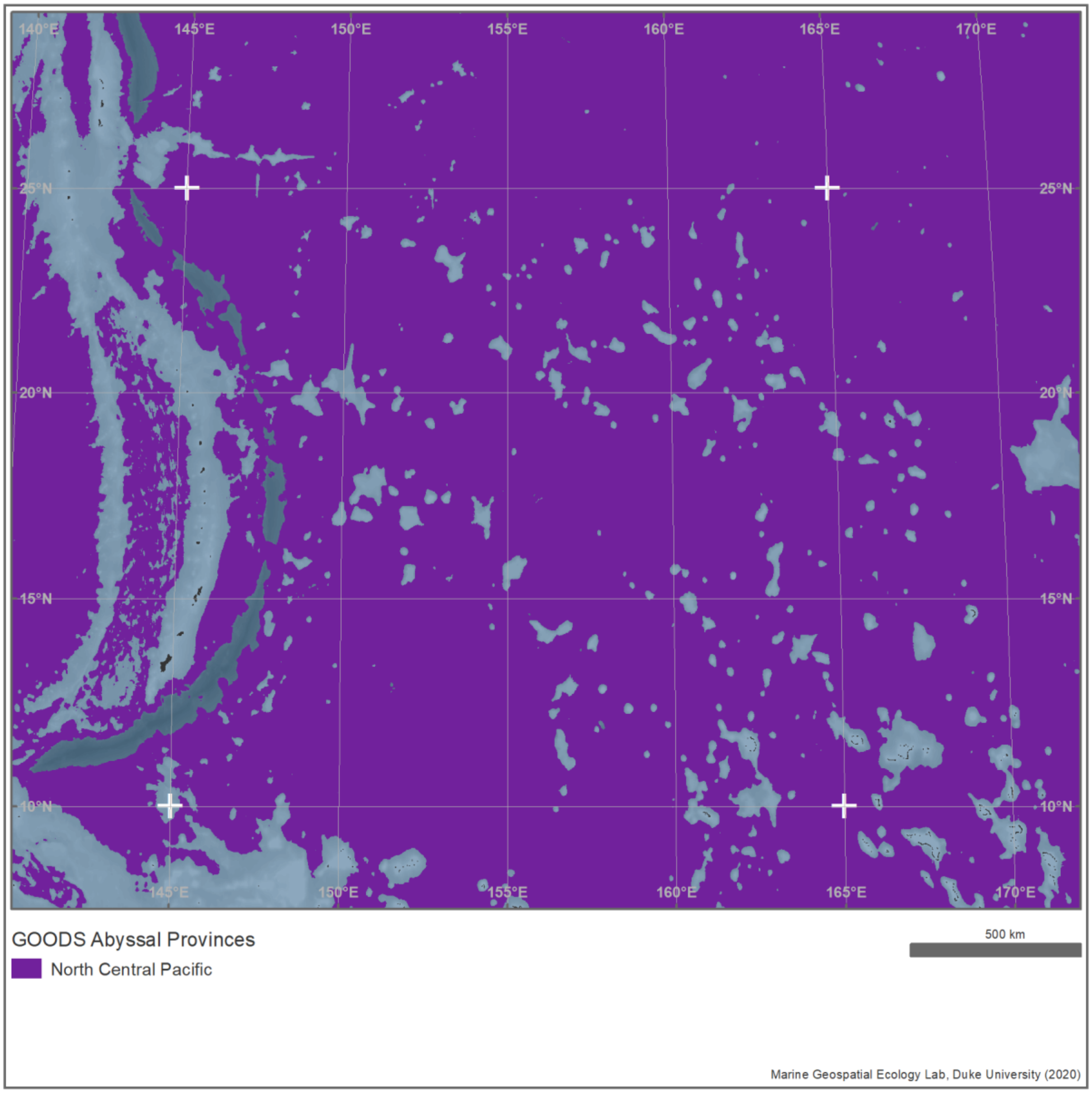


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Figure 4.1-1 GOODS abyssal provinces

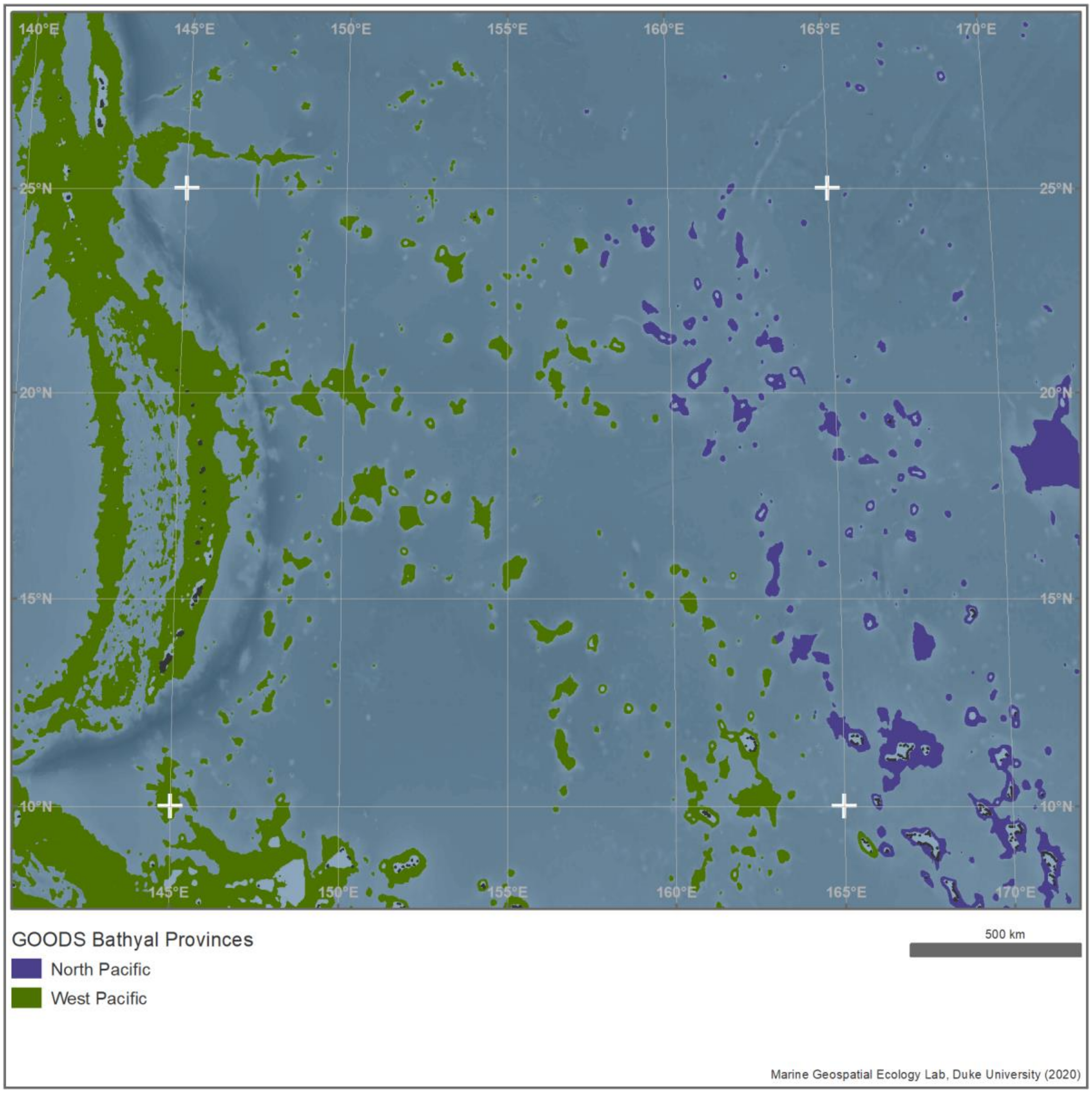

Figure 4.1-2 GOODS bathyal provinces

4.2 Global Mesopelagic Biogeography

Abstract (Sutton et al. 2017):
"We have developed a global biogeographic classification of the mesopelagic zone to reflect the regional scales over which the ocean interior varies in terms of biodiversity and function. An integrated approach was neces- sary, as global gaps in information and variable sampling methods preclude strictly statistical approaches. A panel combining expertise in oceanography, geospatial mapping, and deep-sea biology convened to collate expert opinion on the distributional patterns of pelagic fauna relative to environmental proxies (temperature, salinity, and dissolved oxygen at mesopelagic depths). An iterative Delphi Method integrating additional bio- logical and physical data was used to classify biogeographic ecoregions and to identify the location of ecoregion boundaries or inter-regions gradients. We define 33 global mesopelagic ecoregions. Of these, 20 are oceanic while 13 are 'distant neritic.' While each is driven by a complex of controlling factors, the putative primary driver of each ecoregion was identified. While work remains to be done to produce a comprehensive and robust mesopelagic biogeography (i.e., reflecting temporal variation), we believe that the classification set forth in this study will prove to be a useful and timely input to policy planning and management for conservation of deep- pelagic marine resources. In particular, it gives an indication of the spatial scale at which faunal communities are expected to be broadly similar in composition, and hence can inform application of ecosystem-based management approaches, marine spatial planning and the distribution and spacing of network of representative protected areas."

Reference:
Sutton, T.T., Clark, M.R., Dunn, D.C., Halpin, P.N., Rogers, A.D., Guinotte, J., Bograd, S.J., Angel, M.V., Perez, J.A.A., Wishner, K. and Haedrich, R.L., (2017). A global biogeographic classification of the mesopelagic zone. Deep Sea Research Part I: Oceanographic Research Papers, 126, pp.85-102.

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

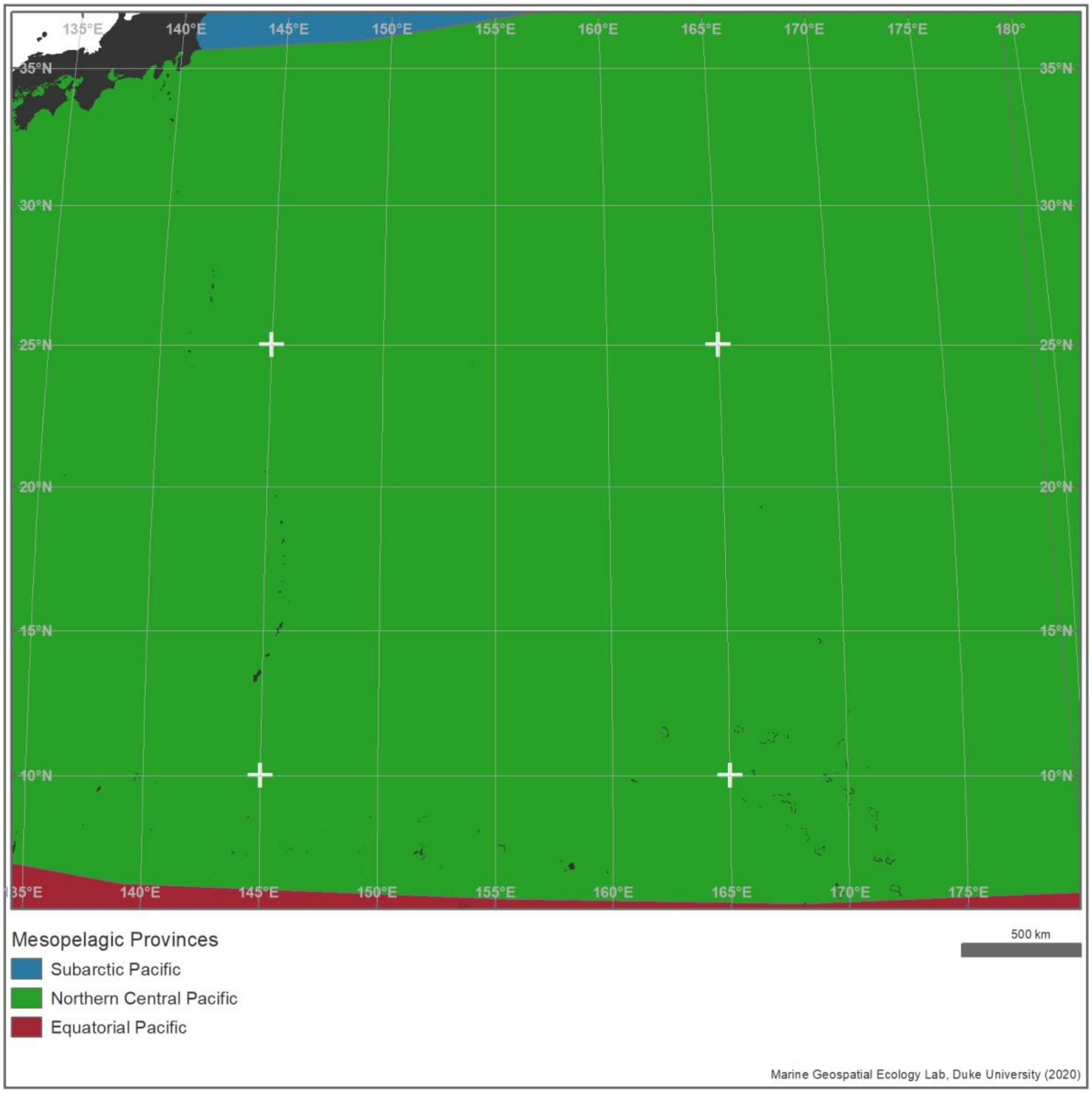

Figure 4.2-1 Mesopelagic provinces

4.3 Longhurst Marine Provinces

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

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

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

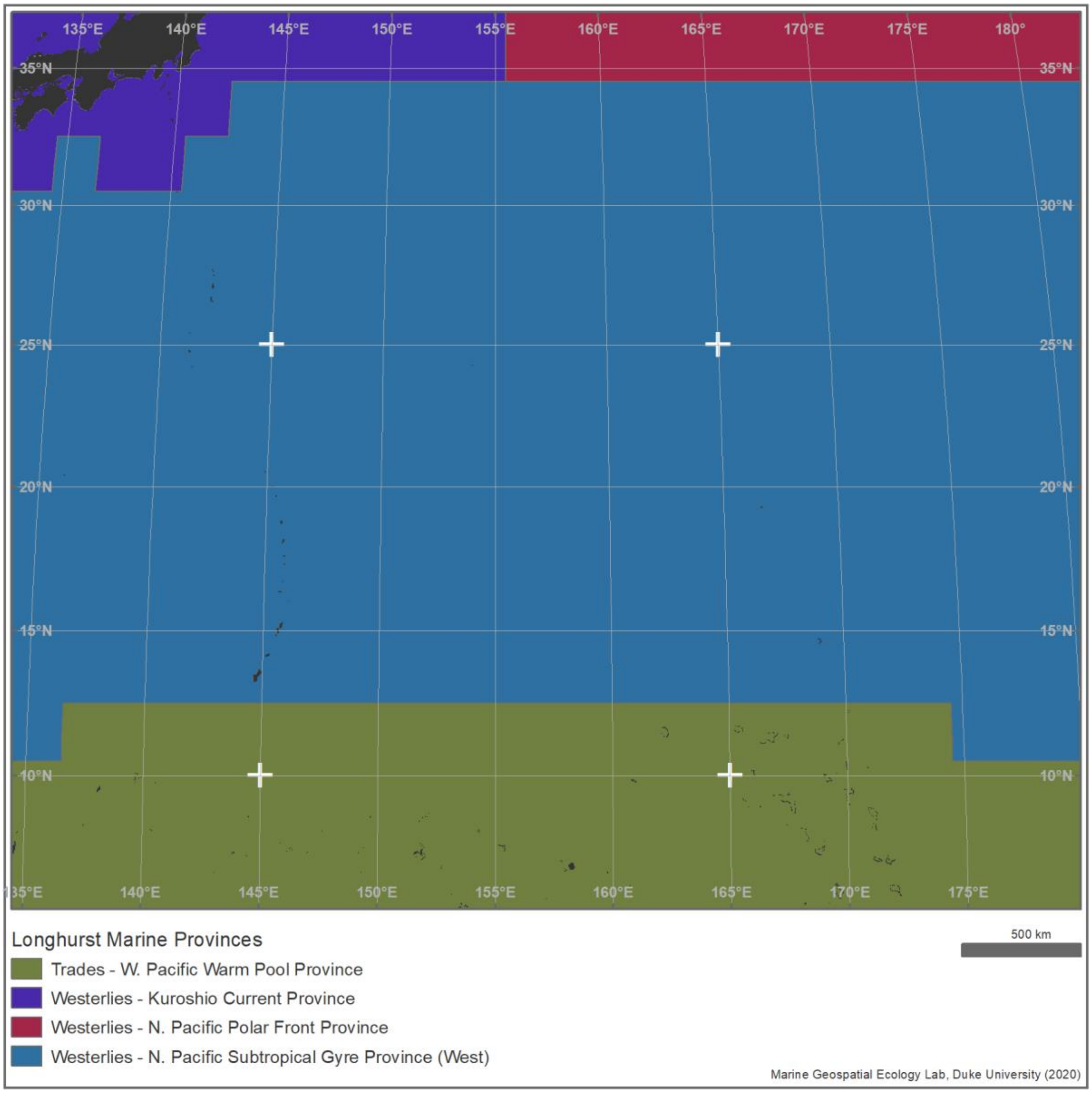

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Figure 4.3-1 Longhurst marine provinces

4.4 Global Seascapes

Abstract (Harris & Whiteway 2009):
"Designing a representative network of high seas marine protected areas (MPAs) requires an acceptable scheme to classify the benthic (as well as the pelagic) bioregions of the oceans. Given the lack of sufficient biological information to accomplish this task, we used a multivariate statistical method with 6 biophysical variables (depth, seabed slope, sediment thickness, primary production, bottom water dissolved oxygen and bottom temperature) to objectively classify the ocean floor into 53,713 separate polygons comprising 11 different categories, that we have termed seascapes. A cross-check of the seascape classification was carried out by comparing the seascapes with existing maps of seafloor geomorphology and seabed sediment type and by GIS analysis of the number of separate polygons, polygon area and perimeter/area ratio. We conclude that seascapes, derived using a multivariate statistical approach, are biophysically meaningful subdivisions of the ocean floor and can be expected to contain different biological associations, in as much as different geomorphological units do the same. Less than 20% of some seascapes occur in the high seas while other seascapes are largely confined to the high seas, indicating specific types of environment whose protection and conservation will require international cooperation. Our study illustrates how the identification of potential sites for high seas marine protected areas can be accomplished by a simple GIS analysis of seafloor geomorphic and seascape classification maps. Using this approach, maps of seascape and geomorphic heterogeneity were generated in which heterogeneity hotspots identify themselves as MPA candidates. The use of computer aided mapping tools removes subjectivity in the MPA design process and provides greater confidence to stakeholders that an unbiased result has been achieved."

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

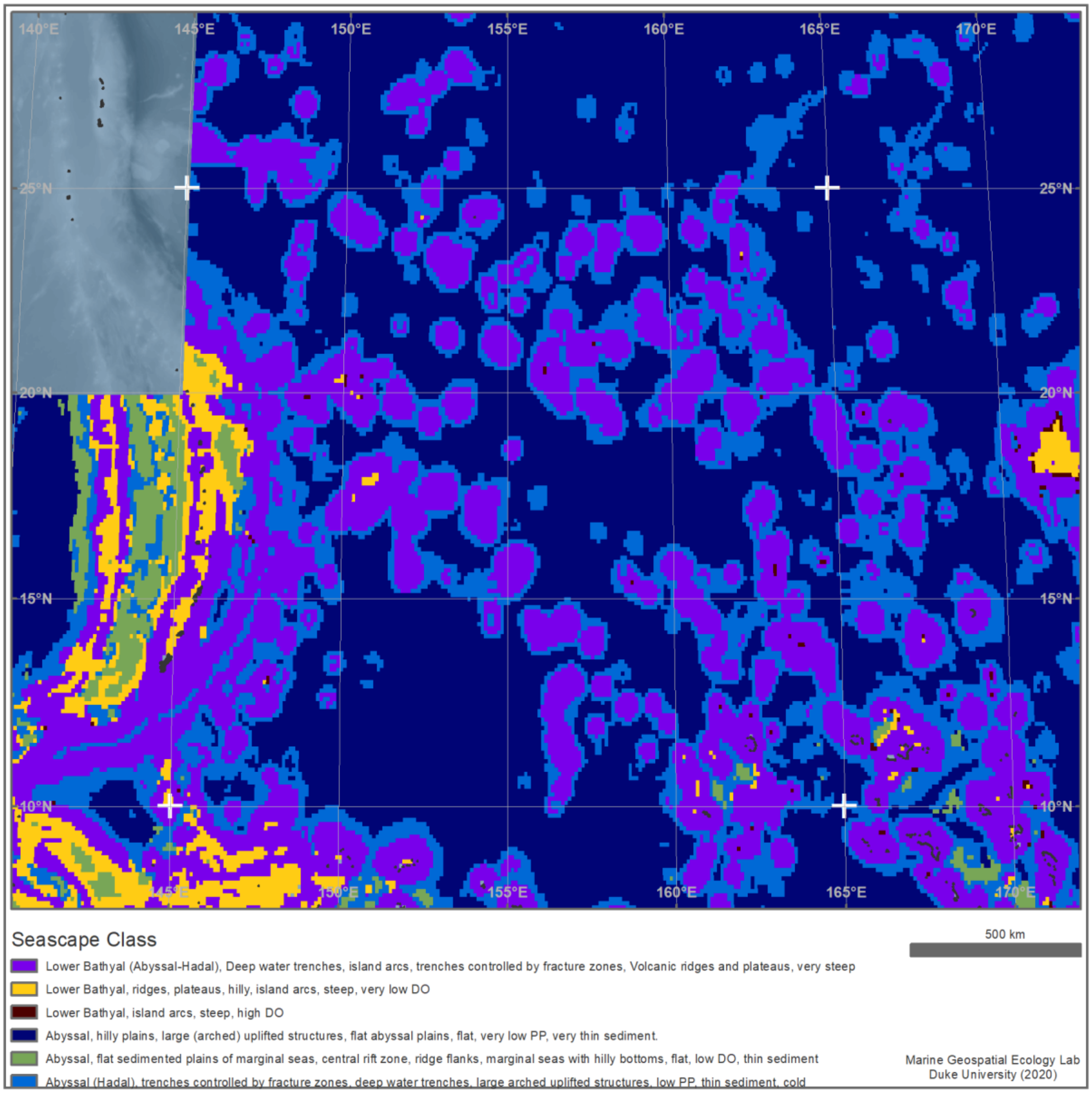

Figure 4.4-1 Global seascapes

5 Human Uses

5.1 Demersal Destructive Fishing

Here we include a map of demersal destructive fishing from Halpern et al. (2015). These data were created as an input for an analysis of the global impact of human uses on the marine ecosystem.

Reference:
Halpern, B. S. et al. 2015. Spatial and temporal changes in cumulative human impacts on the world’s ocean. - Nat Commun 6: 1–7.

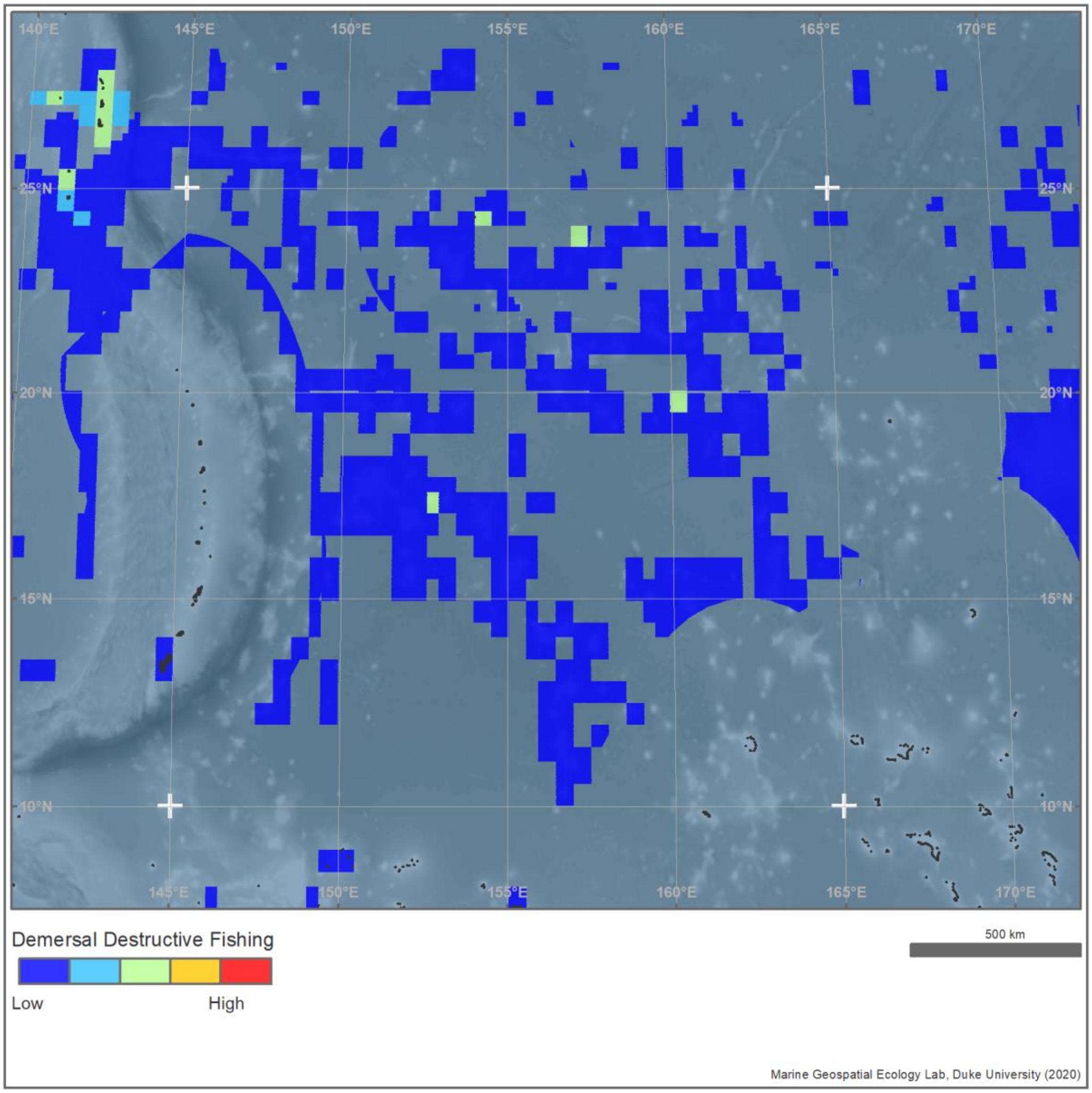

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Figure 5.1-1 Demersal destructive bottom fishing

5.2 Fishing Effort by Gear Type, Global Fishing Watch

Abstract

"Although fishing is one of the most widespread activities by which humans harvest natural resources, its global footprint is poorly understood and has never been directly quantified. We processed 22 billion automatic identification system messages and tracked >70,000 industrial fishing vessels from 2012 to 2016, creating a global dynamic footprint of fishing effort with spatial and temporal resolution two to three orders of magnitude higher than for previous data sets. Our data show that industrial fishing occurs in >55% of ocean area and has a spatial extent more than four times that of agriculture. We find that global patterns of fishing have surprisingly low sensitivity to short-term economic and environmental variation and a strong response to cultural and political events such as holidays and closures."

Reference:

Kroodsma, David A., Juan Mayorga, Timothy Hochberg, Nathan A. Miller, Kristina Boerder, Francesco Ferretti, Alex Wilson, et al. 2018. "Tracking the Global Footprint of Fisheries." *Science* 359 (6378): 904–8. https://doi.org/10.1126/science.aao5646.

"Daily fishing effort, gridded at 0.01 degrees, by geartype and flag state, is available to download. Fishing effort is available for the time period 2012 to 2016."

Source: https://globalfishingwatch.org/datasets-and-code/fishing-effort/

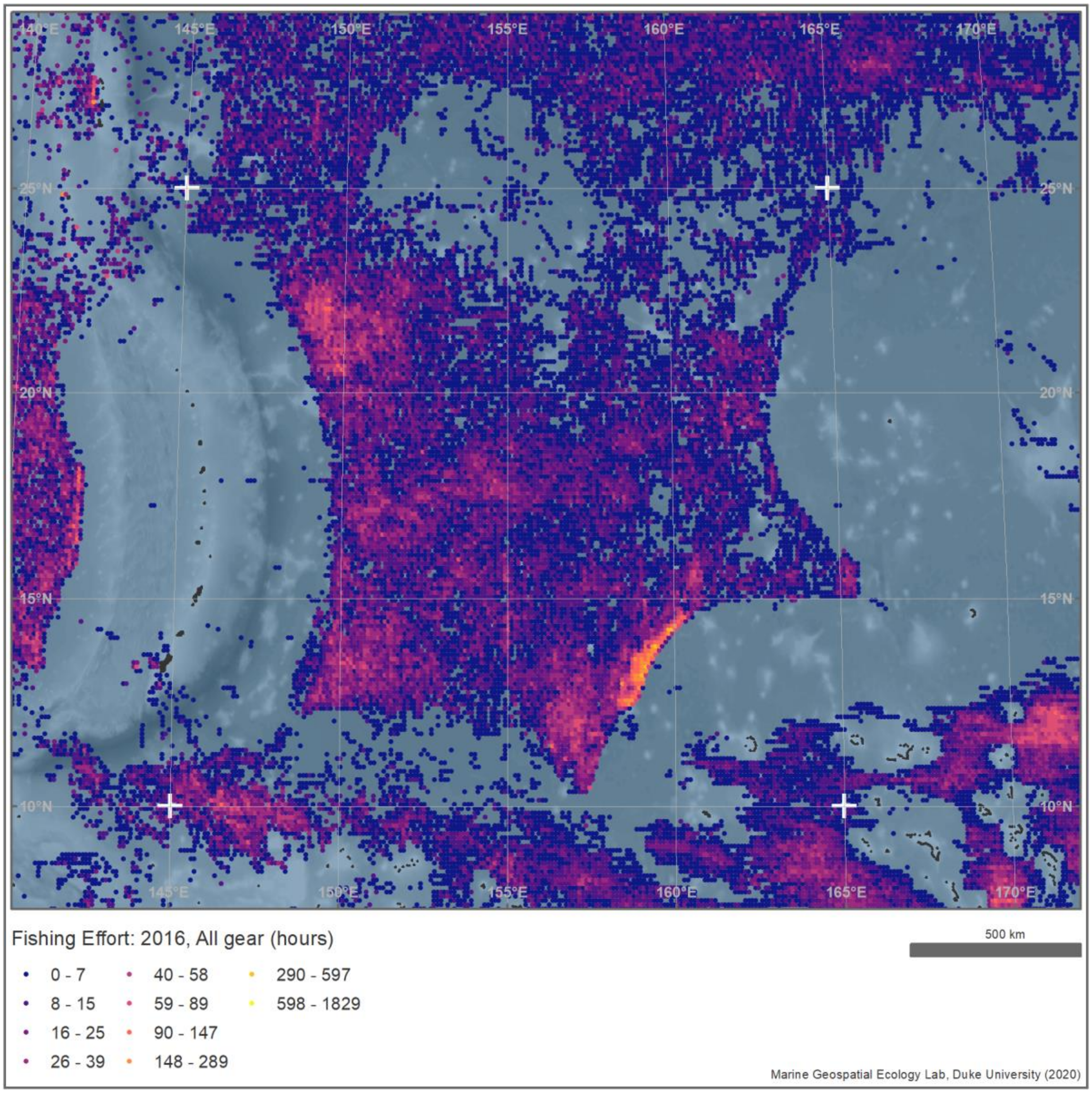

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Figure 5.2-1 Fishing effort in 2016, all gear types

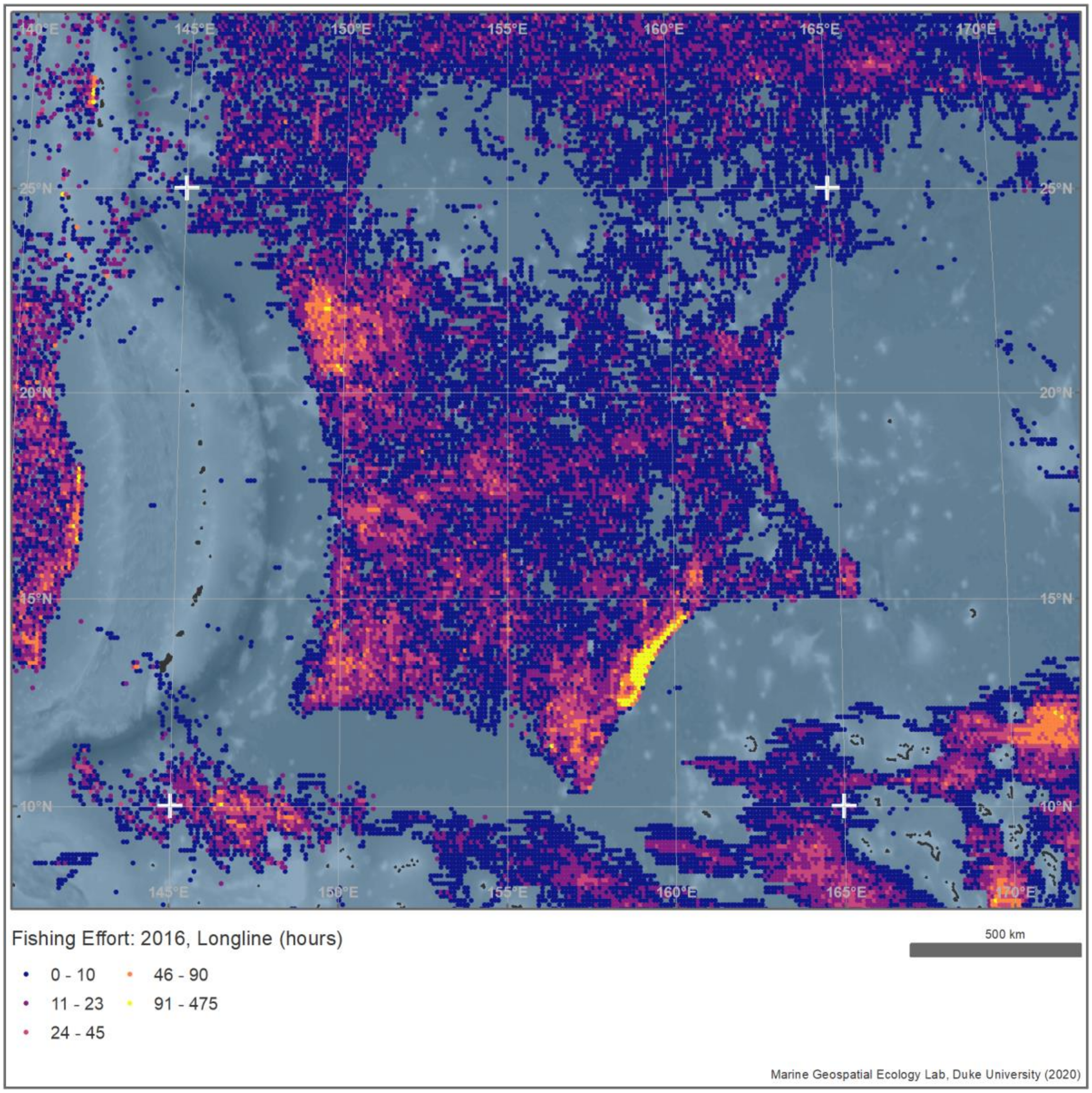

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Figure 5.2-2 Fishing effort in 2016, Longline

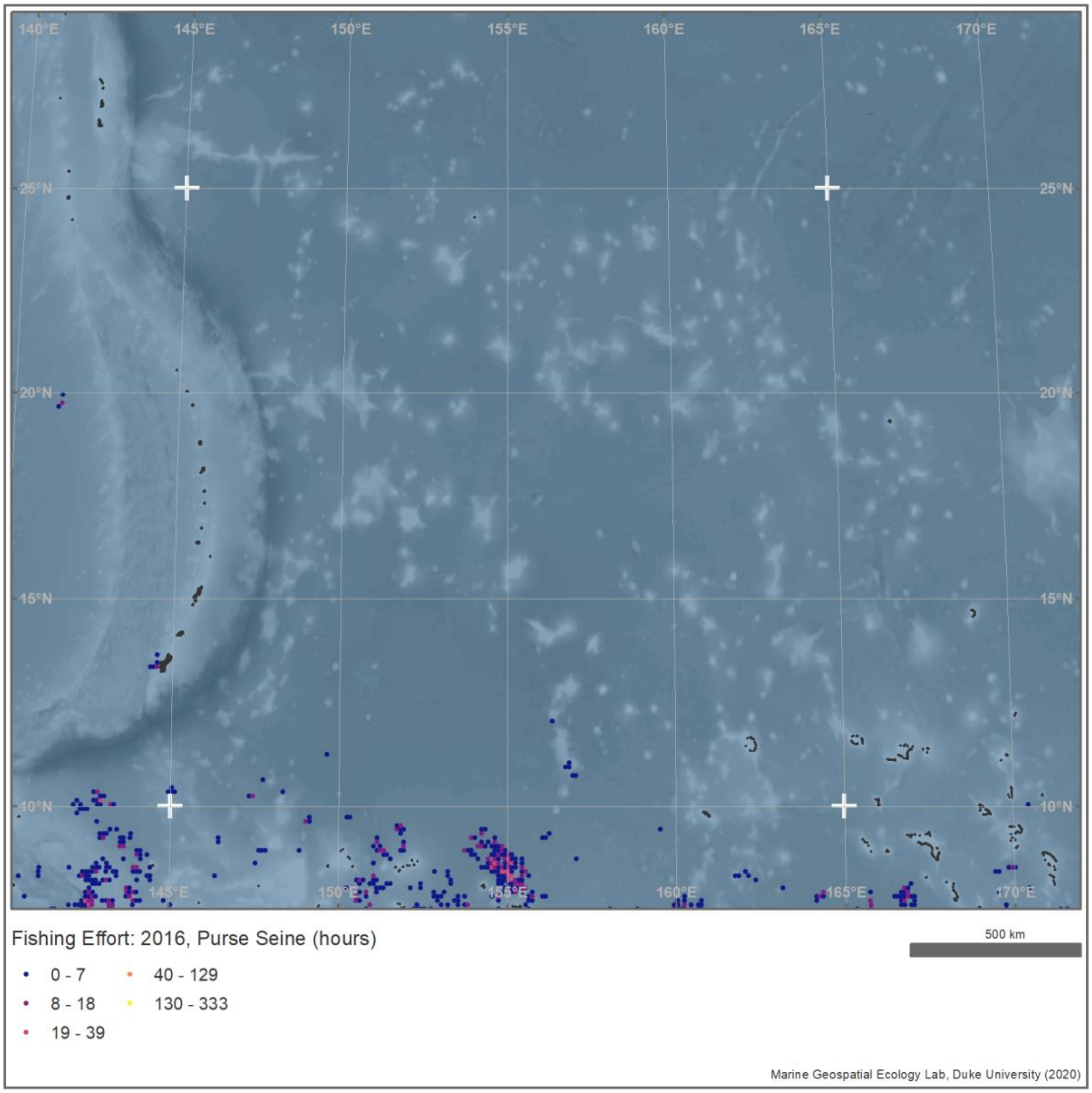

Figure 5.2-3 Fishing effort in 2016, Purse Seine

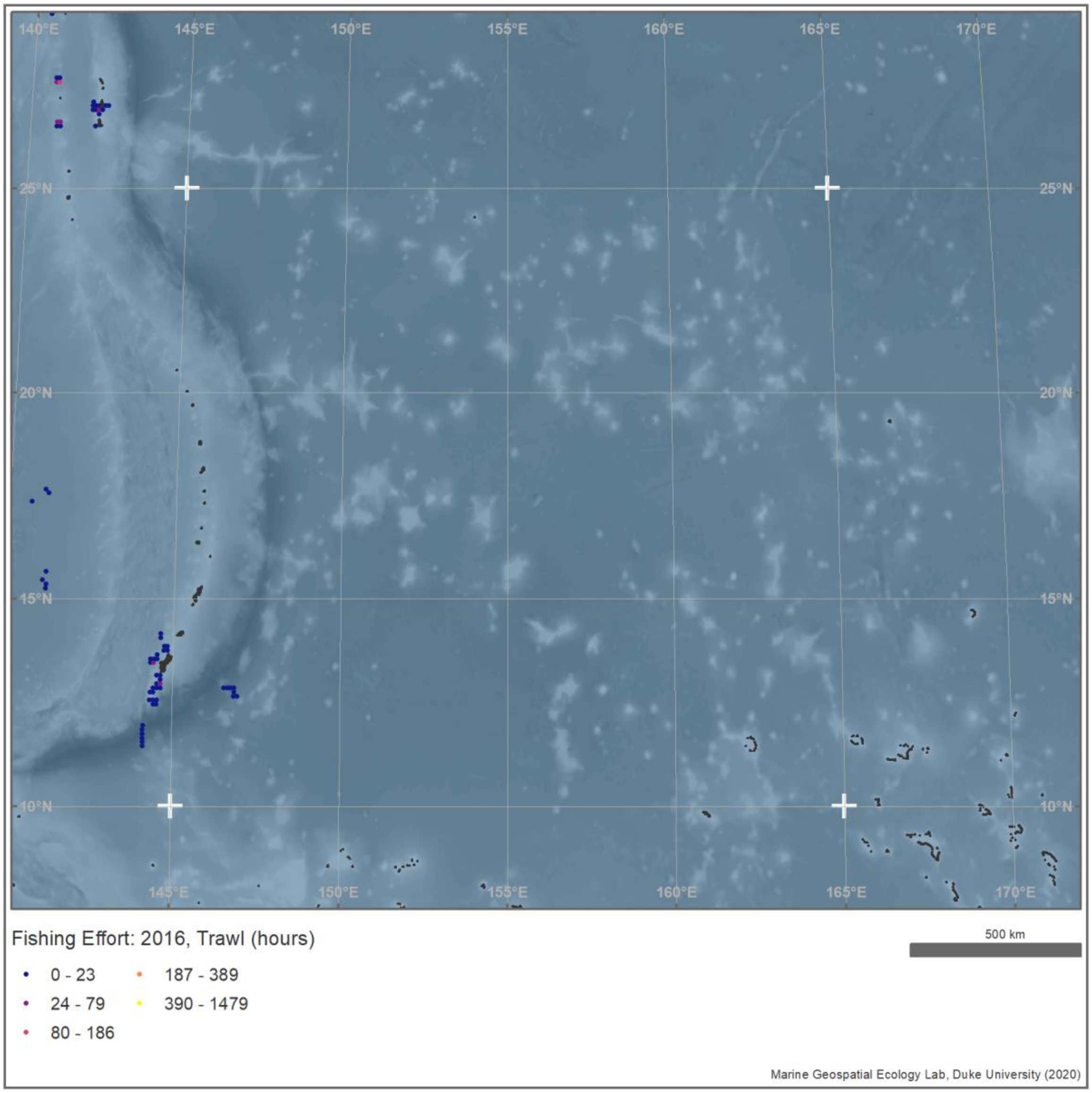

Figure 5.2-4 Fishing effort in 2016, Trawl

5.3 Global Fishing Reconstruction

"The reconstructed data we present combine official reported catch data and reconstructed estimates of unreported catches (including major discards), with reference to individual EEZs. Officially reported catch data are mainly extracted from the Food and Agriculture Organization of the United Nations (FAO) FishStat database. For background information on reconstruction data, download the .pdf associated with each relevant EEZ. The taxon distributions represent the most up-to-date information on biological distribution of taxa, as assembled by FishBase and SeaLifeBase. Users of *Sea Around Us* catch maps and the associated ½ x ½ degree data should be aware that the spatial precision implied by our global use of ½ degree lat./long. cells, which is appropriate for coastal cells, is likely problematic for offshore and High Seas cells. This is due to the catches they contain having been derived from spatially reported catch data provided by Regional Fisheries Management Organizations (RFMOs) in much larger spatial cells (1, 5, 10 or even 20 degree lat./long.). Our subsequent allocation of these data to ½ degree cells *within* each of the RFMO cells is based on our standard allocation approach, as described in Zeller *et al*. (2016, *Marine Policy* 70: 145-152). This allocation is not likely to reflect the precise location of catches being taken from each ½ degree cell within each RFMO cell in each year. Thus, users of these data need to evaluate carefully their use of our spatially allocated data, as the spatial scale at which one analyses these data needs to be driven by the type of question one asks (see Amoroso *et al*. 2018, *Science* 361(6404): eaat6713; and Kroodsma *et al*. 2018, *Science* 361(6404): eaat7789 on appropriate scaling). The *Sea Around Us*, in collaboration with the Global Fishing Watch, is developing improvements in spatial allocations of catch data that address this and related issues."

Source: http://www.seaaroundus.org/data/#/spatial-catch

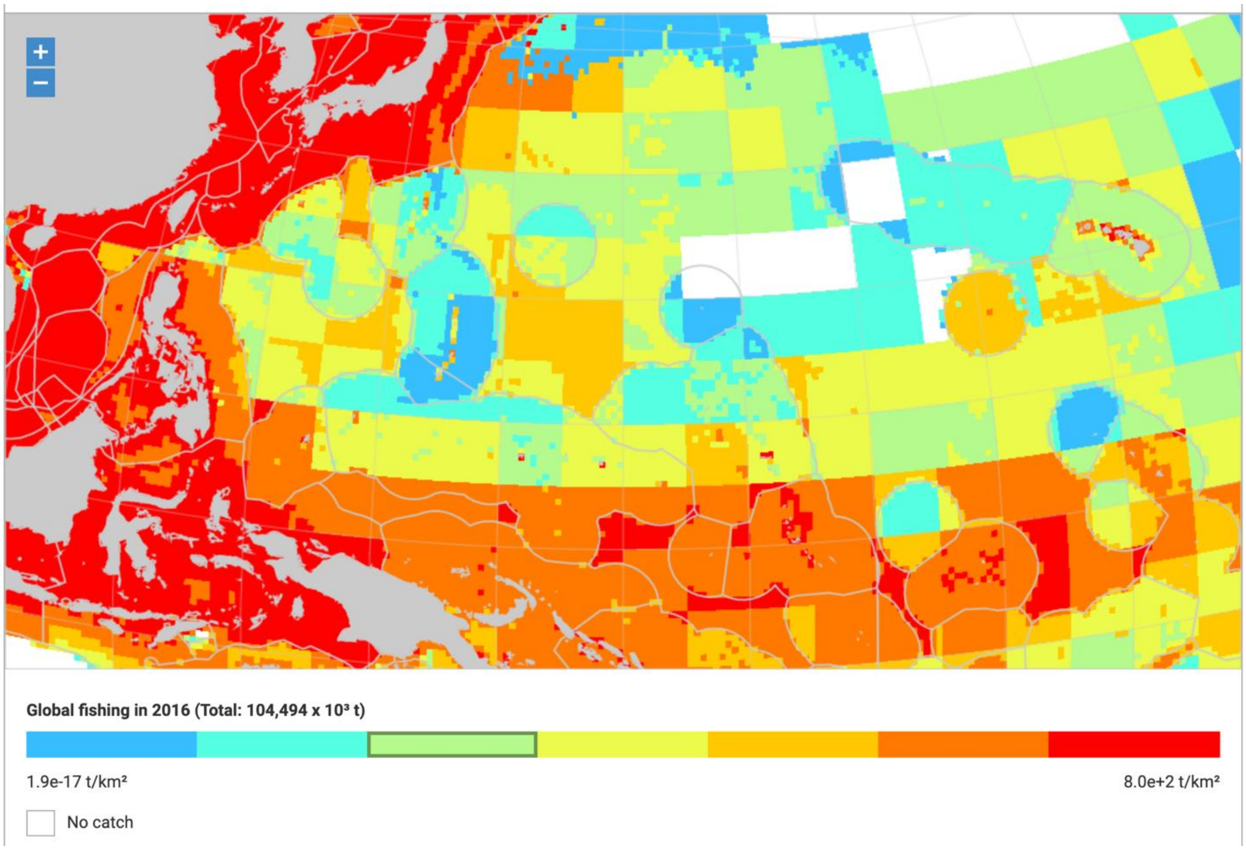

Figure 5.3-1 Global fishing reconstruction, 2016

5.4 Commercial Shipping

Here we include a map of commercial shipping from Halpern et al. (2008) that was created as an input for an analysis of the global impact of human uses on the marine ecosystem.

Supplementary Material:
“Ships from many countries voluntarily participate in collecting meteorological data globally, and therefore also report the location of the ship. We used data collected from 12 months beginning October 2004 (collected as part of the World Meteorological Organization Voluntary Observing Ships Scheme; http://www.vos.noaa.gov/vos_scheme.shtml) as this year had the most ships with vetted protocols and so provides the most representative estimate of global ship locations. The data include unique identifier codes for ships (mobile or a single datum) and stationary buoys and oil platforms (multiple data at a fixed location); we removed all stationary and single point ship data, leaving 1,189,127 mobile ship data points from a total of 3,374 commercial and research vessels, representing roughly 11% of the 30,851 merchant ships >1000 gross tonnage at sea in 2005 (S*14*). We then connected all mobile ship data to create ship tracks, under the assumption that ships travel in straight lines (a reasonable assumption since ships minimize travel distance in an effort to minimize fuel costs). Finally, we removed any tracks that crossed land (e.g. a single ship that records its location in the Atlantic and the Pacific would have a track connected across North America), buffered the remaining 799,853 line segments to be 1km wide to account for the width of shipping lanes, summed all buffered line segments to account for overlapping ship tracks, and converted summed ship tracks to raster data. This produced 1 km2 raster cells with values ranging from 0 to 1,158, the maximum number of ship tracks recorded in a single 1 km2 cell. Because the VOS program is voluntary, much commercial shipping traffic is not captured by these data. Therefore our estimates of the impact of shipping are biased (in an unknown way) to locations and types of ships engaged in the program. In particular, high traffic locations may be strongly underestimated, although the relative impact on these areas versus low-traffic areas appears to be well-captured by the available data, and areas identified as without shipping may actually have low levels of ship traffic. Furthermore, because ships report their location with varying distance between signals, ship tracks are estimates of the actual shipping route taken.”

Reference:

Halpern, B. S. et al. 2008. A Global Map of Human Impact on Marine Ecosystems. - Science 319: 948–952.

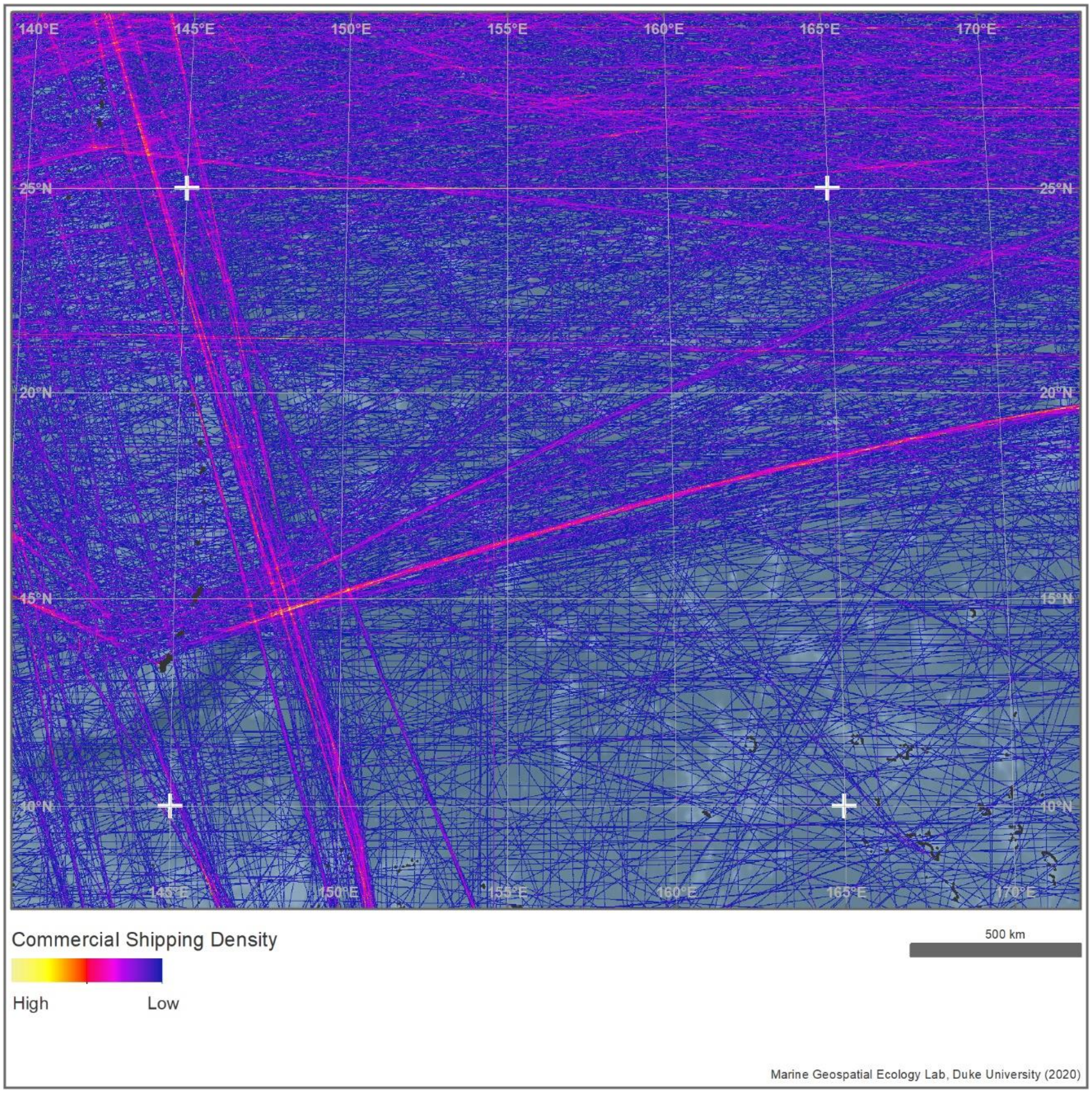

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Figure 5.4-1 Commercial shipping density

5.5 Undersea Telecommunications Cables

“This dataset is an attempt to consolidate all the available information about the undersea communications infrastructure. The initial data was harvested from Wikipedia, and further information was gathered by simply googling and transcribing as much data as possible into a useful format, namely a rich geocoded format.”

Source:
https://koordinates.com/layer/3722-undersea-telecommunication-cables/

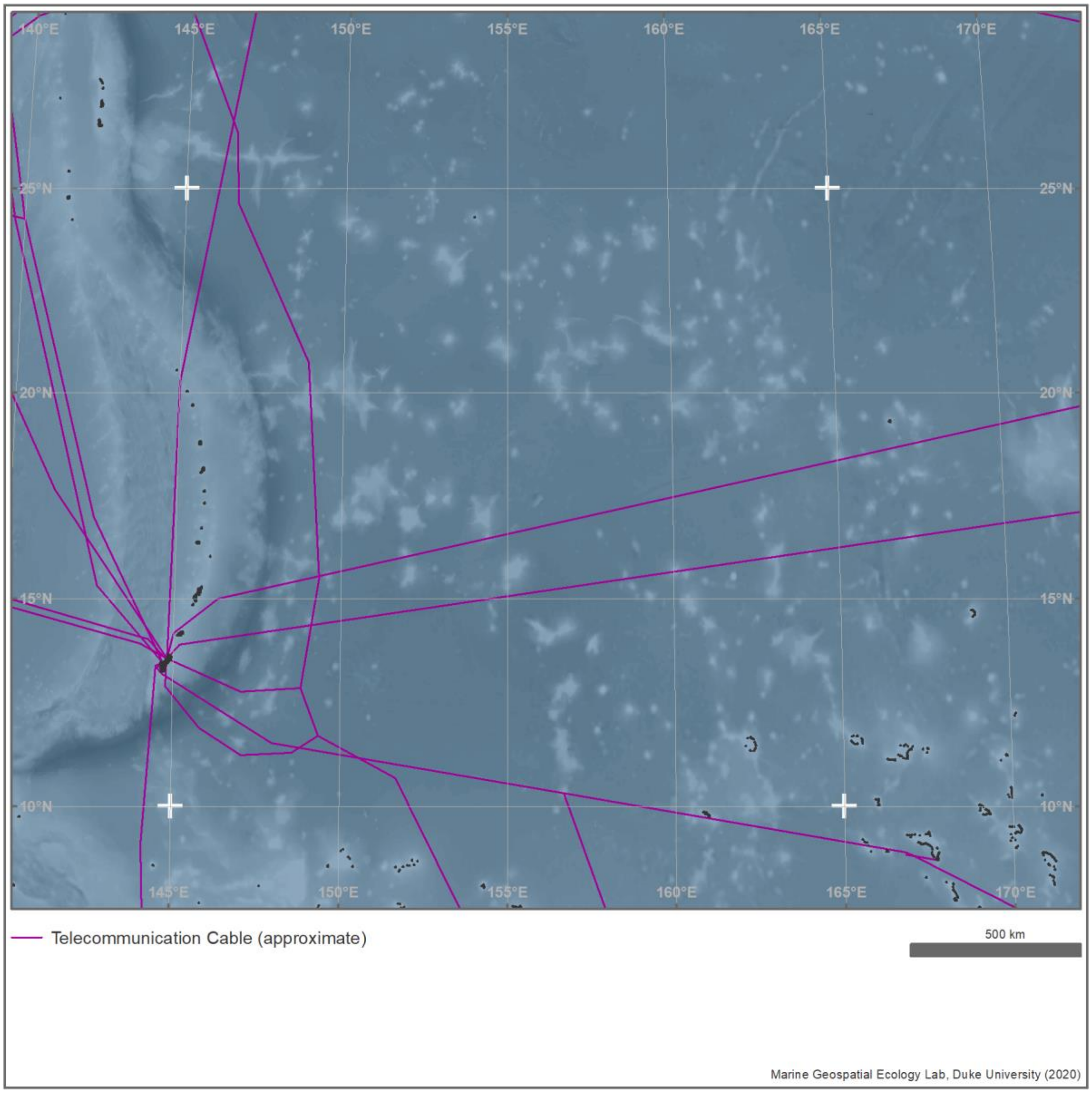

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Figure 5.5-1 Undersea telecommunications cables

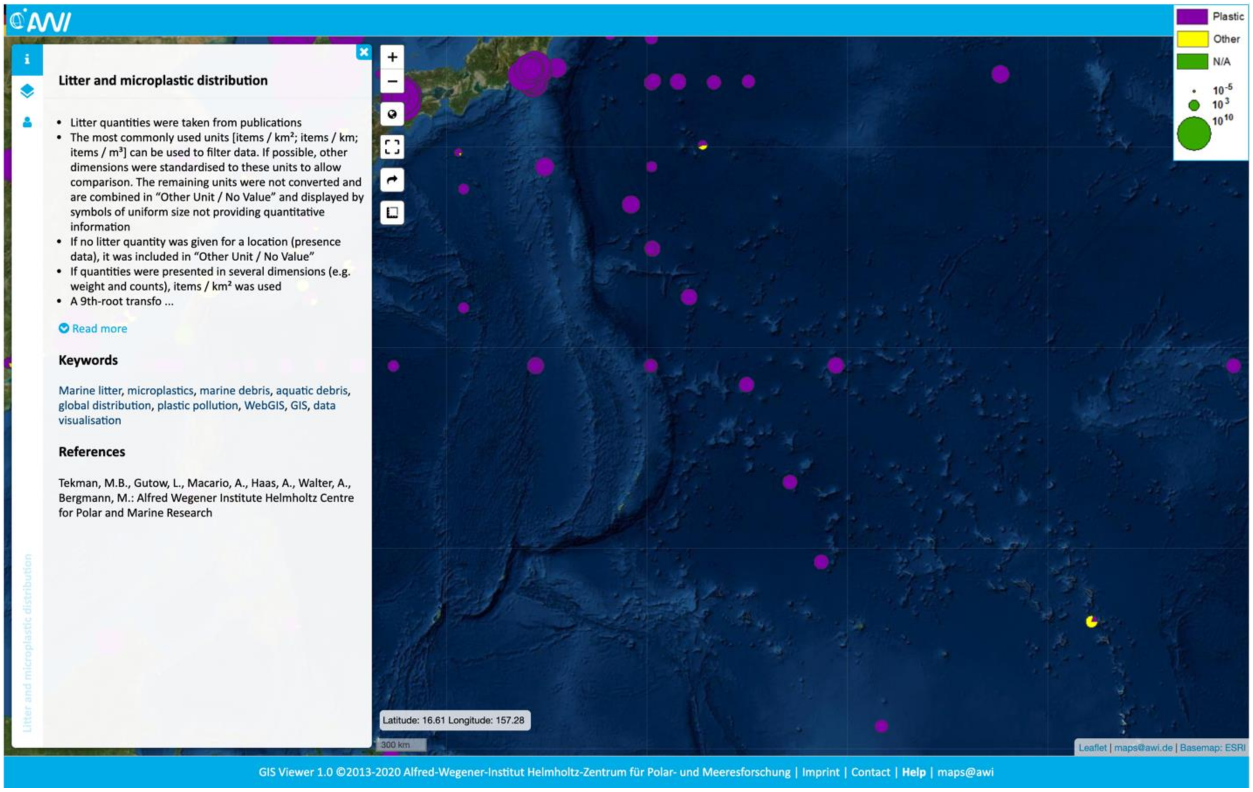
5.6 LITTERBASE: Distribution of Litter and Microplastic

“LITTERBASE currently comprises 1,036 scientific publications on the amount, distribution and composition of litter in the ocean and other watercourses. This information is continuously updated and visualised in global distribution maps. However, litter has been quantified in many different units by different workers, which hampers direct comparison. Therefore, users can select subsets of data with the same unit for direct comparison in addition to global maps with all litter quantities. Furthermore, the information on display can be filtered according to size category of the litter (macro: > 5 mm, micro: ≤ 5 mm, nano: ≤ 100 nm) and habitat considered (beach, sea surface, water column, seabed).

The global map shows that there is already a lot of information available on litter pollution from certain areas, for example, the Mediterranean Sea. By contrast, much less is known about litter pollution in the tropics, around Africa or the Polar Regions. The map also shows that litter quantities vary strongly within certain regions (e.g. in the Southwest Pacific and East Asia).”

Source: https://litterbase.awi.de/litter_detail

Reference:
Tekman MB, Gutow L, Macario A, Haas A, Walter A, Bergmann M: Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung



Litter and microplastic distribution

- Litter quantities were taken from publications
- The most commonly used units [items / km²; items / km; items / m³] can be used to filter data. If possible, other dimensions were standardised to these units to allow comparison. The remaining units were not converted and are combined in “Other Unit / No Value” and displayed by symbols of uniform size not providing quantitative information
- If no litter quantity was given for a location (presence data), it was included in “Other Unit / No Value”
- If quantities were presented in several dimensions (e.g. weight and counts), items / km² was used
- A 9th-root transfo ...

Read more

Keywords

Marine litter, microplastics, marine debris, aquatic debris, global distribution, plastic pollution, WebGIS, GIS, data visualisation

References

Tekman, M.B., Gutow, L., Macario, A., Haas, A., Walter, A., Bergmann, M.: Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Figure 5.6-1 Litter and microplastic distribution

5.7 Cumulative Human Impacts on the World’s Ocean

Abstract (Halpern 2015):
“Human pressures on the ocean are thought to be increasing globally, yet we know little about their patterns of cumulative change, which pressures are most responsible for change, and which places are experiencing the greatest increases. Managers and policymakers require such information to make strategic decisions and monitor progress towards management objectives. Here we calculate and map recent change over 5 years in cumulative impacts to marine ecosystems globally from fishing, climate change, and ocean- and land-based stressors. Nearly 66% of the ocean and 77% of national jurisdictions show increased human impact, driven mostly by climate change pressures. Five percent of the ocean is heavily impacted with increasing pressures, requiring management attention. Ten percent has very low impact with decreasing pressures. Our results provide large-scale guidance about where to prioritize management efforts and affirm the importance of addressing climate change to maintain and improve the condition of marine ecosystems.”

Reference:
Halpern, B. S. et al. 2015. Spatial and temporal changes in cumulative human impacts on the world’s ocean. - Nat Commun 6: 1–7.doi:10.1038/ncomms8615

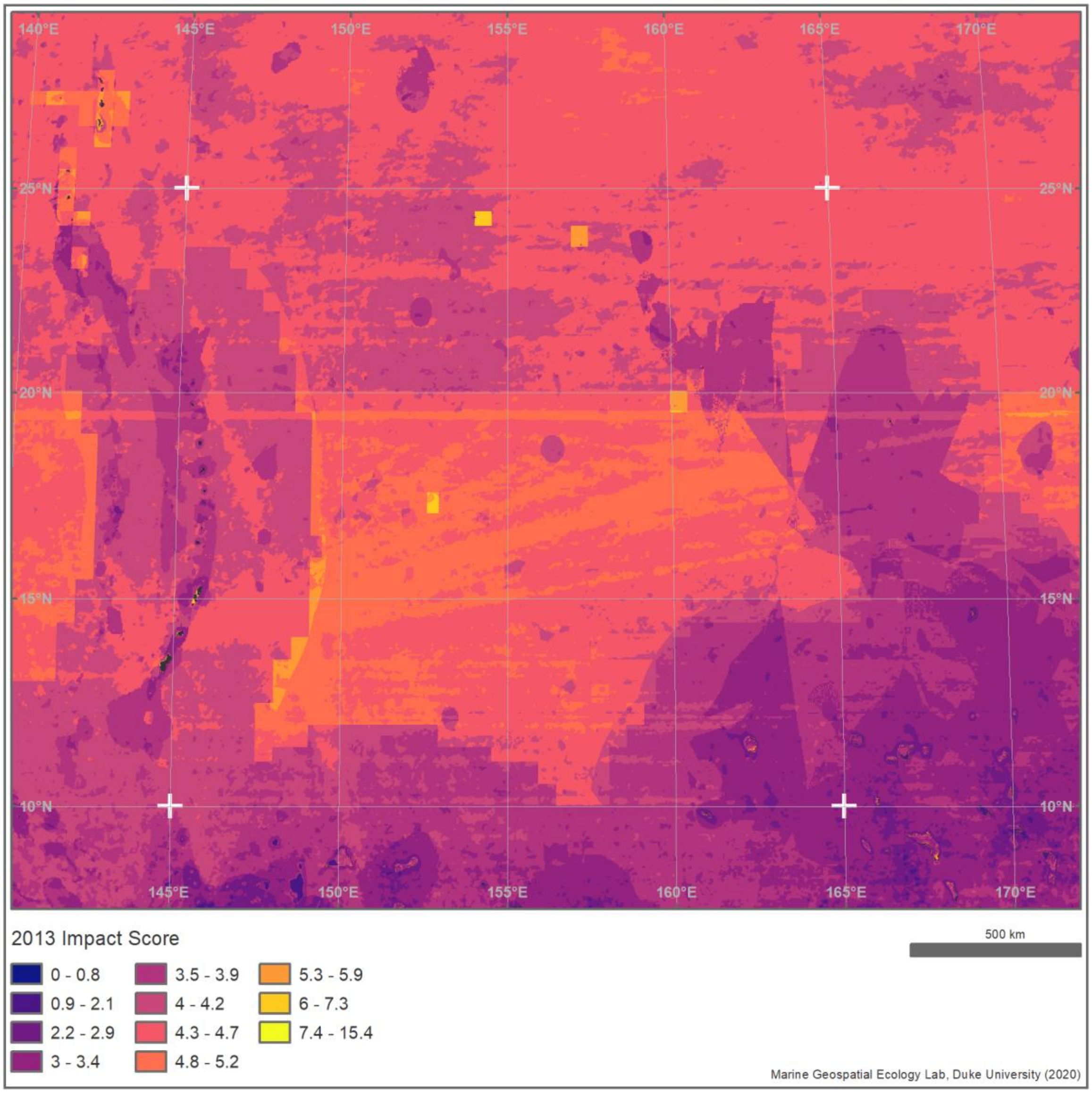


Figure 5.7-1 Cumulative human impact, 2013

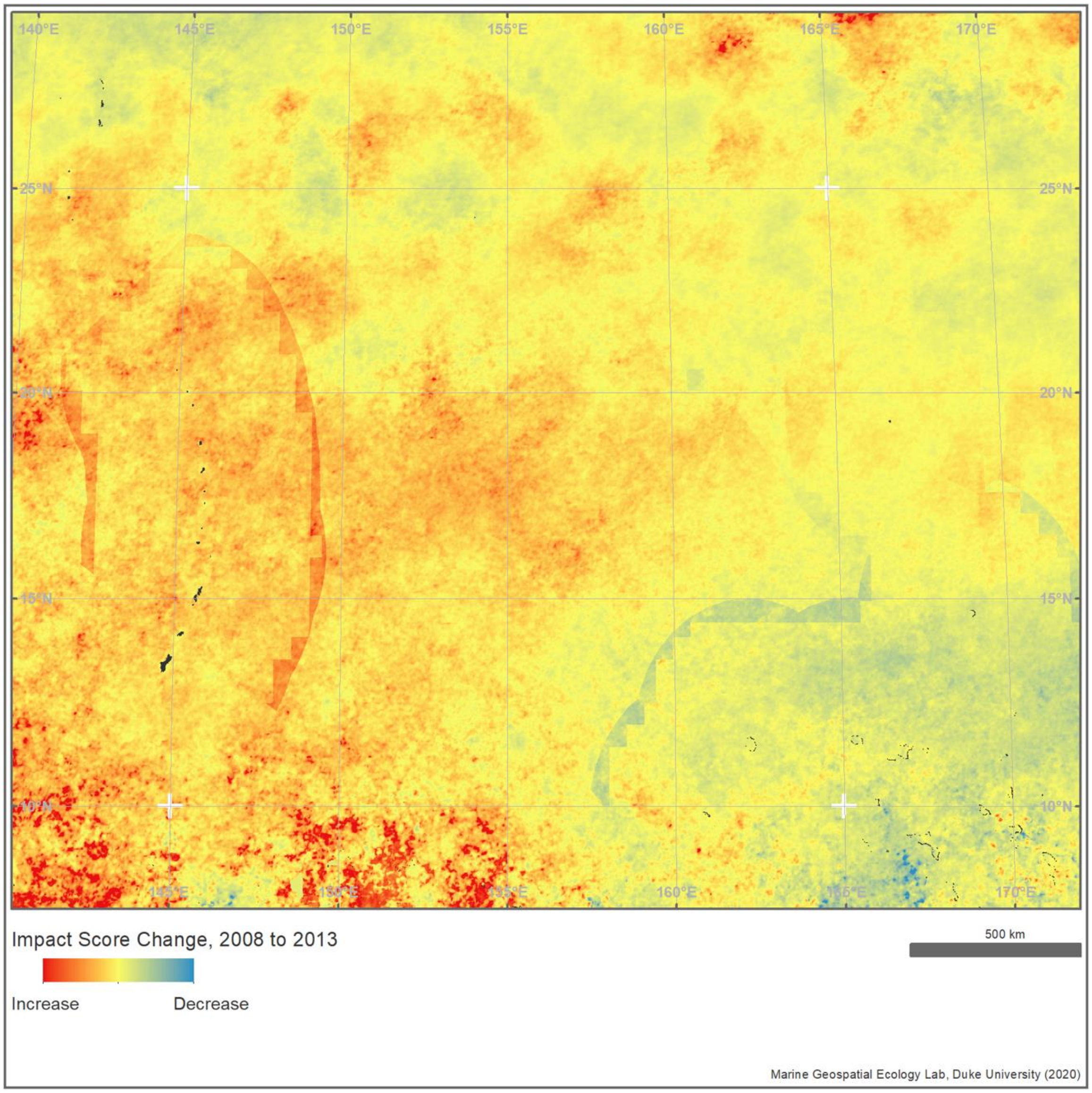


Figure 5.7-2 Change in cumulative human impact, 2008 to 2013

5.8 ISA Contract Areas for Exploration for Mineral Resources in the Area

The International Seabed Authority (https://www.isa.org.jm/) has entered into 15-year contracts for exploration for polymetallic nodules (18 contracts), polymetallic sulphides (7 contracts) and cobalt-rich ferromanganese crusts (5 contracts) in the deep seabed.

Eighteen of these contracts are for exploration for polymetallic nodules in the Clarion-Clipperton Fracture Zone (16), Central Indian Ocean Basin (1) and North-west Pacific (1). There are seven contracts for exploration for polymetallic sulphides in the South West Indian Ridge, Central Indian Ridge and the Mid-Atlantic Ridge and five contracts for exploration for cobalt-rich crusts in the Northwest Pacific and the South Atlantic.

The current areas of exploration are as per the following maps and data produced by the Authority: https://www.isa.org.jm/maps

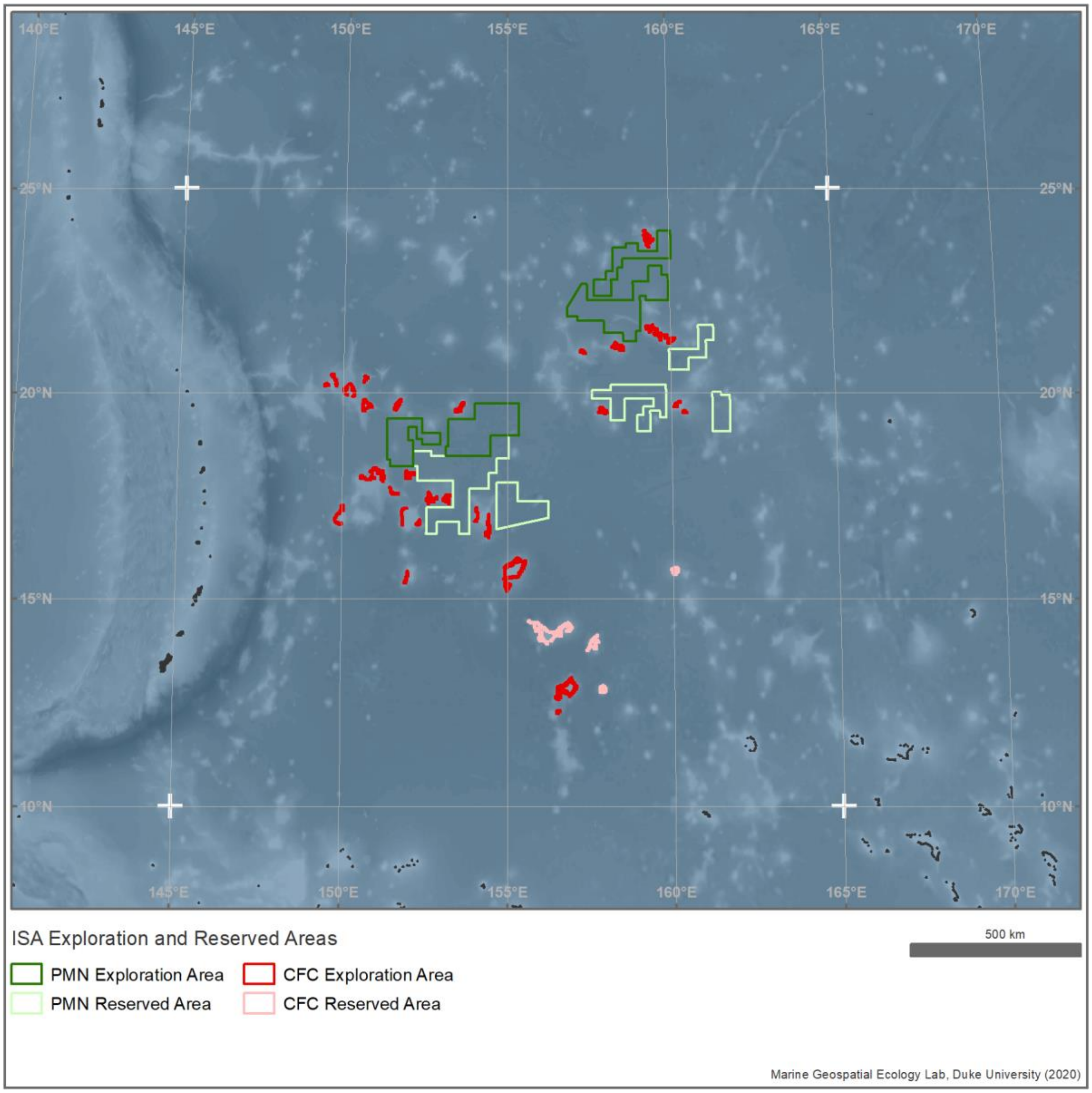


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Figure 5.8-1 ISA exploration and reserved areas

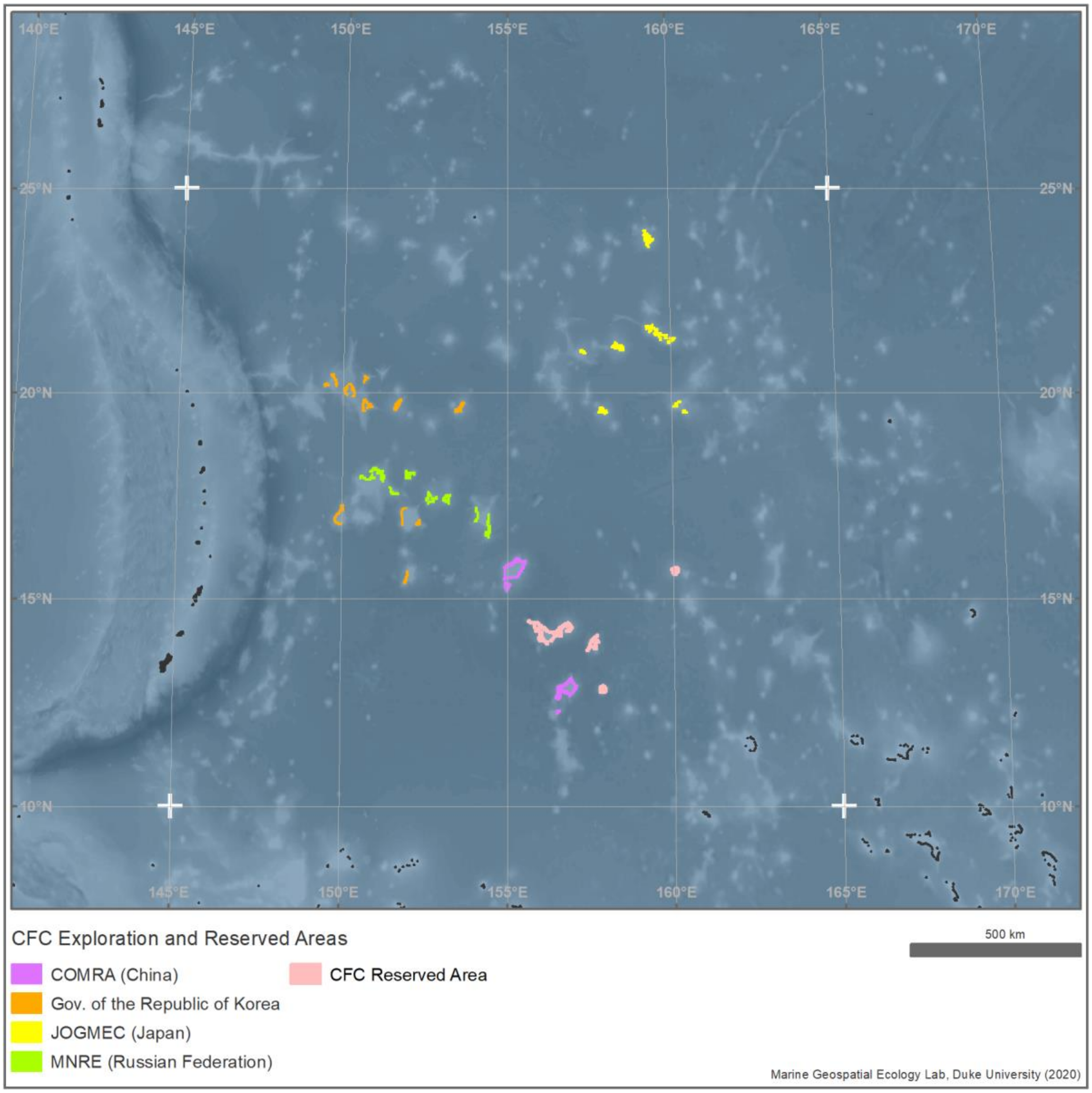

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Figure 5.8-2 ISA Cobalt-Rich Ferromanganese Crusts (CFC) exploration and reserved areas

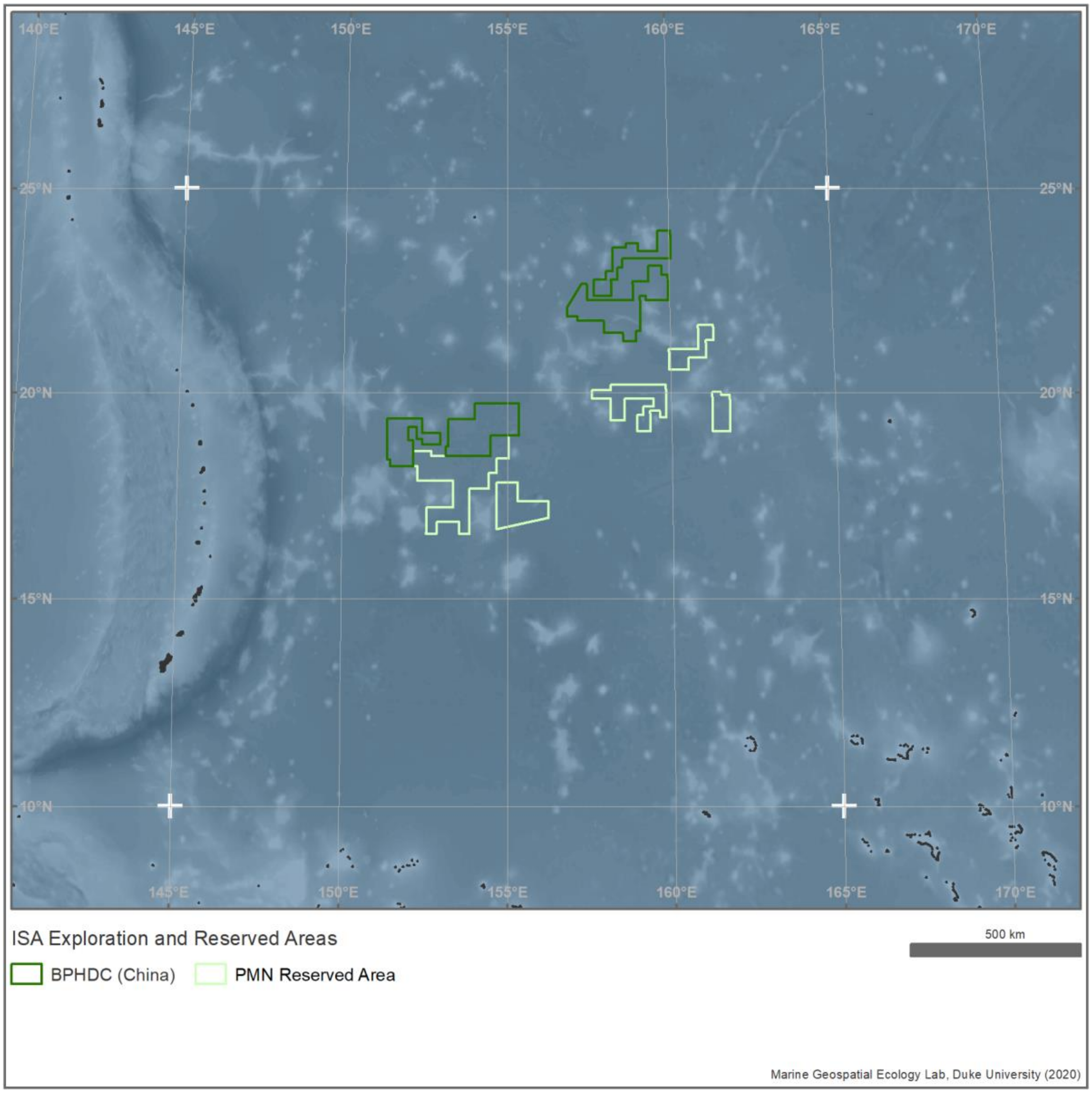

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Figure 5.8-3 ISA Polymetallic Nodules (PMN) exploration and reserved areas

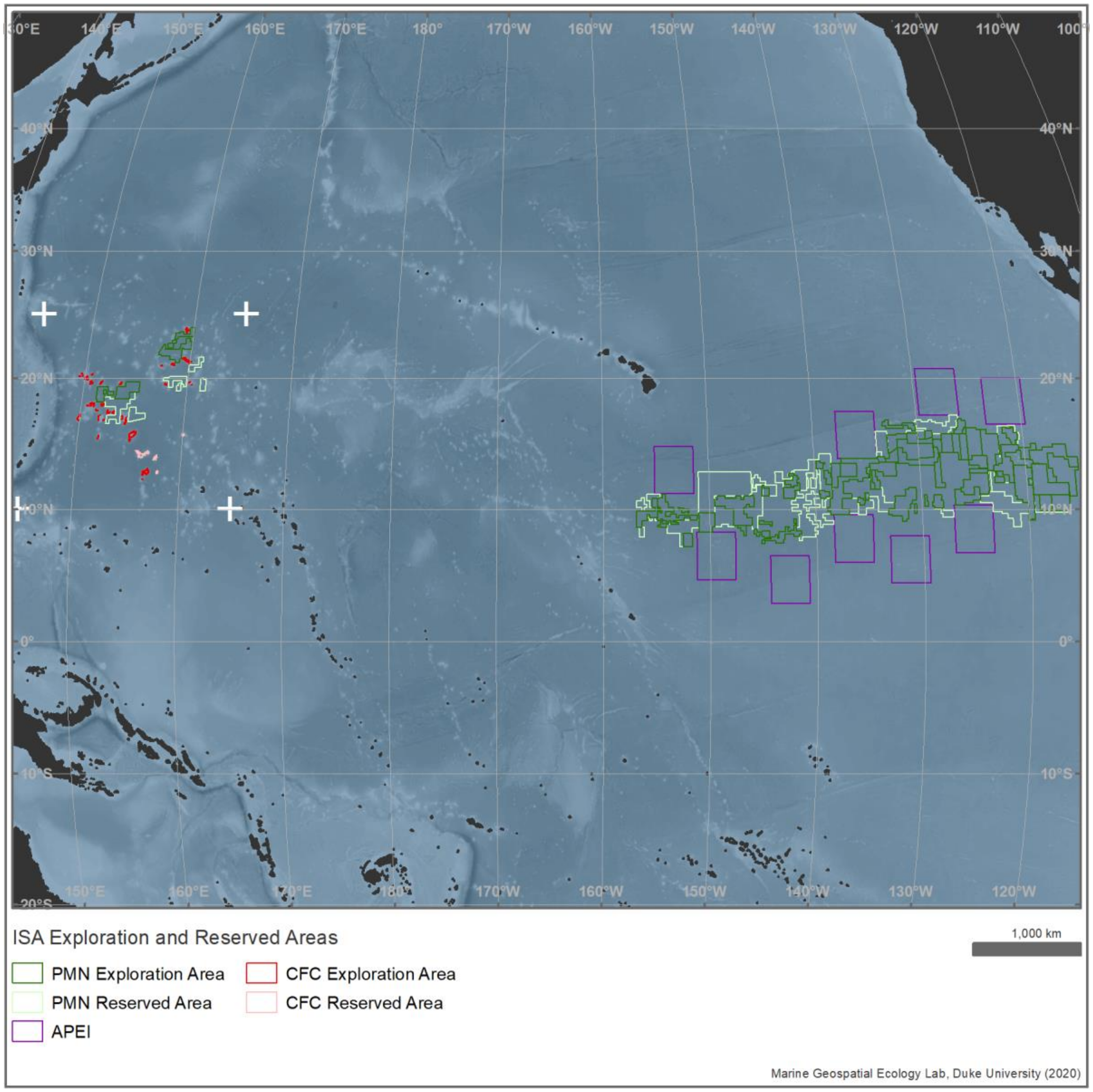

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Figure 5.8-4 ISA exploration and reserved areas in the Pacific Ocean

6 Areas Defined for Management and/or Conservation Objectives

6.1 Regional Fishery Bodies (RFB)

Regional Fishery Bodies (RFBs) are a mechanism through which States or organizations that are parties to an international fishery agreement or arrangement work together towards the conservation, management and/or development of fisheries (http://www.fao.org/fishery/topic/16800/en). The mandates of RFBs vary. Some RFBs have an advisory mandate, and provide advice, decisions or coordinating mechanisms that are not binding on their members. Some RFBs have a management mandate – these are called Regional Fisheries Management Organizations (RFMOs). They adopt fisheries conservation and management measures that are binding on their members. The RFMOs include the North Atlantic Fisheries Organisation (NAFO), North East Atlantic Fisheries Commission (NEAFC), the South East Atlantic Fisheries Organisation (SEAFO).

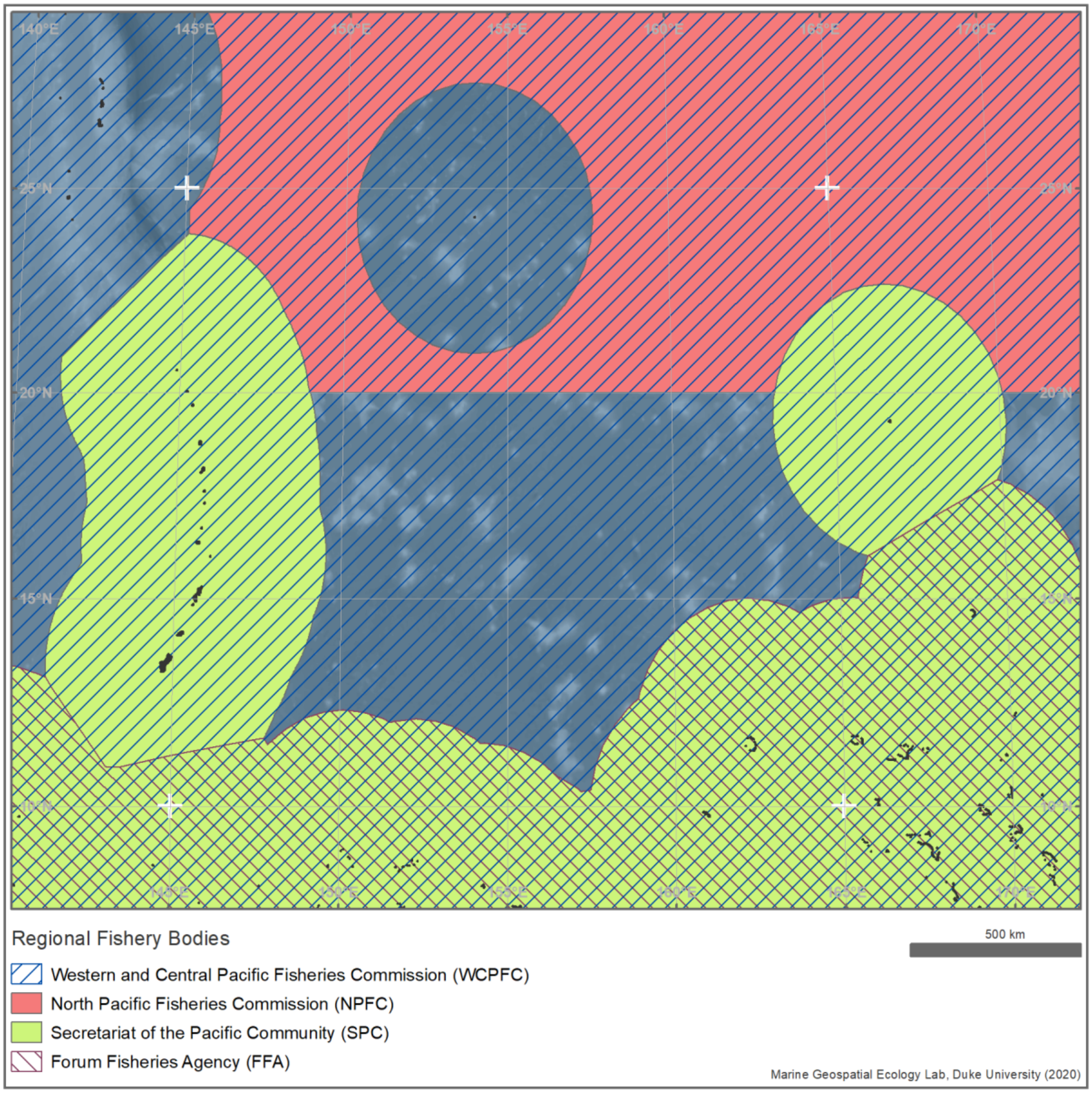

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Figure 6.1-1 Regional Fishery Bodies in the Northwest Pacific

6.2 Marine Protected Areas

“Protected Planet is the most up to date and complete source of information on protected areas, updated monthly with submissions from governments, non-governmental organizations, landowners and communities. It is managed by the United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC) with support from IUCN and its World Commission on Protected Areas (WCPA).
It is a publicly available online platform where users can discover terrestrial and marine protected areas, access related statistics and download data from the World Database on Protected Areas (WDPA).”

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

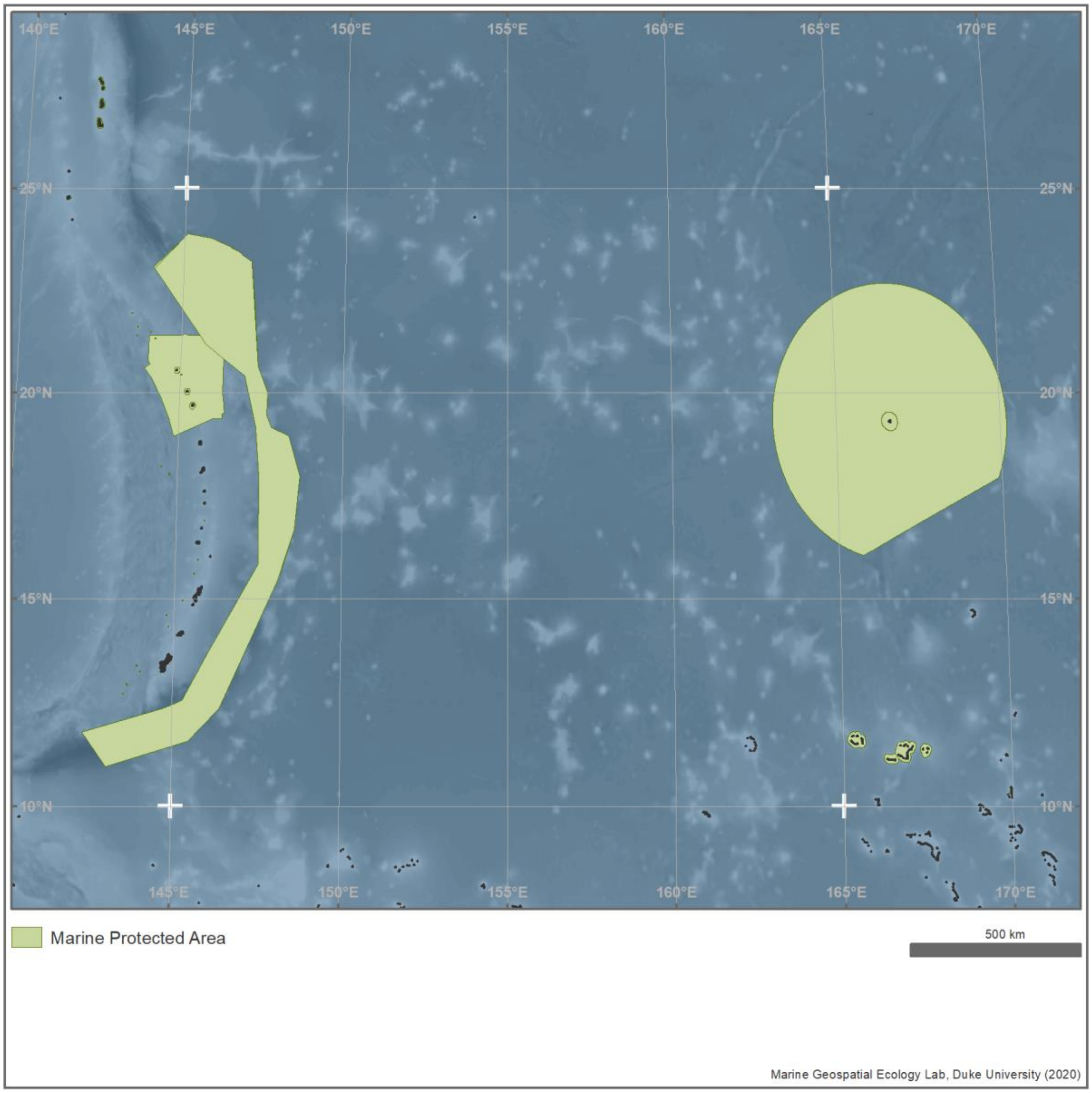

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Figure 6.2-1 Marine protected areas

6.3 Convention on Biological Diversity Ecologically or Biologically Significant Areas (EBSAs)

In 2008, the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 9) adopted the following scientific criteria for identifying ecologically or biologically significant marine areas (EBSAs) in need of protection in open-ocean waters and deep-sea habitats. For more details on the EBSA criteria, please see: wwww.cbd.int/doc/meetings/mar/ebsaws-2014-01/other/ebsaws-2014-01-azores-brochure-en.pdf. CBD scientific criteria for ecologically or biologically significant areas (EBSAs) (annex I, decision IX/20) includes: Uniqueness or Rarity, Special importance for life history stages of species, Importance for threatened, endangered or declining species and/or habitats, Vulnerability, Fragility, Sensitivity, or Slow recovery, Biological Productivity, Biological Diversity, Naturalness. From 2011 to 2019, the CBD convened regional workshops that identified over 300 areas meeting the internationally agreed criteria for Ecologically and Biologically Significant Areas (EBSAs).

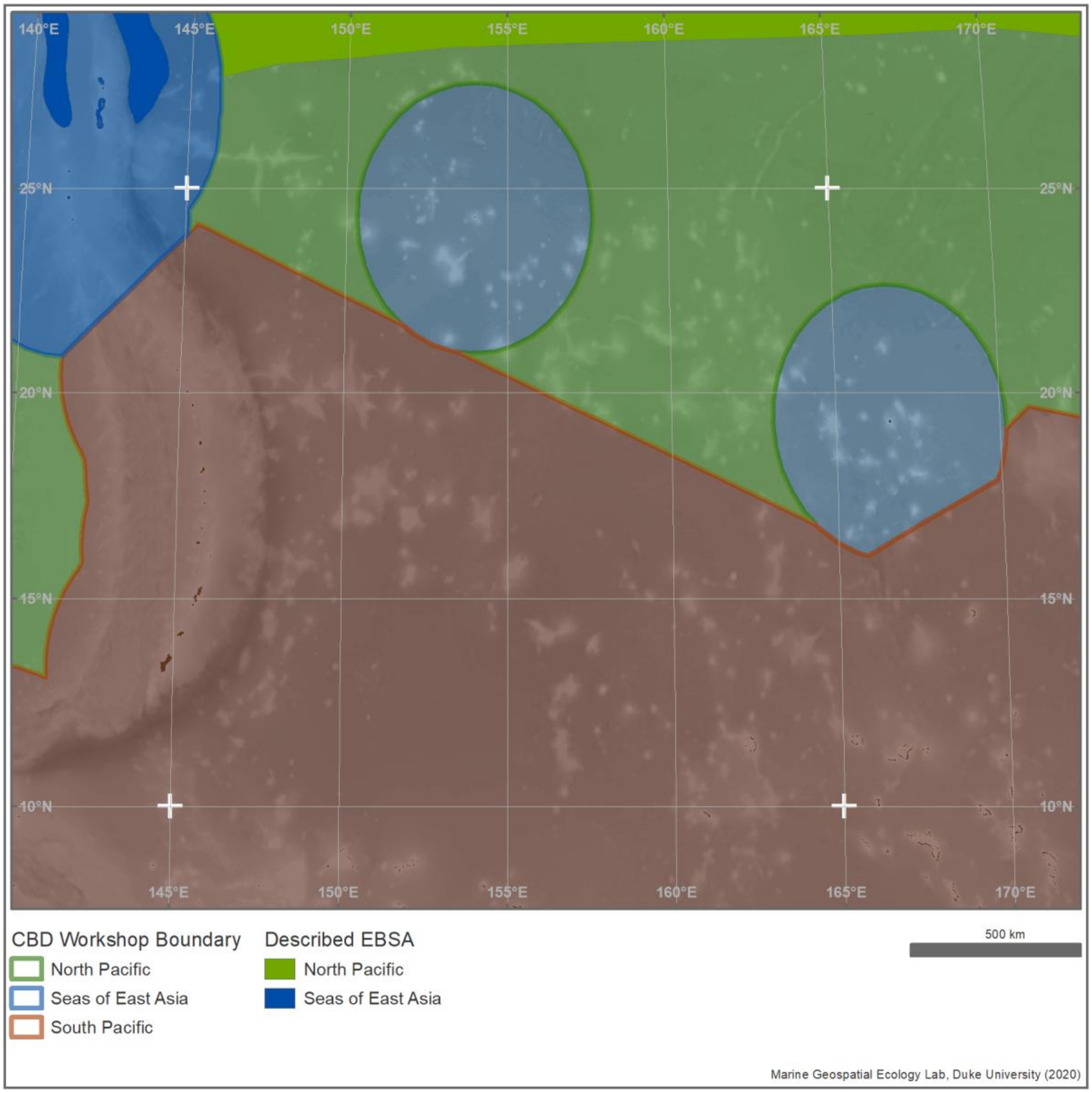

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Figure 6.3-1 CBD Ecologically or Biologically Significant Areas and workshop boundaries

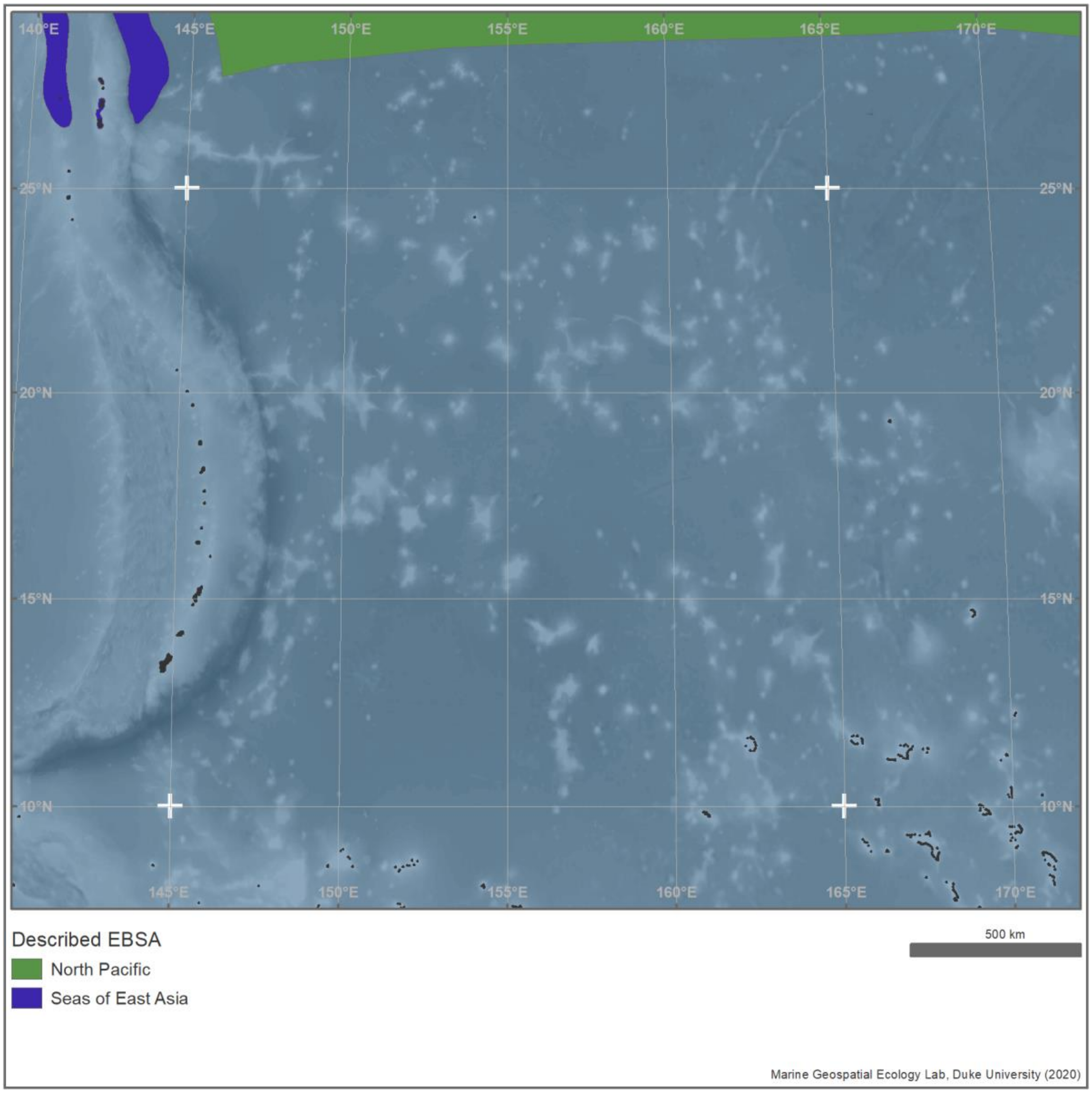

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Figure 6.3-2 CBD Ecologically or Biologically Significant Areas

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