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IMPROVED TRANSDISCIPLINARY SCIENCE FOR EFFECTIVE ECOSYSTEM-BASED MARITIME SPATIAL PLANNING AND CONSERVATION IN EUROPEAN SEAS

Deliverable D2.2

Report on spatial distributions and temporal dynamics of EBSA metrics

Funded by the European Union

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EXECUTIVE SUMMARY

Spatially explicit, quantitative measures of three out of the the seven EBSA criteria (biological productivity; biological diversity; and naturalness) have been established, the necessary data collected for the planning sites and mapped over space and where available also over time.

Naturalness was adressed by collecting data on usage, e.g. shipping traffic or fisheries operations. Since naturalness as such is not measurable, we monitored usage and consider naturaless the reciprocal of this parameter. We did not address the issue of how to combine several pressures on naturalness. However, the choice of pressures should not be the consequence of data availability and how the scientists involved interpreted information in relation to the EBSA criteria. Future work on naturalness should be performed in the context of a cumulative pressures and impact assessments.

For the **Celtic Sea**, we obtained 2160 x 4320 Monthly HDF files from MODIS R2022 Data (Behrenfeld and Falkowski, 1997; Ocean Productivity, 2024) . These data represents modelled net primary productivity (NPP,mg C / m**2 / day) based on the Eppley variation of the VGPM algorithm. The NPP products are derived from modis chl, modis sst4, and seawifs par as input. The monthly files have been extracted from the compressed folders. Using the shapefile of the Celtic Sea PS, the NPP products as a proxy for biological productivity was extracted in R and visualized in ArcMap. To provide a comprehensive overview of biological productivity of the area, an averaged product for all the annual products (2002 - 2023) was generated. The Shannon-Wiener's biodiversity index was calculated in R using data from the DATRAS IAMS (The International Bottom Trawl Survey for anglerfish and megrim) and IGFS (Irish Ground Fish Survey) surveys/datasets for the Celtic Sea from 2016 to 2022. As proxy for naturalness, we gathered data on relative fishing effort by gear type (for Beam Trawls, Bottom Otter Trawls, Dredges, Gillnets, Longlines, Pelagic Trawls, Pots and Seines) for the main commercially exploited species. This data from MI Atlas is based on data from fishing vessels of >=12m in length over the period 2018-2022. Subsequently, amosaiced raster dataset was generated to display averaged fishing effort products by commercial fishing vessels of all nationalities within the Irish EEZ.

For the **Aegean Sea** productivity, we mapped the most dominant fertilizing process, i.e. the inflow and dispersion of mesotrophic Black-Sea Waters from the Dardanelles, and the one process which is originated at locations that can be identified with certain accuracy, i.e. the wind-forced coastal upwelling. The biodiversity dataset provided and mapped counts of marine animals and plants based on their predicted probability pf occurrence generated by Aquamaps at a resolution of 0.5 x 0.5 °. For naturalness, AIS shipping data were used and additionally estimates of the coastal population impact on the Greek Seas.

Biological productivity for the **Bay of Biscay** was calculated based on Chlorophyll-a concentration in seawater data provided by the Ocean Colour Climate Change Initiative project. The original dataset contained monthly Chlorophyll-a concentration from September 1993 to December 2023. Biological diversity was calculated based on the combination of global predicted species richness for Plantae and Animalia kingdoms generated by AquaMaps. Fishing intensity was used as a proxy for Naturalness criterion. The original vector data containing the average 2018-2021 fishing intensity per C-Square 0.5 x 0.5 ° grid (EMODnet) was transformed into the raster format and cropped by the study area.

Primary productivity measured in mg $m^{-3}day^{-1}$ for the **Campania Region**. The most productive areas occur in the north sector of the study area from the Gulf of Naples to Gaeta. The spatial distribution

of the main habitats of the Campania region (e.g. Seagrasses, macroalgae, coralligenous, maerl, shallow rocky reef) were taken as proxy for biological diversity. The importance of the Essential Fish Habitats (spawning and nursery grounds: EFH) of the main commercial species of fish and shellfish is based on measures of temporal persistence of density hot spots obtained during bottom trawl surveys carried out in the period 1994-2010. The distribution of fishing effort was available for the main fleet segments and for the period 2019-2021. EMODnet vessel density data (hours per square kilometer per year per cell, year 2021) indicated some important traffic lanes toward the islands of Ischia, Procida and Capri.

Biological productivity for the **Southern North Sea** case study was calculated based on Chlorophyll-a concentration estimates in seawater. Chlorophyll-a concentration was estimated from satellite images, with the source products coming from publicly accessible archives. Biological diversity of the Southern North Sea was measured using species richness of demersal fish species. To estimate species richness of demersal fish in the southern North Sea, we used already cleaned and merged data from three trawl surveys between 2014 and 2023. To estimate naturalness of the Southern North Sea, fishing intensity was used as proxy. Maps were generated from fishing effort data downloaded from EMODnet. The datasets are created and updated annually for each sea basin by the International Council for the Exploration of the Sea (ICES).

For the **Western Mediterranean** monthly chlorophyll data from 1993 to 2023 surface-150m were part of an ensemble that provided future projections of different environmental variables under climate change. We have processed the data, doing a mean per year (1993-2023) and cropped the map for the Western Mediterranean Sea. Biodiversity Kempton's index was calculated from the Ecopath with Ecosim model for the Western Mediterranean Sea for 1993 to 2023. The same models were applied to detmermine naturalness using relative fishing effort for bottom trawlers, purse seiners and midwater trawlers from 1993 to 2023.

The main objective of the **Azores** Planning Site is to provide scientific information in support of the expansion of the network of benthic deep-sea MPAs in the Azores. The EBSA criteria adopted in this PS are closely related to those used to identify vulnerable marine ecosystems (VMEs), and therefore might be slightly different from other planning sites. Biological productivity in this PS could be inferred from several complementary metrics: i) environmental productivity, ii) geomorphology classification, and iii) proxies for benthic biological productivity. Biological diversity in this PS could be inferred from several complementary metrics: i) from deep-sea benthic occurrence databases and resulting species distribution models of cold-water corals, deep-sea fish and deep-sea sharks, and ii) from proxies of biological diversity derived, for example, from multibeam bathymetry data and the identification of areas with potential higher diversity such as known shallow (<250m) and deep (>1500m) seamounts. Naturalness, in this PS can be inferred from several complementary metrics: i) VMS data on bottom fishing and Natural Jenk breaks for defining categories; ii) known near natural areas in the range of current deep-sea benthic fishing activities (< 1200m) identified by a combination of bathymetry and VMS data; and iii) existing area-based management regulations (e.g. MPAs) that limit human activities.

For the **Western Baltic Sea**, vertically integrated monthly values of Chl-a concentration (mg/m^2) were downloaded from the Baltic Sea Biogeochemistry Reanalysis model for 2001-2021. The dataset was spatially cropped to the planning site area. Biological diversity in the Western Baltic Sea is represented by the biodiversity of demersal fish – in particular by three complementary biodiversity indices: Species richness, Species evenness and Shannon index. Information on fishing activity of bottom-contacting fishing gears was obtained from the Danish Ministry of Food, Agriculture and Fisheries, including international VMS, AIS and Black Box data.

The temporally and geographically explicit layers of quantitative EBSA criteria will be appplied in optimazation models to determine protential protected areas in work package 3.

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AIM OF THE DELIVERABLE

This deliverable provides a data, where available for several years, and maps of the measurable EBSA criteria productivity, biological diversity and naturalness for the Marine Plan Study sites.

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INTRODUCTION

The overall goal of MarinePlan is to develop and apply a Decision Support System (DSS) for ecosystem-based maritime spatial planning (EB-MSP) together with best practice guidance to enhance the design and effectiveness of spatial conservation and restoration measures for marine biodiversity in European Seas. The DSS will be founded on a conceptual EB-MSP implementation process and will provide the tools and best available knowledge to ensure the allocation of coherent MPAs and restoration areas in the context of EB-MSP. MarinePlan regards the operationalisation of ecologically or biologically significant marine areas (EBSA) criteria as a main tool for MPA designation. EBSA criteria have emerged from a global effort led by the Convention on Biological Diversity (CBD).

A prerequisite for Planning Sites to develop scenarios and planning options is a robust science base for the prioritisation and zonation of MPA networks by measuring the spatial distribution of existing and newly developed EBSA criteria. MarinePlan has developed develop under WP2 spatially explicit, quantitative metrics for EBSA criteria that are compatible with ecosystem-based, environmental state indicators (e.g., MSFD). MarinePlan has expanded on previous approaches to operationalize EBSA criteria to be compatible with biodiversity goals including the target of Good Environmental Status. Assessing the spatial connectivity between MPAs, WP2 will also propose spatially efficient zonation and avoiding competing sea uses where possible.

Spatially explicit, quantitative measures of three out of the the seven EBSA criteria (biological productivity; biological diversity; and naturalness) have been be established, the necessary data collected for the planning sites and mapped over space and where available also over time.

Through the developed EBSA metrics, WP2 (supported by WP6) will consider the different temporal and spatial scales and explicitly address the linkages and connectivity between identified hot spots of biodiversity attributes, and already designated MPAs and EBSAs to effectively address conservation and restoration priorities while accounting for the effects of climate change. Under WP2, MarinePlan will measure temporal dynamics and connectivity relevant to the EBSA criteria, in particular in view of climate change. New measures will be developed where necessary (such as regional extinction risk or predicted changes in productivity rates under warming environments), as conditions for the analyses on trade-offs of planning options (WP3, WP5). Temporal dynamics will be considered by investigating variability in connectivity among MPAs at different temporal and spatial scales, including structural and functional connectivity, climatic velocity, the identification of ecological corridors and hot spots, and spillover from MPAs.

We have expand on existing EBSA metrics by formulating quantitative, measurable criteria reflecting attributes that underpin ecosystem functioning and ecosystem services. Applying the EBSA criteria at appropriate spatio-temporal scales to estimate the risk-probabilities of cumulative human pressures for designated MPA networks is one of the key challenges. The EBSA metrics have been spatio-temporally quantified for selected Planning Sites

A prerequisite for these exercises has been to focus on quantifiable criteria that are relevant and applicable in all planning sites and to investigate the availability of data in the different study sites. However, focusing on biodiversity, productivity and naturalness does not mean that MarinePlan will ignore other criteria. These will be included where available and relevant.

Describing Ecologically or Biologically Significant Marine Areas (EBSAs)

EBSAs are special areas in the ocean that serve important purposes, in one way or another, to support the healthy functioning of oceans and the many services that it provides.

The criteria for identifying EBSAs were adopted at the Conference of the Parties to the Convention on Biological Diversity (COP 9) in 2008 (CBD, 2008). The criteria are:

1. Uniqueness or Rarity
2. Special importance for life history stages of species
3. Importance for threatened, endangered or declining species and/or habitats
4. Vulnerability, Fragility, Sensitivity, or Slow recovery
5. Biological Productivity
6. Biological Diversity
7. Naturalness

In 2010, COP 10 stated the following:

- the application of the EBSA criteria is a scientific and technical exercise.
- the identification of EBSAs and the selection of conservation and management measures is a matter for States and competent intergovernmental organisations, in accordance with international law, including the UN Convention on the Law of the Sea.
- the identification of EBSAs should use the best available scientific and technical information and integrate the traditional, scientific, technical, and technological knowledge of indigenous and local communities.
- the Executive Secretary should facilitate the availability and interoperability of the best available marine and coastal biodiversity data sets and information across global, regional and national scales.
- the Executive Secretary should organize a series of regional workshops with the primary objective of facilitating the description of EBSAs through the application of scientific criteria as well as other relevant compatible and complementary nationally and inter-governmentally agreed scientific criteria, as well as the scientific guidance for the application of EBSA criteria.

Following the request by COP 10, the Executive Secretary has convened a series of regional workshops, inviting CBD Party stakeholders, experts and data holders to **assess available information against the seven EBSA criteria** for specific areas of the ocean. Each workshop is tasked to describe the areas fulfilling the scientific criteria for EBSAs based on the best available scientific information. From the workshops result a list of **proposed areas** for consideration as EBSAs. Each of these areas then undergoes a formal evaluation through a structured United Nations (UN) CBD approach and Areas deemed to fulfil the remit of EBSAs are formally described and communicated to the UN General Assembly.

Scientific criteria for identifying EBSAs (adapted from COP decision IX/20, annex 1 (CBD, 2008) and the Training manual for the description of EBSAs in open-ocean waters and deep-sea habitats (CBD, 2012)).

Criteria	**Uniqueness or rarity**
Definition	Area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features
Rationale	Irreplaceable; Loss would mean the probable permanent disappearance of diversity or a feature, or reduction of the diversity at any level.
Consideration in application and Methods	- Where biological information is scarce, physical data may provide the only basis for application (e.g., unique substrates and bathymetries) - Risk of biased-view of the perceived uniqueness depending on the information availability- - Scale dependency of features such that unique features at one scale may be typical at another, thus a global and regional perspective must be taken. - The application of this criterion may be based on biological, ecological and oceanographic information from peer-reviewed literature, technical reports and data sets. Areas containing similar features may be compared to assess the ways in which one area is different or unique.
Examples	*Open ocean waters:* Sargasso Sea, Taylor column, persistent polynyas. *Deep-sea habitat*s: endemic communities around submerged atolls; hydrothermal vents; sea mounts; pseudo-abyssal depression
Criteria	**Special importance for life-history stages of species**
Definition	Areas that are required for a population to survive and thrive.
Rationale	Various biotic and abiotic conditions coupled with species-specific physiological constraints and preferences tend to make some parts of marine regions more suitable to particular life-stages and functions than other parts.
Consideration in application and Methods	- Connectivity between life-history stages and linkages between areas: trophic interactions, physical transport, physical oceanography, and life history of species. - Spatial and temporal distribution and/or aggregation of the species. - Sources for information include: e.g., remote sensing, satellite tracking, historical catch and by-catch data, vessel monitoring system (VMS) data. - Survey data can be used to directly determine abundances/densities within an area if coverage is adequate if the data capture the likely degree of natural variation in a species' distribution and behaviour (covering the appropriate time and spatial scales). - Satellite tracking data offers more detailed information about the movement of a single organism and can be used to identify core use areas for individuals or aggregated to better understand the importance of areas to a population(s). - General techniques that can be used on tracking data: • Sinuosity Analysis • Fractal Analysis • First-Passage Time Analysis • Kernel Analysis • Regression, Autocovariate and other Habitat Modelling • State-Space Models - This criterion can be informed by survey data and models by using physical features known to be associated with biotic features.

Examples	Area containing: (i) breeding grounds, spawning areas, nursery areas, juvenile habitat or other areas important for life history stages of species; or (ii) habitats of migratory species (feeding, wintering or resting areas, breeding, moulting, migratory routes).
Criteria	**Importance for threatened, endangered or declining species and/or habitats**
Definition	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species
Rationale	To ensure the restoration and recovery of such species and habitats
Consideration in application and Methods	- The application of this criterion must be based on pre-existing determinations of the population status of a given species. The use of the IUCN Red List is fundamental to understanding to which species this criterion applies. In data-poor situations, the listing for organisms with similar life history traits should be used until further information on the status of the species is available. - Includes species with very large geographic ranges. - In many cases, recovery will require reestablishment of the species in areas of its historic range. - Sources for information include: e.g., remote sensing, satellite tracking, historical catch and by-catch data, vessel monitoring system (VMS) data. - Methods: Same as criterion “Special importance for life-history stages of species”
Examples	Areas critical for threatened, endangered or declining species and/or habitats, containing (i) breeding grounds, spawning areas, nursery areas, juvenile habitat or other areas important for life history stages of species; or (ii) habitats of migratory species (feeding, wintering or resting areas, breeding, moulting, migratory routes).
Criteria	**Vulnerability, fragility, sensitivity, or slow recovery**
Definition	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.
Rationale	The criteria indicate the degree of risk that will be incurred if human activities or natural events in the area or component cannot be managed effectively or are pursued at an unsustainable rate.
Consideration in application and Methods	- Interactions between vulnerability to human impacts and natural events. - Existing definition emphasizes site-specific ideas and requires consideration for highly mobile species. - Criterion can be used both in its own right and in conjunction with other criteria. - Information on which species or biomes qualify as vulnerable, fragile, sensitive or slow to recover should be based on peer-reviewed scientific literature to the extent possible. - The fragility of certain features to certain pressures (e.g., ice-dependent communities to the effects of climate change) can be taken as self-evident. - This criterion can be informed by survey data and models by using physical features known to be associated with biotic features that are sensitive or slow to recover. - Application of models that extrapolate results of studies in one area to other areas of similar features will be particularly helpful, especially models that predict the sensitivity or fragility of particular community types
Examples	*Vulnerability of species:* - Inferred from the history of how species or populations in other similar areas responded to perturbations. - Species of low fecundity, slow growth, long time to sexual maturity, longevity (e.g. sharks, etc). - Species with structures providing biogenic habitats, such as deepwater corals, sponges and bryozoans; deep-water species. *Vulnerability of habitats:* - Ice-covered areas susceptible to ship-based pollution.

	- Ocean acidification can make deep-sea habitats more vulnerable to others and increase susceptibility to human-induced changes.
Criteria	**Biological productivity**
Definition	Area containing species, populations or communities with comparatively higher natural biological productivity.
Rationale	Important role in fuelling ecosystems and increasing the growth rates of organisms and their capacity for reproduction.
Consideration in application and Methods	- Can be measured as the rate of growth of marine organisms and their populations, either through the fixation of inorganic carbon by photosynthesis, chemosynthesis, or through the ingestion of prey, dissolved organic matter or particulate organic matter. - Can be inferred from remote-sensed products, e.g., ocean colour or process-based models (global datasets are available for Chlorophyll-a, primary productivity, and secondary productivity). - Due to high temporal variability (years, seasons, and short time scales) appropriate temporal coverages should be considered. - High primary productivity near the surface may not necessarily mean higher secondary productivity near the seafloor. - Time-series fisheries data can be used, but caution is required.
Examples	- Frontal areas - Upwellings - Hydrothermal vents - Seamonts polynyas
Criteria	**Biological diversity**
Definition	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.
Rationale	Important for evolution and maintaining the resilience of marine species and ecosystems.
Consideration in application and Methods	- Diversity needs to be seen in relation to the surrounding environment - Diversity indices are indifferent to species substitutions - Diversity indices are indifferent to which species may be contributing to the value of the index, and hence would not pick up areas important to species of special concern, such as endangered species. - Diversity can be inferred from habitat heterogeneity or diversity as a surrogate for species diversity in areas where biodiversity has not been sampled intensively. For benthic habitats, this can be approximated by measuring physical topographic complexity or rugosity; for pelagic habitats, this can be estimated by identifying convergences of differing water masses. - When comparing measures of species diversity among areas, sampling should be sufficient to statistically support such comparisons, for example, by ensuring that species accumulation curves (when considering richness) are saturated prior to conducting pair-wise comparisons. Otherwise, there is a danger of identifying areas with more research effort. - Examples of diversity indices that can be used: • Berger-Parker Index • Simpson’s Index • Shannon-Wiener Index • Pielou’s Evenness Index • Hurlbert (ES50) Index • Rank Abundance Curves
Examples	- Seamounts - Fronts and convergence zones

	- Cold water coral communities - Deep-water sponge communities - reefbuilding communities (Sabellaria)
Criteria	**Naturalness**
Definition	Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.
Rationale	- To protect areas with near natural structure, processes and functions. - To safeguard and enhance ecosystem resilience.
Consideration in application and Methods	- Priority should be given to areas having a low level of disturbance relative to their surroundings. - In areas where no natural areas remain, areas that have successfully recovered, including reestablishment of species, should be considered. - Criterion can be used both in their own right and in conjunction with other criteria. - This criterion is a relative measure. - Mapping and analysing the cumulative effects of human maritime activities should reveal overall patterns that would be useful to identify possibly (more) natural areas of a given habitat type. Stressors can be mapped using a GIS and overlaid on habitat maps to predict the 'naturalness' of an area.
Examples	Most ecosystems and habitats have examples with varying levels of naturalness, and the intent is that the more natural examples should be selected.

It should be noted that the EBSA description process is open-ended, and additional regional or subregional workshops may be organized when there is sufficient advancement in the availability of scientific information (CBD, 2019b). However, there is still a lack of a process on how to describe new areas through mechanisms other than regional workshops and how to incorporate outputs from national processes (CBD, 2020).

THE EBSA CONCEPT IN MARINEPLAN

MarinePlan focuses on quantifying biological productivity (P), biological diversity (D) and naturalness (N). The other EBSA criteria are considered, but by their nature they cannot be quantified and measured as well as the three aforementioned criteria.

In the following section, we used quantification and measurement synonymously. If model data are applied instead of actual measurement it will be explicitly stated.

P, D and N are ideally samples on a spatial scale much smaller than potential EBSAs. This way, we can assess variability and hotpots, and in case can fit designated EBSAs.

Disentangling and decoupling the temporal and spatial dynamics of species diversity is a critical prerequisite for elucidating the effect of EBSAs and the most promising locations for protected areas inside EBSAs. This way, such an understanding can provide valuable input for informing and planning broad-scale conservation and ecosystem-based management strategies. In MarinePlan, we examine spatial and temporal patterns and compare drivers of multiple marine biodiversity, productivity and naturalness indicators (Figure i).

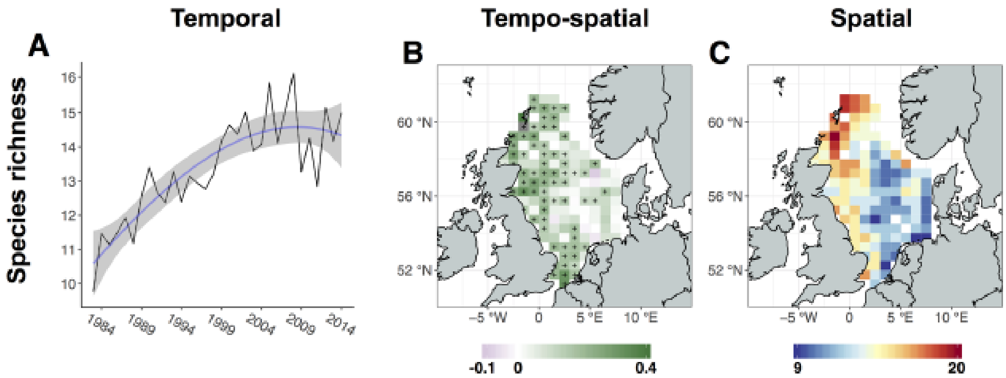

Figure i: Example of species richness, a biodiversity indicator, in the North Sea. Panel A gives the temporal development aggregated for the whole North Sea, panel C on the right the average spatial gradient, while panel B in the centre combines these two and shows the areas with the greatest temporal variability (Dencker et al. 2017).

These data can in the future be used to assess natural and environmental drivers on productivity, biodiversity and naturalness. The drivers can be selected based on their demonstrated importance in shaping patterns of fish biodiversity in marine ecosystems. This way, the Marine-Plan concept for quantifying EBSAs maintains compatibility to quantitative ecological research and allows for forecasting of EBSA properties for example in the course of ongoing climate changes.

The EBSA criteria have strong links to the FAO VME criteria and the CBD COP14/8 biodiversity attributes (Fig. ii). However, while e.g. biological diversity is a measurable quantity, the corresponding criteria 'key biodiversity areas' (CBD COP 14/8) and 'functional significance of habitat' are poorly defined quantitatively.

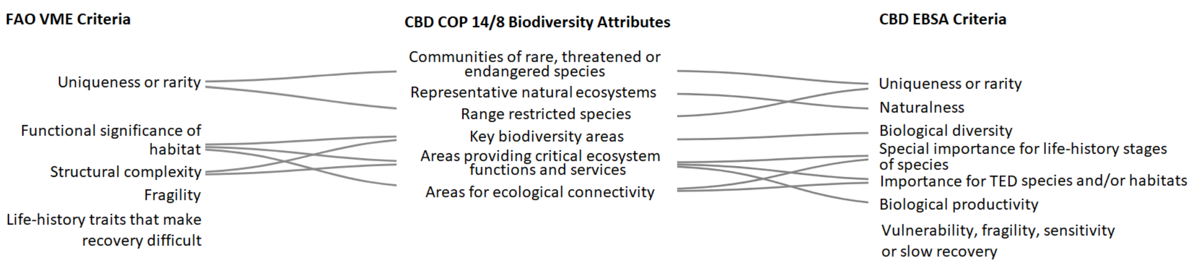

Figure ii: Comparison of the criteria used for VME (FAO 2009) and CBD EBSA (CBD/COP/DEC/IX/20) identification with those provided as CBD Biodiversity Attributes for Other Effective Conservation Measures (OECMs) descriptions of in situ conservation of biodiversity (Criterion C). TED=Threatened, Endangered and Declining. (REF, ices report vanessa mail)

Naturalness was adressed by collecting data on usage, e.g. shipping traffic or fisheries operations. Since naturalness as such is not measurable, we monitored usage and consider naturaless the reciprocal of this parameter. The choice of assessing fishing pressure by bottom contacting gears is deemed as a good approximiation of the spatial footprint of human activities in a given planning site. Since we did not aim for mapping cumulative pressures, we did not further investigate on methods for combining various human pressures. However, through close collaborations with the EU funded project GES4SEAS, where cumulative pressures are mapped at a pan-European scale, we will incorporate such data, once they are available, in the MarinePlan scenario analyses.

The way how the EBSA criteria are supposed to be used in the course of MarinePlan, follows the process decribed in Kuismanen et al (2023):

- “support the healthy functioning of oceans and the many services that it provides”
- “inform decision-making, which may be transboundary, national, or local. Ecologically or Biologically Significant Marine Areas are not proposals for new MPA designations, although protection of EBSAs was encouraged by COP10, but can be used both in developing area-based conservation and in re-allocating human activities through the MSP process”

This gives us two perspectives:

- Identify and work from the receptors or ecosystem components, more specifically species and habitats, that require protection in order to conserve “function and the services it provides”.
- Identify the stressors (i.e. human activities and their pressures) that compromise the above and thus need to be managed through MSP

which matches well with the design of cumulative impact assessments (CIA) and their role to inform ecosystem-based MSP. Therefore, we will aim to apply the CIAs we have available together with the spatial information being collected to provide an EBSA-compliant spatial map to inform MSP.

DATA AVAILABILITY IN THE PLANNING SITES

An overview of the collected data for the EBSA criteria across planning sites are presented in Table 0.1. The remainder of the chapter provides a more detailed insight into the collected data within each planning site. All data are stored on a Sharepoint with restricted access, maintained by DTU Aqua.

Table 0.1 Overview of collected data on Ecologically and Biological Sensitive Areas (EBSA) criteria in each Marine Plan study site. For more detail refer to the data inventories in the appendix.

EBSA Criterion	Azores	Celtic Sea	Greek Aegean/Ionian Sea	Campania Region	Southern North Sea	Western Baltic Sea	Bay of Biscay	Western Med.
Biological Productivity	Chlorophyll-a concentration, net primary productivity, particulate organic carbon flux, location of seamounts, habitat-forming cold-water corals, VME index	Net primary productivity (modelled)	Upwelling, Black Sea Water ratio	Primary productivity	Chlorophyll-a concentration	Chlorophyll-a concentration	Chlorophyll-a concentration	Chlorophyll-a concentration

Biological Diversity	Deep-sea benthic occurrence database and derived species richness and habitat suitability of cold-water corals, deep sea fish, and deep-sea sharks and rays. Multibeam bathymetry data and known shallow (<250m) and deep (>1500m) seamounts	Shannon-Wiener diversity index of fish	Plant and animal species richness	Presence of main habitats, deep sea corals and oyster extent, essential fish habitats, important marine mammal and bird areas	Fish species diversity	Fish species diversity (richness, evenness, Shannon-Wiener)	Plant and animal species richness	Kempton's biodiversity index
Naturalness	Bottom fishing effort, known near natural areas, existing area-based management regulations	Fishing effort offshore and inshore of all commercial fishing vessels	Fishing effort of large vessels (effort of small-scale fleet under preparation), coastal population impact, tourist arrivals impact	Fishing effort of purse seine and otter trawl, artisanal fishing effort, vessel density, shipping lanes, aquaculture, ports, concession of sea state property	Fishing intensity and (sub)surface swept area ratio of mobile bottom-contacting gears	(Sub)surface swept area ratio by mobile bottom contacting gears	Fishing intensity, overall and per gear type (beam trawls, bottom otter trawls, bottom seines, dredges, pelagic trawls and seines, static gears)	Fishing effort of bottom trawlers, and purse seiners and midwater trawlers

CELTIC SEA

Biological productivity

We obtained 2160 x 4320 Monthly HDF files from MODIS R2022 Data (Behrenfeld and Falkowski, 1997; Ocean Productivity, 2024) . These data represents modelled net primary productivity (NPP,mg C / m**2 / day) based on the Eppley variation of the VGPM algorithm. The NPP products are derived from modis chl, modis sst4, and seawifs par as input. The monthly files have been extracted from the compressed folders. Using the shapefile of the Celtic Sea PS, the NPP products as a proxy for biological productivity was extracted in R and visualized in ArcMap. To provide a comprehensive overview of biological productivity of the area, an averaged product for all the annual products (2002 - 2023) was generated (Figure 0.1, Figure 0.2).

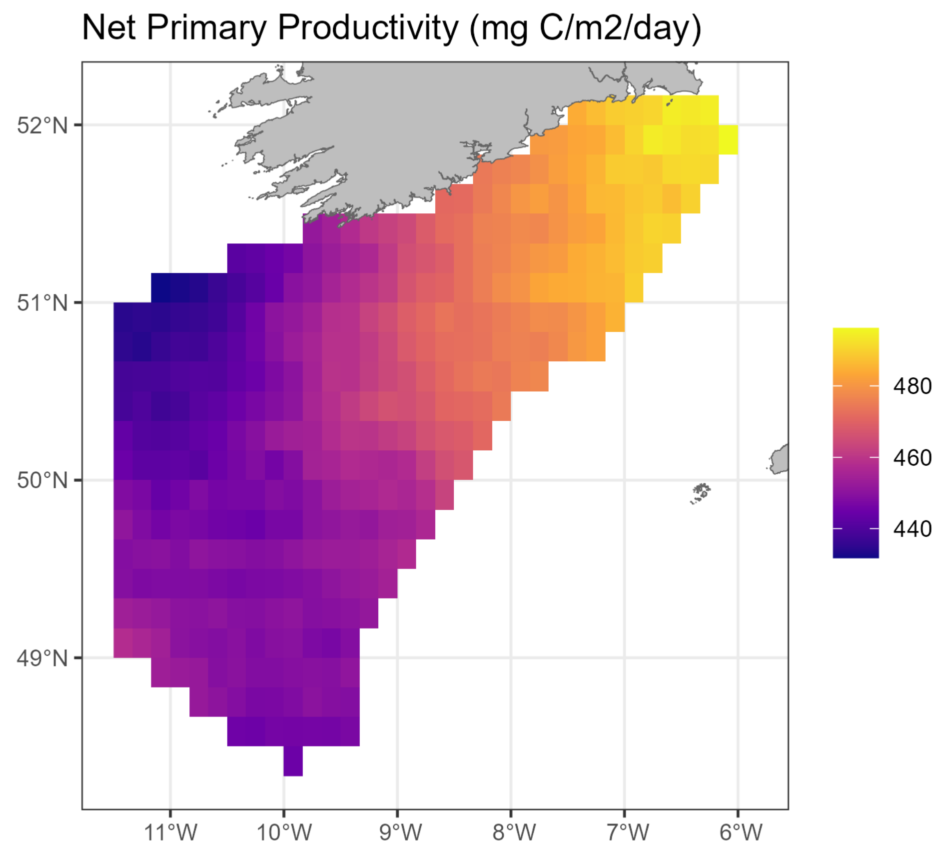

Figure 0.1 Net primary productivity (mg C/m²/day) averaged across 2002-2023.

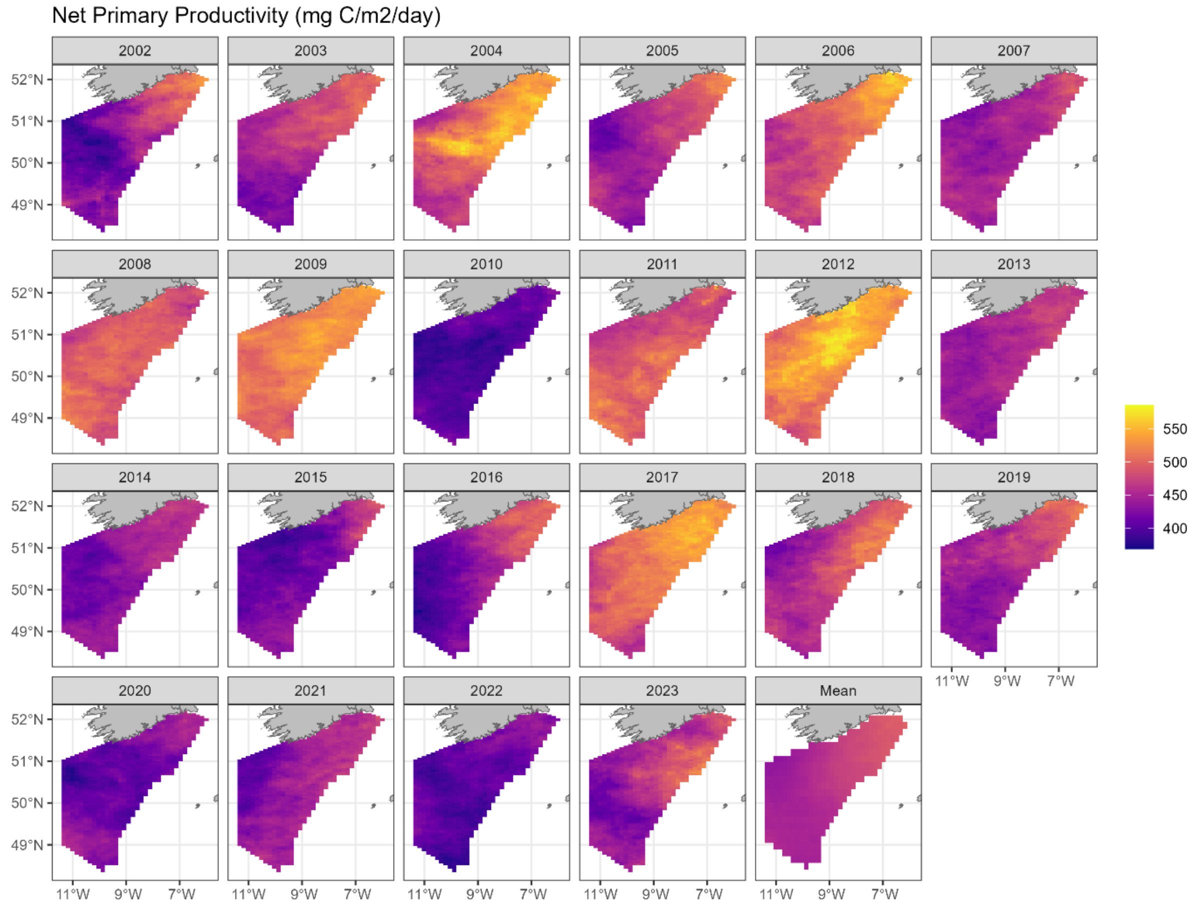

Figure 0.2 Annual and averaged net primary productivity (mg C/m²/day) from 2002-2023

The biological productivity is mainly influenced by interactions between abiotic environmental factors, human activities and inherent biological characteristics of marine species. More specifically, temperature, nutrient availability, and ocean stratification exerts an influence in the abundance and distribution of plankton communities (phytophytoplankton and zooplankon), and have a subsequent influence on higher trophic levels. These physical factors including light availability and nutrient concentrations vary with oceanographic conditions e.g. mixing (Hervann et al., 2020). Similarly, the influence of picoplankton and nanoplankton on primary productivity has been mentioned in previous studies, with these contributing a significant component of the carbon fixation in the area (Joint and Pomroy, 1983). Again, the indirect influence of fishing activities in altering food web structure and energy/biomass flow within the ecosystem has been acknowledged. Overfishing can influence the shifts in species composition, size structure and distribution, potentially leading to cascading effects on the total ecosystem's productivity (Hernvann and Gascuel, 2020).

Biological diversity

The Shannon-Wiener's biodiversity index was calculated in R using data from the DATRAS IAMS (The International Bottom Trawl Survey for anglerfish and megrim) and IGFS (Irish Ground Fish Survey) surveys/datasets for the Celtic Sea from 2016 to 2022 (Figure 0.3). Note that benthic and infauna data were missing at the time of this analysis. This will be updated as soon as the data is made available. We provide both the averaged product and also the yearly products of Shannon-Wiener Diversity Index. These products are generated based on biological point data (Station No./Longitude/Latitude/Species) using krigging interpolation method based on default paramters provided in ArcMap (Krigging method=ordinary; Semivariogram model= spherical; search radius= variable and 12 number of points).

The biological diversity of the Celtic Sea of Ireland is influenced by a combination of several biophysical factors. Factors such as oceanography, the types of spawning fish present, and the distribution of various marine organisms have been shown to play a big role in shaping biological diversity in the Celtic Sea (Harma et al., 2012). Other studies have linked the spatial distribution of infauna (e.g. nematodes) to water depth, bottom temperature and substrate characteristics (Schratzberger et al., 2008). Besides, spatial patterns in larval fish assemblages can be influenced by bathymetry and ocean warming, emphasizing how various physical features of the marine environment can drive patterns in biological diversity (Tiedemann et al., 2014).

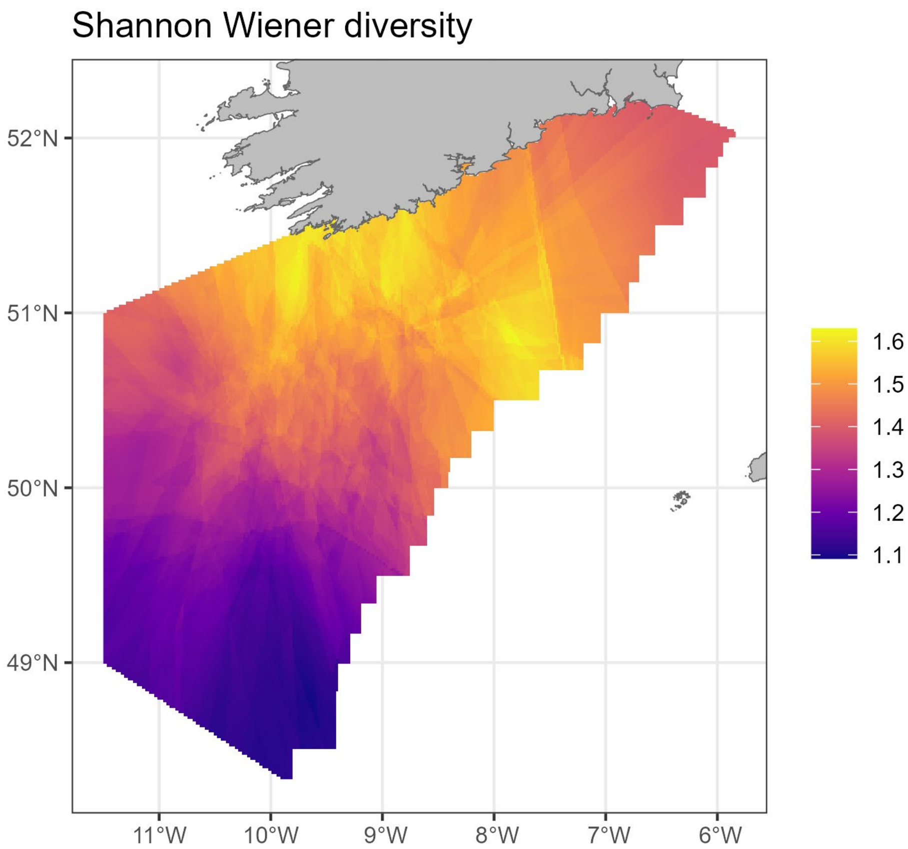

Figure 0.3 Shannon Wiener diversity of fish averaged from 2016-2022.

Naturalness

We gathered data on relative fishing effort by gear type (for Beam Trawls, Bottom Otter Trawls, Dredges, Gillnets, Longlines, Pelagic Trawls, Pots and Seines) for the main commercially exploited species. This data from MI Atlas is based on data from fishing vessels of =12m in length over the period 2018-2022. Subsequently, amosaiced raster dataset was generated todisplay averaged fishing effort products by commercial fishing vessels of all nationalities within the Irish EEZ (Figure 0.4). Fishing effort here is represented as the time spent engaged in fishing operations or time spent at sea, this time may be multiplied by a measure of fishing capacity, e.g. engine power. In this dataset, fishing effort is measured as average hours of fishing per kilometre square, per year. The data from, is collated from 3 sources; vessel monitoring systems, logbooks and EU fleet register (Gerritsen, 2024). Additional data/layers were obtained to generate inshore fishing effort (Figure 5.5). In these layers, vessel count was used as proxy for inshore fishing effort. The raster value is number of vessels per polygon, divided by the number of raster cells intersecting each polygon.

The datasets used here were derived from vessel monitoring and logbook data collected under the Council Regulation (EC) No. 1224/2009 and were aggregated and processed by the Marine Institute. Fishing represent one of the most significant utilization of the ocean resources in the waters around Ireland. However, given the shared nature of the oceans and its resources, detailed spatial information on fishing activity is particularly relevant, especially within the context of Ireland's commitments to offshore wind energy and marine protected areas. The fisheries in Irish waters show a high degree of diversity. Much of this variation and diversity can be explained by spatial patters in the availability of the target species including key fish and shellfish species.

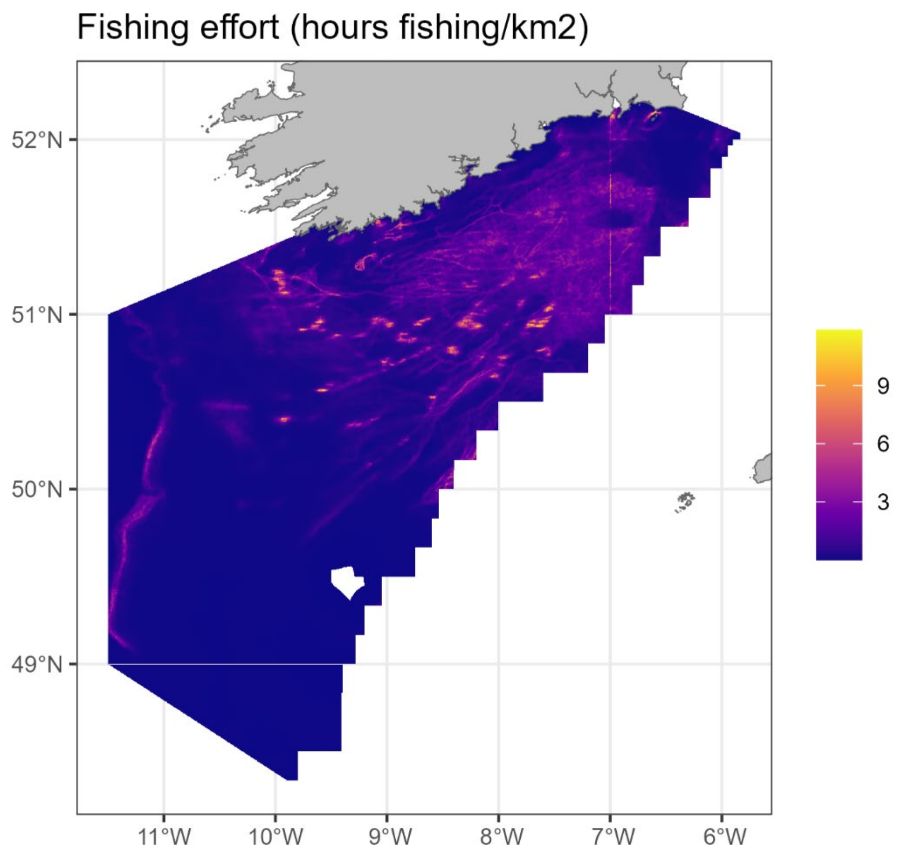

Figure 0.4 Fishing effort for Beam Trawls, Bottom Otter Trawls, Dredges, Gillnets, Longlines, Pelagic Trawls, Pots and Seines from 2018 to 2022 as average hours fishing per kilometre square, per year.

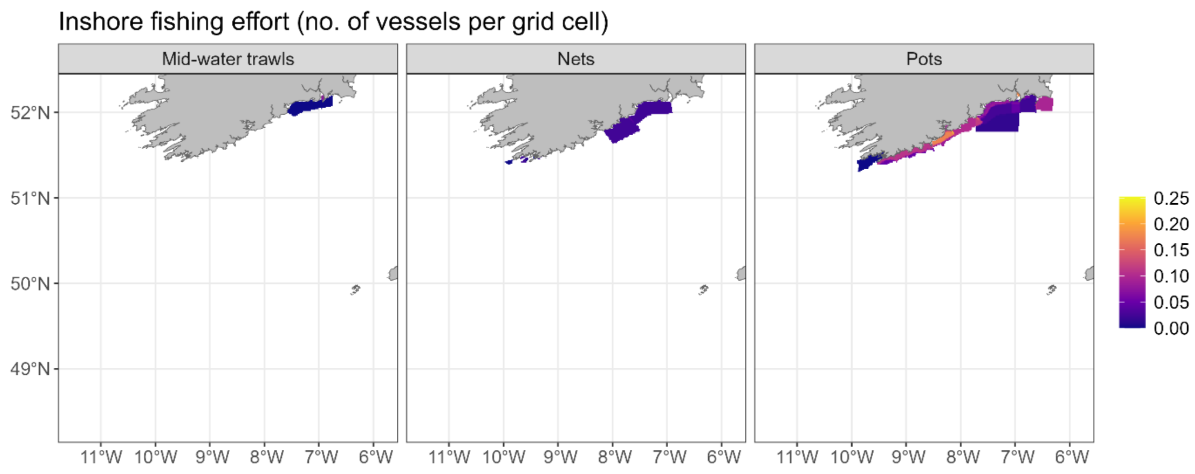

Figure 0.5 Inshore fishing effort represented by number of vessels per grid cell.

Greek Aegean/Ionian Seas

Biological productivity

This work is an effort to map the regions known to the scientific community as hosting the most important processes responsible for the productivity of the Hellenic Seas. It has been implemented in the framework of the project MarinePlan, as a contribution to the Marine Spatial Planning of the Hellenic Seas.

Considering the very weak flow of the Greek and Turkish rivers and their only coastal impact on the marine ecosystem, we investigate the remaining sources of productivity of the Hellenic Seas. The major source of productivity for the Aegean Sea, as evidenced by the zonal trophic gradient recorded in this basin (Ignatiades et al. 2002; Frangoulis et al. 2010; Siokou-Frangou et al. 2002; Lykousis et al. 2002; Skliris and Beckers 2009), is the inflow of modified Black Sea Waters (BSW) through the series of the Bosphorus Strait, the Marmara Sea and the Dardanneles Strait. Other processes contributing to the fertilization of the marine ecosystem, with evidently weaker roles, are the annual vertical mixing through convection processes, taking place in late February – mid-March in the region (Lykousis et al. 2002; Theocharis and Georgopoulos 1993), coastal upwelling taking place every late summer mostly along the eastern shores of the Aegean Sea (Androulidakis, Krestenitis, and Psarra 2017; I. Mamoutos et al. 2017; Chaniotaki et al. 2021; Savvidis et al. 2004), and the potential fertilization through the episodic deposition of Saharan dust through southerly winds (Herut et al. 2005).

Below, we will deal with mapping the most dominant fertilizing process, i.e. the inflow and dispersion of mesotrophic Black-Sea Waters from the Dardanelles, and the one process which is originated at locations that can be identified with certain accuracy, i.e. the wind-forced coastal upwelling.

Dispersion of modified Black Sea Waters

The most prominent characteristic of the waters originated in the Black Sea and exported to the Mediterranean via the Dardanelles Strait is their low salinity, which can be used as a tracer of their presence in the North Aegean (approach which will be used hereafter). Their generally low temperature and high chlorophyll-a concentration can also be used as a tracer, but the results are less solid, for the following reasons: (a) the sea-surface temperature (SST) of the Marmara Sea rises to comparable to the North Aegean values, while in the latter region coastal upwelling in the Eastern Aegean brings cooler waters to the sea surface. Thus, SST can generally be used as a tracer for BSW in the North Aegean, except during the summer months. (b) the Black Sea is considered a mesotrophic basin in relation to the Mediterranean, and its phytoplankton concentration is much higher, to which it owes its high turbidity and thus the name “Black”.

Thus, the BSW is generally characterized by higher chlorophyll-a concentration (chl-a) than the Aegean Sea waters, and hugh chl-a values at offshore waters usually signify its presence, especially in the northwestern shores of the Aegean which host the modified BSW outflow due to the cyclonic general circulation of the basin. However, due to the fact that phytoplankton concentration is not a conservative quantity in the marine environment (like temperature or salinity) due to the range of other processes that can affect its concentration, chl-a can be considered a minor, or secondary tracer of BSW in the North Aegean Sea.

Methodology and data

Thus, in order to trace and map the presence of BSW in the Aegean we assume that the lateral advection is a much more efficient process than air-sea freshwater exchange in determining the sea-surface salinity in the Aegean Sea. Thus, over time-scales of days to months, the sea-surface salinity can be considered as a quasi-conservative quantity, and thus conservation of mass can be employed. Thus, assuming that the sea-surface salinity is a result of mixing of two water types, the BSW and the waters originated from the Levantine (LW) (the latter characterized by maximum salinities), conservation of mass leads to:

$$S = aS_{BSW} + (1-a)S_{LW} \tag{1}$$

where S the salinity of the water mass considered, S_BSW the salinity of the BSW waters off Dardanelles exit, S_LW the salinity of the Levantine-originated waters and a the weight ratio of BSW the mixture of salinity S. Solving the equation 1 for a, we obtain:

$$a = \frac{S_{LW} - S}{S_{LW} - S_{BSW}}. \tag{2}$$

The sea-surface salinity fields that were used in the analysis were provided by a hindcast simulation by Mamoutos et al. (2021), covering the period 2000-2019. The data used were daily maps: every day the salinity immediately off the Dardanelles exit provided S_BSW, while for the definition of S_LW we used the maximum salinity found in the daily salinity field.

Results

The results of the method described above for determination the constribution of BSW in the North Aegean surface waters are presented below:

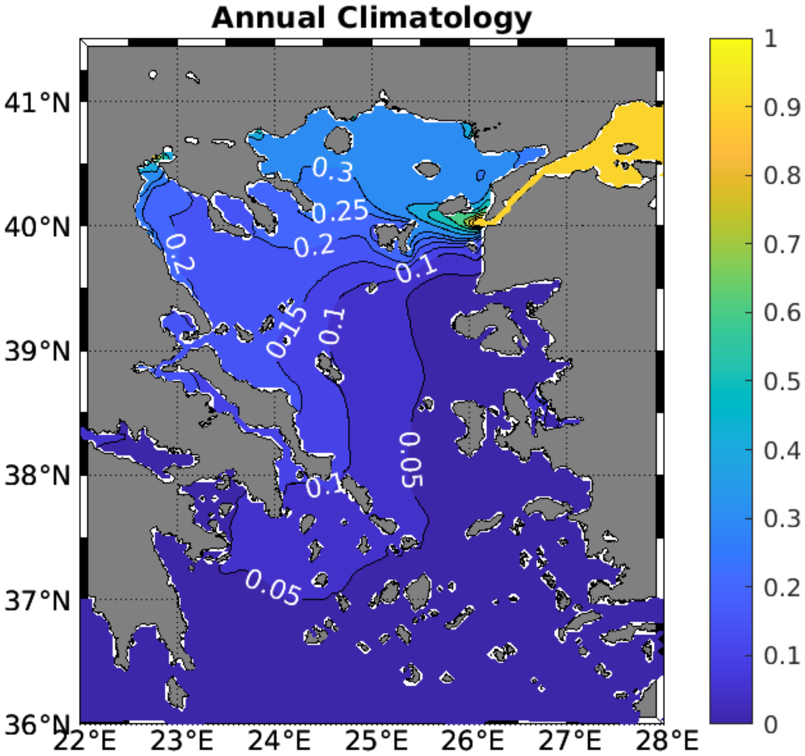

Figure 0.6 The weight ratio of BSW in the Aegean Sea, on an annual basis over 2000-2019

On a seasonal basis, the BSW presence is depicted in the figures below:

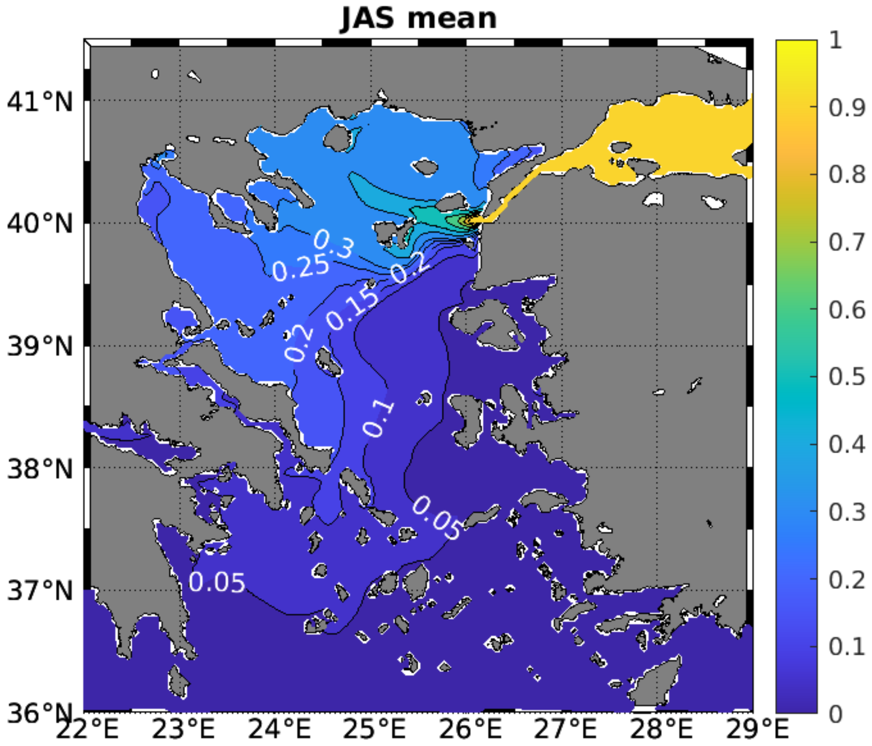

Figure 0.7 Contribution of BSW in Aegean surface waters in Winter (January - March 2000-2019)

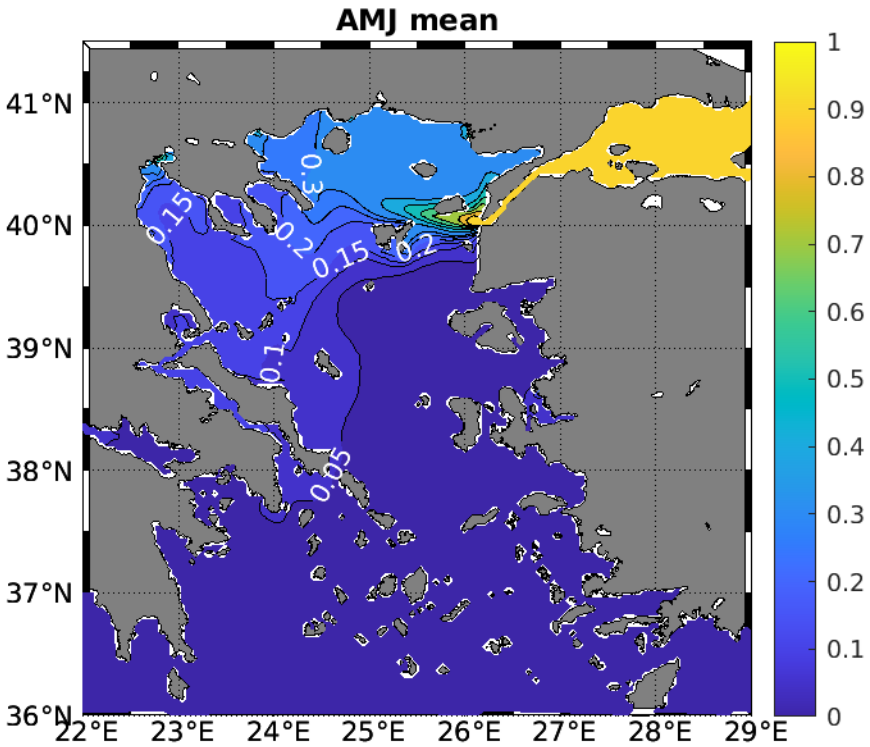

Figure 0.8 As in Figure 5.2, for Spring (April - June 2000-2019)

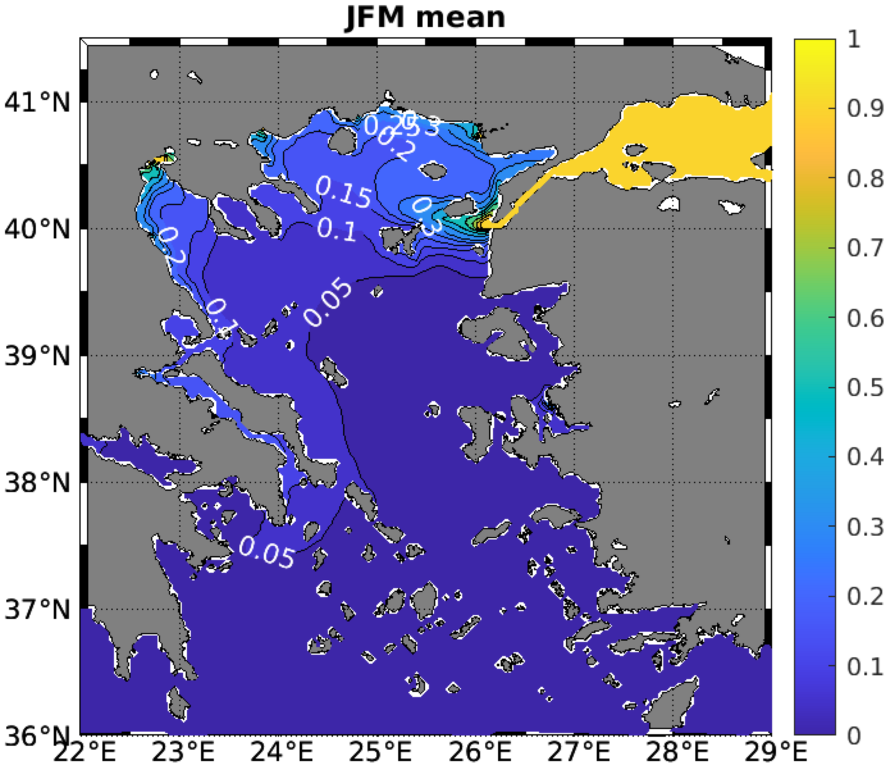

Figure 0.9 As in Figure 5.2, for Summer (July - September) 2000-2019

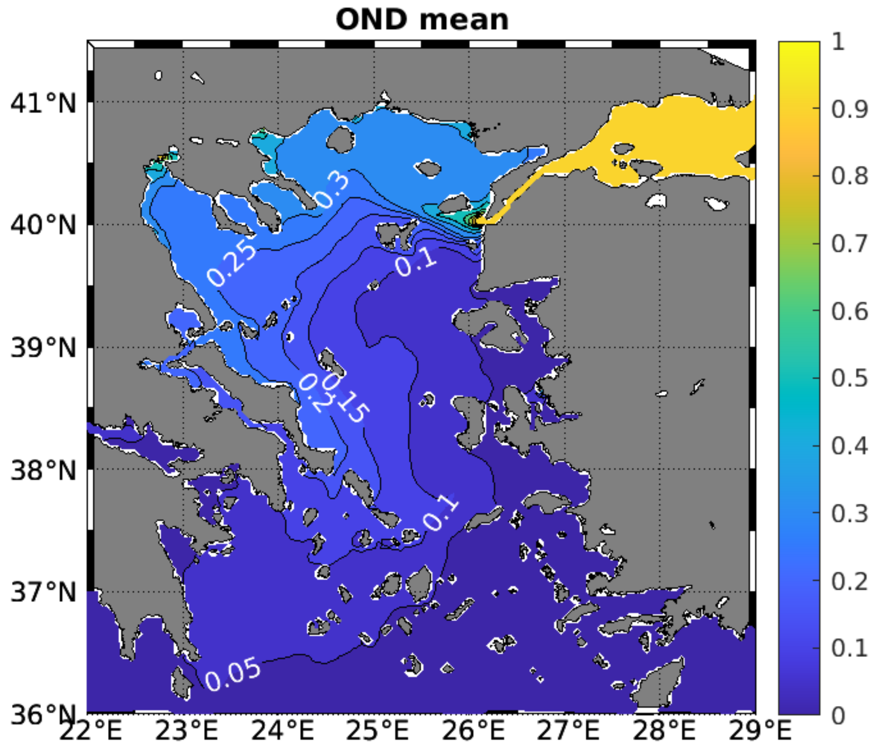

Figure 0.10 As in Figure 5.2, for Fall (October - December) 2000-2019

Discussion

The method employed above permits the direct estimation of the contribution of BSW to the Aegean surface water masses, without the bias often introduced by the very low salinities recorded in Spring and Summer. As expected, modified BSW covers the upper layers of the northern and western Aegean Sea. Its contribution appears to be minimized geographically in Spring, and maximized in Fall, probably in agreement with the seasonal cycle of the Dardannelles export. Productivity estimates derived from BSW content are primarily applicable to the Aegean Sea. Accuracy may be compromised in gulf interiors where river water introduces additional low-salinity sources. Similarly, in the Ionian Sea, Modified Atlantic Water serves as the primary source of low-salinity water.

Ekman Pumping (coastal and offshore upwelling)

In the methodology we will describe below, we have decided not to use the traditional Coastal Upwelling Indices used in the more or less distant past, and proceed to assess the upwelling velocity at the bottom of the Ekman layer, as a function of the Ekman transport divergence. When using the full wind field, the above computation provides the offshore Ekman pumping (assuming no presence of islands or coasts). In order to add the coastal upwelling to this computation, we just use the presence of land to mask the wind field by setting wind velocity equal to zero over land. Following this, wind stress and thus Ekman transport is also set to zero over lands and coasts, with the desirable results when one computes the net (coastal plus offshore) upwelling.

Methodology and data

Our method is based on the classical Ekman dynamics, where Ekman mass transport can be expressed as

$$U_E = -i\frac{\tau}{\rho f}, \qquad (3)$$

where U_E the horizontal Ekman mass transport vector, τ the wind stress vector, ρ the seawater density and f the local Coriolis parameter. Combining (3) with the continuity equation over the Ekman layer, one obtains the estimate of the vertical velocity of the isopycnals at the bottom of the surface layer, i.e. the upwelling velocity of the pycnocline layers into the surface layer:

$$w_E(z = -H) = \nabla \cdot U_E = \frac{\nabla \times \tau}{\rho f}, \qquad (4)$$

where w_E the vertical velocity at the bottom of the surface Ekman layer and H the thickness of the Ekman layer.

In out computations we used the ERA5 wind hourly data from the period 2000 until 2019. The wind speed was converted to wind stress using the Smith (1988) formula for neutral lower atmosphere, as provided by the library Sea-Mat for Matlab. In addition to the mapping of the upwelling sites, as provided by (4), we overlaid satellite Sea-Surface Temperature maps to obtain an assessment of the horizontal dispersion and fate of the upwelled waters.

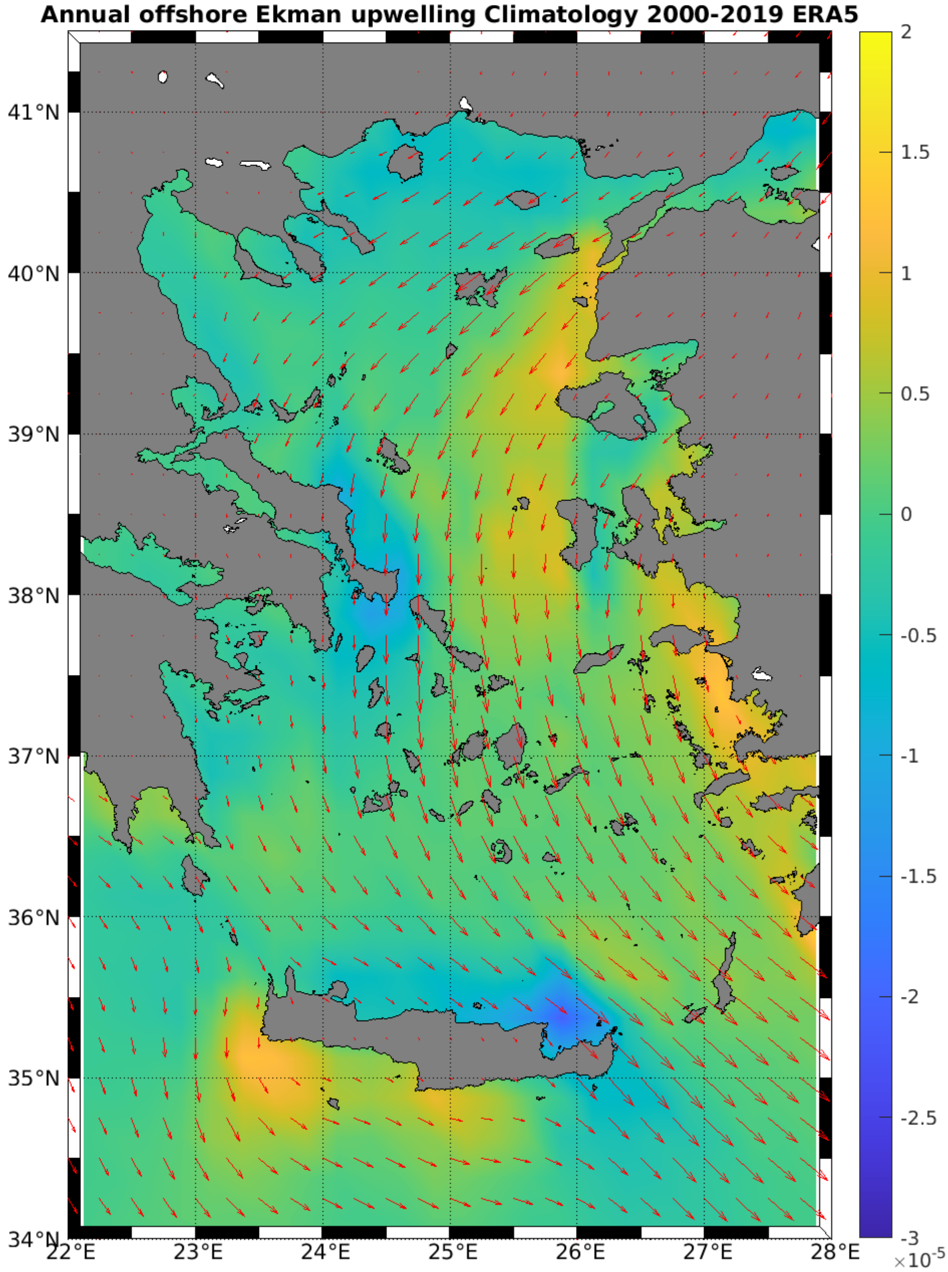

Figure 0.11 Vertical velocity at the bottom of the Ekman layer, as obtained from equation (4) using the full wind field. This corresponds to the theoretical offshore upwelling. The colorbar refers to the vertical velocity, units are in ms^{-1}.

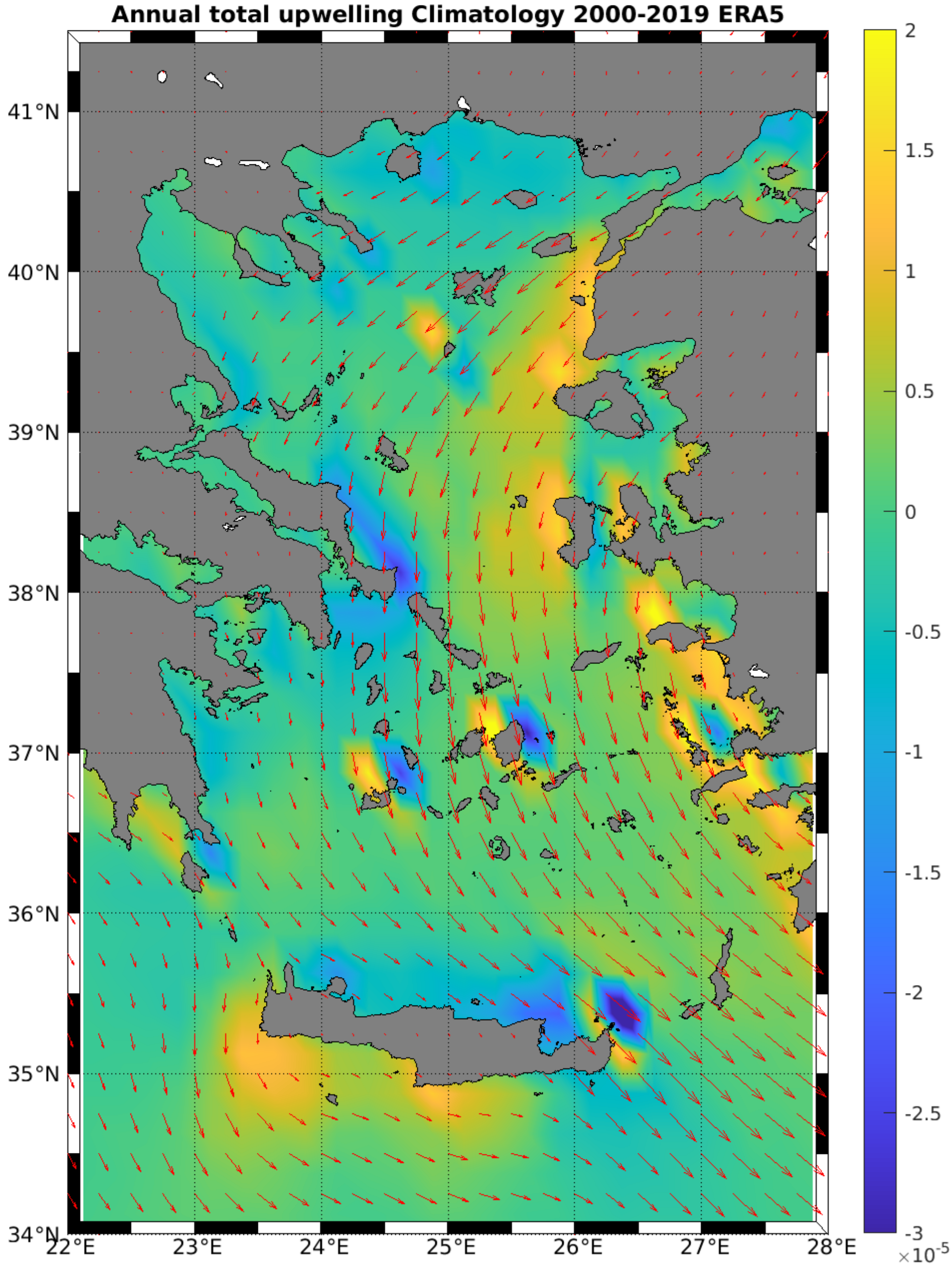

Figure 0.12 As in Figure 0.11, but after setting the wind stress to zero over land areas. This corresponds to the combination of coastal upwelling and offshore Ekman pumping

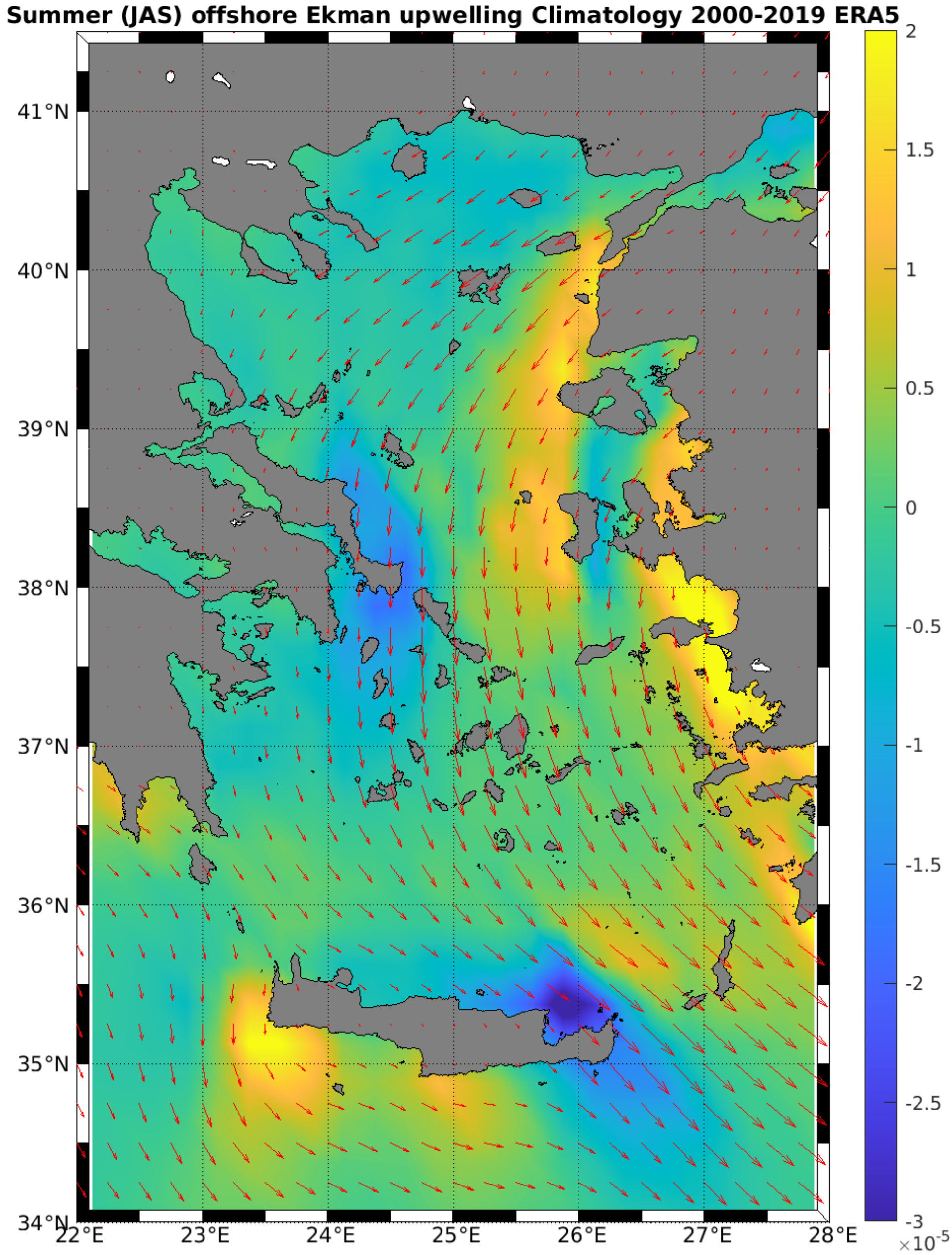

Figure 0.13 As in Figure 0.11, but offshore Ekman pumping results for summer months only (1st July - 30th September)

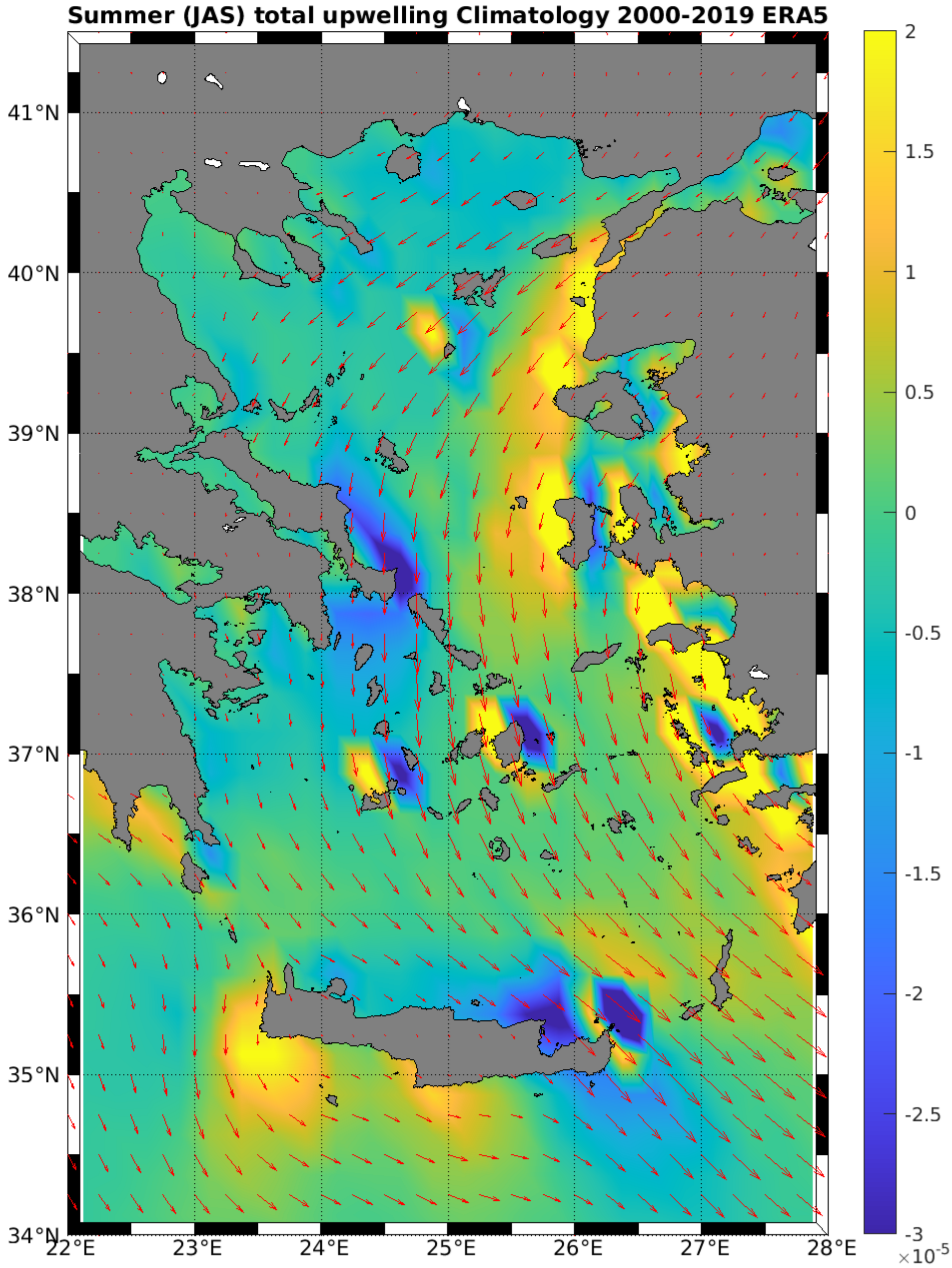

Figure 0.14 As in Figure 0.13, but for total (coastal upwelling and offshore Ekman pumping), for the summer months

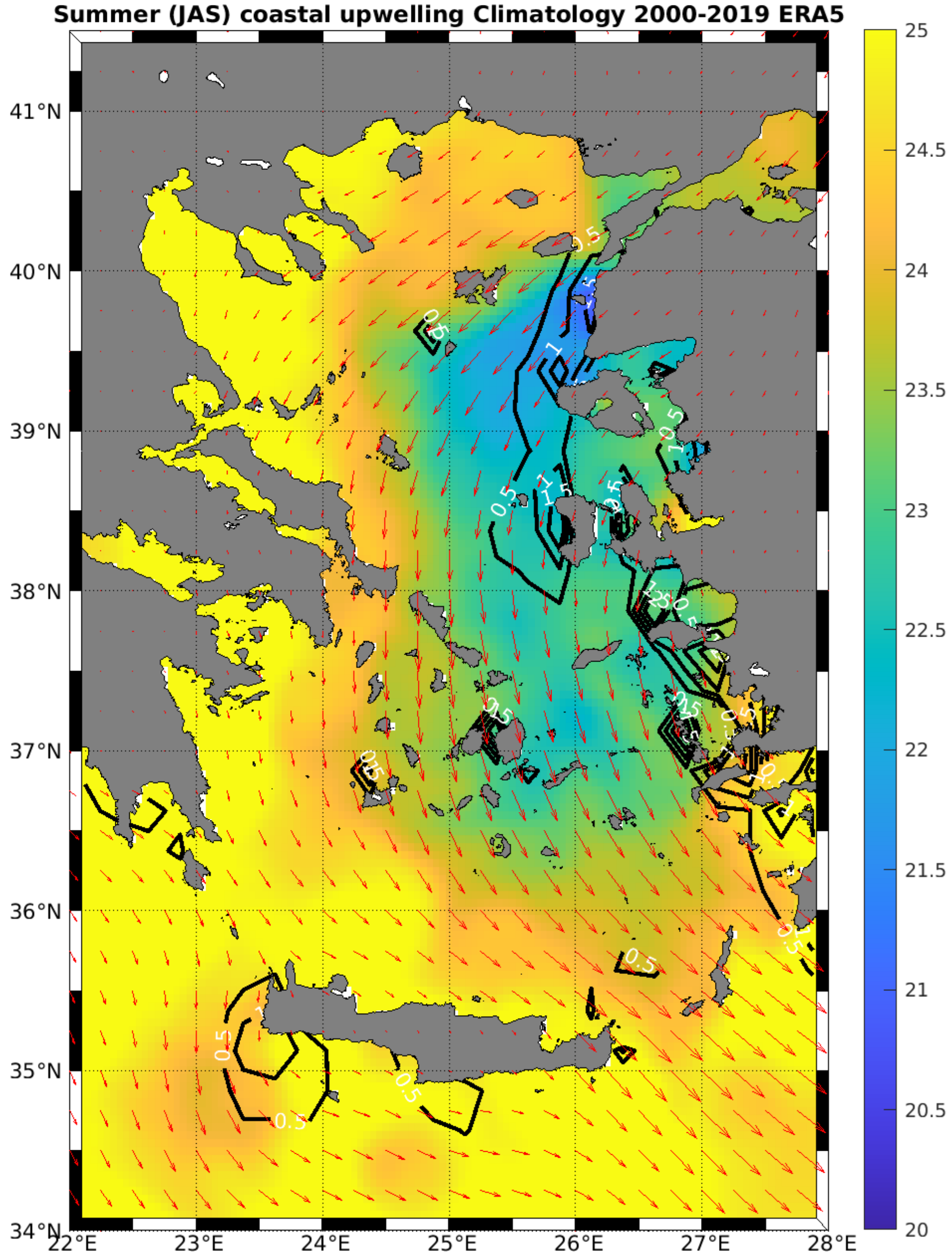

Figure 0.15 This figure refers to the summer months (July – September) climatology for the period 2000-2019. The background color corresponds to SST (colorbar in degrees C). The black contours identify the areas of strong energetic upwelling (vertical velocity contours drawn at 0.5, 1, 1.5 and 2 m day-1). Overlaid are wind-stress vectors showing the summer mean atmospheric momentum forcing.

Discussion

A rather unexpected result (most probably due to the modulation of the wind-field by the presence of high land masses around the Aegean Sea) is that there are not major differences between the

Ekman pumping and the total wind-forced upwelling velocity fields, except some very strong upwelling areas along the shores of the eastern Aegean (especially off the Trojan coast and northwest of Lesvos island), as well as to the downwind side (usually to the southwest) of Crete and a few large islands of the Cyclades.

The main energetic upwelling areas remain the same throughout the year, despite exhibiting somewhat lower vertical velocities due to weaker wind-stress pumping. However, there is no SST signal (except maybe partly in the Spring time), mostly due to thick surfaces layers and deep surface mixed layer during the Fall and Winter periods. These results are not shown but are available upon request.

During the summer months, the SST signal traces the dispersion of the upwelled waters, as clearly seen in Figure 10, which eventually cover the surface layers of the Cyclades islands.

Biological diversity

This dataset provides the count of marine animal and plant species within each cell, based on a predicted probability of occurrence greater than 0.5 (Figure 0.16). The data, automatically generated by Aquamaps, is summarized at a resolution of 0.5 x 0.5 °.

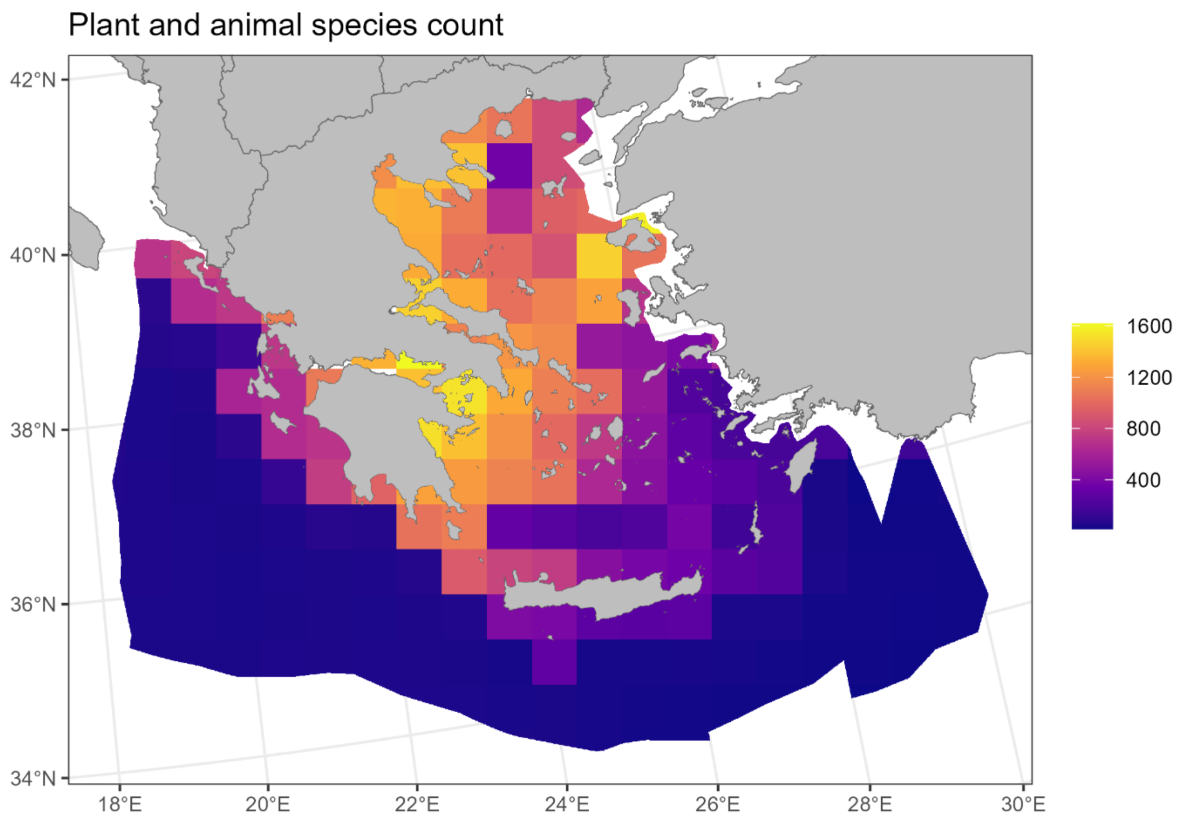

Figure 0.16 Species richness in the Greek Aegean/Ionian Seas. richness is measured as count of all marine plant and animal species with a probability of occurrence greater than 0.5.

Naturalness

The first dataset contains the sum of fishing hours for each cell, derived from AIS data of all large fishing vessels (Figure 0.17). It represents the total time large vessels spent fishing within each cell for the period 01/09/2020 to 31/08/2023. The fishing effort is summarized at a resolution of 0.03 x 0.03 °.

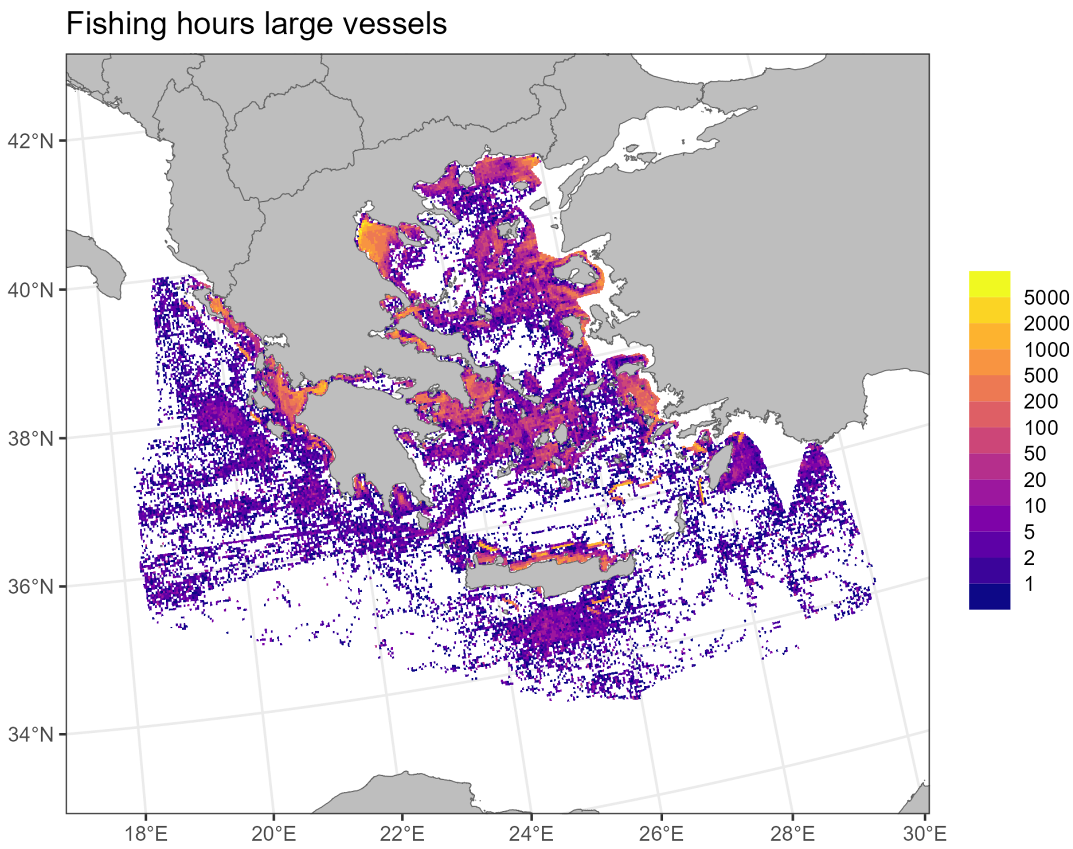

Figure 0.17 Sum of all fishing effort, expressed as the sum of fishing hours across all gears, summed across 2020-2023 for the Greek Aegean/Ionian Seas.

The second dataset, developed by the MarinePlan team following Holon et al. (2015) methodology, estimates the coastal population impact on the Greek Seas (Figure 0.18). The inland area of the Planning Site was divided into catchments and population density was calculated, with assigned population density ratings from 0 to 5, according to the scale provided by Holon et al. (2015. Multi-ring 100-meter buffer zones were generated extending into the marine environment from each catchment. To model the impact of population density, an attenuation curve was applied, assuming a negative exponential decrease from the origin to distances of 1, 3, 5, or 20 kilometers, based on the rating assigned to each catchment. Buffer zones were transformed into a 100 x 100 m grid and adjusted for bathymetry, accounting for a 10% impact loss per 10-meter depth group.

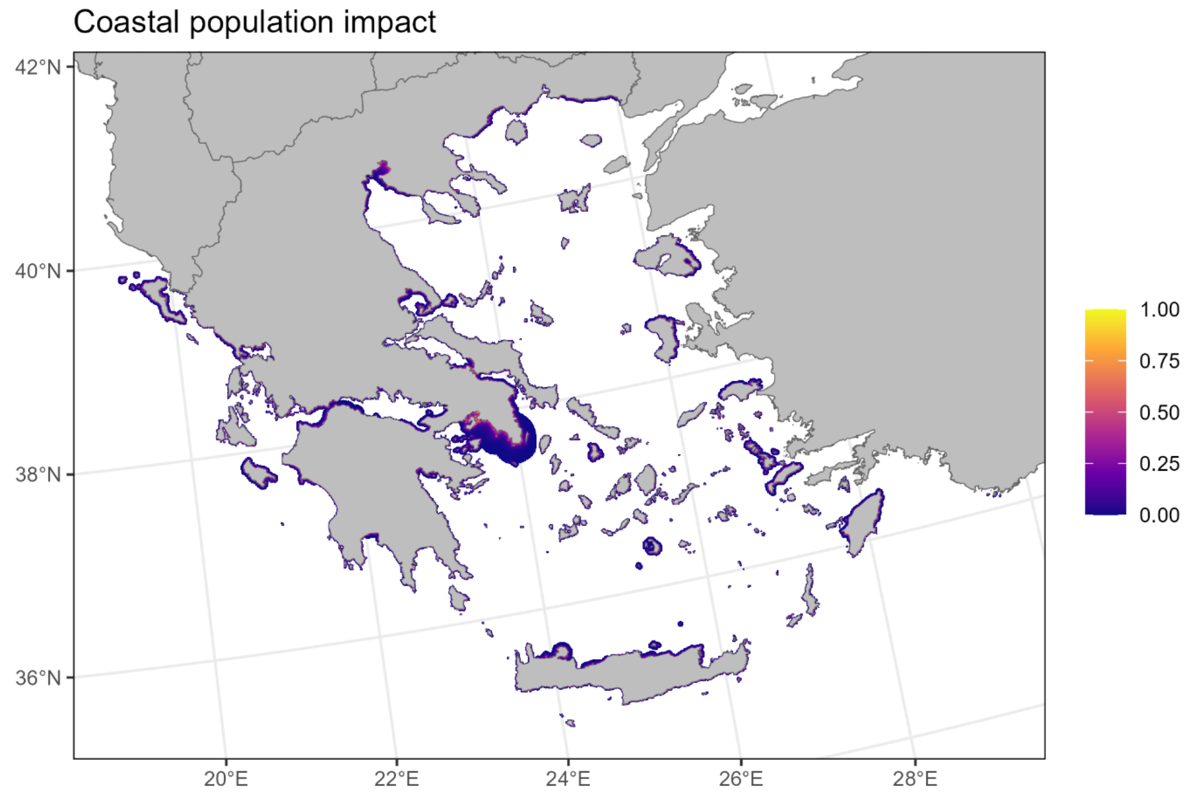

Figure 0.18 Coastal population impact in the Greek Aegean/Ionian Seas based on population density and distance from the coast.

The third dataset, developed by the MarinePlan team following Holon et al. (2015) methodology, estimates the impact of tourist arrivals on the Greek Seas (Figure 0.19). The inland area of the Planning Site was divided into catchments and tourist population density was calculated, with assigned density ratings from 0 to 5, according to the scale provided by Holon et al. (2015. Multi-ring 100-meter buffer zones were generated extending into the marine environment from each catchment. To model the impact of tourist arrivals, an attenuation curve was applied, assuming a negative exponential decrease from the origin to distances of 1, 3, 5, or 20 kilometers, based on the rating assigned to each catchment. Buffer zones were transformed into a 100 x 100 m grid and adjusted for bathymetry, accounting for a 10% impact loss per 10-meter depth group.

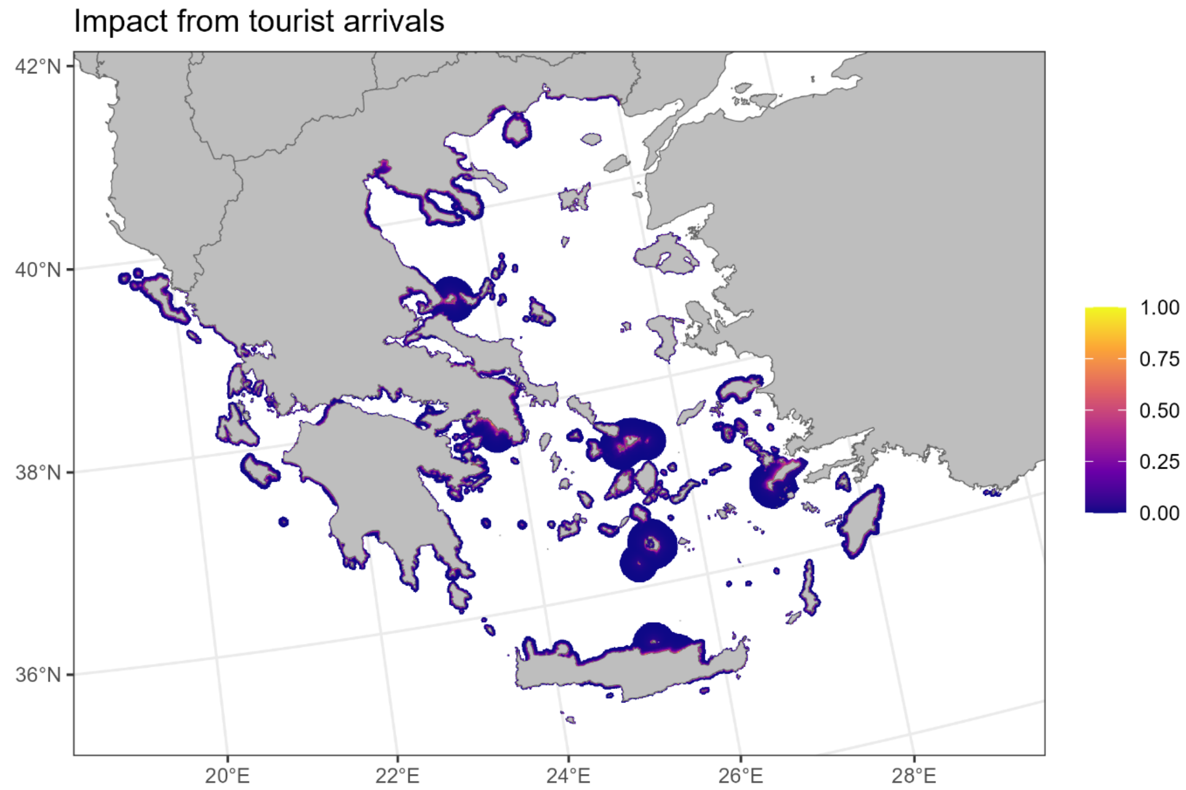

Figure 0.19 Iimpact from tourist arrivals in the Greek Aegean/Ionian Seas based on tourist density and distance from the coast.

Bay of Biscay

Biological productivity

Biological productivity was calculated based on Chlorophyll-a concentration in seawater data provided by the Ocean Colour Climate Change Initiative project (Sathyendranath et al. 2019). The original dataset contained monthly Chlorophyll-a concentration from September 1993 to December 2023. We computed monthly medians per year and per quarter (Q1: Jan-March, Q2: Apr-Jun, Q3: Jul-Sept, Q4: Oct-Dec) and cropped it by the study area. The unit of the chlorophyll is mg/m^3. Data are presented across all years (Figure 0.20), by year (Figure 0.21) and by quarter (Figure 0.22).

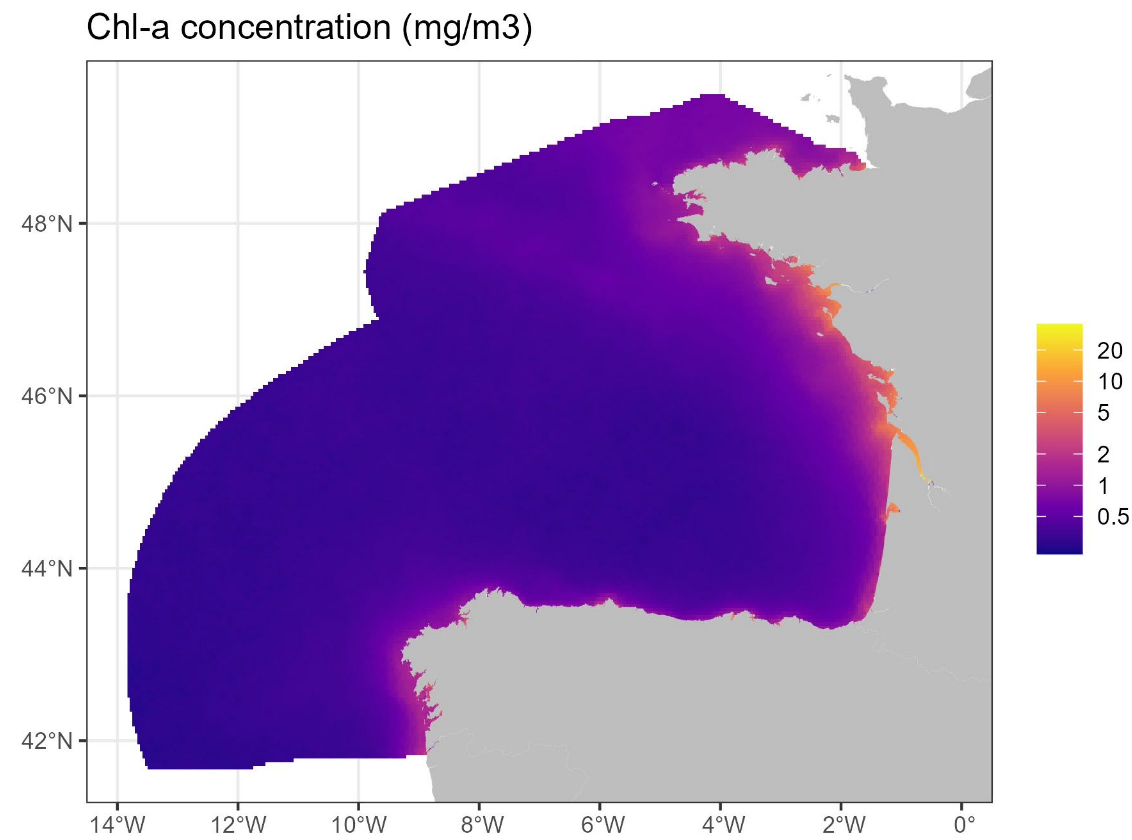

Figure 0.20 Overall chlorophyll-a concentration (mg/m³) averaged across all quarters and years (1993-2023). Colours are on a log-scale.

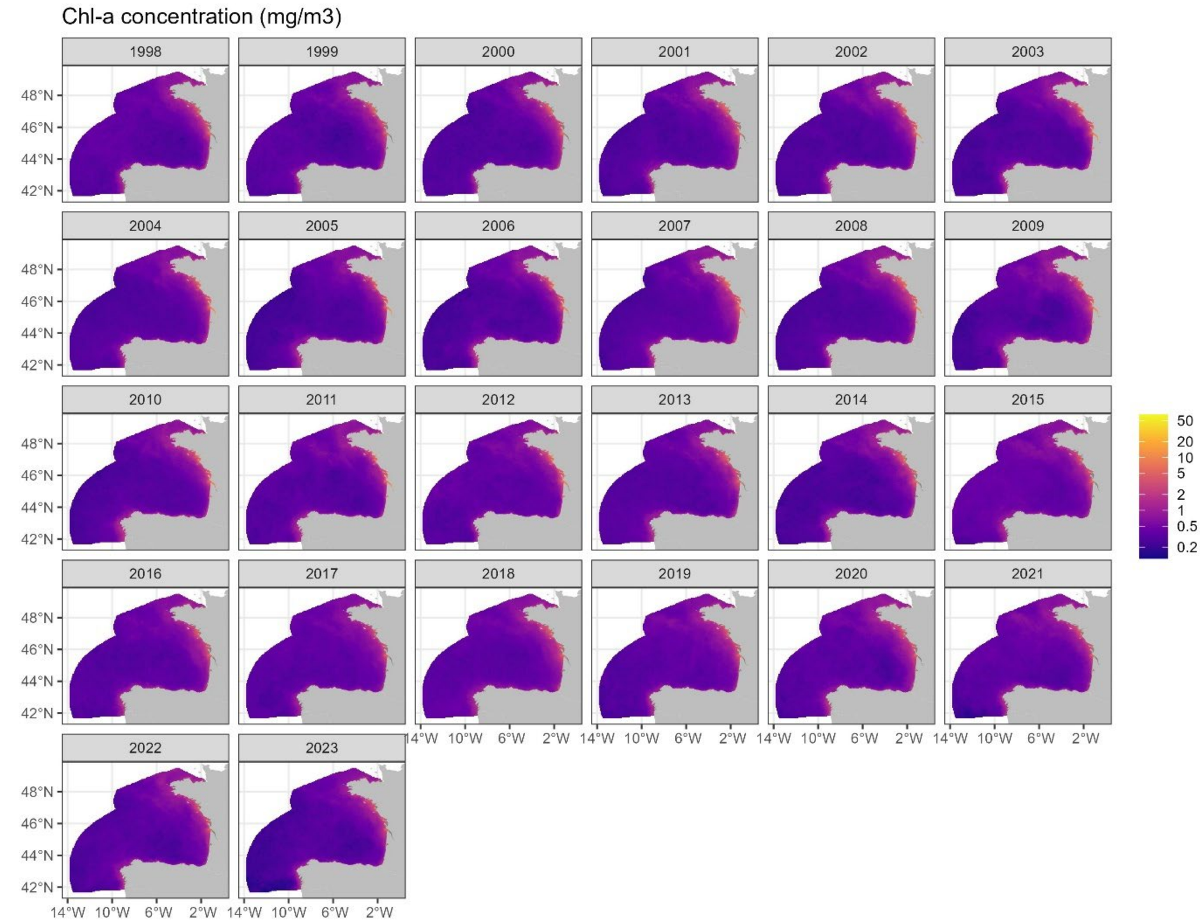

Figure 0.21 Annual chlorophyll-a concentration (mg/m³). Colours are on a log-scale.

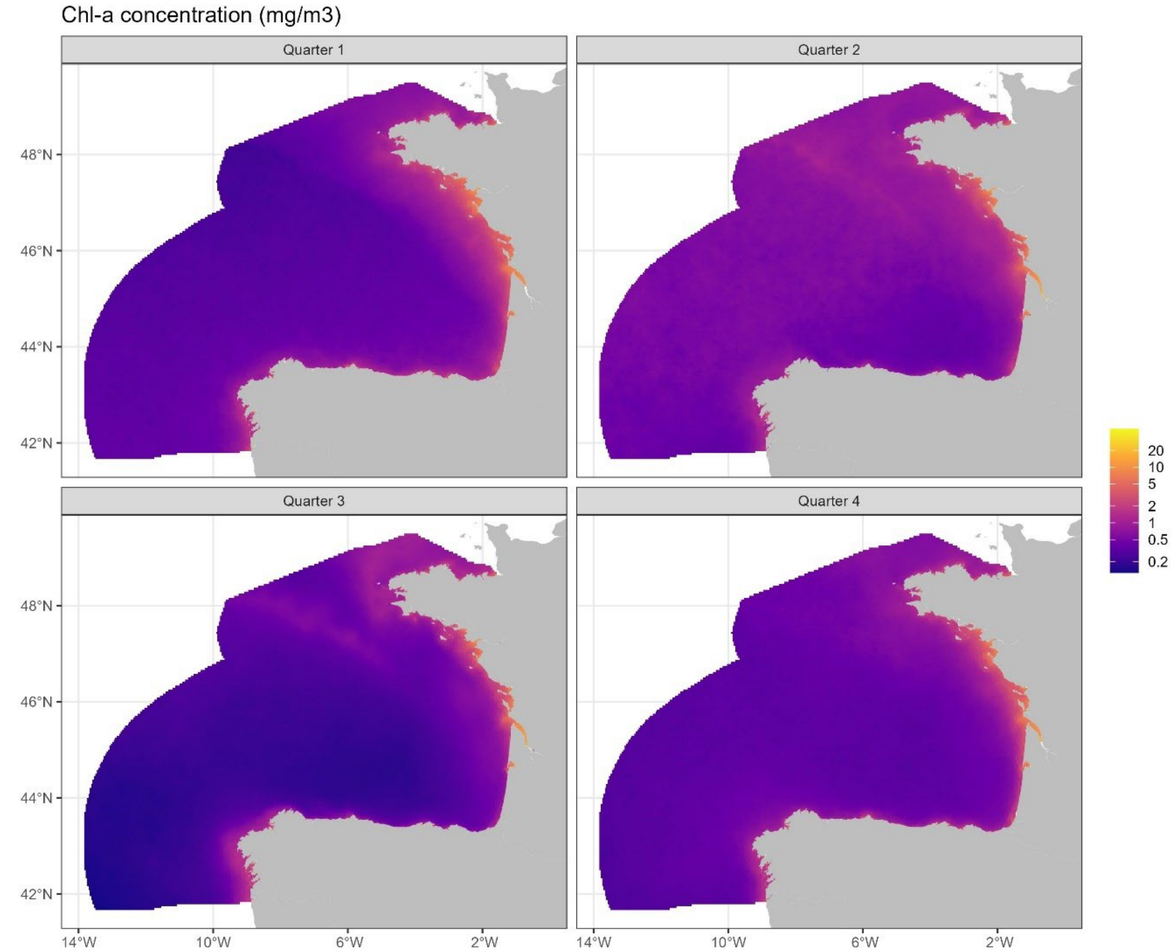

Figure 0.22 Chlorophyll-a concentration (mg/m^3) by quarter, averaged across years (1993-2023). Colours are on a log-scale.

Biological diversity

Biological diversity is calculated based on the combination of global predicted species richness for Plantae and Animalia kingdoms generated by AquaMaps (Kaschner et al. 2019; AquaMaps 2019a,b) (Figure 0.23). The unit is species count.

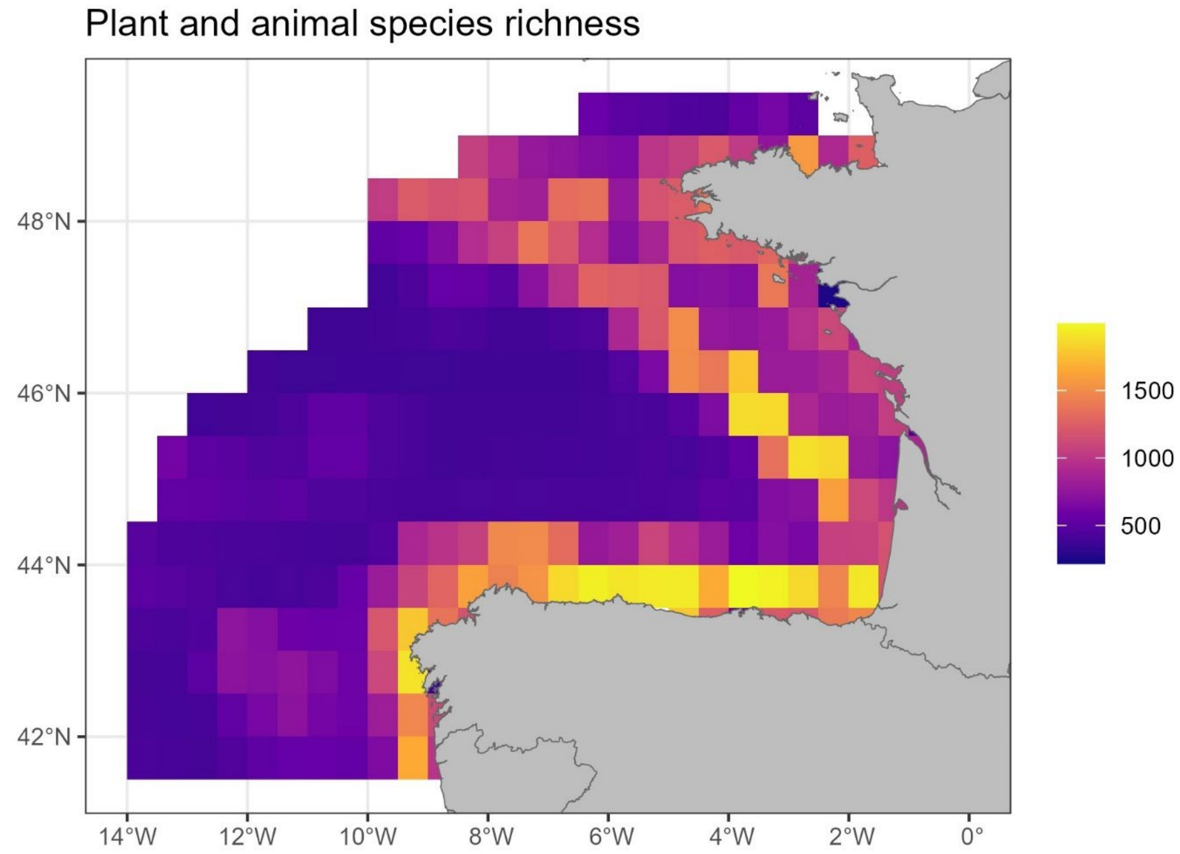

Figure 0.23 Species richness in the Bay of Biscay. The unit is species count.

Naturalness

Fishing intensity is used as a proxy for Naturalness criterion. The original vector data containing the average 2018-2021 fishing intensity per C-Square 0.05x0.05 degree grid (EMODnet) was transformed into the raster format and cropped by the study area. Data are presented as summed fishing effort of all gears (Figure 0.24) and by gear (Figure 0.25).

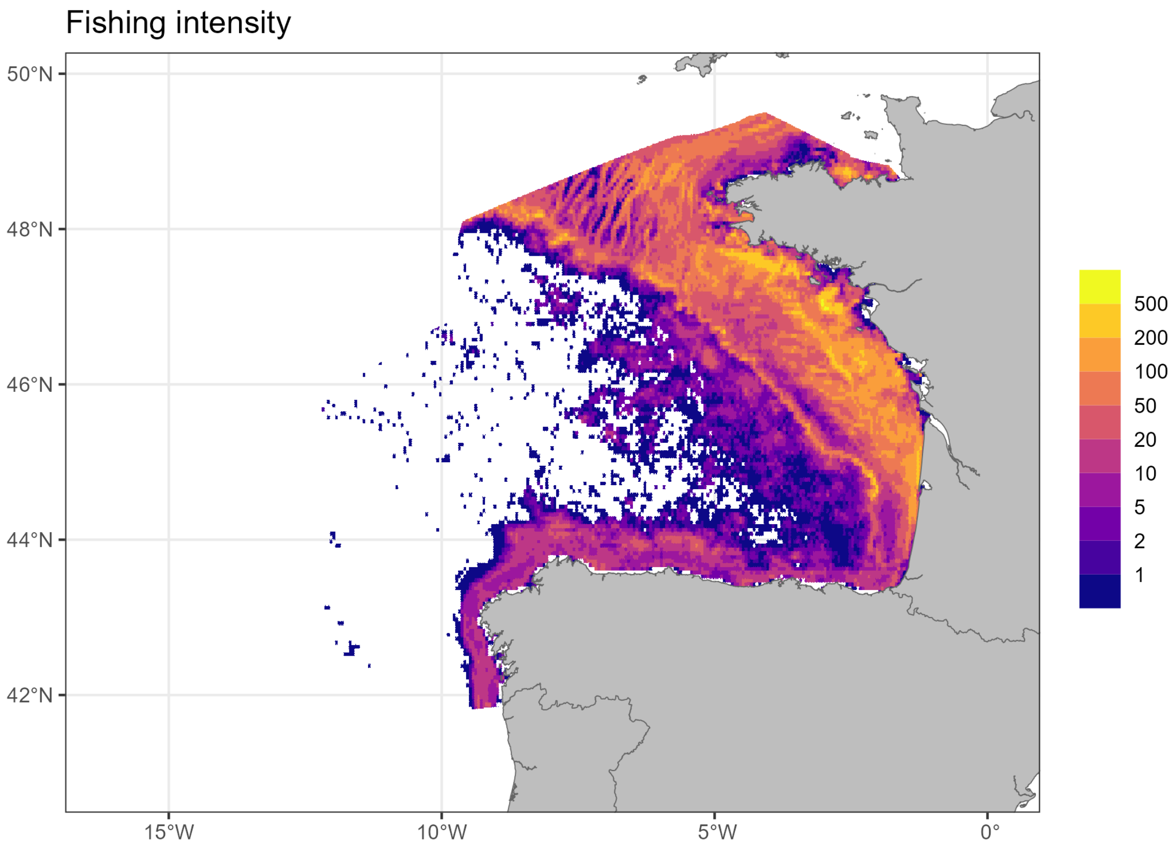

Figure 0.24 Sum of all fishing effort across all gears, averaged across 2018-2021 (mW fishing hours).

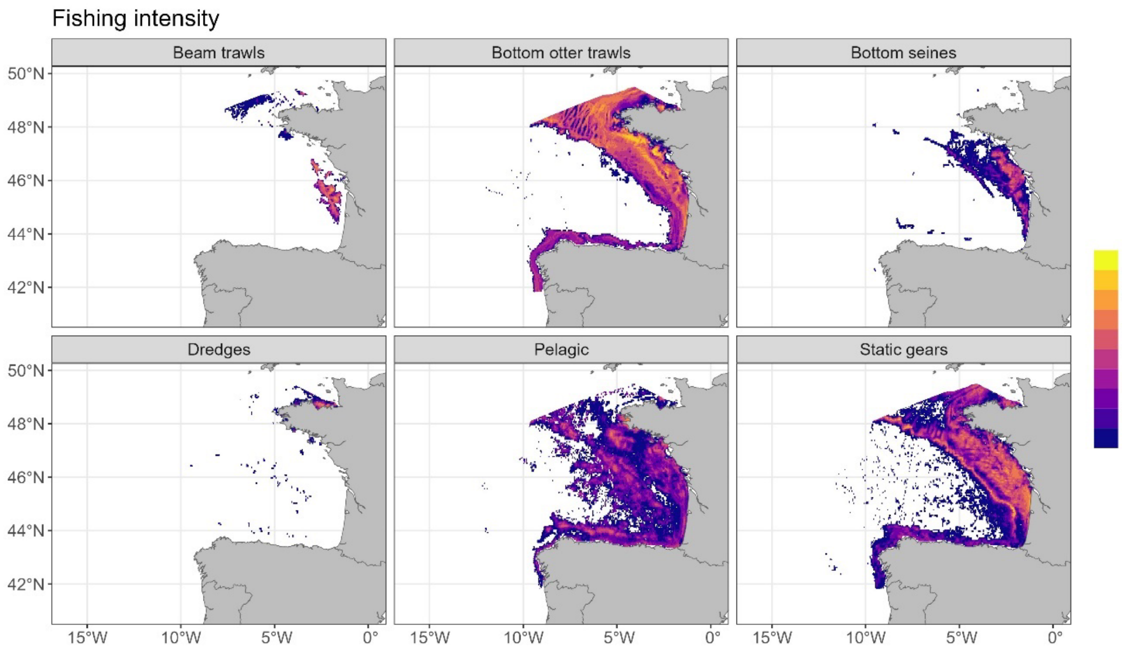

Figure 0.25 Fishing effort by gear, averaged across 2018-2021 (mW fishing hours).

CAMPANIA REGION

Biological productivity

Primary productivity measured in mg $m^{-3}day^{-1}$ (Figure 0.26). The most productive areas occur in the north sector of the study area from the Gulf of Naples to Gaeta. Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=b094d6a9596d424b9c8bbf0ebc4b578d

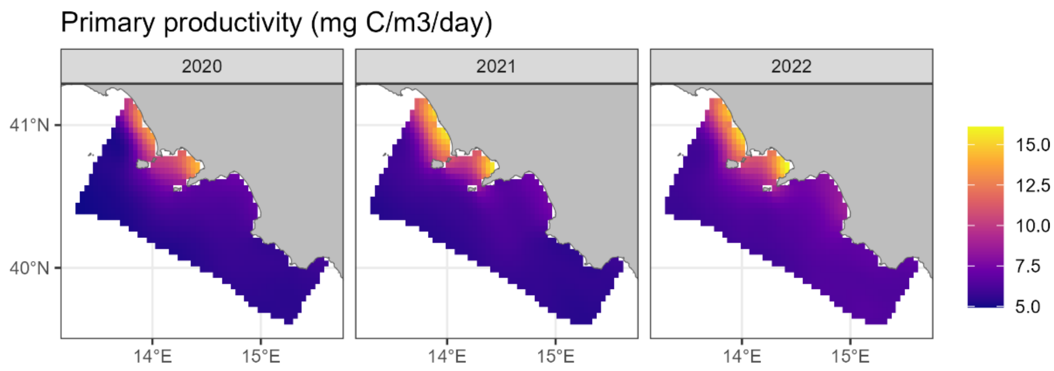

Figure 0.26. Primary productivity from 2020 to 2022 along the Campania coast

Biological diversity

The spatial distribution of the main habitats of the Campania region (Seagrasses, macroalgae, coralligenous, maerl, shallow rocky reef) is shown in Figure 0.27. Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=46dc0451f83548c486f487980f59c52f

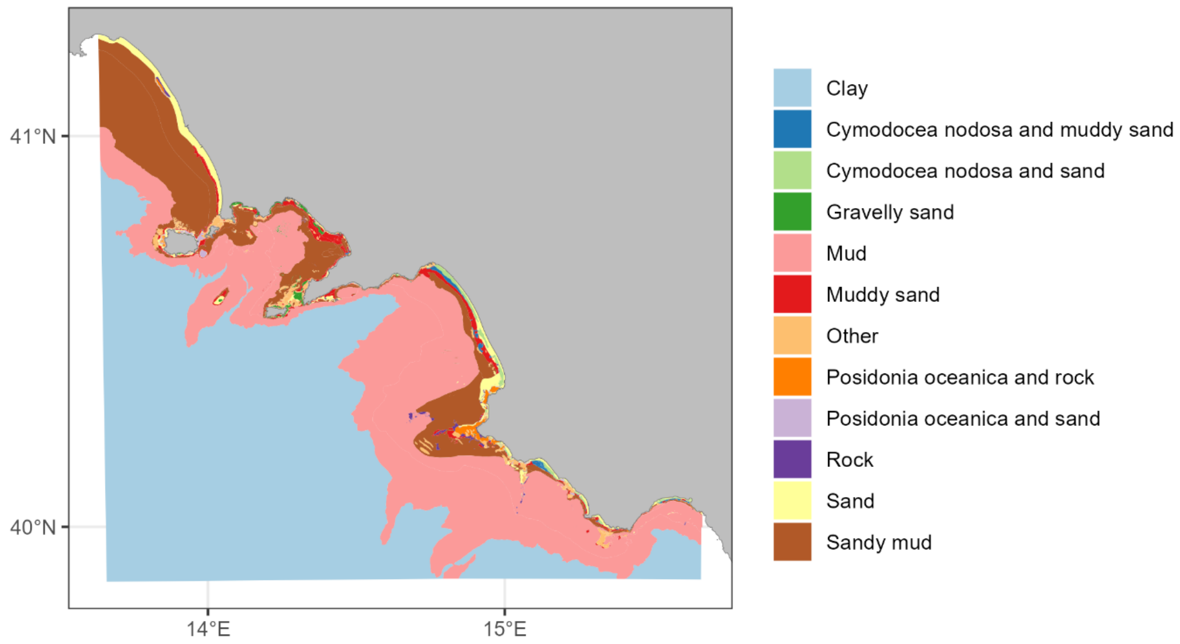

Figure 0.27 Presence of habitats with largest areal extent, together covering 99% of the study area.

Deep Sea coral extent and deep-sea oyster extent (Figure 0.28). Source of data: http://gismargrey.bo.ismar.cnr.it:8080/mokaApp/apps/lifedreamPA2/index.html

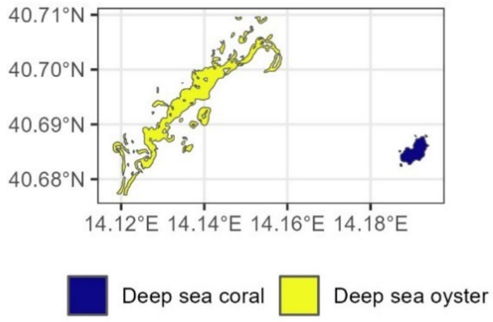

Figure 0.28 Presence of areas with deep-sea corals and deep-sea oysters.

The importance of the Essential Fish Habitats (spawning and nursery grounds: EFH) of the main commercial species of fish and shellfish is based on measures of temporal persistence of density hot-spots obtained during bottom trawl surveys carried out in the period 1994-2010 (MEDITS survey). EFH of *Eledone cirrosa, Galeus melastomus, Illex coindetii, Merluccius merluccius, Mullus barbatus, Nephrops norvegicus, Pagellus erhytrinus, Parapenaeus longirostris, Trachurus mediterraneus* and *Trachurus trachurus* (Figure 0.29). Source of data: https://geonetwork.bioinfo.szn.it/geonetwork/srv/ita/catalog.search#/search?resultType=details&sortBy=relevance&fast=index&_content_type=json&from=1&to=20&any=kriging

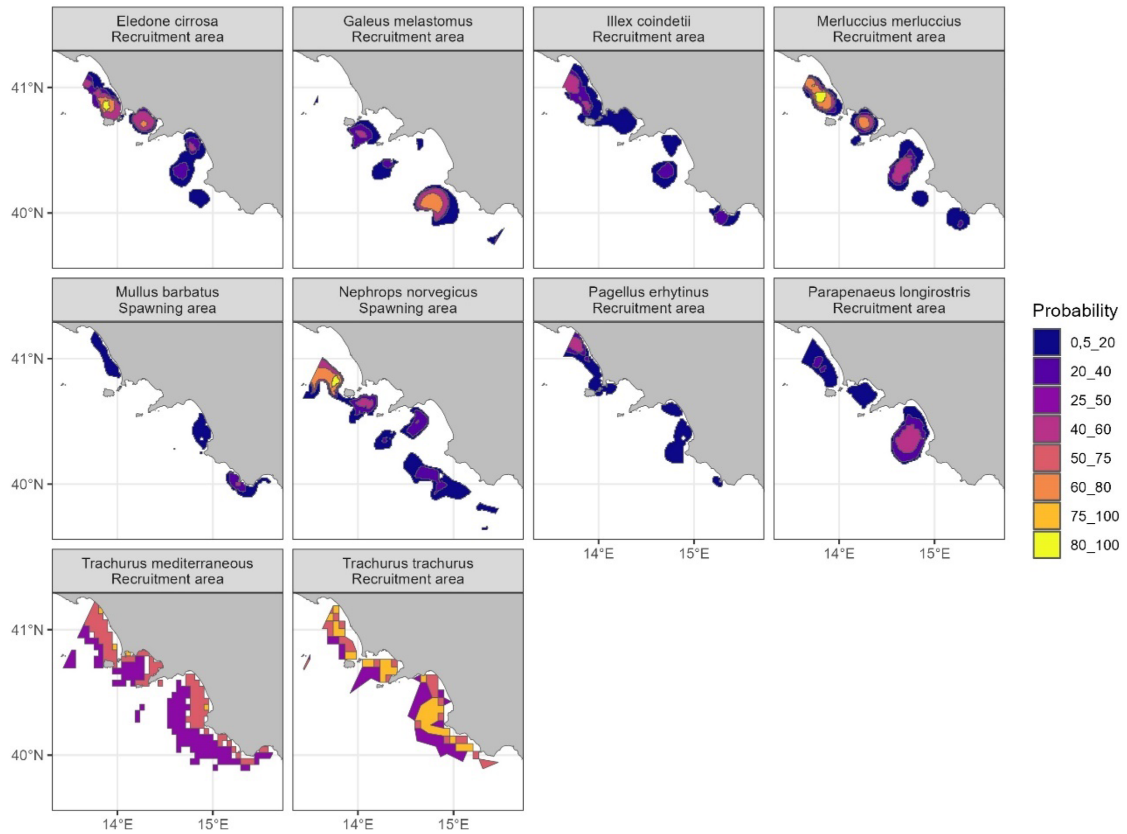

Figure 0.29 Temporal persistence of Essential Fish Habitats of commercial fish and shellfish

Two IMMA (Important Marine Mammals Areas) are located around the Phlegraean Islands and between the Peninsula Sorrentina and the Pontine Islands (Figure 0.30). Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=c73d468591904c72be5b5f962adec38c

Six Important Birds Areas have been identified along the coastal shore and in the mainland (Figure 0.31). Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=afe5b51184ad492c9f801e388a1a20a2

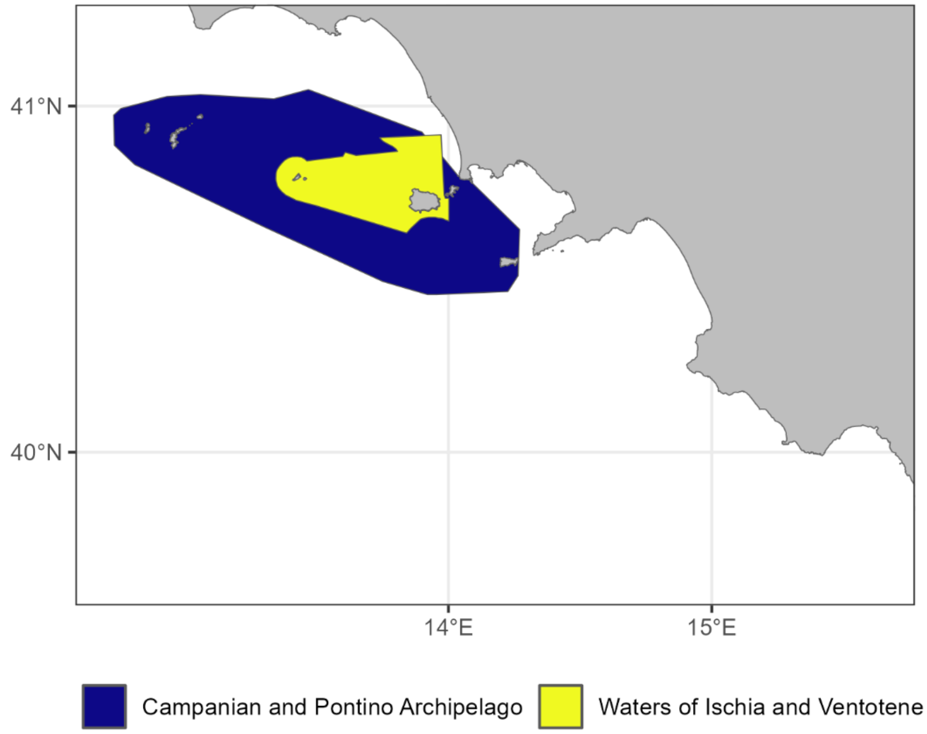

Figure 0.30 Important Marine Mammals Areas

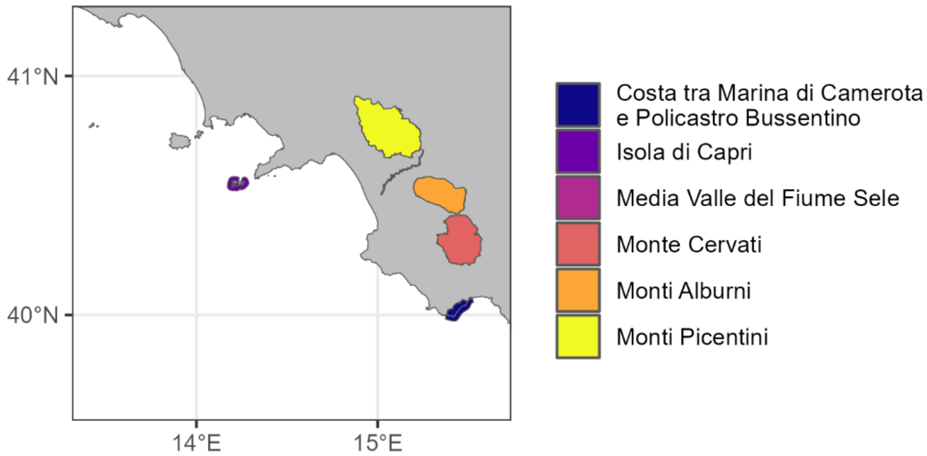

Figure 0.31 Important Birds Areas

Naturalness

The distribution of fishing effort is available for the main fleet segments and for the period 2019-2021. The overall fishing effort of otter trawl and purse seine fleets in 2019 is shown in Figure 0.32. Source of data: https://geonetwork.bioinfo.szn.it/geonetwork/srv/eng/catalog.search#/metadata/c59493ef-8e67-4a56-9ce1-3eacf8bdd0b6

Its evolution during the year (monthly fishing effort) is shown in Figure 0.33 and Figure 0.34. Source of data: https://geonetwork.bioinfo.szn.it/geonetwork/srv/eng/catalog.search#/metadata/e0e9f1b8-7350-427e-92be-00f86abf9a64

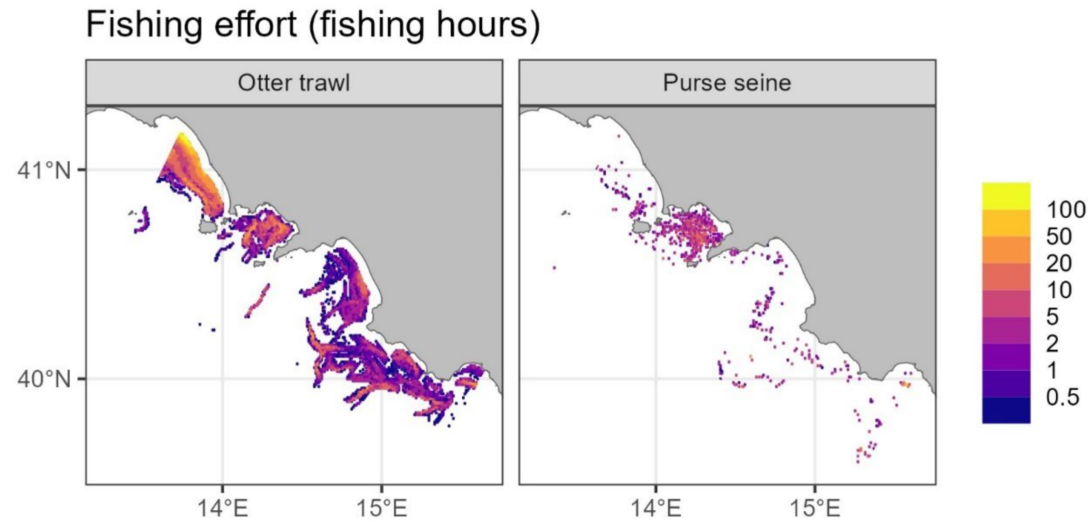

Figure 0.32 Fishing effort of bottom trawlers and purse seiners (n hours/year) exploiting small pelagic fish during 2019. (colours are on a log scale).

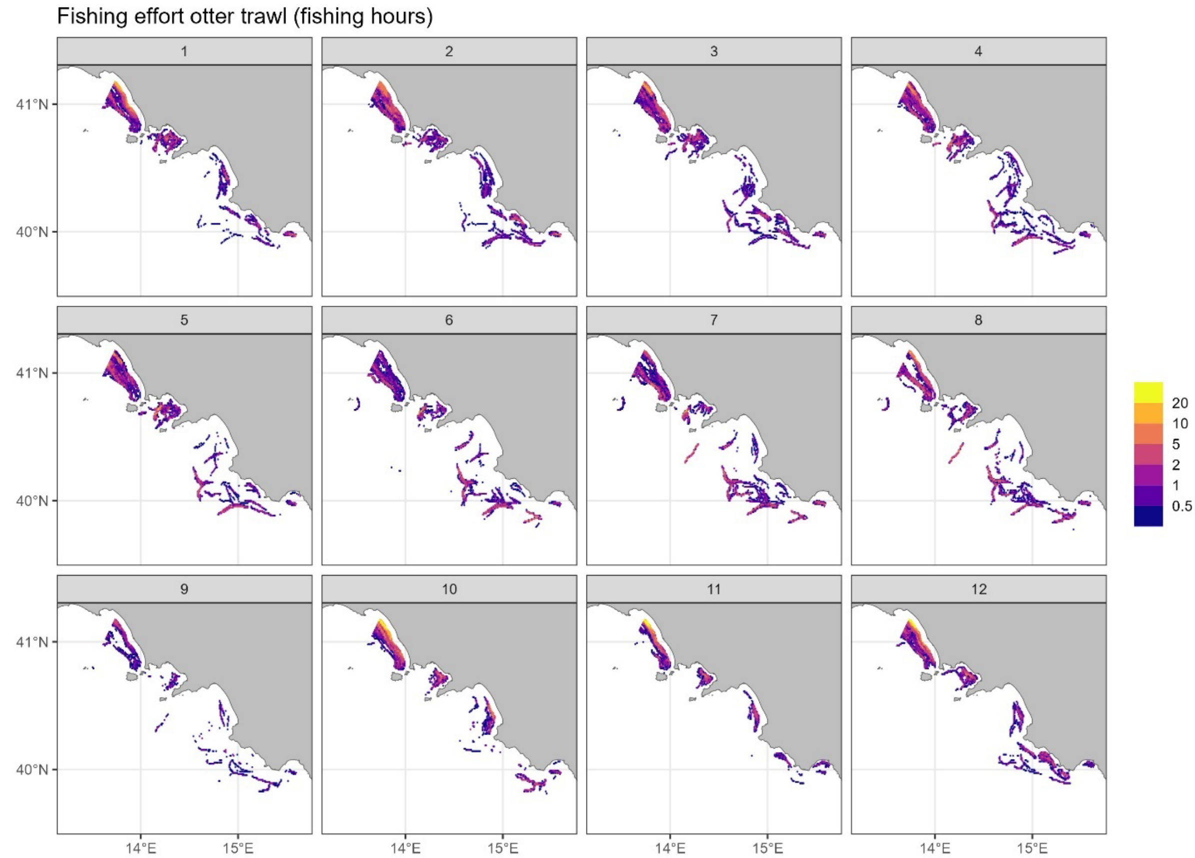

Figure 0.33. Fishing effort of bottom trawlers (n hours/month) by month during 2019 (colours are on a log scale).

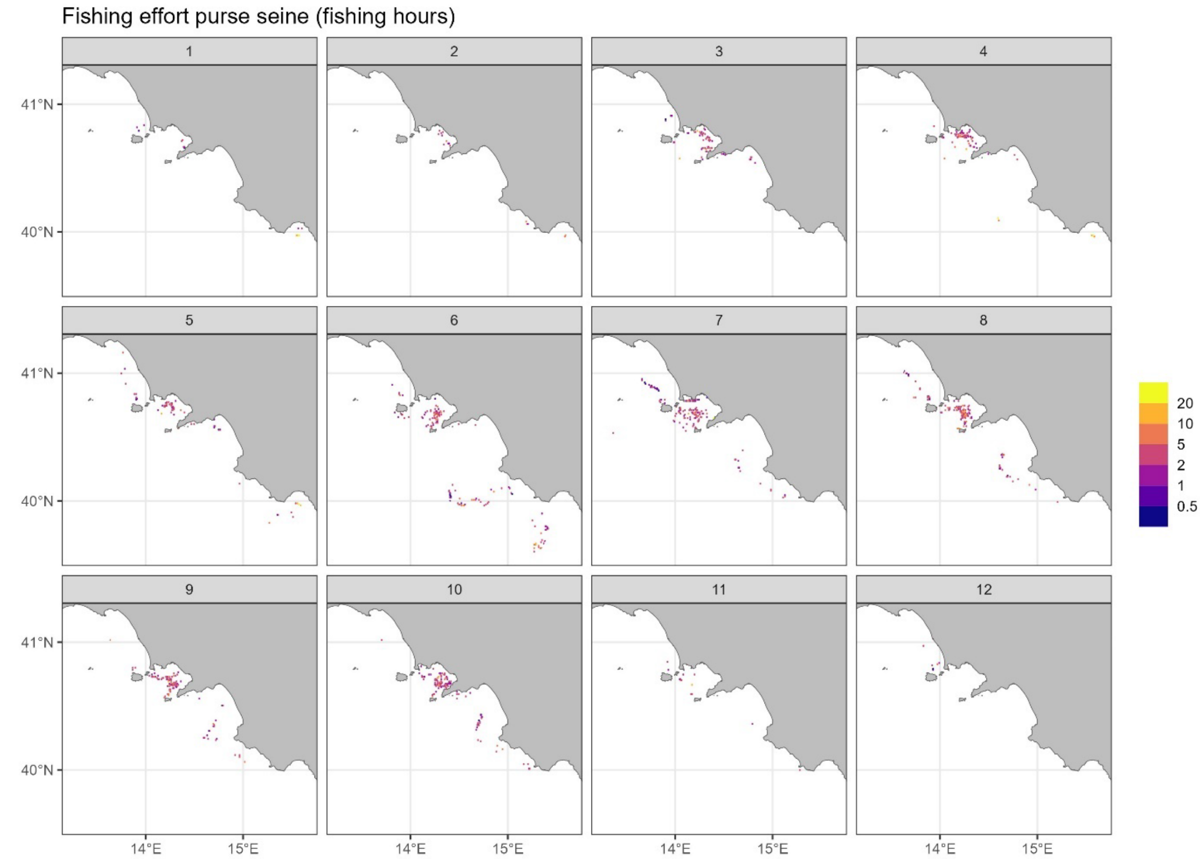

Figure 0.34. Fishing effort of purse seiners exploiting small pelagics (n hours/month) by month during 2019 (colours are on a log scale).

The seasonal change in pelagic fishing areas (number of fishing boats per cell by quarter) during 2019 is shown in Figure 0.35. Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e

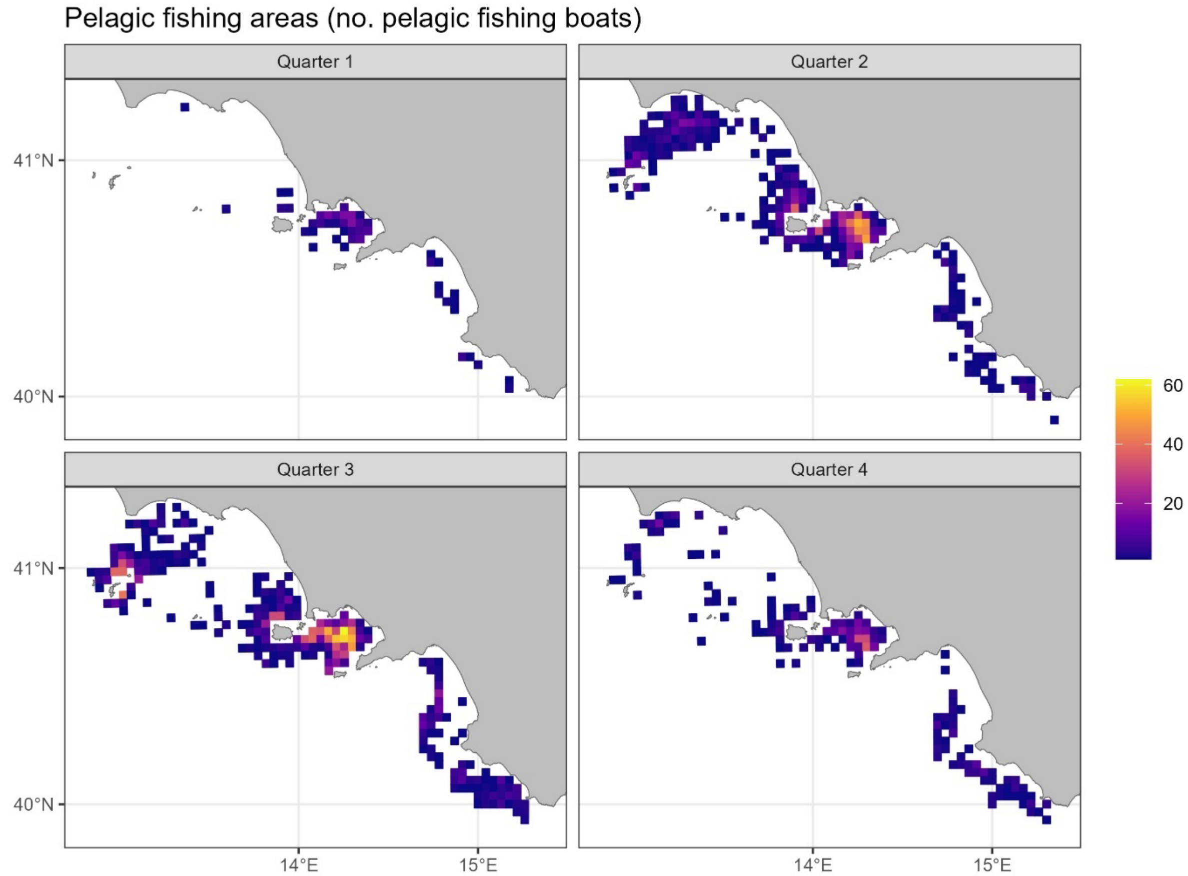

Figure 0.35 Fishing effort of purse seiners as number of fishing boats aggregated by quarter

The main fishing grounds of the artisanal fleet was obtained through interviews in the main fishing harbours during 2021 (Figure 0.36). Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=3a775f4ace194fbaae4d6c5833862c44

Figure 0.36 Fising effort of the artisanal fishing fleet by metier in days at sea (colours are on a log-scale).

EMODnet vessel density data (hours per square kilometre per year per cell, year 2021) indicated some important traffic lanes toward the islands of Ischia, Procida and Capri (Figure 0.37). The map is based on AIS data and show shipping density in 1km*1km cells. Soource of data: https://geonetwork.bioinfo.szn.it/geonetwork/srv/ita/catalog.search#/metadata/d5803423-e4f9-424a-8f15-528f70568271

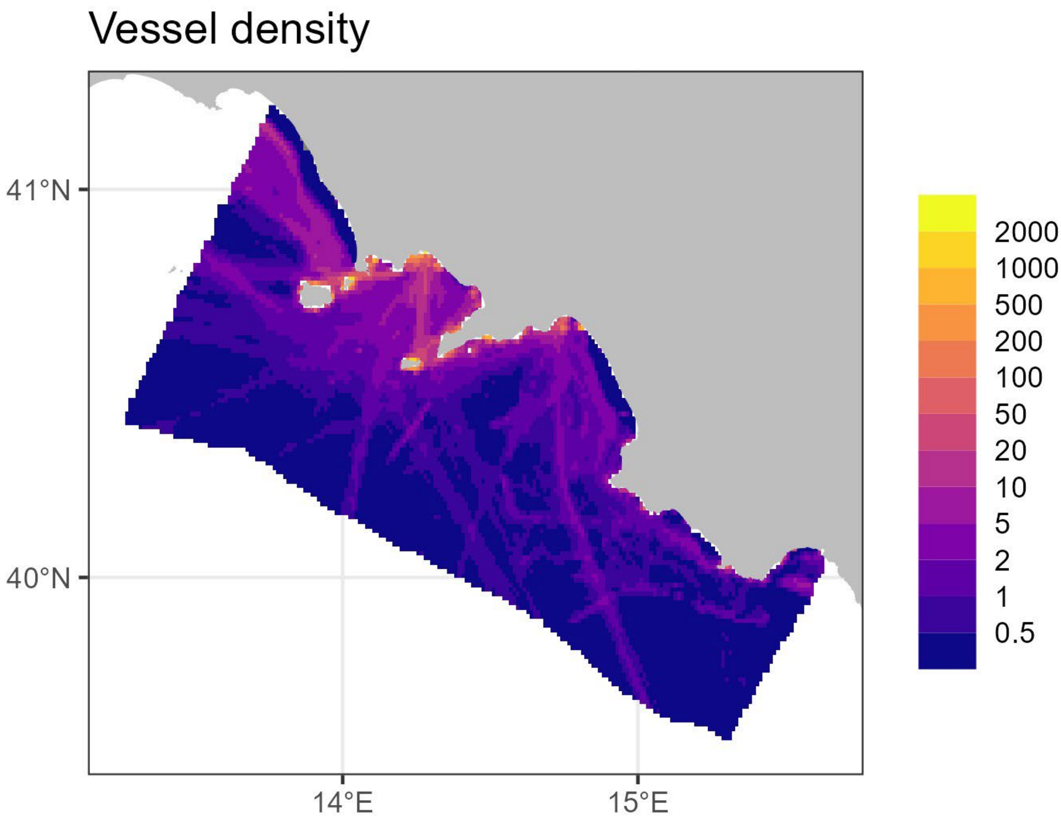

Figure 0.37. Vessels density data along the Campania coast

The main shipping lanes (50 m buffer) are shown in Figure 0.38. Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=5b497ff5fd07410fb81ba812d0e594c1

Aquaculture is mostly represented by mussels farms (mitili) (Figure 0.39). Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=921a7d8c0304453f92c29c4c2af4db9a

Ports (Figure 0.40). Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=3afd335e8d494ad1b9198768b3b123b0

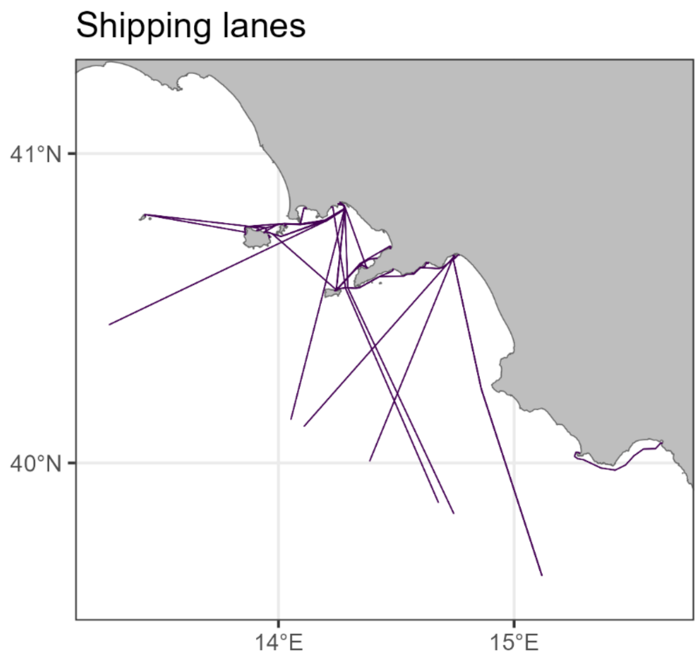

Figure 0.38 Shipping lanes with 50 m buffer

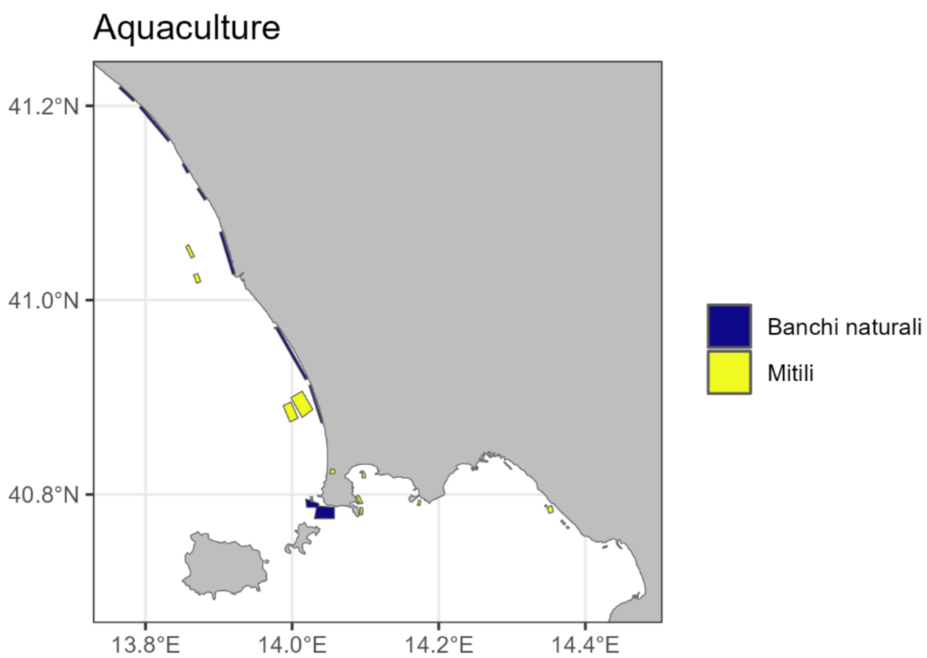

Figure 0.39 Presence of aquaculture activities

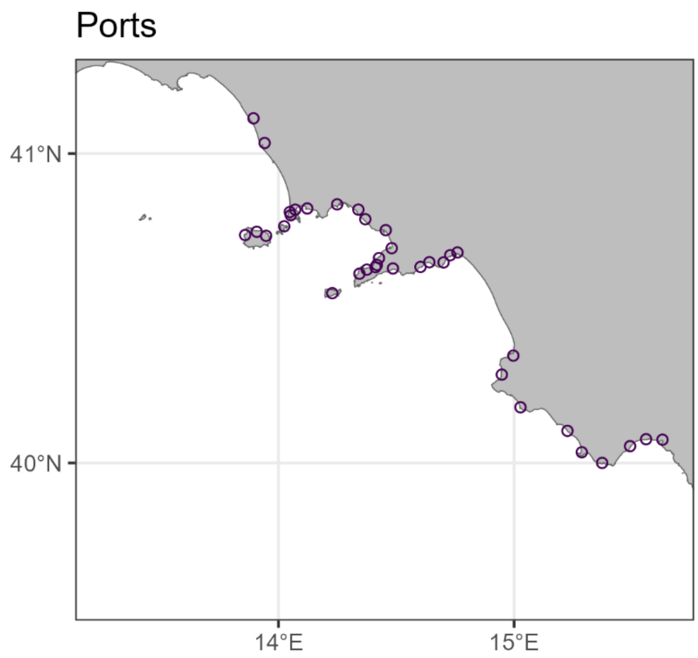

Figure 0.40 Location of ports

Concessions of sea state property (maritime domain) for 2018 includes different types of anthropic uses of the coastal shore such as beach resorts, aquaculture, etc. (Figure 0.41). Source of data: https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=65d42ccaa2c04424bc8d9a9634ec36d4

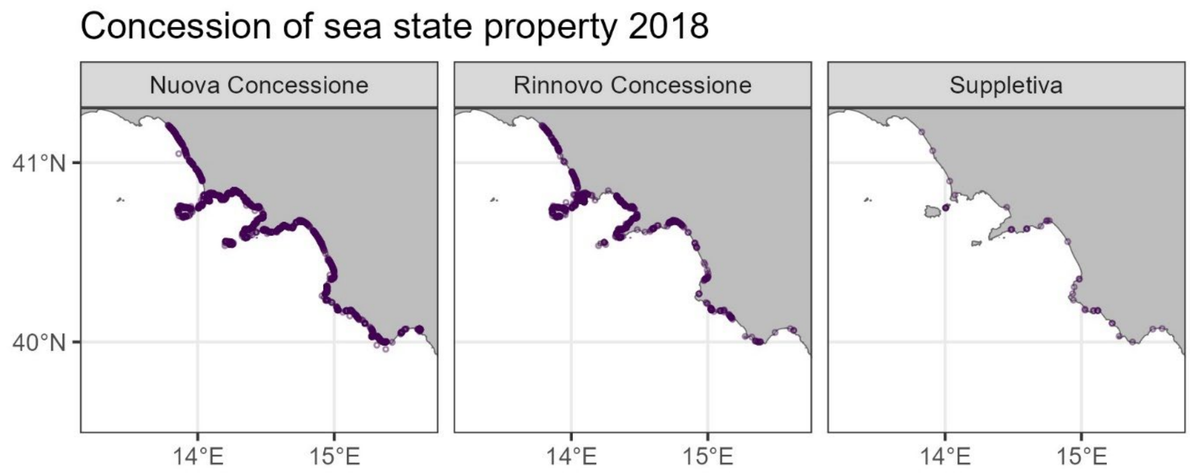

Figure 0.41. Distribution of the concessions of the maritime domain of Campania in 2018.

Southern North Sea

Biological productivity

Biological productivity for the Southern North Sea case study was calculated based on Chlorophyll-a concentration estimates in seawater, maps were provided by the Institute of Natural Sciences of Belgium (Lavigne et al., 2021[1]) based on a dataset generated by request of the OSPAR commission for their latest Quality Status Report.

Chlorophyll-a concentration was estimated from satellite images, with the source products coming from publicly accessible archives, including the Copernicus Marine Environment Monitoring Service and the European Space Agency (Alvera-Azcarate, Van der Zande, Barth, Tourpin, Martin & Beckers, 2021[2]). Three different algorithms based on the optical conditions of each zone: one for open ocean waters, the second for moderately turbid waters and the third for high turbid waters (Alvera-Azcarate, Van der Zande, Barth, Tourpin, Martin & Beckers, 2021[3]).

[1] Lavigne, H., Van der Zande, D., Ruddick, K., Cardoso Dos Santos, J., Gohin, F., Brotas, V., et al. (2021). Quality-control tests for OC4, OC5 and NIR-red satellite chlorophyll-a algorithms applied to coastal waters. *Remote Sens. Environ.* 255:112237. doi: 10.1016/j.rse.2020.112237

[2] Alvera-Azcarate A. & Van der Zande D. & Barth A. & Troupin C. & Martin S. & Beckers J.-M. Analysis of 23 years of daily cloud-free chlorophyll and suspended particulate matter in the Greater North Sea (2021) *Frontiers in Marine Science*, Vol. 13(19) p. 2657. DOI: https://doi.org/10.3389/fmars.2021.707632

[3] Alvera-Azcarate A. & Van der Zande D. & Barth A. & Troupin C. & Martin S. & Beckers J.-M. Analysis of 23 years of daily cloud-free chlorophyll and suspended particulate matter in the Greater North

Four maps were generated, displaying the average seasonal variation in chlorophyll-a concentration from 2017-2020, for each season (Figure 0.42).

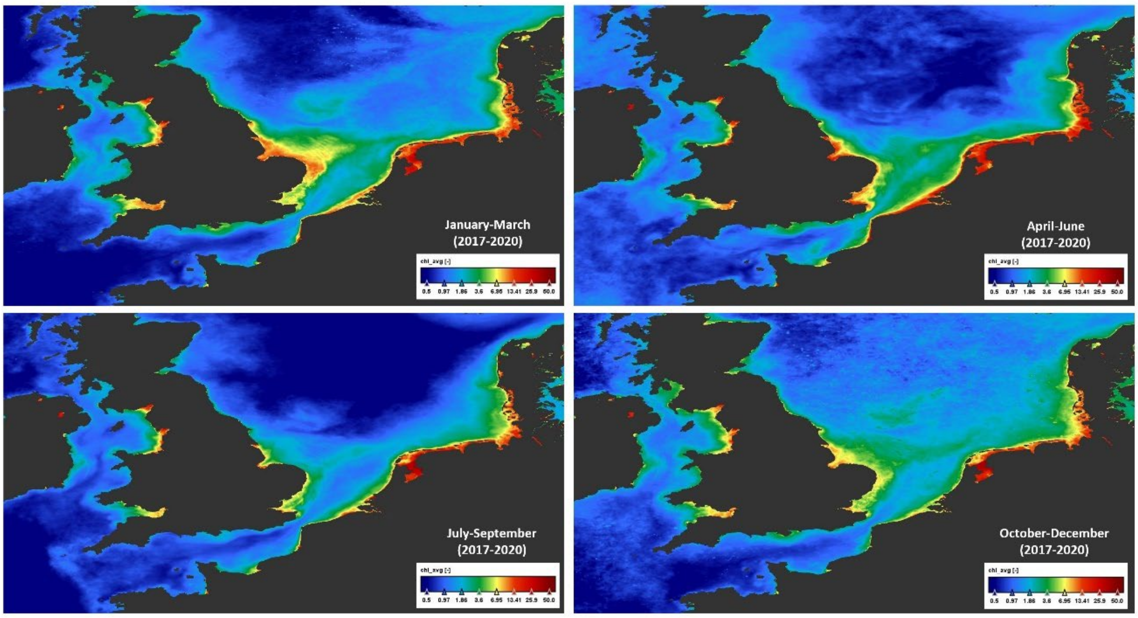

Figure 0.42. Average seasonal variation of chlorophyll-a concentration (on log scale): January-March, April-June, July-September, October-December (2017-2020).

Biological diversity

Biological diversity of the Southern North Sea was measured using species richness of demersal fish species. To estimate species richness of demersal fish in the southern North Sea, we used already cleaned and merged data from 3 trawl surveys between 2014 and 2023 (Probst et al. in prep). This included the DATRAS International Bottom Trawl Survey (IBTS), the Beam Trawl Survey (BTS) and the Demersal Young Fish survey (DYFS).

First, we excluded all non-fish species that were collected in the demersal surveys based on information from FishBase and species with length measurements (indicating fish species). A crosscheck was done to validate the exclusion criteria.

As surveys did not sample stations and areas uniformly and consecutively across data years, we decided to calculate species richness for each individual survey year. This was done to avoid biases and reduce inaccuracy in data representation.

For each survey point, a unique key was created to represent the survey, year, station number, haul number and coordinates. The number of unique species identified for each key was extracted from the total number of fish sampled and the number of different species identified. We used the raw values of unique species identified per key as our value of species richness.

Sea (2021) *Frontiers in Marine Science*, Vol. 13(19) p. 2657. DOI: https://doi.org/10.3389/fmars.2021.707632

Data was exported from R to ArcGIS Pro to create species richness maps. To allow for continues data for the entire Southern North Sea, we used the Inverse Distance Weighting (IDW) tool in ArcGIS Pro to calculate for continues values of species richness for the Southern North Sea. For each year, we used a Standard neighbor search, with an IDW power of 2, a maximum of 10 and a minimum of 5 neighbors to calculate for continues values.

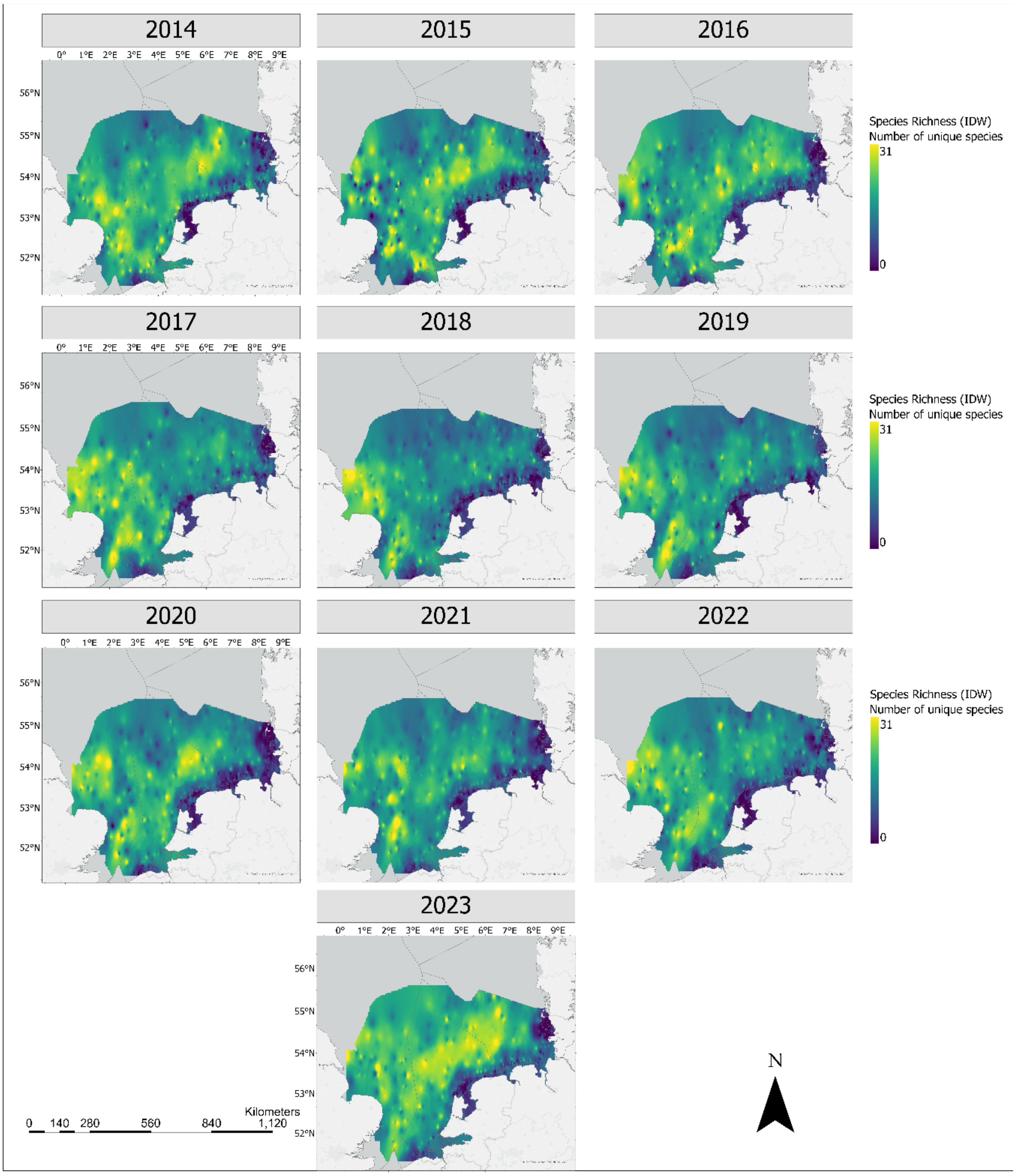

Figure 0.43 Species richness of demersal fish from 2014-2023.

Naturalness

To estimate naturalness of the Southern North Sea, fishing intensity was used as proxy. Maps were generated from fishing effort data downloaded from EMODnet. The datasets are created and updated annually for each sea basin by the International Council for the Exploration of the Sea (ICES).

A first set of maps was produced to display the spatial distribution of average fishing effort for the Southern North Sea case study, per gear type for three different periods (Figure 0.44). Only vessels longer than 12 meters and equipped with a vessel monitoring system (VMS) are taken into account.

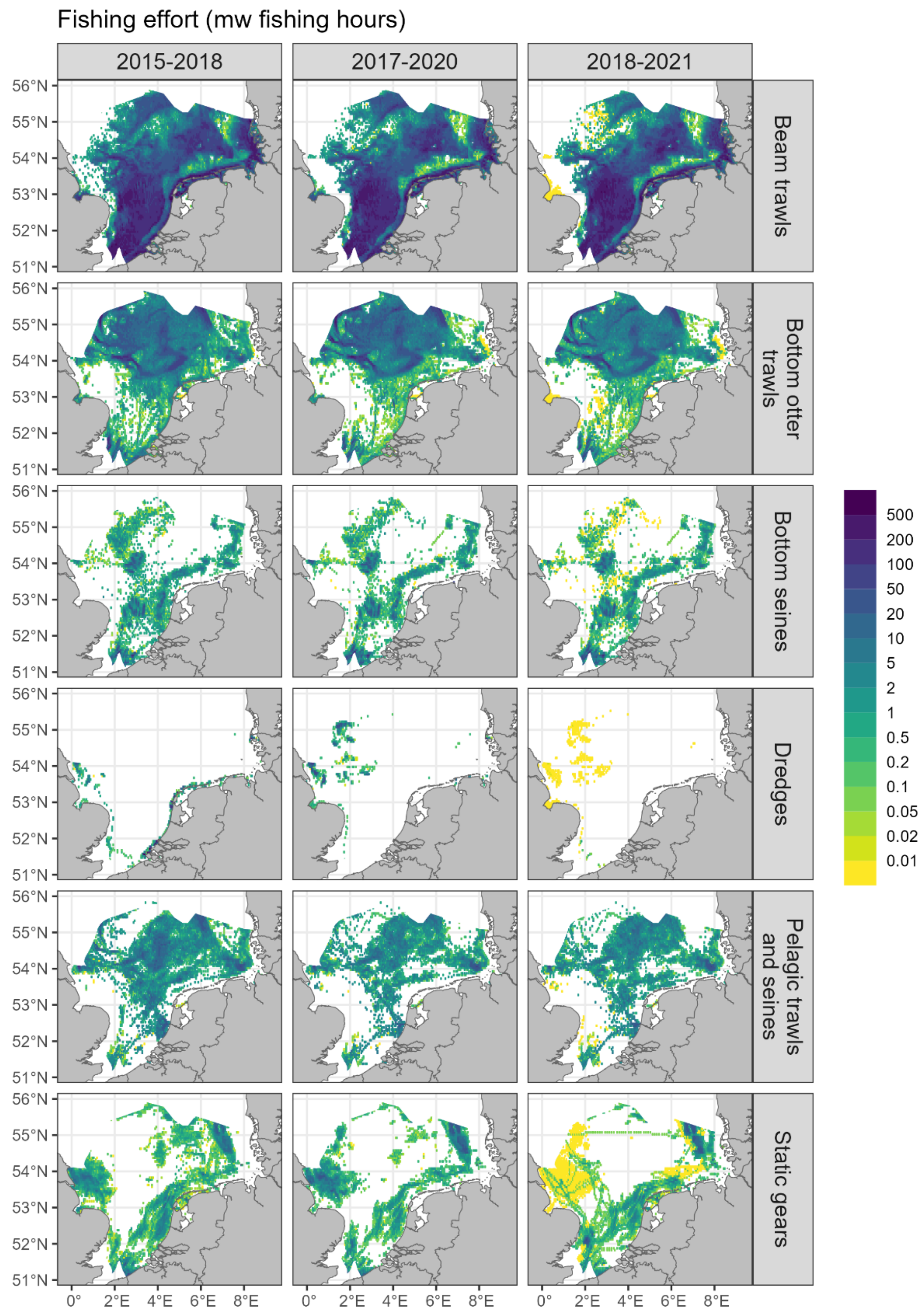

Figure 0.44. Average fishing effort (on log scale) for the Southern North Sea case study, per gear type for three different periods (2015-2018, 2017-2020, 2018-2021).

Fishing effort per fishing gear indicates that beam trawls are the most used gear for fishing in the Southern North Sea, followed by bottom otter trawls and pelagic trawls and seines. Results are consistent throughout the three considered periods. Beam trawls are used in almost the entire area, with the exception of some of the English coast. Across all gears, one area of the English waters seems to be less impacted by fishing, with the exception of static gears.

The second set of maps display the average annual surface (Figure 5.44) and subsurface (Figure 5.45) bottom contacting fishing gear, expressed as average swept area ratio (SAR).

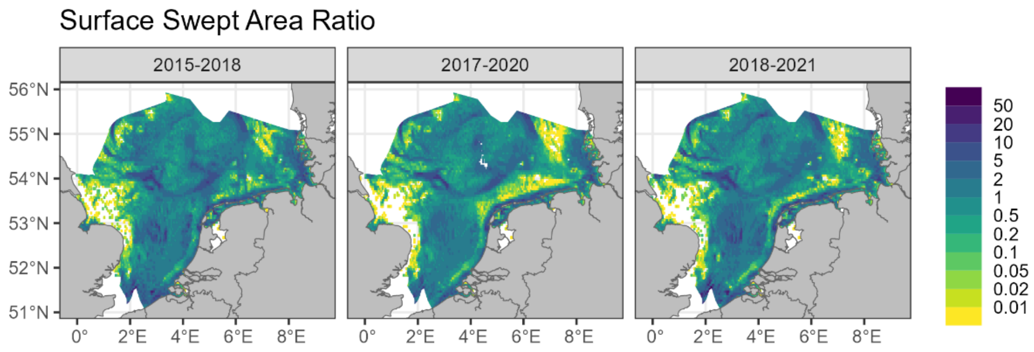

Figure 0.45. Average annual surface swept area ratio (on log scale) for the Southern North Sea, for three periods (2015-2018, 2017-2020, 2018-2021).

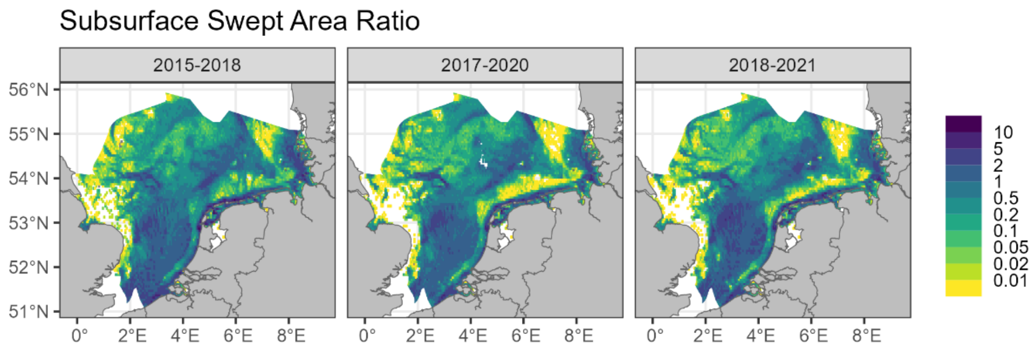

Figure 0.46. Average annual subsurface swept area ratio (on log scale) for the Southern North Sea, for three periods (2015-2018, 2017-2020, 2018-2021).

Both surface and subsurface area swept ratio indicate that the Southern North Sea planning site is heavily impacted by fishing activities. One area along the English coast appears to be less fished, a trend that seems to be increased and confirmed in recent years. As such, it could be a more natural marine environment than the rest of the planning site.

Western Mediterranean

Biological productivity

Kristiansen and collaborators (2024) have produced monthly chlorophyll data from the entire Mediterranean Sea from 1993 to 2023 surface-150m. This data is part of an ensemble that provides future projections of different environmental variables under climate change. The CMIP6 models used for the downscaling of chlorophyll variable are: MPI-ESM1-2-LR (Mauritsen et al. 2019), CanESM5-CanOE (Swart et al. 2019), UKESM1-0-LL (Sellar et al. 2019), CMCC-ESM2 (Lovato et al. 2022), and MIROC-ES2L (Hajima et al. 2020). We have processed the data, doing a mean per year (1993-2023) and cropped the map for the Western Mediterranean Sea (Figure 0.47).

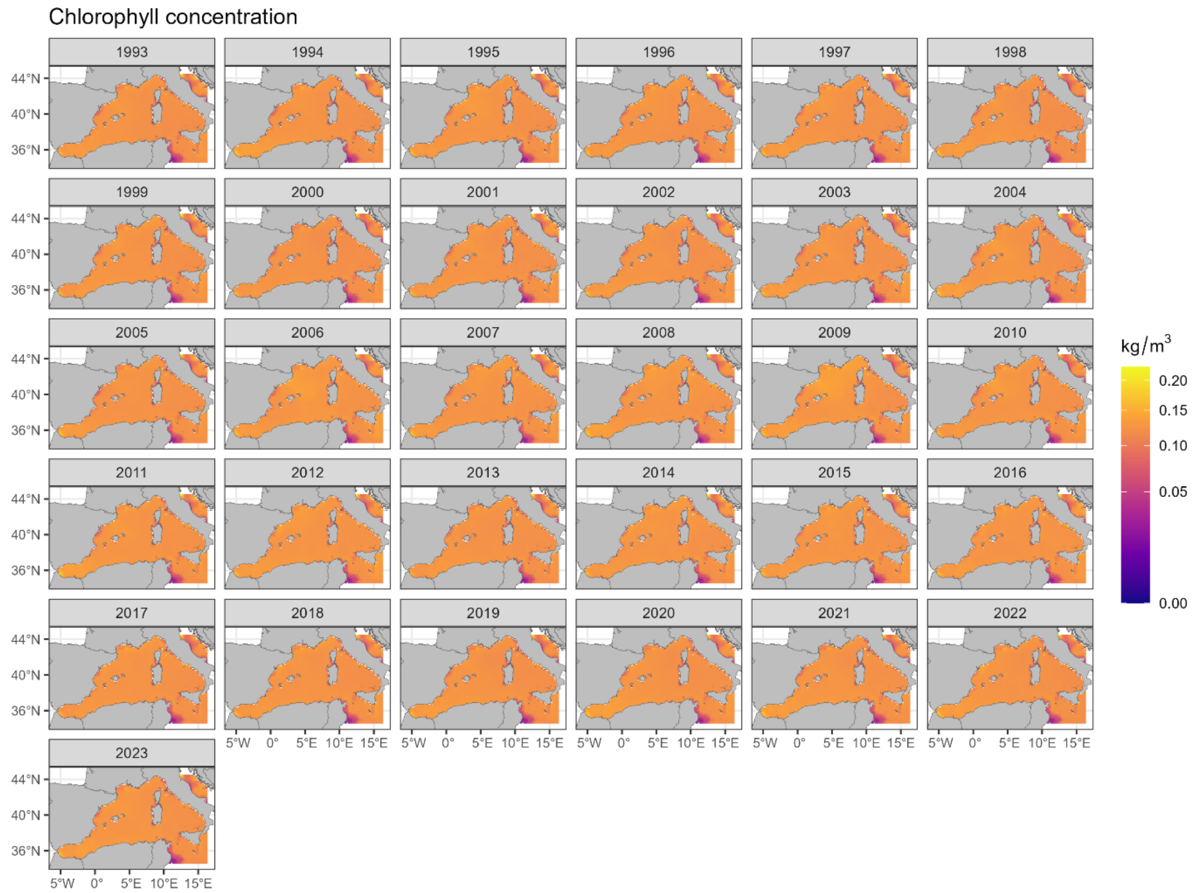

Figure 0.47 Chlorophyll concentration (kg/m³) mean per year from 1993 to 2023 from the Western Mediterranean Sea. Colours are on a square-root scale.

Biological diversity

Biodiversity Kempton's index calculated from the Ecopath with Ecosim (EwE) models for the Western Mediterranean Sea (Coll et al., 2024) from 1993 to 2023 (Figure 0.48).

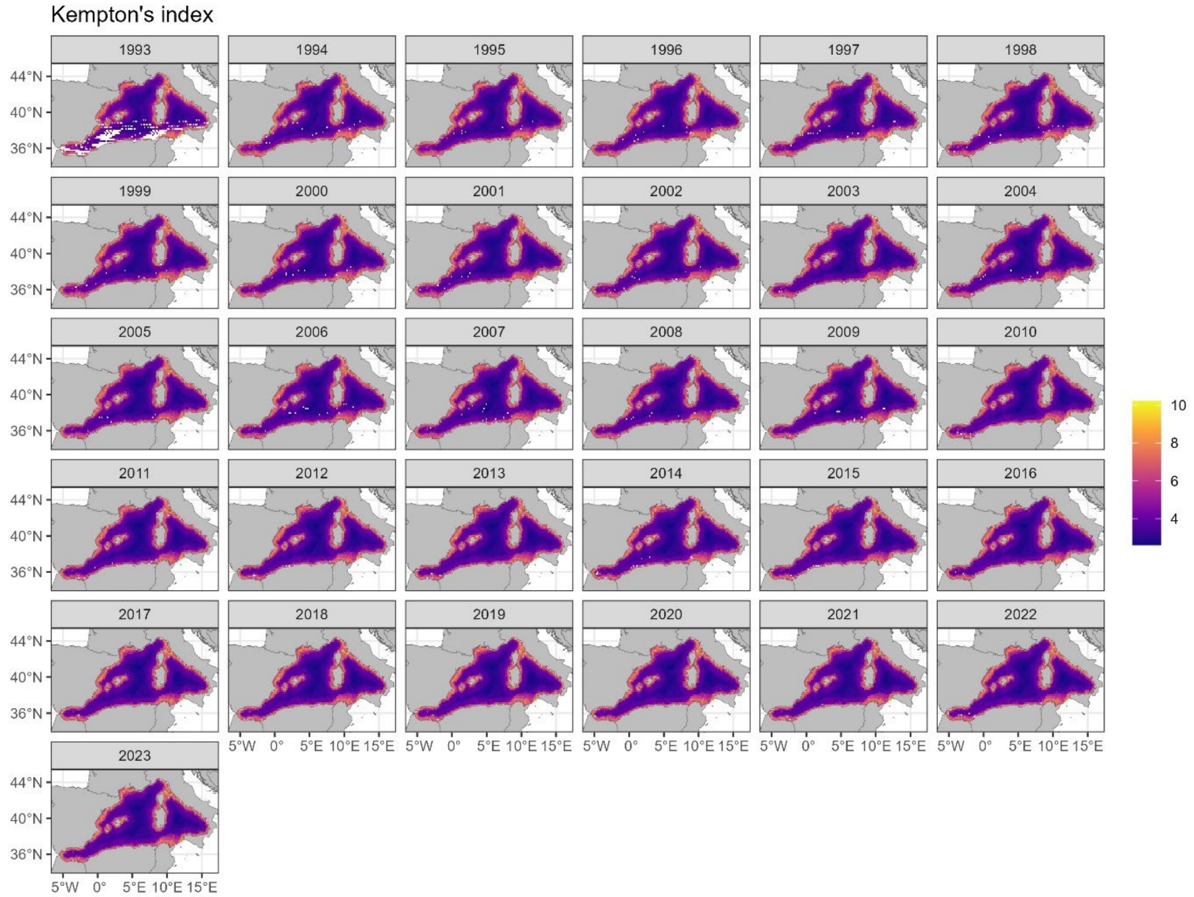

Figure 0.48 Biodiversity Kempton's index from 1993 to 2023 calculated from the EwE models for the Western Mediterranean Sea.

Naturalness

Relative fishing effort for bottom trawlers (Figure 5.48) and purse seiners and midwater trawlers (Figure 5.49) calculated from the EwE models for the Western Mediterranean Sea (Coll et al., 2024) from 1993 to 2023.

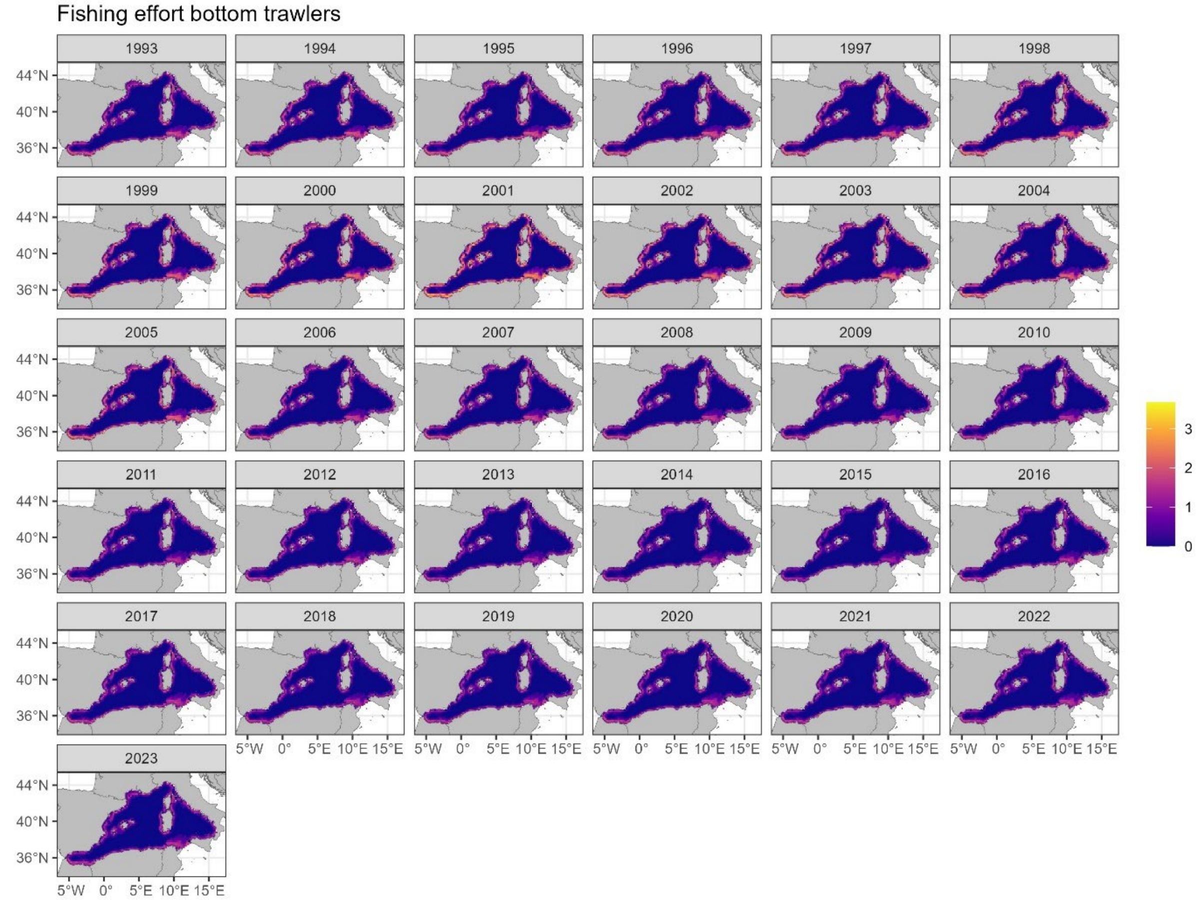

Figure 0.49 Relative fishing effort for bottom trawlers calculated from the EwE models for the Western Mediterranean Sea from 1993 to 2023.

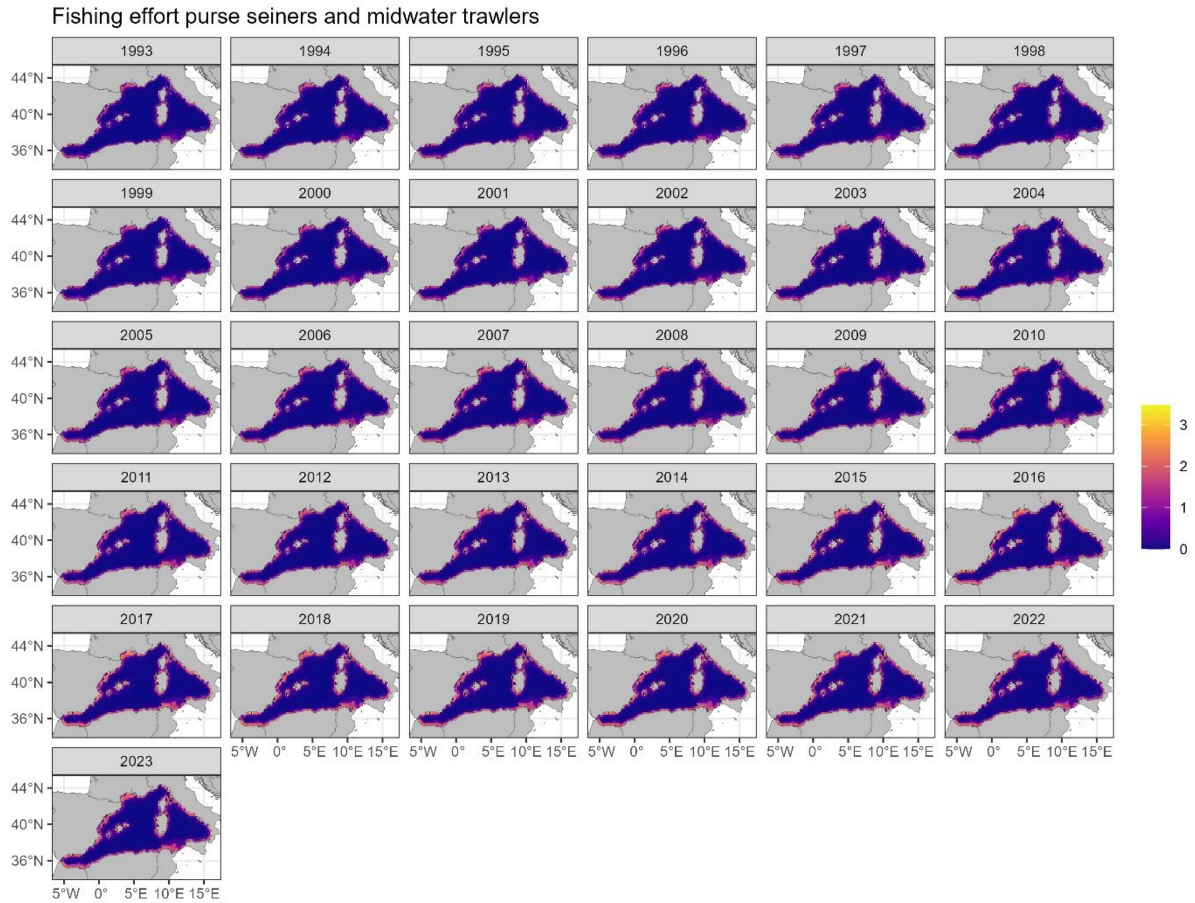

Figure 0.50 Relative fishing effort for purse seiners and midwater trawlers calculated from the EwE models for the Western Mediterranean Sea from 1993 to 2023.

AZORES

The main objective of this Planning Site is to provide scientific information in support of the expansion of the network of benthic deep-sea MPAs in the Azores. As described in D2.1, the EBSA criteria adopted in this PS are closely related to those used to identify vulnerable marine ecosystems (VMEs), and therefore might be slightly different from other planning sites.

Biological productivity

Biological productivity in this PS can be inferred from several complementary metrics: i) environmental productivity, ii) geomorphology classification, and iii) proxies for benthic biological productivity.

First, the environmental productivity can be assessed by the export of particulate organic carbon (POC) to the seafloor (Figure 0.51), but also by sea surface chlorophyll-a concentration (Figure 0.52), and sea surface net primary productivity (Figure 0.53). Bottom current metrics could also be relevant to assess local benthic productivity, however this information is not readily available. Particulate organic carbon (POC) flux a (*epc100*, mg C·m^{-2}·d^{-1}) was converted to export POC flux at the seafloor by Wei et al. (2020) using the Martin curve and setting the export depth to 100 m. Spatially explicit remote sensing chlorophyll-a concentration data was obtained from the Ocean Color (http://oceancolor.gsfc.nasa.gov/) through the MODIS sensor and compiled for the study area from 2003 to 2013. The minimum, maximum, range, mean, and standard deviation values were computed for the whole period (Amorim et al.; 2017a,b). A measure of primary production was obtained by Amorim et al. (2017a,b) from the ocean net primary productivity derived from MODIS data (http://www.science.oregonstate.edu/ocean.productivity). We used monthly data with global grid size of 1/12° (≈ 9 km) in both latitude and longitude for the period 2003–2013, and computed metrics for the whole period.

Second, geomorphology related productivity can be inferred from the presence of different types of geomorphological structures. Some seamounts, for example, are known to increase local productivity and therefore could be considered here. Information on the location of seamounts in the Azores EEZ (Figure 0.54) was obtained from Morato et al. (2008; 2013) and is currently being revised by Rodrigues et al. (in prep.).

Third, the benthic biological productivity of an area could be indirectly assessed by the presence of structural habitat created by the VME indicator species and/or communities. In this case, the habitat suitability models of habitat-forming cold-water corals (Figure 0.55; Taranto et al., 2023) and inferred likelihood of the presence of Vulnerable Marine Ecosystems, measured by the VME index (Figure 0.56; Morato et al., 2018; 2021) could be used as a proxy for identifying areas of increased productivity.

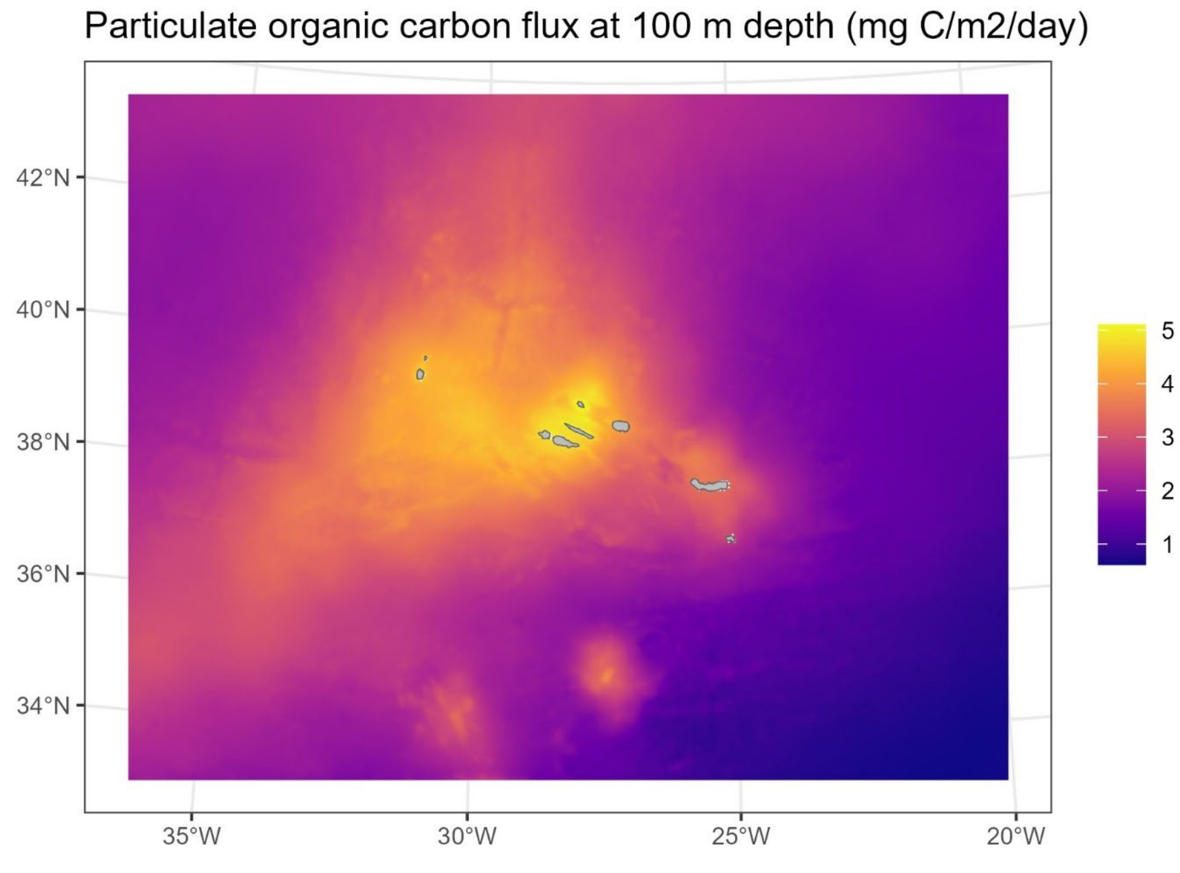

Figure 0.51 Particulate organic carbon (POC) flux (epc100, mg C·m-2·d-1) at the seafloor by Wei et al. (2020).

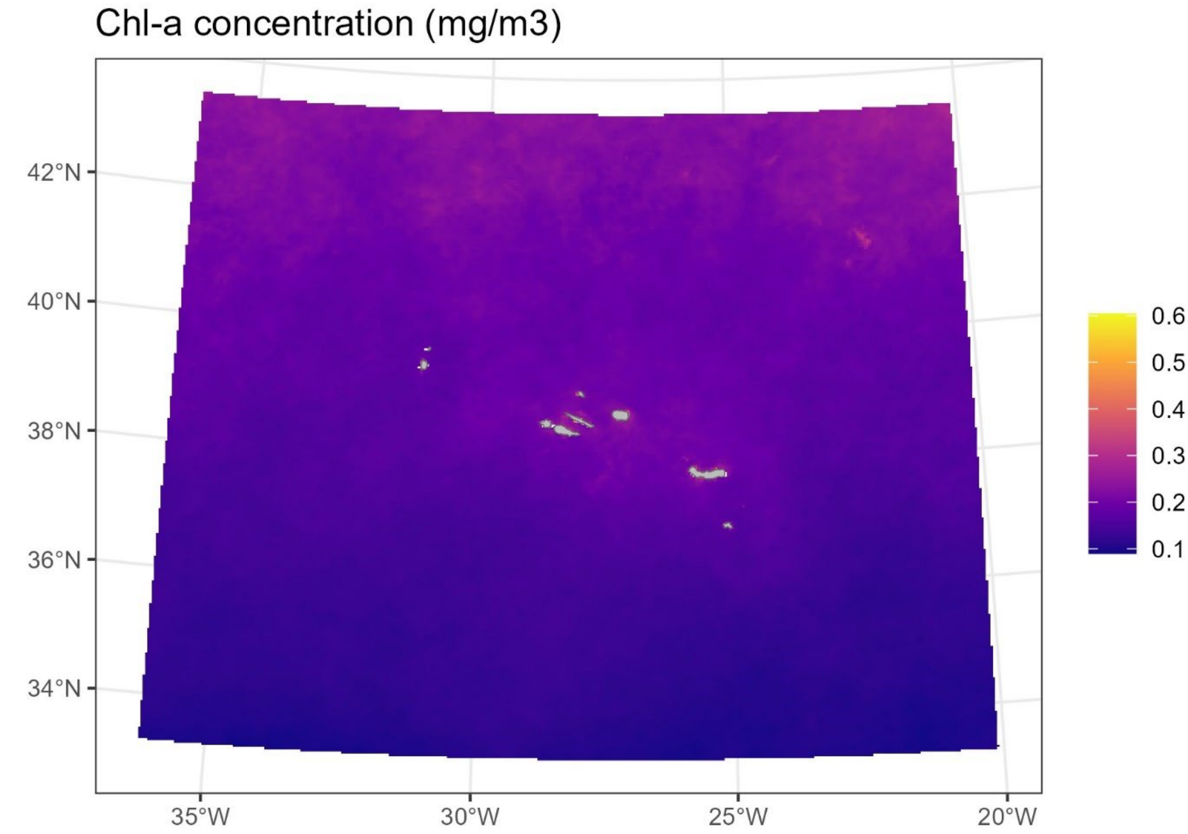

Figure 0.52 Remote sensing chlorophyll-a concentration obtained from the Ocean Color (http://oceancolor.gsfc.nasa.gov/) through the MODIS sensor and averaged for the study area from 2003 to 2013 (Amorim et al.; 2017a,b).

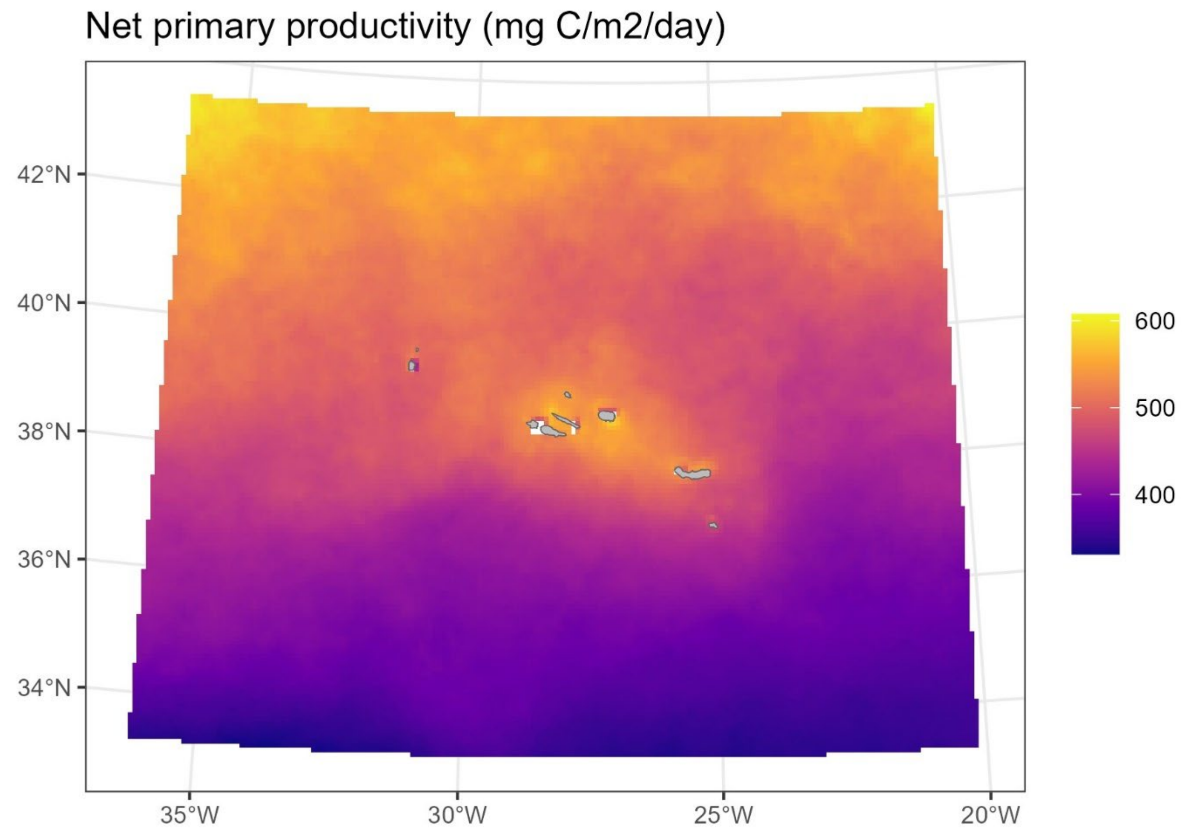

Figure 0.53 Primary production obtained by Amorim et al. (2017a,b) derived from MODIS data. Monthly data with global grid size of 1/12° (≈ 9 km) for the period 2003–2013 was averaged for the whole period (Amorim et al.; 2017a,b).

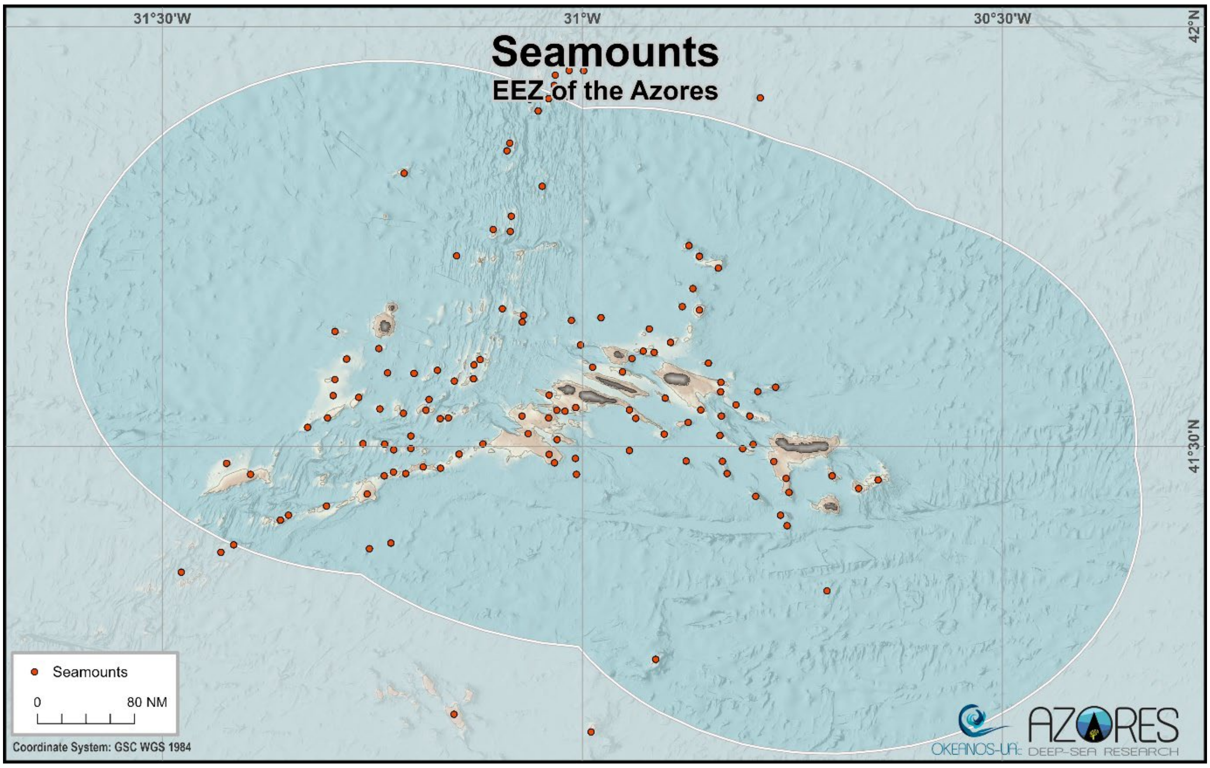

Figure 0.54 Location of known seamounts in the Azores EEZ (Figure 4) obtained from Morato et al. (2008; 2013).

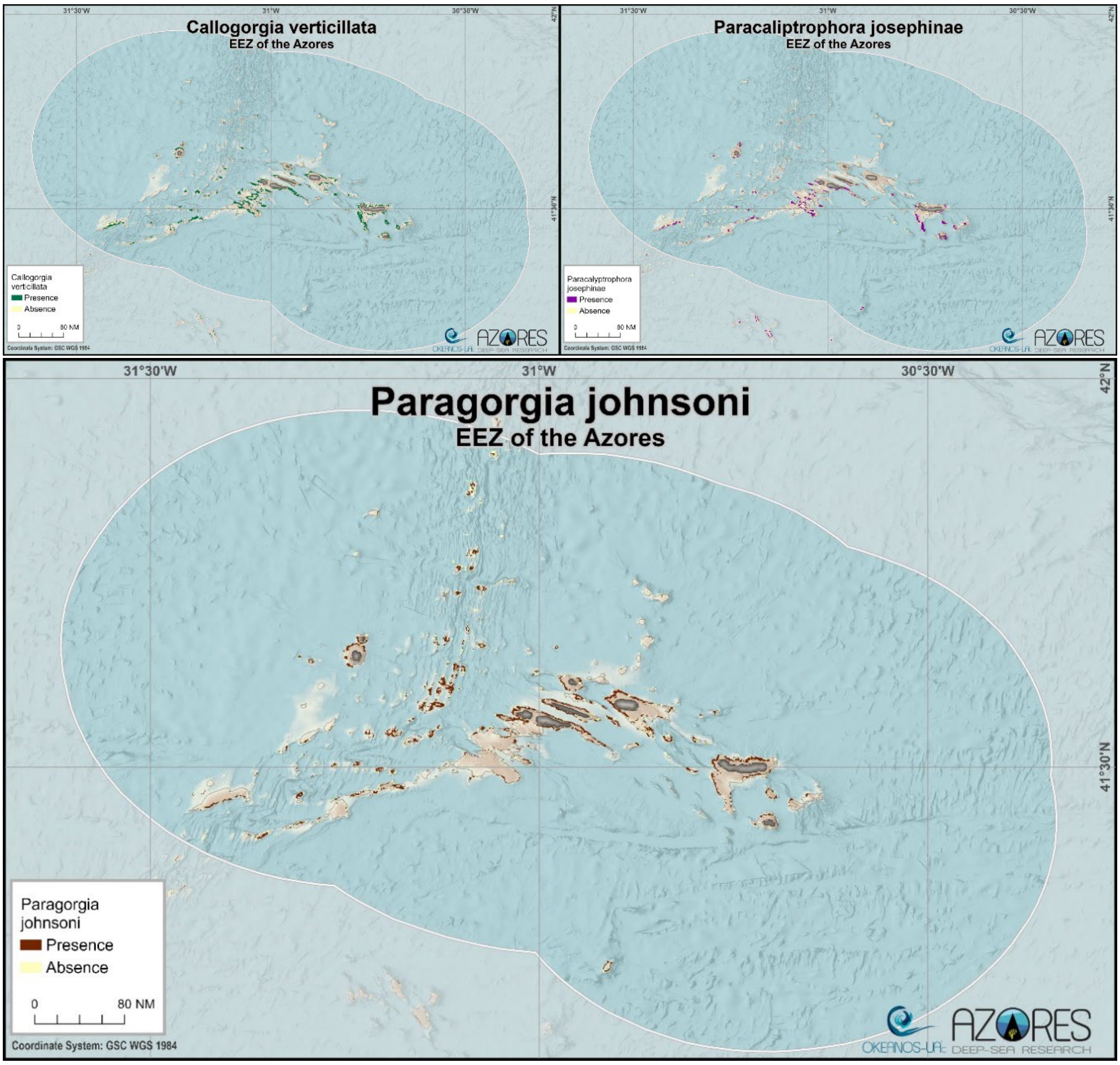

*Figure 0.55 Habitat suitability models outputs of selected habitat-forming cold-water corals (*Callogorgia verticillata*,* Paracaliptrophora josephinae*, and* Paragorgia johnsoni*) obtained from Taranto et al. (2023)*

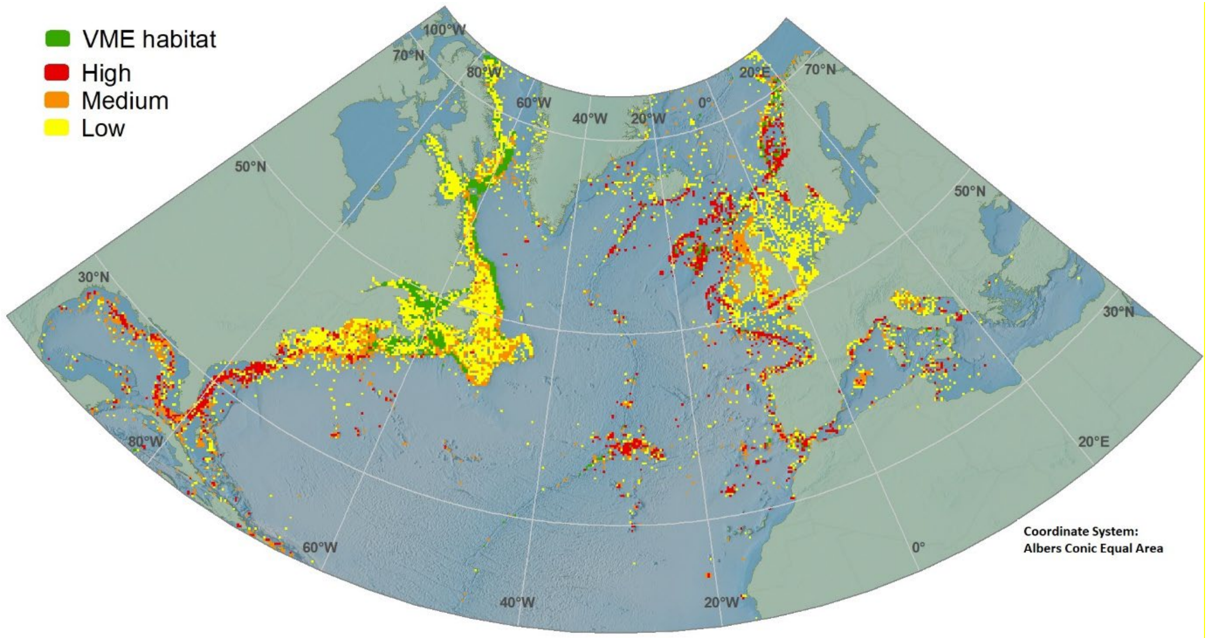

Figure 0.56 Inferred likelihood of the presence of Vulnerable Marine Ecosystems measured by the VME index (Morato et al., 2018; 2021).

Biological diversity

Over the last decade, extensive scientific research supported by multiple projects (e.g. Hermione, CoralFISH, 2020, ATLAS, SponGES, MapGES) has permitted a better understanding of the ecological importance of deep-sea ecosystems in the Azores. Results of these projects have contributed to the identification of the Azores as a cold-water coral hotspot in the NE Atlantic (Braga-Henriques et al., 2013; Sampaio et al., 2019), and as an area of high richness of deep-sea fish and sharks (Das and Afonso, 2017). Because of the perceived rich biodiversity, some seamounts have been classified as important areas for management and conservation (Watling & Auster, 2017). Although not all seamounts are the same, shallow-water and abyssal seamounts have often been nominated as proxies for biodiversity hotspots not only for the benthic fauna but also for the large megafauna that visits these features.

Biological diversity in this PS can be inferred from several complementary metrics: i) from deep-sea benthic occurrence databases and resulting species distribution models of cold-water corals (Figure 0.57), deep-sea fish (Figure 0.58) and deep-sea sharks (Figure 0.59), and ii) from proxies of biological diversity derived, for example, from multibeam bathymetry data and the identification of areas with potential higher diversity such as known shallow (<250m) and deep (>1500m) seamounts (Figure 0.54).

Cold-water corals

Cold water coral richness was estimated based on habitat suitability predictions (Taranto et al., 2023), using only high confidence suitable cells of combined habitat suitability maps (Figure 0.57). Suitable raster cells of combined habitat suitability maps were classified as follows: (i) high confidence suitable cell (3 in raster layers), raster cell predicted as suitable with high-confidence by both GAM and Maxent models; (ii) medium confidence suitable cell (2 in raster layers), raster cell predicted as suitable with medium or high confidence by GAM, Maxent or both and with a local fuzzy similarity greater than 0.5; (iii) low confidence suitable cell (1 in raster layers), any other cell predicted as suitable by GAM and/or Maxent.

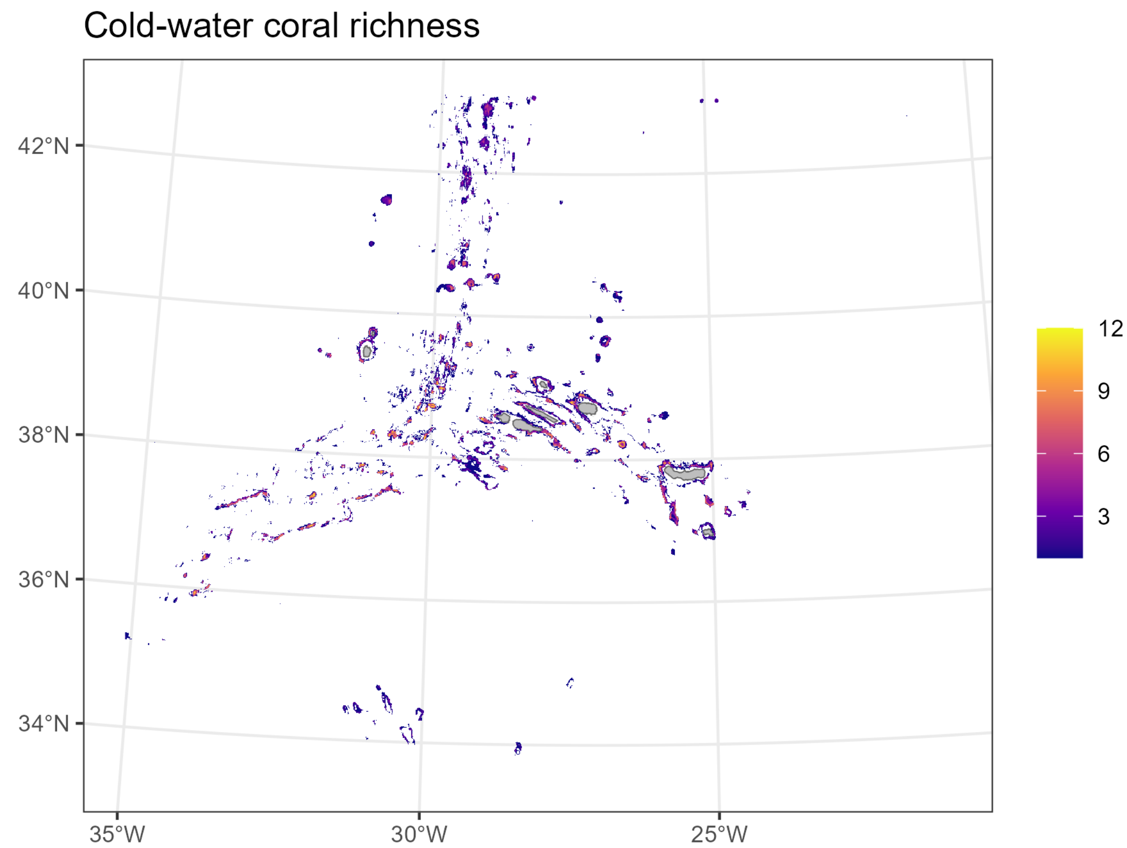

Figure 0.57 Cold water coral species richness obtained from habitat suitability predictions (Taranto et al., 2023) of 13 CWC species, using only high confidence suitable cells.

Deep-sea fish

In this study, we applied generalized additive models (GAMs) to relate presence–absence data of eight economically-important fish species to environmental variables (depth, slope, aspect, substrate type, bottom temperature, salinity and oxygen saturation) (Parra et al., 2017). We combined 13 years of catch data collected from systematic longline surveys performed across the region. Species richness is the number of species predict to occur in each grid cell (Figure 0.58).

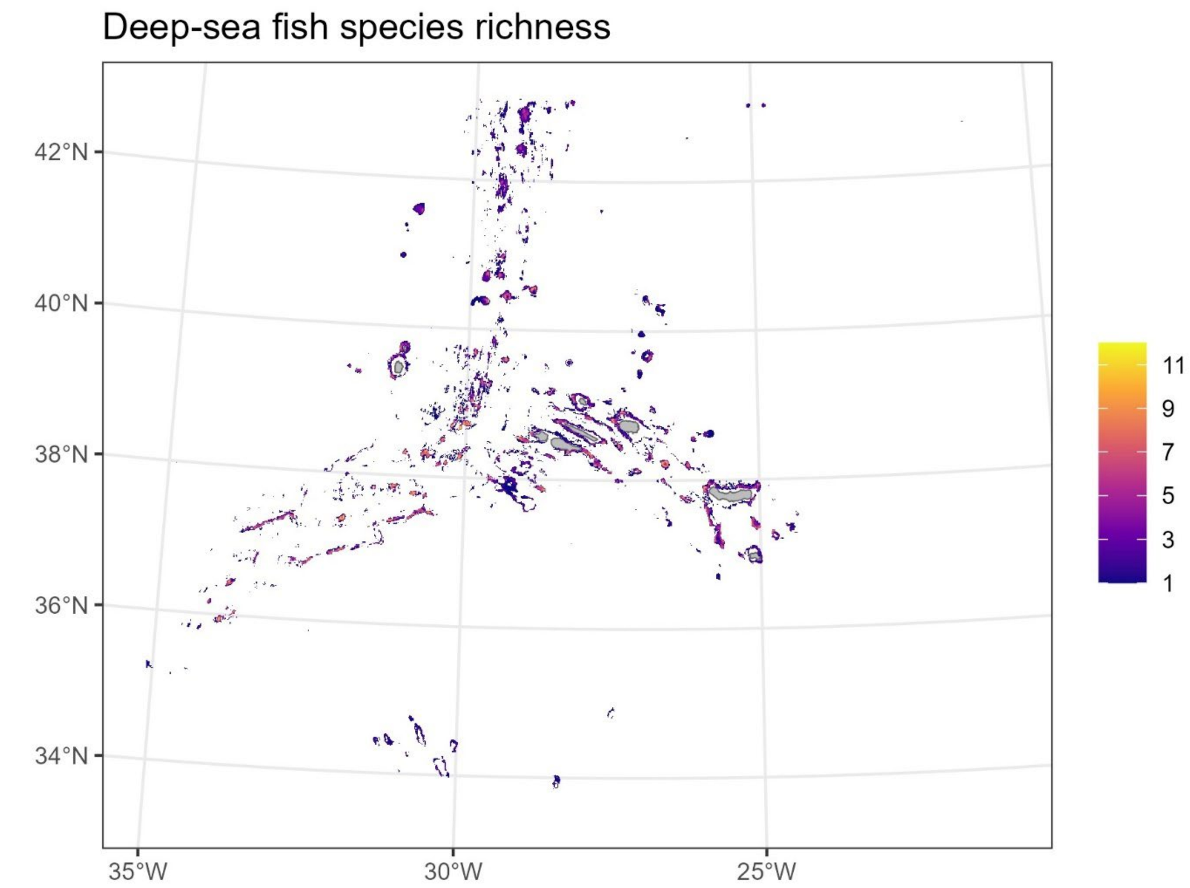

Figure 0.58 Species richness of deep-sea fish obtained from species distribution models of 8 deep-sea fish species (Parra et al., 2017).

Deep-sea sharks and rays

This dataset contains the number of species predicted to occur in each grid cell (Figure 0.59) from binary maps of the predicted probability of presence (Pp) of 15 deep-water shark and rays species in a 1000-hook bottom longline fishing set (type LLA) in the Azores (Das et al., 2022). We used a Generalized Additive Models (GAM) approach with binomial distribution and logit link function and the maximization of the sum of sensitivity and specificity (MSS) threshold, which minimizes misclassification likelihoods of false negatives and false positives. The species modelled were: *Raja clavata*; *Galeorhinus galeus*; *Dipturus batis*; *Leucoraja fullonica*; *Dalatias licha*; *Etmopterus spinax*; *Squaliolus laticaudus*; *Etmopterus pusillus*; *Deania profundorum*; *Deania calcea*; *Centrophorus squamosus*; *Centroscymnus owstonii*; *Centroscymnus crepidater*; *Centroscymnus coelolepis*; *Etmopterus princess*.

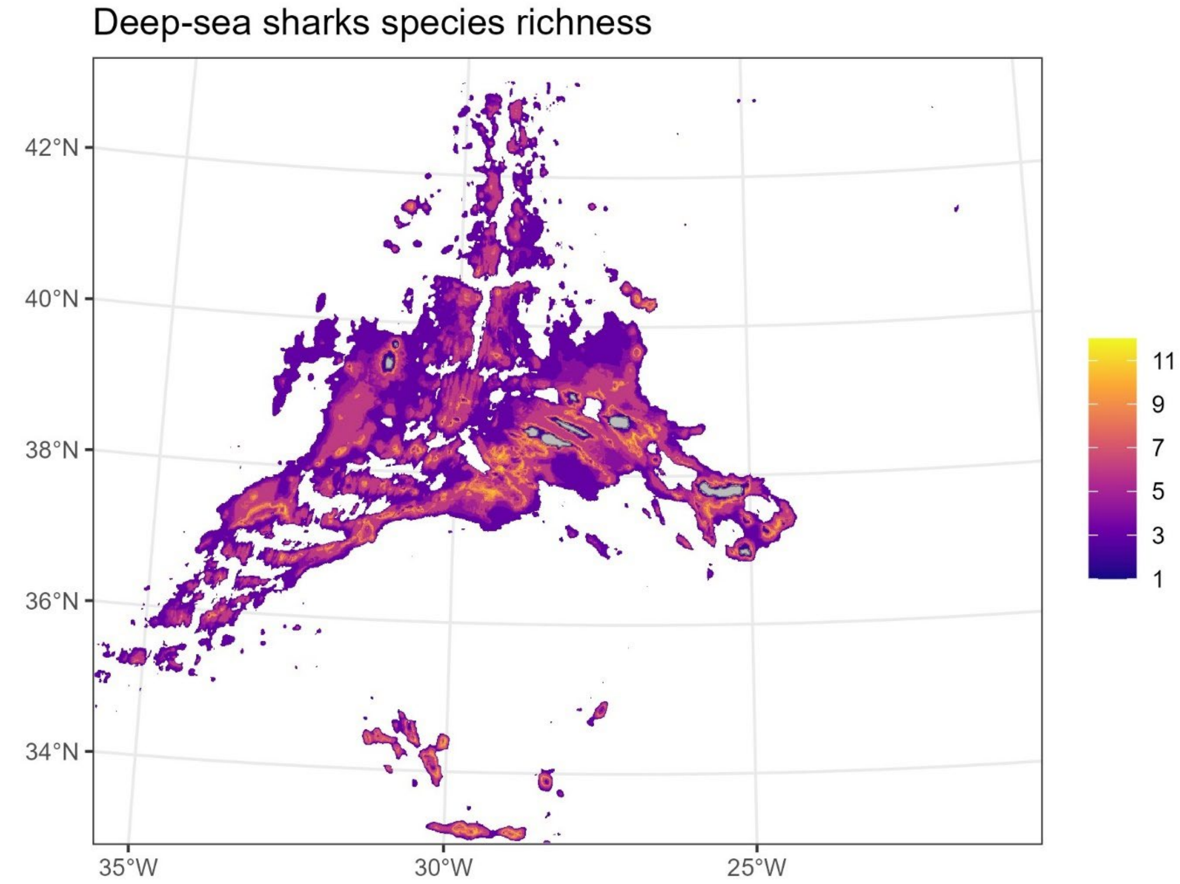

Figure 0.59 Species richness of deep-sea sharks obtained from 13 species distribution models (Das et al., 2022).

Naturalness

Several international regulations recognised the importance of greater protection for areas with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation. In the Azores PS, potential near-natural seabed areas in the Azores were defined as those areas within fishable depths (i.e. shallower than 1200m) that may not have been exploited by deep-sea bottom fishing. These areas may have high potential for hosting of vulnerable, endangered, or critically endangered species or habitats.

Naturalness, in this PS can be inferred from several complementary metrics: i) VMS data on bottom fishing and Natural Jenk breaks for defining categories; ii) known near natural areas in the range of current deep-sea benthic fishing activities (< 1200m) identified by a combination of bathymetry and VMS data; and iii) existing area-based management regulations (e.g. MPAs) that limit human activities.

The bottom-fishing (longline plus handline) effort layer (Figure 0.60) was computed from an analysis of the Vessel Monitoring System (VMS) for vessels licensed for bottom longline or handline fishing gears. The fishing licences granted to each vessel per year were used to allocate a gear type to all VMS pings. We acknowledge that not all boats operating in the spatial planning area (beyond 6 nm from island shores) have VMS systems installed. However, a quick comparison of the VMS outputs with the fishing effort maps obtained from fishers' inquiries (Diogo et al., 2015) revealed similar spatial patterns, but much more spatial detail when using the VMS data. In total, VMS data was obtained from 74 anonymous vessels over the period 2002-2018 with an average of 12 vessels per year. This number represents about 25% of the bottom longline fleet if considering an average of 52 vessels per year that declared landings using bottom longline. The analyses of VMS data for the period 2002 to

2018 indicated that apparently all geomorphologic features shallower than 1000m depth have been fished to some extent. However, the analyses of recently collected multibeam bathymetry surveys conducted by the Portuguese Hydrographic Institute will be used to conduct careful evaluation of VMS data in newly mapped areas.

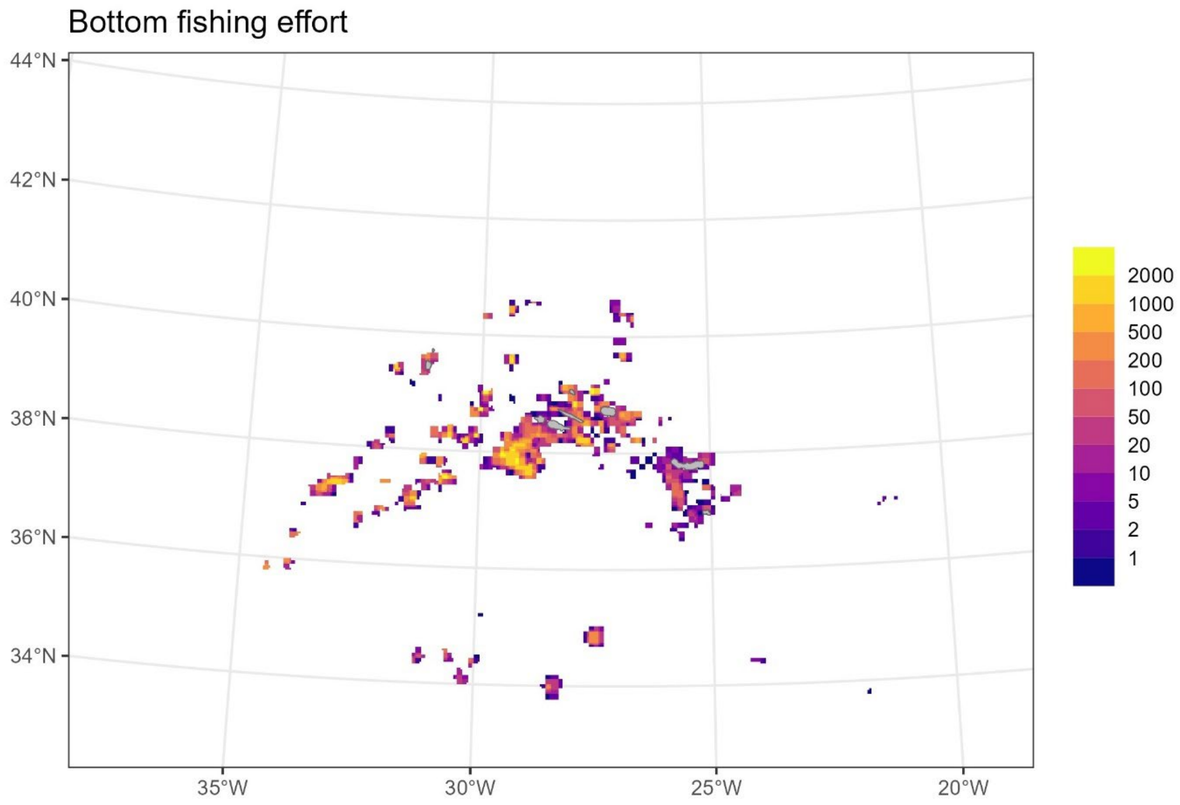

Figure 0.60 Bottom-fishing effort layer computed from an analysis of the Vessel Monitoring System (VMS) for vessels licensed for bottom longline or handline fishing gears. Colours are on a log-scale.

The are several relevant area-based management regulations that limit human activities (Figure 0.61). There has been a long history of marine conservation in the Azores (see Abecassis et al., 2015) that started back in the 1980s with the establishment of six coastal MPAs and one offshore marine reserve encompassing the Formigas islets and Dollabarat reef. Of greater relevance for this Planning site objectives, was the creation of the Azores Network of Marine Protected Areas that includes the Island Natural Park within the territorial waters (12nm) and the Azores Marine Park beyond territorial waters. The impact of fishing activities on benthic ecosystems has been a particular concern in the Azores, and bottom trawling and deep-sea netting are forbidden around since 2005 (European Council Regulation [EC] No. 1568/2005 of 20 September 2005). Further protection of the deep sea throughout the Azores region was added in 2014 by the creation of an extensive fishery management area that encompasses most of the Portuguese extended continental shelf where bottom-trawling is banned, and by setting move-on rules for the incidental capture (bycatch) of corals and sponges (Portaria 114/2014). Also, a 100 miles polygon around the islands limiting the fishing to vessels registered in the Azores was created in 2003 (EC Reg. 1954/2003) and revised in 2013 (EC 1380/2013) and in place until December 2022.

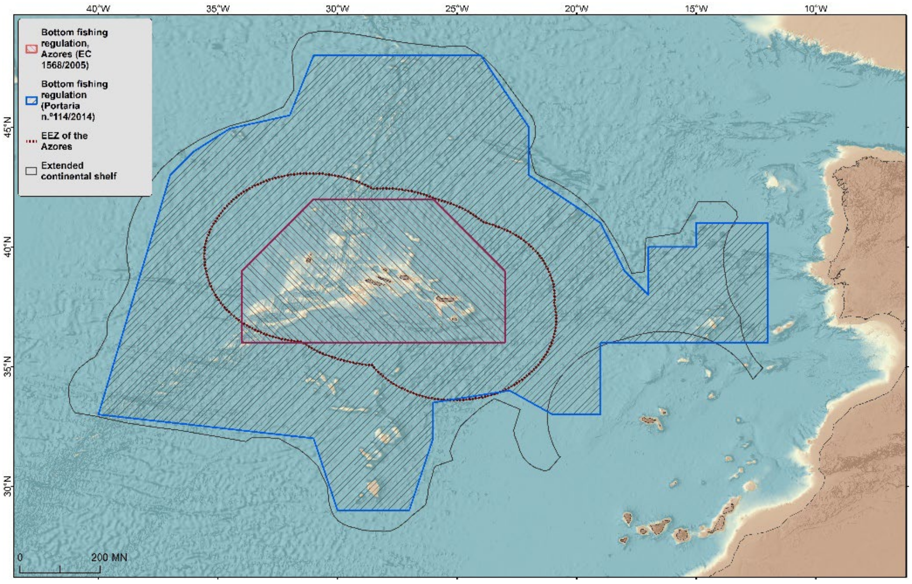

Figure 0.61 Existing area-based management in the Azores. The areas EC 1568 and 114/2014 represent areas where bottom trawl fishing has been banned.

Western Baltic Sea

Biological productivity

Vertically integrated monthly values of Chl-a concentration (mg/m^2) were downloaded from the Baltic Sea Biogeochemistry Reanalysis model (product ID: BALTICSEA_MULTIYEAR_BGC_003_012) for 2001-2021, available from the EU Copernicus Marine Service Information (https://doi.org/10.48670/moi-00012). The dataset was spatially cropped to the planning site area. The data are presented below as median values per year (Figure 0.62) and median values per quarter (Figure 0.63). Spatial patterns of concentrations per year are stable throughout time, with local variations in peak concentrations. Seasonal variation is more pronounced with overall higher concentrations in quarter 1 and 3 compared to quarter 2 and 4. Local peaks of Chl-a concentration are highest in quarter 3 located in semi-closed water bodies, such as fjords and bays.

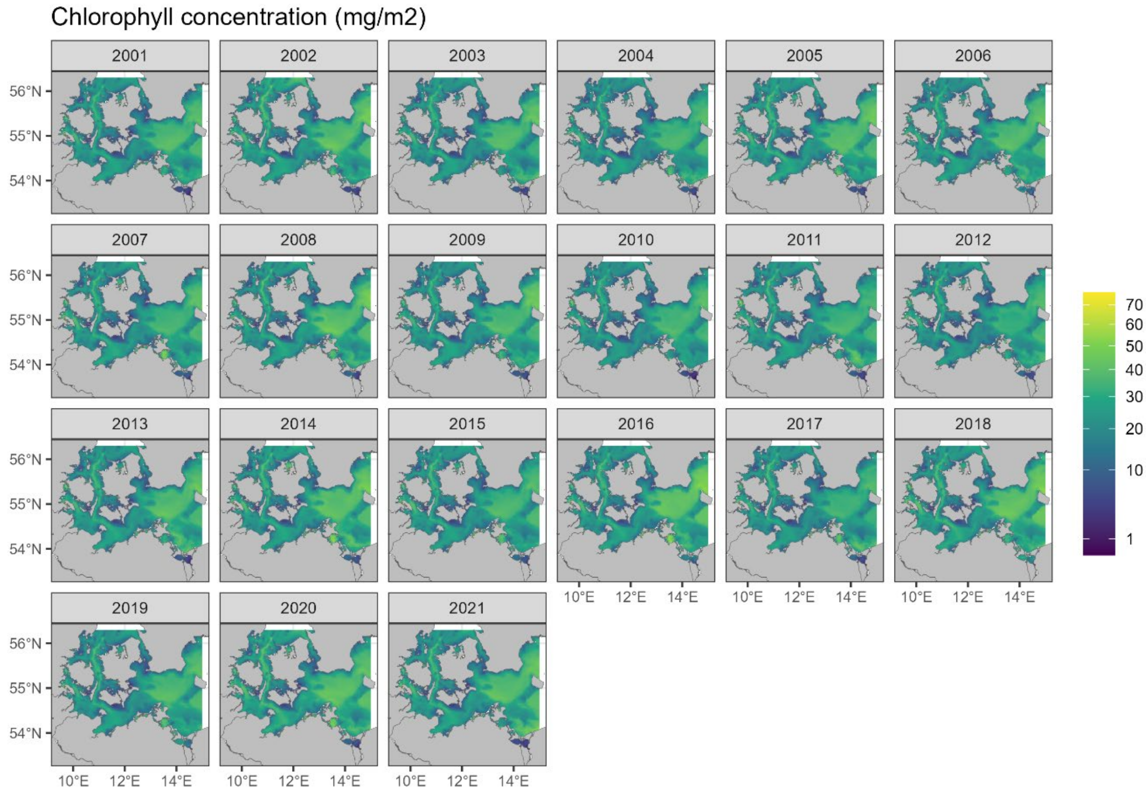

Figure 0.62 Annual cholophyll-a concentration (mg/m²), aggregated across months. Colours are on a squareroot-scale.

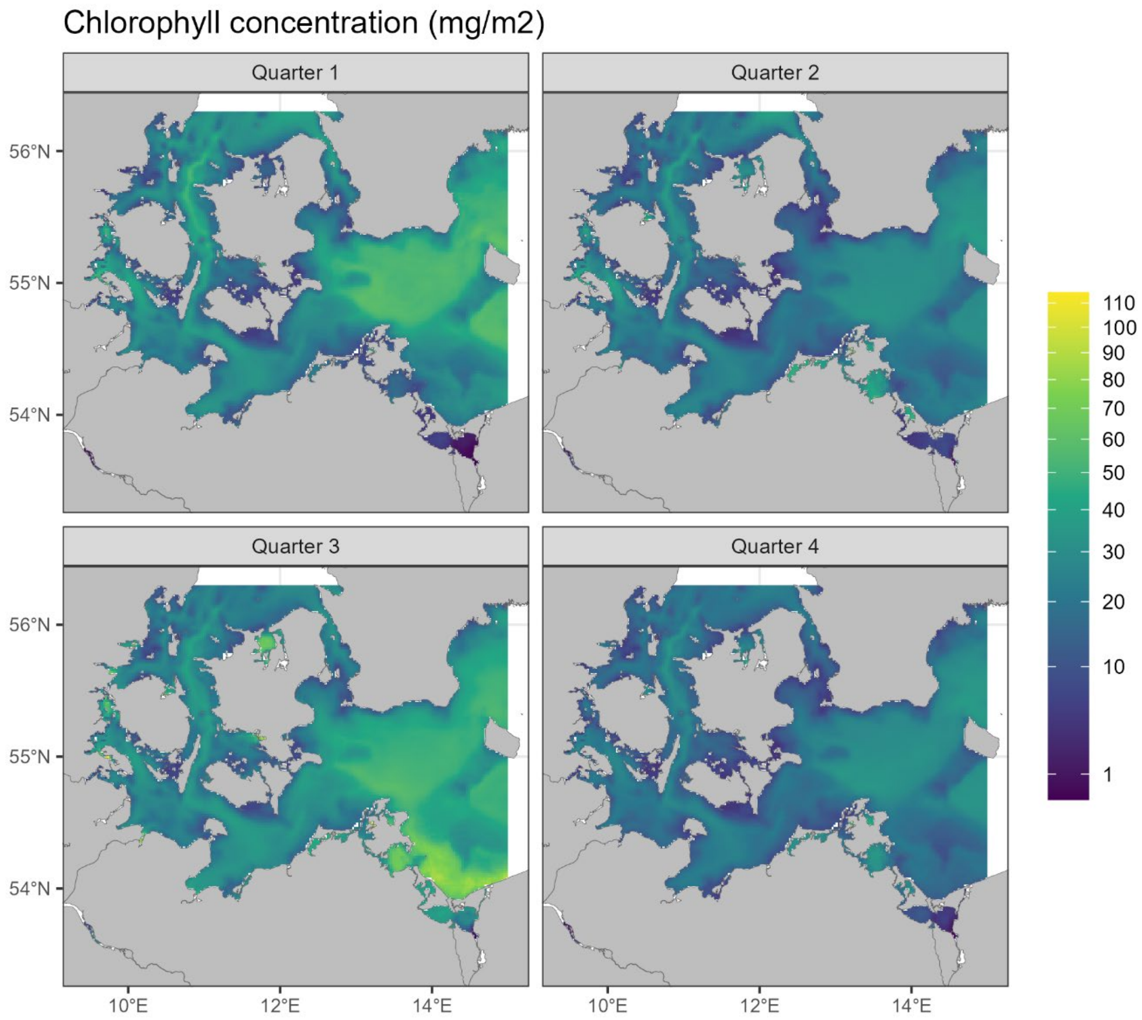

Figure 0.63 Quarterly chlorophyll-a concentration (mg/m^2), aggregated across years (2001-2021). Colours are on a squareroot-scale.

Biological diversity

Biological diversity in the Western Baltic Sea is represented by the biodiversity of demersal fish – in particular by three complementary biodiversity indices:

- Species richness
- Species evenness
- Shannon index

Species richness represents the unique number of species in a community. Species evenness reflects the relative abundance of species in a community, with a community with equal species abundances being even and a community with one or a few species being very abundant (i.e. dominant) compared to all other species in the community being uneven. The Shannon index, based on entropy and information theory, represents the uncertainty of predicting the species identity of a randomly drawn individual from a community. The higher the number of species and/or the more even your community in terms of relative species abundances, the higher the uncertainty of correctly predicting to what species an individual belongs to. The interpretation of the Shannon index thus combines the concepts of richness and evenness.

As biodiversity is neither heterogenous in space nor in time, biodiversity indices were estimated at three different scales, following Dencker et al. (2017):

- Spatial: spatial patterns of biodiversity averaged across time
- Temporal: temporal trends of biodiversity averaged across space
- Spatio-temporal: temporal trends of biodiversity across space

Demersal fish were chosen to reflect biodiversity in the Western Baltic Sea due to the large amount of monitoring data available for this organism group in both space and time. Cleaned bottom trawl survey data for the Baltic Sea from 2001 to 2020 for both quarter 1 and quarter 4 were downloaded from FishGlob_data (Maureaud et al., 2024). The original data source underlying FishGlob_data are the HH and HL unaggregated data of the Baltic International Trawl Survey (BITS) from DATRAS (https://www.datras.ices.dk). The cleaned dataset produced by FishGlob_data constitutes of the number each fish species by haul duration and swept area for each trawl haul. The data were cropped to the area of the planning site by only selecting hauls in ICES rectangles that fall (fully or to some extent) within ICES subdivisions 22-24. All hauls with a trawl duration of 30 minutes were selected to avoid any bias in the biodiversity estimates due to differences in sampling effort.

Species richness was estimated as the mean number of species per haul by year and ICES rectangle. Species evenness and Shannon index were estimated from species abundances per haul by year and ICES rectangle. Besides the mean also the minimum, maximum, first and third quartile, median and standard deviation were calculated to provide information on the between-haul variation. Mean values of the three biodiversity indices were used to calulate mean species richness, species evenness and Shannon index per year (across all rectangles) and per rectangle (across all years). To investigate spatio-temporal patterns, mean index values by year and rectangle were modelled as a linear regression within each rectangle to estimate the rate of change in each index per year, respresented by the slope of the relationship.

The resulting spatial, temporal and spatio-temporal patterns are presented in Figure 0.64. Species richness shows a northwest to southeast gradient, following a decreasing gradient in salinity (Pecuchet et al., 2016; Frelat et al., 2018). Species evenness displays a less clear spatial pattern, yet higher evenness seems to coincide with lower richness, meaning that in the more species-rich communities in the southern Kattegat are at the same time more uneven compared to the more species-poor communities in the Belt Sea and Arkona basin. The Shannon index displays a decreasing gradient from west to east. The low species richness observed in the east, i.e. the Arkona basin, is thus confirmed by a low Shannon diversity too. There does not appear to be much spatial congruence between the Shannon index and species evenness.

Two out of three biodiversity indices show clear increasing trends over time (2001-2020; Figure 0.64). Species richness increased from 7-8 species at the start of the period to 10 species at the end, while the Shannon index increased from 0.9-1.1 at the start to 1.1-1.2 at the end of the period. The trend in species evenness suggests a slight increase, but there are fluctuations throughout the study period and not much difference in index values between the start and end of the period. As indicated by the large error bars in Figure 0.64, the spatial variation within years is of all three indices is large, suggesting that the spatial variation may be as strong or if not stronger than the observed temporal variation.

For the majority of ICES rectangles, spatio-temporal trends are significantly increasing for species richness (Figure 0.64). In the western part of the study where the slope of the linear regression is highest, an increase of 0.2 species per year is estimated, i.e. one new species every 5 years. In the eastern part, where species richness is generally low, slopes are less strong, yet still significant in most ICES rectangles. For species evenness, we generally see significant increases in the Arkona basin, but a few significant decreases in species eveness in the Belt Sea and southern Kattegat. A very similar pattern is observed for the Shannon index. Overall, the spatio-temporal patterns indicate that, although the overall trends in indices over time are increasing, local spatial variation exists in either the strength or direction of the trend.

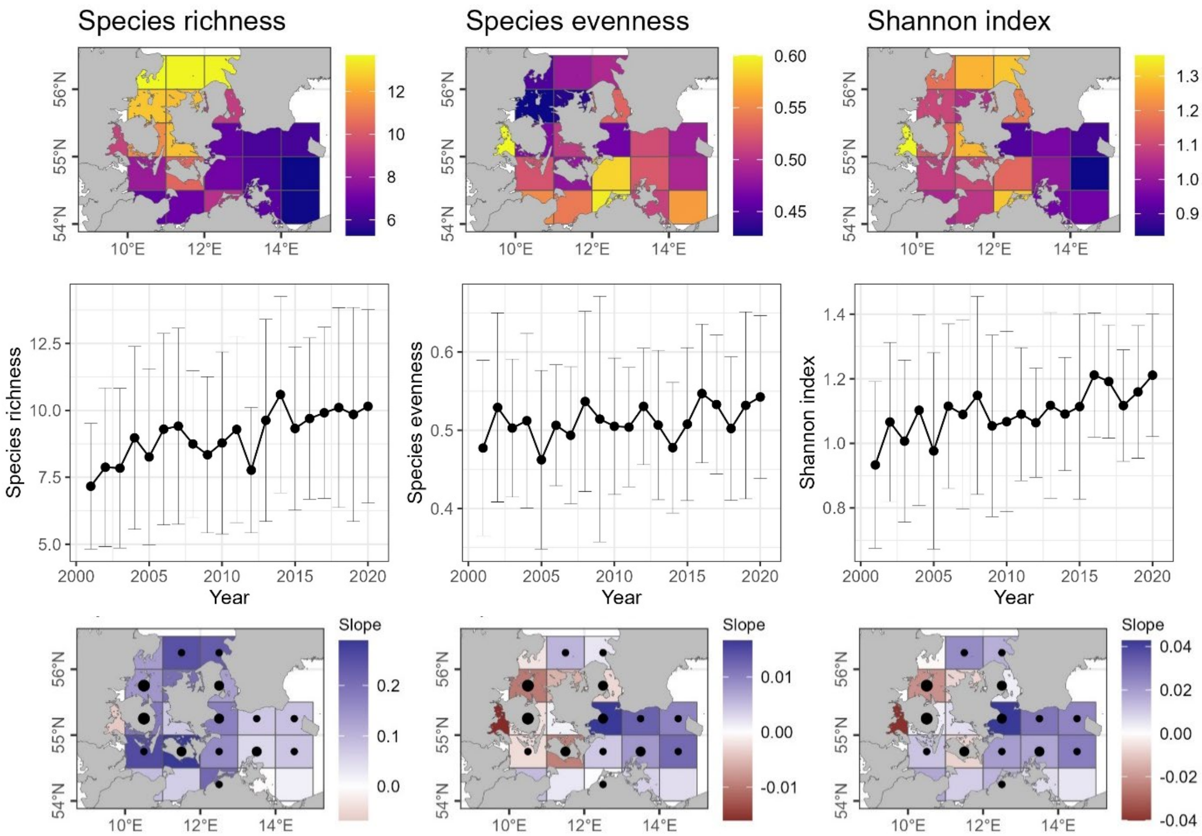

Figure 0.64 Spatial (1st row), temporal (2nd row) and spatio-temporal (3rd row) patterns of species richness (1st column), species evenness (2nd column) and Shannon index (3rd column). Biodiversity indices were estimated from species abundances from 2001-2020. Error bars in the time series plots indicate spatial variation of index values within years. Spatio-temporal patterns represent the rate of change of each biodiversity index calculated as the slope of a linear regression of index values by year. Points indicate significance of trend: small = p<0.05, medium = p<0.01, large = p<0.001, no point = not significant.

Naturalness

Information on fishing activity of bottom-contacting fishing gears was obtained from the Danish Ministry of Food, Agriculture and Fisheries. The activity of Danish fishing vessels is monitored by several systems. The Vessel Monitoring System (VMS) is a satellite-based tracking system that has been mandatory for all fishing vessels over 12 m, since 2012. The system provides the location, speed and course of the vessel at a given time, with an interval rate of around an hour. The Automatic Identification System (AIS) is another tracking system, primarily intended to prevent collisions between vessels. This system is mandatory for all fishing vessels over 15 m since 2015 and registers the same information as the VMS. AIS has a much shorter recording interval (in the order of seconds) than VMS, but a lower spatial coverage, especially offshore. A third tracking system is the Black Box (BB) system, which is mandatory for Danish fishing vessels targeting mussels and oysters This system combines continuous positional data with vessel speed and measurements of winch activity to exactly determine fishing activity location. Lastly, each fishing vessel over 12 meter is obliged to report on their daily landings and the fishing gear used in their online logbook. Information on the activity of non-Danish vessels available to DTU Aqua, were AIS and vessel register data. Hence, resulting fishing intensity estimates for non-Danish vessels are more uncertain and less reliable compared to Danish vessels.

Where possible, AIS and VMS data were interpolated to provide information on fishing acitivity each second, and merged with the logbook data based on fishing vessel ID and timestamp. Then, fishing activity (gear deployment) was determined from gear-specific speed profiles. The seafloor footprint was calculated from the fished locations and the gear width, following a hierarchical method that prioritizes the most detailed information available for each fishing event: first BB, then AIS, and finally VMS. This fishing footprint represents the area swept by the gear (m^2) in individual grid cells with a size of 0.001° x 0.001°, which is approximately 60 x 100 m at the latitude of the Western Baltic Sea. As a final step, the Swept Area Ratio (SAR) was calculated, which is the total fishing footprint in a year as a ratio of grid cell size.

SAR values were calculated for the period 2012-2022 by metier level 5, which specifies the gear type and target assemblage. They are presented below as summed SAR values across all metiers by year (Figure 0.65) and average SAR values across years by metier for the nine most frequently occurring metiers (Figure 0.66). Fishing intensity seemed to be most widespread and pronounced in earlier years of study period (2012-2015; Figure 0.65). Overall spatial patterns of SAR are relatively stable throughout time, yet the high resolution allows for identifying local variations in fishing grounds and intensity between years. Out of the nine most common metiers, bottom otter trawls targeting demersal fish are widespread throughout the Danish Belt Sea and the Arkona basin west of Bornholm (Figure 0.66). Bottom otter trawls targeting both demersal fish and crustaceans are most acrive in the southern Kattegat, whereas anchored seines (also known as 'Danish seines') targeting demersal fish show highest SAR values in waters southeast of Denmark and northern Germany.

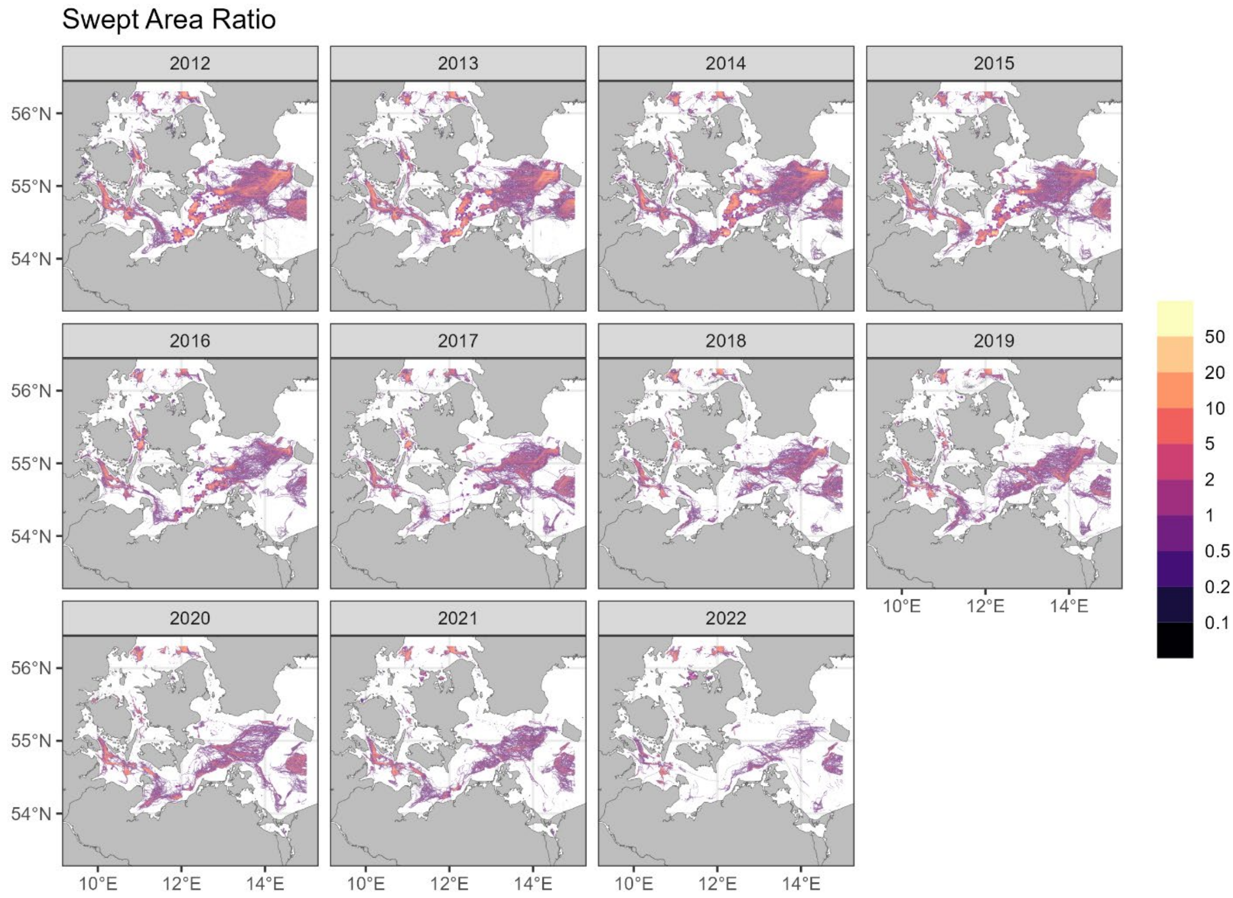

Figure 0.65 Swept Area Ratio per year of bottom fishing gears, summed across all metiers. Colours are on a log-scale.

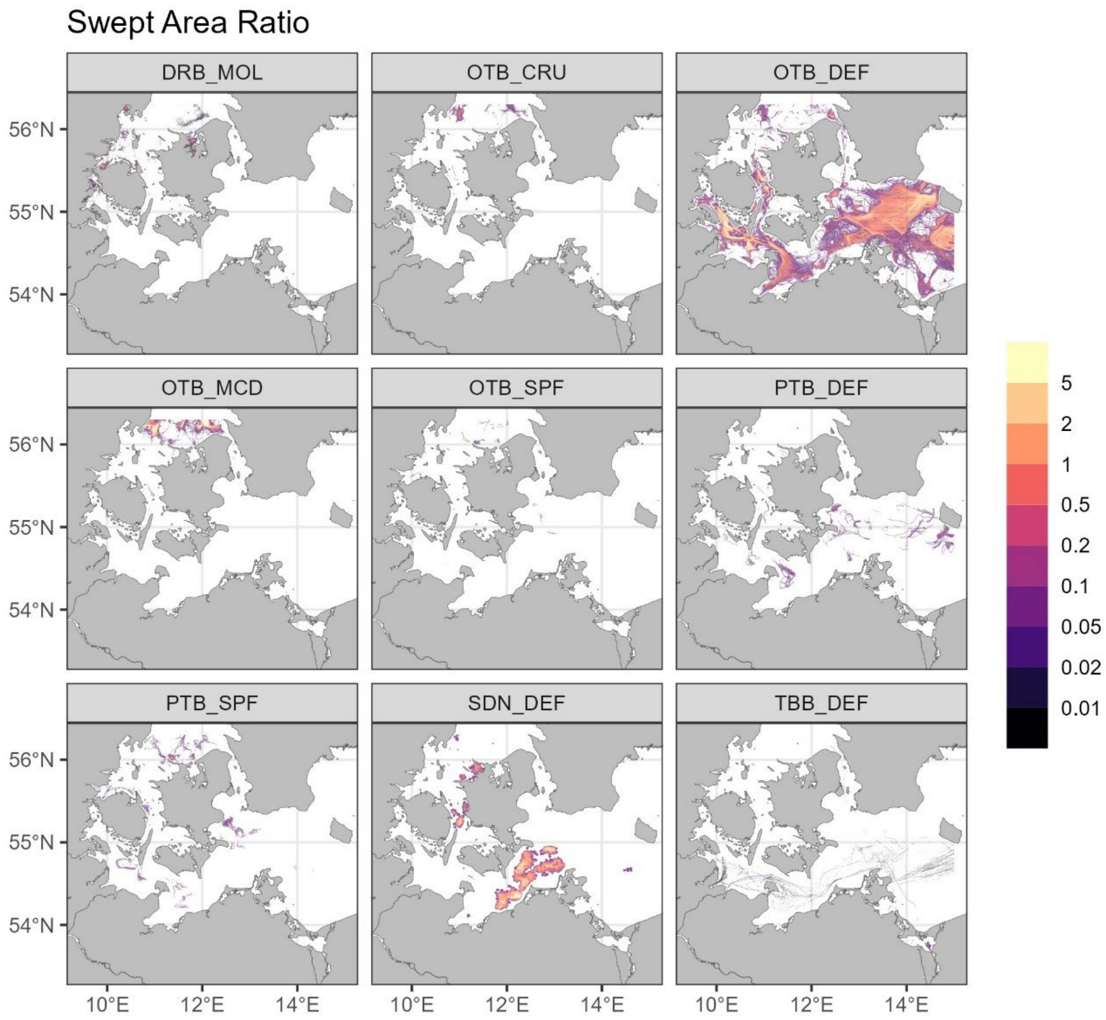

Figure 0.66 Swept Area Ratio by metier averaged across years (2012-2022). Only the nine most common metiers are shown. Colours are on a log-scale. DRB = boat dredge, OTB = bottom otter trawl, PTB = bottom pair trawl, SDN = anchored seine, TBB = beam trawl, MOL = molluscs, CRU = crustaceans, DEF = demersal fish, MCD = mixed crustaceans and demersal fish, SPF = small pelagic fish.

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Data inventory Celtic Sea:

ID	Name	Format	Source	Licence	DOI/Reference	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner	Used in which task(s)
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM team for assistance*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*	*Comma separated lists of tasks that will use the data. If we discover data issues, we will use this information to reporting data issues back to you*
1	Net Primary Productivitity (MODIS Eppley VGPM)	GeoTIFF	http://orca.science.oregonstate.edu/1080.by.2160.monthly.hdf.eppley.m.chl.m.sst.php	Open	http://science.oregonstate.edu/ocean.productivity/references/L&O%201997a.pdf		2160 x 4320	Monthly	EPSG:4326 - WGS 84	We have downloaded 2160 x 4320 Monthly HDF files from MODIS R2022 Data. These data represents modelled net primary productivity net primary production (units of mg C / m**2 / day) based on the eppley variation of the vgpm algorithm. The NPP products are derived from modis chl, modis sst4, and seawifs par as input. The monthly files have been extracted from the compressed folders. Using the shapefile of the Celtic Sea PS, the NPP products as a proxy for biological productivity was extracted in R and visualized in ArcMap.An averaged product for all the annual products (2002 - 2023) was generated.	Celtic Sea	Robert Runya	Task 2.2
2	**Shannon-Wiener Diversity Index**	GeoTiff	Datras: Down	Open	-		0.016 x 0.016	Yearly	EPSG:4326 - WGS 84	BIODIVERSITY CRITERION - EBSAs: Shannon-Wiener's biodiversity index calculated in R from the DATRAS IAMS (anglerfish and megrim survey) and IGFS (Irish Ground Fish Survey) surveys/datasets for the Celtic Sea from 2016 to 2022. Note that benthic data and infauna is missing at the time of this calculation. This will be updated as soon as the data is made available. We provide an averaged product and also the yearly products of Shannon-Wiener Diversity Index. We use krigging interpolation method based default paramters provided in ArcMap (Krigging method=ordinary; Semivariogram model= spherical; search radius= variable and 12 number of points).	Celtic Sea	Robert Runya	Task 2.2
3	**Fishing effort folder** (Beam Trawls Effort, Bottom Otter Trawls, Dredges, Gillnets, Longlines, Pelagic Trawls, Pots, Seines)	GeoTiff	MI Data Catalogue	Open	Gerritsen, Hans. (2024) Atlas of Commercial Fisheries around Ireland, Fourth Edition 2024. Marine Institute. doi: 10/mfb7		0.002 x 0.002	Yearly	EPSG:4326 - WGS 84	NATURALNESS CRITERION - EBSAs: Relative fishing effort for Beam Trawls, Bottom Otter Trawls, Dredges, Gillnets, Longlines, Pelagic Trawls, Pots and Seines from 2018 to 2022 is obtained and mosaiced raster dataset generated. Displays averaged fishing effort products by commercial fishing vessels of all nationalities in Irish EEZ. Fishing effort here is represented as the time spent engaged in fishing operations or time spent at sea, this time may be multiplied by a measure of fishing capacity, e.g. engine power. In this dataset fishing effort is measured as average hours fishing per kilometre square, per year. The data from years 2018 to 2022, is collated from 3 sources; vessel monitoring systems, logbooks and EU fleet register.	Celtic Sea	Robert Runya	Task 2.2

Data inventory Greek Seas:

ID	Name	Format	Source	Licence	DOI/Reference	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner	Used in which task(s)
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM team for assistance*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*	*Comma separated lists of tasks that will use the data. If we discover data issues, we will use this information to reporting data issues back to you*
1	*Naturalness > AIS_fishing_effort*	tif	Global Fishing Watch (2024). Accessed on 14/02/2024. https://globalfishingwatch.org/dataset-and-code-fishing-effort/	Open	Global Fishing Watch (2024). Accessed on 14/02/2024. https://globalfishingwatch.org/dataset-and-code-fishing-effort/		0.03 x 0.03 °	01/09/2020-31/08/2023	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset contains the sum of fishing hours for each cell, derived from AIS data of all large fishing vessels. It represents the total time large vessels spent fishing within each cell for the period 01/09/2020 to 31/08/2023. The fishing effort is summarized at a resolution of 0.03 x 0.03 °. The layer is rescaled to 0.03 ° (~480 m) to align with the boundaries of the study area and for consistency with other datasets.	*Greek EEZ*	Maria Papazekou	*Task 2.2*
2	*Biological Diversity > diversity_aquamaps*	tif	AquaMaps. Accessed on 31/01/2024. https://www.aquamaps.org	Open	AquaMaps (2019, October). Computer Generated Species Richness Map for Animalia. Retrieved from https://www.aquamaps.org.www.aquamaps.org. AquaMaps (2019, October). Computer Generated Species Richness Map for Plantae. Retrieved from https://www.aquamaps.org.www.aquamaps.org.		0.5 x 0.5 °	2019	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset provides the count of animal and plant species within each cell, based on a predicted probability of occurrence greater than 0.5. The data, automatically generated by Aquamaps, is summarized at a resolution of 0.5 x 0.5 °. The layer is rescaled to 0.03 ° (~480 m) to align with the boundaries of the study area and for consistency with other datasets.	*Greek EEZ*	Maria Papazekou	*Task 2.2*
3	*Naturalness > coastal_population*	tif	Center for International Earth Science Information Network - CIESIN - Columbia University. 2018. Gridded Population of the World, Version 4 (GPWv4): Population Count, Revision 11. Palisades, New York: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4JW8BX5. Accessed on 14/02/24. GEBCO Compilation Group (2023) GEBCO 2023 Grid (doi:10.5285/f98b053b-0cbc-6c23-e053-6c86abc0af7b) Holon F, Mouquet N, Boissery P, Bouchoucha M, Delaruelle G, et al. (2015) Fine-Scale Cartography of Human Impacts along French Mediterranean Coasts: A Relevant Map for the Management of Marine Ecosystems. PLOS ONE 10(8): e0135473. https://doi.org/10.1371/journal.pone.0135473	Open			100 x 100 m (~0.001 °)	2020	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset, developed by the MarinePlan team following Holon et al. (2015) methodology, estimates the coastal population impact on the Greek Seas. The inland area of the Planning Site was divided into catchments and population density was calculated, with assigned population density ratings from 0 to 5, according to the scale provided by Holon et al. (2015. Multi-ring 100-meter buffer zones were generated extending into the marine environment from each catchment. To model the impact of population density, an attenuation curve was applied, assuming a negative exponential decrease from the origin to distances of 1, 3, 5, or 20 kilometers, based on the rating assigned to each catchment. Buffer zones were transformed into a 100 x 100 m grid and adjusted for bathymetry, accounting for a 10% impact loss per 10-meter depth group.	*Greek EEZ*	Maria Papazekou	*Task 2.2*
4	*Naturalness > tourist_arrivals*	tif	Hellenic Statistical Authority (2022) Arrivals at hotels and similar establishments (excluding tourist campsites), by Regional Unit and Municipality. Tourism and Culture Statistics Section, Sectoral Statistics Division Section. https://www.statistics.gr/en/statistics/-/publication/STO12/2022 GEBCO Compilation Group (2023) GEBCO 2023 Grid (doi:10.5285/f98b053b-0cbc-6c23-e053-6c86abc0af7b) Holon F, Mouquet N, Boissery P, Bouchoucha M, Delaruelle G, et al. (2015) Fine-Scale Cartography of Human Impacts along French Mediterranean Coasts: A Relevant Map for the Management of Marine Ecosystems. PLOS ONE 10(8): e0135473. https://doi.org/10.1371/journal.pone.0135473	Open			100 x 100 m (~0.001 °)	2022	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset, developed by the MarinePlan team following Holon et al. (2015) methodology, estimates the impact of tourist arrivals on the Greek Seas. The inland area of the Planning Site was divided into catchments and tourist population density was calculated, with assigned density ratings from 0 to 5, according to the scale provided by Holon et al. (2015. Multi-ring 100-meter buffer zones were generated extending into the marine environment from each catchment. To model the impact of tourist arrivals, an attenuation curve was applied, assuming a negative exponential decrease from the origin to distances of 1, 3, 5, or 20 kilometers, based on the rating assigned to each catchment. Buffer zones were transformed into a 100 x 100 m grid and adjusted for bathymetry, accounting for a 10% impact loss per 10-meter depth group.	*Greek EEZ*	Maria Papazekou	*Task 2.2*
5	*Productivity > annual_upwelling_contours*	shapefile	Zervakis, V., Tragou, E., & Mamoutos, I. G. (2024). Mapping of offshore areas important for the fertilization of the Greek Seas (Reporting under D2.2: Report on Spatial Distributions and Temporal Dynamics of Metrics)	Restricted. The data provided is intended solely for use in MarinePlan.				2000-2019	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset, developed by the MarinePlan team, contains estimates of vertical velocity at the bottom of the Ekman layer, representing the upwelling velocity of the pycnocline layers into the surface layer. The methodology utilizes Ekman dynamics, incorporating wind stress data, for the period 2000 to 2019. The final output layer of the dataset displays areas of strong energetic upwelling, with vertical velocity contours drawn at intervals of 0.5, 1, 1.5, and 2 m day-1. Upwelling plays a significant role in productivity because it facilitates the vertical transport of nutrient rich deep-sea water to the euphotic zone, enhancing primary productivity by providing essential nutrients for photosynthetic organisms like phytoplankton. This dataset has been compiled with higher resolution data compared to the upwelling raster grid, resulting in decreased certainty for each observation. For further details, refer to the accompanying report.	*Greek EEZ*	Maria Papazekou	*Task 2.2*
6	*Productivity > upwelling_grid*	tif	Zervakis, V., Tragou, E., & Mamoutos, I. G. (2024). Mapping of offshore areas important for the fertilization of the Greek Seas (Reporting under D2.2: Report on Spatial Distributions and Temporal Dynamics of Metrics)	Restricted. The data provided is intended solely for use in MarinePlan.			0.42 x 0.42 °	2000-2019	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset, developed by the MarinePlan team, contains estimates of vertical velocity at the bottom of the Ekman layer, representing the upwelling velocity of the pycnocline layers into the surface layer. The methodology utilizes Ekman dynamics, incorporating wind stress data, based on wind hourly data from ERA5 for the period 2000 to 2019. The dataset's final output layer showcases the range of annual upwelling velocity values (m day-1) across the study area. Upwelling plays a significant role in productivity because it facilitates the vertical transport of nutrient rich deep-sea water to the euphotic zone, enhancing primary productivity by providing essential nutrients for photosynthetic organisms like phytoplankton. For further details, refer to the accompanying report. The BSW content layer is summarized at a resolution of 0.42 x 0.42 °. The layer is rescaled to 0.03 ° (~480 m) to align with the boundaries of the study area and for consistency with other datasets.	*Greek EEZ*	Maria Papazekou	*Task 2.2*
7	*Productivity > bsw_content*	tif	Zervakis, V., Tragou, E., & Mamoutos, I. G. (2024). Mapping of offshore areas important for the fertilization of the Greek Seas (Reporting under D2.2: Report on Spatial Distributions and Temporal Dynamics of Metrics) Mamoutos, I. G., Potiris, E., Tragou, E., Zervakis, V., & Petalas, S. (2021). A High-Resolution Numerical Model of the North Aegean Sea Aimed at Climatological Studies. Journal of Marine Science and Engineering, 9(12), 1463. https://doi.org/10.3390/jmse9121463	Restricted. The data provided is intended solely for use in MarinePlan.			0.18 x 0.18 °	2000-2019	EPSG:3035 - ETRS89-extended / LAEA Europe	This dataset, developed by the MarinePlan team, provides estimates of the weight ratio of Black Sea Water (BSW) in the Aegean Sea. The methodology assumes that lateral advection predominates over air-sea freshwater exchange in determining sea-surface salinity. Utilizing sea-surface salinity data from a hindcast simulation by Mamoutos et al. (2021) spanning 2000-2019, the dataset delineates the spatial distribution of the proportion of BSW to Levantine-originated waters at each grid cell. BSW content is crucial for Aegean Sea productivity, primarily due to the inflow of modified, productivity-rich BSW through the Bosphorus Strait, the Marmara Sea, and the Dardanelles Strait. Notably, raster values primarily correspond to the Aegean Sea. Accuracy may be compromised in gulf interiors where river water introduces additional low-salinity sources. Similarly, in the Ionian Sea, Modified Atlantic Water serves as the primary source of low-salinity water. For further details, refer to the accompanying report. The BSW content layer is summarized at a resolution of 0.18 x 0.18 °. The layer is rescaled to 0.03 ° (~480 m) to align with the boundaries of the study area and for consistency with other datasets.	*Greek EEZ*	Maria Papazekou	*Task 2.2*

Data inventory Bay of Biscay:

ID	Name	Format	Source	Licence	DOI/Reference/Link	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner	Used in which task(s)
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM team for assistance*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*	*Comma separated lists of tasks that will use the data. If we discover data issues, we will use this information to reporting data issues back to you*
1	**Chlorophyll** (BoB_chl_overall.tif BoB_chl_overall_annual.tif BoB_chl_QX.tif BoB_chl_QX_annual.tif)	tif	The Ocean Colour Climate Change Initiative project https://www.oceancolour.org/ Data was downloaded on 07.02.2024	ESA CCI Data Policy: free and open access.	Sathyendranath, S, Brewin, RJW, Brockmann, C, Brotas, V, Calton, B, Chuprin, A, Cipollini, P, Couto, AB, Dingle, J, Doerffer, R, Donlon, C, Dowell, M, Farman, A, Grant, M, Groom, S, Horseman, A, Jackson, T, Krasemann, H, Lavender, S, Martinez-Vicente, V, Mazeran, C, Mélin, F, Moore, TS, Müller, D, Regner, P, Roy, S, Steele, CJ, Steinmetz, F, Swinton, J, Taberner, M, Thompson, A, Valente, A, Zühlke, M, Brando, VE, Feng, H, Feldman, G, Franz, BA, Frouin, R, Gould, Jr., RW, Hooker, SB, Kahru, M, Kratzer, S, Mitchell, BG, Muller-Karger, F, Sosik, HM, Voss, KJ, Werdell, J, and Platt, T (2019) An ocean-colour time series for use in climate studies: the experience of the Ocean-Colour Climate Change Initiative (OC-CCI). Sensors: 19, 4285. doi:10.3390/s19194285		4 km	Monthly, 1997.09.-2023.12.	WGS 84 (OGC:CRS84)	The original NetCDF dataset contained monthly Chlorophyll-a concentration in seawater data from September 1993 to December 2023. We computed monthly medians per year and per quarter (Q1: Jan-March, Q2: Apr-Jun, Q3: Jul-Sept, Q4: Oct-Dec) and cropped it by the study area. The unit of the chlorophyll is mg/m3. BoB_chl_overall.tif - average monthly value over the whole period BoB_chl_overall_annual.tif - average monthly value per year BoB_chl_QX.tif - average monthly value for X quarter over the whole period BoB_chl_QX_annual.tif - average monthly value for X quarter per year	Bay of Biscay	Olga Lukyanova	Task 2.2
2	**Biodiversity (Species Richness)** (BoB_SpeciesRichness.tif)	tif	https://www.aquamaps.org Data was downloaded on 06.03.2024	Creative Commons Attribution-NonCommercial 3.0 Unported License (CC-BY-NC)	Kaschner, K., Kesner-Reyes, K., Garilao, C., Segschneider, J., Rius-Barile, J. Rees, T., & Froese, R. (2019, October). AquaMaps: Predicted range maps for aquatic species. Retrieved from https://www.aquamaps.org. AquaMaps (2019, October). Computer Generated Species Richness Map for Animalia. AquaMaps (2019, October). Computer Generated Species Richness Map for Plantae.		0.5 x 0.5 degree	NA	WGS 84 (OGC:CRS84)	Combination of global predicted species richness for Plantae and Animalia kingdoms generated by AquaMaps. The unit is species count.	Bay of Biscay	Olga Lukyanova	Task 2.2
3	**Fishing intensity** (BoB_FishingIntensity_sum.tif, BoB_FishingIntensity_stack.tif)	tif	EMODnet Human Activities, Fisheries, Fishing Intensity. https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/d57fbdea-489e-4e11-9ff1-f0f706cfe783 Data was downloaded from EMODnet Map Viewer on 10.10.2023	Re-use of content for commercial or non-commercial purposes is permitted free of charge, provided that the sources (EMODnet - Human Activities, STECF, and the FAO) are acknowledged.	European Marine Observation and Data Network (EMODnet)		0.05 x 0.05 degree	Average 2018-2021	ETRS89-extended / LAEA Europe (EPSG:3035)	The original vector data containing the average 2018-2021 fishing intensity per C-Square 0.05x0.05 degree grid (mW fishing hours) was transformed into the raster format and cropped by the study area: FishingIntensity_sum_BoB.tif - sum of all fishing gears FishingIntensity_stack_BoB.tif - raster stack with fishing intensity per gear type (beam trawls, bottom otter trawls, bottom seines, dredges, pelagic trawls and seines, static gears)	Bay of Biscay	Olga Lukyanova	Task 2.2

Data inventory Campania:

consecutive number	legible name to identify the data	Shapefile, CSV, NetCDF, etc…	e.g. repository name, URL, author email	e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT			If applicable	Start-end date, interval (if applicable)	If applicable. Use EPSG notation or ask the DM team for assistance	Download instructions, processing instructions, other remarks	e.g. German EEZ	Acronym / contact who added the data	
1	ppn_mean_0042res_2020	geotiff	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential			1 km2	seasonal	EPSG:4326 - WGS 84	Primary productivity shapefiles measured in mg m-3day-1	Campania EEZ	UNINA - SZN	Task 2.2
2	ppn_mean_0042res_2021	geotiff	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential			1 km2	seasonal	EPSG:4326 - WGS 84	Primary productivity shapefiles measured in mg m-3day-1	Campania EEZ	UNINA - SZN	Task 2.2
3	ppn_mean_0042res_2022	geotiff	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential			1 km2	seasonal	EPSG:4326 - WGS 84	Primary productivity shapefiles measured in mg m-3day-1	Campania EEZ	UNINA - SZN	Task 2.2
4	habitat_complete	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Presence data for main habitats of the Campania region (Seagrasses, macroalgae, coralligenous, maerl, shallow rocky reef)	Campania EEZ	UNINA - SZN	Task 2.2
5	dohrn_coral_forest_extent	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Deep Sea coral extent	Campania EEZ	UNINA - SZN	Task 2.2
6	dohrn_cwc_oyster_extent	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Deep Sea oyster extent	Campania EEZ	UNINA - SZN	Task 2.2
7	Eledone_cirrosa_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Eledone cirrosa	Campania EEZ	UNINA - SZN	Task 2.2
8	Galeus_melastomus_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Galeus melastomus	Campania EEZ	UNINA - SZN	Task 2.2
9	Illex_coindetii_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Illex coindetii	Campania EEZ	UNINA - SZN	Task 2.2
10	Merluccius_merluccius_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Merluccius merluccius	Campania EEZ	UNINA - SZN	Task 2.2
11	Mullus_barbatus_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Mullus barbatus	Campania EEZ	UNINA - SZN	Task 2.2
12	Nephrops_norvegicus_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Nephrops norvegicus	Campania EEZ	UNINA - SZN	Task 2.2
13	Pagellus_erhytrinus_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Pagellu erhytrinus	Campania EEZ	UNINA - SZN	Task 2.2
14	Parapenaeus_longirostris_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Parapenaeus longirostris	Campania EEZ	UNINA - SZN	Task 2.2
15	Trachurus_mediterraneous_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Trachurus mediterraneous	Campania EEZ	UNINA - SZN	Task 2.2
16	Trachurus_trachurus_r	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Essential Fish Habitat - probability of occurrence data of Trachurus trachurus	Campania EEZ	UNINA - SZN	Task 2.2
17	iucn_imma	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Important Marine Mammals Areas	Campania EEZ	UNINA - SZN	Task 2.2
18	iba	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential					EPSG:4326 - WGS 84	Important Birds Areas	Campania EEZ	UNINA - SZN	Task 2.2
19	effort	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential			1 km2		EPSG:4326 - WGS 84	Fishing effort: purse seine nets (fishing hours per cell) - Density of pings (number of pings per cell)	Campania EEZ	UNINA - SZN	Task 2.2
20	effort_month	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential			1 km2		EPSG:4326 - WGS 84	Fishing effort: trawling per month (2019) and length of nets (fishing hours per cell)	Campania EEZ	UNINA - SZN	Task 2.2
21	pelagic_fishing_areas_1quarter	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential				seasonal	EPSG:4326 - WGS 84	Pelagic fishing (number of fishing boats per cell)	Campania EEZ	UNINA - SZN	Task 2.2
22	pelagic_fishing_areas_2quarter	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential				seasonal	EPSG:4326 - WGS 84	Pelagic fishing (number of fishing boats per cell)	Campania EEZ	UNINA - SZN	Task 2.2
23	pelagic_fishing_areas_3quarter	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential				seasonal	EPSG:4326 - WGS 84	Pelagic fishing (number of fishing boats per cell)	Campania EEZ	UNINA - SZN	Task 2.2
24	pelagic_fishing_areas_4quarter	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=63108d307d2c4c65b64619abdbf3da2e	confidential				seasonal	EPSG:4326 - WGS 84	Pelagic fishing (number of fishing boats per cell)	Campania EEZ	UNINA - SZN	Task 2.2
25	ssf_effort	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=3a775f4ace194fbaae4d6c5833862c44	confidential			1 km2		EPSG:4326 - WGS 84	Artisanal fishing (2021) (days at sea)	Campania EEZ	UNINA - SZN	Task 2.2
26	vessel_density	geotiff	https://geonetwork.bioinfo.szn.it/geonetwork/srv/ita/catalog.search#/metadata/d5803423-e4f9-424a-8f15-528f70568271	confidential			1 km2		EPSG:4326 - WGS 84	Vessel density (number of vessels per cell)	Campania EEZ	UNINA - SZN	Task 2.2
27	shipping_lane_50m	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=5b497ff5fd07410fb81ba812d0e594c1	confidential					EPSG:4326 - WGS 84	Shipping lane (50 m buffer)	Campania EEZ	UNINA - SZN	Task 2.2
28	concessioni_demaniali	point shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=65d42ccaa2c04424bc8d9a9634ec36d4	confidential					EPSG:4326 - WGS 84	Concession of sea state property 2018	Campania EEZ	UNINA - SZN	Task 2.2
29	Aquaculture	multipolygon shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=921a7d8c0304453f92c29c4c2af4db9a	confidential					EPSG:4326 - WGS 84	Aquaculture	Campania EEZ	UNINA - SZN	Task 2.2
30	Ports	point shapefile	https://geoportal.bioinfo.szn.it/arcgis/home/item.html?id=3afd335e8d494ad1b9198768b3b123b0	confidential					EPSG:4326 - WGS 84	Ports	Campania EEZ	UNINA - SZN	Task 2.2

Data inventory Southern North Sea:

ID	Name	Format	Source	Licence	DOI/Reference	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner	Used in which task(s)
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM team for assistance*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*	*Comma separated lists of tasks that will use the data. If we discover data issues, we will use this information to reporting data issues back to you*
1	**SNS Chlorophyll folder**	Geotiff	Alvera-Azcarate A. & Van der Zande D. & Barth A. & Troupin C. & Martin S. & Beckers J.-M. Analysis of 23 years of daily cloud-free chlorophyll and suspended particulate matter in the Greater North Sea (2021) Frontiers in Marine Science, Vol. 13(19) p. 2657.	Open Dataset was generated upon request of the OSPAR commission for their latest QSR reporting, their data policy rules are as follows: *"OSPAR is committed to making as much information as possible publicly available, consistent with achieving other similarly important goals of public policy. The framework for this is set out in Article 9 of the OSPAR Convention. Following this, information presented in the OSPAR Assessment Portal is licensed according to Creative Commons BY 4.0:* *Share - copy and redistribute the material in any medium or format for any purpose, even commercially.;* *- Adapt - remix, transform, and build upon the material for any purpose, even commercially.* *Under the following terms:* *- Attribution - You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.* *- No additional restrictions - You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits."*	DOI: https://doi.org/10.3389/fmars.2021.707632		1km	Average seasonal variation (2017-2020)		Dataset: png of log and linear scales + geotiff of Average Seasonal Variation of Chlorophyll-A Concentration (available on log and linear scales): January- March, April- June, July- September, October- December acquired from RBINS. Raw Data: Source products were obtained from publicly accessible archives: the Copernicus Marine Environment Monitoring Service (CMEMS), European Space Agency (i.e., ODESA) and other data providers (i.e., IFREMER). Description of Data: Average Seasonal Variation of Chlorophyll-A Concentration (available on log and linear scales): January- March, April- June, July- September, October- December	Southern North Sea	Annaïk Van Gerven	Task 2.2
2	**Benthic/demersal diversity**										Southern North Sea	Maren Kruse and Prince Bonsu	
3	**Fishing effort**	GDB	EMODnet - Human Activities, STECF, and the FAO	Open *"Re-use of content for commercial or non-commercial purposes is permitted free of charge, provided that the sources (EMODnet - Human Activities, STECF, and the FAO) are acknowledged. EMODnet - Human Activities accepts no responsibility or liability whatsoever for the re-use of content accessible on its website. For further information on ICES's data policy, please visit https://www.ices.dk/marine-data/guidelines-and-policy/Pages/default.aspx."*	https://emodnet.ec.europa.eu/geonetwork/srv/eng/catalog.search#/metadata/d57fbdea-489e-4e11-9ff1-f0f706cfe783		0.05x0.05	Yearly average (2015-2021)		The datasets on fishing intensity in the EU waters by sea basin are created every year by the International Council for the Exploration of the Sea (ICES). In the 2020 Cogea started to collect and harmonize them according to the EMOdnet Human Activities dataset schema. The EMODnet dataset is updated yearly and as soon as new data from ICES are released, and is available for viewing and download on the EMODnet web portal (Human Activities, https://emodnet.ec.europa.eu/en/human-activities). Where and when available, the fisheries overview data concern: i) the spatial distribution of average annual fishing effort (mW fishing hours) by ecoregion (Azores, Bay of Biscay and the Iberian Coast, Baltic Sea, Barents Sea, Celtic Seas, Faroes, Greater North Sea, Icelandic Waters, Norwegian Sea and Oceanic Northeast Atlantic) and by gear type (Beam trawls, Bottom otter trawls, Bottom seines, Dredges, Pelagic trawls and seines, Static gears). Fishing effort data are only shown for vessels >12 m having vessel monitoring systems (VMS); ii) the average annual subsurface (top) and surface (bottom) mobile bottom contacting fishing gear (i.e. bottom otter trawls, bottom seines, dredges, beam trawls) disturbance by ecoregion in the Bay of Biscay and the Iberian Coast, Baltic Sea, Barents Sea, Celtic Seas, Faroes, Greater North Sea, Icelandic Waters, Norwegian Sea and Oceanic Northeast Atlantic, expressed as average swept-area ratios (SAR). Due to data confidentiality issues, VMS/logbook data are anonymized and aggregated in a 0.05×0.05 degree grid prior to submission to ICES, using the C-squares geocode system (polygons). The last data loaded into the database, from the ICES 2022 Fishing Overview, report the 2018-2021 averages. Compared with the previous one this new version has a new dataset schema and also historical data have been included in the database.	Southern North Sea	Annaïk Van Gerven	Task 2.2, task 3.2

Data inventory Western Med:

ID	Name	Format	Source	Licence	DOI/Reference	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner	Used in which task(s)
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM team for assistance*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*	*Comma separated lists of tasks that will use the data. If we discover data issues, we will use this information to reporting data issues back to you*
1	**Chlorophyll folder** (phyc_0000)	asc	Zenodo, https://doi.org/10.5281/zenodo.6523899, from Kristiansen, T., Butenschön, M., & Peck, M. A. (2024). Statistically downscaled CMIP6 ocean variables for European waters. Scientific Reports, 14(1), 1209.)	CC-BY-NC-SA_4.0_LICENSE (https://zenodo.org/records/6523899)	https://doi.org/10.5281/zenodo.6523899		0.16 x 0.16	yearly	EPSG:4326 - WGS 84	The authors have produced monthly chlorophyll data from the entire Mediterranean Sea from 1993 to 2023 surface-150m. We have processed the data, doing a mean per year and cropped the map for the Western Mediterranean Sea. The unit of the chlorophyll is kg/m	Western Mediterranean Sea	Marta Coll and Maria Bas	Task 2.2
2	**Kempton's index folder** (biodiv_ind_Kempton's Q-0000)	asc	FutureMares EU Project 2024 (from EwE models)	confidential (not yet available)	-	v1	0.16 x 0.16	yearly	EPSG:4326 - WGS 84	BIODIVERSITY CRITERION - EBSAs: Biodiversity Kempton's index calculated from the EwE models for the Western Mediterranean Sea from 1993 to 2023. Note that the final number of each file corresponds in ascending order from 1993 to 2023	Western Mediterranean Sea	Marta Coll and Maria Bas	Task 2.2
3	**Fishing effort folder** (EcospaceMapEffort-Bottom trawls-0000 / EcospaceMapEffort-Purse seiners & midwater trawlers-0000	asc	FutureMares EU Project 2024 (from EwE models)	confidential (not yet available)	-	v1	0.16 x 0.16	yearly	EPSG:4326 - WGS 84	NATURALNESS CRITERION - EBSAs: Relative fishing effort for bottom trawlers and Fishing effort from Purse seiners & midwater trawlers from 1993 to 2023. Note that the final number of each file corresponds in ascending order from 1993 to 2023	Western Mediterranean Sea	Marta Coll and Maria Bas	Task 2.2

Data inventory Azores

ID	Name	Format	Source	Licence	DOI/Reference	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM team for assistance*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*
1	**CWC_richness_Azores**	tif	Taranto, Gerald Hechter; González-Irusta, José-Manuel; Domínguez-Carrió, Carlos; Pham, Christopher Kim; Tempera, Fernando; Ramos, Manuela; Gonçalves, Guilherme; Carreiro-Silva, Marina; Morato, Telmo (2023): Habitat suitability maps for vulnerable and foundation cold-water coral taxa of the Azores (NE Atlantic). PANGAEA, https://doi.org/10.1594/PANGAEA.955223	Open	https://doi.org/10.1594/PANGAEA.955223; https://doi.org/10.1016/j.dsr.2023.104028	v2	0.01°		UTM zone 26N projection	Cold water coral richness based on habitat suitability predictions. The .tif file shows the number of taxa predicted as suitable for each raster cell. Note that only high confidence suitable cells of combined habitat suitability maps are considered.	Azores	Telmo Morato
2	**Individual_CWC_species**	tif	Taranto, Gerald Hechter; González-Irusta, José-Manuel; Domínguez-Carrió, Carlos; Pham, Christopher Kim; Tempera, Fernando; Ramos, Manuela; Gonçalves, Guilherme; Carreiro-Silva, Marina; Morato, Telmo (2023): Habitat suitability maps for vulnerable and foundation cold-water coral taxa of the Azores (NE Atlantic). PANGAEA, https://doi.org/10.1594/PANGAEA.955223	Open	https://doi.org/10.1594/PANGAEA.955223; https://doi.org/10.1016/j.dsr.2023.104028	v2	0.01°		UTM zone 26N projection	Combined habitat suitability maps. Suitable raster cells of combined habitat suitability maps were classified as follows: (i) high confidence suitable cell (3 in raster layers), raster cell predicted as suitable with high-confidence by both GAM and Maxent models; (ii) medium confidence suitable cell (2 in raster layers), raster cell predicted as suitable with medium or high confidence by GAM, Maxent or both and with a local fuzzy similarity greater than 0.5; (iii) low confidence suitable cell (1 in raster layers), any other cell predicted as suitable by GAM and/or Maxent.	Azores	Telmo Morato
3	**Deep-sea_fish_species_richness**	tif	Parra, H. E., Pham, C. K., Menezes, G. M., Rosa, A., Tempera, F., & Morato, T. (2017). Predictive modeling of deep-sea fish distribution in the Azores. Deep Sea Research Part II: Topical Studies in Oceanography, 145, 49-60.	Open	https://doi.org/10.1016/j.dsr2.2016.01.004	v1	0.0027°	1996-2011	UTM 26N (WGS84)	In this study, we applied generalized additive models (GAMs) to relate presence–absence data of eight economically-important fish species to environmental variables (depth, slope, aspect, substrate type, bottom temperature, salinity and oxygen saturation). We combined 13 years of catch data collected from systematic longline surveys performed across the region. Species richness is the number of species predict to occur in eachgrid cell.	Azores	Telmo Morato
4	**Individual_fish_species**	tif	Parra, H. E., Pham, C. K., Menezes, G. M., Rosa, A., Tempera, F., & Morato, T. (2017). Predictive modeling of deep-sea fish distribution in the Azores. Deep Sea Research Part II: Topical Studies in Oceanography, 145, 49-60.	Open	https://doi.org/10.1016/j.dsr2.2016.01.004	v1	0.0027°	1996-2011	UTM 26N (WGS84)	In this study, we applied generalized additive models (GAMs) to relate presence–absence data of eight economically-important fish species to environmental variables (depth, slope, aspect, substrate type, bottom temperature, salinity and oxygen saturation). We combined 13 years of catch data collected from systematic longline surveys performed across the region: Phycis phycis / Abrotea, Beryx splendens / Alfonsim, Pontinus kuhlii / Bagre, Helicolenus dactylopterus / Boca negra, Pagellus bogaraveo / Goraz, Beryx decadactylus / Imperador.	Azores	Telmo Morato
5	**Deep-sea_sharks_species_richness**	tif	González-Irusta, José Manuel; Fauconnet, Laurence; Das, Diya; Catarino, Diana; Afonso, Pedro; Viegas, Cláudia Neto; Rodrigues, Luís; Menezes, Gui M; Rosa, Alexandra; Pinho, Mário Rui Rilhó; Silva, Hélder Marques da; Giacomello, Eva; Morato, Telmo (2022): Outputs of predictive distribution models of deep-sea elasmobranchs in the Azores EEZ (down to 2,000m depth) using Generalized Additive Models. PANGAEA, https://doi.org/10.1594/PANGAEA.940808	Open	https://doi.org/10.1594/PANGAEA.940808; https://doi.org/10.1016/j.dsr.2022.103707	v1	0.012°	1996-2017	Albers equal-area conical projection centered in the middle of the study area	Species richness: This dataset contains the number pf species predicted to occur in each grid cell from binary maps of the predicted probability of presence (Pp) of 15 deep-water shark and rays species in a 1000-hook bottom longline fishing set (type LLA) in the Azores, using a Generalized Additive Models (GAM) approach with binomial distribution and logit link function and the maximization of the sum of sensitivity and specificity (MSS) threshold, which minimizes misclassification likelihoods of false negatives and false positives. Raja clavata; Galeorhinus galeus; Dipturus batis; Leucoraja fullonica; Dalatias licha; Etmopterus spinax; Squaliolus laticaudus; Etmopterus pusillus; Deania profundorum; Deania calcea; Centrophorus squamosus; Centroscymnus owstonii; Centroscymnus crepidater; Centroscymnus coelolepis; Etmopterus princess.	Azores	Telmo Morato
6	**Individual_Deep-sea_sharks_species**	tif	González-Irusta, José Manuel; Fauconnet, Laurence; Das, Diya; Catarino, Diana; Afonso, Pedro; Viegas, Cláudia Neto; Rodrigues, Luís; Menezes, Gui M; Rosa, Alexandra; Pinho, Mário Rui Rilhó; Silva, Hélder Marques da; Giacomello, Eva; Morato, Telmo (2022): Outputs of predictive distribution models of deep-sea elasmobranchs in the Azores EEZ (down to 2,000m depth) using Generalized Additive Models. PANGAEA, https://doi.org/10.1594/PANGAEA.940808	Open	https://doi.org/10.1594/PANGAEA.940808; https://doi.org/10.1016/j.dsr.2022.103707	v1	0.012°	1996-2017	Albers equal-area conical projection centered in the middle of the study area	BinPresence_MSS: This dataset contains the binary maps of the predicted probability of presence (Pp) of 15 deep-water shark and rays species in a 1000-hook bottom longline fishing set (type LLA) in the Azores, using a Generalized Additive Models (GAM) approach with binomial distribution and logit link function and the maximization of the sum of sensitivity and specificity (MSS) threshold, which minimizes misclassification likelihoods of false negatives and false positives. Raja clavata; Galeorhinus galeus; Dipturus batis; Leucoraja fullonica; Dalatias licha; Etmopterus spinax; Squaliolus laticaudus; Etmopterus pusillus; Deania profundorum; Deania calcea; Centrophorus squamosus; Centroscymnus owstonii; Centroscymnus crepidater; Centroscymnus coelolepis; Etmopterus princess.	Azores	Telmo Morato
7	**Epc_FromKrige_3km_1951_2000**	tif	Wei, Chih-Lin; González-Irusta, José Manuel; Domínguez-Carrió, Carlos; Morato, Telmo (2020): Set of terrain (static in time) and environmental (dynamic in time) variables used as candidate predictors of present-day (1951-2000) and future (2081-2100) suitable habitat of cold-water corals and deep-sea fishes in the North Atlantic. PANGAEA, https://doi.org/10.1594/PANGAEA.911117	Open	https://doi.org/10.1594/PANGAEA.911117, https://doi.org/10.1111/gcb.14996		3km	1051-2000	WGS84	The epc100 was converted to export POC flux at the seafloor using the Martin curve (Martin, Knauer, Karl, & Broenkow, 1987) following the equation: epc = epc100*(water depth/export depth)-0.858, and setting the export depth to 100 m.	Azores	Telmo Morato
8	**chloro_mean**	tif	Amorim, Patricia; Perán, António D; Pham, Christopher Kim; Juliano, Manuela; Cardigos, Frederico; Tempera, Fernando; Morato, Telmo (2017): Ocean climatology in the Azores region (North Atlantic) and seabed characteristics, links to GIS layers in ArcGIS format. PANGAEA, https://doi.org/10.1594/PANGAEA.872601	Open	https://doi.org/10.1594/PANGAEA.872601, https://doi.org/10.3389/fmars.2017.00056		1km	2003-2013	WGS84	Obtaining a comprehensive knowledge of the spatial and temporal variations of the environmental factors characterizing the Azores region is essential for conservation and management purposes. Although many studies are available for the region, there is a need for a general overview of the best available information. Here, we assembled a comprehensive collection of environmental data for this region. Data sources used in this study included remote sensing oceanographic data for 2003-2013 (sea surface temperature, chlorophyll-a concentration, particulate inorganic carbon (PIC), and particulate organic carbon (POC)), derived oceanographic data (primary productivity and North Atlantic oscillation index) for 2003-2013, and in situ data (temperature, salinity, oxygen, phosphate, nitrate and silicate) obtained from the World Ocean Atlas 2013.	Azores	Telmo Morato
9	**npp_mean03_13**	tif	Amorim, Patricia; Perán, António D; Pham, Christopher Kim; Juliano, Manuela; Cardigos, Frederico; Tempera, Fernando; Morato, Telmo (2017): Ocean climatology in the Azores region (North Atlantic) and seabed characteristics, links to GIS layers in ArcGIS format. PANGAEA, https://doi.org/10.1594/PANGAEA.872601	Open	https://doi.org/10.1594/PANGAEA.872601, https://doi.org/10.3389/fmars.2017.00056		1km	2003-2013	WGS84	Obtaining a comprehensive knowledge of the spatial and temporal variations of the environmental factors characterizing the Azores region is essential for conservation and management purposes. Although many studies are available for the region, there is a need for a general overview of the best available information. Here, we assembled a comprehensive collection of environmental data for this region. Data sources used in this study included remote sensing oceanographic data for 2003-2013 (sea surface temperature, chlorophyll-a concentration, particulate inorganic carbon (PIC), and particulate organic carbon (POC)), derived oceanographic data (primary productivity and North Atlantic oscillation index) for 2003-2013, and in situ data (temperature, salinity, oxygen, phosphate, nitrate and silicate) obtained from the World Ocean Atlas 2013.	Azores	Telmo Morato
10	**bottom_fishing effort**	tif	unpublished data	confidential (not yet available)		v2	5km	2002-2018	WGS 84	The bottom-fishing (longline plus handline) effort layer was computed from an analysis of the Vessel Monitoring System (VMS) for vessels licensed for bottom longline or handline fishing gears. The fishing licences granted to each vessel per year were used to allocate a gear type to all VMS pings. We acknowledge that not all boats operating in the spatial planning area (beyond 6 nm from island shores) have VMS systems installed. However, a quick comparison of the VMS outputs with the fishing effort maps obtained from fishers' inquiries (Diogo et al., 2015) revealed similar spatial patterns, but much more spatial detail when using the VMS data. In total, VMS data was obtained from 74 anonymous vessels over the period 2002-2018 with an average of 12 vessels per year. This number represents about 25% of the bottom longline fleet if considering an average of 52 vessels per year that declared landings using bottom longline.	Azores	Telmo Morato

Data inventory Western Baltic Sea

ID	Name	Format	Source	Licence	DOI/Reference	Version (if applicable)	Spatial resolution	Temporal resolution	Coordinate system	Description	System/management boundaries	Contributing partner	Used in which task(s)
consecutive number	*legible name to identify the data*	*Shapefile, CSV, NetCDF, etc...*	*e.g. repository name, URL, author email*	*e.g. Open, restricted, confidential, official licences such as GPL, BSD, MIT*			*If applicable*	*Start-end date, interval (if applicable)*	*If applicable. Use EPSG notation or ask the DM*	*Download instructions, processing instructions, other remarks*	*e.g. German EEZ*	*Acronym / contact who added the data*	*Comma separated lists of tasks that will use the data. If we discover data issues, we will use this information to reporting data issues back to you*
1	**Chlorophyll-a concentration (mg/m2)** Monthly mean values: chl_month_2001_2021.tif Annual median values: chl_annual_median.tif Quarterly median values: chl_quarter_median.tif	tif	EU Copernicus Marine Service Information, Baltic Sea Biogeochemistry Reanalysis, https://data.marine.copernicus.eu/product/BALTICSEA_MULTIYEAR_BGC_003_012/description	Public	https://doi.org/10.48670/moi-00012		2 x 2 km	2001-2021, month, annual and quarter	WGS 84	Vertically integrated monthly values of Chl-a concentration were downloaded from the Baltic Sea Biogeochemistry Reanalysis model (product ID: BALTICSEA_MULTIYEAR_BGC_003_012) for 2001-2021, and spatially cropped to the planning site area (ICES subdivision 22 to 24; chl_month_2001_2021.tif). Monthly values were aggregated to median values per year (chl_annual_median.tif) and to median values per quarter (chl_quarter_median.tif).	Western Baltic Sea	Asbjørn Christensen, Esther D. Beukhof, Stefan Neuenfeldt	Task 2.2
2	**Demersal fish biodiversity** *Species richness* WestBaltSea_richness_rect_year.shp WestBaltSea_richness_rect.shp WestBaltSea_richness_year.csv WestBaltSea_richness_rate.shp *Species evenness* WestBaltSea_evenness_rect_year.shp WestBaltSea_evenness_rect.shp WestBaltSea_evenness_year.csv WestBaltSea_evenness_rate.shp *Shannon index* WestBaltSea_shannon_rect_year.shp WestBaltSea_shannon_rect.shp WestBaltSea_shannon_year.csv WestBaltSea_shannon_rate.shp	Shapefile, CSV	Data downloaded from FishGlob_data (https://github.com/AquaAuma/FishGlob_data/tree/main/outputs/Cleaned_data). Original data from DATRAS (https://www.ices.dk/data/data-portals/Pages/DATRAS.aspx).	Public	FishGlob_data paper: https://doi.org/10.1038/s41597-023-02866-w	v.2.0.1	ICES rectangle	2001-2020, annual	WGS 84	Cleaned bottom trawl survey data from 2001 to 2020, quarter 1 and quarter 4, were downloaded from FishGlob_data (see Source). The original data source underlying FishGlob_data are the HH and HL unaggregated data of the Baltic International Trawl Survey (BITS) from DATRAS (https://www.datras.ices.dk). The cleaned dataset produced by FishGlob_data constitutes of the number and weight of each fish species by haul duration and swept area for each trawl haul. Species richness was estimated as the mean number of species per haul by year and ICES rectangle. Species evenness and Shannon index were estimated from species abundances per haul by year and ICES rectangle. Besides the mean also the minimum, maximum, first and third quartile, median and standard deviation were produced. These values are stored in the three files ending with "_rect_year.shp". Mean values of the three biodiversity indices were used to calulate mean species richness, species evenness and Shannon index per year (across all rectangles - see files ending with "_year.csv") and per rectangle (across all years - see files ending with "_rect.shp"). To investigate spatio-temporal patterns, mean index values by year and rectangle were modelled as a linear regression within each rectangle to estimate the rate of change in each index per year, respresented by the slope of the relationship. These are stored in files ending with "_rate.shp".	Western Baltic Sea	Esther D. Beukhof, Stefan Neuenfeldt	Task 2.2
3	**Swept Area Ratio of bottom-contacting fishing gears** Annual values summed across metier (level 5): sar_annual_2012_2022.tif Values by metier (level 5) aggregated across years: sar_metier_2012_2022.tif	tif	DTU Aqua, Jeppe Olsen (jepol@aqua.dtu.dk)	Confidential	Online tool presenting similar data as used for MarinePlan: https://ono.dtuaqua.dk/DFAM/, with the following DOI: https://doi.org/10.11583/DTU.23617944		0.001° x 0.001°	2012-2022, annual	WGS 84	Information on fishing activity was obtained from the Danish Ministry of Food, Agriculture and Fisheries as VMS, AIS and black box data and vessel register information. For non-Danish vessels, only AIS and vessel register information was available. AIS and VMS data were interpolated to provide information on fishing acitivity each second, and merged with the logbook data based on fishing vessel ID and timestamp. Fishing activity (gear deployment) was determined from gear-specific speed profiles. The seafloor footprint was calculated from the fished locations and the gear width, following a hierarchical method that prioritizes the most detailed information available for each fishing event: first BB, then AIS, and finally VMS. This fishing footprint represents the area swept by the gear (m2) in individual grid cells with a size of 0.001° x 0.001°, which is approximately 60 x 100 m at the latitude of the Western Baltic Sea. As a final step, the Swept Area Ratio (SAR) was calculated, which is the total fishing footprint in a year as a ratio of grid cell size. SAR values were calculated for the period 2012-2022 by metier level 5, and aggregated in two ways: 1) summed across metiers per year, and 2) averaged across years per metier.	Western Baltic Sea	Jeppe Olsen, Ole E. Eigaard, Esther D. Beukhof, Stefan Neuenfeldt	Task 2.2