Ocean⁺
Habitats

METHODOLOGY

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CONTENTS

1. INTRODUCTION

The Ocean+ Initiative aims to improve access to—and use of— marine and coastal biodiversity data and information relevant to the conservation and sustainable use of marine ecosystems. Through partnerships with national governments, international organisations and the private sector, Ocean+ manages and convenes biodiversity data and information to support a wide range of activities.

One of our flagship products is **Ocean+ Habitats**, which is a platform providing the world's decision-makers and communities of practice with the best possible global information, knowledge and tools required to manage and conserve ocean ecosystems.

This document provides an overview of the methods used to calculate statistics on Ocean+ Habitats, including some of the challenges of calculating national-level statistics. These have been developed to provide clarity and ensure reproducibility, as well as to welcome feedback on the methodologies used. We also welcome improvements in data quality, where better data are known to exist and are accessible.

The designations employed and the presentation of material on Ocean+ Habitats do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

2. DATASETS

GADM-EEZ

Country-level analyses were based on a dataset joining the Exclusive Economic Zones (200NM) (EEZ)[1] and the Database of Global Administrative Areas (GADM)[2] layers. Any gaps between the two layers were removed and considered land, ensuring accurate country attribution.

Before carrying out the analyses, the layer was dissolved by ISO3 so that land and marine areas were considered the same polygon for each country.

THE WORLD DATABASE ON PROTECTED AREAS AND OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES

The World Database on Protected Areas (WDPA)[3] and World Database on Other Effective Area-based Conservation Measures (WD-OECM) were combined and processed according to the latest manual. Sites with the status "Not reported", "Proposed" or UNESCO Man and Biosphere-Reserve sites were removed. Points were buffered by their respective reported area, while points without a reported area were removed. The processed version of the WDPA—a combination of polygons and buffered points (now effectively polygons)—was then flattened to remove duplication of overlapping areas. This was carried out by dissolving the dataset.

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[1] Flanders Marine Institute (2019). Maritime Boundaries Geodatabase, version 11. Available online at http://www.marineregions.org/. DOI: https://doi.org/10.14284/382.
[2] GADM Database of Global Administrative Areas (2019), version 3.6. Accessed through GADM portal, Available online at https://gadm.org/.
[3] UNEP-WCMC and IUCN (2021). Protected Planet: The World Database on Protected Areas (WDPA) [On-line], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

IUCN RED LIST OF THREATENED SPECIES

The International Union for Conservation of Nature's Red List of Threatened Species[4] has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.

"The IUCN Red List is a critical indicator of the health of the world's biodiversity. Far more than a list of species and their status, it is a powerful tool to inform and catalyse action for biodiversity conservation and policy change, critical to protecting the natural resources we need to survive. It provides information about range, population size, habitat and ecology, use and/or trade, threats, and conservation actions that will help inform necessary conservation decisions".

Within Ocean+ Habitats, we use the IUCN Red List to understand national distributions of species and to understand their IUCN Red List category. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. It divides species into nine categories: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct.

OCEAN HABITAT DATASETS

All habitat layers used for calculations on Ocean+ Habitats are available via the Ocean Data Viewer. These layers include:

- Global Mangrove Watch (2016 layer for reporting current statistics; 1996-2016 for reporting change in extent) (https://data.unep-wcmc.org/datasets/45);
- Global Distribution of Coral Reefs (https://data.unep-wcmc.org/datasets/1);
- Global Distribution of Cold-water Corals (https://data.unep-wcmc.org/datasets/3);
- Global Distribution of Seagrasses (http://data.unep-wcmc.org/datasets/7);
- Global Distribution of Saltmarshes (http://data.unep-wcmc.org/datasets/43)

3. COMPONENT WORKFLOWS

The following sections outline the methods used for each of the sections on the Ocean+ Habitats website.

HABITAT LOCATION

Where are habitats known to occur?

Justification.   As spatial data often do not specifically confirm the absence of a species but rather the absence of knowledge, we recognised the need to conduct a transparent review of known presence, absence or uncertainty regarding the location of marine and coastal habitats around the world.

Method.   Habitat absence or presence per country or territory was assessed primarily using peer-reviewed literature. This information was supplemented by sourcing species locations from the IUCN Red List. When a habitat was known not to occur in a country or territory, the information source was also noted.
This information was reported according to three conditions: 'Known Presence', 'Known Absence' and 'Unknown'. The sources and citations can be viewed by selecting the '*i*' button next to each entry and are available in the statistics file that can be downloaded on each webpage.

Next steps.   This information will now be used to prioritise data improvements in locations where habitats are known to exist, but for which spatial data are not yet available or included within the global datasets.

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4 IUCN 2021. The IUCN Red List of Threatened Species. Version 2021-1. https://www.iucnredlist.org.

What is the current known spatial extent of habitats?

Justification. This section visualises the known distribution of habitats based on available spatial data. This information is important for reporting on national targets and indicators.

Method. The methodologies for each of the spatial datasets used for this section (noted in the reference pop-up, '*i*') can be found in the corresponding peer-reviewed literature and/or the accompanying metadata. In most cases, these have been curated from local or national *in situ* or remotely sensed datasets that have been standardised into global datasets. The individual sources for data by country or territory are recorded at the bottom of each page. In some cases, spatial data exist but are not yet available under an open data licence or online.

Next steps. We welcome improvements in national spatial data where missing or better data are known to exist. If you have or are aware of information missing here, please contact us at oceanplus@unep-wcmc.org.

How much of each habitat is found in each country or territory?

Justification. We are often asked how much habitat occurs in in a country or territory. This is a surprisingly challenging question due to limited spatially defined or agreed boundaries, as well as limited spatial information on the location of many of these habitats. Here, we attempted to answer this question based on available data, with the caveat that these data are regularly improved. We welcome feedback and suggested data improvements if better data are identified.

Method.
1. For habitat datasets comprising points and polygons, point data were handled differently when calculating area. Where "Reported Area" was recorded, the radius was calculated using the formula $r = sqrt((reported\ area\ (km2)\ /\ 3.14))$. In instances where the area was not reported, an area of 1km² was used to reflect occurrence without assuming extent. All points were then buffered by their calculated or assigned radius. This converted the point layers into polygons, which were then merged with the respective polygon layer. This merged layer was then dissolved to produce a 'flat' layer that represents the extent of the habitat.
2. The habitat layer was then diced in to 20,000 vertices chunks.
   - *Note: This occurred to ensure that processing was manageable when performing intersects and calculating geometries.*
3. The diced habitat layer was intersected with the GADM-EEZ layer, maintaining the country or territory ISO3.
4. The geodesic area in km^2 was calculated for each intersected layer using Mollweide projection.
5. The intersected layers were then dissolved by country or territory ISO3, summing the geodesic area to give a total area of habitat per country or territory.
   - *Note: Area of habitat that falls in disputed territories was calculated as per above but is reported as a combined value for all disputed territories globally.*

Next steps. We will continue to update these estimates as new data become available and as boundaries are updated.

What proportion of the country or territory's coastline is covered by these habitats?

Justification. We developed a method to visualise the degree to which one or multiple habitats were found along national coastlines, shown as proportions of coastline covered. This approach provides a better spatial understanding of the presence or absence of these habitats and their proximity to coastal communities. The method also provides a more explicit sense of the relative presence of each habitat or may reveal locations where multiple habitats occur close to one another (e.g. coral reefs, seagrasses and mangroves).

Method.	1.	Coastal countries were identified and their coastal border extracted by converting the GADM EEZ layer to a polyline layer, identifying and storing the neighbouring polygon information.

1. Coastal countries were identified and their coastal border extracted by converting the GADM EEZ layer to a polyline layer, identifying and storing the neighbouring polygon information.
2. Polylines with no bordering country were deemed to be coastal. This was identified by selecting all polylines with a "LEFT_FID" of -1 and exporting to a new layer. Country level information was then reapplied to this layer by joining the ISO3 field from the initial GADM EEZ layer. The join was made using the original "Object_ID" to the "RIGHT_FID" of the polyline layer.
3. The geodesic length of a country's coastline was calculated by adding geometry attributes and summing the length of all the sub-segments that made up the coastline of a selected country.
4. Each of the polygon and point layers were then buffered using the geodesic method (shape preserving) by 30km.
5. Where a point and polygon layer existed for a habitat, these layers were merged into one habitat layer before being dissolved to remove any overlap in the layer.
6. Each layer then had a field added describing the reference layer.
7. All buffered and flattened habitat layers were joined into one layer using the 'Union' tool.
8. This combined layer was then intersected with the coastline layer calculated in the first 3 steps. This assigns the buffered habitat data to the sections of the coastline there is overlap with.
9. For each country, the sections of its coastline covered by an individual habitat were summed and sections where multiple habitats intersect were also summed and reported.
10. All coastline coverage statistics were reported as percentages of the total coastline for each country.

Next steps. We will continue to update these estimates as new data and information become available and as boundaries are updated.

HABITAT PROTECTION

What proportion of habitat is protected within each country or territory?

Justification. We are also often asked how much habitat is protected globally, or by country or territory. This is an important question as it relates to the ecological representativeness of protected and conserved areas. It is important to note that the method below only addresses the habitat area that occurs within a protected or conserved area. However, the level of protection may vary according to protected area management effectiveness and whether the habitat is explicitly considered within the management plan. This also does yet not account for the habitat's condition in that area due to limited data availability.

Method.
1. The diced habitat layer was intersected with the GADM-EEZ layer (as described above), and then intersected with a flattened, processed version of the WDPA, maintaining the ISO3.
   - *Note: using an intersect here only keeps areas of habitat which fall within a protected area.*
2. The geodesic area in km^2 was calculated for each intersected layer using Mollweide projection.
3. The intersected layers were then dissolved by country or territory ISO3, summing the geodesic area to give a total area of habitat protected per country or territory.
   - *Note: Area of habitat that falls in disputed territories was calculated as per above but is reported as a combined value for all disputed territories globally.*
4. Percentage of habitat protected per country or territory is calculated using:
   *% Protected = (Protected area (km^2) / Total area (km^2)) * 100*

Next steps.   We will continue to update these estimates as new data become available and as boundaries are updated. We will also aim to improve information related to the level of protection and habitat condition.

SPECIES STATUS BY HABITAT

How many species occur within a country or territory, and what are their statuses?

Justification.   Each habitat comprises a number of species globally. For instance, there are more than 70 species of seagrasses known to occur globally, while coral reefs are known to have more than 600 species in one country alone. While habitat condition information is often challenging to access at national and global scales, the IUCN Red List of Threatened Species can be used to provide a global overview of the conservation status of individual habitat-building species. This section reflects the diversity of known species found for each habitat by country or territory, as well as their status, where known. Please note that this section refers exclusively to habitat-building species (e.g. the seagrass *Posidonia oceanica*), as opposed to associated species (e.g. the picarel *Spicara smaris*).
Note: Different approaches were necessary depending on the scale at which the status was reported.

Method.   The species comprising each habitat were identified using an extensive literature review process. Species naming conventions were matched to the IUCN Red List of Threatened Species (using the IUCN Red List API) and taxonomic backbones (I.e. World Register of Marine Species).

In countries or territories
The following steps were then taken to align species with each country or territory:
1. Coastal countries were identified using the GADM-EEZ layer.
2. Using the R package 'rredlist', we queried per country the species that were assessed as part of the latest IUCN Red List assessment, currently version 2021-1.
3. The species present (filter presence field by the value 1, extant species)[5] in a country were then filtered to only include mangroves, seagrasses, saltmarshes, cold-water corals and warm-water corals.
4. These species were subsequently grouped by country and habitat, with the number of species falling in each IUCN Red List status counted and reported on.
5. Finally, species identified as present in a country through the literature review (see 'Habitat absence and presence') but not appearing in the IUCN Red List were classified as "Not Evaluated" (NE).

Globally
The number of species within each IUCN Red List status at a global level was calculated by: (1) aggregating the national level data, (2) filtering for a single observation for each species globally and (3) for each habitat, summarising the number of species in each IUCN Red List status.

Next steps.   We will continue to update these numbers as new data and information become available and as boundaries are updated.

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[5] IUCN Red List Technical Working Group. 2019. Mapping Standards and Data Quality for IUCN Red List Spatial Data. Version 1.18. Prepared by the Standards and Petitions Working Group of the IUCN SSC Red List Committee. Downloadable from: https://www.iucnredlist.org/resources/mappingstandards . Table 4 pg 14

What are some examples of species for each habitat in the country or territory?

Justification. We wanted to provide examples of species found in each country or territory, and have highlighted these using the following method. In some cases, we were able to including drawings of these habitats developed for the *World Atlas of Mangroves* (Spalding et al., 2010) and the *World Atlas of Seagrasses* (Green and Short, 2003).

Method. The species lists by country of the IUCN Red List was used, and three random Least Concern species are shown as "Examples of common species" each time the page is loaded. For "Examples of threatened species", the most threatened species as according to their IUCN Red List status are shown in the order "Critically Endangered", "Endangered" or "Vulnerable". If there are more than 3 species of the same Red List status, they are also shown in a randomized order each time the page is loaded.

Next steps. We will continue to update this section as new data and information become available and hope to provide further illustrations of species. We also hope to provide further information on associated species known to depend on these habitats.

CHANGE IN HABITAT COVER

Justification. Another aspect that is important for decision-makers is understanding how important habitats are changing over time, both in extent and condition. This is challenging for many reasons, which include defining an appropriate reference baseline (which varies by source) and availability of globally comprehensive spatial time series data.

Where possible, change in habitat coverage is reported here at national levels using temporal extent data. Unfortunately, temporal data do not yet exist in most cases, making it challenging to calculate change over time spatially. Advances in remote sensing and satellite imagery may soon provide more comprehensive snapshots of habitat change over time. In the meantime, the method below was used to calculate change in habitat cover for mangroves and may also be used for other habitat datasets in the future.

Method.
1. For each year in the temporal habitat dataset, coverage was calculated following the procedure outlined in the 'Geographic coverage and habitat protection' section.
2. From the calculated coverage, change over time was calculated as the difference between two selected time periods. For mangroves, we calculated change as the difference between the reference baseline year (2010) and the latest year provided—currently 2016.
3. For global change of habitat extent over time, we used estimates from the following sources noting reference baseline years:

   - IPBES (2019) Summary for policymakers of the global assessment report of biodiversity and ecosystem services.
   - Crooks S et al. (2011). Mitigating climate change through restoration and management of coastal wetlands and near-shore marine ecosystems: challenges and opportunities. Environment department papers 121. Marine Ecosystem Series. Washington, DC: World Bank.
   - Duarte CM et al (2008). The Charisma of Coastal Ecosystems: Addressing the Imbalance. Estuaries and Coasts 31(2): 233-238. doi: http://dx.doi.org/10.1007/s12237-008-9038-7.

Next steps. We will continue to update these estimates as new data and information become available and as boundaries are updated.