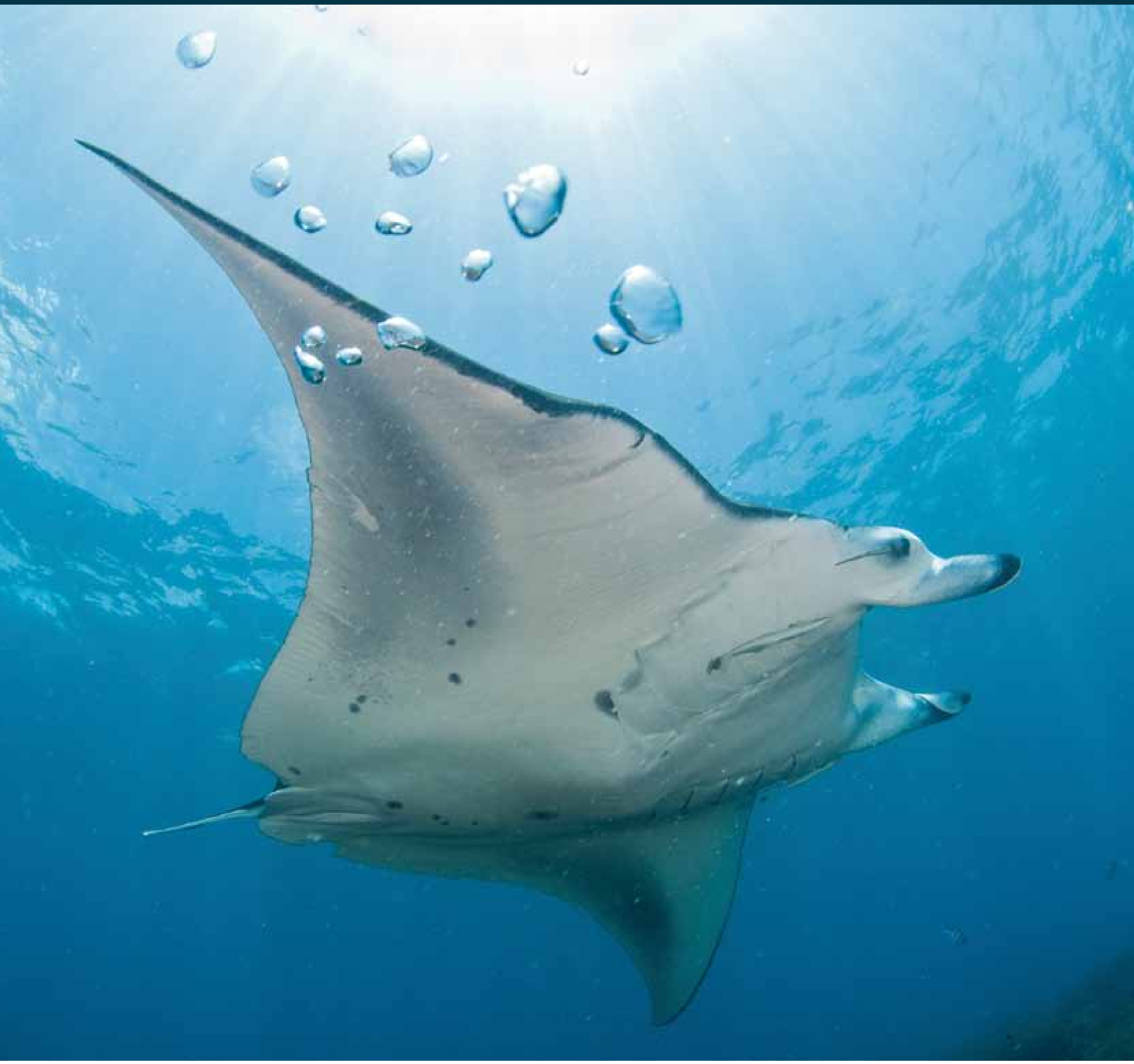
# GOBI Global Ocean Biodiversity Initiative

Working toward high seas conservation

www.GOBI.org



The Global Ocean Biodiversity Initiative (GOBI) is an international partnership advancing the scientific basis for conserving biological diversity in the deep seas and open oceans.

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The deep and open oceans are the least known and least protected areas on Earth

# Global Ocean Biodiversity Initiative

## Working towards high seas conservation

The Global Ocean Biodiversity Initiative is an international partnership advancing the scientific basis for conserving biological diversity in the deep seas and open oceans. It aims to help countries, as well as regional and global organizations, to use and develop data, tools and methodologies to identify ecologically significant areas with an initial focus on the high seas and deep seabed beyond national jurisdiction.

This initiative began in late 2008 as a collaboration amongst the German Federal Agency for Nature Conservation (BfN), IUCN, UNEP World Conservation Monitoring Centre, Marine Conservation Institute, Census of Marine Life, Ocean Biogeographic Information System and the Marine Geospatial Ecology Lab of Duke University. The initiative continues to seek additional collaborators to help bring the best science and data to bear on the identification of ecologically significant areas beyond national jurisdiction. GOBI is facilitated by IUCN with core support from BfN.

The work under this initiative ultimately aims to help countries meet the goals adopted under the Convention on Biological Diversity (CBD), the United Nations General Assembly resolutions, and at the three Earth Summits (Rio 1992; Johannesburg 2002; Rio 2012). These global goals relate to reducing the rate of biodiversity loss, applying ecosystem approaches, determining areas of ecological and biological significance and vulnerable marine ecosystems as well as establishing representative marine protected area networks.

### Objectives

- Establish and support International scientific collaboration to assist States and relevant regional and global organizations to identify ecologically significant areas using the best available scientific data, tools, and methods.
- Provide guidance on how the CBD's scientific criteria and UN resolutions can be interpreted and applied towards management, including representative networks of marine protected areas.
- Assist in regional capacity building and developing regional analyses with relevant organizations and stakeholders.

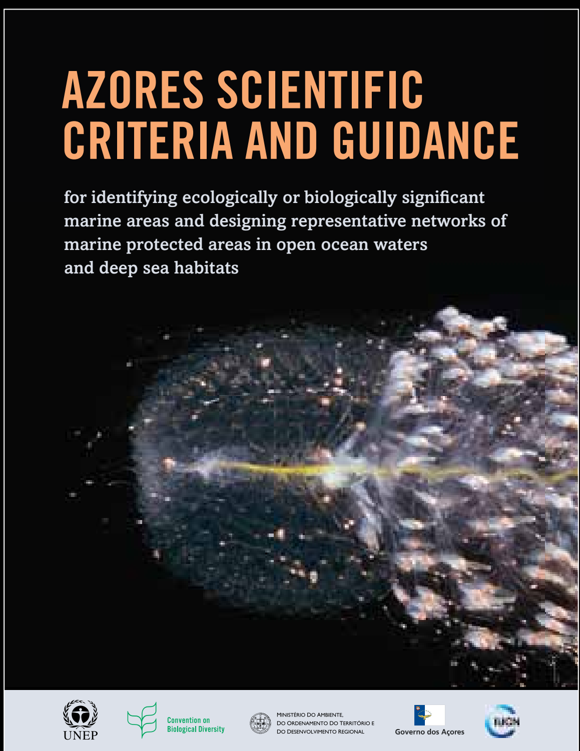


# Why are deep seas and open oceans important?

The deep and open oceans are home to a major part of the world's biodiversity. They support an enormous wealth of productive ecosystems, specialized habitats and individual species, which collectively provide humankind with services, such as the production of oxygen, food, freshwater and the regulation of the Earth's climate.

Mounting pressures from intensifying human uses, climate change and ocean acidification threaten to undermine these ecosystems' balance and resilience. Thus we may lose much of their biodiversity even before it has been discovered or properly explored. Open oceans and deep seas often fall outside of national jurisdictions, beyond the responsibility of any nation, making conservation and management efforts dependent on international cooperation and coordination.

# Identifying ecologically and biologically significant areas in the deep and open oceans




In 2008 in Bonn, Germany, the Parties to the Convention on Biological Diversity adopted a set of seven scientific criteria to identify ecologically and biologically significant areas (EBSAs) in the global marine realm. The criteria were compiled at a CBD expert workshop in the Azores.

Area-based management approaches and tools can address a multitude of threats. These tools include marine protected areas and networks, prior environmental impact assessments, improved regulation of sectoral activities, and broader ecosystem-based marine spatial planning. Using the CBD EBSA criteria to identify ecologically important ocean areas can thus help to inform a variety of conservation and management processes.

# CBD EBSA Criteria

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

# Applying the criteria: GOBI's role

With global agreement on criteria to identify ecologically significant areas, much scientific work remains to be done. There are an increasing number of scientific techniques, and many different types of data, including physical, oceanographic and biological, that may assist in this process. In data-deficient regions, predictive modeling of the occurrence, abundance, movement and range of species or ecosystem features will play an important role.

Overviews of the scientific tools, technologies and data are being used to assist applying the CBD scientific criteria for benthic and pelagic systems. This includes current and emerging techniques and methodologies. The work also highlights key issues concerning the strengths, challenges and limitations of data availability and scientific understanding that ocean management faces at this time, and some strategies to address these challenges.

Practical illustrations relating to species, habitats and oceanographic features for each of the seven CBD scientific criteria, as well as examples of various scientific methods and techniques relevant to each criterion are given on the GOBI website. Some of these illustrations are summarized on the following pages.

# GOBI's practical illustrations of how CBD criteria can be applied

While much scientific discovery lies ahead, available information, current and emerging methodologies and expert knowledge has been sufficient for the CBD regional workshops to begin identifying oceanic features that are likely of particular ecological or biological importance.

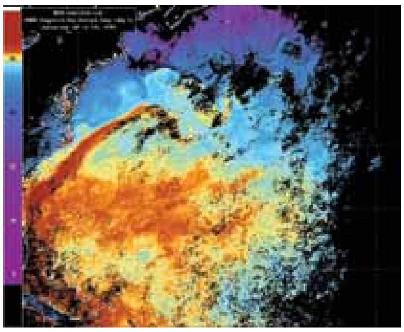
Some GOBI examples of ways that the CBD EBSA criteria can be applied are provided on the following pages. These examples, undertaken by over 30 researchers, are not meant to prejudice discussions on actual EBSAs described by the CBD regional workshops, which sometimes overlap these examples and are still under CBD review.

# Criterion 1: Uniqueness or rarity

*Areas contain 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.*

There are many unique or rare species and habitats in areas of the deep and open oceans. Some of the larger areas, like the two examples below, are already well known, and can be readily identified through a review of scientific literature and expert opinion, and verified through field measurements or remote sensing data.

## The Sargasso Sea



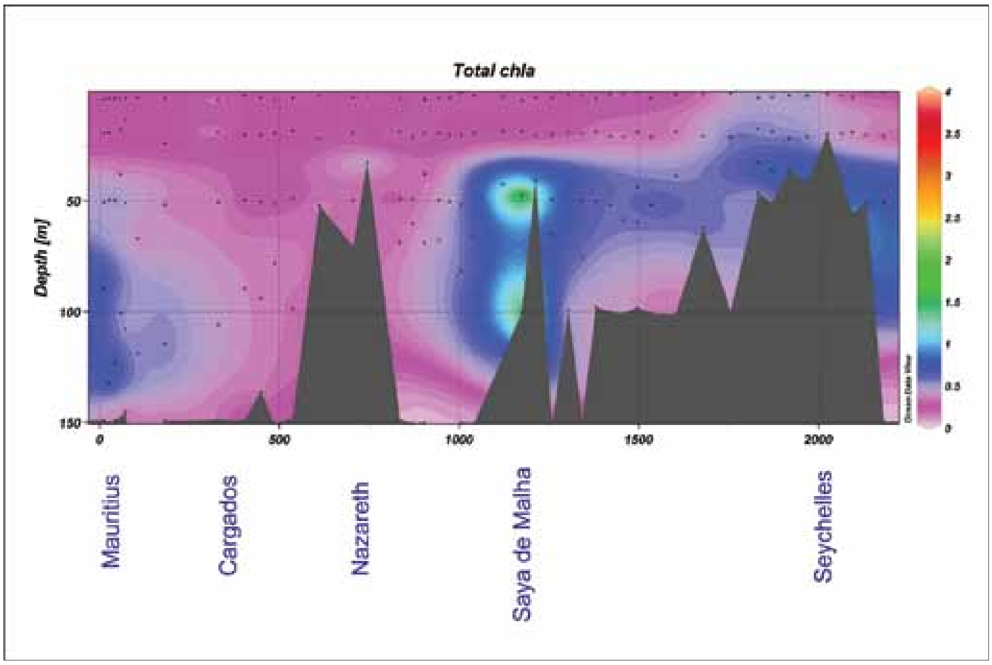
Satellite image of sea surface temperature (SST) within the North West Atlantic. Bright red depicts the warmer water of the Gulf Stream defining the western boundary of the Sargasso Sea.
*Source: BBSR Satellite Laboratory*

Alone in supporting a self-sustaining community of floating drift algae (*Sargassum* spp.), the Sargasso Sea offers a habitat to numerous species including endemic fauna, such as the Sargassum pipefish and crab, as well as commercially important fishes, such as tuna and billfish. The Sargassum weed is also crucial to the survival of hatchling and post-hatchling sea turtles, which spend the first year or more of their lives drifting with the floating mats of Sargassum, where they receive food and protection from predation. Additionally, the Sargasso Sea is an important migratory route for many species, including tuna, sea turtles and humpback whales, and is the spawning site of the critically endangered European eel and endangered American eel.

A considerable wealth of information about the Sargasso Sea exists, dating back to the times of Columbus and documented in scientific publications since at least 1854. Its biological, ecological and oceanographic characteristics were examined and compared to the four other similar regions of the ocean found within subtropical gyres based on peer-reviewed literature, technical reports and available data sets. Building on GOBI's initial work, a comprehensive scientific report has recently been published by the Sargasso Sea Alliance (http://www.sargassoalliance.org/case-for-protection).

# The Saya de Malha Banks

The Saya de Malha Banks contain a unique seagrass community in the open ocean—likely the largest fully submerged seagrass meadow in the world.. Due to their remoteness, the Saya de Malha Banks are host to some of the least explored shallow tropical marine ecosystems globally. The Banks are an ecologically important oasis of high productivity in the Indian Ocean, provide habitat for green turtles and whales, and may serve as an important stepping stone in the migration of shallow water species across the Indian Ocean. Moreover, the Banks' relative isolation may make them more resilient to climate change due to the absence of other direct anthropogenic impacts, such as land-based pollution. Thus, they offer a crucial reference area and a reservoir for the maintenance of biodiversity in the surrounding islands and coastal areas which face the cumulative effects of climate change and other human impacts.




A 2008 research cruise undertaken by the Agulhas and Somali Current Large Marine Ecosystems Project revealed relatively higher chlorophyll-a concentrations around Saya de Malha Banks. Chlorophyll-a is indicative of higher plant biomass in the area.
*Source: ASCLME 2008*

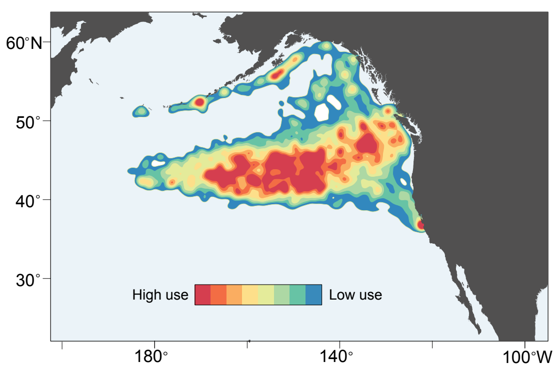
# Criterion 2: Special importance for life-history stages of species



*Areas that are required for a population to survive and thrive.*

Identifying specific areas that support critical life-history stages of individual species requires an understanding of movements or migratory patterns of individual species, which are often related to feeding, breeding or caring for young. As is indicated in the illustrations described below, this assessment generally requires survey data, tracking data and models to describe the relative amount of time that an animal or group of animals spends in a given place.

## Northern elephant seals




High use open ocean areas during the long migration of female northern elephant seals July-November, 2002-2008.
*Source: Autumn-Lynn Harrison/TOPP*

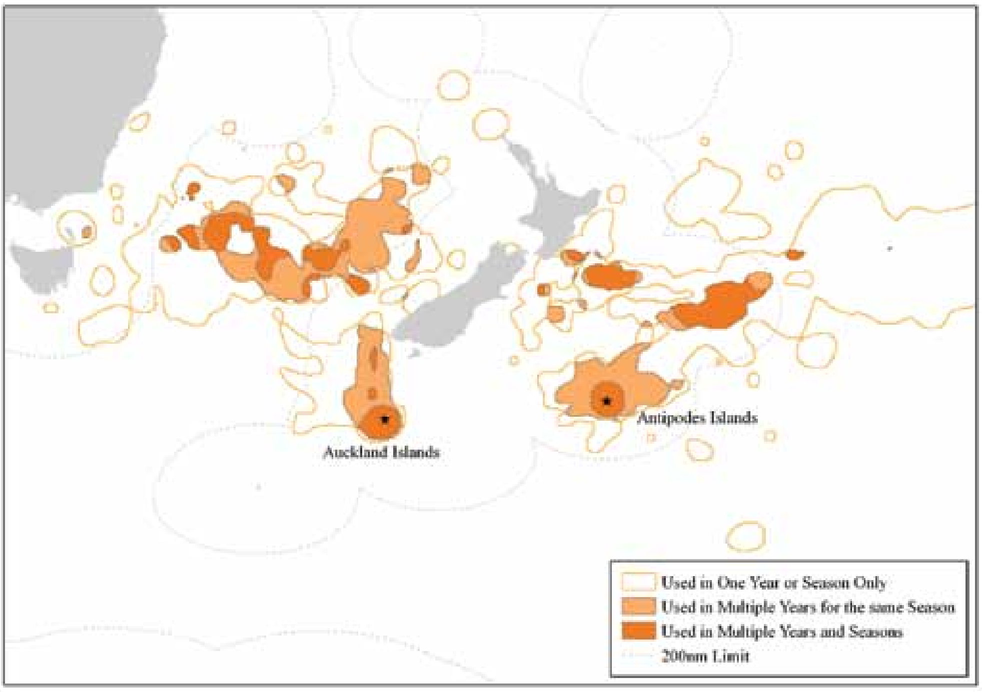
Female northern elephant seals (*Mirounga angustirostris*, male pictured above) haul out on North American west coast beaches twice yearly: once to breed, give birth and nourish young, and once to molt. Following each terrestrial visit, the seals return to the sea to feed. They thus undertake a double foraging migration each year-a “short migration” following breeding and a 6 to 8 month “long migration” following molt. Recent discoveries show that during the long migration, female northern elephant seals travel half way across the Pacific, feeding almost entirely in habitats beyond national jurisdictions. These migrations are extremely important to the survival of elephant seals as they need to build a reserve for subsequent months spent fasting on land while giving birth, nourishing their pup, and breeding.

Data collected from satellite tags deployed as part of the Tagging of Pacific Predators project (www.topp.org), along with modeled habitat utilization distributions, were used to identify an area of high female northern elephant seal density during their annual long migration.

## Antipodean Albatross in the Tasman Sea

The Antipodean Albatross (*Diomedea antipodensis*) is one of the largest seabirds on Earth. It is an endemic breeder to New Zealand offshore islands. These albatrosses travel long distances over the open ocean to forage. Their range includes areas from the Tasman Sea and the South Pacific to as far away as Chile. Declines in adult survival, productivity and recruitment are thought to be due to their mortality as bycatch in longline tuna fisheries, resulting in the Antipodean Albatross currently being listed as Vulnerable on the IUCN Red List of Threatened Species.

Satellite tracking data collected over multiple years and during the different life-history stages of the albatross were analyzed to identify areas that are used most regularly during different seasons and each life-history stage. This methodology allows for the identification of core areas of activity that would require a higher degree of protection to ensure the survival of the Antipodean Albatross. This standardized methodology has been applied in consistent and comparable ways to several bird species and submitted to the CBD regional EBSA workshops..




Areas of regular use during different life-history stages of the Antipodean albatross identified by satellite tracking data.
*Source: BirdLife International*

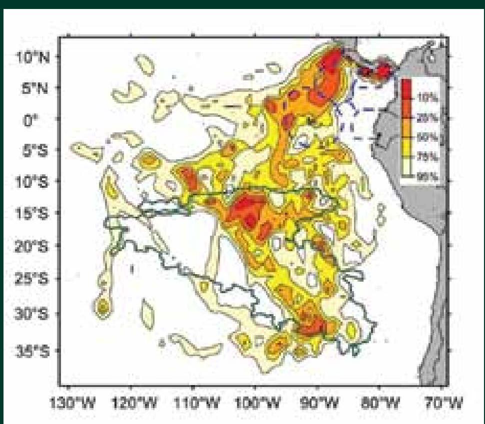
# Criterion 3: Importance for threatened, endangered or declining species and/or habitats

*Area containing significant assemblages or is critical for the survival and recovery of endangered, threatened, declining species and/or habitats.*

This criterion targets threatened, endangered or declining species and their habitats. As with the previous criterion, persistence of use of an area by a threatened or endangered species, as well as the number of individuals from a threatened population using the area, is often determined using survey data, tracking data and models. This criterion also targets threatened, endangered or declining habitats per se.

## Critically endangered Pacific leatherback sea turtles

Like many marine turtle species, slow growth and low reproductive potential of leatherback turtles (*Dermochelys coriacea*) make them particularly sensitive to excessive mortality at adult life stages. Leatherbacks in the Eastern Pacific Ocean have been impacted by poaching, egg collecting on nesting beaches, and losses as bycatch in fisheries, resulting in severe population declines. After leaving nesting beaches, turtles travel south, with most following the same migration corridor across the Equator and into the South Pacific.  New tracking technologies have allowed researchers to examine the movements of critically endangered Pacific leatherback turtles. Years of tracking data have revealed consistent migration routes and a foraging area for leatherback turtles in the South Pacific Gyre.



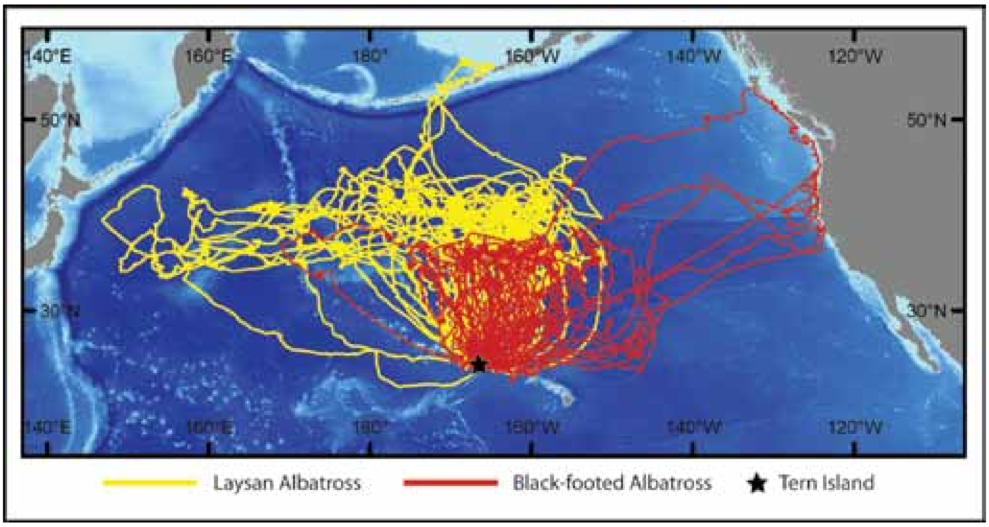

Density utilization distribution of tracked leatherback turtles with red areas being the regions with the highest utilization.  The green outline highlights the region identified as having particularly low primary productivity and eddy kinetic energy.
*Source: Reproduced from Shillinger et al. 2008*

# Black-footed and Laysan Albatross in the North Pacific Transition Zone

Laysan albatross (*Phoebastria immutabilis*, Endangered, IUCN Red List 2009) and Black-footed albatross (*Phoebastria nigripes*, Vulnerable, IUCN Red List 2009), nest on islands of the Pacific, including Tern Island, Northwest Hawaiian Islands, but spend much of their life on the wing feeding at sea. Adult albatrosses are vulnerable as fisheries bycatch; chicks are vulnerable to starvation due to the ingestion of plastics consumed by their parents at sea and which they feed to their chicks upon return to the nesting colony.

Using electronic tracking data from the Tagging of Pacific Predators project (www.topp.org), we identify in the North Pacific Transition Zone two bands of special importance to these globally threatened species.

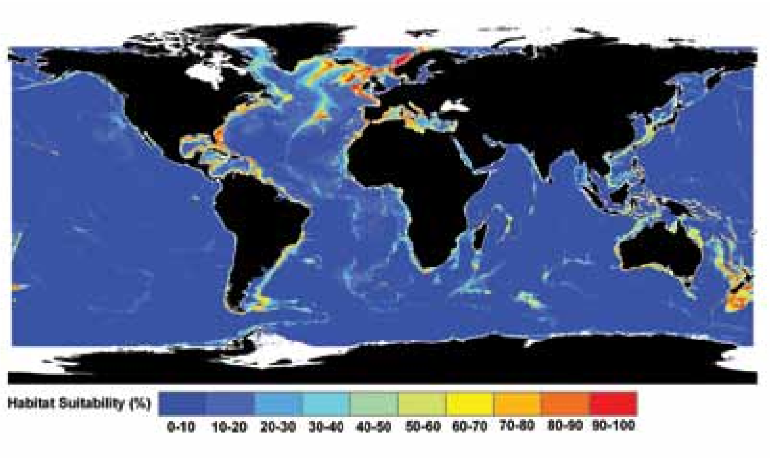



Satellite tracking data reveal high use areas for Laysan and Black-footed albatrosses in the North Pacific Transition Zone
*Source: Michelle Kappes/TOPP*

## Criterion 4: Vulnerability, fragility, sensitivity, or slow recovery

*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.*

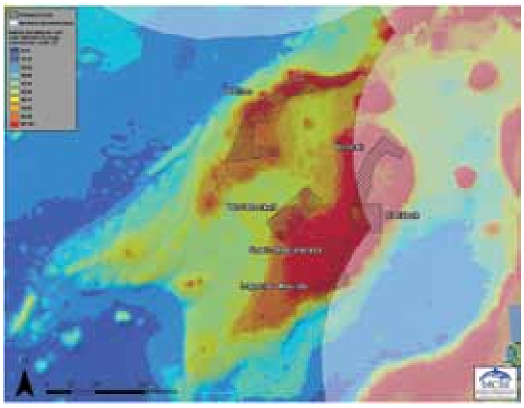
Species with low reproduction rates or habitats with slow potential recovery from perturbation have an inherently higher level of risk to impacts than other species or habitats. Many of these habitats are essential for maintaining fundamental ecosystem functions. In some cases, as demonstrated in the illustration below, the location of these species and/or features is not known, and predictive models are important in locating potential areas of interest.



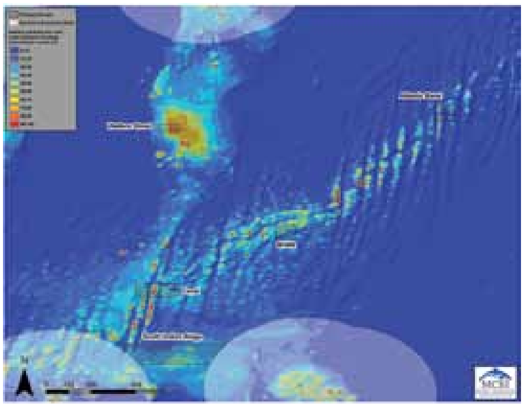

## Global habitat suitability for reef-forming cold water corals

Reef-forming cold water corals are very sensitive to anthropogenic activities, particularly bottom fishing, due to their fragile bush-like structures and slow growth rates, which are only a tenth of the growth rate of warm-water tropical corals. Thus they recover very slowly from physical damage. They are also expected to be heavily affected by ocean acidification. The full extent of cold water coral distribution globally is not known, making their protection more challenging.

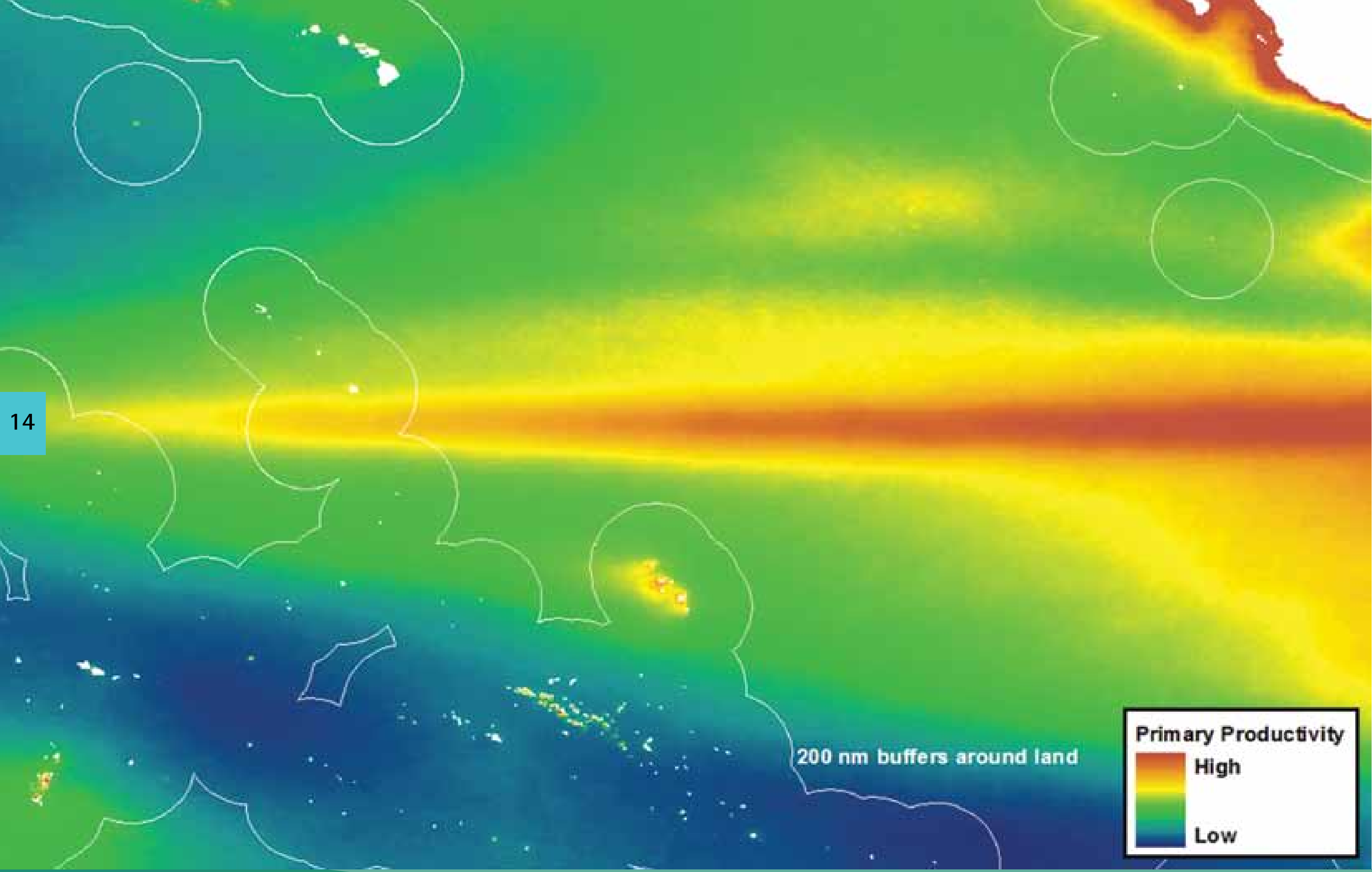
The areas where reef-forming cold-water stony corals are likely to occur can be predicted through the investigation of environmental conditions surrounding known coral locations. The existing locations of the six reef-forming cold water coral species, amassed from research and cruise data bases were used to predict areas of suitable coral habitat throughout the world based on 26 environmental conditions. The fine spatial resolution of these predictions provides a suitable scale for application of conservation measures.



Predicted coral habitat and locations of bottom trawl closures in the NE Atlantic Ocean.
*Source: Marine Conservation Institute*



Predicted coral habitat and locations of selected bottom trawl closures in the Southern Indian Ocean.
*Source: Marine Conservation Institute*




# Criterion 5:
# Biological productivity

*Area containing species, populations or communities with comparatively higher natural biological productivity.*

Highly productive regions are assumed to provide core ecosystem services and are also generally assumed to support relatively high abundances of species. These highly productive regions can often be detected through satellite remote sensing data. Using some species, e.g. oceanic top predators, as indicators of biological productivity could also be applicable. Sites where species at the top of the trophic chain occur in large numbers are often located in areas where productivity is high.

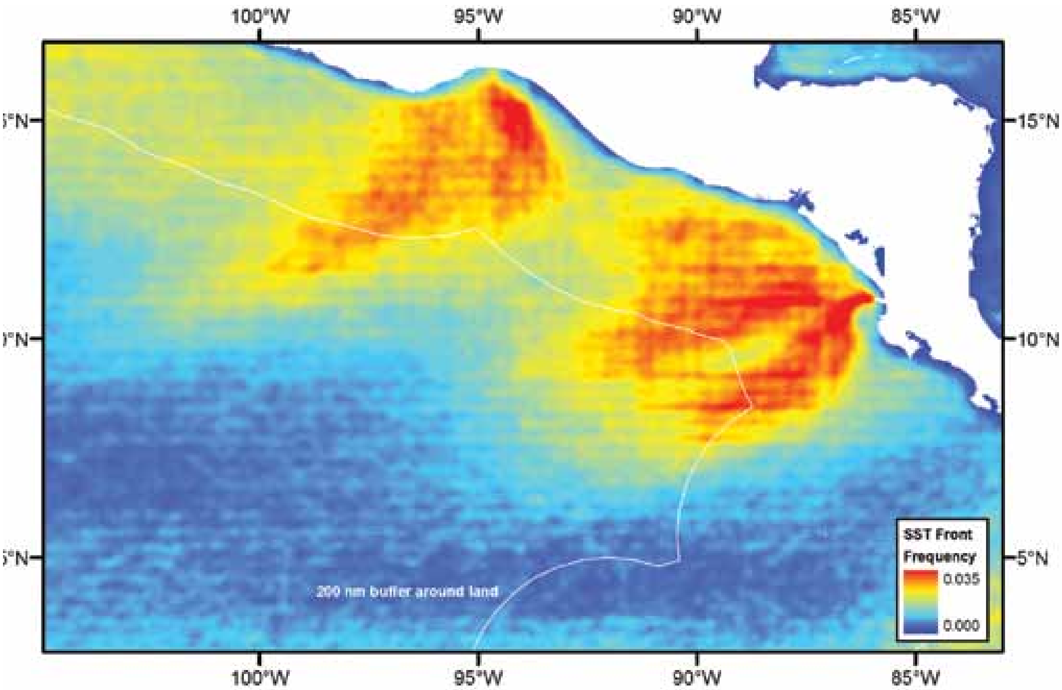
## Pacific equatorial upwelling

At the beginning of most marine food chains are single-celled, microscopic plants called phytoplankton. Through the process of photosynthesis, phytoplankton use chlorophyll and the sun's energy to convert carbon dioxide and water to organic compounds for growth and reproduction. The generation of new plant material by photosynthesis is called primary production. Oceanographers use estimates of primary production as the most basic measure of the ocean's biological productivity. Primary production does not occur uniformly throughout the ocean. For example, the Central Pacific Ocean receives a large amount of light throughout the year but is far from land-based sources of nutrients. Nonetheless, it sustains a high level of primary productivity due to an oceanographic phenomenon called the equatorial divergence, which allows deep nutrient-rich water to flow to the surface.

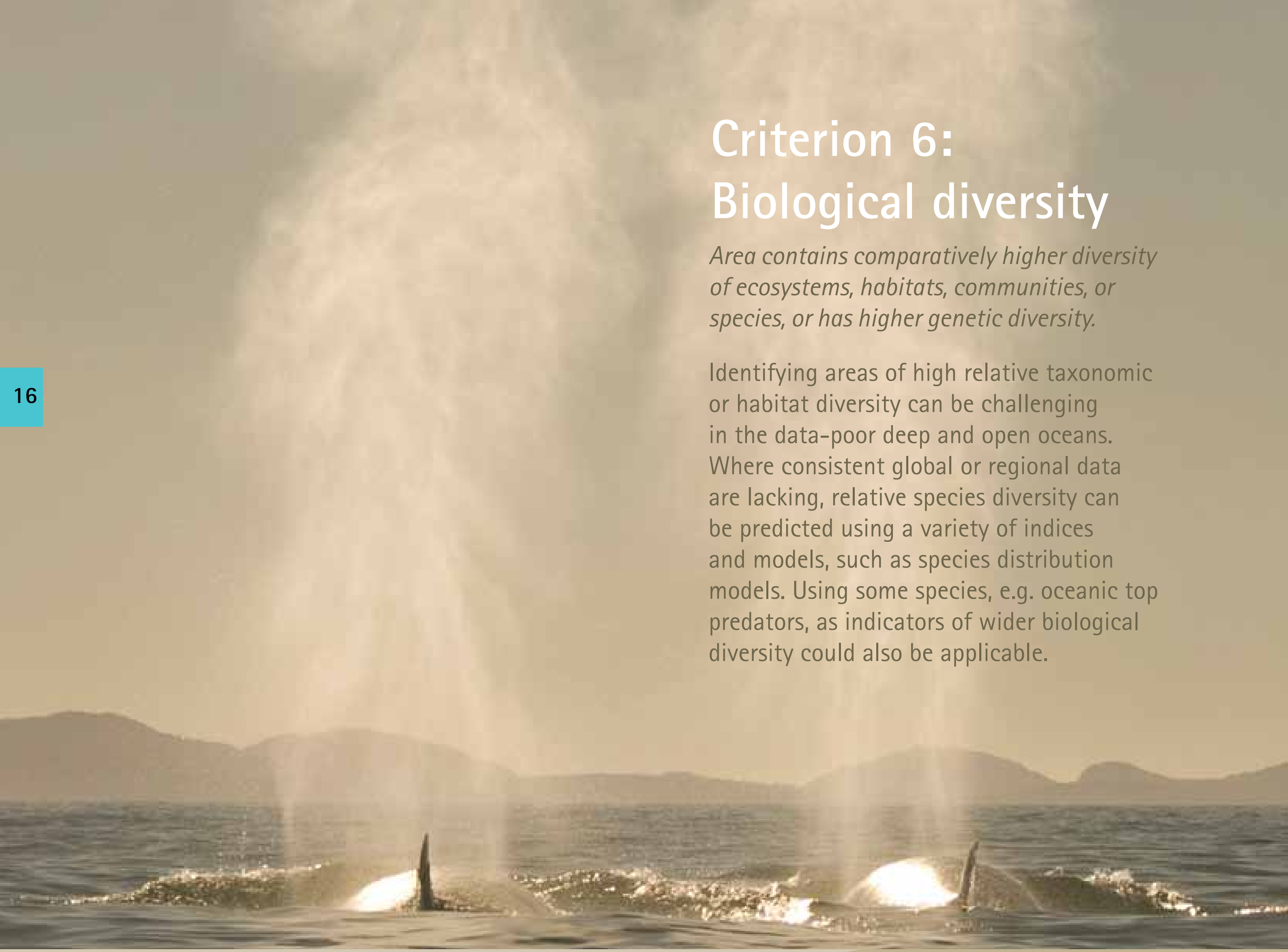
Oceanographers estimate primary production worldwide from satellite observations. Using these data, an area of high productivity on a map of mean annual primary production was visually identified around the Pacific Equatorial Upwelling, and traced using a Geographic Information System.

## Sea surface temperature fronts

Dynamic physical ocean processes including upwellings, currents, and eddies promote biological productivity and structure marine ecosystems by aggregating and dispersing nutrients and organisms. Phytoplankton (see Pacific Equatorial Upwelling illustration) can be detected at the ocean surface by satellites that measure specific wavelengths of reflected sunlight. As distinct water masses flow past each other, they aggregate drifting organisms like phytoplankton along their boundaries, known as fronts. These frontal aggregations of drifters attract mobile predators such as fish, turtles, birds, and marine mammals. The presence of fauna was inferred by identifying fronts visible in images of sea surface temperature (SST). Specifically, an algorithm was applied to SST data to estimate the frequency of sea surface temperature fronts in the eastern tropical Pacific Ocean near Central America. Two zones of high frontal frequency, one south of the Gulf of Tehuantepec and one east of the Gulf of Papagayo, were identified.




Mean frequency of sea surface temperature (SST) fronts off the Pacific coast of Central America, with fronts extending beyond national jurisdiction.



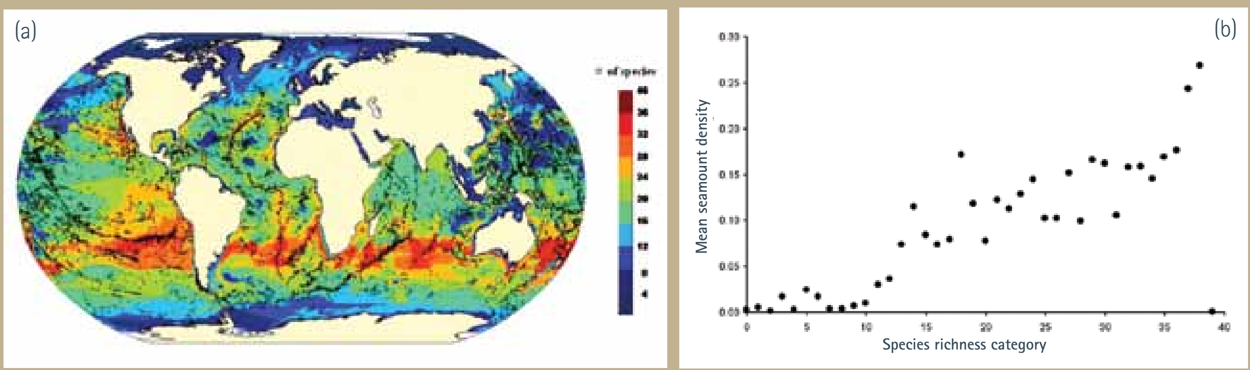
# Criterion 6: Biological diversity

*Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.*

Identifying areas of high relative taxonomic or habitat diversity can be challenging in the data-poor deep and open oceans. Where consistent global or regional data are lacking, relative species diversity can be predicted using a variety of indices and models, such as species distribution models. Using some species, e.g. oceanic top predators, as indicators of wider biological diversity could also be applicable.

## Overlap between hotspots of marine mammal biodiversity and global seamount distributions

Although point observations can be used to create a number of biodiversity indices, they often under-represent the full range of a species. Physical environment variables (e.g. sea surface temperature) often determine the limits of a single species' distribution. Thus environmental envelopes can be created to map a species' theoretical range based on oceanographic variables. The core overlap of such "range maps" can be used as a predictor of species richness. AquaMaps (www.aquamaps.org) is a species distribution model available as an online web service that has been used to generate standardized range maps for more than 9000 marine species. Range maps from AquaMaps for 115 marine mammal species were used to produce a global map of marine mammal biodiversity patterns.



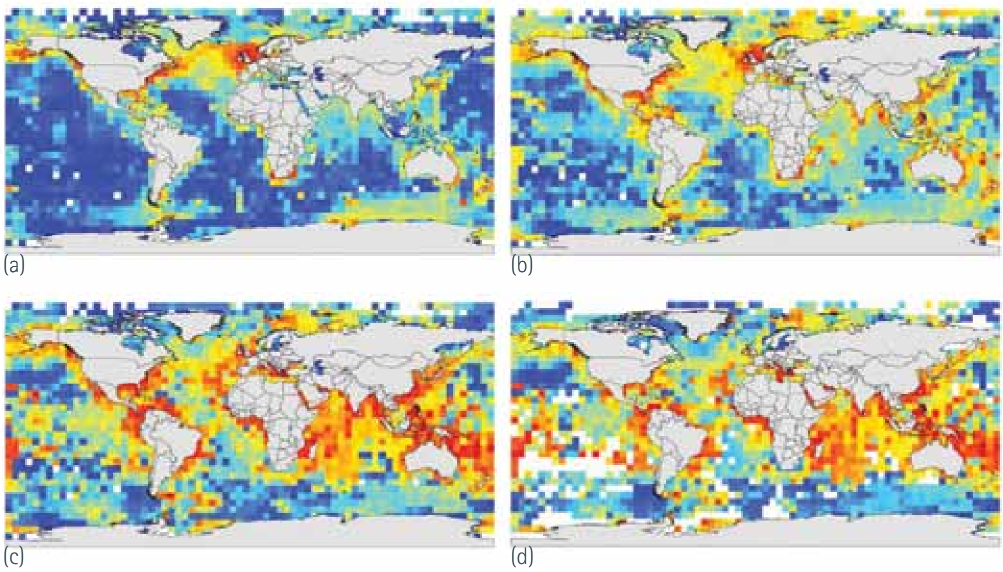

(a) Global map of predicted marine mammal species richness and seamount density and (b) the highly significant relationship between the two, spearman's rho = 0.76, p < 0.0001)
*Source: Both graphs modified from Kaschner, 2007*



## Global patterns of species diversity

One of the most intuitive criteria on which conservation efforts are based is 'Species Diversity' – but measuring diversity is not straightforward. Measures of diversity generally consider one or more of the following factors: 1) number of different elements (species, communities, etc., also referred to as "richness"); 2) the relative abundance of the elements ("evenness" and other related measures); and 3) how different or varied the elements are when considered as a whole (e.g. taxonomic distinctness). Several indices measuring species diversity have been proposed, giving more or less weight to these factors. Not all of these indices are suitable for broad-scale analyses of datasets with uneven distribution or sampling effort, as is the case in the open oceans and deep seas. One index that is relatively insensitive to observation bias is Hurlbert's index, calculated as the number of species in a random subsample of the available data. Hurlbert's index was calculated to identify global patterns of species diversity for a sample size of 50 specimens including a wide variety of marine organisms (fish, invertebrates, microbes, etc.), based on the data holdings of the Ocean Biogeographic Information System (OBIS: www.iobis.org).



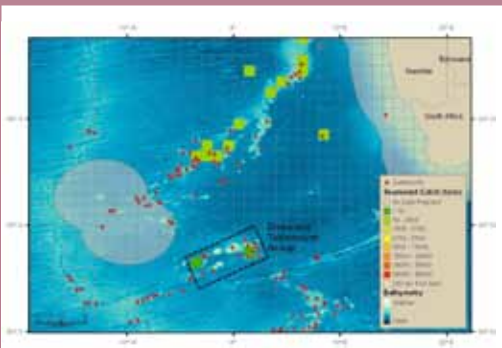

(a) Total records in OBIS, corrected for differences in surface area between squares on different latitude;
(b) the total number of species, corrected for differences in surface area between squares on different latitude;
(c) Shannon Index; (d) Hurlbert's Index, es(50)
*Source: E. Vanden Berghe/OBIS*

# Criterion 7: Naturalness

*Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.*

Relative "naturalness" of open ocean areas compared to other representative examples of habitat types may be evaluated in the context of the history of human activity in the area. Both type and intensity of impact, as well as potential effects on specific ecosystem features, might be taken into account, as was done with regards to fishing on seamounts in the illustration below. Application of this criterion necessarily requires a relative measure of naturalness, and drawing conclusions by making comparisons between sites.

## South East Atlantic Seamounts



Fishing effort and seamount locations (< 2000m deep) in the South East Atlantic. Red indicates a catch greater than 50,000 tons.
*Source: J. Cleary, A. Rowden, M. Clark, & M. Consalvey*

Seamounts are underwater mountains, usually formed by tectonic or volcanic activity. They rise above the surrounding deep seafloor, and can influence the flow of oceanographic currents over and around them, which can increase the productivity of the water column above. Areas of shallow habitat relative to the surrounding abyssal plain, often have highly diverse, and abundant, faunal communities. Remote seamounts can develop special ecosystems, with many endemic species. Fish aggregations often occur in association with seamounts, and seamount fisheries have seen major expansions since the 1960s. Fishing is the single largest human activity that impacts seamount ecosystems.

However, many seamounts are believed to be unfished, and in deep-sea, offshore areas represent "natural" habitats unaffected by direct human activities. Global datasets of the predicted location of large seamounts have been created from ocean bathymetry and satellite altimetry. These data can be combined with historical catch data from seamount fisheries and other anthropogenic marine impacts to identify areas of low impact, where seamounts are still in a relatively natural state. Although this assessment is limited by access to data of exactl CBD decisions, UN resolutions, and other measures y where fishing has occurred, a number of seamounts have been identified as meeting the naturalness criterion. Examples include the seamounts of the Discovery Tablemount group in the South East Atlantic.

## Looking ahead

GOBI will continue to seek out and involve additional scientific groups and will continue its involvement and cooperation with governments, international and non-governmental organizations, as well as industry stakeholders. During 2011 and 2012, GOBI has been working closely with the CBD Secretariat to support five regional workshops to describe areas that meet the EBSA Criteria in the Northeast Atlantic, Southwest Pacific, Caribbean and Western Central Atlantic, Southern Indian Ocean, and Eastern Tropical Pacific. GOBI will continue to support such work, while improving the scientific basis of CBD decisions, UN resolutions, and other measures through the application of analyses, network design, training and capacity building.

## GOBI ADVISORY BOARD

Convention on Biological Diversity
Food and Agriculture Organization
The Global Environment Facility
Intergovernmental Oceanographic Commission of UNESCO
International Maritime Organization
International Seabed Authority
United Nations Development Program
United Nations Environmental Program
As an observer, the Division for Ocean Affairs and the Law of the Sea of the United Nations Office of Legal Affairs

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Ocean Biogeographic Information System
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Duke University Marine Geospatial Ecology Lab
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Marine Conservation Institute
United Nations University Institute of Advanced Studies
AquaMaps
BirdLife International
Australia's Commonwealth Scientific and Industrial Research Organisation
Tagging of Pacific Predators

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IUCN (International Union for Conservation of Nature) brings together States, government agencies and a diverse range of NGOs in a unique world partnership which seeks to assist societies throughout the world to conserve the diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.
www.iucn.org

The German Federal Agency for Nature Conservation (BfN), which is the advisory agency of the German Ministry of Environment, Nature Conservation and Nuclear Safety (BMU), is Germany's central scientific authority for both national and international nature conservation. It has key enforcement functions under international species, biotopes and area conservation agreements, marine conservation law and the Antarctic Treaty.
www.bfn.de

# Initiative Partners

AquaMaps
www.aquamaps.org

BirdLife International
www.birdlife.org

Convention on Biological Diversity
www.cbd.int

CenSeam
http://censeam.niwa.co.nz

Columbia University
www.columbia.edu

CSIRO
www.csiro.au

French MPA Agency (Agence des aires marines protégées)
www.aires-marines.fr

Gray's Reef National Marine Sanctuary
http://graysreef.noaa.gov

GRID-Arendal
http://www.grida.no

Hermione
www.eu-hermione.net

INDEEP - International Network for Scientific Investigations of Deep-Sea Ecosystems
www.indeep-project.org

James Cook University
www.jcu.edu.au

Marine Conservation Institute
www.marine-conservation.org

Duke University Marine Geospatial Ecology Lab (MGEL)
http://mgel.env.duke.edu

Ocean Biogeographic Information System
www.iobis.org

South African National Biodiversity Institute (SANBI)
http://ioc-unesco.org

Society for the Conservation of Reef Fish
www.scrfa.org

Sustainable Fisheries Partnership
www.sustainablefish.org

Tagging of Pacific Predators
www.topp.org

UNEP-World Conservation Monitoring Centre
www.unep-wcmc.org

International Oceanographic Commission of UNESCO
http://ioc-unesco.org

University of Hawaii at Manoa
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THE GLOBAL OCEAN BIODIVERSITY INITIATIVE
is an international partnership advancing the scientific basis for conserving biological diversity in the deep seas and open oceans.

## Credits

### SCIENTIFIC ILLUSTRATIONS AND EXAMPLES

Adapted from the GOBI report: *Defining ecologically or biologically significant areas in the open oceans and deep seas: Analysis, tools, resources and illustrations, by Jeff Ardron, Daniel Dunn, Colleen Corrigan, Kristina Gjerde, Patrick Halpin, Jake Rice, Edward Vanden Berghe, Marjo Vierros..* Illustrations edited by Daniel Dunn, with contributions from Jesse Cleary, Patrick N. Halpin, Ei Fujioka, Ben Best, Jason Roberts, Andre Boustany, Jeff Ardron, Autumn-Lynn Harrison, Ben Lascelles, Lincoln Fishpool, Piers Dunstan, Kristin Kaschner, Marjo Vierros, Sheila McKenna, Arlo Hemphill, Edward Vanden Berghe, Malcolm Clark, Mireille Consalvey, Ashley Rowden

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### DESIGN

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### PHOTOGRAPHY

Cover Manta ray | Fiona Ayerst
Inside Crab (*Eumunida picta*) in thickets of the deep-sea coral (*Lophelia pertusa*) | Sandra Brooke/NOAA
1 *L:* Deep sea orange roughy catch, | Kim Westerskov
*C:* Marine education program, Mayumba, Gabon | Linda Schonknecht/Marine Photobank
*R:* Nuidbranch, Davidson Seamount, 1498 m | NOAA/Monterey Bay Aquarium Research Institute
3 *L:* Primnoid coral loaded with brittle stars, Dickins Seamount | NOAA Office of Ocean Exploration
*C:* Medusa (*Crossota norvegica*), Deep-sea bed, Arctic Ocean | Kevin Raskoff
*R:* COP 9 | CBD Secretariat
4 Long-armed Starfish (*Luidia sarsi*) late larval stage, deep Atlantic | David Shale/npl/Minden Pictures
6 Shrimp and Sargassum, Atlantic Ocean | David Shale/Minden Pictures
7 *L:* Corals and seagrass, Saya de Malha, Indian Ocean | Dr. Peter D. Goreau
*R:* Dr. Thomas Goreau on expedition over seagrass bed, Saya de Malha | Dr. Peter D. Goreau
8 Male northern elephant seal, San Nicolas Island, California, USA | Autumn-Lynn Harrison
9 Antipodean albatross | Ben Lascelles
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