Ecologically or Biologically Significant Areas in the Pelagic Realm: Examples & Guidelines

Workshop Report

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

Report of a scientific workshop organized by the Global Ocean Biodiversity Initiative (GOBI) and the Marine Geospatial Ecology Lab (MGEL) at Duke University, in Sidney, B.C., Canada, from May 12th–14th, 2011.

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May 12th–14th, 2011
The Sidney Pier Hotel, Sidney, B.C., Canada

Workshop Sponsors

The workshop organizers would like to thank the government of Belgium, the Sloan Foundation, the Census of Marine Life, the J.M. Kaplan Fund, the Richard and Rhoda Goldman Fund, and the German Federal Agency for Nature Conservation for their generous support of this workshop. We would also like to thank the participants for their contributions to the workshop and to forwarding our understanding of how to identify ecological or biologically significant areas in the open ocean. Several participants funded their own participation in the workshop and their support and dedication to this work is deeply appreciated. We would also like to thank the workshop participants and Francine Kershaw for their constructive reviews of the report.

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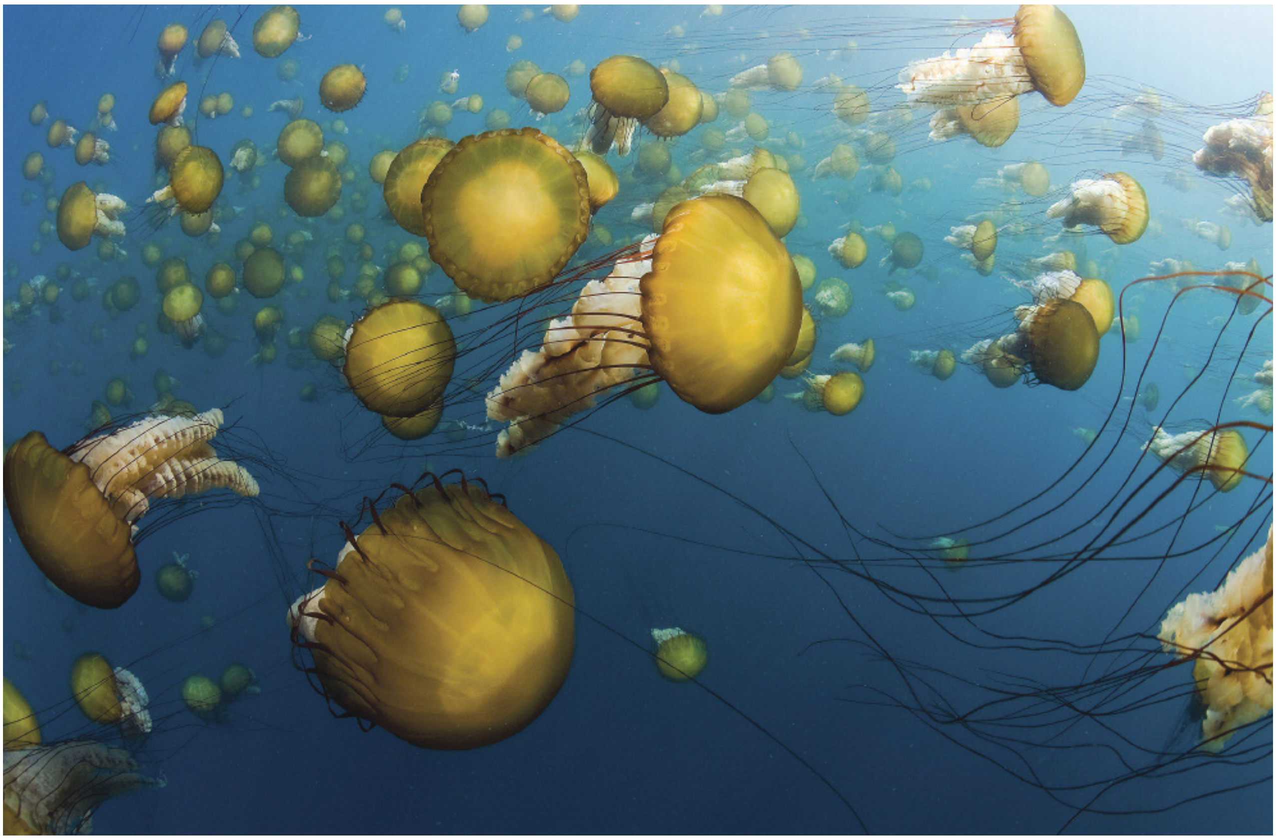
1. Executive Summary

The pelagic realm has twice the surface area and 168 times the habitable volume of terrestrial biomes, and it is as important as it is immense. The ecosystem services provided to us by the pelagic ocean include, among others, the provision of more than half the oxygen we breathe, the absorption of nearly 35% of the CO_2 released into the atmosphere and 80% of the heat added to the climate system by the accumulation of CO_2, the provision of greater than 15% of the animal nutrients consumed, and the transportation of ~90% of international trade. However, the pelagic open ocean is not only important and immense, but deep, distant and dynamic, making it the largest and yet least understood biome on our planet. Despite our limited knowledge of the pelagic ecosystem, human activities and climate change continue to negatively impact its functioning. Assessment of these impacts is very difficult in this biome due to difficulties accessing the open ocean, and because much of the pelagic realm falls outside of national jurisdictions.

There have been a variety of calls for more sustainable use and conservation of the open ocean, leading to the recent re-affirmation by the Convention on Biological Diversity (CBD) of its goal to conserve 10% of the area beyond national jurisdiction (part of the Aichi Biodiversity Targets). As a first step toward this goal, the 10th Conference of Parties to the CBD recommended the convening of a series of regional workshops, in coordination with various relevant partners, to identify Ecologically or Biologically Significant Areas (EBSAs) in need of protection. The development of an EBSA Repository and Information Sharing Mechanism and the relationship between the CBD and other concurrent UN and external processes, as well as management efforts by competent authorities, ensure that the EBSA identification process will inform a wide variety of policy and regulatory decisions.

Given the importance of the pelagic realm and the issues raised above concerning access and assessment, it is vital that the Parties to the CBD



Sea nettles, Chrysaora fuscescens, Monterey Bay, California, October 2007
Credit: Richard Herrmann, Galatée Films, Census of Marine Life

fully consider how to incorporate the pelagic realm into the EBSA identification process. *For the Aichi Biodiversity Targets to be met in full, and for the other relevant processes to be successful, examples and guidelines for the identification of important pelagic areas must be made available to policy makers involved in the EBSA identification process.* In an effort to provide such examples and guidelines, a workshop of 27 international experts on pelagic biodiversity was convened by the Global Ocean Biodiversity Initiative (GOBI) and the Marine Geospatial Ecology Lab (MGEL) of Duke University. The context for that workshop and the examples and guidelines developed by the experts are presented in this report.

Through a series of break-out groups and plenary discussions, in-depth guidelines were developed for specific criteria and over-arching general guidelines were articulated. The general guidelines and considerations developed by the workshop are:

Guidelines

1. *Size matters* – the scale of pelagic features and life-history stages can be 1,000s–10,000s km^2, delineation of EBSAs must match these scales.
2. *Consider time* – the pelagic ocean is highly dynamic, consideration must be given to how features and organisms move over time.
3. *Think deeply* – the average depth of the ocean is ~3,700m, the delineation of pelagic EBSAs should not solely consider surficial elements.
4. *Be dynamic* – the use of oceanographic variables that vary over space and time to delineate EBSAs is possible and encouraged.
5. *Quantify uncertainty and be adaptive* – given the relative lack of data for the pelagic realm, there is an increased need to build uncertainty into the EBSA identification process. Further, there is a need to ensure the process is adaptive and ongoing so adjustments can be made as new data become available.

Other considerations

1. *Not all phytoplankton are created equal* – areas of interest likely involve some level of trophic transfer, not just high productivity.
2. *Prioritize complexity* – areas where currents, frontal systems or eddies meet complex topographic features tend to produce areas of particular ecological interest.
3. *Process drives pattern* – appropriate consideration should be given to the underlying processes that result in an area meeting the EBSA criteria.

Further, the workshop participants developed a typology of oceanographic features that might meet the EBSA criteria and specific examples of each type. The types are also accompanied by a description of how the features have been identified in scientific peer-reviewed literature. The participants in the workshop and the workshop organizers sincerely hope that the provision of these guidelines and examples will both encourage and help relevant organizations and agencies to include pelagic areas of ecological importance in their information-gathering processes and management.

2. Workshop Description

2.1 Purpose

The overarching purpose of the workshop was to enumerate types of pelagic systems that might meet the Convention on Biological Diversity's criteria for Ecologically or Biologically Significant Areas, and to present examples for each criterion. Workshop participants were further tasked with:

1. synthesizing information on factors affecting the ecological significance of pelagic areas;
2. enumerating available data and methods to identify ecologically significant areas in dynamic pelagic systems;
3. compiling a preliminary, non-exhaustive list of candidate areas for pelagic conservation (particularly with reference to the South Pacific) for submission to CBD Regional Workshops, the United Nations Food and Agriculture Organization (FAO), regional fisheries management organizations (RFMOs) and other relevant intergovernmental and regional bodies; and
4. outlining methods for global or regional prioritization of pelagic zones.

The workshop also discussed guidelines for the application of the EBSA criteria to the pelagic zone.

2.2 Process

Twenty-seven international experts including biologists, ecologists, oceanographers, systematic conservation scientists, international marine policy specialists and resource managers met for two days in Sidney, British Columbia, Canada to address the application of the CBD EBSA criteria to the pelagic zone. The workshop programme is available as a supplementary online appendix (S1). Prior to the workshop a large volume of publications on pelagic biodiversity was made available to the workshop participants, as well as a white paper outlining types of pelagic features/habitats that might meet the EBSA criteria. Participants were asked to submit a one-page document describing how their work could inform the identification of EBSAs, or more generally any thoughts they had on pelagic EBSA identification. These were compiled and are also available as a supplementary online appendix (S2).

The first day of this two-day workshop began with an introduction to the Global Ocean Biodiversity Initiative and its supporting role in the collection of information pertinent to the identification of candidate EBSAs. This was followed by general presentations on the international policy context surrounding the identification of EBSAs and a review of the EBSA criteria themselves. The morning session concluded with three discussions about data availability, applicable methods and multi-criteria considerations in the identification of candidate EBSAs.

Ecologically or Biologically Significant Areas in the Pelagic Realm Workshop participants

The main focus of the workshop was a series of break-out groups tasked with looking at specific criteria. These took place on the afternoon of the first day and throughout much of the second day. Questions addressed by the break-out groups included:

1. What types of pelagic areas or systems might meet your criterion?
2. What factors explain the importance of such areas/systems?
3. How can such areas/systems be identified?
4. What data are required to identify such areas/systems?
5. How can such systems be identified in data-poor regions?
6. Is there any way to compare the relative importance of such areas?
7. What are some examples of each type of area/system identified?

To inform the break-out group process, three presentations were given to start the second day. These presentations focused on the regional nature of the CBD EBSA process, the biogeography and policy context of a region of interest (the Southwest Pacific) and an example of a previous workshop on regional EBSA identification (the Arctic). Results from the break-out groups were presented to the whole workshop on the second afternoon and were followed by a lengthy discussion of the findings and the problems/questions raised during the process.

3. Background

3.1 The Pelagic Open Ocean

Pelagic Realm

Defined here, as in Game *et al.* 2009, as: "The physical, chemical and biological features of the marine water column of the open oceans or seas rather than waters adjacent to land or inland waters."

Clione limacina, *an Arctic pelagic snail (pteropod)*
Credit: Kevin Raskoff, Census of Marine Life

The size and importance of the pelagic realm have been repeatedly described over the last several decades (e.g., Riley & Chester 1971; Couper 1983; Angel 1993, 1997 & 2003; Norse & Gerber 1993; Chandler *et al.* 1996; Hyrenbach *et al.* 2000; Verity *et al.* 2002; Game *et al.* 2009; and Robison 2009). Specifically, the pelagic realm is cited as having more than twice the surface area of all terrestrial biomes combined and 168 times the habitable volume. The importance of the pelagic realm is described by the growing list of ecosystem services it provides. More than 70% of the fish consumed come from marine ecosystems. Fisheries support approximately 34 million fishers worldwide and US$93.9 billion in first-sale revenue. Overall fisheries provide 6.1% of all protein (and 15.7% of animal protein) to the world's population (FAO 2010). However, the importance of fisheries to small-scale fishers is not adequately described by such statistics. Fisheries, largely pelagic fisheries, are the "bank of last resort" when economies fail in developing countries. Beyond fisheries, the oceans represent the longest "highways" on the planet, connecting the globe and providing for the transportation of ~90% of international trade. Further, the pelagic ocean provides even more basic service than fisheries and commerce: it provides more than half the oxygen we breathe; on a daily basis it mitigates anthropogenic CO_2 production by absorbing nearly 35% of the CO_2 released into the atmosphere and 80% of the heat added to the climate system by the accumulation of CO_2.

The pelagic open ocean is not only important and immense, but deep, distant and dynamic. These factors combine to make it the largest and yet least understood biome on our planet. The lack of data describing the pelagic realm is well illustrated by an examination of the holdings of the largest marine biogeographic database in the world, the Ocean Biogeographic Information System, where most records are either from surface sampling or in the first 1,000 meters of the benthic environment (Webb *et al.* 2010; Fig. 1). Access and assessment are more difficult in this biome than virtually anywhere else on Earth, presenting some of the greatest challenges for ocean resource management and conservation planning. This situation is only exacerbated by the fact that much of the pelagic realm falls outside of national jurisdictions, which makes management and protection of this biome even more problematic. Probably most challenging is the fact that critical areas in the pelagic environment are often shifting in space and time, requiring the development of methods to delineate the location and factors influencing these features in four dimensions. These challenges, combined with the common misinterpretation that the "freedom of the seas" means unregulated exploitation of the seemingly limitless wealth of the oceans, have limited our efforts to manage and conserve the open ocean to date. However, new technological advances in autonomous data gathering instruments, telemetry and biologging, and geospatial analyses and remote sensing are beginning to allow us to gather and store orders of magnitude more data (Halpin *et al.* 2009; Bograd *et al.* 2010), which can help to define, characterize, monitor and manage dynamic pelagic habitats in the open oceans (Hobday & Hartmann 2006; Howell *et* *al.* 2008; Hobday *et al.* 2010, 2011; Dunn *et al.* 2011).

Pelagic ecosystems face numerous exogenous stressors which threaten the sustainability of their current functions. Eutrophication, habitat degradation, biological and geological removals and collateral impacts from extractive activities, introduction of invasive species, pollution (e.g., physical, thermal or auditory), climate change and ocean acidification are caused by a myriad of human activities. The potential impacts of these stressors on the pelagic open ocean, much less their interaction and cumulative effects, are largely unknown. However, a recent study indicates that there remain no places in the ocean, no matter how deep, distant or dynamic, that are not affected by human activities (Halpern *et al.* 2008). In response to these intensifying threats there have been increasing calls for greater management, conservation and protection of marine biodiversity (see below).

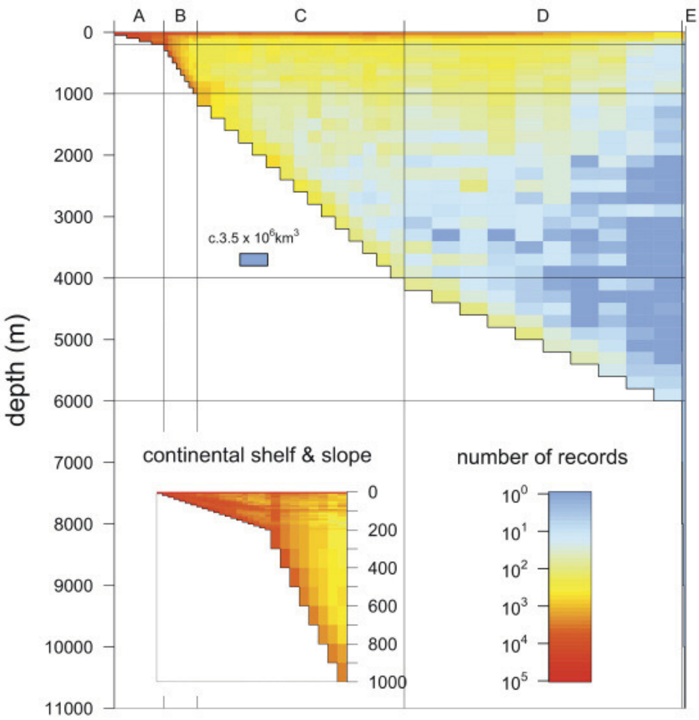


Figure 1: The number of records in OBIS as a function of distance from shore and depth. Webb *et al.* 2010.

Appeals for representative conservation of the all biomes (including the pelagic realm) have been issued for at least two decades. As far back as 1992, the Fourth World Parks Congress called for placing at least 10% of each major biome under protection by the year 2000. This figure was later raised to 30% by 2012 during the Fifth World Parks Congress. Simultaneously, the World Summit on Sustainable Development (WSSD) established a goal in 2002 for the creation of a global network of marine protected areas (MPAs) by the year 2012. Since then, the Convention on Biological Diversity (CBD) adopted the WSSD timeline and committed to protect 10% of each marine biome by 2012. While progress has been made in terrestrial conservation (~12.2% protected), marine biomes have lagged far behind. Currently 6.3% of territorial waters are protected, but only 1.91% of Exclusive Economic Zone (EEZ) waters and a meager 0.5% of areas beyond national jurisdiction (ABNJ) are protected. At the current rate of protection, it is estimated that the targets will be met between the years 2067 and 2092 (Wood *et al.* 2008). The slow progress on achieving these internationally agreed-upon goals was made explicit in the Aichi Biodiversity targets agreed to at the 10th Convention of Parties to the CBD (COP10), where the previous goal of conserving 10% of marine biomes by 2012 was extended to 2020, while the target for terrestrial biomes and inland waters was increased to 17% by the year 2020.

Clearly, management, conservation and preservation of the pelagic realm has been hindered by its deep, distant and dynamic nature, and by the governance challenges presented by an environment that crosses national borders and is largely in areas beyond national jurisdiction. While progress on targets for marine conservation lagged at COP10, other processes to support sustainable use and conservation of the marine realm moved forward. Specifically, the Conference of Parties promulgated more than 25 recommendations outlining the process for identifying and cataloguing information about areas that meet the criteria for Ecologically or Biologically Significant Areas (EBSAs). This process mirrors a number of similar activities in other international policy fora. However, each of these efforts is limited by the scientific information and guidance which is brought to bear during the process. To date this information has been largely limited to benthic habitat types or, more specifically, topographic features. *If the Aichi Biodiversity Targets are to be met in full, examples and guidelines for the identification of important pelagic areas must be made available to policy makers involved in the EBSA identification process.*

3.2 The EBSA criteria

Since the 1980s a variety of national agencies, NGOs, and academic researchers have published or promulgated suites of criteria for the identification of areas of biological or ecological importance in the open ocean. The Convention on Biological Diversity took up the call to identify such areas in 2006 at the eighth meeting of the Conference of Parties (Fig. 2). Decision VIII/24, paragraph 46, called for the convening of an expert workshop to "Refine and develop a consolidated set of scientific criteria for identifying ecologically or biologically significant marine areas in need of protection, in open ocean waters and deep sea habitats, building upon existing sets of criteria used nationally, regionally and globally". The Expert Workshop, held in the Azores in 2007, collated available criteria suites and selected those which fell within the purview of the CBD to supply scientific information on the management and conservation of biodiversity to authorities with competency to manage marine resources.[1] The workshop produced a set of seven criteria which were later adopted by the Parties to the CBD in Decision IX/20 at COP9 in 2008.

More on pelagic ecosystems from Hyrenbach *et al.* 2000

Pelagic systems are inherently different from terrestrial landscapes... Terrestrial and marine ecosystems differ in the ecological constraints shaping life, in the processes responsible for pattern, and in the dominant scales of physical and biological variability (Smith 1978; Steele 1985). The distributions of pelagic species are largely dictated by the intricacies of water flow, and by the coupling of physical and biological processes that promote the growth and retention of planktonic populations (Haury *et al.* 1978; Steele 1978; McGowan and Walker 1985). These, in turn, are mediated by physical forcing dominated by large scales of time and space, between seasons and decades and tens to thousands of kilometers (meso to mega scales; Stommel 1963; Smith 1978; Denman 1994). The dynamic nature of pelagic systems and the prevalence of variability over large scales blur the linkages between physical and biological processes, spreading biotic interactions over spatial scales that greatly exceed those prevalent in terrestrial systems (Vinogradov 1981; Steele 1985; Jaquet *et al.* 1996).

The seven scientific criteria for identifying Ecologically or Biologically Significant Marine Areas (EBSAs) in need of protection are:

1. Uniqueness or rarity
2. Special importance for life history of species
3. Importance for threatened, endangered or declining species and/or habitats
4. Vulnerability, fragility, sensitivity, slow recovery
5. Biological productivity
6. Biological diversity
7. Naturalness

The seven EBSA criteria and four network criteria were adopted in Decision IX/20 and included as appendices (see Appendix 2). COP9 also called for a follow-on CBD expert workshop to be convened to provide "scientific and technical guidance on the use of biogeographic classification systems and identification of marine areas beyond national jurisdiction in need of protection". COP10 took note of the results of the expert workshop, and invited Parties, other Governments and relevant organizations to use the scientific guidance. In the recommendations coming out of COP10, the Parties went on to request that the Secretariat establish a repository and information-sharing mechanism for scientific and technical information and experience related to the application of the EBSA criteria, as well as "other relevant compatible and complementary

[1] The background paper submitted to the workshop by Fisheries and Oceans Canada (Dearden & Topelko 2005) did an excellent job of summarizing the various criteria suites and is recommended for further reading on the subject. See also Gilman *et al.* (2011) for a broader and more recent review.

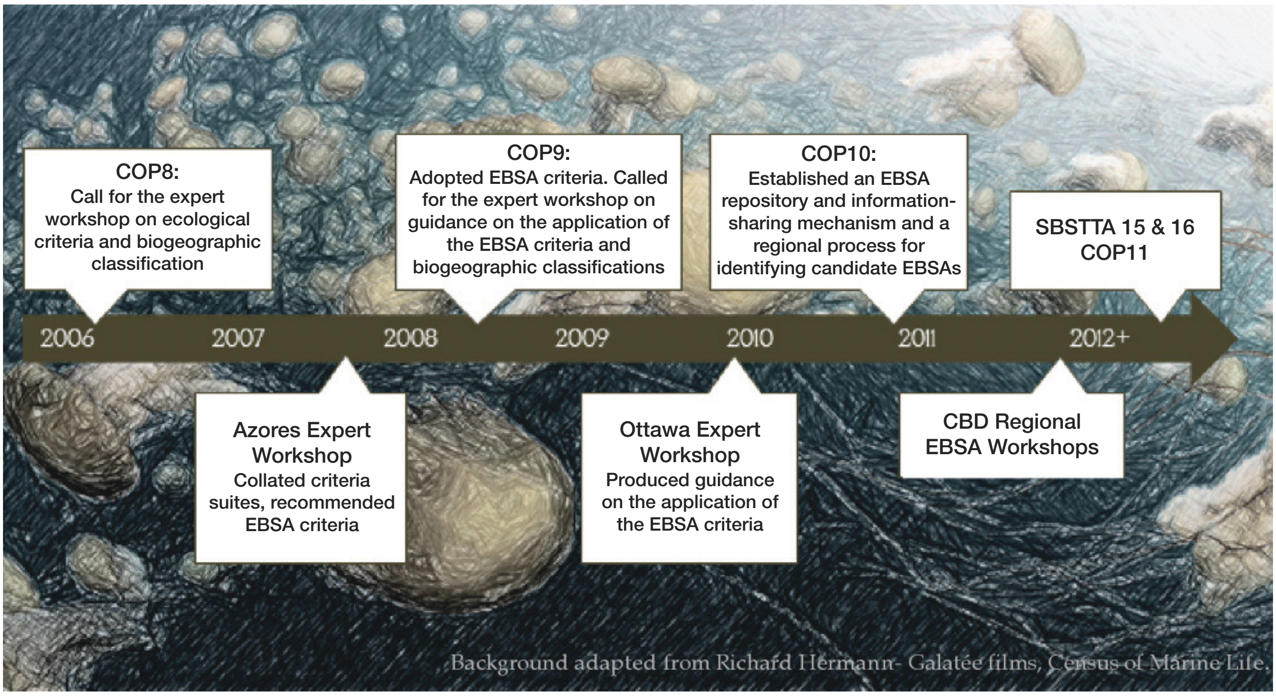


Figure 2: Timeline of the development and application of the CBD EBSA criteria.

nationally and inter-governmentally agreed scientific criteria". In accordance with this further recommendation, the CBD Secretariat or regional partner organizations have scheduled a number of regional workshops for 2011 and 2012 (see Fig. 2) to enable the description of candidate EBSAs.

3.3 The Regional Context & Population of the CBD EBSA Repository

The process by which candidate EBSAs will be described, entered into the repository, and endorsed by the COP was generally laid out during COP10 (Fig. 3). Decision X/29, paragraph 36, offers context for the relevance of a regional process to the identification of EBSAs and the population of the EBSA repository:

> 36. Requests the Executive Secretary to work with Parties and other Governments as well as competent organizations and regional initiatives, such as the Food and Agriculture Organization of the United Nations (FAO), regional seas conventions and action plans, and, where appropriate, regional fisheries management organizations (RFMOs)… *to organize… a series of regional workshops*, before a future meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) prior to the eleventh meeting of the Conference of the Parties to the Convention, *with a primary objective to facilitate the description of ecologically or biologically significant marine areas through application of scientific criteria in annex I of decision IX/20* as well as other relevant compatible and complementary nationally and intergovernmentally agreed scientific criteria… (emphasis added)

The concept of a regional approach to identifying ecologically or biologically important areas is in line with both the approach taken through the various regional seas programmes, action plans and conventions, and with management of fisheries by the regional fisheries management organizations (RFMOs). Further, it is ecologically and politically coherent as it recognizes the fundamentally connected nature of the pelagic environment at a regional scale, and the consequent responsibility which nations have toward their neighbors when their actions affect this shared resource. The regional context is also important to implement another recommendation from the same COP10 decision which called for additional training and capacity building workshops.

The process envisioned by the Parties at COP10 (Fig. 3) put the onus on regional workshops to describe potential EBSAs. These candidate EBSAs would then be entered into the EBSA Repository, shared with relevant agencies, organizations and partners, and compiled into a report to be forwarded to the next meeting of the CBD Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA). The Parties would then recommend specific EBSAs to be included in a report to the COP, which would have an opportunity to endorse the EBSAs recommended by the SBSTTA.

The CBD has begun to implement this process. The EBSA Repository was developed in early 2011 and is currently being reviewed by the Parties. The Secretariat has also produced documentation on the use of the Repository including broader descriptions of the regional process and instructional Powerpoint modules. Both of these products should be released to the public by September 2011. Finally, as mentioned earlier, the CBD and its regional partners have scheduled regional workshops to identify candidate EBSAs in the Northeast Atlantic (OSPAR region), the Mediterranean, the Southwest Pacific, and the Caribbean and Western-central Atlantic (including Brazil).

3.4 Relevance of Identifying EBSAs

How does the identification of areas meeting the EBSA criteria affect management and conservation of the pelagic open-ocean? As the CBD has no management authority, the answer to this question is grounded in the relationship between the CBD, the UN General Assembly, international conventions and other multilateral agreements, and related competent management authorities. The 1982 United Nations Convention on the Law of the Sea (UNCLOS) established zones of national maritime jurisdiction and the governance framework for the regulation of marine areas beyond national jurisdiction (ABNJ). UNCLOS covers a broad range of human activities including, *inter alia*, maritime navigation, rights to marine resources, pollution and conservation of marine biodiversity.
To address issues pertaining to the sustainable use and conservation of biodiversity in ABNJ, the United Nations General Assembly (UNGA) established an *Ad Hoc Open-ended Informal Working Group to*

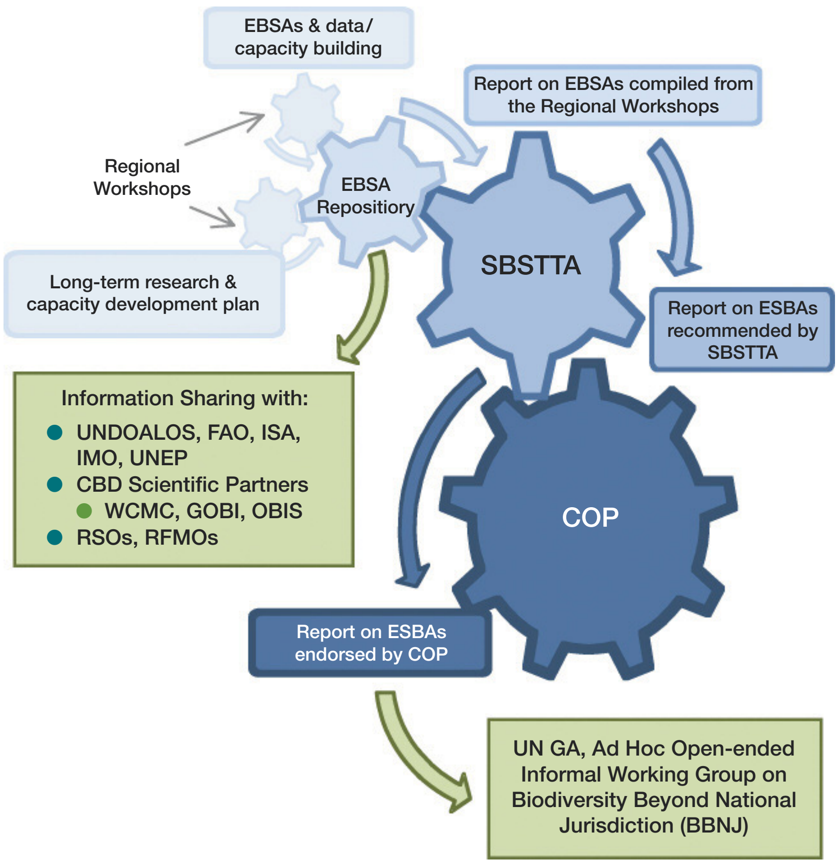


Figure 3: CBD EBSA Identification and information-sharing process.

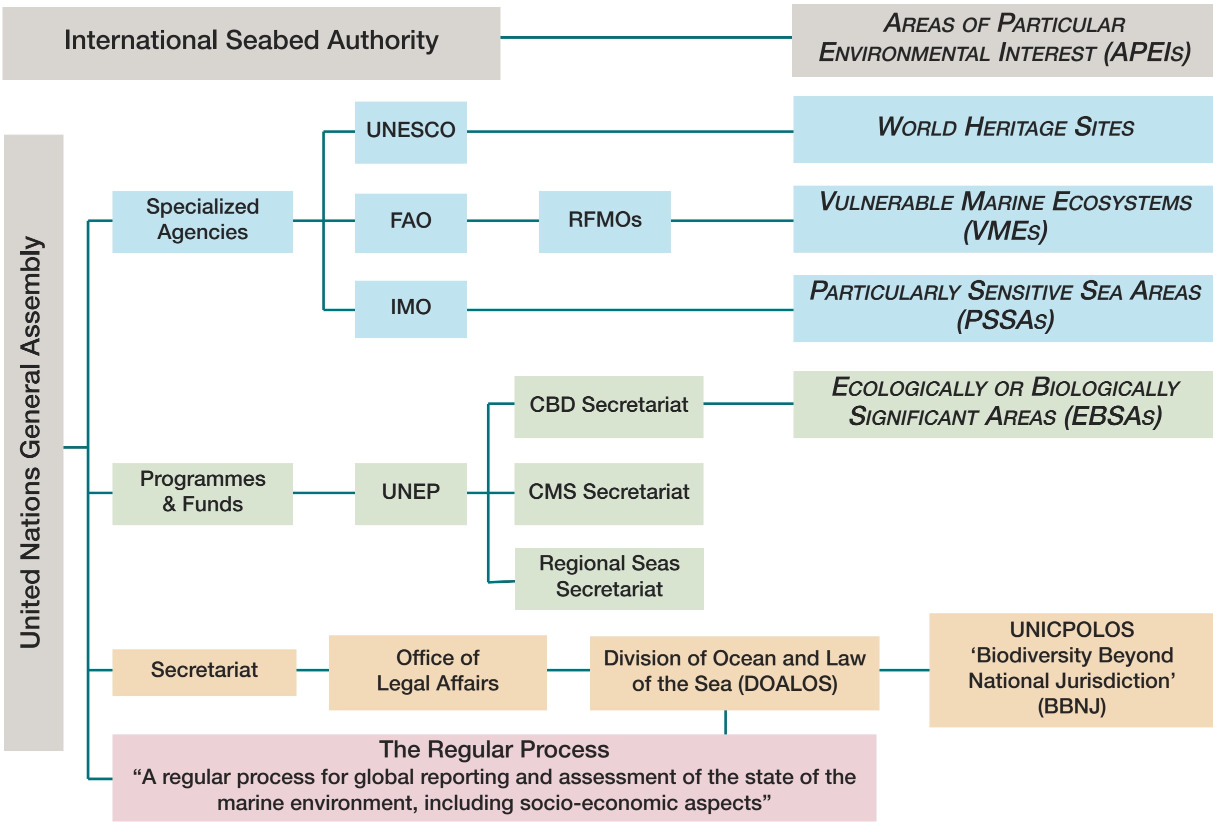


Figure 4: UN Agencies, Programmes and related organizations with criteria suites to identify important marine areas in need of heightened protection. The names given to such areas are italicized in bold.

study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction (or UN Working Group on Biodiversity Beyond National Jurisdiction or BBNJ). The most recent UN Working Group on BBNJ meeting (June 2011) produced strong results recommending that the UNGA develop the legal framework for establishing marine protected areas in areas beyond national jurisdiction – thus laying the groundwork for a new agreement or process to enhance the conservation of biological diversity beyond national jurisdiction. The CBD has a fundamental role in supplying information on biological diversity to the UNGA to support this process.

Further, as mentioned above, there are a number of UN Agencies, Programmes and related organizations, as well as nations and regions, which have proposed or promulgated suites of criteria for the identification of areas of biological or ecological importance to support conservation and sustainable use of biodiversity resources (Fig. 4). The overlap between these criteria suites and the EBSA criteria are significant (e.g., Table 1 – see pages 17-18), and thus there is much to be gained by collaboration and sharing between conventions, agencies and organizations. The Parties to the CBD clearly understand this and have repeatedly recommended working together with relevant organizations, conventions and regional initiatives. They have also recommended the creation of biodiversity information-sharing mechanisms (e.g., the Clearing-House Mechanism and the EBSA Repository). Given their common connection to the UN and their use of a criteria suite to identify marine areas of importance, there are five UN Agencies, Programmes or related organizations for which the identification of EBSAs and the sharing of information and experiences related to EBSAs are directly relevant.

1. The International Seabed Authority: Article 156 of the UNCLOS mandates the creation of the International Seabed Authority (ISA) to regulate activities related to exploration for, and exploitation of, the resources of the seabed "area" beyond national jurisdiction This mandate

carries with it responsibility for the protection of the marine environment from harmful effects which may arise from such activities, including protection and conservation of the natural resources of the area and the prevention of damage to the flora and fauna of the marine environment.

Thus, identification of benthic EBSAs, *or pelagic EBSAs that can be impacted by those activities regulated by the ISA*, is of direct relevance to the management of the area. In the leasing of the area for exploration and extraction activities, the ISA has considered the use of Areas of Particular Environmental Interest (APEIs; Smith 2008). Although there is significant overlap between the APEI criteria and the EBSA criteria, the APEI criteria more closely reflect the criteria for representative networks of MPAs that can be applied in areas with limited knowledge such as the deep seabed. These criteria are considered in Table 1 as they have recently been endorsed by the ISA.

2. The International Maritime Organization: Similarly the International Maritime Organization (IMO) is the global institution responsible for safety of navigation and the prevention of marine pollution from ships. As part of this authority, the IMO developed a set of criteria for identifying Particularly Sensitive Sea Areas (PSSAs) – areas which may be susceptible to the impacts of shipping, and other environmental stressors. In addition, under the International Convention for the Prevention of Pollution From Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78), "special areas" may be designated with heightened discharge controls.

3. The FAO and Regional Fisheries Bodies: The FAO is the UN organization responsible for promoting food security; its Fisheries and Aquaculture Department provides advice to States and regional fisheries bodies (RFBs) for achieving sustainable fisheries and aquaculture. Under the UN Fish Stocks Agreement (UNFSA), states are to cooperate to achieve the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks. UNFSA sets out principles for the conservation and management of those fish stocks and establishes that such management must be based on the precautionary approach and the best available scientific information. It defines and clarifies the role of regional fisheries management bodies. There are three types of regional fisheries management bodies: those established under the UN FAO's constitution, those established outside the FAO charter but for which the FAO performs depository functions, and those established and functioning entirely outside the FAO's structure, known as regional fisheries management organizations or arrangements (RFMOs).

The jewelled squid, Histioteuthis bonnellii*, swims above the Mid-Atlantic Ridge at depths from 500m to 2,000m. Credit: David Shale, Census of Marine Life*

With respect to deep sea fishing that was not covered by the Fish Stocks Agreement or otherwise regulated by the RFMOs, in 2006, the United Nations General Assembly passed Resolution 61/105 calling "upon States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems [VMEs]". The criteria for VMEs, established through a series of FAO Expert Consultations between 2006 and 2008, have much in common with the CBD EBSA criteria. Although they have been focused on deep-sea fisheries and their impacts on benthic communities on seamounts, VMEs are not limited to that ecosystem. Thus, there is an opportunity for the application of the EBSA criteria in the pelagic realm to provide experience and information to the FAO and the RFMOs as they continue to implement Resolution 61/105.

4. UNESCO and the World Heritage Convention: The UN Education, Scientific and Cultural Organization (UNESCO) houses the World Heritage Committee – the body responsible for the implementation of the World Heritage Convention. The criteria for identifying World Heritage Sites were established in 1977 and have been repeatedly refined. The most recent version is contained in the 2008 *Operational Guidelines for the Implementation of the World Heritage Convention*. Only four of the ten World Heritage Site criteria overlap with the EBSA criteria, the other six World Heritage Site criteria incorporate cultural values which are not considered in the EBSA criteria. In particular, the EBSA criteria are very relevant to the application of World Heritage Site criterion 10: "to contain the most important and significant natural habitats for *in situ* conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation."

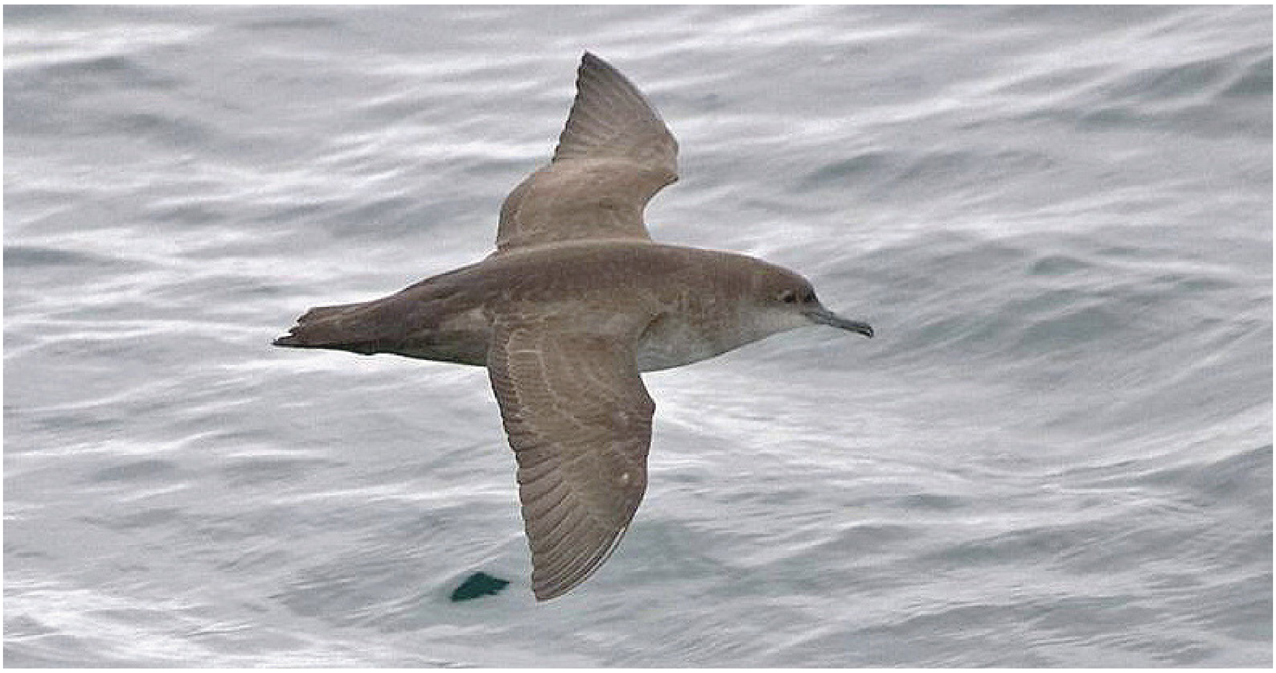
5. The UN Regular Process of Global Reporting and Assessment of the Marine Environment including socio-economic aspects: In 2002 the World Summit on Sustainable Development in Johannesburg decided to put the ocean under permanent review. This decision was adopted as a precautionary measure, because sector-by-sector management of human activities in the ocean has proven insufficient. The UN's shorthand name for this initiative – the "Regular Process" – emphasizes the importance of conducting this assessment regularly, initially planning for an ocean review every 4-5 years. The cyclical nature of the process would enable the adoption of an adaptive strategy for managing the global ocean. In 2010, the UN General Assembly committed to carrying out the first cycle of the assessment from 2010 to 2014.

A juvenile Risso's dolphin. Credit: A.S. Friedlaender

> In 2011–12, preparatory regional workshops are being conducted all over the world to define the priority questions and identify data gaps. Being an integrated assessment using a Driver-Pressure-State-Impact-Response methodology, biodiversity is an extremely important component. The data gathering and information development to identify EBSAs will naturally inform this periodic assessment of the ocean under the authority of the UN General Assembly.

Thus, the CBD is in a valuable position to contribute to the management and conservation of biodiversity in the pelagic realm by sharing information and experiences related to the identification of EBSAs directly with the UNGA through the Regular Process of Reporting and Assessment of the Marine Environment and its Working Group on BBNJ, and with other relevant UN Agencies, Programmes and related organizations. Further, the CBD Secretariat has a role in the provision of information, guidelines and when requested, technical assistance to its Parties to support the identification of EBSAs within national jurisdictions. The importance of this element of EBSA identification was made extremely clear at COP10 by the removal of references to ABNJ in the recommendations pertaining to EBSAs. Reporting on the identification of EBSAs within national jurisdictions may thus be a component of future National Reporting requirements, and a focus of National Biodiversity Strategies and Action Plans.

Finally, the identification of EBSAs is important to businesses and a healthy economy. The EBSA identification process is essentially an information-gathering effort. Where marine spatial planning frameworks exist, EBSAs will inform those planning processes. Where such frameworks don't exist, EBSAs can still inform relevant management authorities of areas in need of enhanced protection and supply vital information to industry to decrease operational and other risks and increase confidence. The global economic downturn arising from the financial crises of 2008 clearly illustrated the role that confidence plays in driving credit markets. Similarly, corporate spending has been hindered since that period by uncertainty surrounding the financial and regulatory landscape. A decrease in uncertainty surrounding operational and legal risk, whether it comes from a clearer regulatory environment or improved knowledge of the ecosystem and ecosystem services, is a goal of any industry. By providing information on marine biodiversity to businesses, it is possible to decrease uncertainty in the operational and legal arena and to allow industry to better quantify the risk associated with operational failures. In this sense, industry has a role in providing information to assist the identification of EBSAs (or supporting the collection of such information).



Balearic Shearwater. Credit: Ben Lascelles, BirdLife International

Table 1: Criteria Crosswalk – Relationship amongst various UN Agencies and Programmes criteria for identifying ecologically important areas.

Organization	CBD	FAO	IMO	UNESCO
Criteria for identification of:	**Ecologically or Biologically Significant Areas**	**Vulnerable Marine Ecosystems**	**Particularly Sensitive Sea Areas**	**World Heritage Sites**
Uniqueness or rarity	**Uniqueness or rarity** – 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.	**Uniqueness or rarity** – An area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include: habitats that contain endemic species; habitats of rare, threatened or endangered species that occur only in discrete areas; or nurseries or discrete feeding, breeding, or spawning areas.	**Uniqueness or rarity** – An area or ecosystem is unique if it is "the only one of its kind". Habitats of rare, threatened, or endangered species that occur only in one area are an example. An area or ecosystem is rare if it only occurs in a few locations or has been seriously depleted across its range. (...) Nurseries or certain feeding, breeding, or spawning areas may also be rare or unique.	Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
Special importance for life-history stages of species	**Special importance for life-history stages of species** – Areas that are required for a population to survive and thrive. (...) Areas 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).	**Functional significance of the habitat** – Discrete areas or habitats that are necessary for the survival, function, spawning/reproduction or recovery of fish stocks, particular life-history stages (e.g., nursery grounds or rearing areas), or of rare, threatened or endangered marine species.	**Spawning or breeding grounds** – An area that may be a critical spawning or breeding ground or nursery area for marine species which may spend the rest of their life-cycle elsewhere, or is recognized as migratory routes for fish, reptiles, birds, mammals, or invertebrates.	Be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals.
Importance to threatened or endangered species	**Importance for threatened, endangered or declining species and/or habitats** – Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species.	**Functional significance of the habitat** – Discrete areas or habitats that are necessary for the survival, function, spawning/reproduction or recovery of fish stocks, particular life-history stages (e.g., nursery grounds or rearing areas), or of rare, threatened or endangered marine species.	**Critical habitat** – A sea area that may be essential for the survival, function, or recovery of fish stocks or rare or endangered marine species, or for the support of large marine ecosystems.	Contain the most important and significant natural habitats for *in situ* conservation of biological diversity, including those containing threatened species of outstanding universal value.
Vulnerability, fragility, sensitivity, or slow recovery	**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.	**Fragility** – An ecosystem that is highly susceptible to degradation by anthropogenic activities. **Life-history traits of component species that make recovery difficult** – Ecosystems that are characterized by populations or assemblages of species with one or more of the following characteristics: slow growth rates; late age of maturity; low or unpredictable recruitment; or long-lived.	**Fragility** – An area that is highly susceptible to degradation by natural events or by the activities of people. (…)	

Table 1 (cont.): Criteria Crosswalk – Relationship amongst various UN Agencies and Programmes criteria for identifying ecologically important areas.

Organization	CBD	FAO	IMO	UNESCO
Criteria for identification of:	**Ecologically or Biologically Significant Areas**	**Vulnerable Marine Ecosystems**	**Particularly Sensitive Sea Areas**	**World Heritage Sites**
Productivity	**Biological productivity** – Area containing species, populations or communities with comparatively higher natural biological productivity.		**Productivity** – An area that has a particularly high rate of natural biological production. Such productivity is the net result of biological and physical processes which result in an increase in biomass in areas such as oceanic fronts, upwelling areas and some gyres.	Be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals.
Biodiversity	**Biological diversity** – Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.		**Diversity** – An area that may have an exceptional variety of species or genetic diversity or includes highly varied ecosystems, habitats, and communities.	Contain the most important and significant natural habitats for *in situ* conservation of biological diversity, including those containing threatened species of outstanding universal.
Naturalness	**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.		**Naturalness** – An area that has experienced a relative lack of human-induced disturbance or degradation.	Contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
Structure		**Structural complexity** – An ecosystem that is characterized by complex physical structures created by significant concentrations of biotic and abiotic features. In these ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high diversity, which is dependent on the structuring organisms.	**Dependency** – An area where ecological processes are highly dependent on biotically structured systems (e.g., coral reefs, kelp forests, mangrove forests, seagrass beds). Such ecosystems often have high diversity, which is dependent on the structuring organisms. Dependency also embraces the migratory routes of fish, reptiles, birds, mammals, and invertebrates.	
Historical geomorphological importance				Be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.

4. Guidelines and considerations for the application of the EBSA criteria in the pelagic zone

The main focus of the workshop and the break-out groups was the development of guidelines and examples of the application of the EBSA criteria in the pelagic realm. Towards this end, the summaries and examples presented by each break-out group were modified and fleshed out as necessary to develop criteria-specific guidelines for this report. The general guidelines in section 4.1 were developed by the editor from the break-out group summaries (sections 4.2 – 4.5) and agreed upon through editing by the group. We provide the general guidelines first as an overview and to denote the importance of these concepts.

4.1 General Guidelines for the identification of pelagic EBSAs

Guidelines:

1. *Think big*

- The scale of many pelagic features and habitats is broad. Practitioners should delineate EBSAs at the scale of these features and habitats. Larger EBSAs, even at the scale of 10,000s of square kilometers, may be informative even if some management measures will be implemented on a finer scale.

2. *Consider time*

- Pelagic EBSAs should incorporate the frequency and persistence of features. The dynamic nature of many pelagic areas over varying time periods means that time series of data can help to most effectively define a site.

3. *Think deeply*

- Accounting for over 99% of the habitable volume of the planet, life in the pelagic realm is not confined to thin layers as it is on land and the seafloor. It interacts over thousands of meters of depth and thousands of kilometers in length and breadth. Full consideration of pelagic biodiversity requires the representation of biodiversity at all depths.

4. *Be dynamic*

- Although the delineation of static EBSAs is likely to be the outcome of initial efforts at delineating EBSAs, those involved in the process are encouraged to explore EBSAs defined by the presence of a feature or by oceanographic variables (e.g., sea surface temperature). Given the strong connections mentioned above between dynamic oceanographic processes and species life-history stages, as well as ecological communities, the use of dynamic delineations may be necessary. The consequence of relying on static EBSAs will be an increase in the size of the EBSAs delineated in order to incorporate the variability in space and time of the feature (habitat) they describe.

5. *Quantify uncertainty and be adaptive*

- Given the relative lack of data for the pelagic realm, there is an increased need to build uncertainty into the EBSA identification process. Further, there is a need to ensure the process is adaptive and ongoing so adjustments can be made as new data become available. This is particularly important in the context of incorporating climate change into the EBSA identification process. (See the specific guidelines on quantifying uncertainty below.) Various approaches can be used to address the relative scarcity of pelagic data, including delphic processes, modeling and proxies (i.e., oceanographic features or indicator species). (See below.)

Other considerations:

6. *Not all phytoplankton are created equal…*

- Practitioners should not assume all areas of high-productivity are "in need of protection". Areas of interest likely involve some level of trophic transfer, not just high productivity.

7. *Prioritize complexity*

- Areas where currents, frontal systems or eddies/eddy fields meet complex topographic features tend to produce areas of particular ecological interest. When specific data are not available, oceanographic complexity may serve as a proxy.

8. *Process drives pattern – incorporate process*

- Many EBSAs will be delineated by means that do not incorporate the oceanographic processes that drive a location to be of ecological or biological significance. These "outside" processes should be considered in the EBSA identification process and cited when they are known so that appropriate consideration can be given to how activities occurring with the same process might affect the EBSA (e.g., down-current effects).

Quantifying uncertainty:

In applying the EBSA criteria we considered both data-rich and data-poor regions and recognized that it is necessary to give some level of certainty to areas identified as important. Various schemes have been used to quantify uncertainty by different organizations. During the workshop the Biological Productivity break-out group recommended one used in fisheries by assigning four levels of certainty to areas identified (Williams *et al.* 1996). These are:

1. Area is well validated by data
2. Area is validated by some data, some expert knowledge
3. Area identified by expert knowledge
4. Area identified by anecdotal information

Using these criteria allow us to assign confidence to any given area, and also helps to identify additional research needs.

Another means of quantifying uncertainty is offered by the Intergovernmental Panel on Climate Change (Metz *et al.* 2007; Table 2).

We highly recommend the adoption and use of a known classification of uncertainty, such as the examples above, by any organization seeking to identify areas of importance in the pelagic realm.

4.2 Special Importance to Life History Stage & Importance for Threatened, Endangered or Declining Species and/or Habitats

Participants: Simon Nicol (chair), Ben Lascelles (rapporteur), Autumn-Lynn Harrison, Daniel Palacios, Lora Reeve, George Shillinger, Maurizio Würtz

Criteria:

These two criteria, the life-history stage and threatened, endangered or declining species, were considered together due to the large overlap in their application. Although the life-history stage criterion can be more broadly applied and should be considered at a population scale, the examples given by the CBD for both criteria are exactly the same (see Appendix 2). The group considered all areas that met the importance for threatened species criterion to meet the importance to life-history stage criterion, but the converse (that all areas meeting the life-history stage criterion would also meet the importance to threatened species criterion) was not necessarily true.

These two criteria are highly relevant to the pelagic realm. Through projects of the Census of Marine Life like OBIS, OBIS-SEAMAP the Tagging of Pelagic Predators (TOPP), and the ongoing work of BirdLife International, Movebank, Seaturtle.org and other research programs supporting the collection and storage of pelagic tagging and surveys efforts over the last decade, the amount of available data to identify core-use areas for many species has increased dramatically.[2] A variety of life-history stage

Table 2: Quantification of uncertainty used in Working Group III to the Fourth Assessment Report of the IPCC (Metz *et al.* 2007).

Level of agreement (on a particular finding) ↑			
	High Agreement, limited evidence	High Agreement, medium evidence	High Agreement, much evidence
	Medium agreement, limited evidence	Medium agreement, medium evidence	Medium agreement, much evidence
	Low agreement, Low evidence	Low agreement, medium evidence	Low agreement, much evidence
Level of agreement (on a particular finding)	Amount of evidence (number and quantity of independent sources) →		

habitats are directly cited in CBD Decision IX/20 as meeting these criteria, specifically:

1. breeding grounds
2. spawning areas
3. nursery areas
4. juvenile habitat
5. habitats of migratory species, including:
    a. feeding areas
    b. wintering areas
    c. resting areas
    d. breeding areas
    e. moulting areas
    f. migratory routes

Other types of areas that might meet these criteria considered by the break-out group were areas of larval dispersal, and feeding areas used during different life-history stages of seabirds (i.e., the potentially different areas seabirds forage in during incubation, brooding, chick-rearing periods). Finally, there was also consensus that greater attention on declining habitats (e.g., sea ice) was needed in the application of the importance to threatened species/habitat criterion, as the CBD offered no examples and the concept of declining habitat seems to get lost in the many species core-use areas that fall under these criteria.

Means of identification:

A number of documents describe the variety of means managers and researchers have at their disposal to define core use areas reflecting various life-history stages. These are listed below with some recent and relevant examples of their application (adapted from Ardron *et al.* 2008; BirdLife International 2009):

- For tracking data:
    - Sinuosity Analysis (Benhamou 2004; Grémillet *et al.* 2004)
    - Fractal Analysis (With 1994; Tremblay *et al.* 2007)
    - Time spent per area (Péron *et al.* 2010; Louzao *et al.* 2011)
    - First-Passage Time Analysis (Fauchald & Tavera 2003; Pinaud & Weimerskirch 2005; Kappes *et al.* 2010; Louzao *et al.* 2011)
    - State-Space Models (SSM) (Jonsen *et al.* 2003 & 2005; Eckert *et al.* 2008; Patterson *et al.* 2008; Bailey *et al.* 2010; Maxwell *et al.* 2011 & in press)
- For tracking and or survey data:
    - Kernel Home Range Analysis (Shillinger *et al.* 2008; Shillinger *et al.* 2010; Maxwell *et al.* 2011; Curtice *et al.* 2011; many others)
    - Regression, Machine Learning (CARTs, Random Forests, Bagged Decision Tree and other Habitat Modelling (Friedlaender *et al.* 2006; Torres *et al.* 2008; Bailey *et al.* 2010; Péron *et al.* 2010; Louzao *et al.* 2011; Zydelis 2011; Nur *et al.* 2011; many others)
    - Water mass distribution based on models of SST preferences (Hobday & Hartmann 2006; other Hobday papers; referred to in Louzao *et al.* 2011)

These methods can be used on both tracking data and survey data. The CBD will make further information on this subject available through their EBSA identification manual which is set to be released in September of 2011 (see also BirdLife International 2009). While these methods are useful in identifying important life-history areas for a given species, the delineation of EBSAs for every species of interest may not be useful. Practitioners should consider larger areas that incorporate the life-history stages of multiple species to make site identification and large-scale management more palatable. More specific, sector-based management may require more detailed information on the distribution of life history-stages of given species, but more general multi-species EBSAs should at least give an initial indication of areas requiring further consideration.

For the importance to threatened, endangered or declining species and/or habitats criterion, some classification will be needed to determine which species and/or habitats to consider. Species can be threatened at global, regional, national or local scales, so an appropriate classification should be fitted to the scale of analysis. The IUCN Red List provides a global classification of species risk of extinction, many regional agreements also contain annexes of threatened species that are of particular

[2] For more information see www.iobis.org, seamap.mgel.duke.edu, www.topp.org, www.seabirdtracking.org, www.movebank.org, www.seaturtle.org

focus. These types of agreed classification systems should be adopted wherever possible. The methods described above also apply to the importance to threatened, endangered or declining species and/or habitats. Fisheries observer data (catch, CPUE, bycatch, etc.) will also be of great use in identifying these areas. Although it is common practice to identify areas of importance to endangered, threatened and declining species by directly mapping areas of high bycatch (e.g., Lewison *et al.* 2009; Peterson *et al.* 2009a & b), it may be more appropriate in the context of EBSAs to use these data to generate habitat suitability models for species of interest (e.g., Zagaglia *et al.* 2004; Hobday & Hartmann 2006; Morris & Ball 2006; see also: Redfern *et al.* 2006). It is also possible to combine tracking data and fisheries observer data in dynamic habitat models (Zydelis *et al.* 2011).

Precautionary points:

- The observation data which drive identification of "core use" areas are often based on sex-, age- and/or life-history stage biased data. For example, most data on sea turtle habitat are based on tagging studies of nesting adult female sea turtles (Godley *et al.* 2008). Clearly such data do not adequately define all areas of importance for sea turtles. Similarly large amounts of data are available on many aspects of breeding seabirds distributions, but studies on movement of juveniles and during the non-breeding period are minimal by comparison (BirdLife International 2004). All efforts must be made to adequately incorporate any sex, age or life-history stage specific differences in habitat usage.
- Caution is necessary when interpreting results from small sample sizes, particularly when looking to extrapolate results from the study population to the wider population.
- This type of niche-partitioning in the pelagic realm is more likely to occur over a greater vertical extent than in any other biome. Thus, the inclusion of three-dimensional data when considering the delineation of pelagic EBSAs is important.
- Within a given pelagic species, life-history stages may also vary widely in scale. As such,

Gentoo penguins in the Antarctic Peninsula. Credit: A.S. Friedlaender sampling and modeling methods must be matched to the specific resolution and scale of the life-history stage being considered.

- Given the number of considerations being brought to bear on the description of core-use areas for the various life-history stages of a singles species, it is understandable that managers and policy makers might be interested in "umbrella" approaches and proxies to identifying EBSAs relevant to these criteria.
  - Top predators can be used as indicators of ecosystem health. Care is needed in choosing appropriate umbrella species, but this approach is reasonable in data limited situations.
  - Physical proxies for areas of importance to life-history stages or threatened species may also offer a means to identify such areas. For many life-history stages, process drives pattern – that is, physical processes govern where prey will be aggregated, and where trophic transfers occur. (See the Productivity criterion below for further discussion of this topic.)

Examples:

- Spawning area:
  - Coral triangle & Equatorial belt (tuna)
- Migratory route:
  - Straits of Gibraltar
  - Line islands – c. 60% of tracked sooty shearwaters use this as a migratory corridor/bottleneck
  - Pacific sea turtle migration corridors
- A larger area containing areas of importance to the life history of multiple species:
  - North Pacific Transition Zone – albatross and other seabirds, loggerhead sea turtles, seals, bluefin tuna
  - Tasman Sea – albatross and other seabirds
  - Patagonian Shelf – seabirds, seals
  - Sargasso Sea – sea turtles, seabirds, fish and sharks
  - Central Indian Ocean – seabirds
  - Humboldt Current

4.3 Biological Productivity

Summarized by Sara Maxwell

Participants: Steven Bograd (chair), Sara Maxwell (rapporteur), Natalie Ban, Nic Bax, Patricio Bernal, Elliott Hazen, Aurélie Spadone

Criteria:

Two areas of importance for determining areas of high biological productivity were considered: (1) areas that result in direct increases of productivity (i.e., upwelling regions) and (2) areas that result in spatial or temporal aggregation of productivity (i.e., fronts). The group considered productive areas to be those that are productive across multiple levels (i.e., primary, secondary and higher). In other words, the area must be important over multiple trophic levels and be persistent or recurrent in space and time. Thus, the three conditions used in determining areas of importance were:

1. Higher biomass or productivity than surrounding area; and
2. At least one level of trophic transfer; and
3. Be recurrent or persistent in space and time

For biologically productive areas there must be some sort of biological forcing that is transferred between trophic levels which may not be the case at, for example, calving grounds in which no foraging occurs.

Means of identification:

A number of mechanisms were identified that result in high biological productivity, including areas of upwelling – whether wind-driven, topographically-induced or equatorial. Some mechanisms result in increased nutrient availability including advection and mixing. Thermocline shoaling can also result in elevated productivity by concentrating productivity vertically; oxycline shoaling can result in similar compression. Aggregating features such as eddies and fronts retain and concentrate productivity both vertically and horizontally and can persist from days to months. Topographic features also increase biological productivity, either by physical forcing (interruptions of flow, upwelling, etc) or by congregating productivity. These features include canyons, shelf breaks, islands and seamounts.

These areas of productivity can be identified in a number of ways including by using:

- Remotely sensed data from the ocean's surface
- *In situ* oceanographic data (ships, moorings)
- Floats, drifters, biologgers (animal-borne data loggers)
- Climatologies for identifying areas of persistence
- Boat-based surveys such as those for marine mammals
- Fishing data (catch, CPUE, bycatch, etc)
- Predictive modeling of additional areas based on in-hand data
- OBIS, AquaMaps and other geographic databases
- Expert opinion

Precautionary points:

- Areas with high productivity can be determined by remote sensing but some productivity occurs in the water column, making these regions more difficult to detect (i.e., Oxygen Minimum Zone (OMZ) shoaling); the subsurface will always be data poor regardless of the region of the world because it cannot be detected by satellite, and *in situ* sampling is sparse and more frequently undertaken at the surface.
- Additionally, some surface productivity does not translate to higher trophic levels and this should be a caution, particularly in trying to determine EBSAs in data-poor regions. Where possible, it is critical to validate high-productivity regions detected via remote sensing and by ground-truthing with biological data (i.e., tagging data, survey data, etc).
- The process should be iterative and adaptive as we acquire more knowledge through time.
- Looking at historical changes to candidate EBSAs may be important for understanding the variability and persistence of the area, and in predicting future changes to these sites, particularly with regard to climate change.

Examples:

We chose the Equatorial Tropical Pacific as an example region and identified a number of potential areas of high biological productivity, the driving mechanisms and associated uncertainty (Fig. 5).

We further identified a number of examples of areas of biological productivity and assigned a level of certainty based on Williams *et al.* (1996) (see section 4.1 General guidelines) to each area discussed.

- Topographically induced upwelling:
  - West of Galapagos
  - Seasonal (Palacios 1999, 2002, 2004)
  - Used by top predators (blue whales, dolphins, sea lions, seabirds)
  - Data uncertainty: 1
- Wind driven:
  - Gulf of Papagayo and Tehuantepec
  - Identified with remote sensing data – SST, chlorophyll (Palacios *et al.* 2006)
  - Leatherback area (Bograd et al – unpublished)
  - Seasonally recurrent (Palacios *et al.* 2006, Chelton *et al.* 2000)
  - Data uncertainty: 2
- Thermocline shoaling:
  - Costa Rica Dome:
  - Lots of data (oceanographic and biological), ETP cruises (Fiedler 2002)
  - Clear remote sensing signal in sea-surface height, chlorophyll, SST (Fiedler 2002)
  - Persistence (Fiedler 2002)
  - High biomass of prey base (Fiedler *et al.* 1998) and top predators (Reilly & Thayer 1990; Fiedler 2002; Balance *et al.* 2006)
  - Data uncertainty: 1
- Shoaling of the OMZ (Area where some oxygen level reaches the photic zone):
  - *In situ* oceanographic data (Fuenzalida *et al.* 2009; Paulmier & Ruiz-Pino, 2009)
  - Persistent feature in time (Fuenzalida *et al.* 2009; Paulmier & Ruiz-Pino, 2009)
  - Vertical compression of habitat that creates a foraging hotspot (trophic complexity; Stramma *et al.* 2010)
  - Data uncertainty: 3

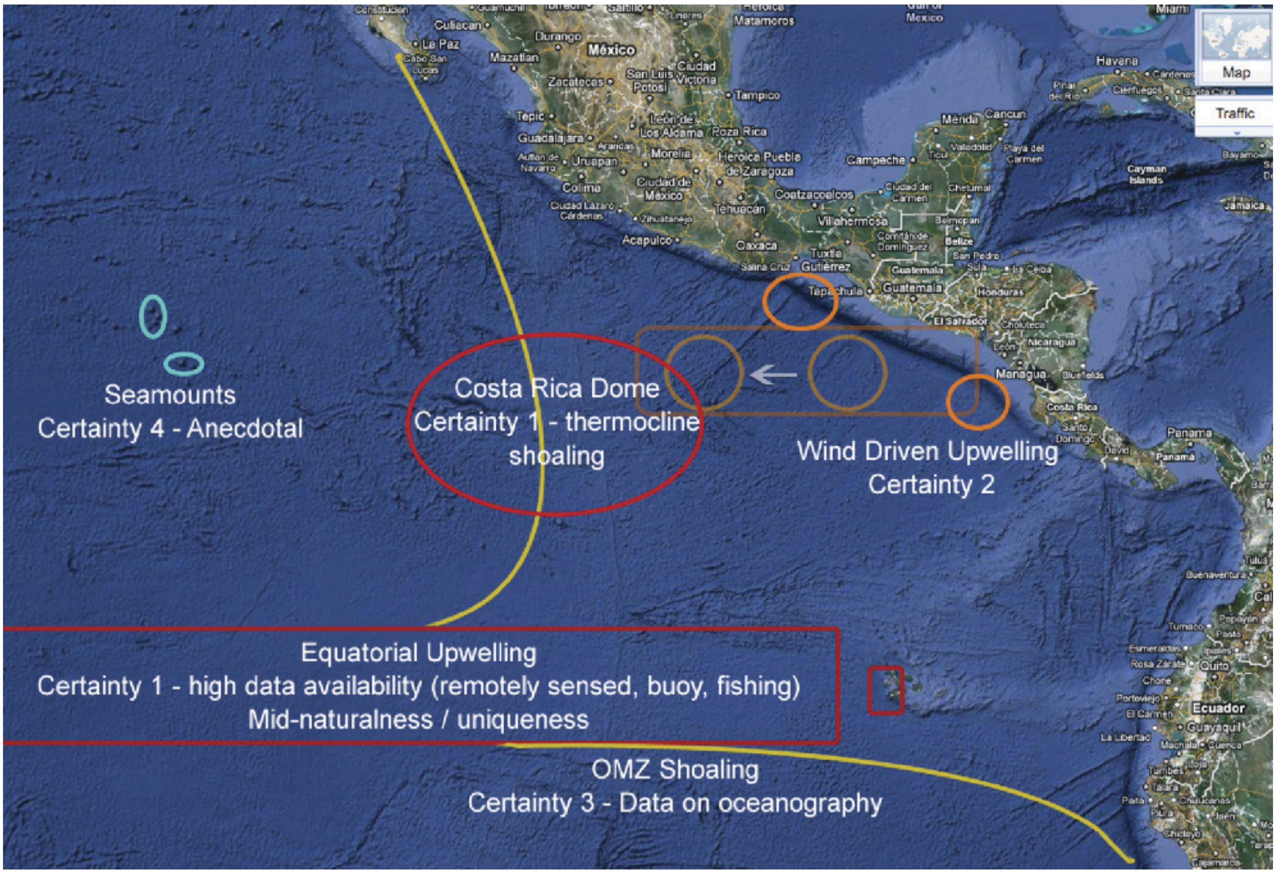


Figure 5: The Equatorial Tropical Pacific as an example of types of areas that might meet the Biological Productivity criterion.

4.4 Biological Diversity

Participants: Kerry Sink (chair), Jeff Ardron (rapporteur), Piers Dunstan, Hedley Grantham, Pat Halpin, François Simard, Franz Smith

Criteria:

As with the two previous criteria, quantifying biodiversity is a data-driven process. However, the data requirements for quantifying biodiversity are significantly harder to meet than in either of those criteria. We are not able to directly remote sense biodiversity as we can with many oceanographic variables, and data are required across all species and all regions. The understanding of pelagic biodiversity pattern lags behind that for benthic biodiversity and there has been less research aimed at elucidating key drivers of pelagic biodiversity pattern at the level of entire pelagic species assemblages. Observation data in the open ocean are generally opportunistic and of insufficient quantity to drive reliable biodiversity estimates, requiring researchers to use data from many different sources. Further, the sampling platform used to collect observation data also biases the estimate. For example, a box core does not sample the same type of organisms as trawl samples. Even two trawls may sample differently based on net characteristics, trawl configuration and the survey duration, location, depth and date/time. These issues are not unique to quantifying biodiversity in the pelagic open ocean, but the challenges mentioned in the introduction of collecting data in a vast, deep, distant and dynamic ocean make it far more difficult to do in the pelagic realm than in any other biome. Given these issues, every effort must be made to make use of available data including fisheries observer datasets and to support data collection programs (e.g., CoML) and data aggregation thorough data warehouses (e.g., OBIS, BirdLife International, Movebank, Seaturtle.org). This criterion was considered less relevant for application in the pelagic realm because of these challenges.

While further data are collected, there is still a need to understand how the biodiversity criterion can be applied in efforts to identify pelagic EBSAs. Three methods are available in the normal circumstance where insufficient data exist to quantify biodiversity through normal metrics: a Delphic approach, use of proxies, and use of predictive models. Through a Delphic approach, scientific, local and indigenous expert opinion can be used to begin a process to identify important pelagic areas that are then ground truthed. Proxies based on correlative or process models from other locations can suggest types of areas that may have increased levels of biodiversity. For instance, Morato *et al.* (2008) found that pelagic biodiversity increased within 40km of seamounts in the southwest Pacific. This information provides grounds for the hypothesis that the same would be true for seamounts in other regions, and thus the area around seamounts in any given region could be considered as a candidate EBSA. Finally, the use of predictive habitat models to drive quantification of biodiversity metrics is another available approach (see Ready *et al.* 2010, Tittensor *et al.* 2010). In each of these cases an adaptive approach is important so that further work can be done to verify the validity of, and adjust as necessary, the area proposed as an EBSA.

Means of identification:

- Traditional biodiversity indices:
  - Berger-Parker Index
  - Simpson's Index
  - Shannon-Wiener Index
  - Pielou's Evenness Index
  - Hurlbert (ES50) Index
- Species richness:
  - based on environmental envelopes (Kaschner 2007, Lucifora *et al.* 2011)
  - based on habitat models (Ready *et al.* 2010; Kaschner *et al.* 2011; Tittensor *et al.* 2010)
  - based on extrapolated species discovery curves (Tittensor *et al.* 2010)
  - based on fisheries catch data
- e.g., Worm *et al.* (2003 & 2005); Trebilco *et al.* (2011)
- distribution maps of relative abundance of target species from fisheries dependent and independent data (Grantham *et al.* 2011)
- Standardized abundance indices (-1 to 1) (Nur *et al.* 2011)
  - calculated for all species and then combined
- Summed weighted core areas (Nur *et al.* 2011)
  - inversely weighted by the size of the core area required by the species and then summed.
- Persistence of hotspot (Nur *et al.* 2011)
  - # of times the cell was in the top 5% of predicted abundance for a species across all years (11 max), averaged over all species
- Rank Abundance Distributions (Dunstan & Foster 2011)
- Proxies:
  - based on distance to seamount (Morato *et al.* 2008)
  - based on distance to frontal zone
  - based on areas of high prey species density:
- Interpolation of copepod biomass from *in situ* zooplankton samples (Grantham *et al.* 2011)
- Relative density of the deep scattering layer (DSL) based on acoustic sampling (Hazen *et al.* 2011)

Precautionary points:

- Not all biodiversity is the same. Thus it may be inappropriate to compare one place to another based on biodiversity indices unless it is known that the sites are biogeographically similar.
- Partly due to the problems just of comparing biodiversity mentioned above, global scale comparisons are less meaningful than regional scale comparisons.
- It bears repeating: Quantification of biodiversity metrics is linked to sampling methods, i.e., the sampling mechanism, the sampling effort, the extent of the area sampled in space and time, and variation in observer experience.
- As the list of methods above indicates, there is no single agreed-upon measure of biodiversity. Care should be taken to understand what the measure used actually quantifies (e.g., the total number of different species, the evenness of abundance of the different species, the phylogenic range of the samples, etc.).

Examples:

- Mediterranean hotspots (Coll *et al.* 2011)
- OBIS ES50 example (see GOBI illustrations)

European Storm-petrels. Credit: Ben Lascelles, BirdLife International

- Aquamaps marine mammal richness studies (Kaschner *et al.* 2011)
- Areas of high richness from pelagic fisheries data (Worm *et al.* 2003)
- Also see Worm *et al.* (2005); Tittensor *et al.* (2010); Trebilco *et al.* (2011)
- BirdLife International albatross hotspots (BirdLife International, 2004)

4.5 Uniqueness and Rarity

Participants: Elliott Norse (chair), Kristina Gjerde (rapporteur), Daniel Dunn, Eddie Game, Erwann Lagabrielle, Sheila McKenna, Franz Smith

Criteria:

The uniqueness and rarity criterion is likely the most easily understood of all the EBSA criteria. On a fundamental level this criterion stresses that "less is more": the smaller the geographic range, the fewer the number of habitats occupied, and the smaller the population size of a given species the rarer it is considered. These ideas were formalized by Rabinowitz (1981) as the seven forms of rarity. Given the incredible dynamism of the pelagic zone, we suggest a fourth factor, temporal periodicity (i.e., patterns in presence of a species or habitat in time), be added to the rarity matrix (Table 3). Uniqueness can simply be interpreted as the highest level of rarity – i.e., there is only one instance of the species or habitat.

Quantification of uniqueness and rarity on a species level relies on the same type of observation data as the biodiversity criterion, and is thus subject to the same biases and problems. In particular, rarity is highly correlated to sample size. Thus an adaptive approach is again recommended such that new estimates of rarity can be produced as more data are collected. The reliance on observation data also means that the same methods may be used in data-poor scenarios (i.e., with increasing complexity and data needs we recommend: a Delphic approach, use of proxies, and use of predictive models.)

However, quantification of rarity in habitat types may be done on a broader scale using remote sensing. For instance, polynyas (large, persistent regions of generally open water within thick pack ice) are specifically mentioned in Annex 2 to CBD Decision IX/20 as meeting the uniqueness and rarity criteria. Such features (and many others) can be identified, measured, counted and tracked with remotely sensed datasets. This is particularly important to the application of the EBSA criteria to pelagic areas, as these data are readily available on a global scale at resolutions relevant to regional and country-level planning and management (see the list of types of pelagic areas that may meet the EBSA criteria below). It is also critical to note that the description in Annex 2 to the CBD decision goes beyond merely identifying species and features in its definition of the uniqueness and rarity criterion to include "unique or unusual geomorphological or oceanographic features". This not only reiterates that types of oceanographic features may meet this criterion, but also broadens the conception of the criterion to include pelagically important geomorphological features like physical bottlenecks (i.e., areas like

Table 3: Fifteen forms of rarity: Categorization of rarity in the pelagic realm (modified from Rabinowitz 1981)

GEOGRAPHIC RANGE		*Large*		*Small*	
HABITAT SPECIFICITY		Wide	Narrow	Wide	Narrow
Frequent or Persistent	Large, dominant somewhere	Constantly, locally abundant over a large range in several habitats	Constantly, locally abundant over a large range in a specific habitat	Constantly, locally abundant in several habitats but restricted geographically	Constantly, locally abundant in a specific habitat but restricted geographically
	Small, non-dominant	Constantly sparse over a large range and in several habitats	Constantly sparse but frequent or persistent in a specific habitat but over a large range	Constantly sparse but frequent or persistent but geographically restricted in several habitats	Constantly sparse but frequent or persistent but geographically restricted in a specific habitat
Infrequent or Ephemeral	Large, dominant somewhere	Intermittently, locally abundant over a large range in several habitats	Intermittently, locally abundant over a large range in a specific habitat	Intermittently, locally abundant in several habitats but restricted geographically	Intermittently, locally abundant in a specific habitat but restricted geographically
	Small, non-dominant	Intermittent and sparse over a large range and in several habitats	Intermittent and sparse in a specific habitat but over a large range	Intermittent, sparse and geographically restricted in several habitats	Intermittent, sparse and geographically restricted in a specific habitat
TEMPORAL PERIODICITY	**LOCAL POPULATION SIZE**	**LESS RARE** --------->	--------->	--------->	**MORE RARE**

straits that physically reduce the amount of space a species has to move through, often increasing their vulnerability to a variety of stressors and impacts.)

Finally, in discussing and presenting examples of uniqueness and rarity in the pelagic realm, the group often found itself offering examples of what might be considered the "best" examples from other criteria. For example, the importance to life-history stage criterion and the importance to endangered species criterion have countless examples to depict each, yet few of these might be entirely unique or even comparatively rare (e.g., only one important site for a given life-history stage). However, there are examples, like the two known spawning aggregations of northern (Atlantic) bluefin tuna or the limited known range of the giant squid, which would meet the uniqueness or rarity criterion. The New Zealand Storm Petrel, Beck's Petrel and Fiji Petrel are all seabirds whose breeding sites are currently unknown, but they have been found at single sites at sea where they are known to regularly congregate. Similarly, endemic species and their habitats would be considered unique.

Means of identification:

- In data limited situations:
  - Delphic processes
  - Proxies
  - Predictive models
- When data are available:
  - Quantification of geographic range, habitat specificity and local abundance (see discussion above on the "forms of rarity")

- Superlative and uncommon examples from other criteria

Precautionary points:

- Uniqueness and rarity are entirely scale dependent. What is rare on a global level might be common on a local or regional level.
- 10.11. Assemblages/congregations (either of single or multiple species) can be rare or unique…

Habitat-specific examples:

- Aggregations of structure forming pelagic species:
  - Sargasso Sea
- Straits & Channels (i.e., physical bottlenecks):
  - Strait of Gibraltar
  - Strait of Messina
  - Strait of Malacca
  - Lombok Strait
  - Bering Strait
  - Sicilian Channel
- Domes:
  - Sumbawa Dome
  - Costa Rica Dome
  - Angola Dome
  - Guinea Dome
- Shallow submerged seamounts, banks, plateaus:
  - Saya de Malha Banks
  - Cortez Bank
  - Argos and Challenger Banks
  - Grand Banks
- On a regional or ocean basin scale:
  - Transition zones
  - Boundary currents
  - Upwelling zones

Species-specific examples:

- Endemic species
- Species with limited number of spawning aggregations/sites
- Aggregations/congregations

Blue whale. Credit: A.S. Friedlaender

4.6 Vulnerability, Fragility, Sensitivity, or Slow Recovery & Naturalness

Issues summarized by J. Ardron (Fragility) and N. Ban (Naturalness)

Criteria:

The fragility criterion and the naturalness criterion were not given the same consideration during the workshop (i.e., they were not topics for their own break-out groups). The main factor driving this decision was not that they were unimportant in the identification of pelagic EBSAs, but that their application in the open ocean was no different than in benthic or neritic environments. As such, the reader is encouraged to review other relevant literature which looks at these criteria in more depth. In particular we would recommend the forthcoming CBD *Training manual for the identification of ecologically and biologically significant areas (EBSAs) in the oceans*, and the *Report of the Expert Workshop on ecological criteria and biogeographic classification systems for marine areas in need of protection*, both of which contain guidelines on the application of the EBSA criteria.

Despite the lack of directed break-out groups, the workshop did come up with a few considerations which are unique to the pelagic realm or bear repeating due to their importance.

Considerations:

Naturalness

- It is critical that the naturalness criterion be not solely based on a snapshot of the present threats and impacts. Historical records or models of resource extraction and pollution are vital to a full understanding of naturalness in the pelagic realm. The trophic structure and functioning of many current ecosystems is a consequence of levels of use in the past, not the present. Further, consideration of future impacts should also be considered when applying this criterion. For example, climate change scenarios offer a means to understand possible levels of naturalness in the future.

- It is important to define baselines from which to judge the naturalness of an area. For example, many current systems differ significantly from pre-industrial times, however the lack of a baseline makes the degree of naturalness difficult to measure.

- The benthic and pelagic realms are not independent. Activities in the one realm can affect communities in the other. These cross-system impacts are more common than not – that is, most activities in one realm have some impact on the other. For example:
  - removal of top predators in a benthic system (who may be pelagic species) by pelagic fishing
  - mortality or behavioral changes in pelagic species from noise produced by energy exploration on the seafloor
  - increased transfer of organic matter to benthic communities from pelagic fishing
  - invasive species and pollution from shipping affects both realms

Fragility, Vulnerability, Sensitivity, or Slow Recovery

- Although cold water coral and chemosynthetic communities are often cited as examples of this criterion, the definition goes well beyond physical fragility and can be applied to a variety of pelagic species and habitats.

- Species that are overfished or where bycatch threatens population sustainability are likely “species that are… highly susceptible to degradation or depletion by human activity” (taken from the CBD Fragility criterion definition).

- Application of this criterion should include consideration of species that may be sensitive to climate change (e.g., krill reliant spp).

- Wasp waist ecosystems (mid-trophic changes) may be more sensitive to threats and stressors than more top-down or bottom-up governed ecosystems.

- Particular attention should be given to the vulnerability of coccolithophores to ocean acidification, given the importance of these organisms as a nutrient source in oligotrophic areas. Loss of the food source in such systems may produce drastic regime shifts.

5. Types of pelagic areas that may meet the EBSA criteria

5.1 Pelagic Areas Over Static Bathymetric Features

A. Continental shelf breaks

i. Examples:
   1. Benguela and Agulhas shelf break
   2. Middle and South Atlantic Bight shelf break
   3. Many more examples are readily available and easily defined

ii. Methods:
   1. Self-evident at coarse resolutions, finer resolutions lead to the identification of multiple breaks
      a. Usually approximated as -200m
      b. Theoretically could use the point of maximum acceleration along a slope (i.e., the maximum slope of the slope)

B. Seamounts

i. Examples:
   1. Ob and Llena South Crozet; Del Cano Rise between Crozet and Prince Edward seamounts (Louzao *et al.* 2011)
   2. Nazca Ridge and Sala y Gomez seamount chain
   3. Eratosthenes seamount
   4. Altair seamount (Ramirez *et al.* 2008)
   5. See also: Pitcher *et al.* (2007); Kaschner (2007); Morato *et al.* (2010)

ii. Methods:
   1. Generally looked at by distance from surface and rise from seabed.
      a. See Kitchingman & Lai (2004); Pitcher *et al.* (2007); Allain *et al.* (2008)
   2. Area of influence estimated:
      a. 10km on each side of the shelf break (Grantham *et al.* 2011; Campbell & Hobday 2003)
      b. 30-40km around the seamount (Morato *et al.* 2010)
   3. Can be identified using satellite tracking data for pelagic predators (Ramirez *et al.* 2008)
   4. See also: Kaschner (2007)

C. Submarine Canyons

i. Examples:
   1. The Gully (Hooker et al 1999)
   2. Mediterranean submarine canyons (Würtz 2011)

ii. Methods:
   1. Self-evident
   2. Can use methods based on terrestrial watershed analysis could apply
      a. Relative Slope Position index, Curvature, etc.

D. Areas of high slope (continental shelf breaks are a sub-class of this)

i. Examples:
   1. Southwest Indian Ridge (Louzao *et al.* 2011)

ii. Methods:
   1. Neighborhood Slope

E. Straits & channels (i.e., physical bottlenecks)

i. Examples:
   1. Sicilian Channel
   2. Strait of Messina
   3. Lombok Strait
   4. Strait of Malacca
   5. Strait of Gibraltar
   6. Bering Strait

ii. Methods:
   1. Self-evident from bathymetry

F. Areas of high rugosity

i. Methods:
   1. Bathymetric gradient (Louzao *et al.* 2011)
   2. Rugosity indices (see Dunn & Halpin 2009; Ardron & Sointula 2002; etc.)

G. Areas of terrestrial nutrient input (not necessarily static…)

- Wind-driven dust

i. Examples:
   1. Southern Mediterranean (Würtz 2011)
   2. Western mid-Atlantic?
   3. South Pacific (Bishop *et al.* 2002)

ii. Methods:
   1. Chlorophyll a levels

- River plumes (though must consider eutrophication effects)

i. Examples:
   1. Amazon and Orinoco Delta
   2. (Negative example: Mississippi Delta)

ii. Methods:
   1. Regionally increased Chlorophyll a levels and turbidity, decreased transparency, possibly decreased salinity levels

5.2 Persistent Hydrographic Features & Ephemeral Features

A. Coastal upwelling

i. Examples:
   1. Chile-Peru (Humboldt) Current System (Bernal *et al.* 1983)
   2. California Current (Bograd *et al.* 2009; Palacios *et al.* 2006; Nur *et al.* 2011)
   3. Benguela Upwelling System (Grnatham *et al.* 2011)
   4. Mauritanian upwelling area

ii. Methods:
   1. Chl a from space-borne sensors
      a. monthly max value (Grantham *et al.* 2011)
      b. Empirical orthogonal function (EOF) analysis of spatially & temporally detrended monthly values (Palacios *et al.* 2006)
   2. Based on SST and Chl a concentration (Klein & Castillo 2009)

B. Fronts & frontal systems

i. Examples:
   1. TZCF (Polovina 2001, 2005; Bograd *et al.* 2004; Palacios *et al.* 2006)
   2. Pacific coastal and marginal seas fronts (Belkin & Cornillon 2003)
   3. Fronts in Large Marine Ecosystems (Belkin *et al.* 2009)
   4. Ocean Fronts in the East China, Yellow and Bohai Seas (Hickox *et al.* 2000)
   5. Antarctic Polar Front (Moore *et al.* 1999)

ii. Methods:
   1. Can be based on Chl a, SST or SLA data
      a. Gradients based on within cell standard deviation (sd; Louzao *et al.* 2011)
      b. Neighboorhood sd (Gardner *et al.* 2008)
      c. Edge-detection algorithms (Cayula & Cornillion 1992, 1995; Ullman & Cornillon 1999, 2000; Diehl *et al.* 2002; Belkin & O'Reilly 2009)
   2. Based on water mass detection using SST (Hobday papers)

C. Currents

i. Examples:
   1. Agulhas
   2. Benguela
   3. California
   4. Canary
   5. Gulf stream
   6. Kuroshio

ii. Methods:
   1. Derived from SSH and SST

D. Eddies & eddy fields: offshore upwelling & downwelling

i. Examples:
   1. Global analysis of eddies (Chelton *et al.* 2007 & 2011)
   2. California current eddies (Palacios *et al.* 2006)
   3. East China Sea eddies (Kobayashi *et al.* 2011)
   4. Costa Rica Dome (Palacios et al 2006)
   5. The Gulfs of Tehuantepec, Papagayo & Panama (Palacios *et al.* 2006.)
   6. Persistent eddy fields
      a. Central North Pacific (Palacios *et al.* 2006)
      b. Northeastern Tropical Pacific (Palacios *et al.* 2006)

ii. Methods:
   1. SLA ±10cm (Chelton *et al.* 2011)
   2. High values from a time series of the standard deviation of the mean monthly SST and SSH (Polovina & Howell 2005)
   3. MSLA height exceeding ±10 cm as indicative of both strength and persistence of feature strength (Grantham *et al.* 2011; Alpine & Hobday 2007)
   4. See also Klein & Castillo (2009)

E. Oxygen minimum zone shoaling

i. Examples:
   1. Eastern South Pacific (Fuenzalida *et al.* 2009; Paulmier & Ruiz-Pino 2009)
   2. Eastern North Pacific (off of Mexico & California)
   3. Northern Indian Ocean
   4. Arabian Sea (Morrison *et al.* 1999)
   5. Bay of Bengal (Paulmier & Ruiz-Pino 2009)

ii. Methods:
    1. Generally cited as waters with ≤20 μM of dissolved oxygen
        a. most references use the World Ocean Atlas 2001 (WOA01) dataset.

F. Thermocline Shoaling

i. Examples:
    1. Over domes:
        a. Costa Rica Dome (Fiedler 2002; Palacios *et al.* 2006)

ii. Methods:
    1. Analysis of hydrographic data (vertical profiles of temperature and salinity)

G. Retention areas

i. Examples:
    1. Eddies (see above)
    2. Taylor columns
    3. Coastal retention areas:
        a. Eg. California current retention areas:
            i. The Strait of Juan de Fuca Eddy Retention Zone
            ii. Central California Retention Zone
            iii. The Southern California Bight Retention Zone

ii. Methods:
    1. Indices of larval retention based on:
        a. Altimetry data driven circulation models (Polovina *et al.* 1999; Polovina & Howell 2005)
        b. Regional Ocean Modelling System (ROMS) derived from Lagrangian particle tracking (Grantham *et al.* 2011)

H. Divergence/Convergence zones

i. Examples:
    1. Inter-tropical Convergence Zone (ITCZ; Zagaglia 2004)
        a. South Pacific Convergence Zone (SPCZ)
    2. Crozet and Kerguelen Basins, and over the Southwest Indian Ridge (Louzao *et al.* 2011)

ii. Methods:
    1. SSH
    2. Oceanographic models (ROMS, etc.)
    3. Water mass distribution based on SST (Louzao *et al.* 2011; Hobday papers)

I. Oceanic gyres

i. Examples:
    1. South Pacific Gyre (Shillinger *et al.* 2008)
    2. Sargasso Sea (McKenna & Hemphill 2009)
    3. Rhodes Gyre

ii. Methods:
    1. Low eddy kinetic energy (EKE; Shillinger *et al.* 2008)

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Appendix 1. Participants List

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Bax, Nic – CSIRO
Bograd, Steven – NOAA Pacific Fisheries Environmental Lab, Tagging of Pacific Predators
Corrigan, Colleen – UNEP-World Conservation Monitoring Center
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Game, Eddie – The Nature Conservancy
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Hazen, Elliott – NOAA Pacific Fisheries Environmental Lab
Lagabrielle, Erwann – Nelson Mandela Metropolitan University
Lascelles, Ben – BirdLife International
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McKenna, Sheila – Ind. Consultant, Sylvia Earle Alliance, Member of IUCN, WCPA
Nicol, Simon – Secretariat of the Pacific Community, Oceanic Fisheries Programme
Norse, Elliott – Marine Conservation Institute
Palacios, Daniel – NOAA Pacific Fisheries Environmental Lab; Tagging of Pacific Predators
Reeve, Lora – University of Hawaii
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Simard, François – IUCN
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Appendix 2. CBD Decision IX/20 Annex I & II

DECISION IX/20 – ANNEX I [ADOPTED AT CBD COP 9 MAY 30, 2008]

SCIENTIFIC CRITERIA FOR IDENTIFYING ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS IN NEED OF PROTECTION IN OPEN-OCEAN WATERS AND DEEP-SEA HABITATS

Criteria	Definition	Rationale	Examples	Consideration in application
Uniqueness or rarity	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	• Irreplaceable • Loss would mean the probable permanent disappearance of diversity or a feature, or reduction of the diversity at any level	*Open-ocean waters* Sargasso Sea, Taylor column, persistent polynyas. *Deep-sea habitats* endemic communities around submerged atolls; hydrothermal vents; sea mounts; pseudo-abyssal depression	• 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
Special importance for life-history stages of species	Areas that are required for a population to survive and thrive	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	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)	• Connectivity between life-history stages and linkages between areas: trophic interactions, physical transport, physical oceanography, life history of species • Sources for information include: e.g., remote sensing, satellite tracking, historical catch and by-catch data, vessel monitoring system (VMS) data • Spatial and temporal distribution and/or aggregation of the species
Importance for threatened, endangered or declining species and/or habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species	To ensure the restoration and recovery of such species and habitats	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)	• Includes species with very large geographic ranges. • In many cases recovery will require re-establishment 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

Criteria	Definition	Rationale	Examples	Consideration in application
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	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	*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	• Interactions between vulnerability to human impacts and natural events • Existing definition emphasizes site-specific ideas and requires consideration for highly mobile species • Criteria can be used both in its own right and in conjunction with other criteria
Biological productivity	Area containing species, populations or communities with comparatively higher natural biological productivity	Important role in fuelling ecosystems and increasing the growth rates of organisms and their capacity for reproduction	• Frontal areas • Upwellings • Hydrothermal vents • Seamounts polynyas	• 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 • Time-series fisheries data can be used, but caution is required

Criteria	Definition	Rationale	Examples	Consideration in application
Biological diversity	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity	Important for evolution and maintaining the resilience of marine species and ecosystems	• Sea-mounts • Fronts and convergence zones • Cold coral communities • Deep-water sponge communities	• 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 • Can be inferred from habitat heterogeneity or diversity as a surrogate for species diversity in areas where biodiversity has not been sampled intensively
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	• To protect areas with near natural structure, processes and functions • To maintain these areas as reference sites • To safeguard and enhance ecosystem resilience	Most ecosystems and habitats have examples with varying levels of naturalness, and the intent is that the more natural examples should be selected	• 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 • Criteria can be used both in its own right and in conjunction with other criteria

DECISION IX/20 – ANNEX II [ADOPTED AT CBD COP 9 MAY 30, 2008]

SCIENTIFIC GUIDANCE FOR SELECTING AREAS TO ESTABLISH A REPRESENTATIVE NETWORK OF MARINE PROTECTED AREAS, INCLUDING IN OPEN OCEAN WATERS AND DEEP-SEA HABITATS

Required network properties and components	Definition	Applicable site specific considerations *(inter alia)*
Ecologically and biologically significant areas	Ecologically and biologically significant areas are geographically or oceanographically discrete areas that provide important services to one or more species/populations of an ecosystem or to the ecosystem as a whole, compared to other surrounding areas or areas of similar ecological characteristics, or otherwise meet the criteria as identified in annex I. Representativity is captured in a network when it consists of areas representing the different biogeographical subdivisions of the global oceans and regional seas that reasonably reflect the full range of ecosystems, including the biotic and habitat diversity of those marine ecosystems	• Uniqueness or rarity • Special importance for life-history stages of species • Importance for threatened, endangered or declining species and/or habitats • Vulnerability, fragility, sensitivity or slow recovery • Biological productivity • Biological diversity • Naturalness
Representativity	Representativity is captured in a network when it consists of areas representing the different biogeographical subdivisions of the global oceans and regional seas that reasonably reflect the full range of ecosystems, including the biotic and habitat diversity of those marine ecosystems	A full range of examples across a biogeographic habitat, or community classification; relative health of species and communities; relative intactness of habitat(s); naturalness
Connectivity	Connectivity in the design of a network allows for linkages whereby protected sites benefit from larval and/or species exchanges, and functional linkages from other network sites. In a connected network individual sites benefit one another	Currents; gyres; physical bottlenecks; migration routes; species dispersal; detritus; functional linkages. Isolated sites, such as isolated seamount communities, may also be included
Replicated ecological features	Replication of ecological features means that more than one site shall contain examples of a given feature in the given biogeographic area. The term "features" means "species, habitats and ecological processes" that naturally occur in the given biogeographic area	Accounting for uncertainty, natural variation and the possibility of catastrophic events. Features that exhibit less natural variation or are precisely defined may require less replication than features that are inherently highly variable or are only very generally defined
Adequate and viable sites	Adequate and viable sites indicate that all sites within a network should have size and protection sufficient to ensure the ecological viability and integrity of the feature(s) for which they were selected	Adequacy and viability will depend on size; shape; buffers; persistence of features; threats; surrounding environment (context); physical constraints; scale of features/processes; spillover/compactness

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IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges.

IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, NGOs, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,000 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world.

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