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Identifying Ecologically and Biologically Significant Areas on Seamounts

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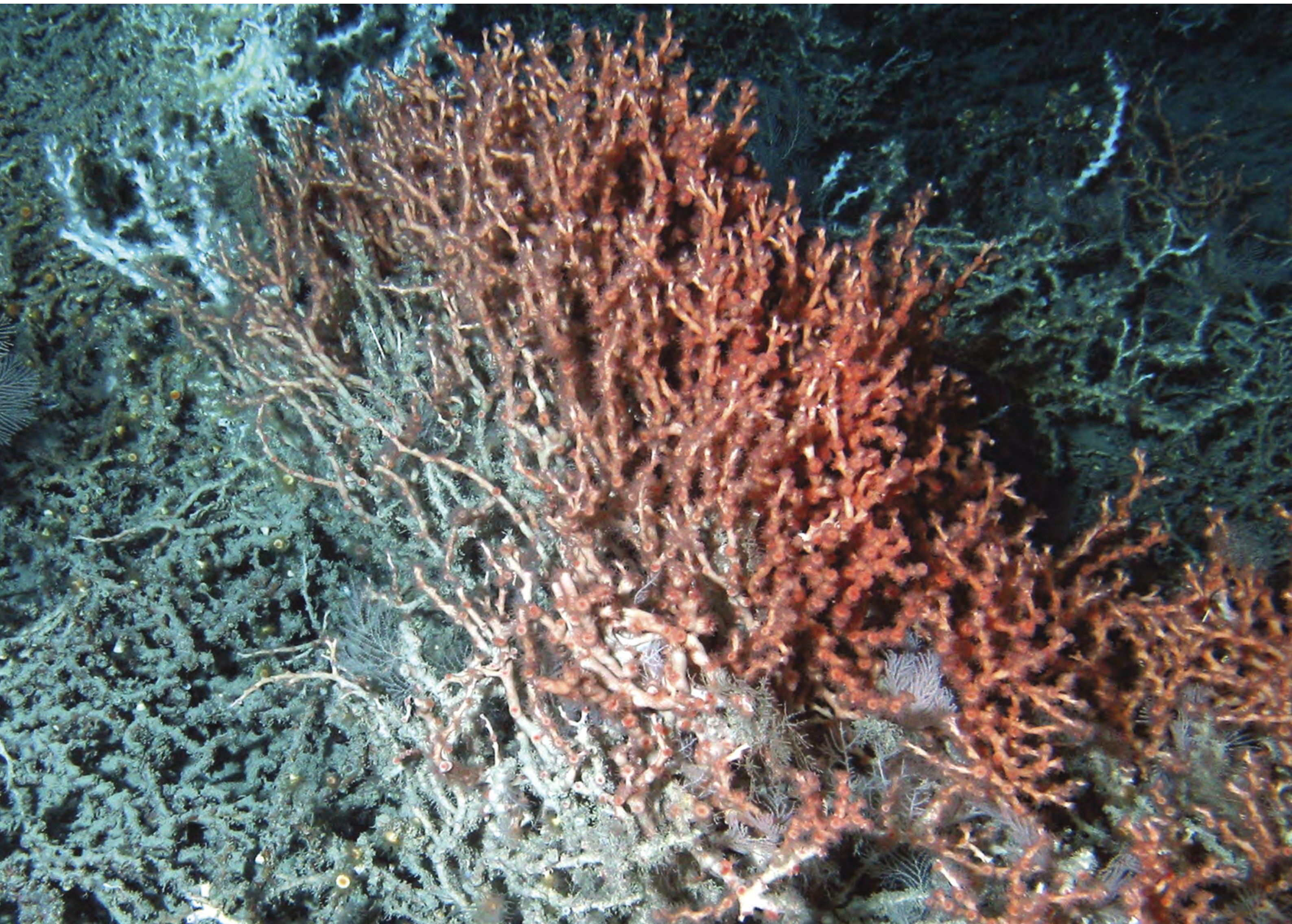
Identifying Ecologically and Biologically Significant Areas on Seamounts

Workshop Report



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Identifying Ecologically and Biologically Significant Areas on Seamounts

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Table of Contents

Introduction

Seamounts are major topographic features on the high seas and form distinctive habitats in areas that would otherwise be dominated by sedimentary plains (Clark *et al*. 2010). They are typified by biota that is distinct from species in surrounding sedimentary areas and can be extremely vulnerable to disturbance (Clark *et al*. 2010). They are a focus for conservation within national boundaries but are not specifically managed on the high seas. Seamount ecosystems have been highlighted by the United Nations General Assembly as vulnerable to fishing (resolutions 61/105, and 59/25, United Nations 2006) and the Food and Agriculture Organization of the UN has developed International Guidelines for the Management of deep-sea fisheries in the High Seas (FAO 2009). Conservation needs for seamounts have been identified in recent years (e.g., Probert *et al.* 2007) including the need for a protected area system to protect seamount biodiversity, and ecosystem structure and function (e.g., Johnston & Santillo 2004; George *et al.* 2007).

In 2008 the Conference of the Parties to the Convention on Biological Diversity (COP9, Bonn, Germany) adopted a set of seven scientific criteria to identify ecologically and biologically significant areas (EBSAs) in the global marine realm (CBD 2009). These criteria had been developed over several years, and consolidated at a CBD Expert Workshop on Ecological Criteria and Biogeographic Classification Systems for Marine Areas in Need of Protection held in the Azores in 2007. Using the CBD EBSA criteria to identify specific ocean areas that require enhanced management and protection can thus help to achieve a variety of international management and conservation objectives.

The Global Ocean Biodiversity Initiative (GOBI; www.gobi.org) is an international partnership advancing the scientific basis to identify marine areas outside national jurisdiction that are in need of protection. GOBI aims to help countries, as well as regional and global organizations, to use and develop data, tools, and methodologies to identify ecologically and biologically significant areas (EBSAs) with a focus on the high seas and deep seabed beyond national jurisdiction. GOBI is identifying regions and biomes in the high seas where there is sufficient information to begin the identification of candidate EBSAs, and GOBI is assisting the CBD in the collection of data that would help the identification of candidate EBSAs to inform spatial management of the open ocean and deep seas by competent authorities.

In appendix II to Decision IX/20 that established the EBSA criteria, the CBD specifically cites seamounts as an example of the first criterion, Uniqueness & rarity. To take advantage of the breadth of knowledge about seamounts held by CENSEAM (the global census of marine life on seamounts (http://censeam.niwa.co.nz) which was a field programme within the Census of Marine Life), GOBI and CENSEAM organized a joint workshop that was held in December 2011 to progress the identification of EBSAs for seamounts in the high seas.

The workshop had three primary goals:

- Determine suitable data for the identification of EBSAs for seamounts
- Develop a process for the identification of priority EBSAs for seamounts
- Identify candidate EBSAs from existing seamount data and knowledge.

1. Provisional process for identification of EBSAs

1.1 Are all EBSA criteria created equal?

The EBSA criteria, taken individually suggest that each one is of equal value. However, due to the broad definitions of the criteria and the sparse data available for the high seas, many areas would be labelled significant in some way without information to differentiate them. However, some of the criteria may be less relevant to particular biomes. In the case of seamounts on the high seas, it is apparent that some of the criteria do not have the same relevance. For example, criterion 7 (Productivity) can, in general, only be weakly linked to biodiversity on seamounts. In contrast, criteria 1 and 3 (Uniqueness or rarity, and Importance for threatened, endangered or declining species/habitats) are more clearly identified with seamount habitats which do possess some endemic species and are a system under threat. Criteria 1 and 3 are also closely linked to FAO VME criteria (FAO 2009) although VMEs must be assessed relative to threats, whereas EBSA criteria can be met without consideration of human impact.

Thus, when considering seamounts, the EBSA criteria fall into a natural ranking of relevance. This ranking will be different for other habitats or biomes, and there may be some situations where all the criteria are considered of equal relevance. Five of the criteria were considered essentially biological in nature, criteria 1, 2, 3, 5 and 6. The remaining criteria, 4 and 7 both contain elements of human interaction and can be separated from the purely biological criteria. This separation is a similar interpretation to the one suggested by the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) working group (CBD 2009).

If criteria are considered to have a relevance rank and be of two types, then it follows that they must be combined in some way that reflects these

Table 1: EBSA criteria ranked according to the suggested importance of the criteria for seamounts

Criterion	Type of criterion	Comments
C1 – Uniqueness or rarity	Biological	C1 & C3 ranked with equal importance as the most important biological criteria for seamounts
C3 – Importance for threatened, endangered or declining species and/or habitats		
C2 – Special importance for life-history stages of species	Biological	Allows identification of areas that may have importance for fish stocks or conservation management
C6 – Biological diversity	Biological	Diversity is important but comprehensive data is sparse
C5 – Biological productivity	Biological	There is only a weak link between surface productivity and seamounts limiting the usefulness of this criteria
Human impacts assessed separately to biological criteria		
C4 – Vulnerability, fragility, sensitivity, or slow recovery	Human impact on vulnerable and fragile biota	The vulnerability of species present to change and disturbance. This may be linked to aragonite saturation layer and climate change in the long term
C7 – Naturalness		Impact of fishing

differences. Several possibilities (e.g., multi-criteria decision analysis) were discussed within the workshop. It was felt that a tractable way to explore methods for combining criteria was to map the distributions of seamounts meeting each criterion, and compare potential EBSAs that arise from a number of different combinations of criteria. It would also be useful to quantify the degree of certainty associated with the data used to inform each criterion. For example, direct measurements will have a higher level of confidence than modelled data, although modelled data will typically be at a broader scale. However, a method to assign confidence to the final combination of criteria was not explored any further in the workshop.

1.2 Provisional process

Without prejudging the future development and refinements of the process to identify EBSAs under the CBD, the participants considered it appropriate to agree on an initial set of steps that could be practically addressed at this meeting as a *Provisional Process* to identify EBSAs on seamounts.

1. Identify the region to be examined – can include multiple biogeographic provinces.
2. Determine appropriate datasets to use for the evaluation, and where appropriate identify gaps.
3. Evaluate the data for each seamount against a set of agreed criteria.
4. Identify an area or areas in which seamounts have high scores (some composite of scored criteria) – taking an area assumes that a functional EBSA is likely to be larger than an individual seamount.
5. Following established procedures, make available a draft submission for identified EBSAs through the CBD repository for consideration by the appropriate regional process, complete with supporting documentation and description of data used.

The workshop further tasked itself with:

- Evaluating the strengths and weaknesses of the provisional process and the GOBI's online candidate EBSA submission tool.
- Considering future data needs, analyses and enhancement of the process.

1.3 A global or regional approach?

A key decision to make at the outset of the process is the scale at which EBSA identification is to be considered. Approaches and data sources differ from a global or regional viewpoint, and the interpretation of criteria may also differ. Global-scale data may be at a coarse resolution, whereas regional datasets may be much more detailed. An important element in determining an appropriate scale is information on biogeographical boundaries; within one biogeographic region faunal communities are expected to be generally similar. The most recent example of a benthic-based biogeographical classification is the Global Open Oceans and Deep Seabed (GOODS) biogeographical classification (UNESCO 2009). This classification potentially provides a framework for identifying regions that have similar biogeography and can be used to partition the benthic realm to reduce the area that needs to be considered at any one time. The classification also includes a depth component, so that biogeographic regions are separated spatially and by depth. However, any use of GOODS needs to acknowledge that while it is currently the best available global biogeographic classification, as additional data and information become available it will need to be modified (e.g., O'Hara *et al.* 2011).

The definitions and interpretations of EBSA criteria have been developed as part of the CBD technical workshop in 2009 (CBD 2009). The intent of the EBSA criteria is global (CBD expert workshop 2009). However, the decision of COP10 (X/29.26) places responsibility of EBSA identification to States and competent international bodies. There is also a regional process developing to identify potential EBSAs.

Adopting a biogeographic approach allows regional experts with access to the most spatially relevant data and knowledge to make evaluations more confidently than a single global approach. The workshop identified a provisional process that can be refined to identify seamounts/areas that meet EBSA criteria within any biogeographic region.

1.4 Available data on EBSA criteria for seamounts

Criterion 1: Uniqueness and rarity

There are only a few sporadic records for individual endemic species from seamounts in the literature (e.g., Webber and Booth 1995). Levels of faunal uniqueness (that can include forms of endemism) and rarity on seamounts is difficult to determine without a comprehensive survey of all seamounts within the region of interest. There are such potential datasets only for limited regions, shallow seamounts and for some selected phyla (e.g., ophiuroids; O'Hara *et al.* 2011). However, criterion 1 allows for physical uniqueness to be substituted for biological uniqueness. Recent mapping using radar topology (Yesson *et al.* 2011) can be used to identify 'potential' seamounts within a region of interest. Isolated seamounts or discrete chains of seamounts may be considered to be expressing a unique physical character within a region which could be linked to a unique biological character (including levels of endemism). The Yesson *et al.* (2011) dataset also includes seamount summit depth, and so particularly shallow or deep seamounts can be identified which are also likely to have different faunal communities. A further quantifier of uniqueness is the presence of hydrothermal vents on seamounts. Data exist for the presence of vents and vent communities on seamounts (http://www.noc.soton.ac.uk/chess/database/db_home.php), although these data are far from complete.

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

There is little information available on the importance of seamounts for the life-history stages of species, particularly for invertebrates in the high seas. However, some information is available for fish species (Clark 2008). The key dataset for this criterion for seamounts is known spawning areas for fish species. Some commercial species are known to aggregate over particular seamounts to spawn. These data will almost always be on a regional/national level and will require collaboration with the relevant national scientific bodies to obtain.

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

The IUCN Red List provides a comprehensive list of species that are threatened, endangered or declining (http://www.iucnredlist.org/). This list may be complemented with similar national lists. These lists can be compared to the records from OBIS and SeamountsOnline of species sampled on or around seamounts. This comparison allows identification of seamounts with threatened, endangered or declining species.

Criterion 4: Vulnerability, fragility, sensitivity and slow recovery

The biota on seamounts deemed to be the most vulnerable, fragile, sensitive and slow to recover are cold-water corals. However, not all seamounts are suitable for coral-water corals; in particular some seamounts may be too deep or shallow to host biogenic reef-forming stony corals. There are maps describing the global distribution of cold-water corals on seamounts (Rogers *et al.* 2007), as well as global maps that predict habitat suitable for stony corals (e.g., Tittensor *et al.* 2009; Davies & Guinotte 2011). Other potential data sources include FAO or RFMO records of Vulnerable Marine Ecosystem (VME) species (which include corals), sensitivity to aragonite saturation depth and assessments on the vulnerability of particular seamounts to fishing impacts (Clark & Tittensor 2010).

Criterion 5: Biological productivity

Data for surface chlorophyll a are relatively easy to obtain from satellite observations. These data can be obtained from either MODIS (http://modis.gsfc.nasa.gov) or SeaWIFS (http://oceancolor.gsfc.nasa.gov/SeaWiFS). Estimates of chlorophyll a have been used to produce global surface productivity models (e.g., Behrenfeld and Falkowski 1997) that can be obtained from http://www.science.oregonstate.edu/ocean.productivity. The flux of productivity (as particulate organic carbon – POC) from the surface mixed layer to the seafloor has been calculated (e.g., Lutz *et al.* 2009), but data are rarely available at the scale of individual seamounts and is based on modelled sinking, dispersal, and predation rates with depth. Coupled biophysical models are being developed that would potentially have improved resolution and relevance at depth, but remain to be validated.

Criterion 6: Biological diversity

Robust estimates of biological diversity are difficult to obtain for seamounts, even within a regional context. Species richness data for restricted taxa (e.g., ophiuroids, galatheid decapods) have been collected from a number of seamounts (e.g., O'Hara and Tittensor 2010), but this is not sufficient to cover all the seamounts globally or even within an ocean basin. Data from OBIS (www.iobis.org) has been used to estimate the species richness of all species within 0.1 degree square cells for the global oceans (www.iobis.org/maps). However, these estimates are dependent on the number of samples taken within each cell (which varies considerably), but in the absence of any other suitable information, could be considered as a broad indication of the diversity that may be associated with seamounts within a cell.

Criterion 7: Naturalness

The key human impact currently for seamounts is benthic fishing, especially bottom trawling (Clark & Koslow 2007). There are global and regional estimates of fishing pressure (e.g., Halpern 2008) that can be used as a proxy for the naturalness of the seamount – how undisturbed it is. Within national boundaries, areas identified as Marine Protected Areas may also indicate a high state of naturalness.

2. An example from the South Pacific Ocean

The workshop was used to demonstrate the provisional process for selecting a region, obtaining appropriate data, evaluating EBSA criteria, identifying areas for seamounts that meet EBSA criteria, and submitting an application for candidate EBSAs to the GOBI online submission portal.

2.1 The region

A region in the South Pacific Ocean, from the Australian EEZ to the Chilean EEZ and latitudes 20 to 60 degrees south, was selected because the majority of workshop participants were familiar with the seamounts and biota of this region. The region encompasses two biogeographic provinces and seafloor at water depths from 50–4,000m. Yesson *et al.* (2011) predict a total of 3,451 seamounts within this region.

2.2 Evaluate the criteria for each seamount

Each of the criteria and corresponding datasets was assessed independently. A GIS system was used to convert each dataset into a spatial layer. This layer was assessed to determine which seamounts met the cut-off for each criteria. A particular seamount was given a score of 1 if it met the EBSA criterion or 0 if it did not. Thus each seamount had seven possible scores of 1 or 0. Seamounts could be sorted by their importance, and evaluated to identify areas of varying

Table 2: Available data sets for assessing the EBSA criteria used in this example

Criterion	Data used and cut-off	Data source
C1 – Uniqueness or rarity	Summit depth <200m or >4250m; 2.5% shallowest and 2.5% of the deepest seamounts in the region Presence of vent communities Presence of *Jasus caveorum* (an endemic lobster species)	Yesson *et al.* (2011) www.noc.soton.ac.uk/chess Webber and Booth (1995)
C3 – Importance for threatened, endangered or declining species and/or habitats	IUCN Red List species found in OBIS records on or above seamounts	www.iobis.org www.iucnredlist.org
C2 – Special importance for life-history stages of species	Spawning areas of orange roughy	Anderson (2006) Clark (2008)
C6 – Biological diversity	OBIS species richness estimate for cell containing seamount data, 5% most abundant selected ES50 >42	www.iobis.org
C5 – Biological productivity	POC exported out of the mixed layer to the seafloor, highest 5% of POC concentration selected Flux >= 2.07	Lutz *et al.* (2009)
C4 – Vulnerability, fragility, sensitivity, or slow recovery	Seamounts with stony coral habitat suitability greater than 70%	Davies and Guinotte (2011)
C7 – Naturalness	Seamounts with known fishing activity. Seamounts without known fish catch selected	Clark and Tittensor (2010)

significance depending on how many categories were identified and how many met the criteria. Using the available datasets, there was no single seamount within the region that met all the EBSA criteria. Equally, if only one criterion is necessary to identify an area then 3,300 seamounts out of a possible 3,451 could be selected. Thus, there was a clear need to identify areas between needing all criteria and only needing one.

2.3 Evaluate a combination of criteria for seamounts

Clearly, for the datasets we considered, selecting only one or all criteria did not provide sufficient information to distinguish potential EBSAs. The workshop evaluated mechanisms whereby the scores from each criterion could be combined. In addition to the all criteria combination, three other possible schemes were trialled, based on selection using AND/OR format statements.

This is not an exhaustive list of the possible combinations but represents a suite of outcomes. The use of established methods for combining criteria (e.g., multi-criteria analysis) may further refine the selection of areas. The workshop considered a large number of possible combinations and used GIS software to display the results of the options. We looked for combinations that would produce a reasonable number of seamounts that could be combined into larger areas. After trying a large number of possibilities it was apparent that a limited number of locations were consistently identified.

2.4 Identify candidate EBSAs

The 340 seamounts that were selected by the combination of the criteria scores were viewed on a map of the region using GIS as the best possible combination of EBSA criteria (option 5). These seamounts were grouped in four distinct areas (Fig. 1). They were the Nazca and Sala y Gomez seamounts Ridge in the eastern Pacific, the Foundation seamounts in the central Pacific, the Louisville seamount chain east of New Zealand and Three Kings Ridge, north of New Zealand.

Each of the candidate areas for the South Pacific Ocean region was given a score of Low/Medium/High depending on the number of individual seamounts in the area that met each

Table 3: Different options for combining EBSA criteria

Option	Combination of criteria	Number of seamounts
Option1 – all criteria	C1 & C3 & C2 & C6 & C5 & C4 & C7	No seamounts selected
Option 2 – any criteria	C1 or C3 or C2 or C6 or C5 or C4 or C7	3,373 seamounts selected
Option 3 – All biologically important (C1, 2 & 3) and human impacts (C4 & 7)	C1 & C2 & C3 & (C6 or C5) & (C4 & C7	0
Option 4 – Any biologically important (C1 or 2 or 3) and human impacts (C4 & 7)	(C1 or C2 or C3) & (C6 or C5) & (C4 & C7)	58
Option 5 – Any biologically important (C1 or 2 or 3 or 6 or 5) and human impacts (C4 & 7)	(C1 or C3 or C2 or C6 or C5) & (C4 & C7)	340 seamounts selected

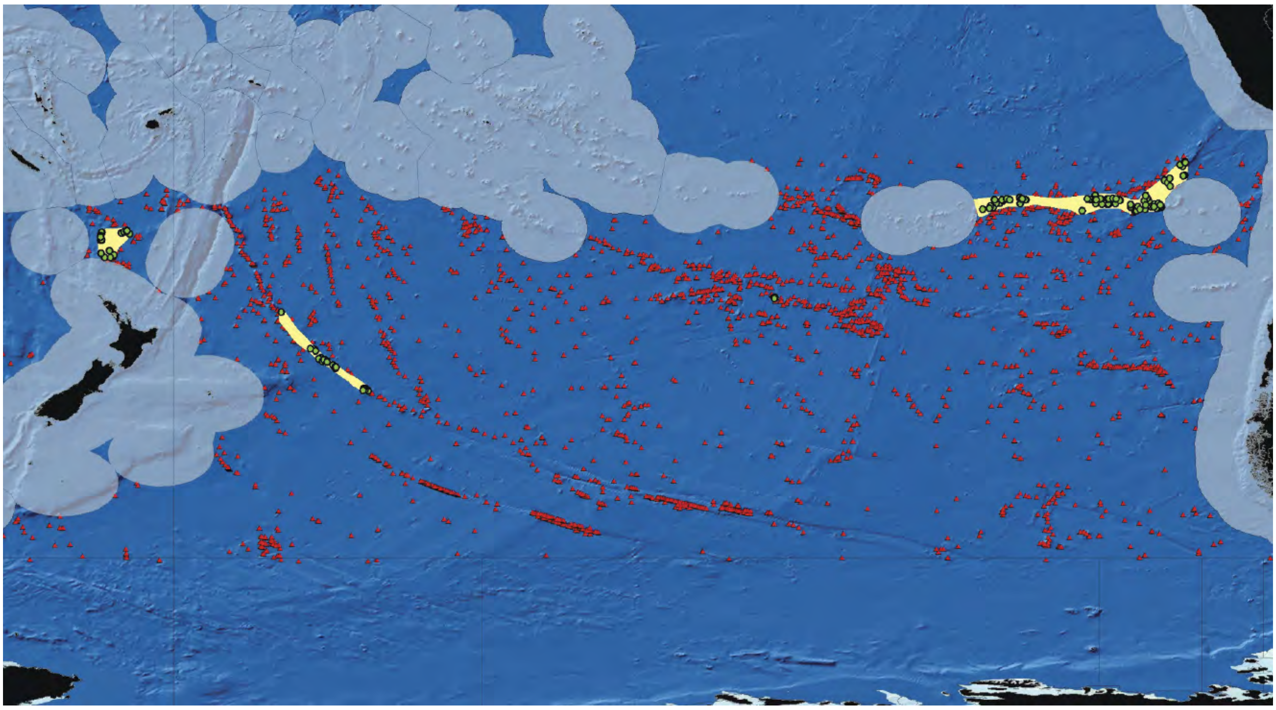

Figure 1: Seamounts (red dots) in the South Pacific Ocean and the four areas that contain seamounts (green dots) identified as meeting a combination of EBSA criteria. (a) Three Kings Ridge, (b) Louisville seamount chain, (c) Foundation seamounts (note the single green dot), (d) The Nazcar- Sala y Gomez seamounts Ridge. Seamount location data are from Yesson et al. *(2011).*

EBSA criteria independently (Table 4). A score of High indicates that almost all the seamounts met the criteria, a score of Medium indicates that approximately half the seamounts met the criteria and a score of Low indicates that almost none of the seamounts met the EBSA criteria.

The Nazca and Sala y Gomez seamounts Ridge has 15 out of 94 seamounts in shallow water and has a high proportion of the total number of shallow seamounts in the region and met the criteria for unique habitats. The area is lightly fished with only 12 seamounts with reported

Table 4: Scores for each of the potential EBSAs identified based on the number of seamounts that met the criteria

EBSA criterion	**Candidate EBSAs**			
	Nazca and Sala y Gomez	Foundation	Louisville	Three Kings
C1	L	H	L	L
C2	L	L	H	L
C3	H	L	L	H
C4	H	H	H	H
C5	L	L	M	H
C6	M	L	L	L
C7	H	H	L	H

fishing activity, so naturalness is reasonably high. Sixteen seamounts have high productivity and 26 high diversity.

The Louisville seamount chain east of New Zealand is a known orange roughy spawning area. Eight of the 31 seamounts within the chain have identified threatened species and 19 have high productivity. However, most of the seamounts (27) of the seamount chain have been fished, so naturalness is probably low.

The Foundation seamounts are all in shallow water (i.e., <200m) and met the criteria for a unique habitat based on their physical attributes. There are no threatened species recorded and productivity is low. However, it is the location of the only known record of the endemic lobster Jasus caveoriun (Webber and Booth 1995). There is no recorded fishing activity on these seamounts, so their naturalness level is high.

The Three Kings seamounts have high productivity (22 of 23 seamounts) and have little recorded fishing so have high naturalness. These seamounts have a high proportion of vulnerable stony coral habitat and a large number of recorded Red List species.

3. Conclusion

Application of the EBSA criteria is relatively untried. The absence of a clear process by which to apply the criteria may limit the usefulness and uptake of the criteria. Thus, there is a need to establish a process that can be used across multiple regions to identify EBSAs in a comparable and robust manner. The workshop was successful in devising a provisional process that can be used to identify candidate EBSAs, as well as identifying the types of data that can be used in the process. The provisional process was developed for seamounts and potentially other benthic systems globally. With modification it should be applicable to pelagic systems.

The provisional process used a combined criteria approach which enabled "high priority" EBSAs to be identified out of a large number of individual seamounts that may qualify for EBSA status based on meeting one or a few of the criteria. The process is transparent and can be modified by regional knowledge on smaller spatial scales than considered here. We believe it can make an important contribution to the CBD objectives in that it can be used to generate a robust selection of candidate EBSAs. To begin to identify networks we would also have to consider the criteria outlined in Annex II of Decision IX/20; they can indicate how to structure networks of protected areas across large ocean-basin scales.

The process was intentionally limited to using data immediately to hand, and using sample data rather than model data where possible. If, and when, new data become available it would be possible to re-run the process and evaluate any changes in the identification of EBSAs that may occur, and therefore the sensitivity of the identification process to variation in data input. Improved information on the composition of biological communities (especially endemic or highly vulnerable species) and the extent of human impact from fishing or mining is necessary to make the evaluation of the criteria more robust. The provisional process should also be tested in other regions with different data sets.

The approach taken here differs from many other expert-driven approaches. We did not identify the areas prior to obtaining data, in fact given the spatial domain we had no pre-existing areas that were identified. This process may provide a more inclusive and objective approach to identifying EBSAs than a process where areas are first identified and then data used as justification for their identification as EBSAs. Consequently, it is important to note that the outcomes of this workshop depended on a large body of pre-existing work. In the absence of this, there would need to be considerable effort expended prior to the assessment of criteria to ensure the most robust outcome. It is also desirable to have an ongoing process of engagement with science providers to deliver ongoing critical advice, to ensure that they are aware of the opportunities and to support future efforts to identify EBSAs. The identification of the four EBSAs for seamounts in the South Pacific Ocean is a result of our trailing the provisional process – and without further analyses, these areas **should not be** considered as formal candidate EBSAs for consideration by the CBD or regional parties.

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