POLICY PERSPECTIVE

Should potential for climate change refugia be mainstreamed into the criteria for describing EBSAs?

David Edward Johnson¹ | Ellen Lorraine Kenchington²

¹Seascape Consultants Ltd., Jermyn’s House, Romsey, Hampshire, SO52 0QA, United Kingdom
²Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS, B2Y 4A2, Canada

Correspondence
David Johnson, Seascape Consultants Ltd., Jermyn’s House, Jermyn’s Lane, Romsey, Hampshire SO51 0QA, United Kingdom. Email: david.johnson@seascapeconsultants.co.uk

Abstract
The world’s oceans are subject to the influence of climate change at all latitudes and depths. There is a growing body of literature on the responses of species to climate change, which has a strong deterministic component indicating that responses can be predicted. At the same time, advances in oceanographic data acquisition and modeling have facilitated the identification of potential climate change refugia. The Convention on Biological Diversity’s “Voluntary Specific Workplan on Biodiversity in Cold-Water Areas within the Jurisdictional Scope of the Convention” explicitly calls for the identification and protection of refugia in cold-water areas. We propose adding “Climate Change Refugium” as an integral consideration for identification of Ecologically or Biologically Significant Marine Areas (EBSAs). We provide a description of this as a potential eighth criterion. We then briefly discuss the pros and cons of introducing this eighth criterion, or an alternative strategy to develop guidelines that explicitly link refugia to the rationale of existing EBSA criteria, in the hope that this opinion piece will launch further discussion on this notion.

KEYWORDS
CBD, climate change, deep-sea biodiversity, EBSA, refugia

1 | INTRODUCTION

Unprecedented anthropogenic emissions of atmospheric greenhouse gases have been attributed to increased global average temperatures, with more than 90% of that energy accumulated between 1971 and 2010 being stored in the world’s oceans (IPCC, 2014). In addition, oceanic absorption of anthropogenic CO2 has resulted in a 26% increase in acidity over the industrial era (IPCC, 2014). Increases in the heat content of the atmosphere and oceans have in turn; increased the volume of melt water into the oceans from glaciers and ice sheets resulting in sea level changes; increased stratification of the water column; altered nutrient availability and primary production; altered oxygen concentrations creating deep-ocean anoxic pools; changed wind patterns and ocean currents; and increased the number of extreme storm events (IPCC, 2014). The impacts are wide-reaching and even deep-sea ecosystems are not immune (Johnson, Ferreira, & Kenchington, 2018a; Sweetman et al., 2017; Yasuhara, Cronin, deMenocal, Okahashi, & Linsley, 2008).

Many marine species are responding to such climate changes through depth and latitudinal changes in distributions (Assis et al., 2017; Chen, Hill, Ohlemüller, Roy, & Thomas, 2011; Hampe & Petit, 2005) and changes to the timing of biological events such spawning (Parmesan & Yohe, 2003; Poloczanska et al., 2013), while evidence for adaptation through evolutionary processes is limited (Miller, Ota, Sumaila, Cisneros-Montemayor, & Cheung, 2018).
redistribution of species and changes in community composition and interactions can affect marine ecosystem functioning with consequences for human well-being (Pecl et al., 2017).  

Range changes are effected through movement of juveniles and adults for mobile species, and through dispersal of gametes, larvae, and reproductive bodies of sedentary and sessile species. Those marine species that shift their distributions do so at similar or comparable rates to terrestrial species (Poloczanska et al., 2013), and at different rates and directions in different areas, because they closely track local climate changes (Pinsky et al., 2013; Poloczanska et al., 2013). Consequently, responses of species to climate change have a strong deterministic component and can be predicted (Beaugrand & Kirby, 2018).

Refugia for marine species during the Last Glacial Maximum (LGM), 25–18 ka, have shaped contemporary distributions of both marine and terrestrial species. Many species survived glacial maxima by retreating to lower latitude refugia and to more cryptic refugia identified through both phylogeographic studies (Provan & Bennett, 2008), and more recently through the combination of global reconstruction models of sea surface temperature at the LGM (e.g., Annan & Hargreaves, 2013), paleoecological and genetic data (e.g., Maggs et al., 2008). Identifying and protecting contemporary climate refugia has been proposed as a mitigation strategy for the conservation of species susceptible to climate change impacts (Morelli et al., 2016), facilitating persistence at regional scales and allowing for adaptation to occur. Climate change refugia are distinct from temporal refuges, pristine habitats and physiological responses such as adaptation and acclimatization (Keppel & Keppel, 2018). Approaches for the identification of refugia are wide-ranging and data-dependent (Keppel et al., 2012; Morelli et al., 2016).

2 | PROTECTION OF REFUGIA AS A MITIGATION POLICY

To our knowledge the Convention on Biological Diversity's (CBD) Conference of Parties (COP) was the first international forum to explicitly call for the identification and protection of marine refugia. COP13 adopted a “Voluntary Specific Workplan on Biodiversity in Cold-Water Areas within the Jurisdictional Scope of the Convention” and in paragraph 4 explicitly called for the identification and protection of refugia in cold-water areas: “(c) Identify and protect refugia sites and areas capable of acting as refugia sites, and adopt, as appropriate, other area-based conservation measures, in order to enhance the adaptive capacity of cold-water ecosystems;” (CBD/COP/DEC/XIII/11; December 10, 2016). Understanding risk and building resilience are also central tenets to the Voluntary Guidelines for the Design of Effective Implementation of Ecosystem-based Approaches to Climate Change Adaptation and Disaster Risk Reduction (CBD/COP/DEC/XIV/5).

2.1 | Measures to mitigate against ocean acidification

The International Union for Conservation of Nature and Natural Resources (IUCN) has proposed the use of area-based management tools (ABMTs) such as networks of Marine Protected Areas (MPAs) to improve the resilience of species and ecosystems to climate change, specifically ocean acidification, by reducing the impacts of other stressors (Herr, Isensee, Harrould-Kolieb, & Turley, 2014). Similar protection through application of ABMTs for ecosystems such as mangrove forests or sponge grounds to support the continued provision of carbon sequestration have also been proposed as mitigation measures for ocean acidification (Herr et al., 2014).

Herr et al. (2014) have summarized international policy and governance options as they relate to ocean acidification. To our knowledge, through to the time of publication the concept of refugia from ocean acidification is not formally addressed in any of these fora, despite a growing scientific literature on the nature and locations of such areas (e.g., Hurd, 2015; Manzello, Enochs, Melo, Gledhill, & Johns, 2012). In 2012, CBD Decision XII/23 Annex, adopted priority actions to achieve Aichi Biodiversity Target 10 for coral reefs and closely associated ecosystems. This recognized the range of risks and stressors and the need for appropriate research and monitoring programmes but does not specifically mention refugia from ocean acidification. However, the Reef Resilience Network of the Nature Conservancy has stated that the best guidance for managing for ocean acidification involves prioritizing management toward protecting natural refugia, and a stakeholder workshop in Australia called for the identification and protection of refugia in the context of prioritizing options for conserving legislatively protected deep-sea coral reefs there (Thrasher, Guinotte, Matear, & Hobday, 2015). In 2016, the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) considered a background document on biodiversity and acidification in cold-water-areas (UNEP/CBD/SBSTTA/20/INF/25). That document recommended that MPAs and other tools be used to protect future refugia sites to mitigate the effects of ocean acidification. This recommendation was accepted and broadened by SBSTTA to include refugia from all climate change impacts: “(c) Identify and protect areas known to be resilient to climate-related impacts and capable of acting as refugia sites in order to enhance the adaptive capacity of cold-water ecosystems” (UNEP/CBD/SBSTTA/20/4) in its recommendations accepted by the 13th meeting of the COP in 2016 (CBD/COP/DEC/XIII/11).
2.2 | Ecologically or biologically significant marine areas (EBSAs)

EBSAs are special areas in the ocean that have heightened importance in supporting the healthy functioning of oceans and the many services that they provide. EBSA description is an expert-led process that gathers and assesses available evidence against internationally agreed criteria (UNEP/CBD/COP/DEC/IX/20) adopted in 2008 during the ninth meeting of the CBD COP. Those criteria are:

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

As a result of CBD COP10 a process was initiated whereby the application of the EBSA criteria and description of EBSAs proceeded through a series of regional workshops organized by the CBD Secretariat. The description of areas meeting the criteria for EBSAs comprises both a textual description and a polygon of the area, as contained in the relevant decisions of the Conference of the Parties to the Convention, including decisions XI/17, XII/22, and XIII/12, and included in the EBSA repository. Johnson et al. (2018b) provide the most recent analysis of the EBSA process as it has evolved over the past decade. Their work highlights different types of gaps both in terms of geographical coverage and scientific application. The analysis was intended to feed into and inform discussions within the CBD to determine a process whereby new or revised information can be added to existing EBSA descriptions; new EBSA descriptions can be initiated; and, if and where appropriate, errors can be corrected.

From 2011 to 2018, 14 workshops have been organized for the purpose of compiling regional data and EBSA descriptions. Extensive scientific work was undertaken to describe the EBSAs and evaluate the associated data for each region. Within the suite of over 300 EBSAs described to date, the Western South Pacific High Aragonite Saturation State Zone (Secretariat of the Convention on Biological Diversity, 2014) identified resilience to climate change, here ocean acidification, as the rationale for designation, providing a H(igh) score for criterion 1 (uniqueness or rarity) and a M(edium) score for criterion 2 (special importance for life history stages of species). This EBSA is located in the South Equatorial Current east of American Samoa, and has the highest aragonite saturation levels recorded in Pacific surface waters. Consequently, this EBSA may be the least affected by ocean acidification for the longest timeframe. EBSA criterion 1, uniqueness or rarity, was appropriately applied following a part of its definition, which describes an area with “unique or unusual oceanographic features”. However, the accompanying rationale, examples and considerations in application associated with this criterion (UNEP/CBD/COP/DEC/IX/20) do not give recognition to the importance of climate change refugia for species and habitats. An evaluation of the impacts of climate change on Area-Based Management Tools (ABMTs) in the North Atlantic (Johnson et al., 2018a) considered the effectiveness (or potential redundancy) of spatially managed protective mechanisms. EBSAs were considered in this evaluation even though they are not strictly ABMTs but rather confer areas where ABMTs may be appropriate. Results indicated that organisms whose presence provided the rationale for the selection of areas identified in the North Atlantic are likely to be significantly compromised by exogenous factors in the next 20–50 years. The only exception was the Hydrothermal Vent Field EBSA in the NW Atlantic, which due to its chemosynthetic food-web and dependence on geochemical energy was less impacted by predicted changes in the overlying water masses. Consequently, raising the profile of climate change refugia within the set of EBSA criteria would serve to draw attention to the temporal effectiveness of ABMTs and provide a mechanism for reporting on the Voluntary Specific Workplan.

3 | PROPOSAL FOR A NEW EBSA CRITERION TO EXPLICITLY IDENTIFY CLIMATE CHANGE REFUGIA

3.1 | An 8th criterion

COP10 recognized that “the application of the EBSA criteria is an open and evolving process that should be continued to allow ongoing improvement and updating as improved scientific and technical information becomes available in each region” (UNEP/CBD/COP/10/27). Currently the EBSA template includes a section describing feature condition and future outlook of the proposed area but this is not specific to climate change impacts. In addition the EBSA template includes an optional opportunity for sharing experience and information applying to other criteria, which could include climate change. However, this optional section has rarely been completed even in regions such as the Arctic where changes in Arctic sea-ice cover is changing rapidly and associated species are particularly vulnerable (Eamer et al., 2013). Following the format used in the Azores Scientific Criteria and Guidance for identifying ecologically or biologically significant marine areas and designing representative networks of marine protected areas in open ocean waters and deep sea habitats (Secretariat of the Convention on Biological Diversity, 2009) we propose an additional criterion as follows:
Criterion: Climate change refugium
Definition: Habitats that components of biodiversity retreat to, persist in, and can potentially expand from under changing environmental conditions (Keppel et al., 2012); areas relatively buffered from contemporary climate change over time that enable persistence of valued physical, ecological, and sociocultural resources (Morelli et al., 2016).
Rationale: To facilitate the survival of biota under changing environmental conditions and to allow time for adaptation to occur in the face of acute effects of climate change.
Examples: Examples include but are not limited to: Western South Pacific High Aragonite Saturation State Zone EBSA (Secretariat of the Convention on Biological Diversity, 2014); other potential areas: upwelling areas (Barceló, Ciannelli, & Brodeur, 2018; Lourenço et al., 2016); slow-flow habitats (Hurd, 2015); seamounts; and hydrothermal vents in areas of slow sea-floor spreading.
Consideration in application: Assessment of the quality of refugia at the level of individual species and whole species assemblages requires further consideration; areas must be large enough to support populations of species over ecological and evolutionary time scales of millennia; ideally refugia should provide protection from a multitude of stressors or to a number of different species (Reside et al., 2014). Areas resistant to change either due to oceanographic conditions and/or to the structure and composition of resident taxa fit the concept of persistence in our definition.

We note that although the current policies calling for the identification of refugia (Section 2) highlight cold-water areas, we envision this criterion to be applied where appropriate to all open ocean waters and deep sea habitats.

3.2 Pros and cons for introducing a new criterion for identifying EBSAs

A CBD Workshop in Berlin (December 5–8, 2017) informed an options paper that was scrutinized at SBSTTA 22 in July 2018 (CBD/SBSTTA/22/7). Participants at the Berlin Workshop favored some form of second round of regional EBSA workshops. Protracted discussions on the modalities for modifying the description of EBSAs, for describing new areas, and for strengthening the scientific credibility and transparency of this process then took place at CBD COP14 in November 2018 (CBD/COP/XIV/9, Annex II). In discussion, parties recognized the need for a strong scientific and technical basis for any proposed modification process and the importance of transparency as well as the need to maintain a record of information about previously described EBSAs. However, due to political sensitivities Annex II was not finalized at COP14. Our proposal does not in any way suggest reopening the EBSA criteria, which have been agreed by Parties and are tried and tested. Rather we envisage this proposed eighth criteria as a complementary exercise to strengthen the scientific credibility and utility of EBSAs without affecting the standing of any other EBSA criteria. An alternative to amending CBD COP Decision IX/20 would be the development of guidelines on the application of criteria where refugia could be explicitly linked to the rationale contained in Annex I of that Decision. For example, with respect to “uniqueness,” a suite of areas to facilitate the survival of biota under changing environmental conditions could be envisaged. Such areas would be unique in that, based on current physical conditions and future projections, they would provide the circumstances for adaptation to occur in the face of acute effects of climate change. These may not be areas where species are most abundant currently but will become important in the future.

COP14 Decision XIV/9, Annex III provides an addendum to the Terms of Reference for the Informal Advisory Group on EBSAs as established by CBD Decision XIII/12 §11. For new areas meeting the EBSA criteria for areas beyond national jurisdiction and, where the parties or other governments so wish, for areas within their national jurisdiction, this group is to “develop guidance for the Executive Secretary on the organization of new workshops to facilitate the description of areas meeting the EBSA criteria; identify the need for scientific gap analysis and/or thematic analysis, which could complement regional workshops; and, as appropriate, provide advice to the Executive Secretary, based on the results of such analysis, and submit draft guidance to a future meeting of SBSTTA for its consideration.” In our opinion it would be appropriate to include ideas set out in this article on the agenda of the Informal Advisory Group on EBSAs.

By including climate change refugia in this way, the types of areas that are identified as EBSAs could be expected to broaden and to include hitherto underrepresented deep-sea locations and support recognition of areas important for providing climate resilience or in need of protection because of their vulnerability to climate change. While EBSAs do not inherently confer management measures or restriction of activities, the areas concerned may require enhanced conservation and management measures to retain their significance. Furthermore, EBSAs are one of the CBD criteria contributing to the design of MPA networks (UNEP/CBD/COP/DEC/IX/20 Annex II). Designation of MPAs with enhanced protection measures can be linked to opportunities for restoration and rehabilitation, and reducing anthropogenic pressures can allow the ecosystem to adapt or evolve in the face of changing physical conditions. For EBSAs
that are deemed to require enhanced protection this new criterion could inform decisions on size (the need for buffer zones), spacing (connectivity) and timing (e.g., temporal closures to endogenous factors during seasons when the feature is most stressed).

Regional workshops to identify EBSAs compiled oceangoraphic, biological, and ecological data layers to guide participants in selection and justification of EBSA proposals. These data are an important repository of information and the addition of this new criterion or strengthening relevant sections of the existing criteria would further develop that resource, although new data layers would likely be needed (e.g., aragonite saturation). It is unclear whether the addition of a new criterion would require reconsideration of all EBSA descriptions, including those for which no new information is available. Current practice is to nominate EBSAs on the criteria, which are most relevant to selection, and it is not necessary to address all criteria. Certainly existing EBSA descriptions could be updated with this information as noted above and as appropriate, further strengthening their selection. Most importantly addition of the proposed criterion would identify new areas that are critical for the conservation of biodiversity and could provide a mechanism for reporting on climate refugia under other international policies as discussed in Section 2.1. Identification of such areas could help inform negotiations for a new legally binding Implementing Agreement for Biodiversity Beyond National Jurisdiction and help prioritize investments in conservation efforts (i.e., UN decade of Ocean Science for Sustainable Development) as well as commitments made in National Biodiversity Strategic Action Plans. An example of where this has already proved to be relevant is in South Africa (Kerry Sink, pers. com 22.11.18). On October 25, 2018, South Africa announced approval of a suite of 20 MPAs, drawing on EBSA data, specifically noting their role as a basis for ongoing resilience to the impact of climate change.2 In particular the South West Indian Seamount MPA, unique coldwater coral gardens that tower 50 m above the seabed, qualifies as a refugia supporting climate resilience by protecting a range of habitats 200–2,000 m in a small space.

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