AÇOREANA, 2021, XI(3): 489-505

A REVIEW OF ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT AREAS (EBSAs) IN THE NORTH ATLANTIC

David Johnson & Christopher Barrio Froján

Seascape Consultants Ltd, Romsey, UK
david.johnson@seascapeconsultants.co.uk, christopher.barrio@seascapeconsultants.co.uk

ABSTRACT

The process of selecting and describing areas that meet the Convention on Biological Diversity's (CBD) criteria on Ecologically or Biologically Significant marine Areas (EBSA) in the North Atlantic Ocean is described, as well as reviewing its results so far. Three regional EBSA workshops (one in the northwest Atlantic, two in the northeast Atlantic) have been conducted, with mixed results. Twenty-five EBSA descriptions exist for the North Atlantic Ocean, seven of which have been formally acknowledged by the CBD Conference of the Parties (COP); the remaining 17 pending acknowledgement at CBD COP-15. The strengths and limitations of conducting the EBSA description process as a regionally focused exercise are discussed, including aspects of ecosystem representativity, connectivity, environmental governance/management for conservation, and the option to update EBSA descriptions once they have been formally acknowledged by the CBD. Suggestions to plug perceived shortfalls in the process are also presented.

RESUMO

Este artigo apresenta a descrição do processo de seleção e descrição de áreas que correspondam aos critérios da Convenção sobre a Diversidade Biológica (CDB), sobre áreas marinhas ecologicamente ou biologicamente significativas (EBSA), no Oceano Atlântico Norte, assim como a revisão dos resultados desse processo. Até ao momento, foram realizados três *workshops* regionais das EBSA (um no Atlântico Noroeste e dois no Atlântico Nordeste), com resultados mistos. Existem 25 descrições de EBSA para o Atlântico Norte, sete das quais foram já formalmente reconhecidas pela Conferência das Partes (COP) da CDB; as restantes 17 estão ainda pendentes de reconhecimento na CDB COP-15. Este estudo reflete sobre os pontos fortes e limitações do processo de descrição das EBSA implementado à escala regional, incluindo aspetos de representatividade dos ecossistemas, conectividade, governança/gestão ambiental para conservação e da opção de atualizar as descrições das EBSA, uma vez que tenham sido formalmente reconhecidas pela CDB. São ainda apresentadas sugestões no sentido de ultrapassar dificuldades percecionadas ao longo do processo.

INTRODUCTION

Ecologically or biologically significant marine areas (EBSAs) are internationally accepted, discrete areas of the ocean representing attributes of the marine environment that are important for the maintenance of biological diversity and ecosystem processes. The EBSA concept has been adopted and championed by the Convention on Biological Diversity (CBD), and is applied through an established process that culminates in the formal acknowledgment of described EBSAs by the CBD's Conference of the Parties (COP). Once acknowledged by the CBD COP, described EBSAs are considered 'identified'.

The selection of areas to describe as EBSAs is a collaborative scientific exercise conducted by State-nominated representatives (often, but not always scientists) invited by the CBD to a regional EBSA workshop, alongside other stakeholder representatives, such as regional resource management organisations and traditional knowledge holders. Selection and description of

candidate EBSAs follows assessment against seven agreed scientific criteria, namely: 1. Uniqueness or rarity; 2. Special importance for life history stages of species; 3. Importance for threatened, endangered or declining species and/or habitats; 4. Vulnerability, fragility, sensitivity, or slow recovery; 5. Biological productivity; 6. Biological diversity; 7. Naturalness (CBD, 2007). Candidate EBSAs can be described if they meet just one or any combination of the seven EBSA criteria. Candidate EBSA descriptions produced by regional EBSA workshops undergo an independent scientific and technical review before being recommended (following a favourable review) to the CBD COP for approval.

To date there have been 15 regional EBSA workshops convened by the CBD, covering all regions of the ocean (76%) except for the Southern Ocean, where an alternative process is in place. These workshops have led to the identification of 321 EBSAs around the world, with a further set of candidate EBSAs from the Northeast Atlantic Ocean (the latest regional EBSA workshop, conducted in 2019) awaiting formal recognition by the CBD COP. Identified EBSAs confer no management obligations, but they do provide scientific and technical justification for a risk-averse, ecosystem-based management regime of such areas to mitigate against adverse impacts from human activities (Johnson *et al.*, 2018a).

The aim of this paper is to examine how the EBSA process has been applied to the North Atlantic Ocean. Is EBSA coverage comprehensive? Has the process been effective? Is there more to do? The outcome of this exercise is intended to illustrate inherent shortfalls and unexpected benefits from the hitherto regional application of the EBSA process, with the potential to inform possible alternative approaches at the global scale.

EBSAs IN THE NORTH ATLANTIC OCEAN

Since the adoption of the EBSA concept by the CBD in 2008 (CBD, 2008), three regional EBSA workshops have targeted the North Atlantic Ocean, although the contested outputs from the first workshop, organised jointly by the OSPAR Commission and the Northeast Atlantic Fisheries Commission (NEAFC) with input from the CBD Secretariat in September 2011 (CBD, 2012a), have been superseded by the latest regional EBSA workshop targeting the Northeast Atlantic, held in September 2019 (CBD, 2019a). The regional EBSA workshop targeting the Northwest Atlantic was held in March 2014 (CBD, 2014). Each of these latter workshops is considered in turn.

Northwest Atlantic Regional EBSA Workshop

With financial support from the Government of Canada, the CBD Secretariat convened the Northwest Atlantic regional EBSA workshop in Montreal, Canada (24-28 March 2014; CBD, 2014). As with all regional EBSA workshops, the point of departure was a compilation of scientific data, information and maps amassed by a dedicated technical team - in this case, staff at Duke University's Marine Geospatial Ecology Lab (MGEL) - supplemented by expert presentations on specific features, environmental phenomena (*e.g.*, seasonal climatologies) and species distributions, together with site-based submissions of scientific information by invited State representatives.

Canada, in particular Fisheries and Oceans Canada (DFO), has been a strong supporter of the CBD's EBSA process and has made significant efforts to describe areas that meet similar criteria in its domestic waters, including Atlantic sub-regions of Newfoundland and Labrador, the Scotian Shelf Bioregion and the Gulf

of St Lawrence. These areas and their diversity of habitats were showcased at the workshop, noting their strengths and limitations. In particular, in terms of a gap, it was highlighted that the distribution and diversity of deep-water habitats, such as abyssal plains, hydrothermal vents, methane hydrate and brine seeps, cold-water coral reefs and deep-water canyons and the biota they support, were poorly inventoried for consideration in this type of analysis. Special attention was also given to highly migratory and mobile species, which are seasonally prevalent in the region as they travel from as far as Antarctica (*e.g.*, Egevang *et al.*, 2010).

The workshop described seven EBSAs (Table 1), all in international waters (also know as areas beyond national jurisdiction – ABNJ) drawing upon relative data richness but noting temporal and spatial data limitations. They also represent all four types of EBSA:

- The Orphan Knoll EBSA, the Slopes of the Flemish Cap and Grand Banks EBSA, the Southeast Shoal and the Adjacent Areas on the Tail of the Grand Banks EBSA (a highly productive spawning ground) are all static single-feature[1] EBSAs.
- The New England and Corner Rise Seamounts EBSA is comprised of two discrete and separately bounded[2] areas), providing benthic habitats for key marine taxa, including unique and endemic faunal assemblages.
- The Seabird Foraging Zone in the Southern Labrador Sea is an ephemeral[3] EBSA, representing a critical intersection of important foraging and wintering habitat for three seabird species from 20 widely dispersed breeding colonies.
- The Labrador Sea Deep Convection Area is an example of a dynamic[4] EBSA supporting a keystone species *Calanus finmarchicus*, one of the most important multicellular zooplankton species in the North Atlantic Ocean (Melle *et al.*, 2014).

These EBSAs were officially identified at CBD COP-12 in October 2014 and placed in the CBD EBSA Repository.

It is interesting to note a number of areas that were excluded. For example, two groups of Northwest Atlantic seamounts in deep water beyond the continental slope were not described as EBSAs on the grounds of insufficient data. These seamount clusters (Fogo Seamounts and Newfoundland Seamounts) are likely to support endemic species and high biodiversity but have yet to be properly surveyed. Similarly, whilst recognising the general ecological significance of subsea canyons, the workshop concluded that there was insufficient information at the time to evaluate individual canyons

1 Static single-feature EBSAs (Type I) represent features that are clearly differentiated in the physical world and fixed in space and time (*e.g.*, a coral reef or an isolated seamount).

2 Static multiple-feature EBSAs (Type II) encompass a set of fixed areas that represent similar features and are generally clustered in space (*e.g.*, a chain of seamounts), where interconnectivity between the individual features is critical for the overall health and survival of the local or regional ecosystem.

3 Ephemeral EBSAs (Type III) represent a fixed area in which, over time, portions of the area meet the defining criteria and other portions do not; the location of relevant portions may shift within the whole area over time (*e.g.*, spawning areas for fish or feeding hotspots for seabirds).

4 Dynamic EBSAs (Type IV) capture persistent but mobile features of the ecosystem whose boundaries may shift due to seasonal, annual or longer- term cycles (*e.g.*, shelf-ice edges and oceanographic fronts).

TABLE 1. List of EBSAs described during the Northeast and Northwest Atlantic regional EBSA workshops. * Key: Criteria C1 - Uniqueness or rarity; C2 - Special importance for life-history stages of species; C3 - Importance for threatened, endangered or declining species and/or habitats; C4 - Vulnerability, fragility, sensitivity, or slow recovery; C5 - Biological productivity; C6 – Biological diversity; C7 - Naturalness. Ranking: H - High; M - Medium; L - Low; ni - no information.

Regional EBSA workshop	EBSA	Criteria/ Ranking*	EBSA Type	Description
Northwest Atlantic [adopted at CBD COP-12]	Hydrothermal Vent Fields	C1: H C2: H C3: H C4: H C5: H C6: H C7: H	I. Single static feature	This area follows the Mid-Atlantic Ridge (MAR) from the Lost City vent fields and includes the confirmed active Broken Spur and Trans-Atlantic Geotraverse (TAG) vents. The Lost City vent field is estimated to have been active for more than 30,000 years and has unique characteristics, being a low temperature vent with high alkalinity. The entire feature is located beyond national jurisdiction.
	New England and Corner Rise Seamounts	C1: H C2: H C3: ni C4: M C5: L C6: H C7: M	II. Group of static features	The New England and Corner Rise seamount chains host complex coral and sponge communities, including numerous endemic species. Benthic diversity is very high relative to the surrounding abyssal areas. Seamount slopes and deeper summit environments (greater than 2,000 m from the surface) currently remain free of any direct impacts of human activities, although some of the shallower seamounts have been commercially fished.
	Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank	C1: H C2: H C3 H C4: M C5 H C6: H C7: L	I. Single static feature	The Southeast Shoal and adjacent areas is an ancient beach relic that provides a shallow, relatively warm, sandy habitat. It is a highly productive ecosystem hosting a unique offshore capelin-spawning ground, a nursery for yellowtail flounder, and spawning areas for depleted American plaice, depleted Atlantic cod and striped wolfish. Blue mussels and wedge clams are also found. It is an important feeding area for cetaceans, including humpback and fin whales, and is frequented by large numbers of seabirds.
	Slopes of the Flemish Cap and Grand Bank	C1: H C2: M C3: H C4: H C5: M C6: H C7: M	I. Single static feature	The slopes of the Flemish Cap and Grand Banks of Newfoundland has a high biodiversity of marine taxa. It contains large aggregations of taxa indicative of vulnerable marine ecosystems, such as deep-sea corals and sponges. Many species present are listed as Threatened. The area is a component of the Greenland halibut fishery grounds in international waters.
	Orphan Knoll	C1: H C2: ni C3: ni C4: H C5: L C6: H C7: H	I. Single static feature	The Orphan Knoll provides an island of hard substratum and uniquely complex habitats that rise from the soft sediments of Orphan Basin. It appears to have a distinctive fauna that includes fragile and long-lived corals and sponges. A Taylor Cone circulation has been identified, providing a mechanism for retention of larvae over the feature.
	Seabird Foraging Zone in the Southern Labrador Sea	C1: M C2: H C3: M C4: M C5: M C6: M C7: M	IV. Dynamic feature	The waters off Newfoundland and Labrador support globally significant populations of marine vertebrates, including an estimated 40 million seabirds annually. The Labrador Sea is a foraging habitat for seabirds, including over-wintering black-legged kittiwakes thick-billed murres and breeding Leach's storm-petrels. While the habitat supporting these seabirds spans the Canadian EEZ and the adjacent area beyond national jurisdiction, this EBSA represents the portion located within the pelagic zone beyond national jurisdiction.
	Labrador Sea Deep Convection Area	C1: H C2: M C3: ni C4: M C5: L C6: L C7: M	IV. Dynamic feature	The Labrador Sea is a key component of the global ocean circulation system. It is the only site in the Northwest Atlantic where deep winter convection serves to exchange surface waters with the deep ocean. This area also provides the mid-water overwintering refuge for pre-adult copepod species, which seed zooplankton populations on the Labrador Shelf and areas further downstream. The ongoing warming and freshening of subpolar surface waters is likely to be a factor leading to weaker convection overall. Consequently, ecologically significant change in this area could be propagated through the ecosystems of the Northwest Atlantic.

Regional EBSA workshop	EBSA	Criteria/ Ranking*	EBSA Type	Description
Northeast Atlantic [pending adoption at CBD COP-15]	Danish Skagarrek	C1: H C2: H C3: M C4: L C5: H C6: M C7: L	I. Single static feature	This area focuses on a highly productive upwelling zone along the southern edge of the Norwegian Trench. It contains high fish biomass and diversity, and the upwelling zone also provides valuable feeding grounds for several cetacean and bird species.
	Danish Kattegat	C1: H C2: H C3: H C4: H C5: M C6: M C7: M	I. Single static feature	The Danish Kattegat hosts shallow sandy flats, deeper muddy channels and areas with boulder reefs and bubbling reefs. The area has a diverse avifauna, with elements from pelagic environments in the North Sea, as well as wintering birds from breeding grounds in the Russian Federation and Scandinavia. The area is a meeting site for two subpopulations of harbour porpoise. Eelgrass meadows exist here, as do seaweed forests. Horse-mussel beds are found primarily in the southern part of Kattegat, where they form biogenic reef structures.
	Cantabrian Sea (Southern Bay of Biscay)	C1: H C2: H C3: H C4: H C5: H C6: H C7: L	I. Single static feature	The Cantabrian Sea ecosystem includes the continental shelf and slope and the deep abyssal basin located along the northern border of the Iberian Peninsula. The area contains important geomorphological elements, such as large submarine canyons and seamounts. The hydrology is complex due to the interaction between waters formed in the Atlantic and waters of Mediterranean origin. This area includes a variety of benthic habitats, some considered hotspots of biodiversity, and which serve as spawning grounds for several commercial species. The area also contains habitats for endangered, threatened and declining species and for migratory pelagic species, including cetaceans.
	Western Iberian Canyons and Banks	C1: H C2: H C3: H C4: H C5: H C6: H C7: L	II. Group of static features	This area includes hotspots of marine life, and they represent areas of enhanced productivity, especially when compared with surrounding areas. The area has a high diversity of benthic communities and spawning grounds for several species, and it is an important area for cetaceans. A total of 3,411 species are listed in the area, 11% of which are protected under international or regional law. The area contains several designated MPAs.
	Gulf of Cádiz	C1: H C2: H C3: H C4: H C5: H C6: H C7: L	I. Single static feature	The Gulf of Cádiz is a structurally complex area, containing important geomorphological elements, such as large submarine canyons, seamounts and mud volcanoes. The hydrology is complex due to the interaction between waters formed in the Atlantic and waters of Mediterranean origin. The area includes a variety of benthic habitats, both on soft and rocky bottoms, that are considered hotspots of biodiversity and which serve as various habitats for endangered, threatened and declining species. It is also a seasonal migratory pathway for large migratory pelagic species and is an important area for cetacean species.
	Madeira - Tore	C1: H C2: H C3: H C4: H C5: H C6: H C7: M	I. Single static feature	This area includes 19 remarkable structures, 17 of which are seamounts. Notable features include the Gorringe Bank and the Josephine Seamount High Seas Marine Protected Area. A total of 965 species are present in this area, 7% of which are protected under international or regional law.
	Desertas	C1: H C2: H C3: H C4: H C5: ni C6: ni C7: ni	I. Single static feature	The Desertas Islands hold some of the most important seabird colonies in the Atlantic, with large populations of Procellariiformes, including the only population of vulnerable Desertas petrel. They also contain important reproductive and resting habitats for the endangered monk seal in the form of pupping caves and resting beaches.

Regional EBSA workshop	EBSA	Criteria/ Ranking*	EBSA Type	Description
	Oceanic Islands and Seamounts of the Canary Region	C1: H C2: H C3: H C4: H C5: H C6: H C7: M	I. Single static feature	The area includes a set of islands and seamounts influenced by magma-driven processes over tens of millions of years over the Canary hotspot. This region, with its subtropical oceanographic conditions, represents the southern distribution limit for many pelagic and benthic species. It includes a variety of benthic habitats, including some that are considered hotspots of biodiversity. These habitats serve as spawning grounds for several commercial species. The area also includes habitats for endangered, threatened and declining species and for migratory pelagic species, including cetaceans.
	Tropic Seamount	C1: H C2: ni C3: H C4: H C5: M C6: H C7: H	I. Single static feature	The Tropic Seamount is home to numerous vulnerable taxa, including high-density octocoral gardens, xenophyophores, crinoid fields and deep-sea sponge grounds. Predicted habitat for glass sponge species, a biogeographically restricted hexactinellid forming extensive near-monospecific grounds, was found to favour the deep seamount flanks of this area within a very narrow oceanographic regime.
	Atlantis-Meteor Seamount Complex	C1: H C2: H C3: H C4: H C5: M C6: H C7: M	I. Single static feature	The Atlantis-Meteor Seamount Complex comprises 10 seamounts. These seamounts are hotspots of marine life and areas of enhanced productivity, especially when compared with surrounding abyssal areas. This seamount complex has a total area of 134,079 km^2, with depths ranging from 265 m (top of Atlantis seamount) to 4,800 m (base of Great Meteor seamount). A total of 437 species are present in this area (with 16% of mega- and macrofauna and up to 91% of meiofauna endemic to the seamount group), 3.9% of which are protected under international or regional law.
	Ridge South of the Azores	C1: H C2: H C3: H C4: H C5: H C6: H C7: H	I. Single static feature	The Ridge South of the Azores encompasses the axial valley and ridge crests of the Mid-Atlantic Ridge, from the Menez Gwen hydrothermal vent field area to the Haynes fracture zone. The features in this area are both hotspots of marine life and areas of enhanced productivity when compared with surrounding bathyal and abyssal areas. The hydrothermal temperatures range between 10°C and 362°C. The area also includes other seafloor features at the ridge crest that host sponge aggregations, cold-water corals and other charismatic fauna.
	Graciosa	C1: H C2: H C3: H C4: H C5: ni C6: ni C7: ni	I. Single static feature	Graciosa is a key area for the only breeding population of the vulnerable and endemic Monteiro's storm-petrel and is also important for the breeding population of the Audubon's shearwater, which is listed as a threatened and/or declining species. Many other seabirds occur in these waters, such as band-rumped storm-petrel, Cory's shearwater, common tern and roseate tern. All these species have low recovery rates and are highly sensitive to environmental degradation or depletion by human activity.
	North Azores Plateau	C1: H C2: H C3: H C4: H C5: M C6: H C7: M	I. Single static feature	This area is composed of several seamounts, one hydrothermal vent field, an undersea trough and a large portion of the Mid-Atlantic Ridge north of the Azores Plateau. The structures in this area are hotspots of marine life and, in general, areas of enhanced productivity, especially when compared with surrounding abyssal areas. The Moytirra is the first known deep-sea hydrothermal vent field on the slow-spreading Mid-Atlantic Ridge north of the Azores, making this area highly unique. A total of 536 species have been observed in this area, 6% of which are protected under international or regional law.

Regional EBSA workshop	EBSA	Criteria/ Ranking*	EBSA Type	Description
	Mid-North-Atlantic Frontal System	C1: ni C2: H C3: M C4: H C5: H C6: H C7: H	I. Single static feature	The Mid-North-Atlantic Frontal System is a remote area of intense mesoscale activity with near-stationary eddies and numerous thermal fronts aligned in zonal bands. These fronts and eddies enhance primary productivity and retain and concentrate secondary productivity both vertically and horizontally. The combination of localised high-intensity mixing in the eddies results in patchy, high surface, productivity at fine scales. Tracking data collected for seabirds, whales, sea-turtles, tunas and sharks (several of which are globally threatened) confirm that this is an area of high productivity, with a high intensity of foraging activity, suggesting that productivity cascades to higher trophic levels.
	Charlie-Gibbs Fracture Zone	C1: H C2: ni C3: H C4: H C5: ni C6: H C7: M	I. Single static feature	The Charlie-Gibbs Fracture Zone is an unusual left lateral strike-slip double transform fault in the North Atlantic Ocean. It opens the deepest connection between the northwest and northeast Atlantic and is approximately 2,000 km in length, extending from about 25°W to 45°W. It is the most prominent interruption of the Mid-Atlantic Ridge between the Azores and Iceland. Two named seamounts are associated with the transform faults: Minia and Hecate. There is evidence of both deep-sea sponge aggregations and cold-water corals in this area.
	Southern Reykjanes Ridge	C1: H C2: M C3: H C4: H C5: M C6: H C7: ni	I. Single static feature	Reykjanes Ridge is part of the major topographic feature of the Mid-Atlantic Ridge. This region is largely composed of volcanic rock, which is the foundation of the area and provides a hard-bottom substrate for the colonisation of benthic communities, including vulnerable and habitat-forming species. The area supports several endangered and threatened shark and ray species. The Ridge itself and its complex hydrographic setting contribute to enhanced vertical mixing and turbulence, resulting in areas of increased productivity above the Ridge.
	Hatton and Rockall Banks and Basin	C1: H C2: M C3: H C4: H C5: M C6: H C7: M	I. Single static feature	The Hatton and Rockall Banks, as well as their associated slopes and connecting basin, represent offshore pelagic and bathyal habitats from the surface to 3,000 m deep that collectively constitute a unique and prominent feature of the Northeast Atlantic. The area has high habitat heterogeneity and supports a wide range of benthic and pelagic species and associated ecosystems. Its comparatively remote oceanic location several hundred kilometres from the continental shelf afford it a level of protection and isolation from many human activities that are known to degrade the natural marine environment.

against the EBSA criteria. Likewise, data on migratory corridors for large baleen whales proved to be inconclusive despite inferences from tagged animals and consideration of physical proxies, such as the distinctive chlorophyll-*a* concentration on the Western Greenland Shelf attesting to the high productivity of this area.

Northeast Atlantic Regional EBSA Workshop

With financial support from the Governments of Sweden, France, Germany and Denmark, the CBD Secretariat convened the Northeast Atlantic regional EBSA workshop in Stockholm, Sweden (23-27 September 2019), preceded by a training session on EBSAs for participants. Expert technical assistance was again provided by the MGEL team. In addition to an overview of the CBD EBSA process, a number of presentations included information containing scientific guidance on the application of the EBSA criteria, an overview of relevant scientific programmes on a regional scale, a regional overview of biogeographic information on open-ocean water and deep-sea habitats, and ending with a proposed geographic scope for the workshop (CBD, 2019a).

This regional EBSA workshop built on the outcomes of the first workshop convened by OSPAR and NEAFC in September 2011 and hosted by the Government of France (CBD, 2012a). Furthermore, it recognised the limitations of the 2011 workshop (CBD, 2012b), and experts were able to draw on new and updated information to address these. For example, the EU ATLAS Project[5] (2016-2020) provided detailed new knowledge on the Tropic Seamount located in the subtropical North Atlantic ABNJ (23°55′ N, 20°45′ W, 1,000-4,200 m depth), which hosts high-density octocoral gardens, *Solenosmilia variabilis* patch reefs, Xenophyophores, crinoid fields, and deep-sea sponge grounds. The ATLAS submission also highlighted a recent study offering the first biological insight to ground-truth the occurrence of potential Vulnerable Marine Ecosystems (as defined by FAO, 2009) on Tropic Seamount (15 cold-water coral species), alongside predictive models to increase the spatial coverage beyond direct observation surveys. Predicted habitat for the glass sponge *Poliopogon amadou*, a biogeographically restricted hexactinellid forming extensive near-monospecific grounds, was found to favour the deep seamount flanks within a very narrow oceanographic regime.

A summary report from the Northeast Atlantic regional EBSA workshop (CBD, 2019a) containing 17 EBSA descriptions – one representing multiple static features[2] (Western Iberian Canyons and Banks), the rest all single static features[1], including the Tropic Seamount (Table 1) - was submitted for review to the CBD Subsidiary Body for Science, Technical and Technological Advice (SBSTTA), and in November 2019 the SBSTTA recommended all 17 described EBSAs for adoption at CBD COP-15 (CBD, 2019b), where if accepted by Parties they will become 'identified'.

This regional EBSA workshop was the final 'piece of the jigsaw' for the global coverage of regional EBSA workshops, delivering a global total of 338 areas described as EBSAs, 17 of which, as explained, are pending identification by CBD COP.

Characteristics of the EBSA process in the North Atlantic

North Atlantic EBSAs described thus far are predominantly located in ABNJ, together with features located in the Exclusive Economic Zones of Portugal

5 URL: www.eu-atlas.org/index.html.

and Spain. Some of these areas remain politically complicated in terms of jurisdiction and vested interests (*e.g.*, the Hatton-Rockall plateau; Johnson *et al.*, 2019). All coastal states around the North Atlantic have their own well-established national systems for designating marine protected areas (MPAs) in their national waters[6]. This is further consolidated in the Northeast Atlantic by the European Union's Natura 2000 network and the OSPAR Network of Marine Protected Areas (Johnson *et al.*, 2014). The EBSA process can therefore most effectively be applied to ABNJ, where as yet there is no overarching governance system - although OSPAR has successfully designated a set of High Seas MPAs (O'Leary *et al.*, 2012).

The EBSA process relies on compilation of scientific data. Baseline data layers are developed for each workshop, with approximately 75 data layers (biogeographic, biological and physical) made available. Biogeographic data are drawn from major biogeographic classification systems, such as the Global Open Oceans and Deep Seabed (GOODS; UNESCO, 2009), Marine Ecoregions of the World (MEOW; Spalding *et al.*, 2007) and Large Marine Ecosystems (LMEs; Sherman, 1991). Biological data layers include raw data and statistical indices compiled by the Ocean Biogeographic Information System (OBIS; Grassle, 2000). Physical data layers include bathymetric and physical substrate data, oceanographic features and remotely sensed data. Physical data tend to be more comprehensive than biological data, particularly for deeper waters. The North Atlantic as a marine region is relatively data-rich. Biological information is held by national databases and collective repositories (*e.g.*, EMODnet[7]), supported by impartial scientific organisations, such as the International Council for the Exploration of the Sea (ICES[8]) and expert groups, such as the Global Ocean Biodiversity Initiative (GOBI[9]; Johnson *et al.*, 2018b). North Atlantic EBSA workshops have therefore been able to incorporate information from deep-sea scientific projects/expeditions (a legacy of the Census of Marine Life[10]), draw upon well-networked scientific organisations and individuals, and benefit from the resources of exclusively developed nations. Even so, in common with many other regions, there is a need to consider habitat suitability modelling and possible proxies. A universal gap in data is in the mesopelagic zone (200-1,000 m depth), as well as a scarcity of physical and biological data from abyssal and hadal depths (*i.e.*, >4,000 m depth; Crist & O'Dor, 2013). Specific gaps have also been noted that might benefit from further consideration, such as the critical Leatherback turtle foraging area off Nova Scotia and the paucity of coverage for elasmobranchs (Johnson *et al.*, 2018a).

The North Atlantic regional EBSA workshops exemplify the good working relationship between the CBD and respective Regional Fishery Management Organizations (RFMOs). Since 2006, the Northwest Atlantic Fisheries Organization (NAFO) has put in place closures to bottom fishing to protect seamounts and significant concentrations of sponges and corals in the NAFO Regulatory Area (Koen-Alonso *et al.*, 2019). NAFO's Working Group on Ecosystems and Scientific Advice has

6 The majority of States represented at the Northeast Atlantic regional EBSA workshop contributed summaries of national efforts, which are included in the workshop report (CBD, 2019a).

7 URL: https://emodnet.eu.
8 URL: https://www.ices.dk.
9 URL: https://www.gobi.org.
10 URL: http://www.coml.org.

reviewed over 500 benthic taxa, as well as fish, marine mammals and sea turtles. This information contributed to the description of the Slopes of Flemish Cap and Grand Banks EBSA, which includes most of the aggregations of indicator taxa for Vulnerable Marine Ecosystems identified in the NAFO Regulatory Area, as well as a component of the Greenland halibut fishery grounds in international waters. The Southeast Shoal and Adjacent Areas on the Tail of the Grand Banks EBSA incorporates a nursery ground for yellowtail flounder, as well as spawning areas for several threatened fish species. In the Northeast Atlantic, NEAFC together with its Regional Seas counterpart, the OSPAR Commission, initiated the 2011 regional EBSA workshop on behalf of Contracting Parties. Fisheries data were provided by ICES, including access to stock assessments, although individual catch statistics were not explored. Fisheries input was also made on behalf of the IUCN Fisheries Expert Group. Nevertheless, in both Northeast Atlantic regional EBSA workshops, the 'Banana Hole' area in ABNJ is specifically identified as a gap. Even though this area is known to support significant biomass production at all trophic levels, including large schools of feeding pelagic fish (*e.g.*, spring-spawning herring, mackerel and whiting), it was deemed by the workshop participants to lack specific biological or ecological information.

DISCUSSION

Is EBSA coverage comprehensive?

Each regional EBSA workshop has acknowledged gaps. In some cases, these are data gaps that can be addressed by new scientific information. In their review of the EBSA process, Johnson *et al.* (2018a) concluded that best available, regularly updated information is needed to maximise EBSA utility. The Northwest Atlantic regional EBSA workshop acknowledged the seasonality of many data (resulting from recurrent, tightly focussed and relatively short surveys conducted at the same time of year, such as fish stock assessments) and a lack of consistent region-wide biological surveys. Information on benthic biota for deeper seamounts was also very limited. Dunn *et al.* (2019) highlighted the inclusion of migratory connectivity in the design of conservation and management measures as critical to ensure such measures are appropriate for the level of risk associated with various degrees of connectivity. Both North Atlantic regional EBSA workshops recognised data gaps with regard to migration corridors for marine mammals. Multiple studies, particularly of tagged animals, are needed to evidence these corridors. The Northeast Atlantic regional EBSA workshop report confirmed that in common with many other marine regions, benthic and pelagic interconnectivity, as well as interconnections between the High Seas and surrounding shelf ecology, are not completely understood.

Although the EBSA description process is envisaged as open-ended (paragraphs 9 and 12 of CBD COP Decision XI/17; CBD, 2012c), currently the procedure for adding new EBSAs, or strengthening and modifying EBSA descriptions when new information becomes available, is unclear. A CBD Expert Workshop held in Brussels in February 2020 sought to address this (CBD, 2021a). At CBD COP-15, Parties will be requested to consider a Recommendation clarifying how EBSA information is curated, reasons for modification of EBSA descriptions, who can propose modification, and the rationale for modification or describing new areas in different jurisdictions. Clarification will enable scientific research projects, such as those in the

North Atlantic basin that are generating relevant new information (*e.g.*, Morato *et al.*, 2020), as well as the forthcoming UN Decade of Ocean Science for Sustainable Development and UN Decade of Ecosystem Restoration, to supply new EBSA-relevant data to the process.

Efforts by conservationists to ramp up representative coverage of area-based management tools (ABMTs) and to inform choices about areas to protect are evolving under the systematic conservation planning discipline (Margules & Pressey, 2000; McIntosh *et al.*, 2017). For example, Visalli *et al.* (2020) used a data-driven algorithm-guided process to identify potential ABMTs in ABNJ as a complement to identified EBSAs. Ambitious targets associated with the CBD's post-2020 Global Biodiversity Framework will provide added incentive to find suitable representative areas. In ABNJ, systematic conservation planning can provide an important contribution to future marine spatial planning (Wright *et al.*, 2019). These ideas have already been taken forward in the North Atlantic by Combes *et al.* (2021), who focus on the identification of conservation priority networks for Vulnerable Marine Ecosystems based on a multi-objective prioritisation, enabling detailed consideration of elements such as biologically-informed connectivity.

The CBD and regional EBSA workshop participants recognise that indigenous people and local communities have a significant amount of endemic traditional knowledge relevant to the description of EBSAs (Article 8(j) of the Convention on Biological Diversity and Aichi Biodiversity Target 18). However, even though a member of the Saami Council participated in the Northeast Atlantic regional EBSA workshop, neither regional EBSA workshop in the North Atlantic harnessed indigenous and local knowledge (such as fishing grounds, spawning areas, customary use of areas, cultural heritage sites, subsistence use areas and sacred sites) in a meaningful way.

Has the EBSA process been effective?

EBSAs do not confer any management obligations, but they do highlight areas where additional management measures may be appropriate. This includes an input to prioritising precautionary efforts and encouraging the use of ABMTs, such as activity-specific management zones (*e.g.*, areas to be avoided, closed areas, fishing gear restricted zones and particularly sensitive or low-emission areas). For ABNJ this will be important once the International Legally Binding Instrument, an Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of ABNJ, has been negotiated. The revised draft text for this Agreement currently highlights the importance of international cooperation to avoid undermining existing ABMTs (including MPAs and other effective area-based conservation measures[11]). States need to determine the process for designing, putting in place and managing ABMTs. To this end, the EBSA process can provide a scientific basis for rapid implementation. In some circumstances, such as the Charlie-Gibbs Fracture Zone (Johnson, 2016), MPA designation and EBSA descriptions already coincide. The extent of overlap of EBSAs with

11 Other effective area-based conservation measures are defined as "a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the *in-situ* conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values." (IUCN-WCPA, 2019).

other ABMTs, including those with management obligations, together with judgements on representativity for biogeographic coverage, is perhaps a useful starting point when considering whether coverage is comprehensive, but proposals should be taken on a case by case basis.

Ultimately, the effectiveness of conservation measures has to be judged against environmental baselines on the basis of periodic review. The OSPAR Commission's Quality Status Reports (2000, 2010) and Intermediate Assessment (2017), seek to inform such judgements. For the majority of national waters in the Northeast Atlantic, this is also the objective of the EU Marine Strategy Framework Directive and its Good Environmental Status (GES) goal. Thresholds for achieving GES in deeper waters have also been explored by Kazanidis *et al.* (2020). EBSAs may help focus actions to ensure GES.

Is there more to do?

The North East Atlantic regional EBSA workshop noted that many threatened and/or declining species and habitats in the region exhibit traits with little adaptation potential to threats associated with climate change (Johnson *et al.*, 2018c). Climate change impacts and implications could eclipse the current EBSA criteria, and there have been calls to consider 'climate resilience and refugia' as an additional EBSA criterion (Johnson & Kenchington, 2019).

A strength of the EBSA process has been the synthesis of information at an ecosystem level that can be used by a diverse set of decision-makers. However, using regional EBSA workshop results requires education of stakeholders so that due regard of EBSA qualities can be taken appropriately by States and competent international organisations. An example of where this could be more transparent is in the context of the International Seabed Authority (ISA) and the Lost City hydrothermal vent field (Johnson, 2019). The Northwest Atlantic regional EBSA workshop described a linear EBSA capturing hydrothermal vent fields along the Mid-Atlantic Ridge. This EBSA includes the Lost City vent field and the confirmed active Broken Spur and Trans-Atlantic Geotransverse (TAG) vents. The ISA subsequently (February 2018) entered into a 15-year contract for exploration for polymetallic sulphides with the Government of Poland, its area coincident with the Hydrothermal Vent Fields EBSA. Each ISA contractor is required to submit an annual report on its programme of activities and the ISA is developing a Regional Environmental Management Plan for the Mid-Atlantic Ridge, but it is difficult to ascertain yet whether or not the EBSA has informed management considerations.

CONCLUSIONS

The EBSA process is widely regarded as an important and successful CBD initiative facilitating significant buy-in from Parties (CBD, 2021b). This detailed review of the North Atlantic EBSAs has shown unexpected benefits, inherent shortfalls and the potential for complementarity amongst similar ABMT implementation processes.

Unexpected benefits

The EBSA process facilitates scientific collaboration and information-sharing at national, sub-regional and regional levels. In doing so it provides an opportunity to access and integrate new data. For example, the Northwest Atlantic regional EBSA workshop was the first to use seabird tracking data alone to recognise and describe an important area for seabird foraging. Seabirds are long-lived and slow to reproduce, and

they are particularly vulnerable to by-catch by fisheries. Marine Important Bird and Biodiversity Areas (IBAs) have been described using standardised procedures initially based on information from the Tracking Ocean Wanderers, the IUCN Red List, and Seabird Foraging Range databases. How compatible this information is with the EBSA process, including a need for appropriate contextual and meta-information, was a major point of discussion at the Northwest Atlantic regional EBSA workshop. The upshot was successful identification of the Seabird Foraging Zone in the South Labrador Sea EBSA that includes a core pelagic foraging and wintering area for three seabird species from 20 breeding colonies located on both sides of the ocean. Information provided by BirdLife International to the Northwest Atlantic regional EBSA workshop was taken up again at the Northeast Atlantic regional EBSA workshop. Tracking data of North Atlantic breeding seabird populations and of southern hemisphere migrant species defined a persistent usage hotspot that coincided with the subpolar frontal zone. Enhanced primary production present in this zone is linked to the role of fronts and eddies promoting high surface productivity. This phenomenon underpinned the description of the North-Atlantic Current and Mid-Atlantic Sub-Polar Frontal System EBSA, with its high intensity of foraging activity evidenced by tracking data collected not only for seabirds but also whales, sea turtles, tunas and sharks. BirdLife International have used this information to promote a candidate High Seas MPA, to be part of the OSPAR MPA Network in the Northeast Atlantic (Davies *et al.*, 2021).

Inherent shortfalls

Despite efforts to ensure consistency, such as using the same technical teams for all regional EBSA workshops, decision-making during the EBSA description process across successive workshops is an iterative exercise. Each region has its own nuance - partly driven by expert and data availability - and challenges are addressed according to precedent, wherever possible, or pragmatically opting for the least-objectionable solution for all participants. Also, the priorities of individual States and their other vested interests vary between regions. Participating experts are invited based on nominations by CBD National Focal Points. Inevitably, this means that some important elements may be missed, as not all States nominate a representative with the appropriate expertise. Moreover, some invited experts are unable to attend (or opt not to attend) regional EBSA workshops, depriving the workshop of their expertise and rendering their respective national waters off limits to the EBSA process. As a result, ecosystem attributes or features that straddle jurisdictional boundaries of absent States cannot be described as a whole.

Another important issue is the geographic scope of each regional EBSA workshop. The boundary for each workshop is considered and agreed collectively by workshop participants after an assessment of available evidence, whilst also taking into consideration the extent of adjacent regional EBSA workshops and limitations of expertise or jurisdiction. Limited geographical overlap with adjacent regional EBSA workshops can be justified if new information is available in the area of overlap, the absence of which during the earlier workshop prevented the description of known attributes (*e.g.*, the Tropic Seamount EBSA, not described by the Southeast Atlantic regional EBSA workshop, yet described by the Northeast Atlantic regional EBSA workshop, the scope of which was extended southwards

explicitly for the purpose, given the newly available evidence (Ramiro-Sánchez *et al.*, 2019)). However, the overlapping of regional EBSA workshop extents is not without consequence, as the absence of representation from stakeholders or States whose interests are within or adjacent to the area of overlap may have cause to object.

For the North Atlantic, primarily focusing on ABNJ, ecological connections between ABNJ and national waters do not feature prominently. Again, this can be explained by the legitimate desire of invited experts to exclude their State's national waters from consideration by the EBSA process. This can lead to the recognition in principle of important ecological attributes and features that straddle (thus, connect) national and international waters, but which can only be described as truncated features in ABNJ (compromising their integrity as EBSAs), or cannot described at all for political, rather than scientific reasons.

Potential for complementary approaches at a global scale

As already noted, marine IBAs have been instrumental in the provision of evidence (seabird tracking data) to support EBSA descriptions, exemplifying the complementarity and potential for integration of different processes with the EBSA process. Based on this example, experts in marine mammal ecology have devised equivalent Important Marine Mammal Areas (IMMAs; Corrigan *et al.*, 2014). The intention of the IMMA process is to collate available information on marine mammal populations and their spatial ecology to delineate areas that are important to them. To date, the IMMA process has also adopted a regional approach to its implementation, with most progress being made in the southern hemisphere (Notarbartolo di Sciara & Hoyt, 2020; Marine Mammal Protected Area Task Force IMMA E-Atlas[12]). Despite this early geographical bias, marine mammal data not yet incorporated into IMMAs in the northern hemisphere were included in the description of several EBSAs in the Northeast Atlantic (*e.g.*, Gulf of Cadiz EBSA and Madeira-Tore EBSA; CBD, 2019a). Other similar taxon-specific data collation initiatives are also in development, such as Important Sea Turtle Areas and Important Shark and Ray Areas, by their respective expert communities.

To provide balance and smooth out inherent limitations of a hitherto regional approach, a complementary thematic approach to describing EBSAs, focusing on specific EBSA criteria or on specific features, such as seamounts or vent fields, could be introduced, particularly for ABNJ. The details behind such an evolution of approach have yet to be worked out and negotiated, and will require consent from the CBD COP before they can progress to implementation.

ACKNOWLEDGEMENTS

This work is a contribution to the GPS Azores – Geographical and Political Scenarios and Maritime Spatial Planning for the Azores and North Atlantic, (Ref. ACORES-01-0145-FEDER-00002 GPS Azores) financed by Azores2020 Operational Programme (85% by FEDER and 15% by Regional Funds). The Global Ocean Biodiversity Initiative (GOBI) is supported by the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

12 URL: https://www.marinemammalhabitat.org/imma-eatlas/.

LITERATURE CITED

CBD, 2007. *Report of the expert workshop on ecological criteria and biogeographic classification systems for marine areas in need of protection, Azores, Portugal, 2-4 October* 2007, 24 pp. Convention on Biological Diversity Document UNEP/CBD/EWS. MPA/1/2.

CBD, 2008. *Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its ninth meeting, Bonn, 19–30 May 2008*, 12 pp. Convention on Biological Diversity Document UNEP/CBD/COP/DEC/IX/20.

CBD, 2012a. *Report of joint OSPAR/NEAFC/CBD scientific workshop on EBSAs, Montreal, 30 April-5 May 2012*, 164 pp. Convention on Biological Diversity Document UNEP/CBD/SBSTTA/16/INF/5.

CBD, 2012b. *Review of the report of the joint OSPAR/NEAFC/CBD scientific workshop on EBSAs in the Northeast Atlantic, Montreal, 30 April-5 May 2012*, 6 pp. Convention on Biological Diversity Document UNEP/CBD/SBSTTA/16/INF/5/Add.1.

CBD, 2012c. *Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its eleventh meeting, Hyderabad, India, 8-19 October 2012*, 32 pp. Convention on Biological Diversity Document UNEP/CBD/COP/DEC/XI/17.

CBD, 2014. *Report of the North-West Atlantic regional workshop to facilitate the description of Ecologically or Biologically Significant marine Areas, Montreal, 24-28 March 2014*, 122 pp. Convention on Biological Diversity Document UNEP/CBD/EBSA/WS/2014/2/4.

CBD, 2019a. *Report of the regional workshop to facilitate the description of Ecologically or Biologically Significant marine areas in the North- East Atlantic Ocean, Stockholm, 22-27 September 2019*, 351 pp. Convention on Biological Diversity Document CBD/EBSA/WS/2019/1/4.

CBD, 2019b. *Recommendation adopted by the Subsidiary Body on Scientific, Technical and Technological Advice at its twenty-third meeting, Montreal, Canada, 25-29 November 2019*, 164 pp. Convention on Biological Diversity Document CBD/SBSTTA/REC/23/4.

CBD, 2021a. *Report of the expert workshop to identify options for modifying the description of Ecologically or Biologically Significant marine Areas and describing new areas, Brussels, 3-5 February 2020*, 23 pp. Convention on Biological Diversity Document CBD/EBSA/WS/2020/1/2.

CBD, 2021b. *Special places in the ocean: a decade of identifying Ecologically or Biologically Significant marine Areas*, 68 pp. Convention on Biological Diversity Document.

Combes, M., S. Vaz, A. Grehan, T. Morato, S. Arnaud-Haond, C. Dominquez-Carrio, A. Fox, J.M. Gonzaley-Irusta, D. Johnson, O. Callery, A. Davies, L. Fauconnet, A. Grehan, E. Kenchington, C. Orejas, G. Taranto & L. Menot, 2021. Systematic conservation planning at an ocean basin scale: identifying a viable network of deep-sea protected areas in the North Atlantic and the Mediterranean. *Frontiers in Marine Science*, https://doi.org/10.3389/fmars.2021.611358.

Corrigan, C.M., J.A. Ardron, M.T. Comeros-Raynal, E. Hoyt, G. Notarbartolo Di Sciara & K.E. Carpenter, 2014. Developing important marine mammal area criteria: learning from ecologically or biologically significant areas and key biodiversity areas. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 24: 166-183.

Crist, D.T., & R. O'dor, 2013. Census of Marine Life. *In*: Levin, S.A. (ed.), *Encyclopedia of Biodiversity*, Second Edition, pp. 1-22. Academic Press.

Davies, T., A. Carneiro, B. Campos, C. Hazin, D. Dunn, K. Gjerde, D. Johnson & M. Dias, 2021. Tracking data and the conservation of the high seas: opportunities and challenges. Journal of Applied Ecology 58(12): 2703-2710. https://doi.org/10.1111/1365-2664.14032.

Dunn, D.C., A.-L. Harrison, C. Curtice, S. Deland, B. Donnelly, E. Fujioka, E. Heywood, C.Y. Kot, S. Poulin, M. Whitten, S. Åkesson, A. Alberini, W. Appeltans, J.M. Arcos, H. Bailey, L.T. Ballance, B. Block, H. Blondin, A.M. Boustany, J. Brenner, P. Catry, D. Cejudo, J. Cleary, P. Corkeron, D.P. Costa, M. Coyne, G. Ortuño Crespo, T.E. Davies, M.P. Dias, F. Douvere, F. Ferretti, A. Formia, D. Freestone, A.S. Friedlaender, H. Frisch-Nwakanma, C. Barrio Froján,

K.M. Gjerde, L. Glowka, B.J. Godley, J. Gonzalez-Solis, J.P. Granadeiro, V. Gunn, Y. Hashimoto, L.M. Hawkes, G.C. Hays, C. Hazin, J. Jimenez, D.E. Johnson, P. Luschi, S.M. Maxwell, C. Mcclellan, M. Modest, G. Notarbartolo Di Sciara, A. Herrero Palacio, D.M. Palacios, A. Pauly, M. Rayner, A.F. Rees, E. Ross Salazar, D. Secor, A.M.M. Sequeira, M. Spalding, F. Spina, S. Van Parijs, B. Wallace, N. Varo-Cruz, M. Virtue, H. Weimerskirch, L. Wilson, B. Woodward & P.N. Halpin, 2019. The importance of migratory connectivity for global ocean policy. *Proceedings of the Royal Society B*, 286: 2019 1472.

Egevang, C., I.J. Stenhouse, R.A. Phillips, A. Petersen, J.W. Fox & J.R.D. Silk, 2010. Tracking of Arctic terns *Sterna paradisaea* reveals longest animal migration. *Proceedings of the National Academy of Sciences*, 107(5): 2078-2081.

FAO, 2009. *International Guidelines for the Management of Deep-sea Fisheries in the High Seas*, 73 pp. FAO, Rome.

Grassle, J.F., 2000. The Ocean Biogeographic Information System (OBIS): An On-line, Worldwide Atlas for Accessing, Modeling and Mapping Marine Biological Data in a Multidimensional Geographic Context. *Oceanography*, 13(3): 5-7.

IUCN-WCPA, 2019. *Recognising and Reporting Other Effective Area-based Conservation Measures. Technical Report*, 45 pp. IUCN, Switzerland.

Johnson, D.E., 2016. Conserving the Charlie-Gibbs Fracture Zone: one of the world's first High Seas Marine Protected Areas. *In*: Mackelworth, P. (ed.), *Marine Transboundary Conservation and Protected Areas. Earthscan Oceans*, Chapter 15, pp. 271-285.

Johnson, D.E., 2019. Protecting the Lost City vent system: all is not lost, or is it?. *Marine Policy*, 107:103593.

Johnson, D., J. Ardron, D. Billett, T. Hooper, T. Mullier, P. Chaniotis, B. Ponge & E. Corcoran, 2014. When is a marine protected area network ecologically coherent? A case study from the North-east Atlantic. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 24(2): 44-58.

Johnson, D.E., & E.L. Kenchington, 2019. Should potential for climate change refugia be mainstreamed into the criteria for describing EBSAs?. *Conservation Letters*, 12:e12634.

Johnson, D.E., C. Barrio Froján, P.J. Turner, P. Weaver, V. Gunn, D.C. Dunn, P. Halpin, N.J. Bax & P.K. Dunstan, 2018a. Reviewing the EBSA process: Improving on success. *Marine Policy*, 88: 75-85.

Johnson, D.E., C. Barrio Froján, N. Bax, P. Dunstan, S. Woolley, P. Halpin, D. Dunn, C. Hazin, M. Dias, T. Davies, J. Jimenez, E. Ross, C. Van Dover, G. Notarbartolo Di Sciara, E. Hoyt, V. Gunn & H. Von Nordheim, 2018b. The Global Ocean Biodiversity Initiative: Promoting scientific support for global ocean governance. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 29(S2): 162-169.

Johnson, D., M.A. Ferreira & E. Kenchington, 2018c. Climate change is likely to severely limit the effectiveness of deep-sea ABMTs in the North Atlantic. *Marine Policy*, 7: 111-122.

Johnson, D.E., C. Barrio Froján, F. Neat, D. Van Oevelen, D. Stirling, M. Gubbins & J.M. Roberts, 2019. Rockall and Hatton: resolving a super wicked marine governance problem in the High Seas of the North-East Atlantic Ocean. *Frontiers in Marine Science*, 6:69.

Kazanidis, G., C. Orejas, A. Borja, E. Kenchington, L.-A. Henry, O. Callery, M. Carreiro-Silva, H. Egilsdottir, E. Giacomello, A. Grehan, L. Menor, T. Morato, S. Ragnarsson, J.L. Rueda, D. Stirling, T. Stratmann, D. Van Oevelen, A. Palialexis, D. Johnson & J.M. Roberts, 2020. Assessing the environmental status of selected North Atlantic deep-sea ecosystems. *Ecological Indicators*, 119: 106624.

Koen-Alonso, M., P. Pepin, M.J. Fogarty, A. Kenny & E. Kenchington, 2019. The Northwest Atlantic Fisheries Organization Roadmap for the development and implementation of an Ecosystem Approach to Fisheries: structure, state of development, and challenges. *Marine Policy*, 100: 342-352.

Margules, C.R., & R.L. Pressey, 2000. Systematic Conservation Planning. *Nature*, 405: 243-253.

McIntosh, E., R. Pressey, S. Lloyd, R. Smith & R. Grenyer, 2017. The impact of Systematic Conservation Planning. *Annual Review of Environment and Resources*, 42: 677-697.

Melle, W., J. Runge, E. Head, S. Plourde, C. Castellani, P. Licandro, J. Pierson, S. Jonasdottir, C. Johnson, C. Broms, H. Debes, T. Falkenhaug, E. Gaard, A. Gislason, M. Heath, B. Niehoff, T.G. Nielsen, P. Pepin, E.K. Stenevik & G. Chust, 2014. The North Atlantic Ocean as habitat for *Calanus finmarchicus*: Environmental factors and life history traits. *Progress in Oceanography*, 129(B): 244-284.

Morato, T., J.M. Gonzalez Irusta, C. Dominguez Carrio, Cl. Wei, A. Davies, A.K. Sweetman, G.H. Taranto, L. Beazley, A. García Alegre, A. Grehan, P. Laffargue, F.J. Murillo, M. Sacau, S. Vaz, E. Kenchington, S. Arnaud-Haond, O. Callery, G. Chimienti, E. Cordes, H. Egilsdottir, A. Freiwald, R. Gasbarro, C. Gutiérrez Zárate, M. Gianni, K. Gilkinson, V.E. Wareham Hayes, D. Hebbeln, K. Hedges, L.-A. Henry, D. Johnson, M. Koen-Alonso, C. Lirette, F. Mastrototaro, L. Menot, T. Molodtsova, P. Durán Muñoz, C. Orejas, M.G. Pennino, P. Puerta, S.Á. Ragnarsson, B. Ramiro Sánchez, J. Rice, J. Rivera, J.M. Roberts, S.W. Ross, J.L. Rueda, Í. Sampaio, P. Snelgrove, D. Stirling, M.A. Treble, J. Urra, J. Vad, D. Van Oevelen, L. Watling, W. Walkusz, C. Wienberg, M. Woillez, L.A. Levin & M. Carreiro-Silva, 2020. Climate-induced changes in the suitable habitat of cold-water corals and commercially important deep-sea fishes in the North Atlantic. *Global Change Biology*, 26: 2181-2202.

Notarbartolo Di Sciara G., & E. Hoyt, 2020. Healing the wounds of marine mammals by protecting their habitat. *Ethics in Science and Environmental Politics*, 20: 15-23.

O'leary, B.C., R.L. Brown, D.E. Johnson, H. Von Nordheim, J. Ardron & T. Packeiser, 2012. The first network of marine protected areas (MPAs) in the high seas: The process, the challenges and where next. *Marine Policy*, 36: 598-605.

OSPAR Commission, 2000. *Quality Status Report 2000*, 108 + vii pp. OSPAR Commission, London.

OSPAR Commission, 2010. *Quality Status Report 2010*, 176 pp. OSPAR Commission, London.

OSPAR Commission, 2017. *Intermediate Assessment 2017*. OSPAR Commission, London. Online resource [https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/].

Ramiro-Sánchez, B., J.M. González-Irusta, L.-A. Henry, J. Cleland, I. Yeo, J.R. Xavier, M. Carreiro-Silva, Í. Sampaio, J. Spearman, L. Victorero, C.G. Messing, G. Kazanidis, J.M. Roberts & B. Murton, 2019. Characterization and mapping of a deep-sea sponge ground on the Tropic Seamount (Northeast Tropical Atlantic): Implications for spatial management in the high seas. *Frontiers in Marine Science*, 6: 278.

Sherman, K., 1991. The Large Marine Ecosystem Concept: Research and Management Strategy for Living Marine Resources. *Ecological Applications*, 1(4): 350-60.

Spalding, M.D., H.E. Fox, G.R. Allen, N. Davidson, Z.A. Ferdaña, M. Finlayson, B.S. Halpern, M.A. Jorge, A. Lombana, S.A. Lourie, K.D. Martin, E. McManus, J. Molnar, C.A. Recchia & J. Robertson, 2007. Marine Ecoregions of the World: A bioregionalization of coastal and shelf areas. *BioScience*, 57(7): 573-583.

UNESCO, 2009. *Global Open Oceans and Deep Seabed (GOODS) biogeographic classification. IOC Technical Series 84*, 95 pp. UNESCO-IOC, Paris.

Visalli, M.E., B.D. Best, R.B. Cabral, W.W.L. Cheung, N.A. Clark, C. Garilao, K. Kaschner, K. Kesner-Reyes, V.W.Y. Lam, S.M. Maxwell, J. Mayorga, H.V. Moeller, L. Morgan, G. Ortuño Crespo, M.L. Pinsky, T.D. White & D.J. McCauley, 2020. Data-driven approach for highlighting priority areas for protection in marine areas beyond national jurisdiction. *Marine Policy*, 122: 103927.

Wright, G., K. Gjerde, D.E. Johnson, A. Finkelstein, M.A. Ferreira, D.C. Dunn, M. Rodriquez Chaves & A. Grehan, 2019. Marine spatial planning in areas beyond national jurisdiction. *Marine Policy*, Article 103384.