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Offshore Ecologically and Biologically Significant Areas in the Scotian Shelf Bioregion

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Ecologically and Biologically Significant Areas (EBSAs) are areas of particularly high ecological or biological importance relative to other areas in a region. Considerable work has been done over the past decade to identify EBSAs in the Scotian Shelf Bioregion. The purpose of this report is to present and describe a revised list of EBSAs for the offshore component of this bioregion. A concise overview of available bioregional-scale ecological or biological data layers that have been compiled or created to help evaluate and identify offshore EBSAs is also presented. The information in this report was reviewed through a Regional Science Advisory Process hosted by the Canadian Science Advisory Secretariat in Halifax, Nova Scotia from February 18-20, 2014. The revised list of offshore EBSAs was created through the evaluation and refinement of 42 EBSAs identified through scientific expert opinion (SEO) in 2007. The first step in this process was to compile or develop data-layers relevant to the various EBSA criteria. Each of the original SEO EBSAs was then evaluated based on an overlay analysis with the EBSA data layers and a review of the literature to identify further evidence of their ecological and biological significance. Areas found to have insufficient evidence were removed from the process while those with sufficient evidence were included in the updated list of offshore EBSAs. Where necessary, the boundaries of the refined EBSAs were also updated. A concise description was developed for each of the updated EBSAs. The process yielded a total of 18 offshore EBSAs in the Scotian Shelf Bioregion, with 17 of those occurring on the Scotian Shelf or Scotian Slope and one in the deeper waters beyond the slope. Notable ecological and biological features were highlighted for each EBSA under the different Fisheries and Oceans (DFO) EBSA criteria. The updated list of EBSAs presented in this report will be considered in a broad range of coastal and oceans management and planning processes in the Scotian Shelf Bioregion.

Zones d'importance écologique et biologique au large des côtes de la biorégion du plateau néo-écossais

RÉSUMÉ

Les zones d'importance écologique et biologique (ZIEB) sont des zones d'importance particulièrement élevée par rapport à d'autres zones dans une région. Des efforts considérables ont été consentis au cours de la dernière décennie pour désigner les ZIEB dans la biorégion du plateau néo-écossais. Ce rapport a pour objet de présenter et décrire une liste révisée des ZIEB pour la composante extracôtière de cette biorégion. On y trouve également une vue d'ensemble concise des couches de données écologiques et biologiques disponibles à l'échelle biorégionale qui a été compilée ou rédigée afin d'aider à évaluer et à localiser les ZIEB extracôtières. Les renseignements contenus dans ce rapport ont été examinés au moyen d'un processus d'avis scientifique régional, organisé par le Secrétariat canadien de consultation scientifique (SCCS) à Halifax, en Nouvelle-Écosse, du 18 au 20 février 2014. La liste des ZIEB extracôtières a été révisée en fonction de l'évaluation et du peaufinage des 42 ZIEB désignées au moyen d'avis scientifiques spécialisés en 2007. La première étape du processus consistait à compiler ou à élaborer des couches de données qui se rapportent aux divers critères liés aux ZIEB. Chacune des ZIEB originales désignées en fonction d'avis scientifiques spécialisés a été ensuite évaluée en fonction d'une analyse d'éléments superposés avec les couches de données des ZIEB et d'un examen de la documentation afin de déterminer d'autres preuves de leur importance écologique et biologique. Les zones pour lesquelles les preuves étaient insuffisantes ont été retirées du processus, tandis que celles pour lesquelles les preuves suffisaient ont été incluses dans la liste mise à jour des ZIEB extracôtières. Le cas échéant, les limites des ZIEB peaufinées ont également été mises à jour. Une courte description a été élaborée pour chaque ZIEB mise à jour. Le processus a permis de délimiter au total 18 ZIEB extracôtières dans la biorégion du plateau néo-écossais, dont 17 se situaient sur le plateau néo-écossais ou le talus du plateau néo-écossais, et une dans les eaux profondes au-delà du talus. D'importantes caractéristiques écologiques et biologiques ont été mises en évidence pour chaque ZIEB en fonction des différents critères de Pêches et Océans Canada (MPO) concernant les ZIEB. La liste des ZIEB mise à jour qui figure dans le présent rapport sera prise en compte dans un vaste éventail d'exercices de planification et de gestion des zones côtières et des océans dans la biorégion du plateau néo-écossais.

INTRODUCTION

Ecologically and Biologically Significant Areas (EBSAs) are areas of particularly high ecological or biological importance relative to other areas in a region (DFO 2004). The identification of an area as an EBSA does not give it any special legal status or automatically trigger a management response. However, a higher degree of risk aversion may be required in the management of activities affecting EBSAs. The purpose of this report is to present and describe a revised list of EBSAs for the offshore component of the Scotian Shelf Bioregion (Figure 1). The work has been carried out, in part, in response to advice provided through a Canadian Science Advisory Secretariat (CSAS) Regional Science Advisory Process (RAP) on the objectives, data considerations and methods for marine protected area (MPA) network development in the bioregion (herein referred to as the 2012 MPA Network RAP) (DFO 2012a). The information in the current report was subsequently reviewed through separate CSAS RAP held in Halifax, Nova Scotia from February 18-20, 2014.

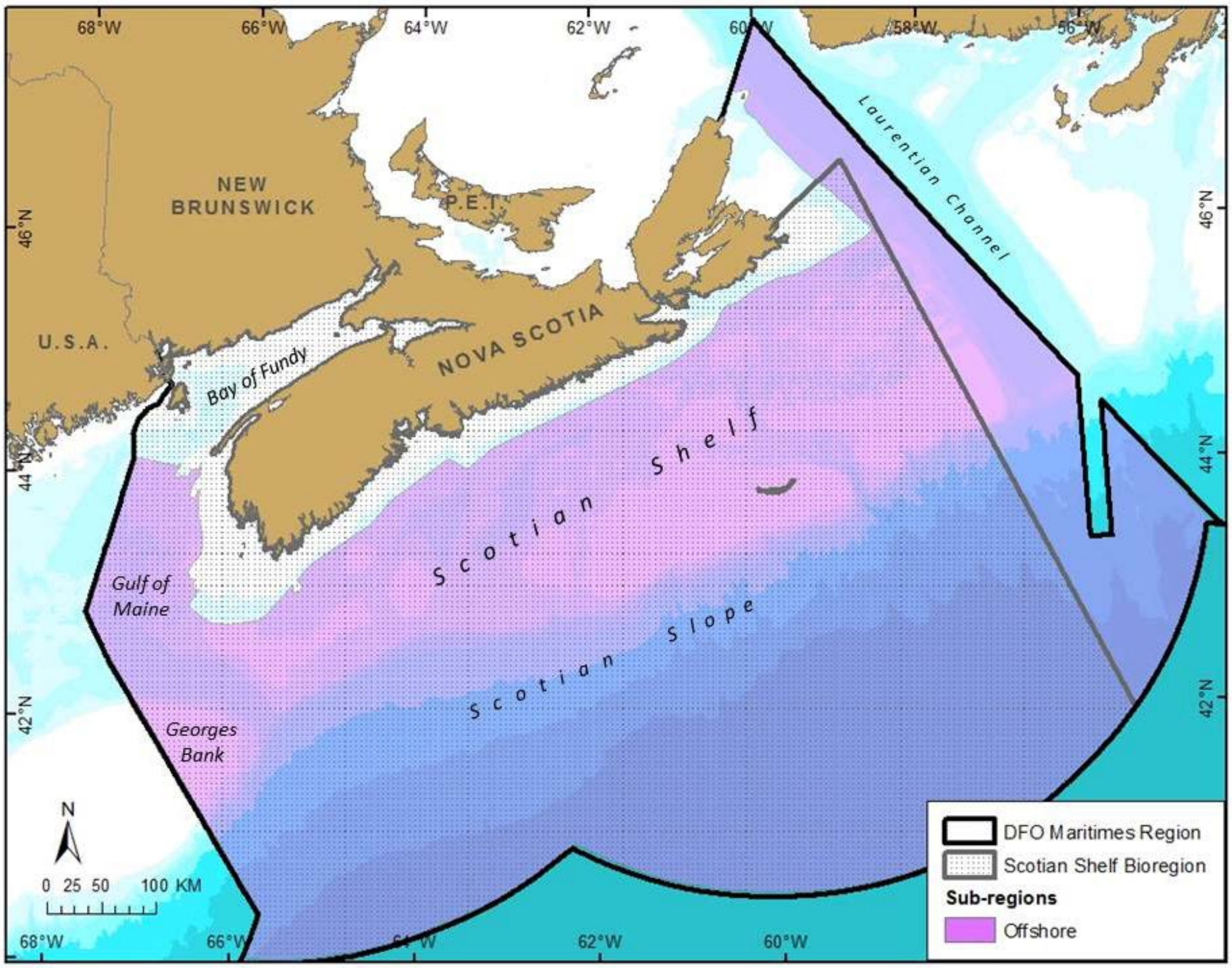

Figure 1. The offshore component of the Scotian Shelf Bioregion, which includes the Scotian Shelf, the offshore Canadian portions of the Gulf of Maine and Georges Bank, the Scotian Slope, and the deep water beyond the slope. Note that the bioregion boundary roughly corresponds with the Fisheries and Oceans Canada (DFO) Maritimes Region administrative boundary. The administrative boundary is used in this exercise.

The EBSAs presented in this report will be considered in a broad range of coastal and oceans management and planning processes in the Scotian Shelf Bioregion, including in the design of a network of MPAs (DFO 2012a). It is important to emphasize that not all EBSAs resulting from this process will be part of the bioregional MPA network. Looking ahead, the management needs of all EBSAs will be evaluated. Certain EBSAs or parts of EBSAs that are suitable for spatial management may be protected as an MPA or through some other spatial protection tool. Other EBSAs may be better-suited for activity-specific mitigation measures. Finally, some EBSAs may not require any additional management measures.

EBSA CRITERIA

Fisheries and Oceans Canada (DFO 2004) and the Convention on Biological Diversity (CBD 2009) developed separate criteria for the identification of EBSAs, but it is recognized that using either set of criteria will result in the identification of the same or similar areas (DFO 2012a). The DFO (2004) criteria are summarized as:

- Uniqueness: Areas that contain unique, rare, or distinct features in a regional, national or global context.
- Aggregation: Areas where significant numbers of a species or a wide variety of species are found during certain times of the year or year-round, or areas where a structural feature or ecological process is observed in exceptionally high density.
- Fitness Consequences: Areas where important life history activities (e.g., reproduction) that strongly affect the fitness of a species or population take place.
- Resilience: Areas that include habitat structures or species that are highly sensitive, easily perturbed, and/or slow to recover.
- Naturalness: Relatively pristine areas with little to no evidence of human influence.

The CBD (2009) EBSA criteria are summarized as:

- Uniqueness or rarity: Areas that contain a unique, rare, or endemic species, population, community, habitat or ecosystem or an unusual geomorphological or oceanographic feature.
- Special importance for life-history stages of species: Areas required for a population to survive and thrive (e.g., breeding or nursery grounds, spawning areas, migratory species habitat).
- Importance for threatened, endangered or declining species and/or habitats: Areas containing habitat that is critical for the survival and recovery of endangered, threatened, or declining species or significant assemblages of endangered, threatened, or declining species.
- Vulnerability, fragility, sensitivity, or slow recovery: Areas that contain a high proportion of sensitive habitats, biotopes, or species that are especially susceptible to degradation or depletion, and/or are slow to recover.
- Biological productivity: Areas that contain species, populations, or communities with comparatively higher natural biological productivity.
- Biological diversity: Areas with comparatively higher diversity of ecosystems, habitats, communities, or species, or that display high genetic diversity.
- Naturalness: Areas that exhibit a comparatively higher degree of naturalness resulting from little to no anthropogenic pressure.

Table 1 illustrates how the DFO and CBD EBSA criteria are aligned. Because this is a DFO-led process, the DFO criteria have been used as the primary basis for identifying EBSAs. However, the CBD EBSA criteria have also been considered because the updated EBSAs:

(a) may be used by other federal or provincial departments,
(b) will be considered in the shared federal (Parks Canada and Canadian Wildlife Service (CWS))/provincial (Nova Scotia and New Brunswick) MPA network development process, and
(c) may eventually be submitted to the international repository under development by the CBD.

The DFO and CBD criteria are used to identify areas that are significant from an ecological and biological standpoint when compared to other areas in the bioregion. The process to identify EBSAs is based purely on ecological and biological factors and does not consider threats, risk, or the economic values of the area. These factors will be considered at a later stage when each EBSA undergoes further evaluation.

Table 1. Alignment between DFO (2004) and CBD (2009) EBSA criteria (based on Buzeta 2014. Cells with an 'X' indicate that DFO and CBD criteria are the same or similar, and blank cells indicate that the criteria are not similar.

CBD (2009)	DFO (2004)				
	Uniqueness	Aggregation	Fitness Consequences	Resilience	Naturalness
Uniqueness or rarity	X				
Special importance for life-history stages of species		X	X		
Importance for threatened, endangered or declining species and/or habitats		X	X		
Vulnerability, fragility, sensitivity, or slow recovery				X	
Biological productivity		X			
Biological diversity		X			
Naturalness					X

METHODS

The geographic scope of this paper is the offshore component of the Scotian Shelf Bioregion (Figure 1). However, nearly all of the EBSAs described occur on the Scotian Shelf or Scotian Slope while only one EBSA was identified in the deeper waters beyond the slope. This spatial gap is largely due to the limited ecological and biological data available for these deep-water areas. Another EBSA described in this report partially falls within the coastal component of the bioregion.

This report builds on the considerable work over the last decade to identify EBSAs in the offshore Scotian Shelf Bioregion (Breeze 2004, Doherty and Horsman 2007, MacLean et al.

2009, Horsman et al. 2011, Zwanenburg unpublished[1]). A range of approaches have been employed in these works, including literature review, Scientific Expert Opinion (SEO), Local Ecological Knowledge (LEK), and data-driven. For the current process, a hybrid approach has been adopted where the SEO EBSAs described by Doherty and Horsman (2007) have been evaluated based on available regional-scale ecological data and a review of the literature. It is the intent of this report to present an updated list of EBSAs for the offshore component of the bioregion. Many of the areas proposed as EBSAs in this document have been identified as special areas in the past works noted above.

This paper is organized into three main sections. Section 1 provides a brief overview of the different data layers that have been compiled to evaluate and identify EBSAs. Section 2 presents an updated list of EBSAs for the offshore component of the Scotian Shelf Bioregion. Recommendations and proposed next steps are outlined in Section 3.

An important deliverable under the Health of the Oceans Initiative is to update the list of EBSAs for the Scotian Shelf Bioregion. Advice from the 2012 MPA Network RAP also suggested that the original SEO EBSAs be re-evaluated (DFO 2012a). The approach used to update the list of EBSAs consisted of an evaluation of the previously described SEO EBSAs (Doherty and Horsman 2007) based on available broad-scale ecological and biological data and a review of the literature. The SEO EBSAs were identified through an expert workshop and encompass many of the same areas identified through other approaches (e.g., Breeze 2004, MacLean et al. 2009), indicating that there is strong evidence supporting their ecological and biological significance. The overall approach is outlined in Figure 2 and described below.

[1] Zwanenburg produced an unpublished report titled, *Conservation Priorities for the Scotian Shelf*, which summarized the species within and the physical characteristics of each of the original Scientific Expert Opinion (SEO) EBSAs described by Doherty and Horsman (2007).

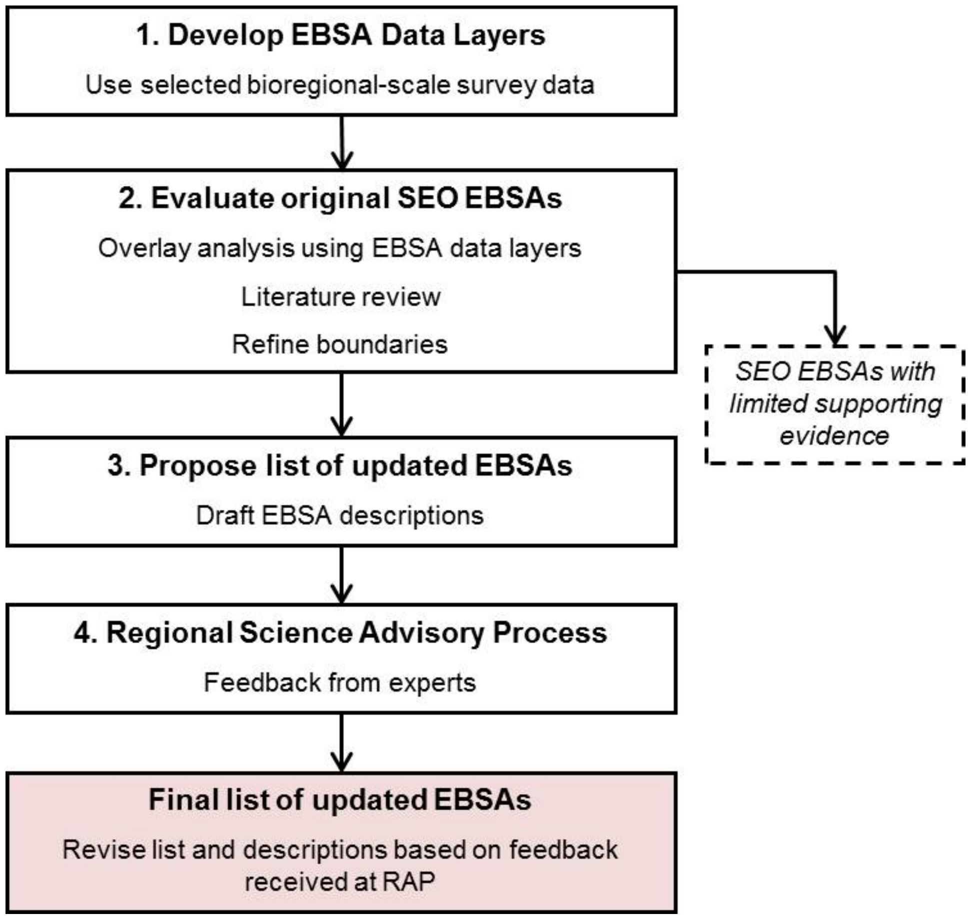

Figure 2. Summary of approach used to update EBSAs for the offshore component of the Scotian Shelf Bioregion.

1. Develop EBSA Data Layers: The first step in the process was to compile or develop data-layers relevant to the various EBSA criteria. Available published layers were assembled and some of these were updated using the most recent data (e.g., summer fish and invertebrate habitat layers). Additional layers were created using available bioregional-scale survey data. The data layers considered in this process are described in Section 1. Many of the layers used were also used by Horsman et al. (2011) in their initial MPA network analysis for the Scotian Shelf.
2. Evaluate original SEO EBSAs: The second step was to do a preliminary evaluation of the SEO EBSAs to determine if they should be included in the updated list of EBSAs and, where necessary, to refine their boundaries. The evaluation was based on an overlay analysis using the various EBSA data layers and a scan of the literature to identify further evidence for the ecological or biological significance of the areas. In some cases, the overlays and literature review offered new or supporting evidence for the significance of a particular EBSA or a portion of an EBSA. Two areas that partially overlap with SEO EBSAs but were not specifically identified in the initial SEO process were identified through the overlay analysis. These two areas were also identified by Horsman et al. (2011). There were other SEO EBSAs for which very little supporting evidence was found. These sites were removed from the current process (see Section 2, Table 4) but could re-emerge at a later date based on new evidence or research findings.

It must be acknowledged that the approach used to evaluate and update EBSAs has certain limitations. Most notably, using the SEO EBSAs as a starting point for the process somewhat constrained the exercise from the outset. A more systematic, data-driven approach could have been applied (see Horsman et al. 2011); however, such a method would have produced results that were skewed toward highly sampled components of the bioregional ecosystem (e.g., demersal fishes). The approach that was employed made use of available broad-scale data while also considering smaller scale site-specific research findings and expert knowledge. However, only areas that were at least partially identified through the SEO exercise were considered.

Many of the SEO EBSAs were roughly delineated so, where necessary, the boundaries were refined as part of this evaluation. For many of the EBSAs, the underlying bathymetry was a key consideration, and where appropriate, boundaries were roughly aligned with recognized physical features (e.g., banks and basins). In some cases, boundaries were adjusted based on how they coincided with certain species or other features. For example, the North Atlantic Right Whale Critical Habitat area designated under the *Species at Risk Act* (SARA) was considered along with the underlying bathymetry in delineating the Roseway Basin EBSA. In other instances, EBSAs that overlapped or were immediately adjacent to one another were combined into a larger EBSA or 'EBSA complex'. For example, The Gully, the Gully Trough, Shortland Canyon, and Haldimand Canyon EBSAs were merged into a larger complex based on proximity and shared ecological linkages. It should be noted that EBSA boundaries should still be considered approximate because they typically encompass broad areas that contain multiple ecosystem features which, in many cases, are mobile and may move beyond EBSA boundaries. With this in mind, an effort was made to keep boundaries as simple as possible.

3. Propose list of updated EBSAs: The next step was to develop a concise description for each of the proposed updated EBSAs. The descriptions (Section 2) summarize the evidence of the ecological and biological significance of each area using available data and supporting references.
4. Regional Science Advisory Process: The proposed list of EBSAs was refined further based on the feedback received through the February 2014 RAP (DFO 2014a). The final list of EBSAs is published in the Science Advisory Report from the meeting (DFO 2014a). EBSAs and their boundaries may evolve with time, as new information becomes available. For example, the larger EBSAs, such as the Scotian Slope, may be refined in the future.

SECTION 1: EBSA DATA LAYERS

The purpose of this section is to provide a concise overview of the different ecological or biological data layers that have been compiled or created to help evaluate and identify EBSAs in the offshore component of the Scotian Shelf Bioregion. It is not a comprehensive inventory of all available ecological or biological data in the bioregion. The emphasis has been placed on bioregional-scale survey data that can be used to characterize the relative distribution of specific ecosystem features (e.g., populations, species, habitats) or characteristics (e.g., species richness) throughout the bioregion. Countless site-specific, smaller-scale research projects have been carried out in this data rich bioregion but these are not considered in this section of the report. Relevant site-specific research for each EBSA is cited in Section 2. Additional site-scale data and analysis may also be considered at a later date as EBSA descriptions are refined and potential management measures are explored.

The layers considered in this process are summarized in Table 2 and were compiled based on the advice resulting from the 2012 MPA Network RAP (DFO 2012a). It should be noted that some of the information included in this section was presented at the 2012 RAP. Less emphasis has been placed on describing these layers in this paper and, in some cases, only a brief update is provided on the work that has been done or will be done in the future. More emphasis has been placed on describing new data layers.

Many of the layers described in this section were used by Horsman et al. (2011) in their initial MPA network analysis for the Scotian Shelf. The updated layers presented in this report may be included in future analyses to inform the design of a bioregional network of MPAs. A separate process will be carried out to determine which layers should be included in the network design process.

Table 2. Summary of data layers compiled or created for the offshore component of the Scotian Shelf Bioregion and the DFO and CBD EBSA criteria that have been associated with each layer. Numbers in parentheses indicate the number of layers in each category. DFO EBSA criteria abbreviations: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, and N = Naturalness. CBD EBSA criteria abbreviations: U = Uniqueness, LH = Life History Stages, ET = Endangered or Threatened Species, VS = Vulnerable Species, P = High Biological Productivity, D = High Biodiversity, and N = Naturalness. Cells with an 'x' indicate that data meet DFO or CBD criteria. Blank cells indicate that criteria are not considered to be applicable.

EBSA Data Layers and Source Data	DFO Criteria					CBD Criteria						
	U	A	FC	R	N	U	LH	ET	VS	P	D	N
Areas of high biological productivity or biomass												
Areas of high chlorophyll concentrations (100-1500 m) (MODIS[1] ocean colour data) (1)		x	x									
Areas of high chlorophyll concentrations (>1500 m) (MODIS ocean colour data) (1)		x	x									
Fish biomass (1970-2012)(RV[2] data) (1)		x								x		
Fish biomass (1978-85)(RV data) (1)		x								x		
Invertebrate biomass (1999-2012)(RV data) (1)		x								x		
Areas of high fish and invertebrate diversity												
Fish species richness (RV data) (1)	x	x				x					x	
Invertebrate species richness (RV data) (1)	x	x				x					x	
Fish species evenness (RV data) (1)	x	x				x					x	
Invertebrate species evenness (RV data) (1)	x	x				x					x	
Fish species diversity (ESW[3])(RV data) (1)	x	x				x					x	
Invertebrate species diversity (ESW)(RV data) (1)	x	x				x					x	
Small fish species richness (stomach contents from RV data) (1)	x	x	x			x	x				x	
Small invertebrate species richness (stomach contents from RV data) (1)	x	x				x					x	
Larval fish genus richness (SSIP[4] data) (1)	x	x	x			x	x				x	
Important habitat for fishes and invertebrates												
Important summer habitat for fish species (1970-2012)(RV data) (34)		x		x				x	x	x		
Important spring habitat for fish species (1979-85)(RV data) (30)		x		x				x	x	x		
Important fall habitat for fish species (1978-84)(RV data) (30)		x		x				x	x	x		
Important summer habitat for invertebrates (1999-2013)(RV data) (16)		x								x		
Larval fish abundance (8)		x	x				x	x				
Critical Habitat for Endangered Species												
Endangered whale Critical Habitat (2)		x	x				x	x				
Leatherback turtle Important Habitat Area (1)		x	x				x	x				
Corals and sponges												
Coldwater coral occurrences (ROV[5], FOP, RV data) (1)	x	x		x	x	x			x		x	x
Sponge occurrences (ROV, FOP[6], RV data) (1)	x	x		x	x	x			x		x	x
Areas of high sponge density (RV data) (1)	x	x		x	x	x			x		x	x
Important areas for seabirds												
Important areas for seabird functional guilds (CWS data) (8)		x	x				x	x				
Distinct physical conditions												
Areas of very high scope for growth			x							x		
Areas of very low scope for growth				x					x			
Areas of very low natural disturbance				x					x			

Notes: [1]Moderate Resolution Imaging Spectroradiometer; [2]Research Vessel; [3]Exponential of Shannon-Wiener Index; [4]Scotian Shelf Icthyoplankton Program; [5]Remote Operated Vehicle; [6]Fisheries Observer Program.

The Scotian Shelf Bioregion is considered rich in terms of available ecological, biological, and physical data. However, it is important to acknowledge that significant gaps still exist. For example, less information is available for the slope than the shelf and very little is known about the vast deep-water environments in the bioregion. In general, the demersal component of the shelf ecosystem is also better sampled than the pelagic and meso-pelagic realms. As a result, many of the data layers presented below focus on the well-sampled demersal communities (e.g., fishes). Detailed region-wide distribution information is also lacking for certain species groupings (e.g., cetaceans).

1.1 AREAS OF HIGH BIODIVERSITY

Areas that contain comparatively higher diversity of ecosystems, habitats, communities or species, or areas that have high genetic diversity qualify as EBSAs under the DFO Aggregation criterion and the CBD Biological Diversity criterion. They may also satisfy the Uniqueness criterion (DFO and CBD). A considerable amount of research has been devoted to understanding and describing the spatial distribution of biodiversity in the Scotian Shelf Bioregion, including multiple efforts to map areas of high species richness and other diversity indices for certain taxa (e.g., Shackell and Frank 2000, Shackell and Frank 2003, Shackell and Frank 2007, Horsman et al. 2011, Cook and Bundy 2012).

New diversity mapping was completed to inform the current EBSA evaluation process. Following the recommendation of Kenchington and Kenchington (2013), this work produced three fish and invertebrate diversity indices, including Species Richness, Heip's Evenness Index, and the Exponential of Shannon-Wiener Index. This new work is described in a separate document (Ward-Paige and Bundy 2016).

Several of the previously published biodiversity layers were also considered in the current EBSA evaluation. These layers are briefly described below.

1.1.1 Areas of High Small Fish and Small Invertebrate Species Richness

Small fish and invertebrate species richness patterns were described by Cook and Bundy (2012) based on an analysis of the stomach contents of common groundfish caught in the Research Vessel (RV) surveys. These layers were considered in the current EBSA evaluation exercise (Figures 3 and 4). The small invertebrate species richness layer captures some of the smaller species not caught or recorded in the RV survey. The small fish species richness layer was also used as a proxy for juvenile fish diversity. Records of small fishes that were not juveniles were removed from the dataset to provide a truer representation of juvenile fish diversity.

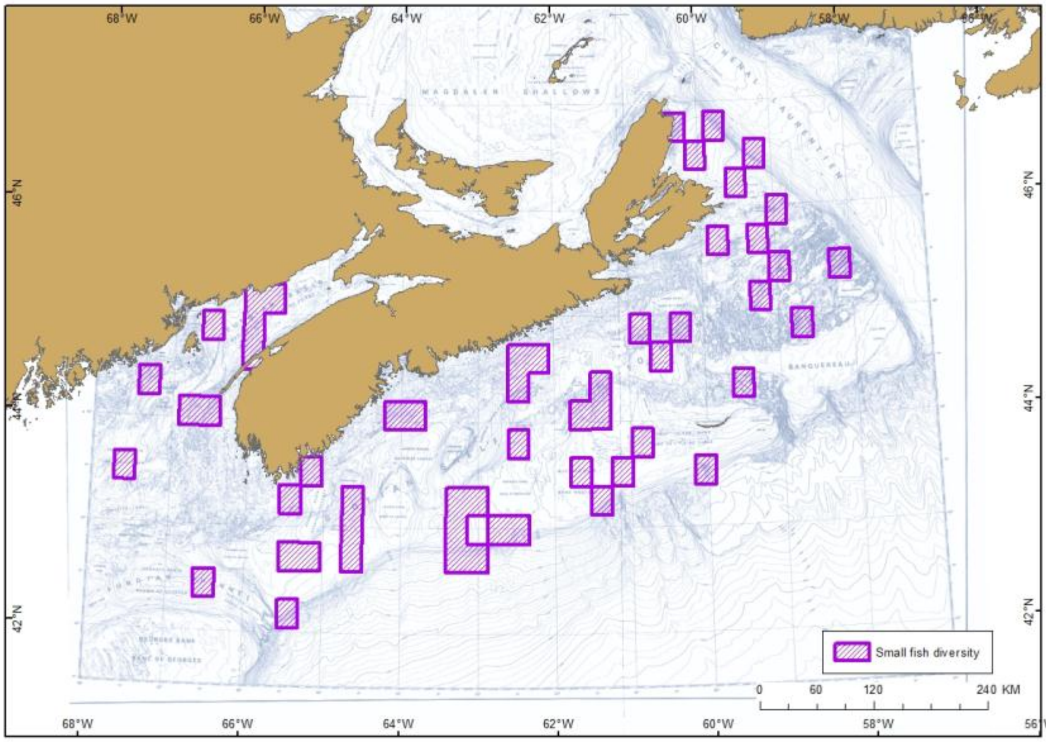

Figure 3. Areas of high small fish species richness based on stomach contents of common fishes captured in DFO RV surveys (Cook and Bundy 2012).

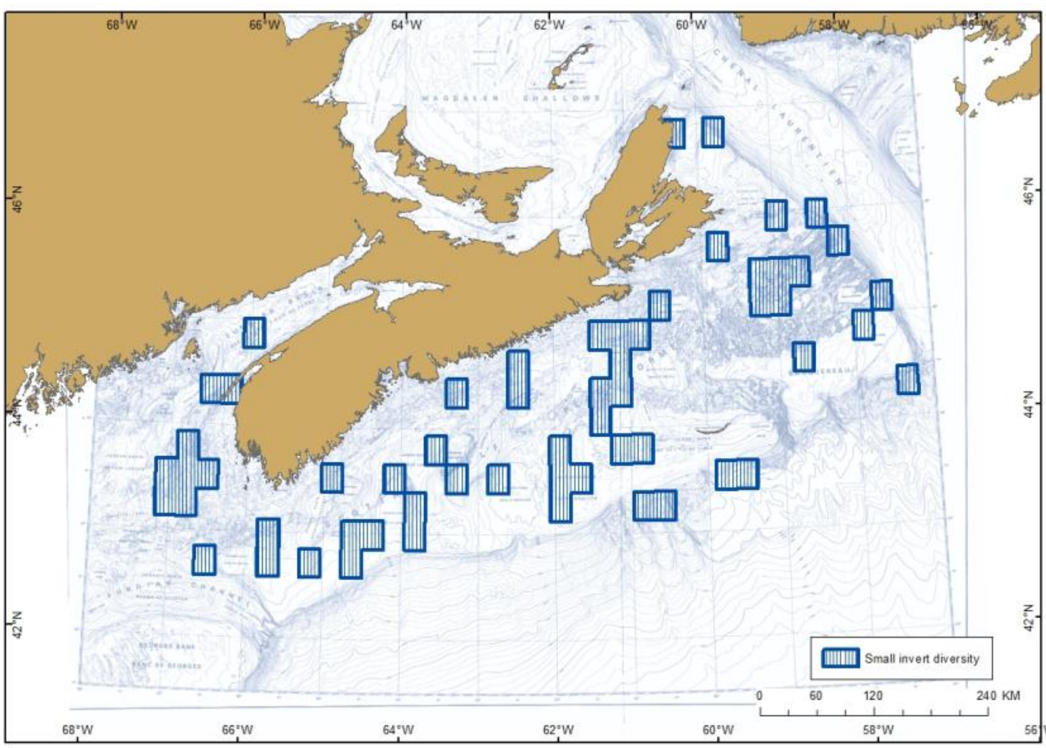

Figure 4. Areas of high small invertebrate species richness based on stomach contents of common fishes captured in DFO RV surveys (Cook and Bundy 2012).

1.1.2 Areas of High Larval Fish Genus Richness

A larval fish genus richness layer was created using data from the Scotian Shelf Icthyoplankton Program (SSIP), which ran from 1978 to 1982. The method used to develop this layer was similar to that of Shackell and Frank (2000) which described larval fish diversity patterns in the bioregion using the same data. The number of genera per tow was calculated rather than the number of species per tow because many records were not identified to species level. Genera per tow was then interpolated to provide a continuous surface. The layer was classified using quintiles, with the top quintile (top 20%) considered an area of high larval fish genus richness to be used in the EBSA evaluation exercise (Figure 5). One important caveat with this layer is the age of the source data. In essence, the layer represents historical larval fish genus richness. Given the well-documented changes in the fish assemblages on the Scotian Shelf over the last several decades (e.g., Shackell and Frank 2007) it is unlikely that species composition in areas of high genus richness during the SSIP was the same as it is today. However, general ocean circulation patterns have not changed significantly so it is possible that the same gyre features that retain larvae in certain areas remain and have a similar effect.

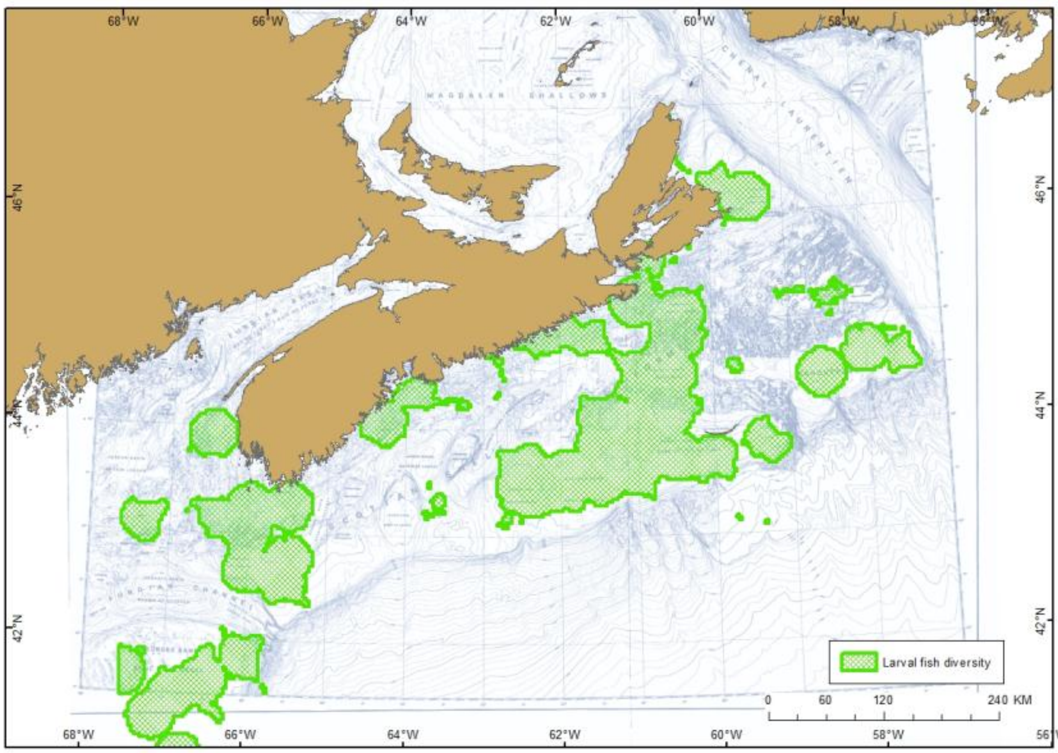

Figure 5. Areas of larval fish genus richness based on SSIP data from 1978-1982 (adapted from Shackell and Frank 2000).

1.2 AREAS OF HIGH BIOLOGICAL PRODUCTIVITY OR HIGH BIOMASS

Areas that support high biological productivity qualify as EBSAs under the DFO Aggregation and Fitness Consequences criteria and the CBD Biological Productivity criterion. Locations that contain comparatively higher biomass than surrounding areas can also be considered EBSAs under the DFO Aggregation criterion and possibly the CBD Biological Productivity criterion.

Persistent areas of high chlorophyll a concentrations were mapped within the bioregion using satellite-based ocean colour data and used in the EBSA evaluation. The methods and results of this work are presented in a separate document (Fuentes-Yaco et al. 2015).

1.2.1 Areas of High Fish and Invertebrate Biomass

Data and Methods

Areas of high fish and invertebrate biomass on the Scotian Shelf were identified using data from the RV Survey. The total biomass caught per tow was calculated and then interpolated to provide a continuous surface. The layer was then classified into quintiles, with the top quintile (top 20%) considered an area of high biomass. For fish, this analysis was done for years 1970-2012 (the complete dataset) (Figure 6) and years 1978-1984 (historical dataset) (Figure 7) to consider historical versus present regimes. The period of 1978 to 1985 was a time of groundfish recovery where the biomass of most commercial stocks was relatively high (Horsman and Shackell 2009). Data from 1999 to 2012 were used to create the invertebrate layer (Figure 8) because invertebrates have only been systematically recorded in the RV survey since 1999 (Tremblay et al. 2007).

Results

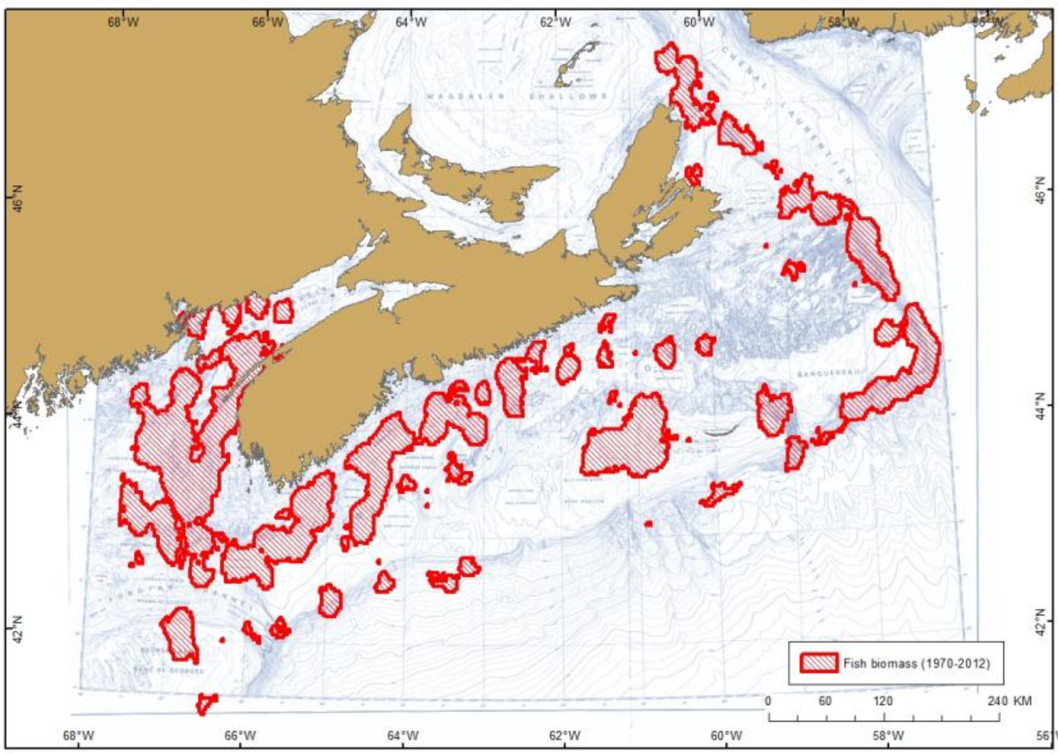

Figure 6. Areas of high fish biomass (1970-2012) based on RV data.

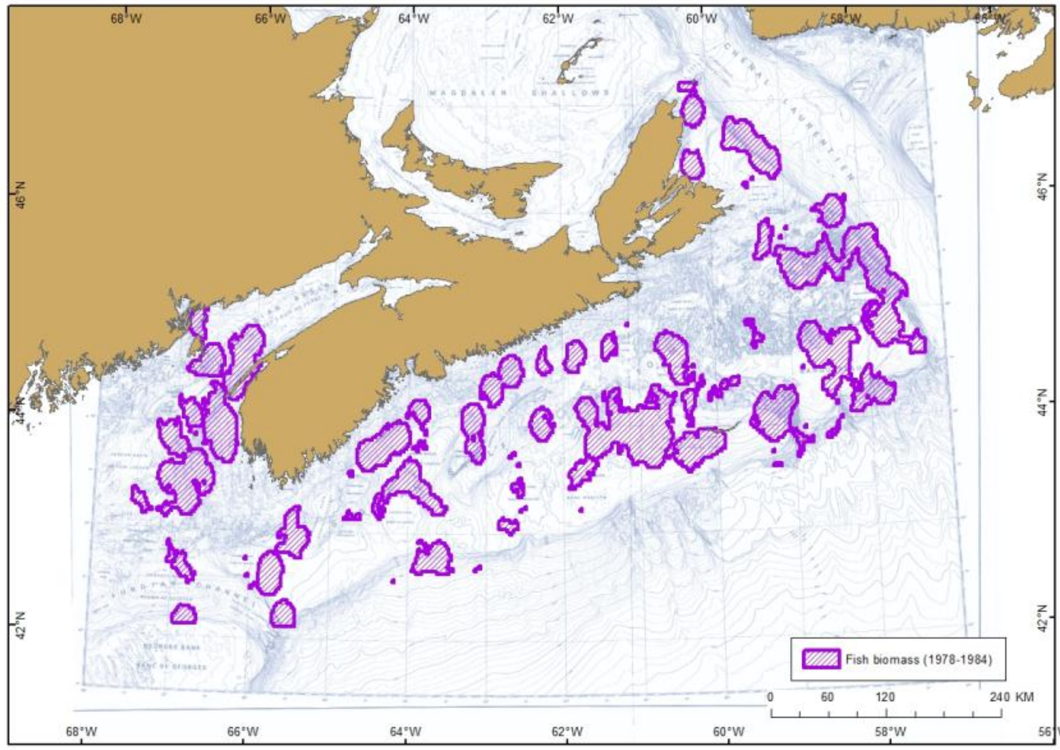

Figure 7. Areas of high fish biomass (1978-1984) based on RV data.

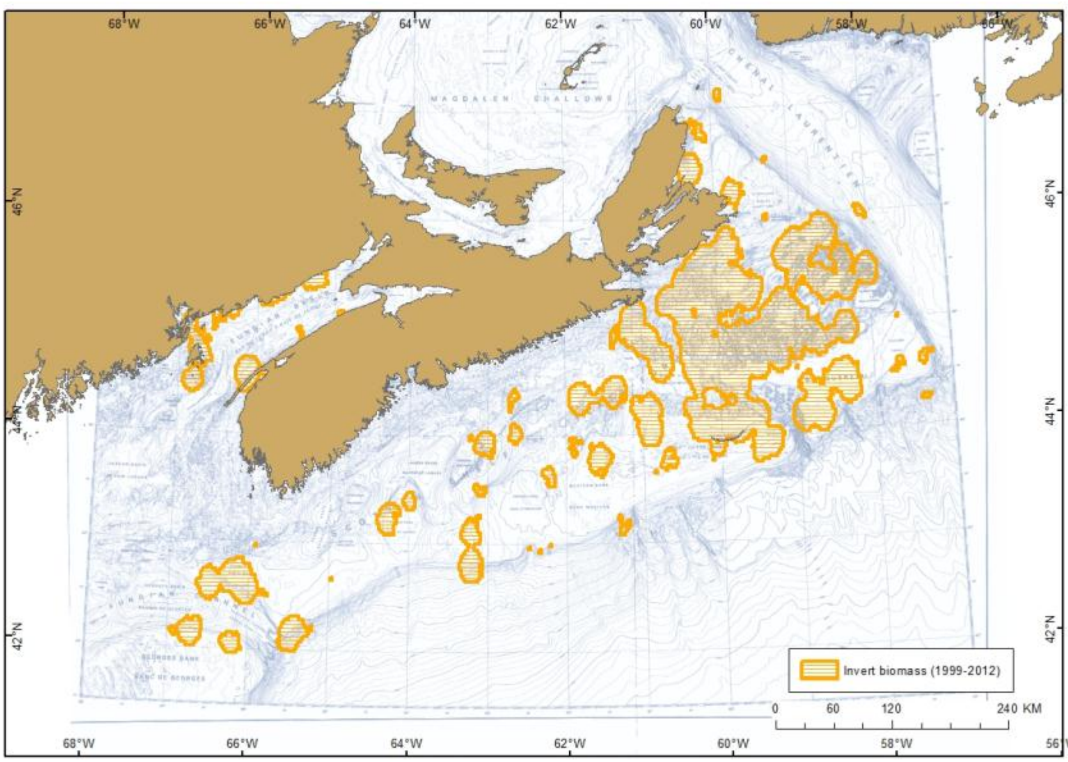

Figure 8. Areas of high invertebrate biomass (1999-2012) based on RV data.

1.3 IMPORTANT HABITAT FOR FISHES AND INVERTEBRATES

1.3.1 Important Habitat for Fishes

Horsman and Shackell (2009) created an atlas of important summer habitat for key fish species of the Scotian Shelf based on DFO RV Survey data. They divided the data into four time periods (1970-1977, 1978-1985, 1986-1993, and 1994-2006) based on significant changes in fisheries management and water temperatures. Within each time period, data were interpolated over space and ranked from 1-10 according to relative biomass (observed weight per tow). These ranks were then summed for all time periods to map important habitat for each species over the 36-year time series. Depleted, ecologically significant, and other dominant fish species were included in the analysis. More details on the methods can be found in Horsman and Shackell (2009). The resulting species-specific map layers were included in Horsman et al. (2011). Georges Bank is not part of the DFO summer RV survey so it was not included in the Horsman and Shackell (2009) fish atlas. For the same reason, Georges Bank was not included in the RV data analyses described in this report. A separate RV survey is devoted to Georges Bank.

For this analysis, the Horsman and Shackell (2009) habitat layers have been updated with the most recent survey data by adding a fifth time period (2007-2012) (Figure 9). In addition, certain species have been split into two or three distinct population layers. These decisions were based on an analysis by Fisher and Frank (2002) that described spatially distinct populations for a number of fish species on the Scotian Shelf. Species that have been split into separate populations include: American plaice, Atlantic cod, haddock, longhorn sculpin, moustache sculpin, redfish[2], sea raven, smooth skate, thorny skate, white hake, winter flounder, winter skate, and yellowtail flounder. See Table 3 for a list of the species and populations included. For each species or population, the total biomass caught per tow was calculated and then interpolated to provide a continuous surface. The layer was then classified into quintiles, with the top quintile (top 20%) considered important habitat for a particular time period. Areas in the top quintile in over the five time periods were considered important habitat in the EBSA evaluation exercise.

[2] Redfish were not identified by Fisher and Frank (2002) but this species was split based on the two recognized management units (Unit 2 and Unit 3).

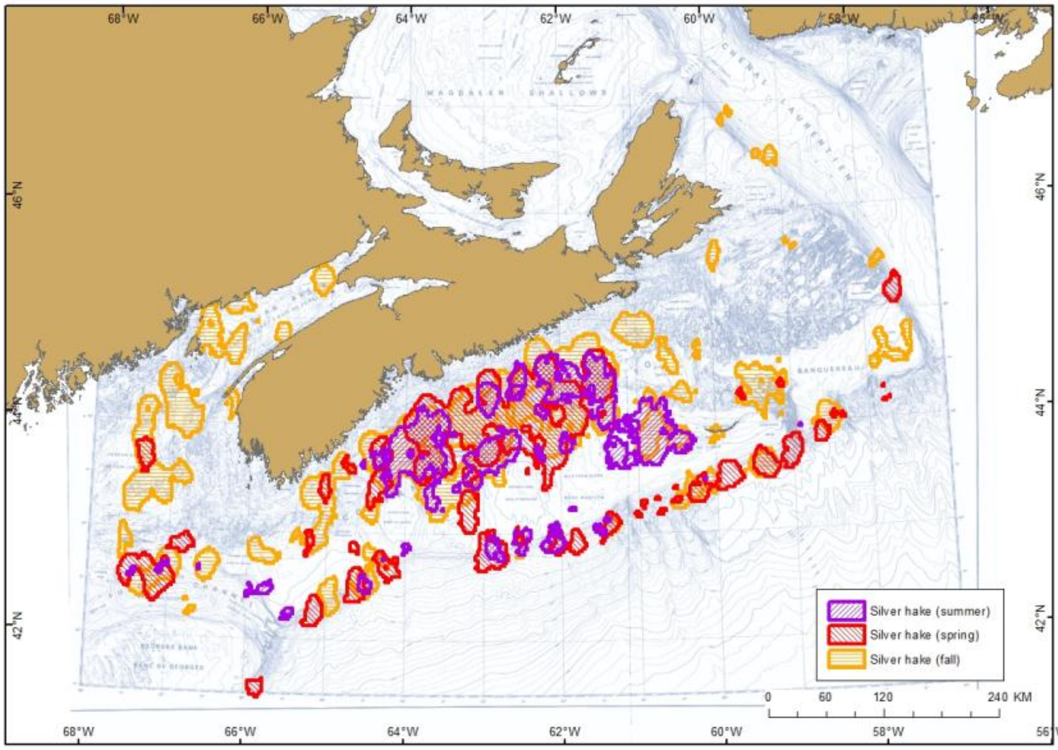

Figure 9. Areas of high silver hake biomass based on summer (1970-2012), fall (1978-1984), and spring (1979-1985) RV data.

Certain fish species, such as cusk and Atlantic halibut, are not effectively sampled by the DFO summer RV survey. For these two species, it is more appropriate to use species distribution models to predict their distribution (see example for cusk in Figure 10). Sandlance is another species that is not well-sampled by the RV survey. The sandlance data layer used in the current analysis was derived from the RV survey stomach contents database (Cook and Bundy 2012).

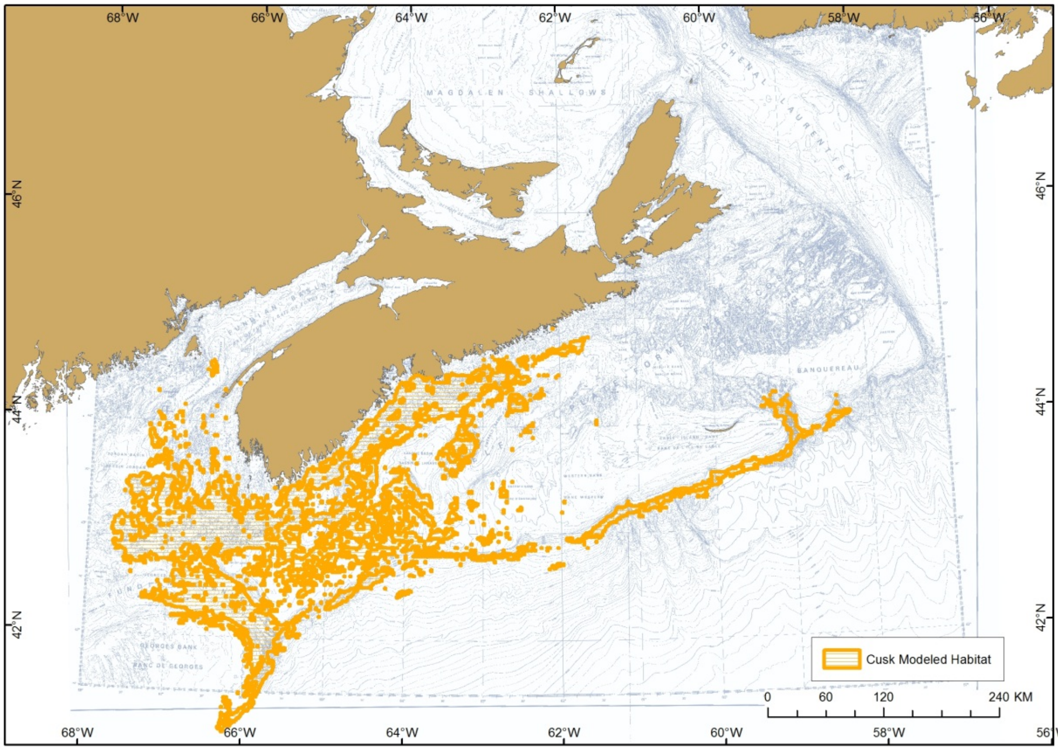

Figure 10. Predicted cusk habitat (DFO 2014b).

Smith et al. (2015) mapped the distribution of various fish species caught in the spring and fall RV surveys for years 1978-1984. The same mapping approach as Horsman and Shackell (2009) was used; however, only one time period was available for the spring and fall surveys. This time period was a time of high groundfish abundance in the region so areas of high relative abundance likely represent important habitats for these species (Table 3). These layers were included to try to account for seasonal shifts in the distribution of mobile groundfish species.

Table 3. Species or populations for which habitat maps have been created using the DFO RV and SSIP data. The type [i.e., ecologically significant (ES), depleted (D), and other dominant (OD)] of the different species is also provided based in part on Horsman and Shackell (2009). Type has not been defined for the invertebrates.

Fishes Summer	Type	Fishes Spring	Type	Fishes Fall	Type	Fish Larvae	Type	Inverts Summer
American plaice 4VW	D	American plaice	D	American plaice	D	American plaice	D	Green sea urchin
American plaice 4X	D	Atlantic argentine	OD	Atlantic argentine	OD	Haddock	ES	Iceland scallop
Atlantic argentine	OD	Atlantic cod	D	Atlantic cod	D	Mackerel	ES	Jonah crab
Atlantic cod 4Vn	D	Atlantic halibut	ES	Atlantic halibut	ES	Pollock	ES	Lobster
Atlantic cod 4VsW	D	Atlantic wolffish	D	Atlantic wolffish	D	Redfish	D	Lyre crab
Atlantic cod 4X	D	Capelin	ES	Capelin	ES	Silver hake	ES	Northern shrimp
Atlantic halibut	ES	Cusk	D	Cusk	D	Witch flounder	ES	Northern stone crab
Atlantic wolffish	D	Haddock	ES	Haddock	ES	Yellowtail flounder	OD	Red crab
Capelin	ES	Herring	ES	Herring	ES			Rock crab
Cusk	D	Longfin hake	OD	Longfin hake	OD			Sand dollar
Haddock 4VW	ES	Longhorn sculpin	ES	Longhorn sculpin	ES			Sea cucumber
Haddock 4X	ES	Mackerel	ES	Mackerel	ES			Sea scallop SFA 25
Herring	ES	Mailed sculpin	OD	Mailed sculpin	OD			Sea scallop SFA 26
Longfin hake	OD	Monkfish	OD	Monkfish	OD			Sea scallop SFA 28
Longhorn sculpin 4VW	ES	Northern shortfin squid	ES	Northern shortfin squid	ES			Sea stars
Longhorn sculpin 4X	ES	Northern wolffish	D	Northern wolffish	D			Snow crab CFA 20 to 22
Mackerel	ES	Ocean pout	OD	Ocean pout	OD			Snow crab CFA 23 & 24
Mailed sculpin 4VW	OD	Pollock	ES	Pollock	ES			Striped pink shrimp
Mailed sculpin 4X	OD	Red hake	ES	Red hake	ES			Toad crab
Monkfish	OD	Redfish	D	Redfish	D			
Northern shortfin squid	ES	Sea raven	OD	Sea raven	OD			
Northern wolffish	D	Silver hake	ES	Silver hake	ES			
Ocean pout	OD	Smooth skate	D	Smooth skate	D			
Pollock	ES	Spiny dogfish	D	Spiny dogfish	D			
Red hake	ES	Spotted wolffish	D	Spotted wolffish	D			
Redfish Unit 2	D	Thorny skate	D	Thorny skate	D			
Redfish Unit 3	D	White hake	D	White hake	D			

Fishes Summer	Type	Fishes Spring	Type	Fishes Fall	Type	Fish Larvae	Type	Inverts Summer
Sandlance	ES	Winter flounder	OD	Winter flounder	OD			
Sea raven 4VW	OD	Winter skate	D	Winter skate	D			
Sea raven 4X	OD	Witch flounder	ES	Witch flounder	ES			
Silver hake	ES	Yellowtail flounder	OD	Yellowtail flounder	OD			
Smooth skate 4VsW	D							
Smooth skate 4X	D							
Spiny dogfish	D							
Spotted wolffish	D							
Thorny skate 4VsW	D							
Thorny skate 4X	D							
White hake 4VW	D							
White hake 4X	D							
Winter flounder 4VW	OD							
Winter flounder 4X	OD							
Winter skate 4VsW	D							
Winter skate 4X	D							
Witch flounder	ES							
Yellowtail flounder 4VW	OD							
Yellowtail flounder 4X	OD							

1.3.2 Areas of High Larval Fish Abundance (using SSIP data)

Horsman and Shackell (2009) created larval abundance maps for some fish species using data from the SSIP. The 80% contours (areas containing 80% of observed individuals in the survey) from Horsman and Shackell's (2009) maps were used for this analysis (as example for haddock is provided in Figure 11). Species distributions were not split into populations as there were not enough data to do so. See Table 3 for a list of species included.

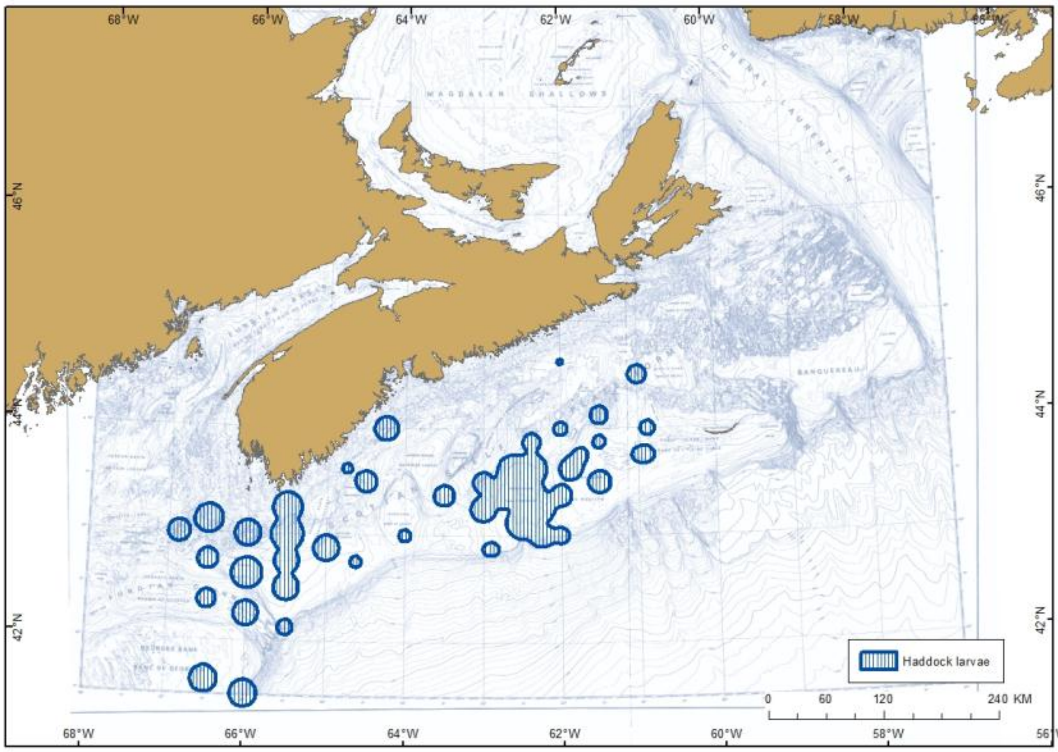

Figure 11. Areas of high larval haddock abundance (1978-1982) based on SSIP data (adapted from Horsman and Shackell 2009).

1.3.3 Important Habitat for Invertebrates

Important habitat maps were created for 16 common invertebrate species identified by Tremblay et al. (2007) as species that are reliably sampled and recorded in the summer RV survey (Table 3). Data for years 1999-2012 were used, as invertebrates were not consistently recorded in the survey before 1999. For each species, the weight caught per tow was interpolated, the resulting surface was then classified into quintiles, and the top quintile (top 20%) was considered important habitat. Certain species were split into populations when research showed distinct populations or if the distribution looked skewed east or west (maps for snow crab and sea stars are provided in Figure 12). Species that were split into populations were: northern stone crab, sea stars, snow crab, striped pink shrimp, and sea scallop.

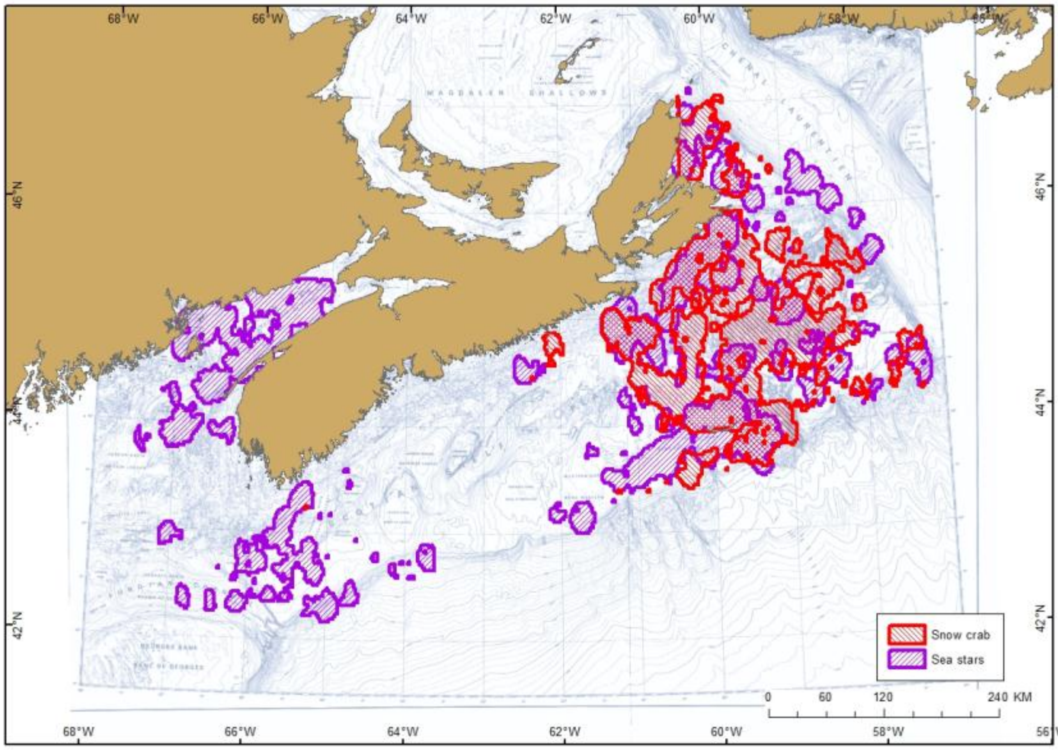

Figure 12. Important summer habitat for snow crab in Crab Fishing Areas 20-22 and 23-24 and important summer habitat for sea stars based on RV data (1999-2012).

1.4 CETACEAN DISTRIBUTION

The majority of cetacean distribution data in the Scotian Shelf Bioregion is in the form of opportunistic sightings that cannot be used to develop reliable relative distribution maps (Gómez-Salazar and Moors-Murphy 2014). Habitat suitability models (HSMs) based on the relationship between cetacean occurrences and environmental variables can be used to predict cetacean distributions. Gómez-Salazar and Moors-Murphy (2014) examined the potential for using HSMs in the bioregion and provided recommendations regarding how HSMs can be effectively applied in the future.

1.5 CRITICAL HABITAT FOR SPECIES AT RISK

Given the patchiness of the available cetacean data, critical habitat polygons for the endangered North Atlantic right whale (Brown et al. 2009) and Northern bottlenose whale (DFO 2010a) have been used in this evaluation exercise. Leatherback turtles are also listed as endangered under the SARA. There has not been an official area of Critical Habitat designated for this species; however, areas of important habitat have been identified on the Scotian Shelf (DFO 2011a). These areas were used in this analysis.

1.6 COLDWATER CORAL AND SPONGE DISTRIBUTIONS

Available coral and sponge distribution data in the Scotian Shelf Bioregion have been described by Cogswell et al. (2009). The Maritimes Region Coral Database includes records collected during the DFO RV surveys, bycatch records from commercial fisheries from the Fisheries Observer Program (FOP), LEK studies and Remotely Operated Vehicle (ROV) surveys. Figures 13 and 14 show the distribution of available RV, FOP, and ROV data for corals and sponges, respectively. Due to sampling biases, these data cannot be used to develop accurate relative distribution maps for the bioregion. The majority of records in the database are from ROV surveys that have focused on areas thought to contain high densities of corals or sponges. Kenchington et al. (2010) have used the DFO summer RV survey data to complete a Kernel Density Analysis to identify high concentrations of certain corals and sponges. Modeling approaches are also being developed (e.g., Knudby et al. 2013) and will be applied in the Scotian Shelf Bioregion.

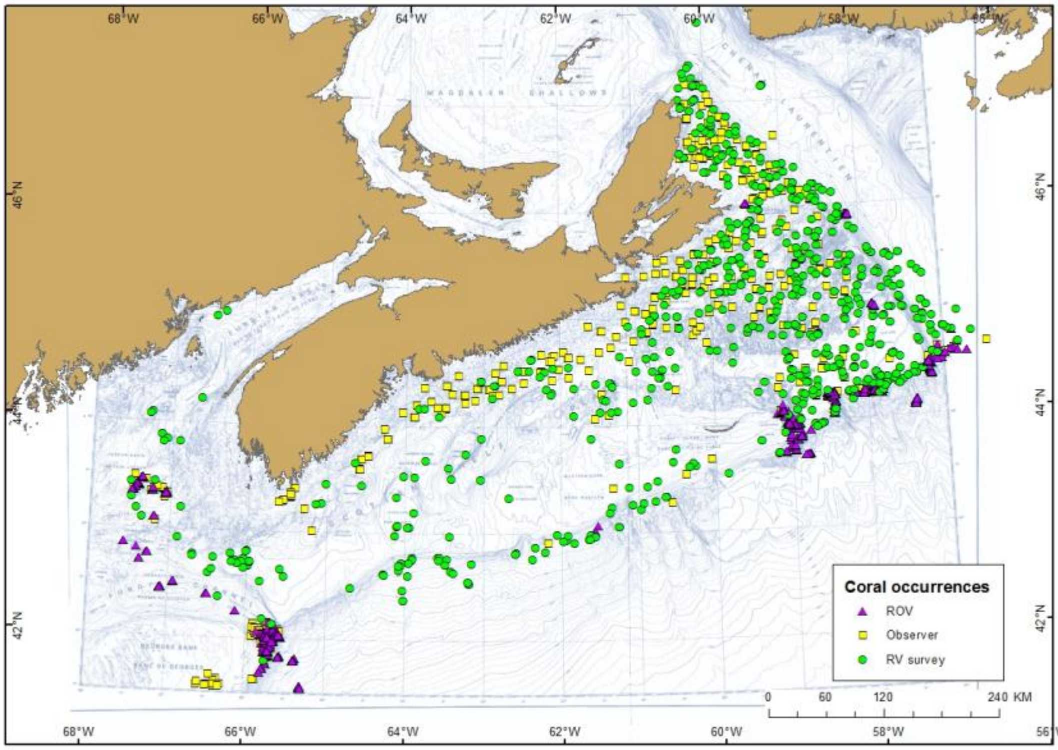

Figure 13. Coral occurrences based on ROV (2005-2013), FOP (2003-2013), and RV survey (2003-2013) data obtained from the Maritimes Region Coral Database.

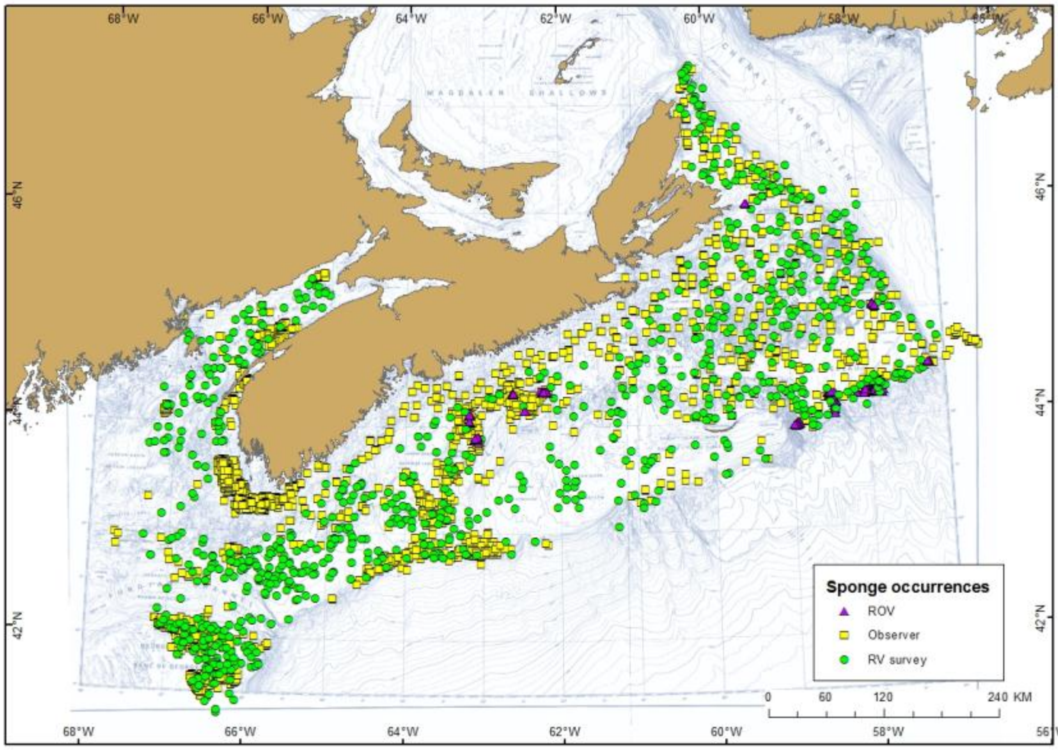

Figure 14. Sponge occurrences based on ROV (2005-2013), FOP (2003-2013), and RV survey (2003-2013) data obtained from the Maritimes Region Coral Database.

1.7 IMPORTANT HABITAT FOR SEABIRDS

The northwest Atlantic, including the Scotian Shelf Bioregion, supports important aggregations of marine birds throughout the year. This includes species that breed in Eastern Canada as well as migrants from northern and southern hemispheres (Allard and Gjerdrum unpublished report[3]). Distribution and abundance data are required to understand the role marine birds play in marine ecosystems and to identify and minimize human impacts on birds at sea. The Canadian Wildlife Service (CWS) of Environment Canada collects data on bird distribution and abundance at-sea (Figure 15). These data provide critical information for environmental assessments related to offshore development, emergency response related to oil spills, risk assessment, conservation planning, and other management and conservation initiatives.

[3] Unpublished working paper by K. Allard, and C. Gjerdrum on “Using marine bird distribution and abundance toward assessment of important marine habitat locations” as presented at the CSAS Regional Science Advisory Process held during February 18-20, 2014, in Halifax, Nova Scotia.

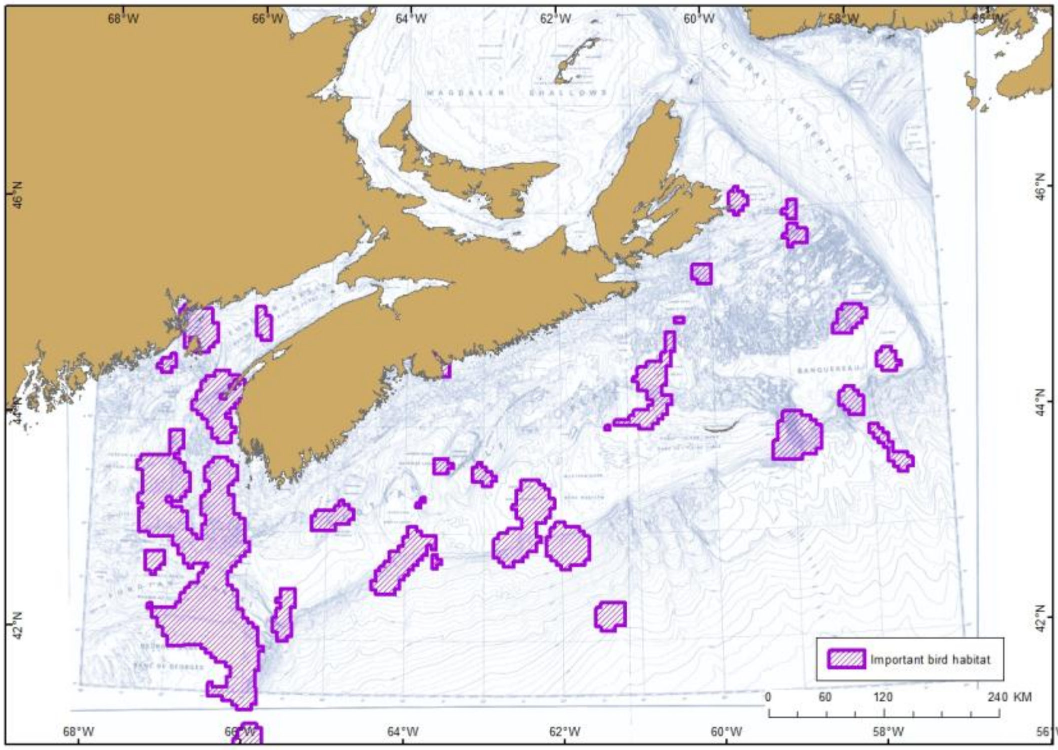

Figure 15. Simplified seabird (all species combined) concentrations in the Scotian Shelf Bioregion based on CWS data (Allard and Gjerdrum unpublished report[3]).

SECTION 2: UPDATED EBSAS

The purpose of this section is to describe each of the updated EBSAs for the offshore component of the Scotian Shelf Bioregion. The most notable ecological features or characteristics that are relevant to the various DFO EBSA criteria are highlighted. Maps of key ecological features or characteristics for each EBSA are also included. The descriptions include the original rationale provided by Doherty and Horsman (2007) and any additional rationale that was found in the literature or through the overlay analysis. A comprehensive overview of the physical, chemical, and ecological characteristics of each EBSA is not provided in this report.

Each of the original SEO EBSAs was evaluated based on an overlay analysis with the various EBSA data layers and a review of the literature to identify further evidence for the significance of the areas. The areas for which sufficient evidence was found are considered updated EBSAs for the offshore component of the bioregion (Figure 16, Table 4). Sufficient evidence was not found for several of the original SEO EBSAs, so these sites are not described in this section of the report. These areas may still be EBSAs, but they will be considered a lower priority moving forward unless new evidence of their ecological or biological significance is identified.

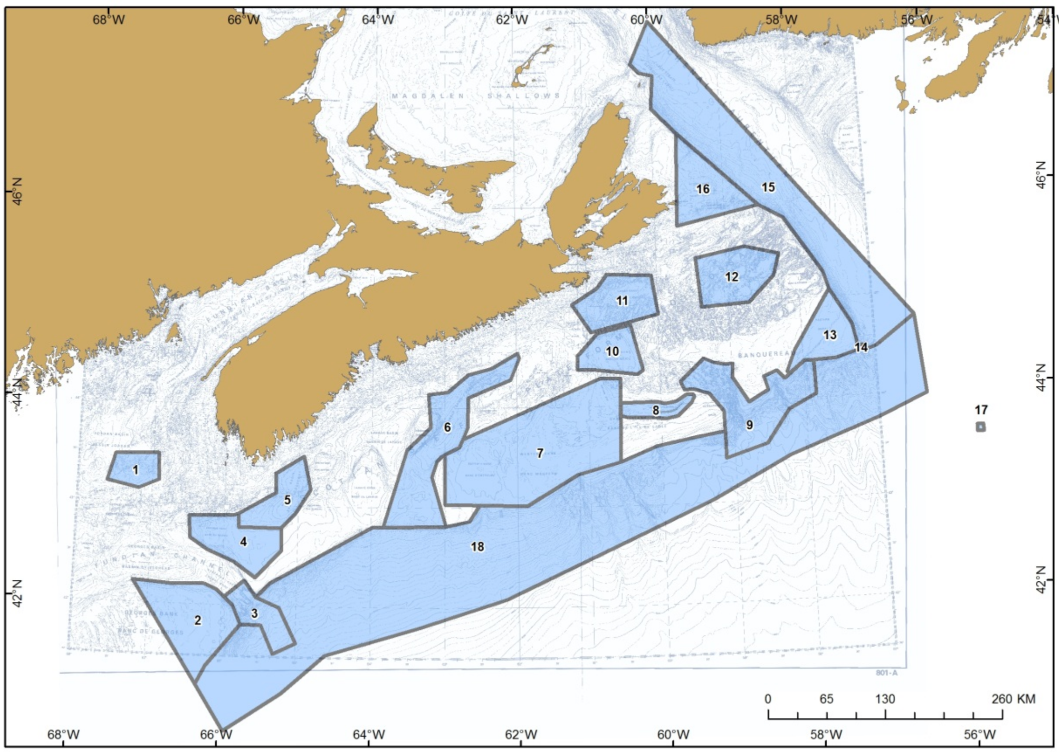

Figure 16. Ecologically and Biologically Significant Areas for the offshore component of the Scotian Shelf Bioregion: (1) Jordan Basin and the Rock Garden, (2) Canadian portion of Georges Bank, (3) Northeast Channel, (4) Browns Bank, (5) Roseway Basin, (6) Emerald Basin and the Scotian Gulf, (7) Emerald-Western-Sable Island Bank Complex, (8) Sable Island Shoals, (9) Eastern Scotian Shelf Canyons, (10) Middle Bank, (11) Canso Bank and Canso Basin, (12) Misaine Bank, (13) Eastern Shoal, (14) Stone Fence, (15) Laurentian Channel, (16) St. Anns Bank, (17) Laurentian Fan Cold Seep Communities, (18) Scotian Slope.

Table 4. The proposed EBSAs for the offshore of the Scotian Shelf Bioregion compared to the original SEO EBSAs described by Doherty and Horsman (2007). Blank cells indicate that the original SEO EBSA was either removed from the list or merged with an updated EBSA.

Original SEO EBSA (Doherty and Horsman 2007)	2014 #	Updated EBSA (2014)	Comments
The Rock Garden and Environs	1	Jordan Basin and the Rock Garden	Includes all of southern portion of Jordan basin that falls within Canadian waters
Canadian portion of Georges Bank	2	Canadian portion of Georges Bank	No significant changes
Northern edge of Georges Bank (Herring Spawning Area)			Merged with 2
Northern edge of Georges Bank (Tube Worm Habitat)			Merged with 2
Northeast Channel	3	Northeast Channel	Boundary extended down the slope
Browns Bank and Edge Slope	4	Browns Bank	No significant changes
Fundian Moraine (Browns Bank)			Merged with 4
Southwest Nova Scotia and frontal area from Browns Bank			Included in Atlantic Coast EBSA report (Hastings et al. 2014)
Roseway Basin	5	Roseway Basin	Expanded to include part of right whale Critical Habitat
Roseway Bank			Lack of supporting evidence
Baccaro Bank			Lack of supporting evidence
LaHave Bank			Lack of supporting evidence
LaHave Basin			Lack of supporting evidence
Sambro Bank			Lack of supporting evidence
Emerald Basin	6	Emerald Basin and the Scotian Gulf	Expanded to include the Scotian Gulf
Emerald Basin and the Patch			Merged with 6
Emerald Bank - for potential sub-populations of groundfish			Merged with 7
Emerald Bank - Hot Box			Merged with 7
Emerald Bank			Merged with 7
Western Bank - high fish concentrations			Merged with 7
Emerald Bank, Western Bank, Sable Island Bank	7	Emerald-Western-Sable Island Bank Complex	Boundary shifted to the northeast
Sable Island Bank - Hot Box			Merged with 7
Sable Island Area	8	Sable Island Shoals	Boundary expanded slightingly to encompass shallow waters surrounding the island

Original SEO EBSA (Doherty and Horsman 2007)	2014 #	Updated EBSA (2014)	Comments
The Gully	9	Eastern Scotian Shelf Canyons	Boundary expanded to form complex with adjacent canyons and the Gully Trough
Haldimand Canyon			Merged with 9
Shortland Canyon			Merged with 9
Gully Trough			Merged with 9
The Bull Pen, the Cow Pen and the Owl			Lack of supporting evidence
Middle Bank	10	Middle Bank	No significant changes
Canso Bank	11	Canso Bank and Canso Basin	Expanded to the west to include Canso Basin
[No equivalent SEO EBSA]	12	Misaine Bank	Partially overlaps with Deep holes of Banquereau Bank. Separated based on EBSA data layers and literature
Deep holes north of Banquereau Bank			Lack of strong evidence (partially merged with 12)
The Noodles			Lack of strong evidence
Deep holes of Canso area			Merged with 11
Eastern Shoal	13	Eastern Shoal	No significant changes
Stone Fence and Laurentian environs	14	Stone Fence	Boundary adjusted to include known coral records
Laurentian Channel & slope			Merged with 15
Laurentian Channel slope	15	Laurentian Channel	No significant changes
Logan Canyon			Merged with 18
Banquereau - Sandy area north of Haldimand Canyon			Lack of supporting evidence
[No equivalent SEO EBSA]	16	St. Anns Bank	Partially overlaps with Laurentian Channel. Separated based on EBSA data layers and literature
Laurentian Channel cold seep	17	Laurentian Fan Cold Seep Communities	No significant changes
Banquereau - fish sub populations			Lack of supporting evidence
Scotian Slope/Shelf Break	18	Scotian Slope	Boundary adjusted to exclude other EBSAs that extend onto the slope

Each EBSA description presented in this section includes a table that outlines:

(a) the features (species, habitats, processes, characteristics) known to occur in the area, and
(b) the DFO EBSA criteria each feature meets.

The information source (referenced literature or bioregional-scale data) for each feature included in an EBSA is provided. A table that summarizes the CBD EBSA criteria that each site satisfies is also provided.

For the purpose of this exercise, 'depleted species' are those listed as Endangered (E), Threatened (T), or Special Concern (SC) under SARA or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). When an EBSA includes important habitat for a depleted species, the COSEWIC or SARA designation for that species is indicated in parentheses (e.g., SARA-E, COSEWIC-SC).

2.1 JORDAN BASIN AND THE ROCK GARDEN

This EBSA is located in the eastern Gulf of Maine. It has been delineated based on the Canadian portion of the southern component of Jordan Basin and is generally defined by the 200 m isobaths (Figure 17).

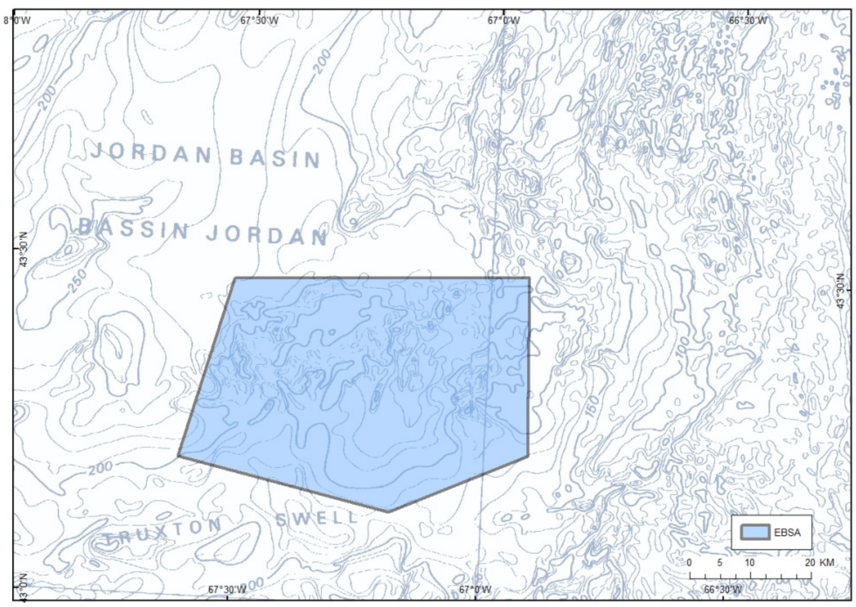

Figure 17. Jordan Basin and the Rock Garden EBSA (1824 km^2).

The key features of this EBSA are presented in Table 5. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 6. Maps of a subset of the key features for this EBSA are displayed in Figure 18.

Table 5. Key features for the Jordan Basin and the Rock Garden EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
The "Rock Garden" component of this EBSA is a complex bedrock outcrop within Jordan Basin that supports a unique and diverse filter feeding benthic community (e.g., corals, anemones, hydrozoans) (Breeze et al. 1997, Doherty and Horsman 2007, DFO 2013a). Concentrations of the gorgonian coral, *Primnoa resedaeformis,* in similar rocky habitats in the United States portion of Jordan Basin provide habitat for redfish and cusk (Auster 2005).	x	x		x	
Persistent area of high chlorophyll concentration (MODIS[1] ocean colour data).		x	x		
Dense aggregations of krill (Doherty and Horsman 2007).		x	x		
Area of very high scope for growth (Kostylev and Hannah 2007).		x	x		
Area of high fish biomass (RV data).		x			
Area of high fish species richness and ESW[2] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species richness and evenness (Ward-Paige and Bundy 2016).	x	x			
Area of high species richness for small invertebrates (Cook and Bundy 2012).	x	x			
Area of high larval fish genus richness (Shackell and Frank 2000, SSIP).	x	x	x		
Important habitat for white hake (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x			
Important habitat for spiny dogfish (summer/fall/spring) (COSEWIC-SC) (Horsman and Shackell 2009, RV data).		x			
Important habitat for redfish (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data). Redfish is a slow-growing and long-lived species (DFO 2010b).		x		x	
Habitat for cusk (COSEWIC-E) (DFO 2014b).		x			
Important seabird habitat (most functional guilds) (CWS data).		x	x		

Notes: [1]Moderate Resolution Imaging Spectroradiometer; [2]Exponential of Shannon-Wiener Index.

Table 6. The Jordan Basin and the Rock Garden CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Jordan Basin and the Rock Garden	x		x	x	x	x	

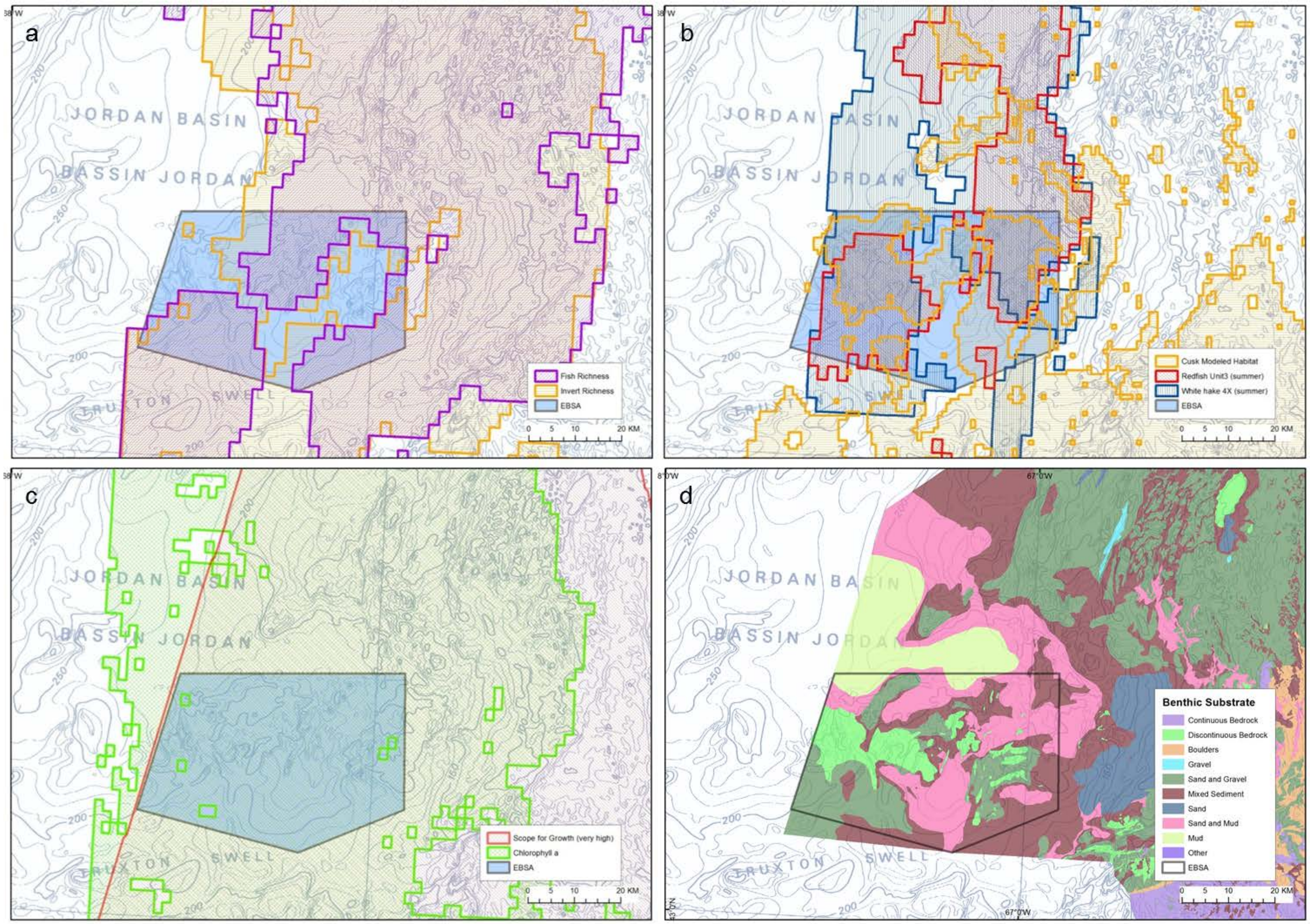

Figure 18. The distribution of a) fish and invertebrate species richness estimates, b) modeled cusk habitat (DFO 2014b), important redfish habitat and important white hake habitat, c) areas of high chlorophyll a and high scope for growth, and (d) different substrate types within the Jordan Basin EBSA.

Additional Information

Further research is required to define and clearly delineate the Rock Garden feature in Jordan Basin and identify other similar features that may exist. Other coral communities have been discovered in the western portion of Jordan Basin (Auster et al. 2013), which falls within U.S. waters. The western portion of Jordan Basin was also recently identified as a possible winter mating ground for the North Atlantic right whale (Kraus et al. 2012, Cole et al. 2013). More research in this area could reveal that this endangered species is also mating in the Canadian portion of Jordan Basin. The use of important habitats for this species can shift with varying environmental conditions (Patrician and Kenney 2010).

High numbers of juvenile redfish were observed in Jordan Basin in 1997 (Branton 1999). Further evidence may suggest that this is a redfish nursery area. Jordan Basin may also be part of a lobster migration area as Bay of Fundy lobsters have been observed there during the summer (Campbell and Stasko 1986).

2.2 CANADIAN PORTION OF GEORGES BANK

Banks were typically defined by the 110 m isobaths; however, some important features for Georges Bank lied outside of that contour. Therefore, the majority of the boundary for this EBSA was based on the 200 m isobath. The western boundary was delineated by the Canada/U.S. border (Figure 19).

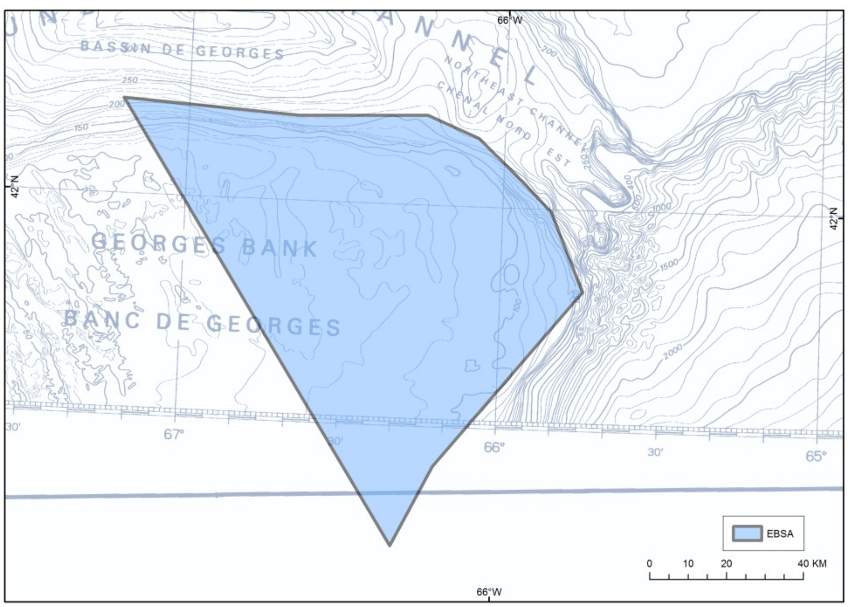

Figure 19. Canadian Portion of Georges Bank EBSA (7014 km^2).

The key features of this EBSA are presented in Table 7. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 8. Maps of a subset of the key features for this EBSA are displayed in Figure 20.

Table 7. Key features for the Canadian Portion of Georges Bank EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Very strong tidal currents over steep topography lead to a tidal mixing front along the northern flank of Georges Bank. Nutrients are upwelled into the frontal zone through the frontal dynamics. This nutrient pump feeds a very productive ecosystem which continues to support active fisheries. The primary production has been estimated to be about 40% greater than the surrounding shelf regions and the fish production is twice that of the surrounding areas. The Georges Bank tidal mixing front is likely the largest in Canada and one of the largest in the world (Doherty and Horsman 2007).	x	x	x		
Northern region of Georges Bank contains communities of unique structure forming polychaete worms, which support a high diversity of other organisms (Collie et al. 1997, Collie et al. 2000, Kennedy et al. 2011). Areas that contain these structure forming worms are likely areas that have had minimal disturbance from trawling (Collie et al. 1997, Collie et al. 2004).	x	x			x
One of the world's most productive areas for scallop (WWF-Canada 2009, DFO 2011b).	x	x			
Persistent high chlorophyll concentrations (100-1500 m) (MODIS ocean colour data) and an area of very high scope for growth (Kostylev and Hannah 2007).		x	x		
Tropical and northern waters mix resulting in high species diversity (DFO 2011b).		x			
Cod and haddock spawning area (Kennedy et al. 2011, DFO 2011b, DFO 2013b, O'Boyle 2011). Nursery area for Atlantic cod (DFO 2011b).		x	x		
Herring, yellowtail flounder, winter skate, and pollock spawning area (Kennedy et al. 2011, DFO 2011b).		x	x		
Area of high larval fish genus richness (Shackell and Frank 2000, SSIP).	x	x			
High concentrations of *Calanus* (Harrison et al. 2009, Johnson et al. 2012,).		x			
Important foraging habitat for Bluefin tuna (Kennedy et al. 2011, DFO 2011b)		x	x		
Important seabird habitat (all functional guilds) (CWS data).		x			

Table 8. The Canadian portion of Georges Bank CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Canadian portion of Georges Bank	x	x	x		x	x	x

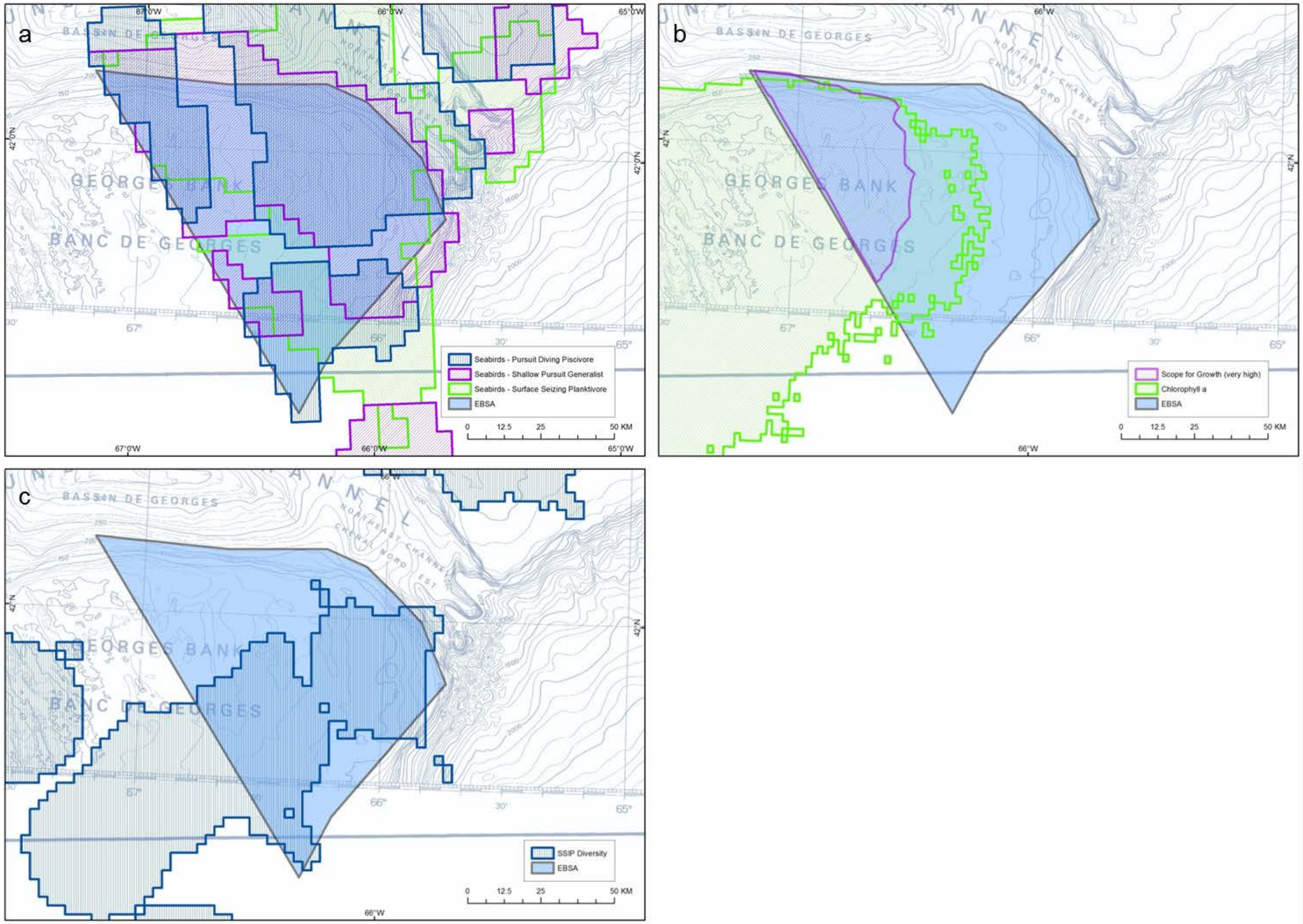

Figure 20. The distribution of a) seabird functional guilds, b) areas of high scope for growth and chlorophyll a, and c) SSIP larval fish diversity within the Canadian portion of Georges Bank EBSA.

Additional Information

The Scotian Shelf RV survey does not cover the Canadian portion of Georges Bank but there is a separate Georges Bank RV survey that could be analyzed to map species distributions and identify more discrete ecologically significant areas within this broadly defined EBSA.

2.3 NORTHEAST CHANNEL

The Northeast Channel, which is the outer part of the Fundian Channel, is a large channel dividing Georges Bank and Browns Bank that extends into the deeper slope area as a depositional fan feature. The shallower section of this EBSA is delineated using the 200 m isobath along the banks on either side of the Channel. This captures the expected depth range of the large gorgonian coral species that represent the key ecological feature of this EBSA. The boundary extends into deeper portions of the slope, out to approximately 2500 m, the deepest observed extent of coldwater corals in this area. The shape of this outer portion is designed to capture the Northeast Fan, which is a depositional feature formed during the last glacial maximum (Robichaud 2006) (Figure 21).

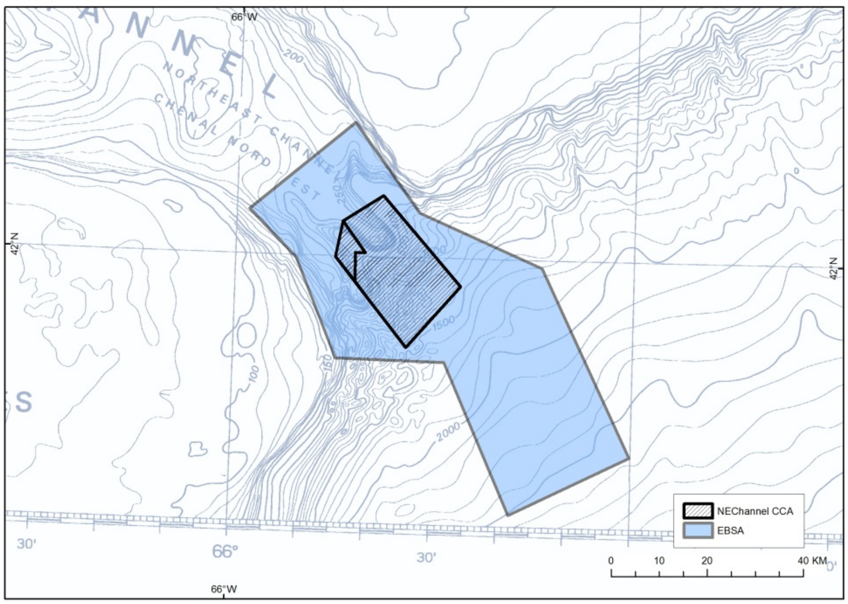

Figure 21. Northeast Channel EBSA (2589 km^2).

The key features of this EBSA are presented in Table 9. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 10. Maps of a subset of the key features for this EBSA are displayed in Figure 22.

Table 9. Key features for the Northeast Channel EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Area of high abundance for coldwater corals. Branching octocorals, primarily *Paragorgia arborea* (bubblegum coral) and *Primnoa resedaeformis* (seacorn coral) are found in high densities. Within the channel, the feature known as Romeys Peak is the centre of high densities of intact corals (Cogswell et al. 2009). The Northeast Channel (inside and outside Conservation Area) contains the densest concentration of *Primnoa* in the Maritimes, and possibly Atlantic Canada, including the northeast continental margin of the United States. It may be the largest stand of any large coral species across this geographical range (E. Kenchington *pers. comm.*). Research has shown that four unique taxa occur within the deeper waters (>1000 m) of the slope portion of the Channel (Cogswell et al. 2009).	x	x		x	
Deep channels with strong current flows may result in other enhanced biological processes in the water column and near the surface. The Northeast Channel was identified as such an area by multiple scientific experts (Doherty and Horsman 2007, MacLean et al. 2009). The area known as the Hell Hole (south of Browns Bank) is a distinct oceanographic feature that occurs within this EBSA. High levels of mixing result in the aggregation of large pelagic fish during certain periods of the year. Cetaceans may also be in higher abundances in this area (Doherty and Horsman 2007).	x	x			
Persistent area of high chlorophyll concentration (MODIS[1] ocean colour data).		x	x		
Habitat for cusk (COSEWIC-E) (DFO 2014b).		x			
Redfish larvae (SSIP[2]).			x		
Important seabird habitat (most functional guilds) (CWS data).		x	x		

Notes: [1]Moderate Resolution Imaging Spectroradiometer; [2]Scotian Shelf Icthyoplankton Program.

Table 10. The Northeast Channel CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Northeast Channel	x		x	x			

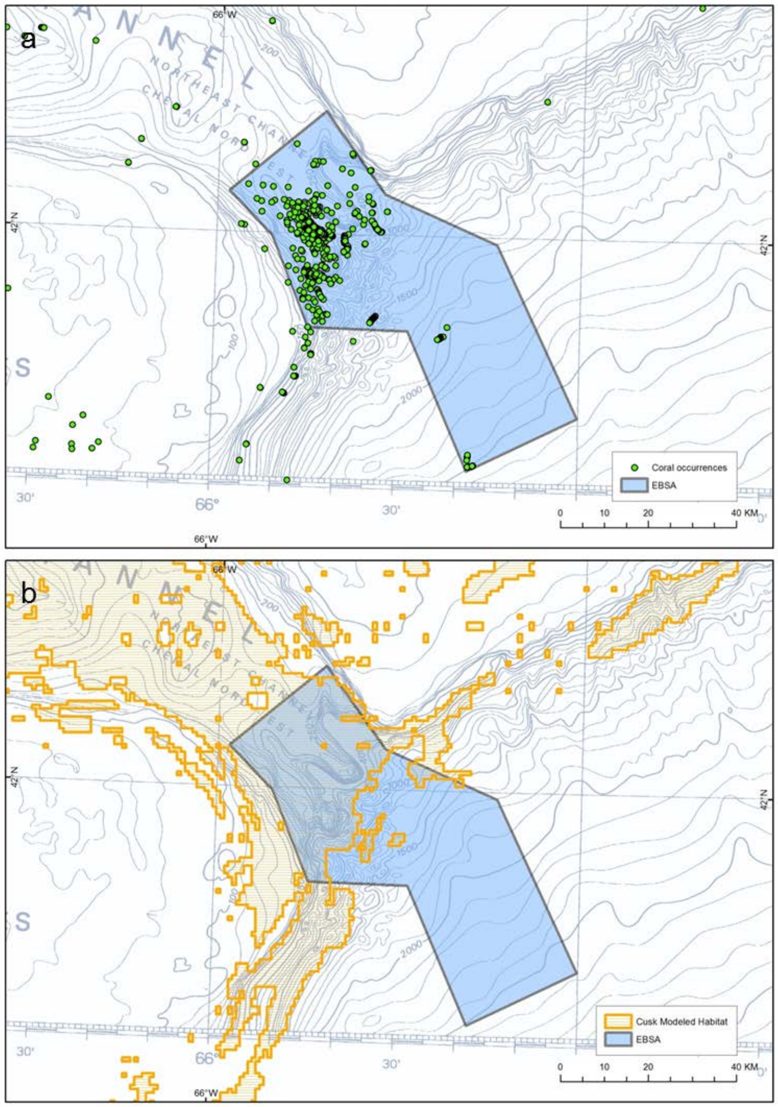

Figure 22. The distribution of a) coral occurrences (E. Kenchington and C. Lirette, BIO, pers. comm.), and b) modeled cusk habitat (DFO 2014b) within the Northeast Channel EBSA.

Additional Information

The Northeast Channel has long been recognized as an area of importance for coldwater corals (Breeze et al. 1997, DFO 2006). The Northeast Channel Coral Conservation Area was established in 2002 and falls within this EBSA (DFO 2006).

Many DFO surveys (e.g., RV survey) do not sample the deeper areas of the Northeast Channel so the importance of this EBSA to fishes is not well-understood. However, a number of associated fauna, including fishes (e.g., redfish and pollock) and invertebrates have been observed near or among the dense coral concentrations in this area (Mortensen et al. 2006).

Knowledge concerning the distribution of corals in deeper waters in the Northeast Channel and in Atlantic Canada in general is incomplete. Recent surveys have documented new species records for Canadian waters and some species new to science. These include *Anthipatharia* spp., *Stauropathes arctica*, *Chrysogorgia agassizii*, and *Balticina finmarchica*. *Anthipatharia* (black/thorny corals), which are extremely rare throughout the world's oceans and in some regions, are listed as *threatened* under the International Union for the Conservation of Nature.

The southern and deeper portions of this EBSA could be adjusted in the future following additional surveys. Optical surveys of the Channel took place in the summer of 2014, including in the deeper waters (Peter Lawton, *pers. comm*).

2.4 BROWNS BANK

The boundary for this EBSA is largely based on the 110 m isobath; however, the eastern boundary was drawn to encompass the important features that occur on the bank. Browns Bank includes two major platform areas with the shallowest in the west (defined by the 80 m isobath) and the deeper to the southeast (roughly 90 m in depth) (Fader unpublished report[4]). Browns Bank extends eastward and eventually transitions into Baccaro Bank (Figure 23).

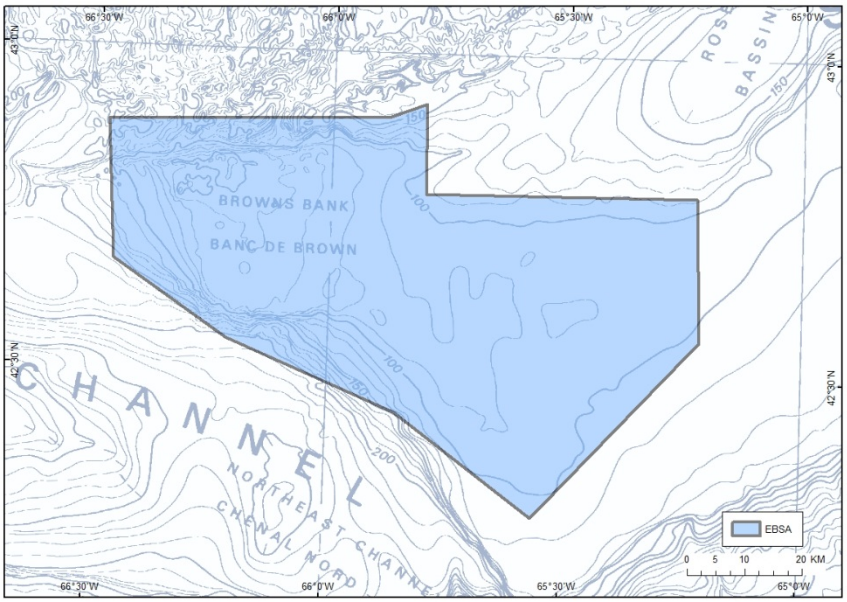

Figure 23. Browns Bank EBSA (4308 km²).

The key features of this EBSA are presented in Table 11. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 12. Maps of a subset of the key features for this EBSA are displayed in Figure 24.

[4] G.B.J. Fader's unpublished consultant report to WWF-Canada (Classification of Bathymetric of the Scotian Shelf, 2007).

Table 11. Key features for the Browns Bank EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
The Fundian Moraine runs from east to west along the northern flank of Browns Bank. This rocky shallow ridge-like feature is unique to Browns Bank (Fader unpublished report) and may serve as a natural refuge (Doherty and Horsman 2007).	x	x			
Highly productive area. Strong tidal currents meet the ridge along the northern flank of the bank resulting in local turbulence and vertical mixing (Breeze et al. 2002, Fader unpublished report).		x	x		
Known concentration of large lobsters that may produce larvae which seed the area off southwestern Nova Scotia (Doherty and Horsman 2007). Bank contains brood stock and adult lobster release larvae on the bank (Pezzack et al. 1992, O'Boyle 2011). Important habitat for lobster (RV[1] data).		x	x		
Cod (COSEWIC-E) and haddock spawning and nursery area (Doherty and Horsman 2007, Breeze et al. 2002, O'Boyle 2011, MacLean et al. 2009). Important habitat for Atlantic cod and haddock (summer/fall/spring) (Horsman and Shackell 2009, RV data).		x	x		
Herring spawning area (Melvin et al. 2002).		x	x		
Important habitat for Atlantic wolffish (summer/fall/spring) (COSEWIC-SC) (DFO 2013c, Horsman and Shackell 2009).		x			
Important habitat for winter skate (summer) (COSEWIC-SC) (Horsman and Shackell 2009, RV data).		x		x	
Area of high fish and invertebrate biomass (RV data).		x			
Area of high invertebrate species richness, evenness and ESW (Ward-Paige and Bundy 2016).	x	x			
Area of high species richness for small invertebrates (Cook and Bundy 2012).	x	x			
Area of high larval fish genus richness (Shackell and Frank 2000, SSIP).	x	x	x		
Partial gyre that encourages physical retention (Hannah et al. 2001, Breeze et al. 2002).		x			
Area of very high and high scope for growth (Kostylev and Hannah 2007).		x			
Important seabird habitat (most functional guilds) (CWS data).		x	x		

Table 12. The Browns Bank CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Browns Bank	x	x	x	x	x	x	

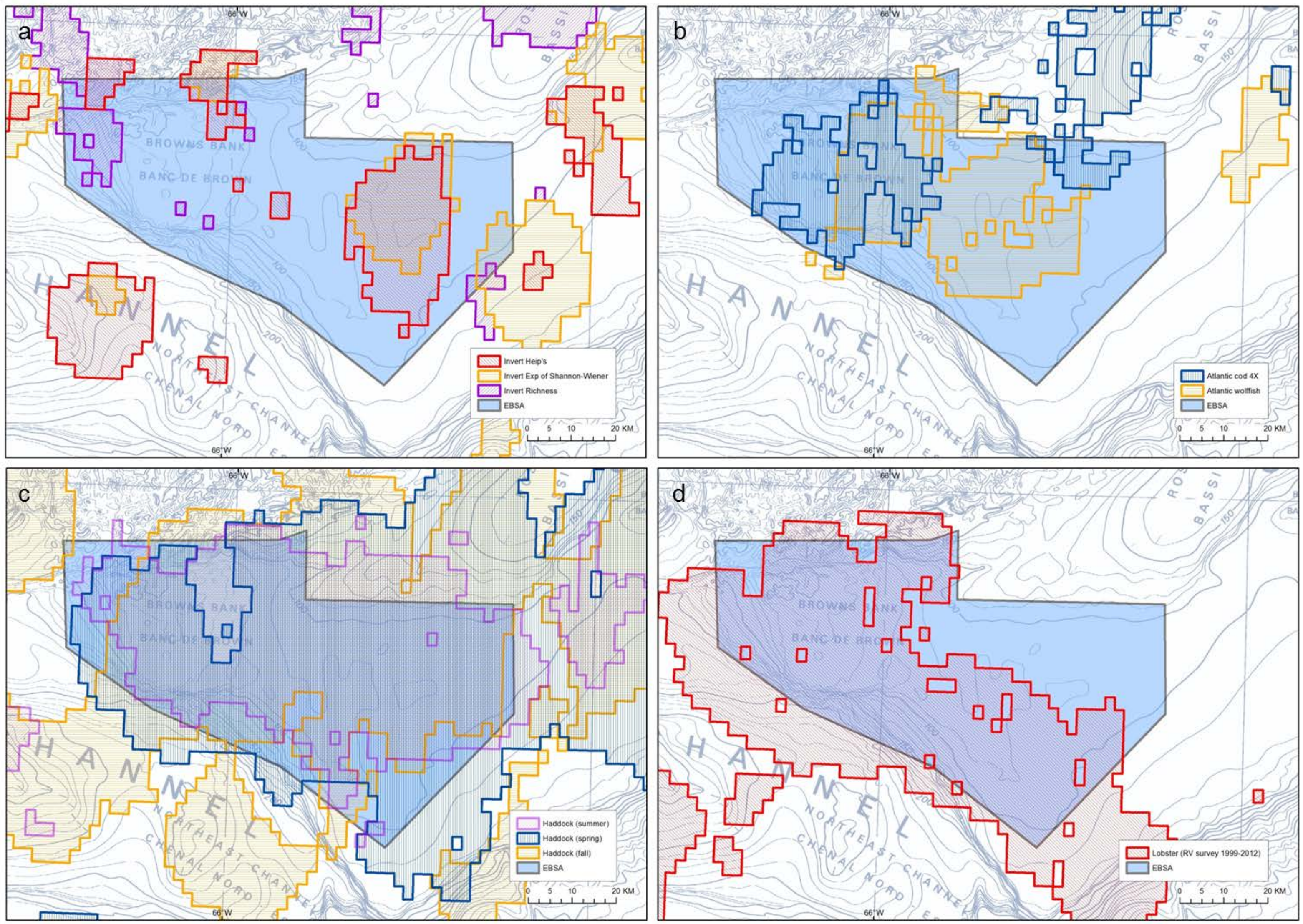

Figure 24. The distribution of a) invertebrate species diversity, b) important summer habitat for Atlantic cod and Atlantic wolfish, c) important habitat for summer, spring, and fall haddock, and d) important habitat for lobster within the Browns Bank EBSA.

Additional Information

Browns Bank has been closed to lobster fishing since 1979 as part of the LFA 40 closure (Pezzack et al. 1992). There is also a seasonal haddock spawning closure (O'Boyle 2011).

2.5 ROSEWAY BASIN

This EBSA is delineated based on the extent of Roseway Basin and the distribution of the North Atlantic right whale. Roseway Basin is a relatively shallow basin that is roughly defined by the 130 m contour and has a maximum depth of just over 180 m (Fader unpublished report[4]) (Figure 25).

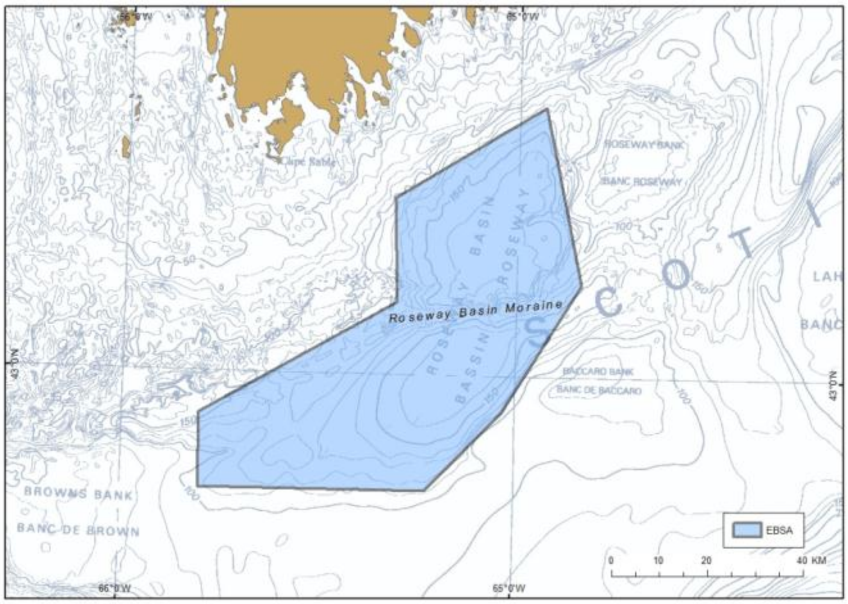

Figure 25. Roseway Basin EBSA (3158 km^2).

The key features of this EBSA are presented in Table 13. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 14. Maps of a subset of the key features for this EBSA are displayed in Figure 26.

Table 13. Key features for the Roseway Basin EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Important feeding, socializing and possible mating area for the highly migratory and endangered North Atlantic right whale (SARA-E) (Brown et al. 2009, Cole et al. 2013, Doherty and Horsman 2007). This species is late to mature and has been very slow to recover from past overexploitation. Right whales feed on dense aggregations of the copepod *Calanus finmarchicus*.	x	x	x	x	
Other whale species, such as blue whales (SARA-E) and fin whales (SARA-SC), have been observed and possibly whaled here (Breeze et al. 2002, Doherty and Horsman 2007).		x			
High biological productivity. Persistent upwelling leads to high level of surface chlorophyll year-round[1]. Krill and *Calanus* concentrations (Doherty and Horsman 2007, Brown et al. 2009). Detailed information on prey concentrations is not available (DFO 2007).		x	x		

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Important redfish habitat (summer/fall/spring) (Horsman and Shackell 2009, RV data). High concentrations of juvenile redfish (COSEWIC-T) (Doherty and Horsman 2007). Part of Roseway Basin is closed to fishing with small mesh gear to limit catch of small redfish (DFO 2001). Area of high abundance for redfish larvae (spawning area) (SSIP[2]). Redfish is a slow-growing and long-lived species (DFO 2010b).		x	x	x	
Important habitat for smooth skate (summer/fall/spring) (COSEWIC-SC) (Horsman and Shackell 2009, RV data). Smooth skate is slow growing, late-to-mature, and has low fecundity (Kulka et al. 2006), indicating it is vulnerable to overexploitation (Stevens et al. 2000).		x		x	
Important habitat for American plaice (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x			
Important habitat for Atlantic cod (summer/fall/spring) (COSEWIC-E) (Horsman and Shackell 2009, RV data).		x			
Important habitat for Atlantic wolfish (fall/spring) (COSEWIC-SC) (RV data).		x			
Habitat for cusk (COSEWIC-E) (DFO 2014b).		x			
Area of high fish biomass (RV data).		x			
Area of high fish and invertebrate species richness (Ward-Paige and Bundy 2016).	x	x			
Important seabird habitat (several functional guilds) (CWS data).		x	x		
The northern and southern portions of the basin are separated by the Roseway Basin Moraine (Fader unpublished report), which is part of the Fundian Moraine (King and Fader 1986, Todd et al. 1999). Moraines are often made up of glacial erratics (large bounders deposited by glaciers), which result in higher benthic habitat heterogeneity and species richness (Kenchington 2014).		x			
The surface of Roseway Basin is covered with pockmarks, which are cone-shaped circular depressions formed by the venting of gas from the seabed (Fader 1989, 1991). These features can be up to 30 m deep and one kilometer wide and add relief to an otherwise smooth and flat seabed (Fader unpublished report). Fader (1989) indicates that gas is actively venting from these features and supporting chemosynthetic biological communities which are forming calcrete deposits.	x				

Notes: [1]Note that an analysis of the Moderate Resolution Imaging Spectroradiometer (MODIS) ocean colour data by Fuentes-Yaco et al. (2015) presented at the February 2014 RAP did not identify Roseway Basin as an area of persistent high chlorophyll concentration;[2]Scotian Shelf Icthyoplankton Program.

Table 14. The Roseway Basin CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Roseway Basin	x	x	x	x	x	x	

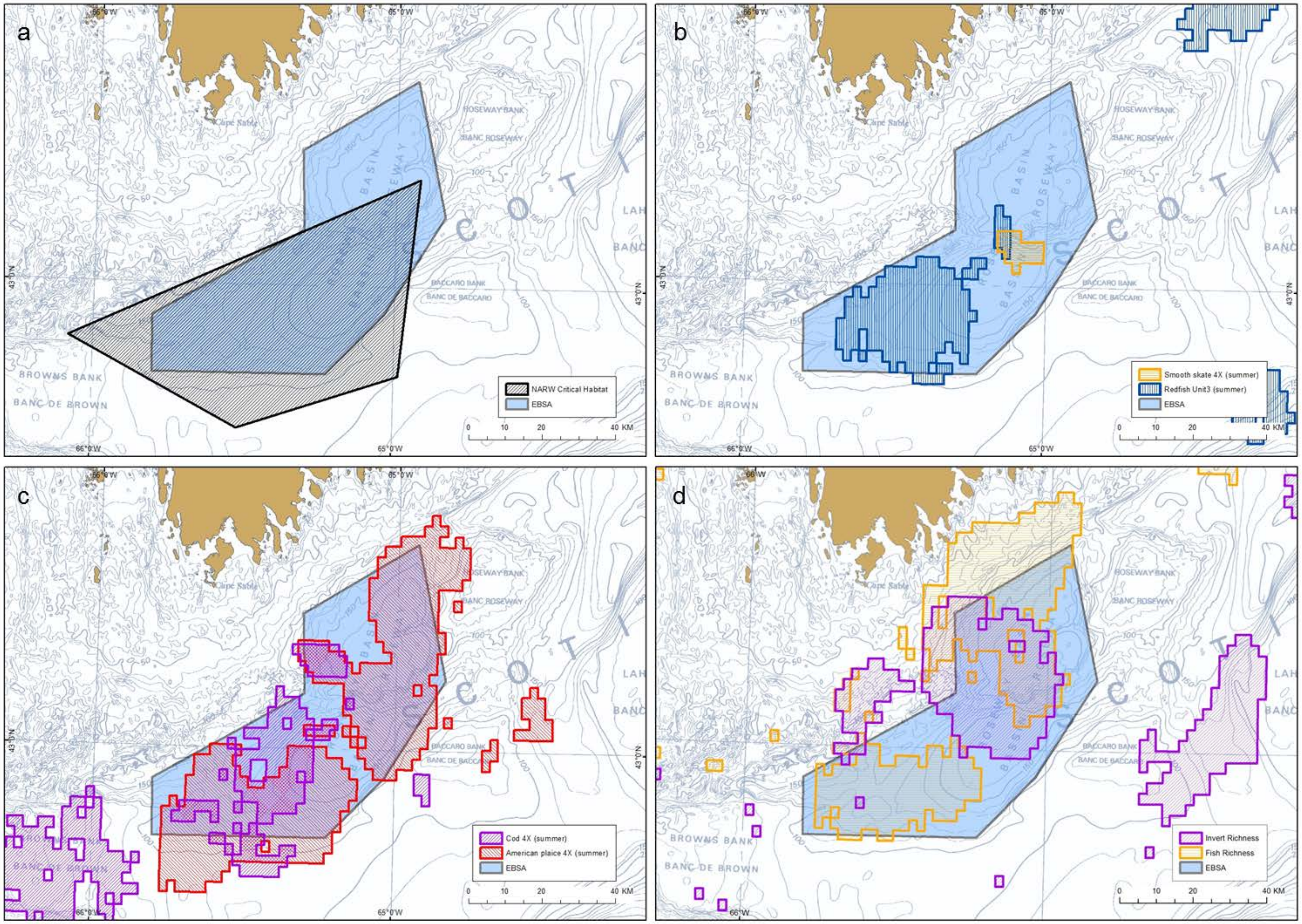

Figure 26. The distribution of a) North Atlantic right whale critical habitat, b) smooth skate and redfish important summer habitat, c) Atlantic cod and American plaice important summer habitat, and d) invertebrate and fish richness within the Roseway Basin EBSA.

Additional Information

Power et al. (2003) indicate that the part of Roseway Basin known as the Western Hole (just west of Bacarro Bank) is an area where herring feeding aggregations have been observed in April and June. Herring represent an important forage species in the ecosystem (Horsman and Shackell 2009).

The mechanisms that dictate the formation and persistence of copepod patches in Roseway Basin are not fully understood and prey availability can vary from year to year. Overall copepod distribution is governed by physical features and processes, such as frontal boundaries, vertical stability and stratification in the water column, and bottom topography (Brown et al. 2009). Davies et al. (2013) offer a hypothesis of the special conditions that exist in Roseway Basin that result in copepod concentrations.

2.6 EMERALD BASIN AND THE SCOTIAN GULF

This EBSA includes Emerald Basin and the depression between Emerald Bank and LaHave Bank, which is known as the Scotian Gulf. Emerald Basin is located in the central portion of the Scotian Shelf and contains the deepest point on the shelf at 291 m (Fader unpublished report[4]). The boundary for the Emerald Basin component of this large EBSA is mainly based on the 200 m isobath, which is typically used to define basins in the bioregion. For the purposes of this exercise, the southern extent of this EBSA is defined by the 200 m isobath, which is also the southern extent of the Scotian Gulf. The boundary of this EBSA was also adapted to ensure that it include known concentrations of the sponge *Vazella pourtalesi* (Figure 27).

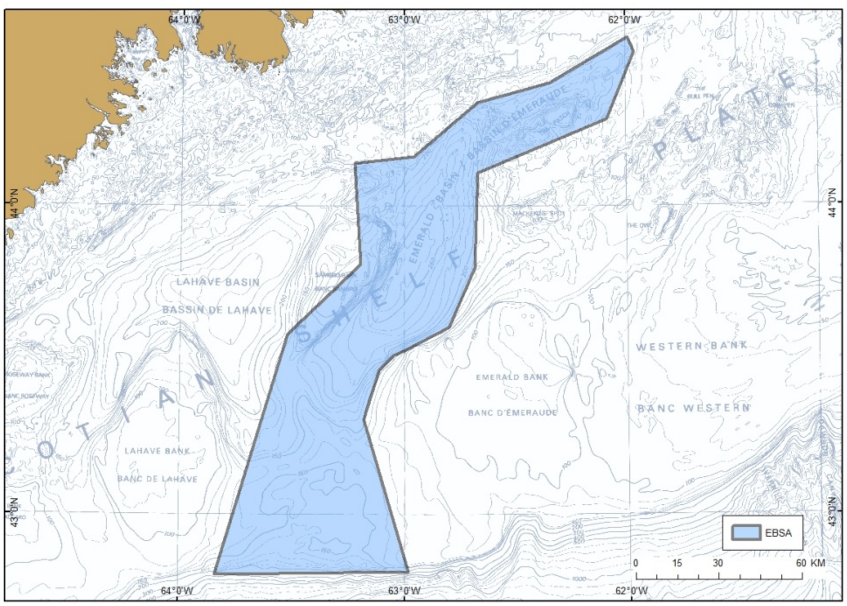

Figure 27. Emerald Basin and the Scotian Gulf EBSA (8513 km^2).

The key features of this EBSA are presented in Table 15. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 16. Maps of a subset of the key features for this EBSA are displayed in Figure 28.

Table 15. Key features for the Emerald Basin and the Scotian Gulf EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Globally unique concentrations of the Hexactinellid sponge *Vazella pourtalesi*, also known as Russian Hats. Occur in dense patches in different parts of the basin, usually in association with exposed glacial till. Highest concentrations appear to be in the shallower area that divides the basin into southwest and northeast components but there is also evidence of dense concentrations in other portions of the basin and the Scotian Gulf. These sponges are long lived, slow growing and sensitive to disturbance (Kenchington 2014). The area has been heavily fished but dense patches remain. These sponges provide habitat for other species (Doherty and Horsman 2007, Fuller et al. 2008, Kenchington et al. 2010).	x			x	x
Unique temperature and salinity regime where bottom temperatures remain relatively warmer than the rest of the Scotian Shelf due to the incursion of dense saltier and warmer continental slope water through the Scotian Gulf (Drinkwater and Trites 1987, Petrie et al. 1996, Breeze et al. 2002, Loder et al. 2003).	x				
Overwintering area for the copepod *Calanus finmarchicus* (important springtime source to the Western Scotian Shelf). Highest biomass of the euphausiid *Meganyctiphanes norvegica* on the shelf (Doherty and Horsman 2007). Emerald Basin and LaHave Basins are the only basins on the shelf that contain large populations of *C. finmarchicus* and *M. norvegica* below 200 m throughout the year (Sameoto and Cochrane 1996). The high concentrations of zooplankton represent an important food source for juvenile silver hake and other young fishes (Sameoto et al. 1994).	x	x	x		
Primary residence and nursery area for silver hake (Sameoto et al. 1994) (Doherty and Horsman 2007). Important habitat for silver hake (summer/fall/spring) (Horsman and Shackell 2009, RV data).		x	x		
Probable feeding area for cetaceans, including certain at-risk species (e.g., blue whale) (Beauchamp et al. 2009, Breeze et al. 2002, Breeze 2004, Doherty and Horsman 2007).		x	x		
Immature porbeagles are caught in this area during the spring and fall (Campana and Joyce 2004) so it may be a nursery area. Also an overwintering and mating area for the basking shark (COSEWIC-SC) (DFO 2008).		x	x	x	
Summer residence of tuna and swordfish (Doherty and Horsman 2007).		x			
Area of high fish species evenness and ESW[1] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species richness (Ward-Paige and Bundy 2016).	x	x			
Area of high species richness for small fish and invertebrate species (Cook and Bundy 2012).	x	x			
Important habitat for white hake (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x			
Area of high fish and invertebrate biomass (RV data).		x			
Important habitat for sandlance (RV stomachs) (Cook and Bundy 2012).		x			
Important habitat for northern shortfin squid (RV data).		x			
Important seabird habitat (most functional guilds) (CWS data).		x	x		
Very low natural disturbance (Kostylev and Hannah 2007).				x	
The surface of Emerald Basin is covered with pockmarks, which are cone-shaped circular depressions formed by the venting of gas from the seabed (Fader 1989, 1991). These features can be 30 m deep and 1 kilometer wide and add relief to an otherwise flat seabed (Fader unpublished report). Fader (1989) indicates that gas is venting from these features and supporting chemosynthetic biological communities which are forming calcrete deposits.	x				

Notes: [1]Exponential of Shannon-Wiener Index.

Table 16. The Emerald Basin and the Scotian Gulf CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Emerald Basin and the Scotian Gulf	x	x	x	x	x	x	

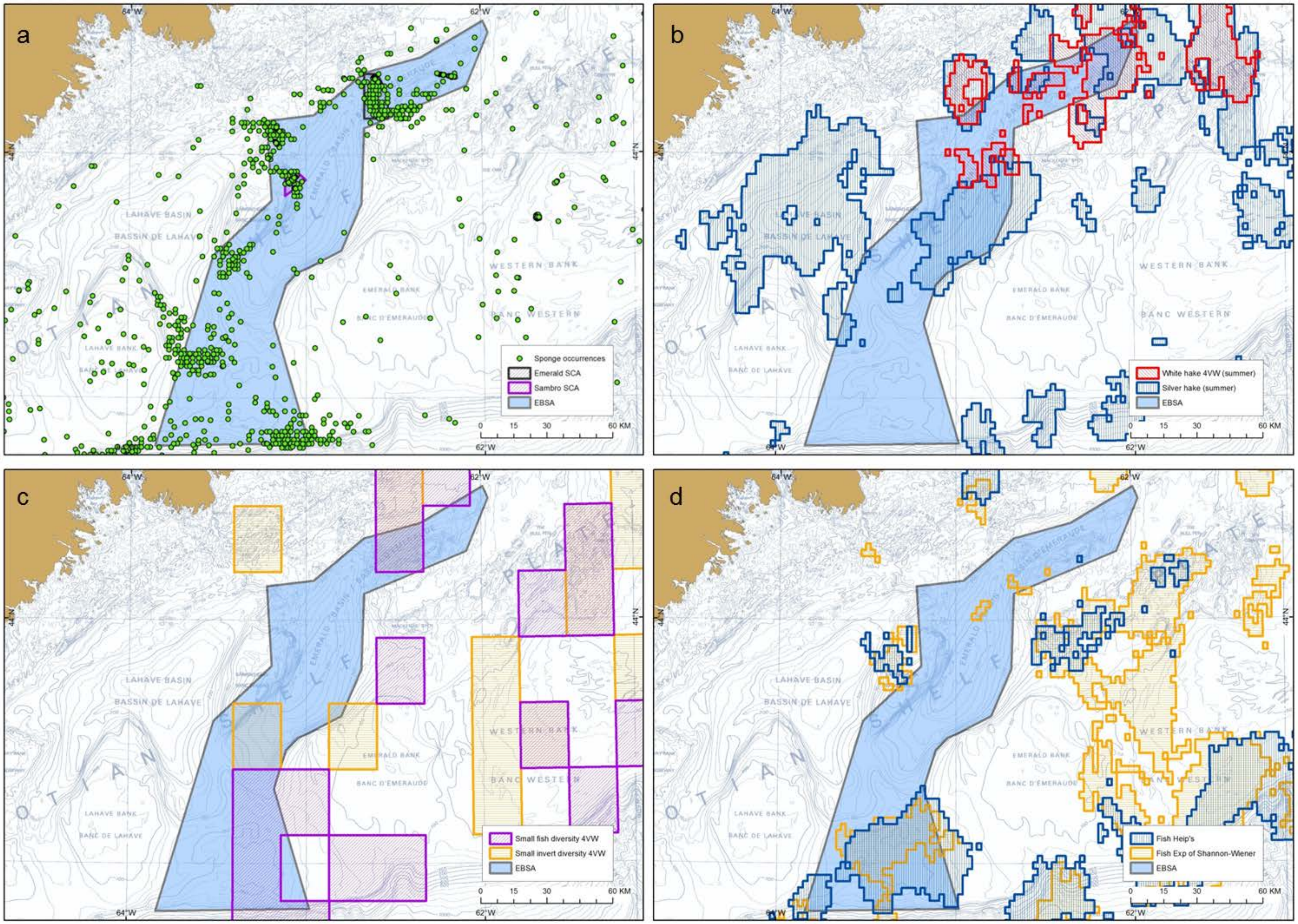

Figure 28. The location of a) sponge occurrences (E. Kenchington and C. Lirette, BIO, pers. comm.), and Emerald Basin and Sambro Sponge Conservation Areas, b) important habitat for white and silver hake, c) areas of high small fish and invertebrate diversity, and d) areas of high fish diversity within the Emerald Basin and the Scotian Gulf EBSA.

Additional Information

Emerald Basin also appears to be important habitat for redfish, pollock, red hake, monkfish and other fishes based on RV data. The eastern portion of Emerald Basin includes a series of exposed moraines, which are boulder-covered linear ridges (Fader unpublished report[4]) that typically equate high habitat benthic heterogeneity and species richness (Kenchington 2014).

Two fisheries closures under the *Fisheries Act* have been established in Emerald Basin to protect two significant concentrations of Russian Hat sponges (*Vazella pourtalesi*) from bottom fishing activity (DFO 2013d).

Emerald Basin may be particularly important to several cetacean species; however, sightings data are incomplete for this area. Given the high concentration of krill and copepods in the basin (Cochrane et al. 2000), this area could serve as a foraging habitat for several species. There have been investigations to determine whether North Atlantic right whales use this basin in a similar manner as Roseway Basin. Historical whaling records indicate that right whales and many other species were observed or harvested in Emerald Basin (Kenney 1994, Sutcliffe and Brodie 1977). More recently, Mellinger et al. (2007) recorded right whale calls in the southern portion of Emerald Basin from July until the end of December. Additional surveys or acoustic monitoring work is required to determine with greater specificity the importance of Emerald Basin to cetaceans.

2.7 EMERALD-WESTERN-SABLE ISLAND BANK COMPLEX

This EBSA was delineated by overlaying the original EBSA (Doherty and Horsman 2007) with the existing Haddock Box fishery closure and the distribution of notable ecological features in this large bank complex. The revised EBSA encompasses all of Emerald Bank and Western Bank and a portion Sable Island Bank. This area includes a complex array of sediments and bedforms. The southern boundary is based on the 110 m isobath. The western boundary is different than the Haddock Box (shifted to the east based on the distribution of key features). The northern boundary is defined roughly by the bank edges and existing boundary of the Haddock Box, but is extended to the northeast to capture the shallow feature known as the Northern Spur. The eastern boundary is defined based on the extent of key ecological features (Figure 29).

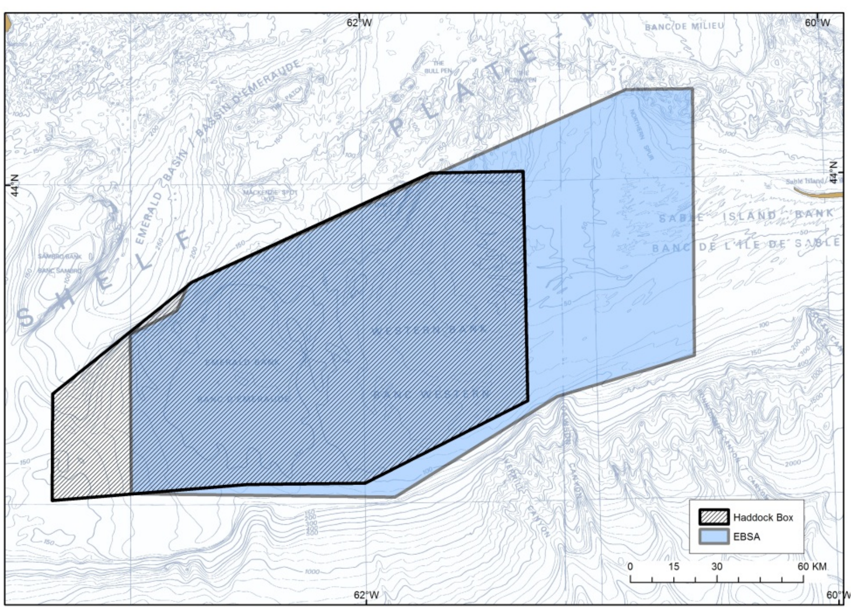

Figure 29. Emerald-Western-Sable Island Bank Complex EBSA (17900 km^2).

The key features of this EBSA are presented in Table 17. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 18. Maps of a subset of the key features for this EBSA are displayed in Figure 30.

Table 17. Key features for the Emerald-Western-Sable Island Bank Complex EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Important habitat for haddock (summer/fall/spring) (Horsman and Shackell 2009, RV data). Known haddock spawning and nursery area (Frank et al. 2000, Ollerhead 2007). Emerald Bank and Western Bank have large areas of suitable spawning habitat (gravel or sand-gravel).		x	x		
Important habitat for Atlantic cod (COSEWIC-E) (Horsman and Shackell 2009). Recognized as a cod spawning area with large areas of suitable habitat. Western Bank defined as an important area of the central Scotian Shelf for larval cod (Reiss et al. 2000, Lochmann et al. 1997).		x	x		
Important habitat for silver hake (Horsman and Shackell 2009) with concentrations of silver hake eggs and larvae found in the summer (Rikhter et al. 2001).		x	x		
Important habitat for winter skate (COSEWIC-T) (summer/fall/spring) (Horsman and Shackell 2009).		x		x	
Important habitat for yellowtail flounder (summer/fall/spring) (Horsman and Shackell 2009, RV data).		x			
Atlantic herring are known to spawn in this area during the fall (Harris and Stephenson 1999).		x	x		
Area of concentration for the eggs and larvae of several species, including haddock, mackerel, pollock, silver hake, yellowtail (SSIP[1] data). The area includes a partial gyre, which results in higher levels of retention of pelagic larvae and their food (Reiss et al. 2003). Western and Sable Island Bank were found to be areas of high larval fish diversity with higher levels of genus richness and abundance in all seasons compared to other parts of the Scotian Shelf (Shackell and Frank 2000).		x	x		
Area of high fish and invertebrate biomass (RV data).		x			
Area of high fish species richness (RV data). Large bank areas, such as Sable Island and Western Banks, were found to be areas of high adult fish diversity when compared with other smaller bank areas of the Scotian Shelf (Frank and Shackell 2001). Western Bank may have higher levels of invertebrate diversity, compared to other eastern Scotian Shelf banks (Henry et al. 2002). Greater species richness was attributed to greater habitat heterogeneity. High diversity of zooplankton species (Doherty and Horsman 2007).		x			
Area of high fish species evenness and ESW[2] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species richness, evenness, and ESW (Ward-Paige and Bundy 2016).	x	x			
Important habitat for seabirds (most functional guilds) (CWS data).		x			

Notes: [1]Scotian Shelf Icthyoplankton Program; [2]Exponential of Shannon-Wiener Index.

Table 18. The Emerald-Western-Sable Bank complex CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Emerald-Western-Sable Bank complex		x	x	x	x	x	

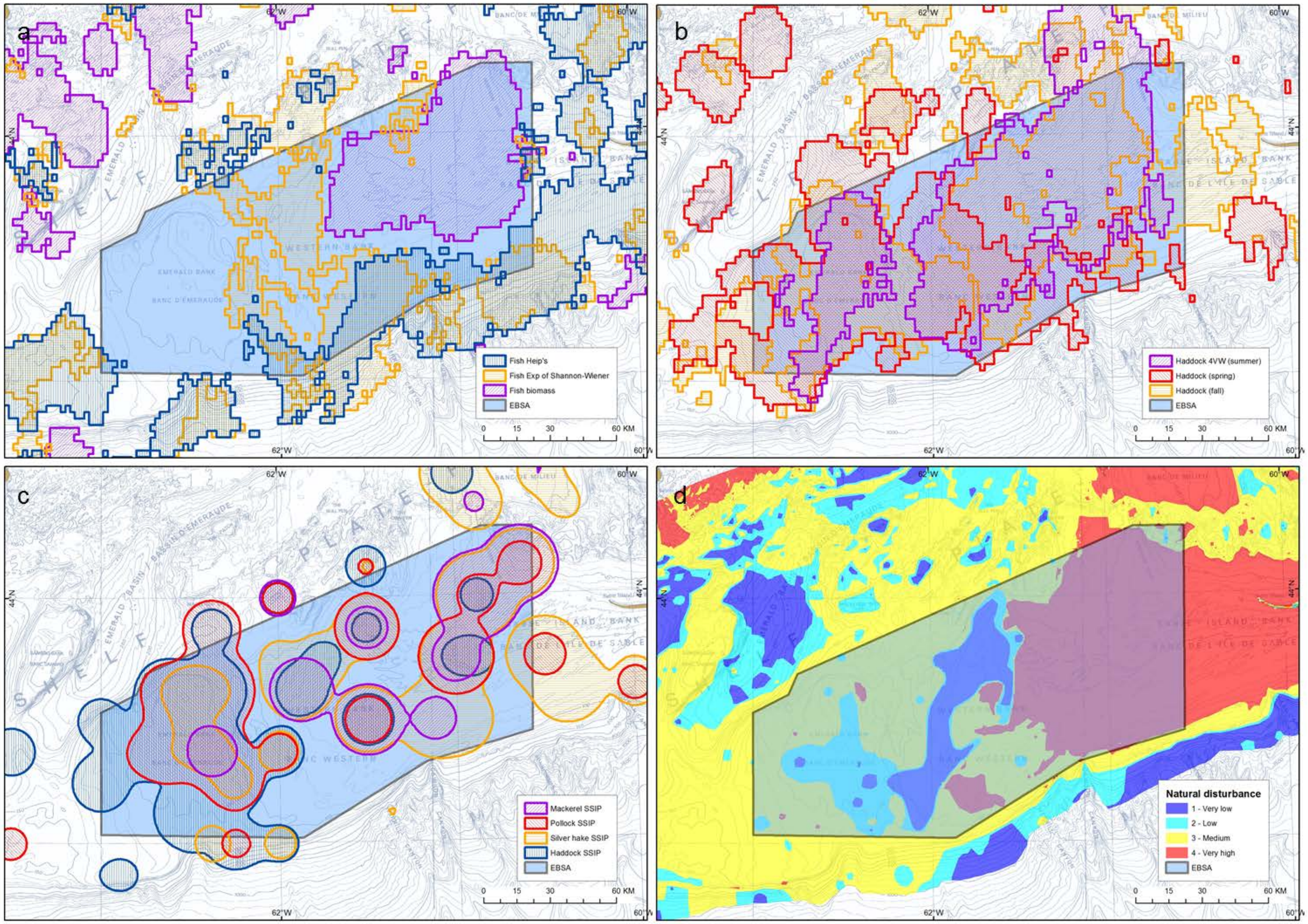

Figure 30. The distribution of a) areas of high fish species evenness (Heip's), Exponential of Shannon-Wiener, and biomass, b) important habitat for haddock (spring, summer, fall), c) mackerel, pollock, silver hake, and haddock larvae, and d) different natural disturbance conditions (based on Kostylev and Hannah 2007) within the Emerald-Western-Sable Island Bank EBSA.

Additional Information

A year-round groundfish fishery closure called the Haddock Box was first established in 1987 on Emerald and Western banks to protect a juvenile haddock nursery area (Fanning et al. 1987). The effectiveness of this closure has been reviewed in several publications (e.g., Frank et al. 2000, Shackell and Frank 2007, O'Boyle 2011). O'Boyle (2011) noted increases in the abundance of other groundfish but found limited evidence of benefits to haddock stock productivity. However, this may be due to broader changes across the shelf ecosystem. Fisher and Frank (2002) noted linkages between the fish populations of the Haddock Box and those found on Browns Bank. As a result of the groundfish closure, the area may possess a higher degree of naturalness due to lower levels of benthic disturbance. However, portions of the EBSA continue to be fished for scallop using dredges.

Several features attributed to Western Bank are shared with Sable Island Bank. The geomorphological characteristics along with the currents and other oceanographic conditions between the two banks are closely connected and it has been described as one continuous feature. Further work to refine the extent of this EBSA (eastern boundary) within this large combined bank feature may be required.

Portions of this EBSA may be of particular importance to cetaceans. In particular, the Western Gully, a narrow depression that separates Emerald Bank from Western Bank, was an area frequented by whalers in the 1960s and 1970s (Sutcliffe and Brodie 1977). Fin whales appear to have been particularly abundant in the area; however, other species such as right whales, humpback whales, blue whales, sei whales, minke whales, sperm whales, and common dolphins were also observed (Mitchell et al. 1986, Kenney 1994). This is currently not a regular area of cetacean surveys and additional work is required to confirm its importance.

2.8 SABLE ISLAND SHOALS

This EBSA was delineated, beginning with a buffer around the island of roughly 10 kilometers (from high water mark). The EBSA encompasses the shallow waters around the island, which are particularly important to wildlife on the island itself, namely seals (grey and harbour) and seabirds (terns and gulls). The western portion of the buffer was modified to include areas of high concentrations of chlorophyll a. This boundary is for illustrative purposes only, as a much larger area of Sable Bank is likely supporting the key species on the island (Figure 31).

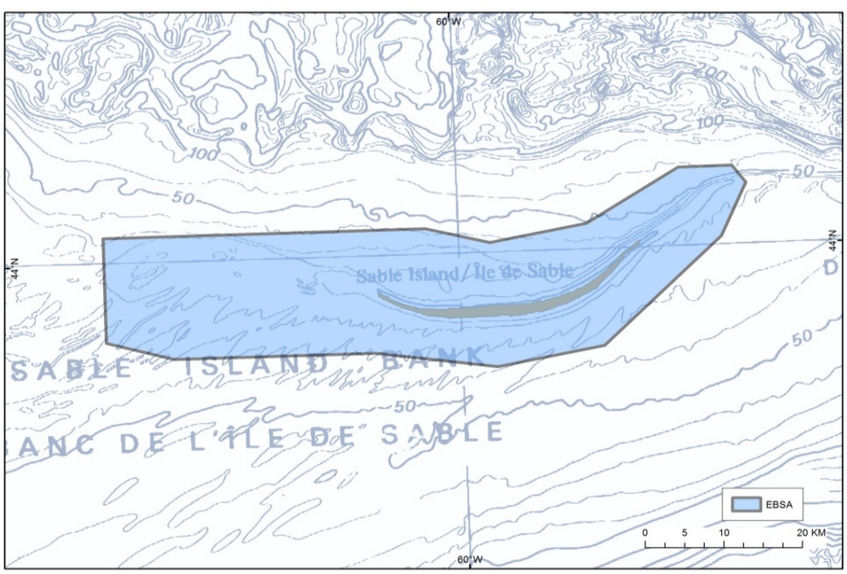

Figure 31. Sable Island Shoals EBSA (1297 km^2).

The key features of this EBSA are presented in Table 19. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 20. Maps of a subset of the key features for this EBSA are displayed in Figure 32.

Table 19. Key features for the Sable Island Shoals EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Sable Island is unique in that it is the only truly offshore island in the bioregion. Sandy beaches and shallow coastal habitats are surrounded by an offshore environment.	x				
Sable Island is the world's largest breeding colony of grey seals and has a small population of harbour seals (DFO 2010c). 81% of grey seal pups are born on Sable Island (DFO 2010c). Seals forage in the waters surrounding the island, with key prey species including sandlance and selected groundfish (Austin et al. 2006, Bowen et al. 2006, Bowen and Harrison 2006).	x	x	x		
Area with high concentrations of juvenile fish, particularly haddock (young-of-year and age 1) (Doherty and Horsman 2007). Annual groundfish surveys for juvenile fish in the shallow waters were conducted from 1981 to 1985, and 36 fish species were collected. Haddock, silver hake, Atlantic cod (COSEWIC-E) and yellowtail flounder comprised the bulk of the catch (Scott 1987). Juvenile haddock appear to be highly concentrated in the shallows around the island, at least in some years (Scott 1987, Frank et al. 2001).		x	x		
Sable Island has a significant breeding populations of terns (common, arctic, and roseate) (SARA-E) and gulls (great black backed and herring). Defined globally as an Important Bird Area, it is a nationally significant site (Bird Studies Canada 2013). Tern studies on mainland NS showed foraging (sandlance and small groundfish) within close proximately (~10km) of nesting locations (Rock et al. 2007).		x	x		
Persistent high chlorophyll concentrations (MODIS[1] ocean colour data).		x	x		
Important seabird habitat (plunge diving piscivores, shallow diving piscivores, shallow pursuit generalists) (CWS data).		x	x		
Area of high fish species evenness and ESW[2] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species evenness and ESW (Ward-Paige and Bundy 2016).	x	x			

Notes: [1]Moderate Resolution Imaging Spectroradiometer; [2]Exponential of Shannon-Wiener Index.

Table 20. The Sable Island Shoals CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Sable Island Shoals	x	x	x		x		

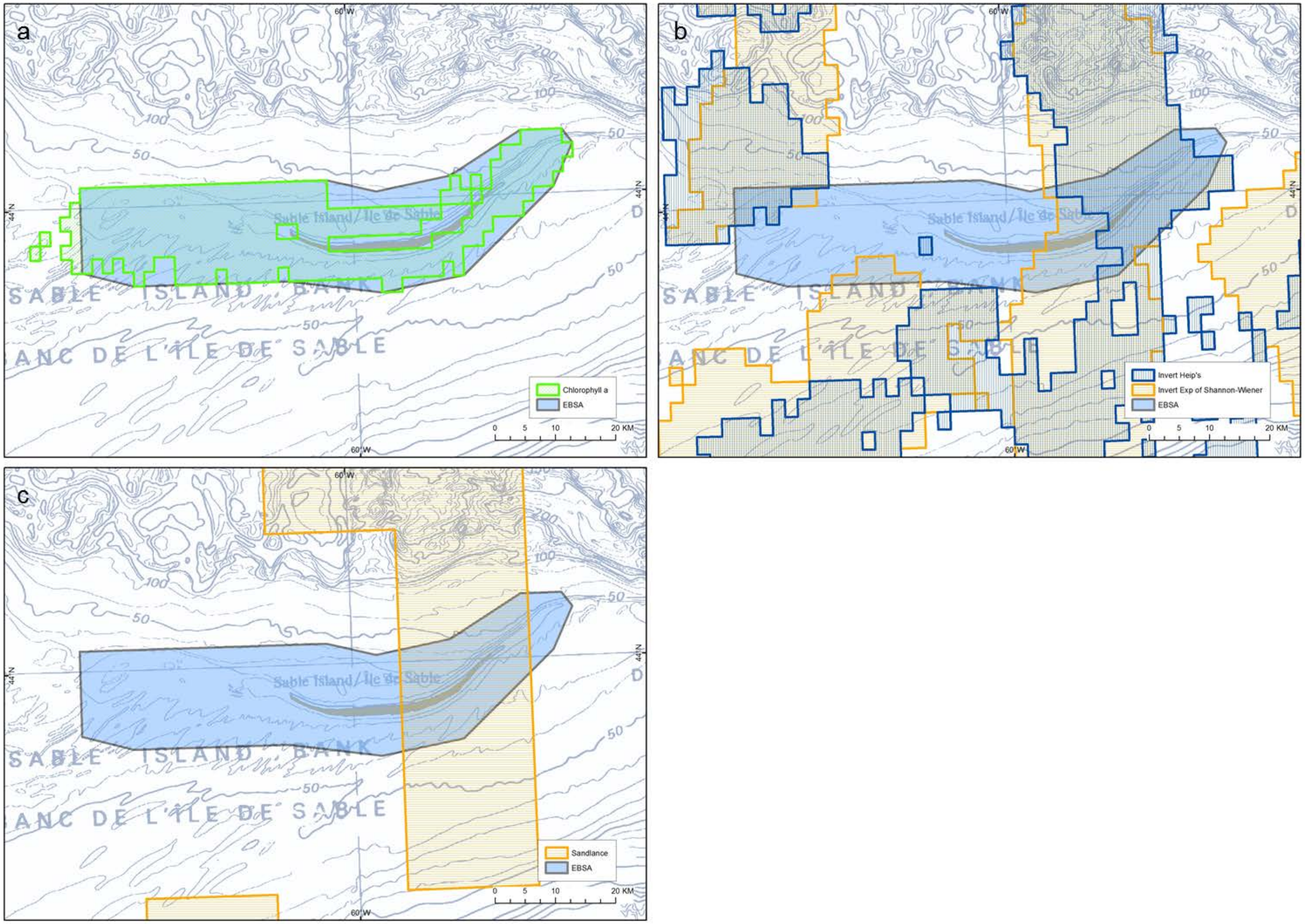

Figure 32. The distribution of a) high chlorophyll a concentrations, b) areas of high invertebrate species evenness (Heip's), and Exponential of Shannon-Wiener, and c) important habitat for sandlance within the Sable Island Shoals EBSA.

Additional Information

Sable Island is a National Park Reserve (established in 2013) providing enhanced protection of the island's wildlife. The waters surrounding the island are intrinsically linked to the island's unique wildlife and their long-term survival. Efforts are underway by the Parks Canada Agency and its partners to document the island's ecology and develop management and monitoring documents for the island. This EBSA is not regularly surveyed by DFO (e.g., through the RV survey). A finer resolution boundary may be possible based on future survey results, or further work on the foraging behaviors of key species. This EBSA is a possible area of juvenile snow crab abundance (Doherty and Horsman 2007). High levels of recruitment and abundance were seen in recent surveys in an area south of Sable Island (DFO 2012b).

2.9 EASTERN SCOTIAN SHELF CANYONS (THE GULLY, INCLUDING THE GULLY TROUGH, SHORTLAND AND HALDIMAND)

This EBSA encompasses the Gully, the Gully Trough, Shortland Canyon, and Haldimand Canyon. The deep water portions of this EBSA are roughly defined by the 2000 m isobath (bounded by straight lines). The shelf-ward boundary is based on the 110 m isobath, which marks the edge of the shelf; the western boundary is defined by the Gully MPA boundary; and the eastern boundary is generally aligned with the Haldimand Canyon northern bottlenose whale Critical Habitat boundary. The EBSA includes the large depression northwest of the Gully known as the Gully Trough. The northwestern portion of this EBAS is intended to capture the three prominent fingers of the trough (as defined by a 200 m contour). This area can be best described as an EBSA complex as it encompasses four previously defined EBSAs. The ecological linkages through oceanographic circulation patterns and species movements form the basis for combining these into a larger EBSA (Figure 33).

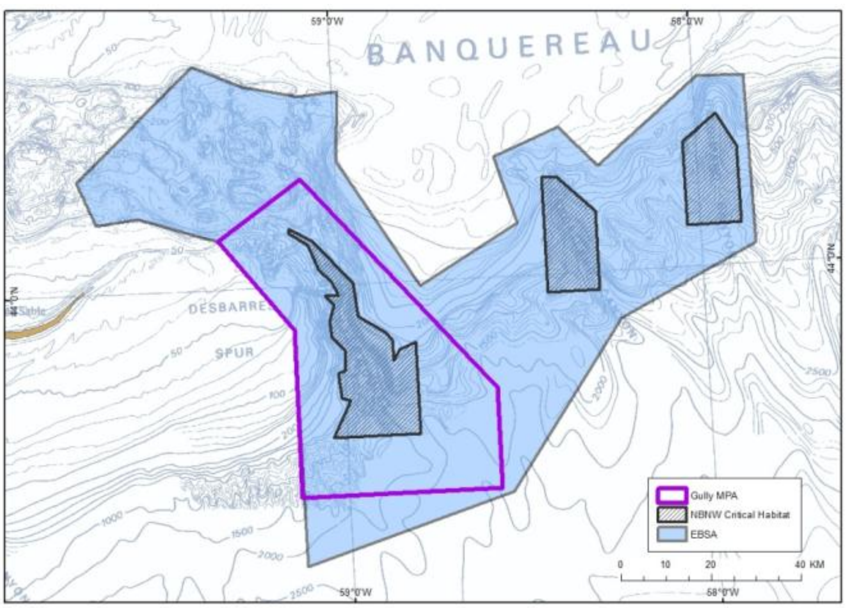

Figure 33. Eastern Scotian Shelf Canyons EBSA (7434 km²).

The key features of this EBSA are presented in Table 21. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 22. Maps of a subset of the key features for this EBSA are displayed in Figure 34.

Table 21. Key features for the Eastern Scotian Shelf Canyons EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
The Gully is the largest submarine canyon off Eastern North America. Shortland and Haldimand canyons are also large, distinct features on the Scotian Slope, resulting in unique environments and ecology in the bioregion.	x				
The deeper waters of these three canyons have been designated Critical Habitat (SARA) for Northern bottlenose whales (SARA-E) as they support many life history functions (DFO 2009). Sighting rates are highest in the Gully (Wimmer and Whitehead 2004). The slope edge between the canyons has also been defined as important habitat for this species (Moors 2012).		x	x		
The Gully is an important habitat for marine mammals on the Scotian Shelf, with 16 species of whales and dolphins observed in the area. The Gully has been identified as an area of consistent sightings for blue whales (Whitehead 2013). High sighting rates of Sowerby's beaked whales (SARA-SC) and other cetacean species also occur within the canyons (Whitehead 2013).		x			
The large size, shape, depth range, and unique location of the Gully results in a wide variety of benthic and pelagic habitats. Although smaller, Shortland and Haldimand Canyons are also expected to have significant habitat diversity. There is evidence across this broad area of higher levels of diversity for finfish (RV data), cetaceans (Moors-Murphy 2014) and invertebrates (coral database and RV data). This diversity has also been noted by fish harvesters (MacLean et al. 2009).		x			
Approximately 30 different species of coral have been identified in the Gully to date, making it the area with the highest coral diversity in Atlantic Canada. Several vulnerable and/or rare taxa have been documented, including Alcyonacea, Gorgonacea (e.g., *Keratoisis ornata*, *Paragorgia arborea),* Pennatulacea (seapens) and Scleractinia (*Flabellum* spp.) Significant corals have been documented in Shortland and Haldimand Canyons as well, including concentrations of Gorgonacea and Pennatulacea (seapens). High densities of *Flabellum alabastrum* (cup coral) have also been observed in Shortland Canyon (Cogswell et al. 2009).	x	x		x	
Important habitat for cod (summer/fall/spring) (COSEWIC-E) (Horsman and Shackell 2009, RV data).		x			
Important habitat for white hake (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x			
Important habitat for smooth skate (summer/fall/spring) (COSEWIC-SC) (Horsman and Shackell 2009, RV data).		x		x	
Important redfish habitat (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x		x	
Area of high fish and invertebrate biomass (RV data).		x			
Area of high fish species richness, evenness, and ESW[1] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species richness, evenness, and ESW (Ward-Paige and Bundy 2016).	x	x			
Important seabird habitat (most functional guilds) (CWS data).		x	x		

Notes: [1]Exponential of Shannon-Wiener Index.

Table 22. The Eastern Scotian Shelf Canyons CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Eastern Scotian Shelf Canyons	x	x	x	x	x	x	

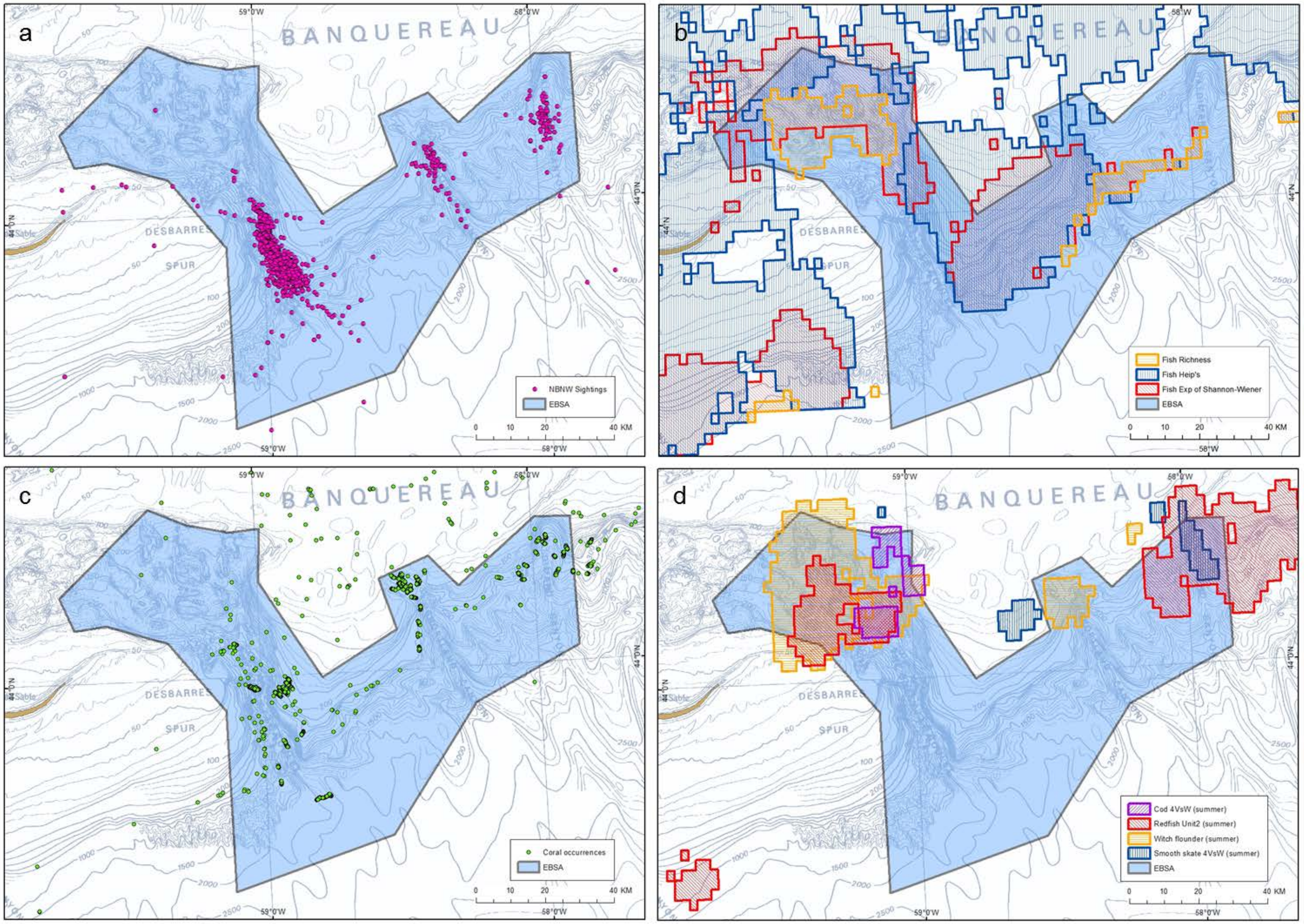

Figure 34. The distribution of a) northern bottlenose whale occurrences, b) areas of high fish species richness, species evenness, and Exponential of Shannon-Wiener, c) coral occurrences (E. Kenchington and C. Lirette, BIO, pers. comm.), and d) important habitat for Atlantic cod, redfish, witch flounder, and smooth skate within the Eastern Scotian Shelf Canyons EBSA.

Additional Information

The Gully MPA (*Oceans Act* MPA) was established in 2004, providing legal protection for a large portion of this EBSA (Canada Gazette 2004). The Gully is very well-studied while considerably less is known about the other canyons and the Gully Trough.

The Trough connects the Gully canyon to the broader shelf ecosystem through the exchange of slope and shelf waters. Note that the boundary in the trough feature could be extended westward, as it is expected to be an important area for a number of invertebrates (based on preliminary analyses).

Globally, canyon features that occur along continental slopes are considered significant due to increased biological productivity and diversity (Moors-Murphy 2014, Hickey 1995). The Gully may have enhanced productivity; however, evidence has been inconclusive to date (Kenchington 2010). Reviews of key indicators such as phytoplankton, zooplankton, and mesopelagics indicate no notable differences in abundance in the canyon from the rest of the eastern Scotian Shelf and its adjacent continental slope. However, the high abundances of higher trophic species, such as cetaceans, often suggest greater ecosystem productivity (Moors-Murphy 2014).

Breeze (2004) placed emphasis on the Southwest Prong of Banquereau Bank, on the eastern side of the Gully, as an area of particular importance. The Southwest Prong is a broad, deep part of Banquereau that was described as an overwintering area for haddock and other groundfish, pre-moratorium. Fanning et al. (1987) profiled this area in consideration for management measures to reduce impacts on juvenile haddock.

2.10 MIDDLE BANK

Middle Bank is located to the northwest of Sable Island and is defined by the 110 m isobaths (Figure 35).

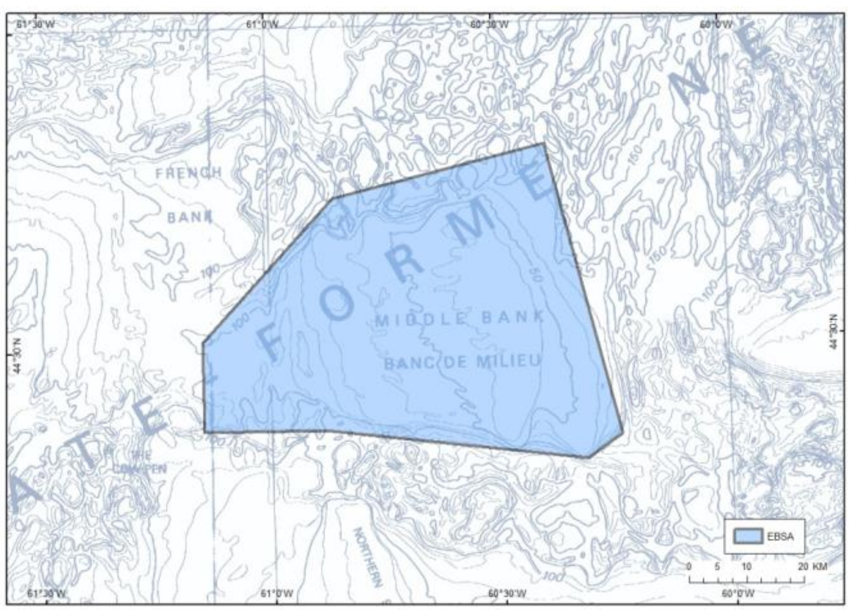

Figure 35. Middle Bank EBSA (2748 km^2).

The key features of this EBSA are presented in Table 23. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 24. Maps of a subset of the key features for this EBSA are displayed in Figure 36.

Table 23. Key features for the Middle Bank EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Atlantic cod spawning and nursery area (Gagne and O'Boyle 1984, Sinclair 1992, MacLean et al. 2009). Past tagging studies provide evidence that sub-populations of cod existed on Middle Bank (McKenzie 1956, Doherty and Horsman 2007). Important habitat for Atlantic cod (summer/fall) (COSEWIC-E) (Horsman and Shackell 2009, RV data).		x	x		
High larval fish genus richness (Shackell and Frank 2000, SSIP[1]).	x	x			
Area of high invertebrate species evenness and ESW[2] (Ward-Paige and Bundy 2016).	x	x			
Area of high small fish species richness (Cook and Bundy 2012).	x	x			
Abundant American plaice (COSEWIC-T), redfish (COSEWIC-T), silver hake, yellowtail flounder, and witch flounder larvae (SSIP). Possible spawning and/or nursery area for these species.		x	x		
Area of high invertebrate biomass and historically an area of high fish biomass (RV data).		x			
Area where fin whales (SARA-SC) and minke whales are observed in the summer and fall (MacLean et al. 2009).		x			
High primary productivity[3]. Fall phytoplankton bloom occurs in this general area (Breeze et al. 2002, Breeze 2004).		x	x		
Important seabird habitat (most functional guilds) (CWS data).		x	x		

Notes: [1]Scotian Shelf Icthyoplankton Program; [2]Exponential of Shannon-Wiener Index; [3]Note that an analysis of the Moderate Resolution Imaging Spectroradiometer (MODIS) ocean colour data by Fuentes-Yaco et al. (2015) presented at the February 2014 RAP did not identify Middle Bank as an area of persistent high chlorophyll concentration.

Table 24. The Middle Bank CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Middle Bank		x	x		x	x	

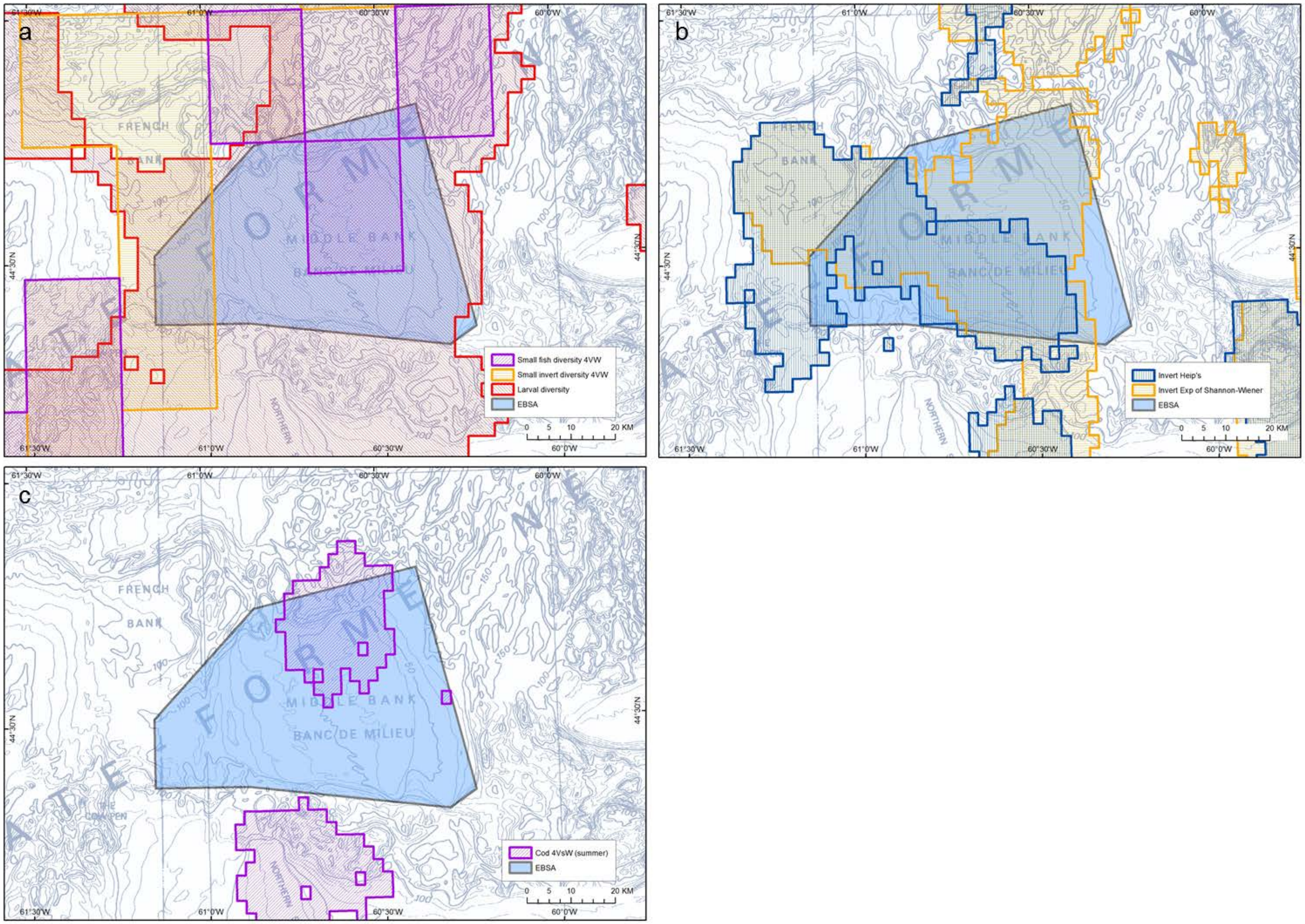

Figure 36. The distribution of a) areas of high small fish diversity, small invert diversity, and larval fish diversity, b) areas of high invertebrate species evenness (Heip's) and Exponential of Shannon-Wiener, c) area of important Atlantic cod habitat within the Middle Bank EBSA.

Additional Information

Middle Bank and the areas surrounding it are also important for several commercially valuable invertebrate species. The bank is important for sea scallop and sea cucumber while the deep holes surrounding the bank support concentrations of northern shrimp and snow crab.

2.11 CANSO BANK AND CANSO BASIN

Canso Bank and Canso Basin are located east and southeast of the town of Canso. The bank is defined by the 110 m isobath while the deep holes and basin-like habitat to the west of the bank has been informally named Canso Basin, which is mostly deeper than 150 m (Fader unpublished report[4]). The boundary for this EBSA has been drawn to include all of Canso Bank and Canso Basin because of the high fish, invertebrate and larval fish diversity in the area (Figure 37).

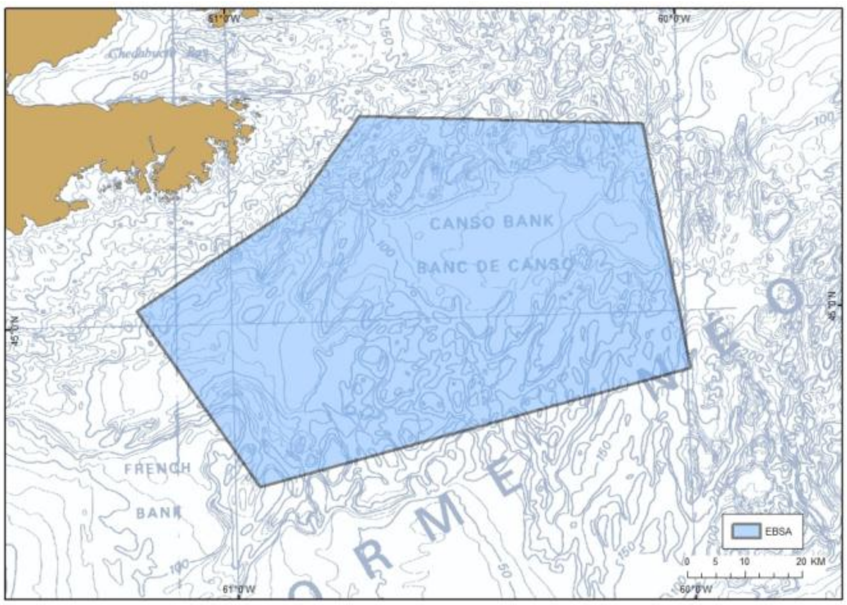

Figure 37. Canso Bank and Canso Basin EBSA (4113 km^2).

The key features of this EBSA are presented in Table 25. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 26. Maps of a subset of the key features for this EBSA are displayed in Figure 38.

Table 25. Key features for the Canso Bank and Canso Basin EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO EBSA Criteria				
	U	A	FC	R	N
High larval fish genus richness (Shackell and Frank 2000, SSIP).	x	x			
Area of high fish species richness, evenness (Heip's), and ESW[1] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species evenness (Heip's), and ESW (Ward-Paige and Bundy 2016).	x	x			
High small fish and small invertebrate species richness (Cook and Bundy 2012).	x	x	x		
Area of high invertebrate biomass (RV data).		x			
Persistent high chlorophyll concentrations (MODIS[2] ocean colour data).		x	x		
Important habitat for northern shrimp, striped pink shrimp, snow crab, toad crab, and several other invertebrates (RV data).		x			
Important habitat for sandlance (RV stomachs) (Cook and Bundy 2012).		x			
Important habitat for American plaice (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data). Also abundant American plaice larvae so this area could be a spawning area for this species (SSIP[3]).		x	x		
Important seabird habitat (most functional guilds) (CWS data).		x	x		
The bank component of this EBSA has not been subjected to the same level of fishing intensity as other banks in the bioregion (Breeze 2004).					x

Notes: [1]Exponential of Shannon-Wiener Index; [2]Moderate Resolution Imaging Spectroradiometer; [3]Scotian Shelf Icthyoplankton Program.

Table 26. The Canso Bank and Canso Basin CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Canso Bank and Canso Basin		x	x		x	x	x

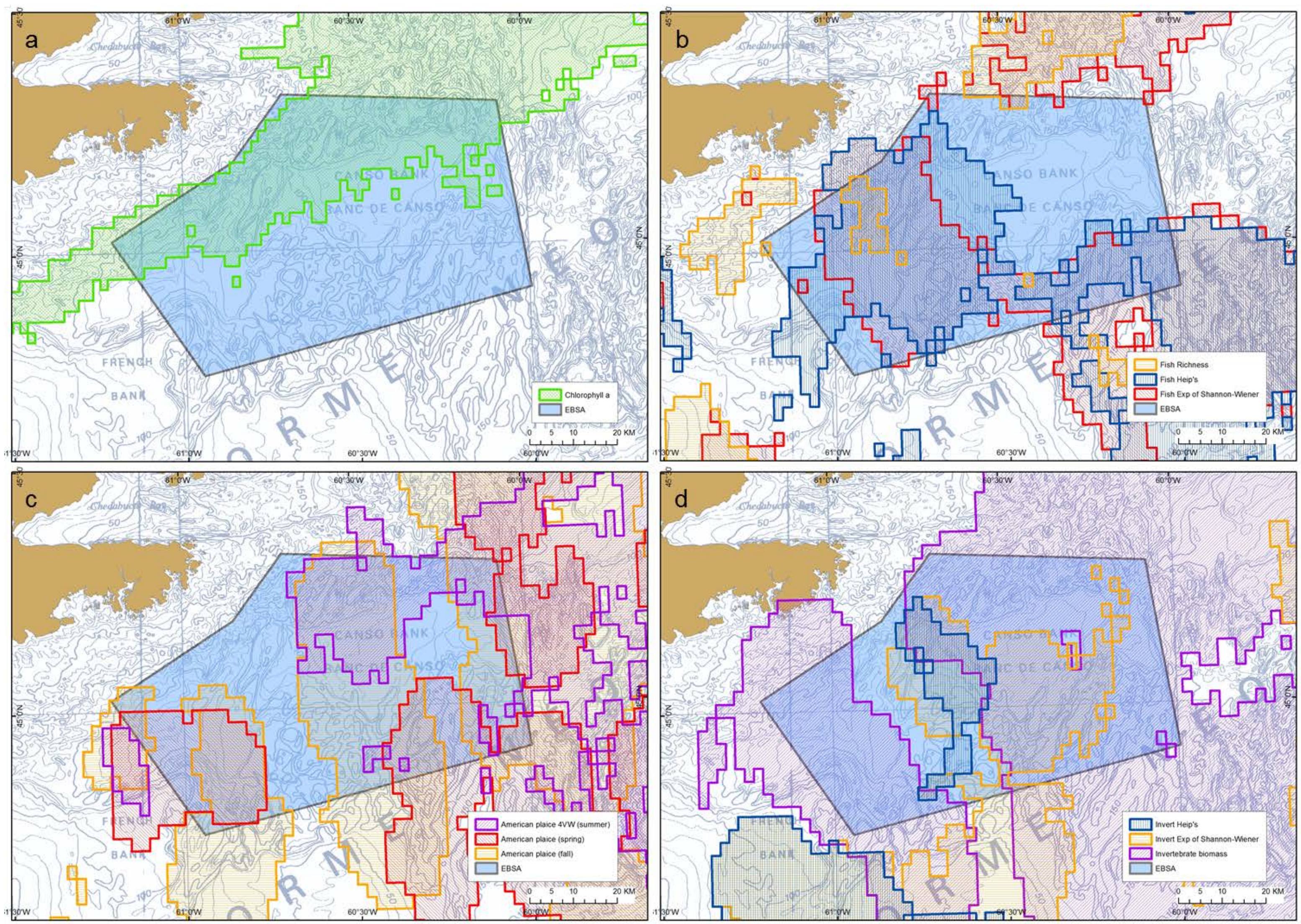

Figure 38. The distribution of a) persistent high chlorophyll a concentrations, b) areas of high fish species richness, evenness (Heip's), and Exponential of Shannon Wiener, c) important habitat for American plaice (spring, summer, fall), and d) areas of high invertebrate species evenness (Heip's) and Exponential of Shannon-Wiener within the Canso Bank and Canso Basin EBSA.

Additional Information

This EBSA overlaps with areas of very low and low Scope for Growth (Kostylev and Hannah 2007) as well as important habitat for herring, capelin, and mackerel in the late 1970s to early 1980s (RV data).

2.12 MISAINE BANK

Misaine Bank is located on the eastern Scotian Shelf north of Banquereau Bank. This bank is heavily incised by deep channels resulting in an irregular shape and has been described as a bank complex as opposed to a single bank (Fader unpublished report[4]). The banks that make up this complex are defined by the 110 m isobath. Invertebrate species richness was also taken into account when delineating this EBSA (Figure 39).

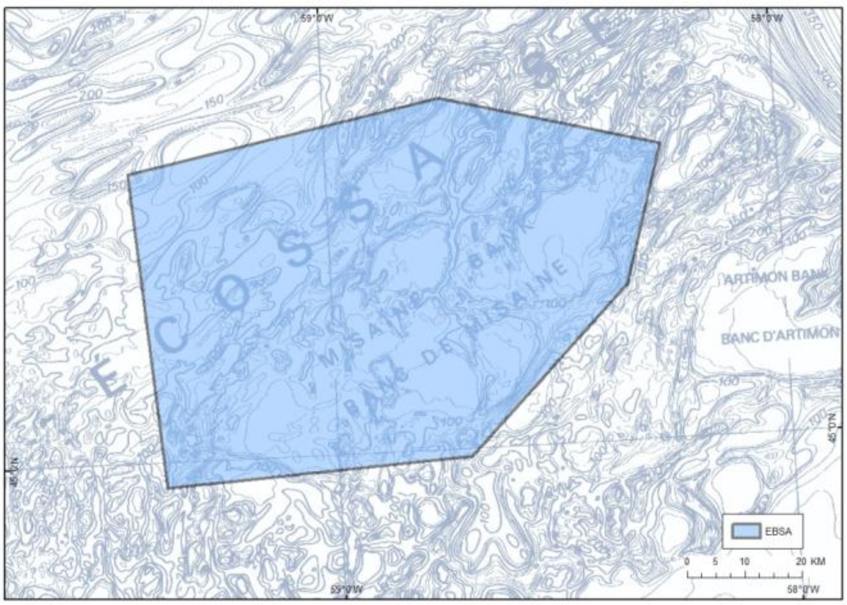

Figure 39. Misaine Bank EBSA (4599 km²).

The key features of this EBSA are presented in Table 27. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 28. Maps of a subset of the key features for this EBSA are displayed in Figure 40.

Table 27. Key features for the Misaine Bank EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Area of high fish species evenness (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species evenness and ESW[1] (Ward-Paige and Bundy 2016).	x	x			
High small fish and small invertebrate species richness (Cook and Bundy 2012).	x	x	x		
Area of high invertebrate biomass (RV data).		x			
Important habitat for northern shrimp, striped pink shrimp, green sea urchin, several crab species, and other invertebrates (RV data).		x			
Important habitat for thorny skate (summer/fall/spring) (COSEWIC-SC) (Horsman and Shackell 2009, RV data).		x		x	
Important habitat for American plaice (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x			
Cod spawning area (COSEWIC-E) (Hanke et al. 2000).		x	x		
Important habitat for sandlance (RV stomachs) (Cook and Bundy 2012).		x			
Important seabird habitat (pursuit diving piscivores) (CWS data).		x			
High primary productivity. Fall phytoplankton bloom occurs in this general area (Breeze et al. 2002).		x	x		
Very low natural disturbance and low scope for growth (Kostylev and Hannah 2007).				x	
The bank component of this EBSA has not been subjected to the same level of fishing intensity as other banks in the bioregion (Breeze 2004).					x

Notes: [1]Exponential of Shannon-Wiener Index.

Table 28. The Misaine Bank CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Misaine Bank		x	x	x	x	x	x

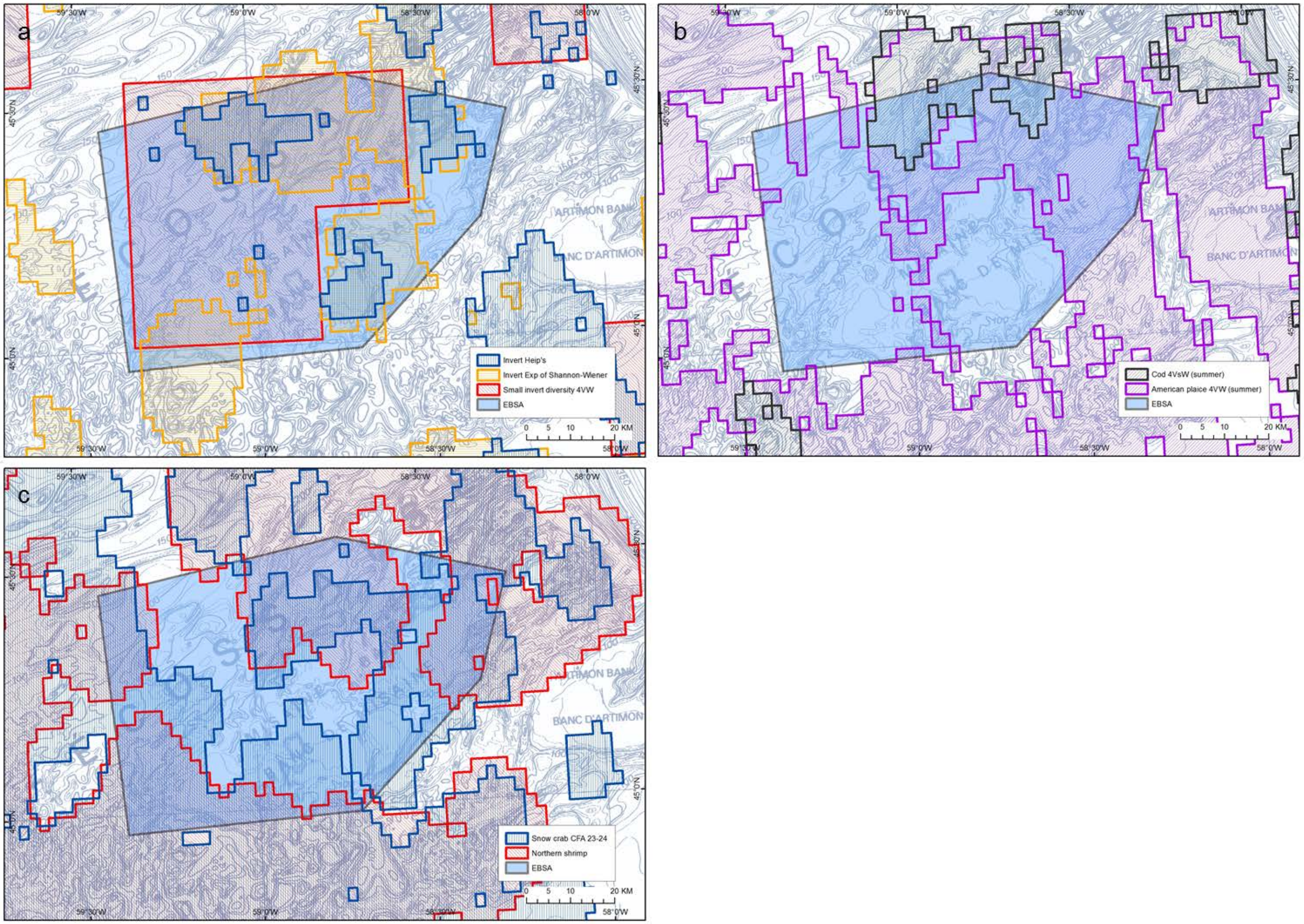

Figure 40. The distribution of a) areas of high invertebrate species evenness (Heip's), Shannon Wiener, and small invertebrate species diversity, b) important summer habitat for Atlantic cod and American plaice, and c) important summer habitat for snow crab and northern shrimp within the Misaine Bank EBSA.

Additional Information

Misaine Bank was not one of the original SEO EBSAs described by Doherty and Horsman (2007); however, it is nearby several SEO EBSAs and was identified as significant by Breeze (2004) and by fish harvesters (MacLean et al. 2009). The overlay analysis also produced strong evidence for the ecological significance of this site due to the apparent high species richness in the region and its importance to depleted groundfish species. It also supports high aggregations of many invertebrate species.

The Misaine Bank EBSA possesses many of the same features and characteristics as the Canso Bank and Canso Basin EBSA. For example, both areas support high invertebrate biomass and fish and invertebrate species richness. Snow crab, northern shrimp, American plaice, and sandlance are also abundant in both areas. The bank components of both EBSAs have also been subjected to relatively low levels of fishing activity, particularly in recent decades. Canso Bank and Canso Basin appears to contain higher primary productivity but Misaine Bank is more important for depleted groundfish species.

2.13 EASTERN SHOAL

Eastern Shoal is a large, shallow sand body that extends in a southwest to northeast direction across the entire eastern portion of Banquereau Bank. Eastern Shoal is defined by the 40 m isobath but has a shallow point of 27 m. The boundary for this EBSA extends to the southeast of Eastern Shoal to the edge of the bank (110 m) to capture additional habitat for American plaice, Atlantic cod, and sandlance (Figure 41).

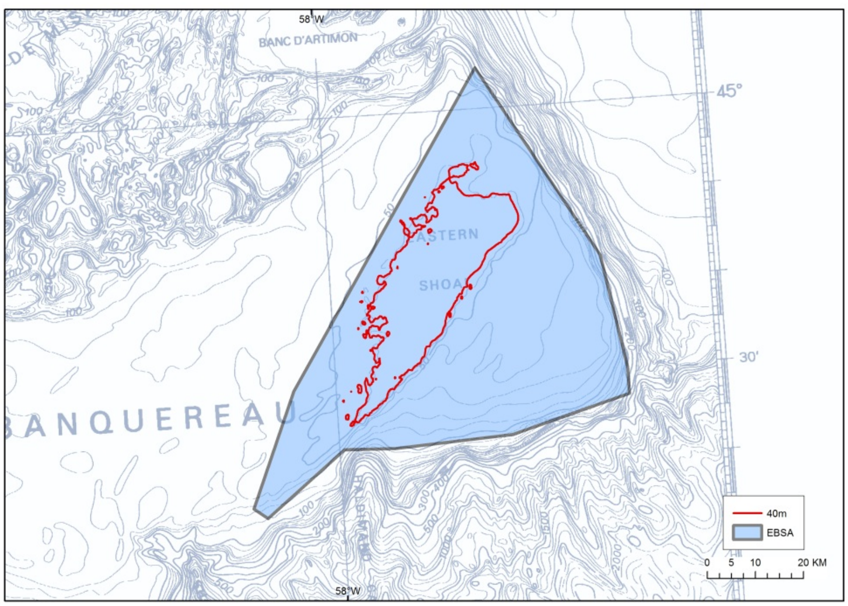

Figure 41. Eastern Shoal EBSA (3397 km^2).

The key features of this EBSA are presented in Table 29. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 30. Maps of a subset of the key features for this EBSA are displayed in Figure 42.

Table 29. Key features for the Eastern Shoal EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
The large, shallow sand body that makes up Eastern Shoal is a unique geological feature that supports aggregations of surf clams, scallops, and quahogs (Fader unpublished report, Doherty and Horsman 2007).	x	x			
Important habitat for Atlantic cod (summer/fall/spring) (COSEWIC-E) (Horsman and Shackell 2009, RV data). Possible cod nursery area (Sinclair 1992).		x	x		
Important habitat for winter skate (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x		x	
Important habitat for American plaice (summer/fall/spring) (COSEWIC-T) (Horsman and Shackell 2009, RV data).		x			
Important habitat for thorny skate (summer/fall/spring) (COSEWIC-SC) (Horsman and Shackell 2009, RV data).		x		x	
High larval fish genus richness (Shackell and Frank 2000, SSIP).	x	x			
Area of high fish species evenness (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species evenness and ESW[1] (Ward-Paige and Bundy 2016).	x	x			
Abundant yellowtail flounder, silver hake, witch flounder, and redfish larvae (SSIP). Possible spawning and/or nursery area for these species.		x	x		
Important habitat for sandlance (RV stomachs) (Cook and Bundy 2012).		x			
Important seabird habitat (several functional guilds) (CWS data).		x			

Notes: [1]Exponential of Shannon-Wiener Index.

Table 30. The Eastern Shoal CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Eastern Shoal	x	x	x	x		x	

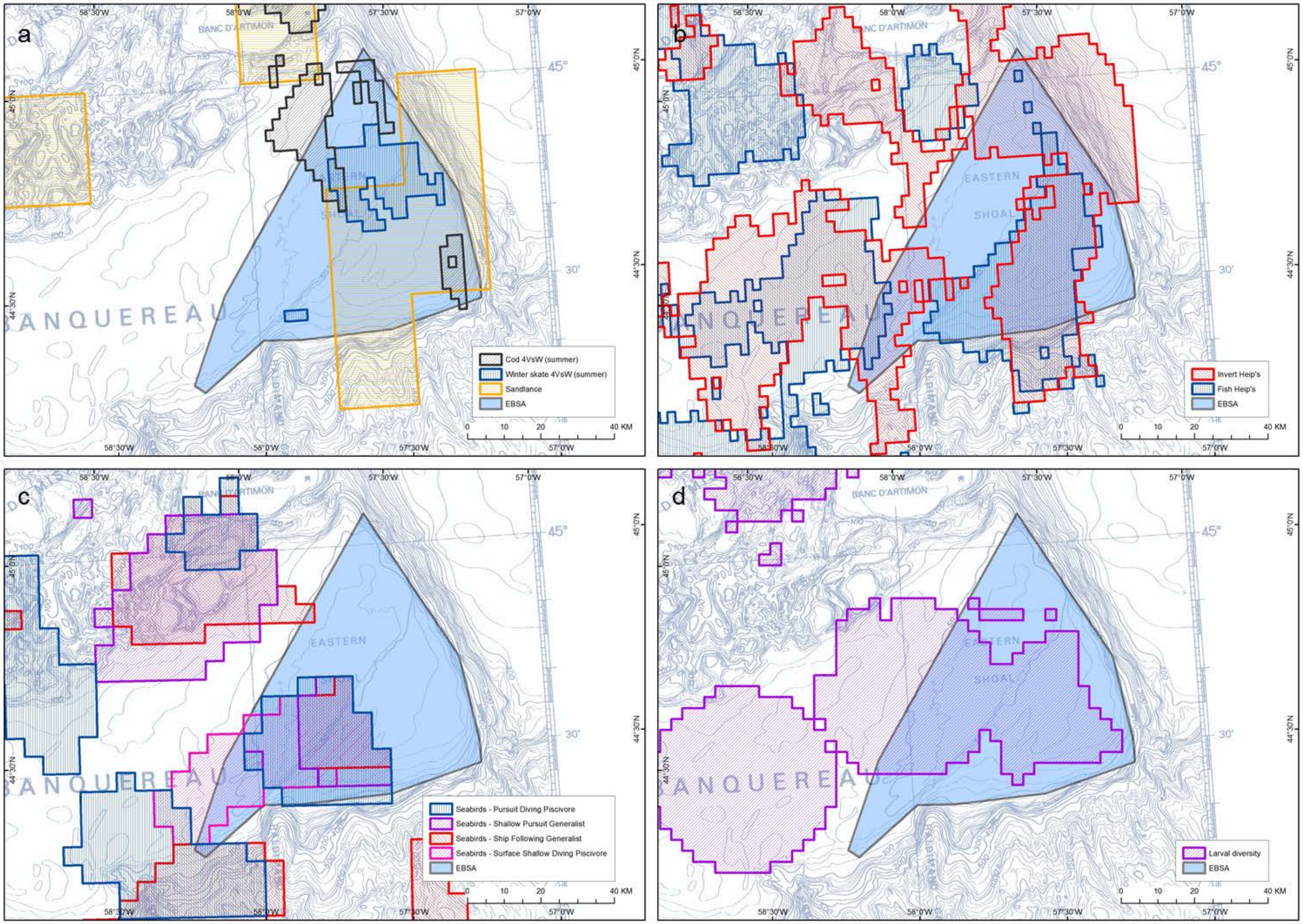

Figure 42. The distribution of a) Atlantic cod, winter skate, and sandlance, b) areas of high invertebrate and fish species evenness (Heip's), c) seabird functional guilds, and d) areas of high larval fish species diversity within the Eastern Shoal EBSA.

Additional Information

This EBSA also encompasses an area of high fish biomass, high invertebrate species richness, very low scope for growth, and an area of high natural disturbance.

2.14 STONE FENCE

This EBSA is generally delineated based on the known *Lophelia pertusa* coral records in the Stone Fence in the southwestern Laurentian Channel area. The rare small Lopehlia reef and the Lophelia Coral Conservation Area put in place to protect this feature are contained within this larger EBSA boundary (Figure 43).

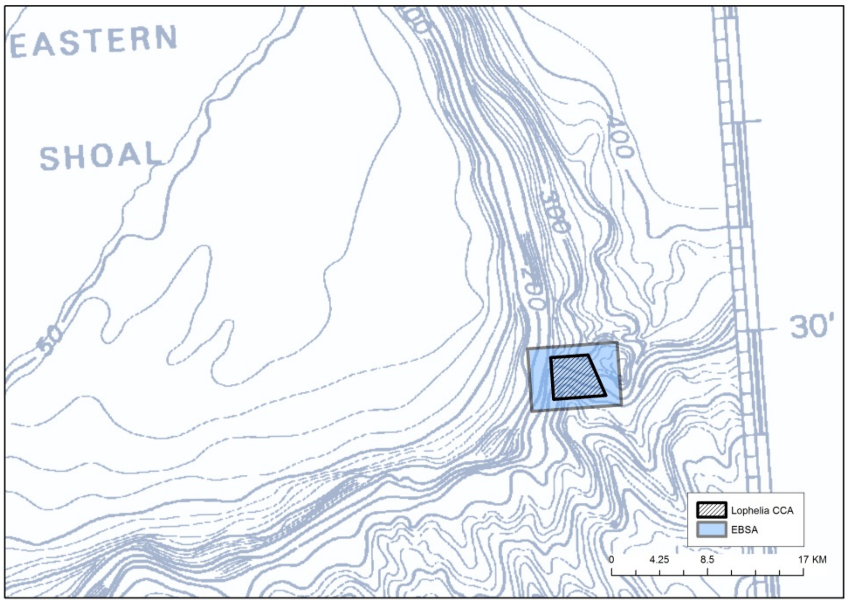

Figure 43. Stone Fence EBSA (44 km^2).

The key features of this EBSA are presented in Table 31. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 32. Maps of a subset of the key features for this EBSA are displayed in Figure 44.

Table 31. Key features for the Stone Fence EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Benthic surveys in the fall of 2003 discovered the *Lophelia pertusa* reef and revealed that it had been severely damaged by fishing gear. The Lophelia Coral Conservation Area (LCCA) was established in the spring of 2004 (15 km^2) to protect this feature from the potential impacts of bottom fishing (DFO 2006). This feature is the only known *Lophelia pertusa* reef structure in Atlantic Canada (Cogswell et al. 2009). Cogswell et al. (2009) describes other coral species found within the general Stone Fence/Laurentian Channel area based on photo and video surveys and other sources. The taxa in this area include *Keratoisis ornata*, *Anthomastus* spp., *Drifa glomerata*, *Anthoptilum* spp., *Flabellum alabastrum* and *Anthipatharia* spp. In an area south of the LCCA (approximately 10 kilometers) the rare species of *Paragorgia johnsoni* and *Telepathes magna* were discovered.	x	x		x	

Table 32. *The Stone Fence CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.*

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Stone Fence	x		x	x			

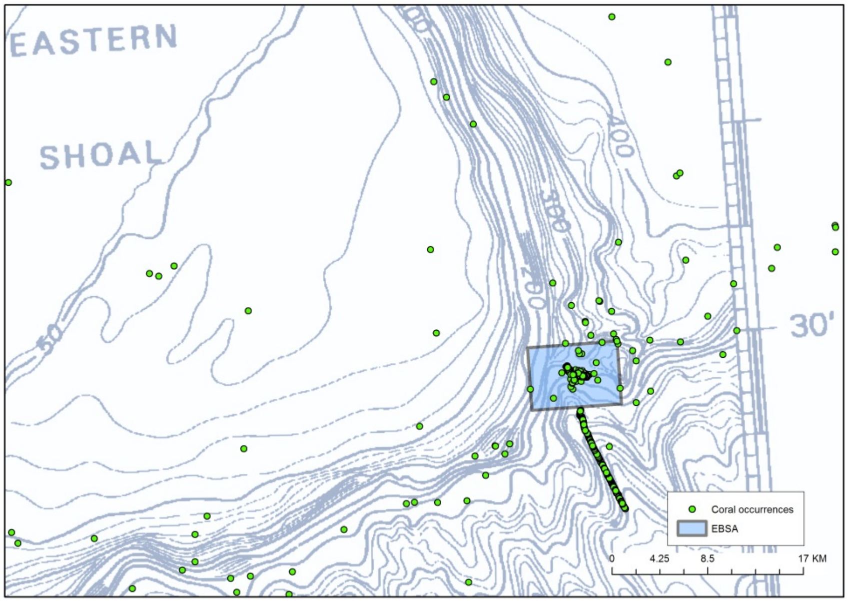

Figure 44. The distribution of coral occurrences within and adjacent to the Stone Fence EBSA (Cogswell et al. 2009).

Additional Information

The spatial extent coral species in this general area extend well beyond the proposed EBSA boundary (Figure 44). Breeze et al. (1997) and Gass and Willison (2005) describe the general Stone Fence area to be a hotspot for coldwater corals based on a variety of information sources, including past fishing gear interactions. The area described in these studies is larger than the proposed EBSA boundary. Although portions of this area have been explored, additional surveys could refine and potentially expand the EBSA.

The Stone Fence and mouth of the Laurentian Channel is a major redfish fishing area. The Stone Fence is also an important halibut fishing area on the eastern Scotian Shelf. Coldwater corals have a number of associated fauna, and many fish and invertebrate species are frequently observed in this area (Mortensen et al. 2006).

2.15 LAURENTIAN CHANNEL

The western boundary of this EBSA was delineated using the 200 m isobath and the eastern extent is the administrative boundary between the Maritimes and Newfoundland regions, which generally follows the middle of the channel. The Laurentian Channel and Slope was also identified as an EBSA by DFO Newfoundland and Labrador Region (Templeman 2007) and DFO Gulf Region (Swain and Benoît 2007) (Figure 45).

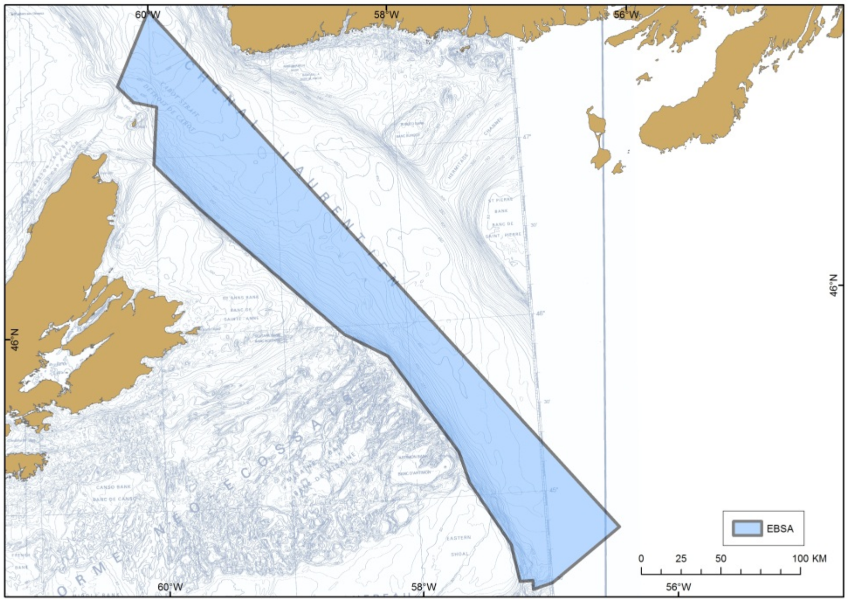

Figure 45. The Laurentian Channel EBSA (21484 km^2).

The key features of this EBSA are presented in Table 33. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 34. Maps of a subset of the key features for this EBSA are displayed in Figure 46.

Table 33. Key features for the Laurentian Channel EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
The western edge of the Laurentian Channel is an important overwintering area for multiple populations of Atlantic cod (Campana et al. 1999, Ford and Serdynska 2013, Swain et al. 2001, Swain and Benoît 2007, Doherty and Horsman 2007).		x	x		
Overwintering area for, white hake (COSEWIC-T), Dover sole, turbot (Greenland halibut), redfish (COSEWIC-E), Greenland shark, plaice, witch flounder, and thorny skate (COSEWIC-SC) (Swain and Benoît 2007, Doherty and Horsman 2007). Important migration route via Cabot Strait to Gulf (Doherty and Horsman 2007).		x	x		
Important aggregation area for krill and zooplankton (Sourisseau et al. 2006, Head and Pepin 2008, Doherty and Horsman 2007). Laurentian Channel is a major source of *Calanus* spp. for the Scotian Shelf (Sameoto and Herman 1992).		x	x		
High fish species richness (Ward-Paige and Bundy 2016).	x	x			
High invertebrate species evenness (Ward-Paige and Bundy 2016).	x	x			
Migration corridor for many fish and cetacean species (Doherty and Horsman 2007, Bowering 1984, Campana et al. 1999).		x	x		
Important mating area for porbeagle shark (COSEWIC-E) (Campana et al. 2003).		x	x		
Important migration route for cetaceans between the Scotian Shelf and the Gulf of St. Lawrence (Doherty and Horsman 2007).		x	x		
Important habitat for redfish (COSEWIC-E) (Horsman and Shackell 2009, Ford and Serdynska 2013, McClintock 2006).		x			
Significant concentrations of seapens (Kenchington et al. 2010). Corals and sponges also known to occur in this area (Cogswell et al. 2009).		x		x	
Important summer feeding habitat for leatherback turtles (James et al. 2005, James et al. 2006, DFO 2011a).		x	x	x	
Persistent high chlorophyll concentrations (100-1500 m) (MODIS[1] ocean colour data).		x	x		
High fish biomass (RV data).		x			

Notes: [1]Moderate Resolution Imaging Spectroradiometer.

Table 34. The Laurentian Channel CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Laurentian Channel Slope	x	x	x	x	x	x	

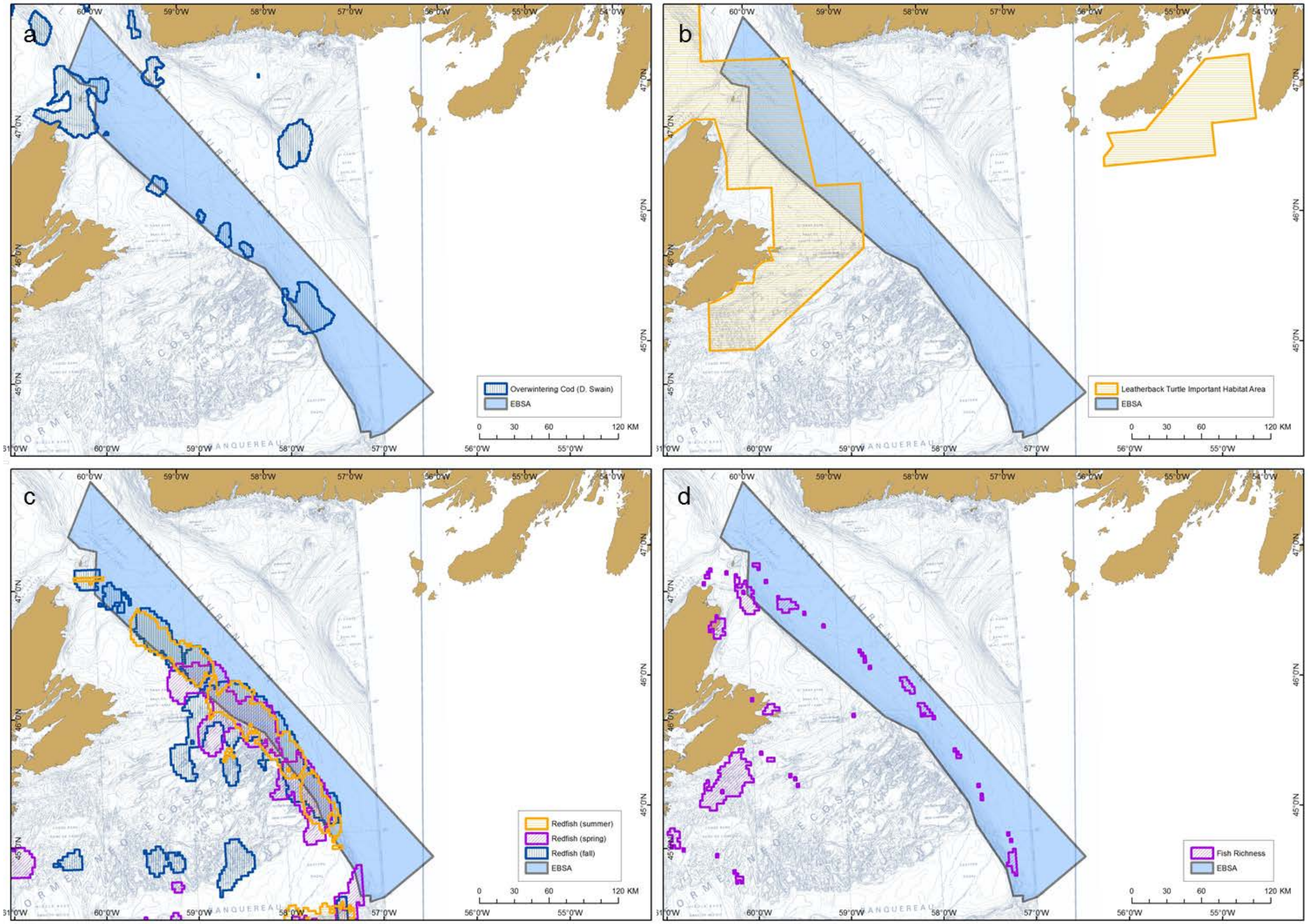

Figure 46. The distribution of a) Atlantic cod overwintering areas (D. Swain pers. comm. in Ford and Serdynska, 2013), b) important leatherback turtle habitat, c) important habitat for redfish (spring, summer, fall), and d) fish species richness within the Laurentian Channel EBSA.

Additional Information

The Laurentian Channel slope has been previously identified as an EBSA for demersal fishes (Swain and Benoît 2007). Much of the groundfish survey efforts have been primarily focused on the shallower portions of the Laurentian Channel slope (to approx. 400 m), and there is limited data available for the deeper portion of the channel.

High krill concentrations in this EBSA likely support baleen whale species. This area has been identified as an important migration area for cetaceans; however, reliable data are limited. Further cetacean surveys could reveal this area as an important summer feeding area for baleen whales.

2.16 ST. ANNS BANK

The southern boundary of this EBSA was delineated based on the 110 m isobath. The 200 m isobath, which represents the edge of the Laurentian Channel, was used as the eastern boundary while the western boundary was delineated based on the available data for habitat and species distributions on the bank. Unlike other banks in the bioregion, St. Anns Bank is directly adjacent to land (Figure 47).

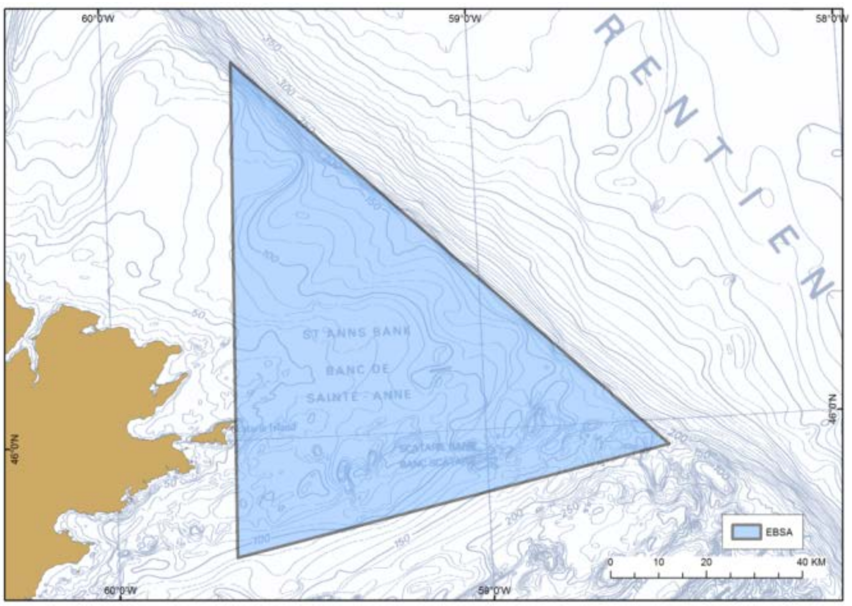

Figure 47. The St. Anns Bank EBSA (4661 km^2).

The key features of this EBSA are presented in Table 35. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 36. Maps of a subset of the key features for this EBSA are displayed in Figure 48.

Table 35. Key features for the St. Anns Bank EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Important habitat for three populations of Atlantic cod: Southern Gulf of St. Lawrence (4TVn) Atlantic cod overwinter in the area, Resident 4Vn cod and 4VsW stock occur in the St. Anns Bank area at all times of the year (Ford and Serdynska 2013, Horsman and Shackell 2009).		x	x		
Important habitat for Atlantic wolfish (summer) (Horsman and Shackell 2009, Ford and Serdynska 2013).		x	x		
Includes the Big Shoal herring spawning area (Power et al. 2010).		x	x		
Regionally significant seapen and sponge concentrations (Kenchington et al. 2010). Reports from fishermen describe large gorgonian coral in St. Anns Bank (Gass and Willison 2005).				x	
Important migration route for many fish and cetacean species (Ford and Serdynska 2013).		x	x		
Important summer feeding habitat for leatherback turtles (James et al. 2005, James et al. 2006, DFO 2011a)		x	x	x	
Area of high fish species evenness and ESW[1] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species evenness and ESW (Ward-Paige and Bundy 2016).	x	x			
Area of high species richness for small fish (Cook and Bundy 2012).	x	x			
Area of high larval fish species richness (Shackell and Frank 2000, Breeze et al. 2002)	x	x	x		
Area of high fish biomass (1978-85) (RV data).		x			
Persistent high chlorophyll concentrations (100-1500 m) (MODIS[2] ocean colour data).		x			
Several seabird species occur in high densities within and in the vicinity of the St. Anns Bank (Ford and Serdynska 2013, CWS data).		x			
Important habitat for seabirds (several functional guilds) (CWS data).		x	x		
May encompass porbeagle shark mating area (Ford and Serdynska 2013).		x	x		

Notes: [1]Exponential of Shannon-Wiener Index; [2]Moderate Resolution Imaging Spectroradiometer.

Table 36. The St. Anns Bank CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
St. Anns Bank	x	x	x	x	x	x	

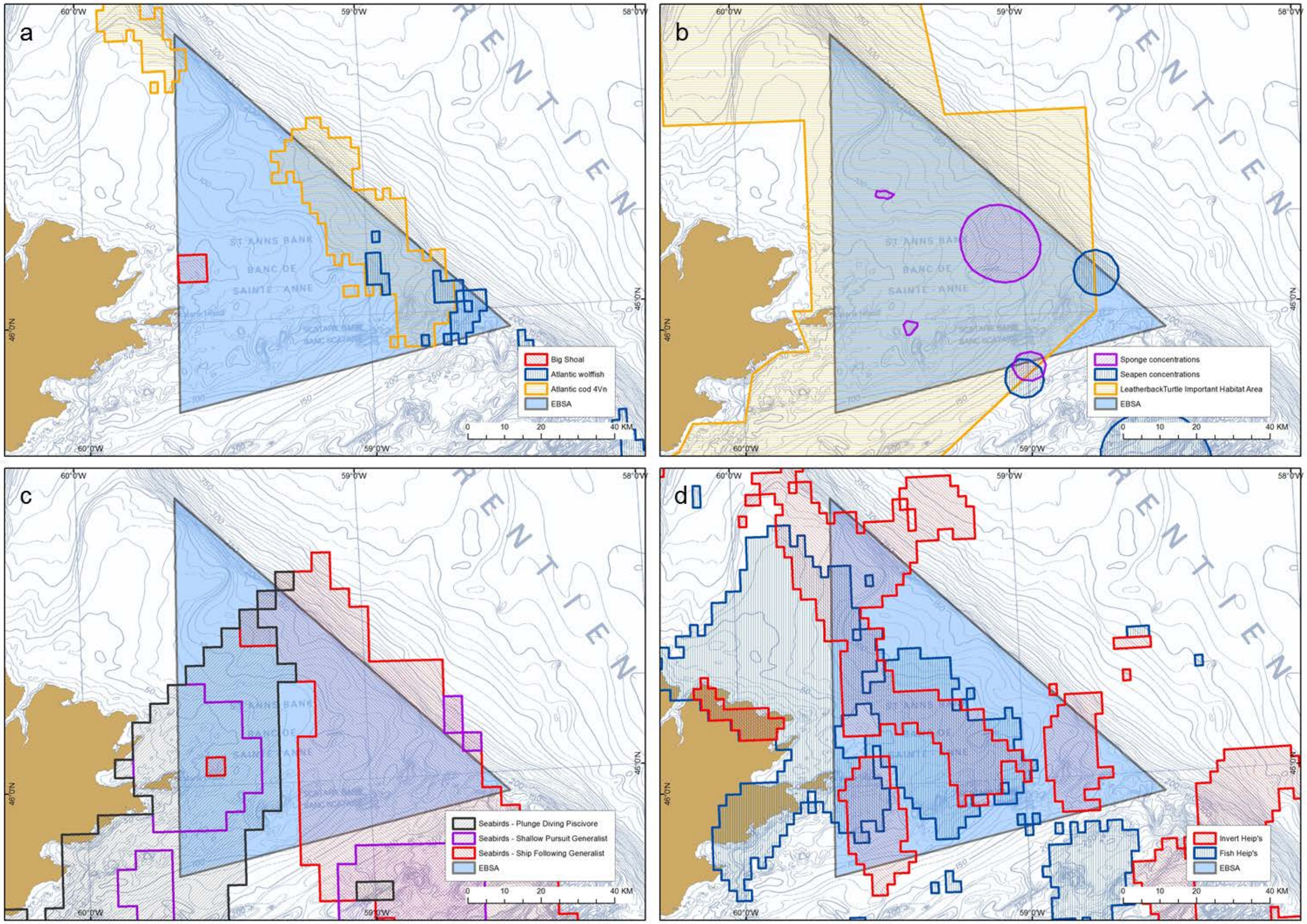

Figure 48. The location or distribution of a) the Big Shoal herring spawning area, important summer habitat for Atlantic wolffish and Atlantic cod, b) important habitat for leatherback turtle, sponges, and seapens, c) important habitat for several seabird guilds, and d) invertebrate and fish species evenness (Heip's) within the St. Anns Bank EBSA.

Additional Information

A significant portion of this EBSA is a proposed MPA under the *Oceans Act*. The proposed MPA also extends into the Laurentian Channel EBSA.

Although the area has been identified as an important migration area for cetacean species, reliable data are limited. Further cetacean surveys could reveal this area as an important summer feeding area for baleen whales.

2.17 LAURENTIAN FAN COLD SEEP COMMUNITIES

This EBSA is delineated based on the area of a survey carried out as part of the *Alvin* diving program (Mayer et al. 1988) (Figure 49).

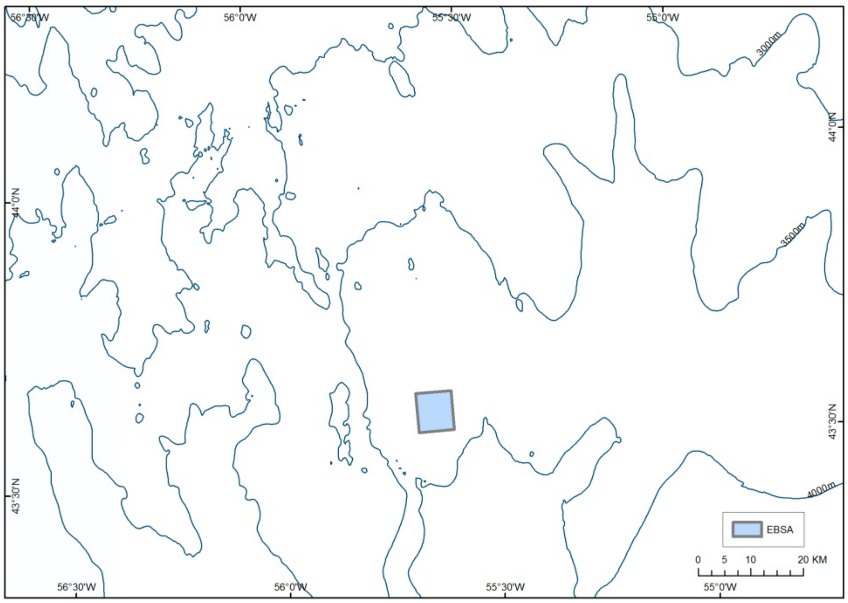

Figure 49. Laurentian Fan Cold Seep Communities EBSA (52 km^2).

The key features of this EBSA are presented in Table 37. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 38.

Table 37. Key features for the Laurentian Fan Cold Seep Communities EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
Dense chemosynthetic communities associated with cold seeps in very deep water (>3800 m) on the Laurentian Fan. Indications of highly productive and diverse benthic community as compared with other deep-water areas in the region (Mayer et al. 1988). New family of polychaete identified in the area.	x	x		x	x

Table 38. The Laurentian Fan Cold Seep Communities CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Laurentian Fan Cold Seep Communities	x				x	x	x

Additional Information

In 1987, scientists conducting geological surveys of the Eastern Valley of the Laurentian Fan found four large, dense chemosynthetic communities at depths between 3840 and 3890 metres (Mayer et al. 1988). The communities consisted of vesicomyid and thyasirid clams, gastropods, galatheid crabs, and other organisms. The fauna were significantly different and much more abundant than the fauna observed on other dives in the area. Because the researchers were not properly equipped to undertake a biological survey, few samples were taken. However, from the few samples, a new family of polychaete was identified.

The researchers noted that the composition of these communities resembled that of hydrothermal vent areas (at the time, there had been little research carried out on cold seep communities). All known vesicomyid bivalves have specialized tissue with carbon-fixing, sulfide-oxidizing endosymbiotic bacteria and are found in sulfide-rich areas (Goffredi and Barry 2002). These bacteria provide organic materials to their hosts. As well as the evidence provided by the presence of the vesicomyid bivalves, the huge, localized biomass suggested to the researchers that these communities were being sustained by chemosynthetic processes. The researchers noted that these communities were found near the crests of gravel waves. By disturbing the sediments, the 1929 Grand Banks earthquake may have created appropriate conditions for this community (Mayer et al. 1988). No other potential cold seep communities in Atlantic Canada are known.

There has been no further research on the benthic communities in this area and no similar communities have been discovered in the Laurentian Fan area or other areas with the Scotian Shelf Bioregion. However, cold seep communities have been discovered near submarine canyons off the U.S. mid-Atlantic states (Brooke and Ross 2012).

2.18 SCOTIAN SLOPE

This large EBSA includes the entire Scotian Slope, which is roughly defined as the area between 200 m and 3000 m along the edge of the shelf. Other EBSAs overlap with or are embedded within this large EBSA (e.g., Northeast Channel, Eastern Scotian Shelf Canyons). Additional smaller EBSAs (e.g., Corsair Canyon) could be delineated and described within this EBSA in the future (Figure 50).

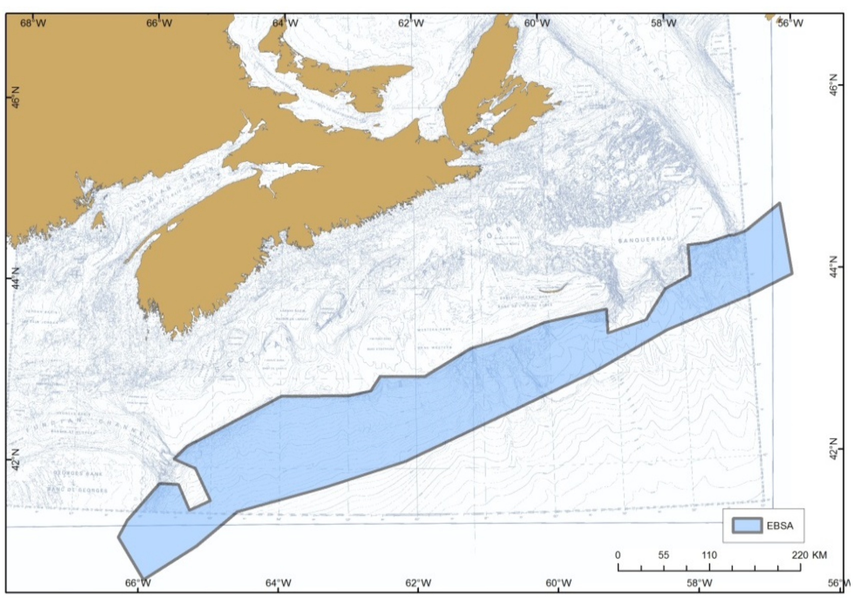

Figure 50. Scotian Slope EBSA (72800 km^2).

The key features of this EBSA are presented in Table 39. Alignment between each feature and the DFO EBSA criteria is also indicated. The overall alignment of this EBSA with the CBD EBSA criteria is presented in Table 40. Maps of a subset of the key features for this EBSA are displayed in Figure 51.

Table 39. Key features for the Scotian Slope EBSA. Abbreviations for DFO EBSA criteria are: U = Uniqueness, A = Aggregation, FC = Fitness Consequences, R = Resilience, N = Naturalness. Cells with an 'x' indicate that the features or characteristics meet DFO EBSA criteria. Blank cells indicate that these criteria are not met.

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
The steep topography along the shelf break causes enhanced vertical mixing, which results in high primary productivity (Breeze et al. 2002). Oceanic fronts also regularly occur along the Scotian Slope as cold shelf waters meet the warmer slope waters. The location of these frontal areas varies throughout the year (Horne 1978, Fournier 1978). Chlorophyll a concentrations are consistently high along the slope (>1500 m depth) relative to deeper waters (MODIS[1] ocean colour data).		x	x		
Migratory route for cetaceans and large pelagic fishes (e.g., sharks, swordfish, tuna) (Doherty and Horsman 2007).		x	x		
Appears to be an important area and part of a migratory route for the leatherback turtle (SARA-E). The slope off Georges Bank and the southwest Scotian Slope appear to be the most important areas of the slope for this species. Important prey for leatherback turtles (e.g., jellyfish and salps) concentrate along the slope (Doherty and Horsman 2007).		x	x		
Habitat for Sowerby's beaked whale (SARA-SC) (COSEWIC 2006).		x			
Important habitat for seabirds (most functional guilds) (CWS data).		x	x		
High diversity of finfish (including demersal, mesopelagic, and large pelagic fishes) and squid due to habitat heterogeneity provided by broad range of depths (Doherty and Horsman 2007, Halliday et al. 2012).	x	x			
Area of high fish species evenness and ESW[2] (Ward-Paige and Bundy 2016).	x	x			
Area of high invertebrate species richness and evenness (Ward-Paige and Bundy 2016)	x	x			
Area of high species richness for small fishes and small invertebrates (Cook and Bundy 2012).	x	x			
Overwintering area for a number of shelf fishes (e.g., halibut, mackerel) and invertebrates (e.g., lobster along SW slope) (Breeze et al. 2002, Doherty and Horsman 2007).		x	x		
Important habitat for many demersal fish species (summer/fall/spring), including cusk (COSEWIC-E) (DFO 2014b), redfish (COSEWIC-T), white hake (COSEWIC-T), thorny skate (COSEWIC-SC), Atlantic halibut, longfin hake and Atlantic argentine (Horsman and Shackell 2009, RV data).		x			
Important habitat for many invertebrates, including red crab, northern shortfin squid, northern stone crab, American lobster and sea stars (RV data).		x			
Multiple submarine canyons exist on the edge of the shelf along the Scotian Slope. Submarine canyons can encompass many different habitats in a relatively small area and, as a result, often support high species richness (Hecker 1990, Hargrave et al. 2004). Kenchington (2014) identifies canyons as distinctive physical features of the slope that provide varied physical habitats and generally support high species diversity. They are also often vulnerable ecosystems (FAO 2009). The Gully is the largest and best-studied canyon in the bioregion and is known to support high biodiversity, including coldwater corals (Cogswell et al. 2009). Less is known about the other canyons in the bioregion. It is anticipated that canyons in the western portion of the bioregion (e.g., Corsair Canyon on the edge of Georges Bank) would contain different species than the canyons on the eastern Scotian Shelf (which are roughly 200 km away).		x		x	
A variety of coldwater coral species is known to occur along the slope, with highest concentrations of certain species in submarine canyons (Cogswell et al. 2009). Certain coral species (e.g., octocorals) can form dense concentrations called *forests*		x		x	

Feature or characteristic of the area	DFO Criteria				
	U	A	FC	R	N
and seapens can form large *fields*. Both features can add to the structural complexity of the seafloor and serve as habitat for fishes and other invertebrates (Mortensen et al. 2006). Many rare species within Canadian waters have been identified in the slope areas off the Scotian Shelf (Cogswell et al. 2009).					

Notes: [1]Moderate Resolution Imaging Spectroradiometer; [2]Exponential of Shannon-Wiener Index.

Table 40. The Scotian Slope CBD EBSA criteria. Cells with an 'x' indicate that the EBSA meets the CBD criteria. Blank cells indicate that these criteria are not met.

EBSA	CBD Criteria						
	U	LH	ET	VS	P	D	N
Scotian Slope		x	x	x	x	x	

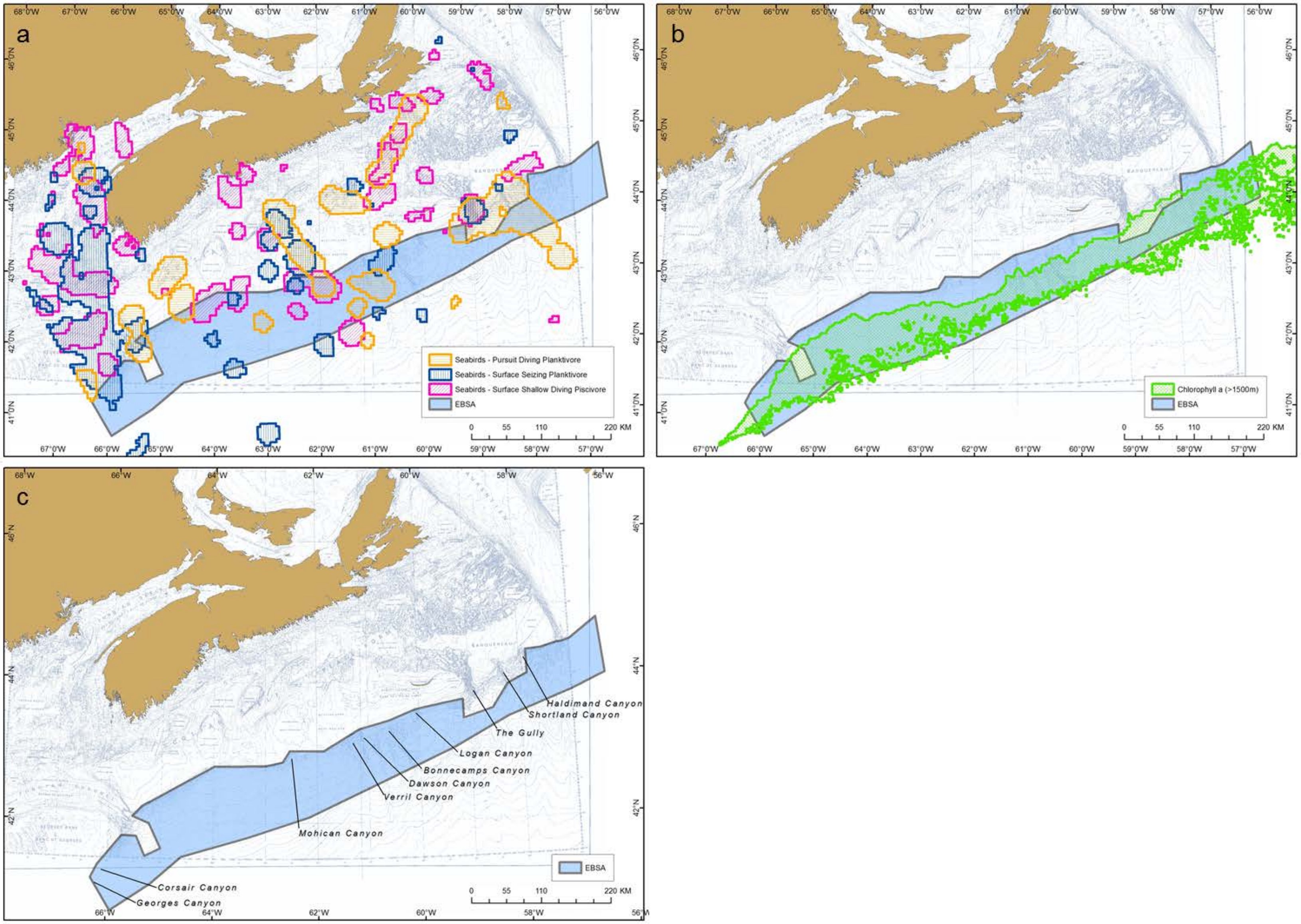

Figure 51. The distribution of a) seabird functional guilds, b) concentrations of chlorophyll a, and c) canyons within the Scotian Slope EBSA.

Additional Information

This large EBSA spans the length of the bioregion. Some of the features in this EBSA occur at this broad scale, such as the high primary productivity that occurs along the entire slope or the migration corridor used by many species. This broad EBSA also contains many smaller scale features that would qualify as EBSAs in and of themselves. A potential next step for this EBSA is to identify, delineate, and describe smaller-scale EBSA features (e.g., canyons, coral concentrations) within this broad-scale EBSA based on available data from smaller-scale surveys.

Research carried out in the late 1970s found that the fauna of the wall of Corsair Canyon was heavily dominated by corals (Hecker and Blechschmidt 1980). This canyon could be better delineated and described as a distinct EBSA.

SECTION 3: SUMMARY AND NEXT STEPS

Over the last decade there have been multiple efforts to identify, describe and delineate EBSAs in the Scotian Shelf Bioregion using a variety of methods (e.g., Breeze 2004, Doherty and Horsman 2007, MacLean et al. 2009). The current exercise aimed to build on this past work and provide a more complete description of, and rationale for, a subset of the original SEO EBSAs that clearly meet the DFO EBSA criteria. A summary of the proposed EBSAs for the offshore component of the Scotian Shelf Bioregion and the EBSA criteria they meet is provided in Table 41.

Table 41. Summary of key features contained within each of the proposed EBSAs in the offshore component of the Scotian Shelf Bioregion. Cells with an 'x' indicate that the key features meet DFO EBSA criteria. Blank cells indicate that these criteria are not met. ESW = Exponential of Shannon-Wiener Index.

EBSA	Key features	DFO Criteria					Other EBSA Reference
		U	A	FC	R	N	
1. Jordan Basin and Rock Garden (1824 km^2)	High primary productivity, unique and sensitive benthic community (Rock Garden), important for groundfish (cusk, white hake, redfish, spiny dogfish), high fish biomass, high fish species diversity (richness, ESW), high invertebrate species diversity (richness, evenness), high larval fish genus richness, high small invertebrate species richness, important seabird habitat (most functional guilds)	x	x	x	x		Doherty and Horsman (2007); Horsman et al. (2011)
2. Canadian portion of Georges Bank (7014 km^2)	High primary productivity, important for groundfish (Atlantic cod and haddock spawning and nursery area, cusk), Atlantic Herring spawning area, high sea scallop abundance, high larval fish genus richness, unique benthic community (tube worm), porbeagle shark mating ground, important seabird habitat (all functional guilds)	x	x	x		x	Doherty and Horsman (2007); Breeze (2004); Horsman et al. (2011); MacLean et al. (2009)
3. Northeast Channel (2589 km^2)	Highest known densities of large and sensitive gorgonian corals in the region, high primary productivity, important seabird habitat (most functional guilds), cusk habitat	x	x	x	x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. 2011; MacLean et al. (2009)
4. Browns Bank (4308 km^2)	Moraine feature along northern flank may serve as a natural refuge, important for groundfish (Atlantic cod and haddock spawning and nursery area, Atlantic halibut nursery area, cusk, american plaice, atlantic wolffish, winter skate, yellowtail flounder), important for commercial invertebrates (abundant large American lobster, sea scallop), high larval fish genus richness (partial gyre promotes retention), high fish and invertebrate biomass, high invertebrate species diversity (richness, ESW, evenness), high small invertebrate species richness, important seabird habitat (most functional guilds)	x	x	x	x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. (2011); MacLean et al. (2009)
5. Roseway Basin (3158 km^2)	Endangered North Atlantic right whale Critical Habitat, high copepod biomass,	x	x	x	x		Doherty and Horsman (2007);

EBSA	Key features	DFO Criteria					Other EBSA Reference
		U	A	FC	R	N	
	important for groundfish (redfish nursery, smooth skate, American plaice, Atlantic cod, cusk), high fish biomass, high fish species diversity (richness), important seabird habitat (several functional guilds), moraine feature, pockmarks (possible chemosynthetic communities)						Breeze (2004); Horsman et al. (2011)
6. Emerald Basin and the Scotian Gulf (8513 km^2)	Unique benthic community [Russian Hat sponges (*Vazella pouralesi*)], unique temperature and salinity regime, high zooplankton biomass in basin, important for groundfish (silver hake, pollock, white hake), high fish and invertebrate biomass, high fish species diversity (ESW, evenness), high invertebrate species diversity (richness), high small fish and small invertebrate species richness, important for northern sandlance and shortfin squid, pockmarks in basin (possible chemosynthetic communities), important seabird habitat (most functional guilds), very low natural disturbance	x	x	x	x		Doherty and Horsman (2007); Breeze 2004; MacLean et al. (2009)
7. Emerald-Western-Sable Island Bank Complex (17900 km^2)	Important for groundfish (haddock spawning and nursery area, Atlantic cod spawning area, winter skate, silver hake, Atlantic halibut), Atlantic herring spawning, high larval fish abundance and diversity (gyre leads to retention), commercial and non-commercial invertebrates, high fish and invertebrate biomass, high fish species diversity (ESW, evenness), high invertebrate species diversity (richness, ESW, evenness), important seabird habitat (most functional guilds), Western Gully area of potential significance to cetaceans		x	x	x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. 2011; MacLean et al. (2009)
8. Sable Island Shoals (1297 km^2)	Unique coastal habitat in the offshore, world's largest grey seal breeding colony, nursery area for many fishes, area of high primary productivity, important seabird habitat (plunge diving piscivores, shallow diving piscivores, shallow pursuit generalists), high invertebrate biomass, high invertebrate species diversity (ESW, evenness), high fish species diversity (ESW, evenness)	x	x	x			Doherty and Horsman (2007); Breeze (2004); MacLean et al. (2009)
9. Eastern Scotian Shelf Canyons (7434 km^2)	Unique submarine canyon ecosystems (The Gully is largest off eastern North America), canyons are Critical Habitat for Endangered northern bottlenose whale, important for other cetaceans (blue whale, Sowerby's beaked whale), diverse and sensitive benthic communities (diverse and abundant coldwater corals), high fish and invertebrate species diversity (richness, ESW, evenness), high fish and invertebrate biomass, important for groundfish (Atlantic cod, Atlantic halibut, redfish, smooth skate, white hake), important seabird habitat (most	x	x	x	x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. (2011); MacLean et al. (2009)

EBSA	Key features	DFO Criteria					Other EBSA Reference
		U	A	FC	R	N	
	functional guilds)						
10. Middle Bank (2748 km^2)	Important for groundfish (Atlantic cod spawning and nursery area), high larval fish genus richness, high invertebrate species diversity (ESW, evenness), high small fish species richness, high invertebrate biomass, important seabird habitat (most functional guilds)		x	x			Doherty and Horsman (2007); Breeze (2004); Horsman et al. (2011)
11. Canso Bank and Canso Basin (4113 km^2)	High fish species diversity (ESW, evenness), high invertebrate species diversity (ESW), high larval fish genus richness, high invertebrate biomass, high small fish species richness, commercial (northern Shrimp, snow crab)and non-commercial invertebrates, high primary productivity, important for groundfish (American plaice), northern sandlance, relatively high naturalness (bank portion), important seabird habitat (several functional guilds)		x	x		x	Doherty and Horsman (2007); Horsman et al. (2011); MacLean et al. (2009)
12. Misaine Bank (4599 km^2)	High fish species diversity (evenness), high invertebrate species diversity (ESW, evenness), high invertebrate biomass, important for commercial invertebrates (northern shrimp, snow crab), important for groundfish (Atlantic cod, american plaice, thorny skate), northern sandlance, relatively high naturalness (bank portion), important seabird habitat (particularly pursuit diving piscivores)		x	x	x	x	Horsman et al. (2011); MacLean et al. (2009)
13. Eastern Shoal (3397 km^2)	Large, shallow sand body is unique, important for groundfish (Atlantic cod, American plaice, winter skate, thorny skate), northern sandlance, unique shallow sand body, commercial invertebrates (surf clams, scallops, quahogs), high fish species diversity (evenness), high invertebrate species diversity (ESW, evenness), important seabird habitat (several functional guilds)	x	x	x	x		Doherty and Horsman (2007); Horsman et al. (2011); MacLean et al. (2009)
14. Stone Fence (44 km^2)	Unique and sensitive benthic community (*Lophelia pertusa* reef)	x	x		x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. 2011; MacLean et al. (2009)
15. Laurentian Channel (21484 km^2)	High primary productivity, high zooplankton biomass, important for groundfish (overwintering area for Atlantic cod and other species, redfish, white hake), abundant redfish larvae, high fish biomass, northern sandlance, migratory route (groundfish, cetaceans, leatherback sea turtle), sensitive benthic communities (sea pen fields), high invertebrate species diversity (evenness), high small fish and small invertebrate species richness.		x	x	x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. (2011); MacLean et al. (2009)
16. St. Anns	High primary productivity, high larval fish	x	x	x	x		Doherty and

EBSA	Key features	DFO Criteria					Other EBSA Reference
		U	A	FC	R	N	
Bank (4661 km^2)	genus richness, important for groundfish (used by 3 populations of Atlantic cod, Atlantic wolffish), high fish and invertebrate species diversity (ESW, evenness), high small fish species richness, located on a migratory route (groundfish, cetaceans, leatherback sea turtle), sensitive benthic communities (sea pen fields), important for seabirds (particularly plunge diving piscivores)						Horsman (2007); Horsman et al. (2011); MacLean et al. (2009)
17. Laurentian Fan Cold Seep Communities (52 km^2)	Unique, diverse and highly productive chemosynthetic cold seep community	x	x				Doherty and Horsman (2007); Breeze (2004)
18. Scotian Slope (72800 km^2)	High primary productivity, high fish species diversity (ESW, evenness), high small fish and small invertebrate species richness, important for groundfish (cusk, redfish, white hake, thorny skate, Atlantic halibut), migratory route (cetaceans, large pelagic fishes), important for seabirds (most functional guilds), unique habitats and sensitive benthic communities		x	x	x		Doherty and Horsman (2007); Breeze (2004); Horsman et al. (2011); MacLean et al. (2009)

As previously indicated, the final updated list of EBSAs will undergo further evaluation by DFO to identify any potential management needs. EBSA-specific evaluations will include a description of human activities, an analysis of the potential risk those activities pose to the significant ecological features, and management advice for each area. The list of EBSAs presented in this report will be considered in a broad range of coastal and oceans management and planning processes in the Scotian Shelf Bioregion, including in the development of a network of MPAs (DFO 2012a).

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