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Canadian Science Advisory Secretariat
Maritimes Region **Science Response 2018/005**

DELINEATING IMPORTANT ECOLOGICAL FEATURES OF THE EVANGELINE – CAPE BLOMIDON – MINAS BASIN ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREA (EBSA)

Context

In 2012, a number of Ecologically and Biologically Significant Areas (EBSAs) were identified in the Bay of Fundy through a Fisheries and Oceans Canada (DFO) Maritimes Region Science Advisory Process, including the Evangeline - Cape Blomidon - Minas Basin area (DFO 2012, Buzeta 2014). The area captures features with characteristics that fit with DFO's criteria for EBSAs (Buzeta 2014).

The Evangeline - Cape Blomidon - Minas Basin EBSA (hereafter referred to as the Minas Basin EBSA) was recognized as important in several reports documenting unique and significant habitat features in the Bay of Fundy region (Buzeta et al. 2003, Buzeta 2014). The Minas Basin EBSA encompasses a very large area, containing the Minas Channel, Minas Passage, Minas Basin and Cobequid Bay marine regions of Nova Scotia, hosting a variety of habitats important for diverse coastal and marine fauna. Buzeta (2014) described the spatial and temporal aspects of many of these features in general terms. Subsequently, further research has generated additional information pertaining to some of the features. While identification as an EBSA is not a legal designation, information on ecological features within the area can be used in sustainable management of marine resources and activities. To ensure the most up-to-date information on the important documented features of the Minas Basin EBSA are available for management decisions, DFO Oceans and Coastal Management Division, Maritimes Region, requested DFO Science advice on the important ecological features of the Minas Basin EBSA and their extent. As not all the features occur year-round, it was also important to document the seasonality of the features[1].

A consultant was hired to review recent literature, consult government data holdings (DFO, Canadian Wildlife Service and Nova Scotia Department of Natural Resources) and, where possible, prepare maps that identified and delineated significant EBSA features. A Science Response process was used to review this report and provide a summary of available information on the defined ecological features of the EBSA.

This Science Response Report resulted from the Science Response Process March 1, 2017, on the Science Response to the Delineation of Important Ecological Features in the Evangeline-Cape Blomidon-Minas Basin Ecologically and Biologically Significant Area (EBSA).

Additional publications from this meeting will be posted on the DFO Science Advisory Schedule as they become available.

[1] It should be noted that the ability to delineate features of the EBSA is a function of the best available information, and this delineation can be expected to change as new information is generated. There are knowledge gaps about the spatial and/or temporal delineation of some of the features.

Background

Coastal and Ocean Management

Canada has committed to establishing a national network of Marine Protected Areas (MPAs) in support of integrated coastal and ocean management. Fisheries and Oceans Canada, Maritimes Region, is leading the development of an MPA network plan for the Scotian Shelf Bioregion. A series of science review processes (DFO 2010, DFO 2012, DFO 2018) have provided advice on developing the network. As part of that work, EBSAs were delineated in the three planning areas of the bioregion – the Bay of Fundy, Atlantic Coast of Nova Scotia and Offshore planning area (Buzeta 2014, Doherty and Horsman 2007, Hastings et al. 2014) – and classification systems were identified for the purpose of selecting representative habitats (DFO 2012).

The evaluation of sites as potential EBSAs is a relative process. Identified features correspond to EBSA criteria that are used to identify areas as especially "ecologically and biologically significant" compared to other similar areas in the region. The first order criteria developed for the identification of EBSAs are (DFO 2004):

- Uniqueness (degree to which the characteristics of the area are unique, rare, distinct, and have few or no alternatives);
- Aggregation (of individuals of a species, of different species, of structural features, of oceanographic processes); and
- Fitness Consequences (degree to which the area is required by a population or species for various life stages and activities).

The following second order criteria may subsequently be applied to help prioritize areas for management:

- Resilience (degree to which habitat structures or species are sensitive, easily disturbed, or slow to recover); and
- Naturalness (degree to which areas are pristine and contain native species).

For more detail on EBSA identification refer to DFO (2004).

It is recommended that EBSAs be managed in a more risk-averse manner to aid in the maintenance of overall ecosystem health and function (DFO 2004). In some cases, appropriate management may include the establishment of a marine protected area; in other cases, appropriate management may include ensuring that the appropriate mitigation is established or best management practices followed to ensure that the key features of the EBSA continue to be maintained.

The MPA network design strategies developed for the coastal planning area includes ensuring that at least one representative example of each eco-unit is included in the MPA network. The Minas Basin EBSA (Figure 1) covers a large portion of the Inner Bay of Fundy eco-unit (see Greenlaw et al. in prep)[2]. As representation is a strategic objective of the Scotian Shelf MPA network and EBSAs will be used to inform the MPA network design in the coastal planning area, better delineation of the features within the Minas Basin EBSA will assist in MPA network site selection. It will also be used for the planning and management of human activities in the EBSA.

[2] Greenlaw, M., Smith, K., Rubidge, E., and Martin, R. In prep. A subtidal marine ecological classification system to represent species diversity and distribution patterns in the Maritimes Region.

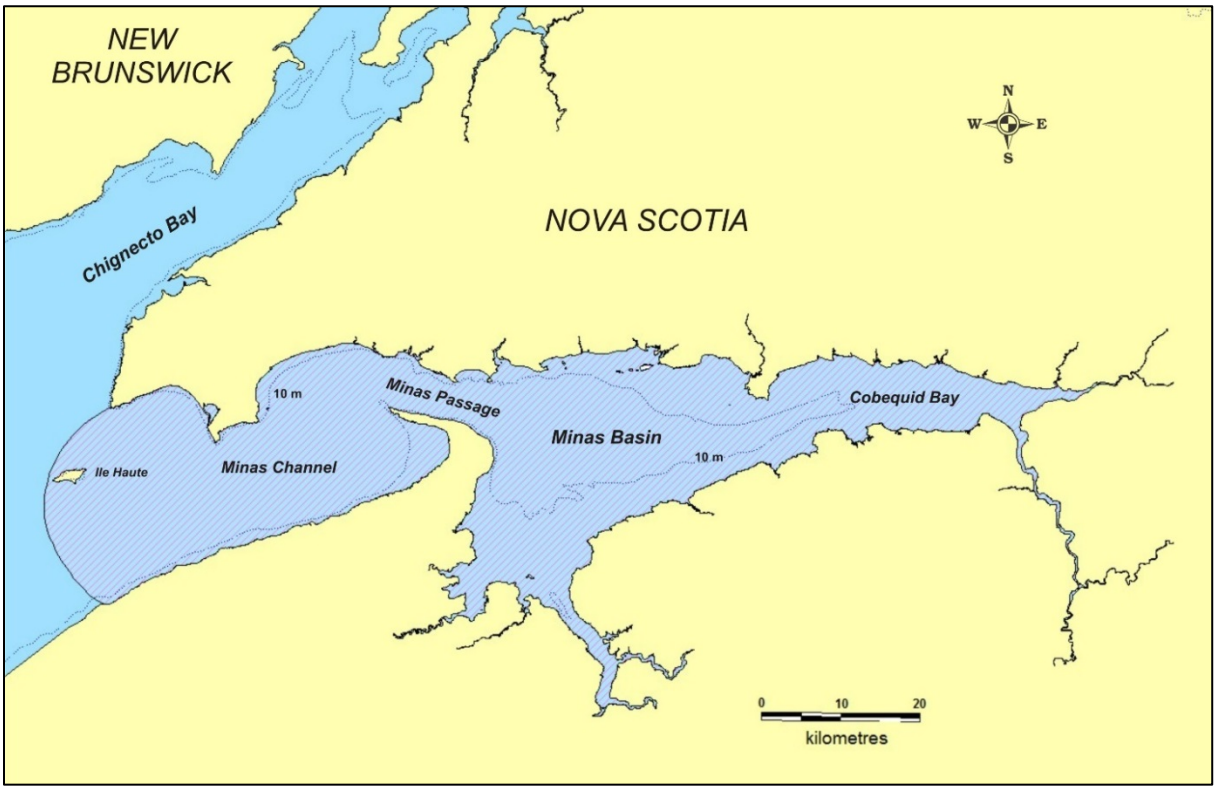

Figure 1. The Evangeline – Cape Blomidon – Minas Basin Ecologically and Biologically Significant Area (EBSA).

Description of the Minas Basin EBSA

The Minas Basin EBSA encompasses several linked physical and oceanographic features. The Minas Basin itself is a large, semi-enclosed body of water, approximately 80 kilometres long and 30 kilometres wide at its widest point. A narrow passage, 5 kilometres wide by 15 kilometres long, connects the Minas Basin to the rest of the Bay of Fundy. At tidal ebb and flood, the current in the Minas Passage reaches peak speeds of about 5 metres per second (Karsten et al. 2011). A massive amount of water – 3 billion cubic metres – flows into and out of the Basin twice daily (Atlantic Tidal Power Programming Board cited in Parker et al. 2007).

The oceanography of the Minas Basin is dominated by its tides, the highest in the world. The highest recorded tide was 16.27 metres at Burntcoat Head and the average tide there is about 13 metres (Dawson 1899, Desplanque and Mossman 2004, CHS 2017). The extreme tides influence many other physical characteristics of the area. Extensive mudflats appear at low tide and the intertidal zone is approximately 400 square kilometres, the largest for a marine area of that size (Bousfield and Leim 1959). In general, waters are well-mixed by the tidal flow and there are large areas of high turbidity, particularly in Cobequid Bay and the Southern Bight.

These physical characteristics influence the structure of biological communities found in the Minas Basin. The turbidity limits phytoplankton production in the Basin and, in general, there are few areas suitable for seaweeds. However, the mudflats are a source of primary production in the form of benthic diatoms, and the extensive salt marshes of the area are key contributors to primary productivity. The mud flats and salt marshes fuel the mudflat biological community, with some additional primary production provided by phytoplankton and seaweeds in less turbid areas. Salt marshes and the extensive estuarine environments of the Basin provide shelter and

foraging habitat for juvenile fish and migrating marine birds. The mudflats host high densities of various marine invertebrates, supporting a variety of predatory species, including dense aggregations of migrating shorebirds that stage annually to feed intensively within the EBSA during mid to late summer. A wide variety of anadromous fish species make use of the Basin, moving between freshwater and nearshore environments and deeper waters of the Basin. Deposit feeders are the dominant macrobenthic invertebrates of the Basin (Parker et al. 2007).

Many human activities occur in the EBSA, while much of the surrounding watershed has been highly impacted by human use, including agriculture and forestry (Willcocks-Musselman 2003). The EBSA includes the area with the highest potential for tidal power in Atlantic Canada (CHC 2006).

Given the diversity of habitats found in the Minas Basin EBSA, a number of ecological features that meet the EBSA criteria have been defined. While there are many ecological features of the EBSA, only those considered regionally, nationally or internationally significant are defined as specific features of the EBSA. Additional features may not yet have been identified or documented. Buzeta (2014) described ecological features of the Minas Basin EBSA that corresponded to the first order criteria; further review of the literature by DFO's Oceans and Coastal Management Division identified other features that may also correspond to the first order criteria. In addition, during the review of the information, a number of other important features were identified as warranting further investigation to determine if they meet the EBSA criteria (Table 1).

Table 1. List of ecological features for the Evangeline - Cape Blomidon - Minas Basin Ecologically and Biologically Significant Area (based on Buzeta 2014). An "x" indicates that the criterion applies. A dash (-) indicates that the criterion is not considered applicable. The shaded areas (+) represent other characteristics of the EBSA that may be considered as ecological features, derived from literature reviews and expert opinion.

Feature of the EBSA, used in identifying it as an EBSA	**DFO EBSA Criteria***				
	U	**A**	**FC**	**R**	**N**
Mud-piddock clam	x	-	x	-	-
Important area for multiple life-history stages of inner Bay of Fundy (iBoF) Atlantic Salmon	-	-	x	-	-
Important feeding area for Atlantic Sturgeon	-	-	x	-	-
Spawning area for Atlantic Herring	-	x	x	-	-
Nursery area for Atlantic Herring	-	x	x	-	-
Concentration of habitat used by American Eel	-	-	-	-	-
Nursery/juvenile area for multiple fish species	-	x	x	-	-
Important feeding area for migrating shorebirds	-	x	x	-	-
Important feeding area for migrating and overwintering waterfowl, raptors, other marine birds	-	x	x	-	-
Other important characteristics of the EBSA that may also correspond to the first order EBSA criteria:					
Important area for multiple life-history stages of Striped Bass	+	+	+	+	+
Migration route used by multiple species	+	+	+	+	+
Kelp beds	+	+	+	+	+
Salt marsh	+	+	+	+	+
Intertidal flats	+	+	+	+	+
Other characteristics of the EBSA to investigate:					
Nursery area for American Lobster					
Regular sightings of Harbour Porpoise					
Occurrence of Lady Crab					
Occurrence of *Sabellaria* reefs					

*DFO EBSA Criteria:
U – Uniqueness: the degree to which the characteristics of areas are unique, rare, distinct, and have few or no alternatives.
A – Aggregation: of individuals of a species, of different species, of structural features, of oceanographic processes.
FC – Fitness Consequences: the degree to which the area is required by a population or species for various life stages and activities.
R – Resilience: the degree to which the area is required by a population or species for various life stages and activities.
N – Naturalness: degree to which areas are pristine and contain native species.

Analysis and Response

Description of Ecological Features

The EBSA features described below are grouped as

1. features used to identify the area as an EBSA;
2. other characteristics that may correspond to first order EBSA criteria; and
3. other characteristics of the EBSA to investigate.

Within each grouping, features are presented in the same order as they appear in Table 1. The information presented below is a summary of the review, based on recent literature and government data holdings, completed by Kendall et al. (2018). That document should be consulted for the best available information and sources, including supporting documentation and references, as well as maps showing the spatial distribution of the various features.

Overview of Ecological Features Used in Identifying the Area as EBSA

The most recent information on the location and seasonality of the ecological features used in identifying the area as an EBSA was reviewed by Kendall et al. (2018) and is summarized below.[3]

The Atlantic Mud-piddock is confirmed as an ecological feature of the EBSA, based on the uniqueness and fitness consequences criteria. This species, listed as Threatened under the *Species at Risk Act* (SARA), has its only Canadian occurrence in the Minas Basin, making it nationally significant. The species has been documented at 14 discrete sites in intertidal portions of the Minas Basin where firm red-mudstone substrate exists and no significant sediment accumulation occurs. The Atlantic Mud-piddock is restricted to an area of less than 0.6 km^2. Changes or disturbances to this sediment type are a key threat for the species.

The EBSA contains a number of ecological features identified on the basis of the fitness consequences criteria, including the importance of the area for inner Bay of Fundy (iBoF) Atlantic Salmon. All life-history stages of iBoF Salmon, a species listed as Endangered under SARA, are present at one time or another in the Minas Basin and this review confirms this species as a feature of the EBSA. Thirteen rivers of the Minas Basin watershed are occupied by iBoF Salmon, with the highest densities found in the Stewiacke and Gaspereau rivers. The area is important from the spring to fall, with Atlantic Salmon kelts[4] present throughout this time. Adults move through the area for spawning from May to October, but the peak migration is generally between July and September. The EBSA is particularly important as a migration route for iBoF Salmon between freshwater spawning and nursery areas and maturation areas in the outer Bay of Fundy.

Another feature of the EBSA, identified on the basis of the fitness consequences criteria, is the local populations of Atlantic Sturgeon, which use the area for feeding. Populations from Saint John, New Brunswick, and Kennebec, Maine, aggregate in the Minas Basin to feed in the spring, summer and fall, with peak abundance occurring from June to September. The species has been reported to feed on soft-bodied invertebrates, in particular polychaete worms common to the Minas Basin (Pearson et al. 2007). Throughout the feeding aggregation months, there is movement and local occurrence of sturgeon throughout the entire basin. However, it appears that the north shore of the Basin is occupied more during the spring, while the south side is occupied more in the summer, suggesting migration in and out of the Basin is clockwise, following the residual current structure. Sturgeon are not known to be present in the Minas Basin during the winter months. Atlantic Sturgeon are assessed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Atlantic Herring, which use the EBSA for both spawning and as a nursery area, is confirmed as an ecological feature based on the aggregation and fitness consequence criteria. There are two areas within the EBSA that support spawning for Atlantic Herring; the outer portions of the Minas Passage are important for a summer-spawning stock and the area from Cape Sharp to

[3]Additional sources of information that were identified through the Science Response meeting are cited in the summary below. All other references can be found in Kendall et al. (2018).
[4] A kelt is a salmon that has spawned the previous fall and over-wintered in the river.

Five Islands is used by a unique spring-spawning population. Juvenile Herring are also found throughout the EBSA, with abundance on the south shore of the Minas Basin highest in June to August and on the north side from mid-June through early August.

The concentration of habitat used by American Eel is also confirmed as an ecological feature of the EBSA. Adult American Eels, assessed as Threatened by COSEWIC, move through the Minas Basin and Minas Passage in the fall (mid-September to mid-November), after leaving a number of rivers in the area as they migrate to the Sargasso Sea. They remain in the Minas Basin for about a month before leaving through the Minas Passage. Movements occur primarily in the southern half of the Minas Passage. While the Minas Basin is used by American Eel and represents a component of the diversity of habitat types that the species uses, it is part of the mosaic of rearing habitat available to eel across its natural range (Florida to Labrador) and is not considered obligatory habitat for the completion of its lifecycle. There is no evidence to suggest that the habitat in the Basin is of higher quality or greater significance than elsewhere; however, it is also noted that loss of American Eel habitat in the Minas Basin and Minas Passage would represent a relatively significant proportional loss to the productivity (e.g., spawning stock biomass) of the population.

Based on the aggregation and fitness consequence criteria, the use of the EBSA as a nursery area for multiple fish species was identified as an ecological feature. This area is important nursery habitat for local populations of flounder, Striped Bass, Rainbow Smelt, Alewife, Blueback Herring, and American Shad, as well as important juvenile rearing habitat for non-local populations of migratory species such as Atlantic Sturgeon, Alewife, Blueback Herring, and American Shad. The species found in the EBSA are generally a cross-section of those in other coastal areas of Nova Scotia, although the seasonality and development cycles for these species may be expected to have some unique characteristics in the EBSA due to the unusual physical and biological conditions of the Minas Basin. Most fish found in the EBSA are strictly marine, although anadromous and catadromous species also occur. The macrotidal nature of the Minas Basin largely explains how juveniles of many of the species, particularly species inhabiting primarily coastal waters, tend to be distributed widely in the Minas Basin. Factors such as turbidity or salinity gradients may also partly explain the distribution and dynamics of some of these species (e.g., Bradford and Iles 1992). Depending on the species, spawning and the subsequent larval/juvenile development, occurs at different times of the year. Therefore, use of the EBSA as a nursery area can take place throughout the year.

An additional ecological feature of the EBSA that has been identified and confirmed by this review is the use of the EBSA as a migratory staging area for shorebirds, linked to highly predictable and elevated concentrations of foraging resources. Areas used persistently by feeding shorebirds were defined as features based on both the aggregation and fitness consequences criteria. Most shorebird species are found seasonally in coastal and wetland areas throughout Atlantic Canada. Intertidal areas of the EBSA offer important feeding opportunities while high tide roost locations on mudflat margins offer important resting opportunities (i.e. lower risk of disturbance from predators and humans). The Semipalmated Sandpiper is the most abundant shorebird migrant in the area; at least 10 percent of the global population uses the Minas Basin EBSA annually (J. Paquet, pers. comm. 2017). Mudflats and saltmarsh coastal environments, particularly in the Southern Bight and Cobequid Bay, are used by shorebirds primarily between July and October, with peak abundances generally occurring in August and September. The diet of shorebirds in the Bay of Fundy is known to vary among species, date, year and conditions. The amphipod *Corophium volutator* is an important food item for some shorebird species, especially the Semipalmated Sandpiper, in areas where the amphipod is available at high densities. Elsewhere, a wide variety of other marine invertebrate

and diatom prey is also consumed, including in areas where Semipalmated Sandpiper and other shorebird species numbers are elevated and *Corophium volutator* densities are low to nil.

The relative importance of the Minas Basin as a feeding area for waterfowl, other marine birds and raptors, is such that it also meets the aggregation and fitness consequence criteria and is identified as an ecological feature of the EBSA. Waters within the EBSA are used by both resident and migrant species, with the temporal and spatial use of the area varying among species. Raptor species of note include Peregrine Falcon and Bald Eagle. The south shore of the EBSA includes a known wintering location for Harlequin Duck, an at-risk species nationally (Special Concern) and provincially (Endangered). Based on the information reviewed, though the EBSA was identified as important in general as a feeding area for "other marine birds", it is clearly important for dabbling ducks (e.g., American Black Duck), with relatively high aggregations in comparison to other portions of the Scotian Shelf marine bioregion. Dabbling ducks especially are found in greater abundance in the Minas Basin portion of the EBSA as compared with the Channel and Passage.

Other Important Characteristics That May Also Correspond to the EBSA Criteria

In addition to the ecological features used in identifying the area as an EBSA, a number of other potential ecological features have since been identified by DFO's Oceans and Coastal Management Division. These characteristics were also part of the literature review conducted by Kendall et al. (2018) and information from this review is summarized below.

Striped Bass are a year round resident in the Minas Basin and Cobequid Bay. The Minas Basin provides nursery habitat for young Striped Bass, with juveniles remaining in the Basin until they reach sexual maturity (3-4 years for males; 4-6 years for females). Adults are predominantly found between May and October, with overwintering occurring in freshwater habitats. It is thought that young of the year remain in the Minas Basin year-round. The resident population in the Minas Basin originates in the Shubenacadie River and is the last confirmed spawning population remaining in the Bay of Fundy. The Bay of Fundy population is assessed as Endangered by COSEWIC.

A significant migration route, the Minas Channel and Minas Passage connect the Minas Basin and the outer Bay of Fundy. Migratory species move in and out of the Bay during particular life-history stages. Migration can be broadly grouped as

1. fish that move long distances and easily move beyond the area of the EBSA,
2. local migratory species that move short distances seasonally, and
3. freshwater migratory species that move significant distances into freshwater systems for part of their life cycle.

Species including Atlantic Salmon, Striped Bass, Atlantic Sturgeon, American Shad, Gaspereau, Atlantic Herring, American Eel, shark species and lobster are among the list of species that pass through the Channel. A complete list of fish species recorded in the EBSA is included in Kendall et al. (2018).

The Minas Channel and Basin also constitute an important migratory corridor for migrating birds. The Bay of Fundy as a whole acts as a funnel for spring migratory movements of water-associated birds northwards. Oceanic species also experience a northern summer shift into Atlantic coastal waters that can result in many species of birds entering the Bay of Fundy. Migratory bird species that are found in the EBSA include Black Scoter, Surf Scoter, White-winged Scoter, Common Eider, Long-tailed Duck, Red-throated Loon (spring and fall) and Northern Gannet (summer).

Buzeta (2014) highlighted the occurrence of kelp beds off Blomidon as a feature of possible significance in the EBSA. However, no comprehensive surveys have been completed to map the distribution of macroalgae in the EBSA.

Another important feature of the EBSA are the salt marshes found throughout the Minas Basin. These areas provide habitat for waterfowl and wildlife and are nursery areas for coastal fish. Given that there have been extensive historic losses of natural marshes to agriculture, the remaining salt marsh areas in the inner Bay of Fundy have particular significance. There is ongoing work to restore salt marshes in the Minas Basin.

Intertidal flats, including mudflats and sand flats, may be considered ecological features of the EBSA. These extensive areas are distinctive features of the Minas Basin and are important in both the physical and biological dynamics of the ecosystem. About half of the benthic primary production in the Minas Basin is due to benthic production on mudflats. Up to date mapping of the intertidal flats would contribute to assessing the overall importance of the area.

Other Characteristics of the EBSA to Investigate

As part of the peer review meeting held on March 1, 2017, additional potential ecological features were suggested for further investigation. A preliminary review of information is included in Kendall et al. (2018), which is summarized below.

The EBSA is not known as a nursery area for American Lobster and the Minas Basin appears to be mainly a summer feeding area. There are unconfirmed accounts from fishers, however, of the presence of planktonic and juvenile lobster in Minas Basin.

Harbour Porpoise, assessed as a species of Special Concern by COSEWIC, is found both in the Minas Passage and Minas Basin, with movements influenced by the movements of prey, primarily Atlantic Herring. The species' presence tends to peak in early spring to early summer. However, sightings of the species in the Bay of Fundy, including the EBSA, have been largely anecdotal and are not considered to represent an important component of the overall population. Overall, research to date does not indicate that the EBSA is of greater importance than other parts of the Bay of Fundy for Harbour Porpoise.

Specimens of *Sabellaria* tube worms have been found in the Minas Basin and Chignecto Bay, however, information on the current occurrence or distribution is unknown. If the *Sabellaria* reefs can be confirmed to still be present in the EBSA, this would be a unique occurrence in Atlantic Canada and, therefore, significant in terms of ecological significance criteria for the EBSA.

In addition to the species at risk discussed above, several other at-risk species (protected under SARA or assessed by COSEWIC) occur occasionally within the EBSA. While there are occasional occurrences of White Shark, Shortnose Sturgeon, Leatherback Sea Turtle, North Atlantic Right Whale, and Fin Whale in the EBSA, these species are not known to directly inhabit the area for their complete life cycle. The relationship between the EBSA and these occasional occurrences is currently unclear, but it is unlikely that the EBSA is of particular importance for these species. It is likely that other marine areas, where these species regularly occur, are far more important for supporting the species. Species at risk for which the EBSA is particularly important are described earlier in the document.

Confirmation of Significant Ecological Features

Based on the information compiled, the Science Response process determined whether each identified characteristic of the EBSA should be confirmed as a feature that contributes to the designation of the area as an EBSA. Table 2 presents a summary of all the characteristics

reviewed, indicating the EBSA criteria that the feature meets, whether the data continues to support the characteristic as an ecological feature, and the status of the current knowledge of spatial and temporal delineation of the features within the EBSA.

Table 2 also presents a summary of information about a series of characteristics defined as other important features or characteristics and as features that should be investigated. These are features that were not originally defined by Buzeta (2014) in the original identification of the ecological features of the EBSA. This current review confirmed a number of other characteristics as ecological features that contribute to the EBSA designation, as well as identifying a number of characteristics for which additional review or information would be required to determine if they meet the EBSA criteria relative to other parts of the region.

Table 2. Confirmation of ecological features for the Minas Basin EBSA Ecologically and Biologically Significant Area. A dash (--) indicates "not applicable".

Feature or characteristic of the EBSA	EBSA Criteria Met*	Confirm as a Feature (Y/N)	Spatial Info. Available	Temporal Info. Available	Comments
Mud-piddock clam	U, FC	Y	Partial	Not available	Additional field research is planned for summer 2017 to map the habitat in the area to determine spatial distribution (DFO-Science)
Important area for multiple life-history stages of inner Bay of Fundy (iBoF) Atlantic Salmon	FC	Y	Partial	Partial	Additional information is needed on kelt habitat to refine the understanding of marine distribution. Overwintering information is also limited. Additional information will be collected as part of the on-going process to identify and refine marine and estuarine critical habitat under SARA (DFO-Science).
Important feeding area for Atlantic Sturgeon	FC	Y	Y	Y	No comment
Spawning area for Atlantic Herring	A, FC	Y	Partial	Y	No comment
Nursery area for Atlantic Herring	A, FC	Y	Y	Y	No comment
Concentration of habitat used by American Eel	FC	Y	Y	Y	No comment
Nursery/juvenile area for multiple fish species	A, FC	Y	Partial	Partial	The relative importance of this area for certain species compared to other areas requires further investigation.
Important feeding area for migrating shorebirds	A, FC	Y	Y	Y	No comment
Important feeding area for migrating and overwintering waterfowl (e.g., American Black Duck), raptors (e.g., Peregrine Falcon, Bald Eagle), other marine birds	A, FC	Y	Y	Y	No comment
Other important features or characteristics of the EBSA that may also correspond to the first order EBSA criteria:					
Important area for multiple life-history stages of Striped Bass	A, FC	Y	Partial	Y	Additional information is needed to confirm whether there are additional spawning populations and to determine the significance of Striped Bass overwintering in the Passage.
Migration route used by multiple species – fish and invertebrates	FC	Y	Partial	Partial	The availability of information is variable depending on the species. In particular, data on winter use is lacking.
Migration route used by multiple species – seabirds and waterfowl (e.g., Black	FC	Y	Y	Y	No comment

Feature or characteristic of the EBSA	EBSA Criteria Met*	Confirm as a Feature (Y/N)	Spatial Info. Available	Temporal Info. Available	Comments
Scoter, Surf Scoter, White-winged Scoter, Common Eider, Long-tailed Duck, Red-throated Loon, Northern Gannet)					
Kelp beds	A	More information required	Partial	Not available	Updated information on the kelp beds identified off Blomidon is needed as the area has not been studied subsequent to their initial identification. Significance of the area relative to other parts of the region is unclear.
Salt marsh	A	Y	Partial	Not available	More recent estimates of areas of salt marsh habitat to be completed soon (Saint Mary's University)
Intertidal flats	U, A	Y	Partial	Partial	Physical features of the EBSA create habitat within the ecosystem. Spatial extent and boundaries of habitat types provide information for species temporal and spatial distribution.
Other features of the EBSA to investigate					
Nursery area for American Lobster	--	N	Not available	Not available	Existing evidence suggests it is not a lobster nursery area but more investigation may be needed.
Regular sightings of Harbour Porpoise	--	N	Not available	Not available	At this time, available information does not indicate that the EBSA is of greater importance than other parts of the Bay of Fundy.
Occurrence of Lady Crab	--	More information required	Not available	Not available	More information is needed on the distribution in order to determine the significance of the EBSA for Lady Crab
Occurrence of *Sabellaria* reefs	--	More information required	Partial	Not available	More information is needed on the distribution in order to determine the significance of the EBSA for *Sabellaria* reefs

*DFO EBSA Criteria:
U – Uniqueness: the degree to which the characteristics of areas are unique, rare, distinct, and have few or no alternatives.
A – Aggregation: of individuals of a species, of different species, of structural features, of oceanographic processes.
FC – Fitness Consequences: the degree to which the area is required by a population or species for various life stages and activities.
R – Resilience: the degree to which the area is required by a population or species for various life stages and activities.
N – Naturalness: degree to which areas are pristine and contain native species.

EBSA Boundaries

Boundaries for the sixteen EBSAs in the Bay of Fundy were mapped in Buzeta (2014), including the Minas Basin EBSA (Figure 1). Upon review of the information on the ecological features, it is recommended that the outer boundary of this EBSA be redrawn at the outer extent of the Minas Passage and that the estuarine portion of the Avon River be included within the boundaries of the EBSA (Figure 2). The spatial extent of most ecological features is from the Minas Passage inwards to the Basin, which is the basis for the recommendation to move the outer boundary. However, the result of refining this boundary would be to exclude a portion of the known spawning area for the summer spawning population of Atlantic Herring (Scots Bay stock). Ile Haute, which is known as an important area for certain breeding bird species, would also be excluded from the EBSA.

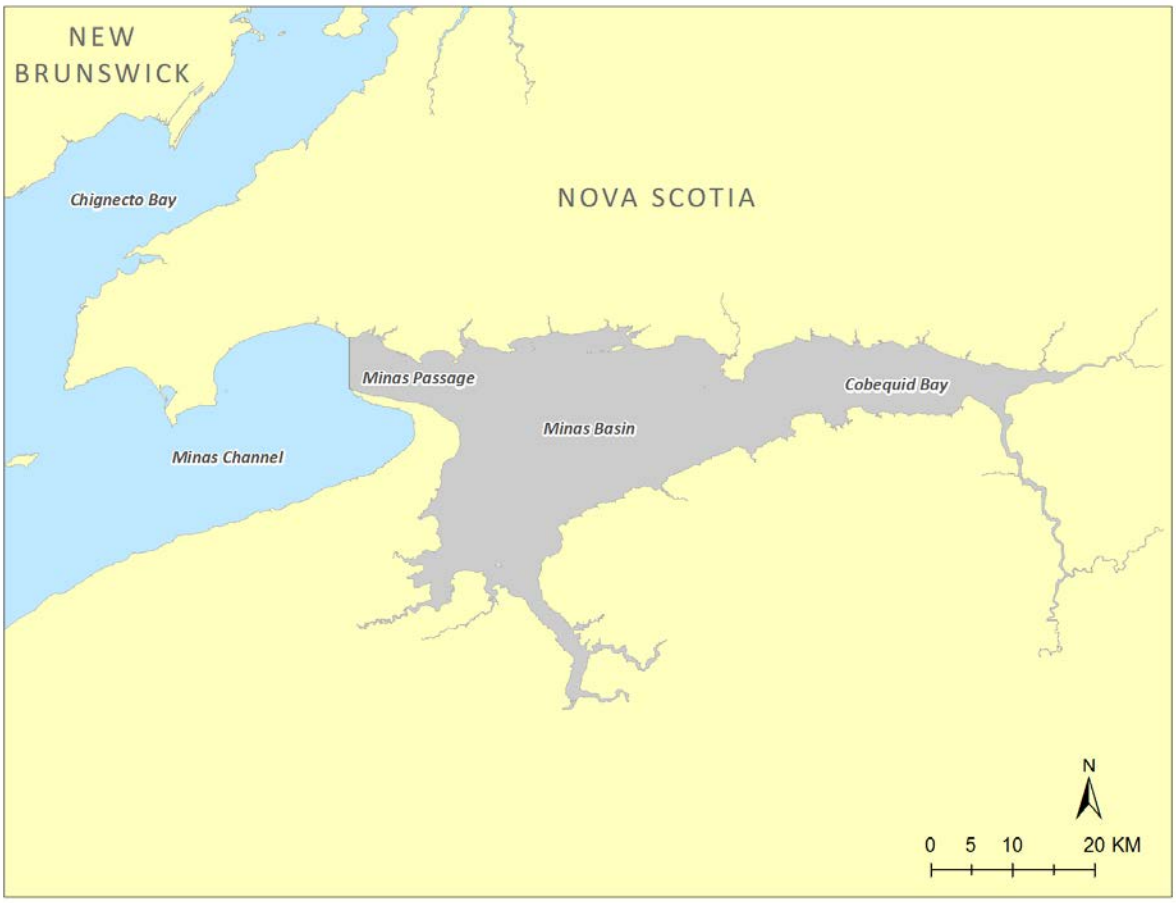

Figure 2. The recommended revision to the boundaries of the Evangeline – Cape Blomidon – Minas Basin Ecologically and Biologically Significant Area (EBSA).

No additional refining of the EBSA boundaries is recommended. The ecological features within the EBSA are dynamic. While there is some spatial structuring, the information available does not support changing other boundaries of the EBSA. It will be important to continue to review and monitor the information available on the ecological features on a regular basis, to determine if any changes are taking place in the spatial use of the area, especially as climate change may affect certain features. This will allow management to adapt to ecological changes.

Data Gaps

While efforts have been made to document the biological community of the Basin, extensive gaps in our knowledge remain. Research is needed on use of the Basin by many different species. Kendall et al. (2018) provide a summary of data gaps in relation to each of the ecological features reviewed. These identified data gaps have been prioritized, based on the importance of the information to:

1. further delineating spatial or temporal information about the ecological feature of the EBSA,
2. management of activities in the EBSA,
3. understanding the aggregation of features in the EBSA, and/or
4. defining additional ecological features of the EBSA.

Table 3 outlines data gaps and related potential research activities, linked to themes. The establishment of research activities should also consider the recommendation by Parker et al. (2007) that future studies should focus on ecological linkages, including physical-biological and biological interactions. Further, it was recommended that the bay-scale watershed is an appropriate resolution for studies and that environmental effects monitoring approaches should be used, where possible, to evaluate relationships between biota and their environment.

As an overarching priority, the ecological connections between the biota and their physical environment, as well as connections between biota should be further examined. An improved understanding of the relative importance of the EBSA for a variety of the ecological features and emergent features compared to other areas of the Bay of Fundy or Atlantic coast would assist in further delineation of, and management of, the EBSA.

It is important to note that this list was developed in relation to the utility of the information in informing either the identification of ecological features of the EBSA or future management of the EBSA. Different programs or initiatives may identify other data gaps.

Table 3. Data gaps related to confirming ecological features of the EBSA, understanding the spatial and temporal extent of features, management of activities in the EBSA, and/or understanding interactions between physical features and the biological community. NOTE: X = a strong linkage to the theme; dash (--) = a weak or no linkage to the theme.

Feature / Characteristic	Data Gap	Confirmation of Ecological Features	Spatial Delineation	Temporal Delineation	Management of the EBSA	Interactions b/n Physical and Biologial
Mud-piddock clam	Sampling in the sub-tidal and upper-intertidal range to determine if Atlantic Mud-piddock occur beyond the intertidal range.	--	X	--	X	--
	Comprehensive habitat requirements for Atlantic Mud-piddock.	--	X	--	X	--
	Life processes of the Atlantic Mud-piddock, including timing of fertilization and development, process of larval attachment, and life span.	--	--	--	X	--
Important area for multiple life-history stages of iBoF Atlantic Salmon	Feeding behaviour and year-round residency in the Bay of Fundy for all life-history stages of iBoF Atlantic Salmon, in particular 2SW Salmon and kelts.	--	--	X	--	--
	Data on the outer coastal southwest portion of the EBSA for iBoF Atlantic Salmon.	--	X	X	--	--
	Sources of mortality to iBoF Atlantic Salmon kelts in river and coastal estuaries.	--	--	--	X	--
	Once there is a better understating of iBoF Atlantic Salmon kelt, marine distribution data should be re-analyzed.	--	X	--	--	--
Important feeding area for Atlantic Sturgeon	Over-wintering habitat and migration patterns of Atlantic Sturgeon.	--	X	--	X	--
	Importance of the EBSA for Atlantic Sturgeon spawning.	--	--	--	X	--
	Whether there are other feeding aggregation areas in the Bay of Fundy for Atlantic Sturgeon, outside the Minas Basin, in order to determine relative importance of the EBSA for feeding.	--	--	--	--	--
	Monitoring of Atlantic Sturgeon and the species' ability to respond to environmental changes.	--	--	--	X	--
Spawning area for Atlantic Herring	Surveys of all Herring spawning beds in the EBSA to better delineate location and timing.	--	X	X	X	--
Nursery area for Atlantic Herring	Dynamics of water movement and turnover in the central portion of the Minas Basin in relation to its role as a potential Herring larval retention area.	--	X	--	--	--
	Develop monitoring capacity for the Minas Basin spring-spawning Herring population.	--	--	--	X	--

Feature / Characteristic	Data Gap	Confirmation of Ecological Features	Spatial Delineation	Temporal Delineation	Management of the EBSA	Interactions b/n Physical and Biologial
Concentration of habitat used by American Eel	Relative importance of EBSA for American Eel (aggregation, fitness consequences) and areas of aggregation, if any.	--	X	--	--	--
	Threats to American Eel in the EBSA.	--	--	--	X	--
	Information on stability and trends in abundance of American Eel in the EBSA.	--	--	--	X	--
Nursery/ juvenile area for multiple fish species	Significance of the EBSA to critical life-history stages or habitat use by a variety of fish species.	X	X	X	--	--
Important feeding area for migrating shorebirds	Effects of sedimentation rates on the biological community and specifically shorebird prey.	--	--	--	X	X
	Documenting and monitoring type and extent of shoreline armouring and other types of tidal barriers, and their effects on physical and biological characteristics of adjacent mudflats (habitat resiliency).	--	--	--	--	X
	Relationship of physical and biological characteristics of mudflats to biological community, including availability and use of shorebird foraging areas, and especially roosting sites.	--	--	--	--	X
	Anthropogenic disturbance baselines and monitoring; effects of type and intensity of human disturbance on availability and use of foraging areas and roosting sites (e.g., shorebird stay duration).	--	--	--	X	--
	Aerial surveys of shorebirds to monitor changes in spatiotemporal patterns of use over time.	--	X	X	X	--
	Assess persistence of key feeding areas and roosting sites within the EBSA to target threat mitigation measures.	--	--	--	X	--
Important feeding area for waterfowl, raptors, other marine birds	Aerial and ground-based surveys of marine birds (especially waterfowl and loons) to monitor changes in spatiotemporal patterns of use over time.	--	X	X	X	--
	Assess persistence of key staging areas within the EBSA to target specific threat mitigation measures.	--	X	--	X	--
Important area for multiple life-history stages	Overwintering behaviour of Striped Bass in the Minas Passage, including physiology and feeding behaviour, with respect to migration and distribution ranges.	--	X	--	--	--

Feature / Characteristic	Data Gap	Confirmation of Ecological Features	Spatial Delineation	Temporal Delineation	Management of the EBSA	Interactions b/n Physical and Biologial
of Striped Bass	Additional information needed to confirm whether there are additional Striped Bass spawning populations (beyond the Stewiacke River spawning population).	--	X	--	--	--
	The influence of changes in water temperature profiles on the range distribution of Striped Bass.	--	X	--	--	--
Migration route used by multiple species – fish/ invertebrates	Local routes through the EBSA that fish use to migrate to particular target locations.	--	X	--	--	--
	Winter movement patterns of numerous fish species.	--	X	X	--	--
	Significance of the EBSA to critical life-history stages or habitat use by a variety of fish species.	X	X	X	--	--
Kelp beds	Comprehensive surveys to map the distribution of macro algae (kelp) and eelgrass in the EBSA.	X	X	--	--	--
Salt marsh	Continue to update distribution maps.	--	X	--	X	--
	Document use of salt marsh habitat in the area by different species, particularly juvenile fish.	--	--	--	--	X
Intertidal flats	Distribution of tidal flats within the EBSA.	--	X	X	--	--
	Increase understanding of the processes of intertidal flats.	--	--	--	--	X
Nursery area for American Lobster	Determination of whether there is spawning by American Lobster occurring within the EBSA.	X	--	--	--	--
Occurrence of Lady Crab	Distribution of Lady Crab in Minas Basin and the importance of its occurrence there relative to the rest of Atlantic Canada.	--	X	--	--	--
Occurrence of *Sabellaria* reefs	Determination of location of *Sabellariid* tube worm structures.	X	X	--	--	--
Other	Bathymetry and seabed characteristics of the outer Minas Basin.	--	--	--	--	X
	Seabed features through habitat classification coupled with multibeam mapping.	--	--	--	--	X
	Determining whether the Shortnose Sturgeon distribution extends into the Minas Basin.	X	--	--	--	--

Conclusions

Many features of the Minas Basin EBSA, including the macrotidal environment, the high tides and tidal currents, the unique combination of estuarine environments, the unique geological features including extensive mudflats, the relative shallowness relative to the size of the area and the use by a full spectrum of marine birds, marine invertebrates and fish, make the area significant.

Sedimentary and tidal processes are the key elements that distinguish the Minas Bain EBSA from other areas. These processes lead to unique habitat characteristics, which in turn support an assemblage of unique ecological processes. The habitat features may be more important than the actual biological features, as these habitat features are not seen elsewhere.

An important characteristic of the area is its importance for multiple species at risk, particularly diadromous species (e.g., Atlantic Salmon, Atlantic Sturgeon, Striped Bass, American Eel). While this collective importance is not a specific feature of the EBSA, it does highlight an important role that the area plays in supporting these populations.

The EBSA is also particularly important as a migratory route for many species, such as the diadromous species listed above.

A number of data gaps have been identified to further the understanding of the temporal or spatial extent of ecological features of the EBSA or to support management of activities in the EBSA. As an overarching priority, the ecological connections between the biota and their physical environment, as well as connections between biota should be further examined. An improved understanding of the relative importance of the EBSA for a variety of the ecological features and emergent features compared to other areas of the Bay of Fundy or Atlantic coast would assist in further delineation of, and management of, the EBSA.

Future work to present the spatial delineation of all the ecological features of the EBSA on one consistent map would assist in the management of the area.

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