Existing regional environmental characteristics, fisheries information and mapping data for the Scotian Shelf-Bay of Fundy

DFO Maritimes response to Request for Advice from the Committee for the Regional Assessment of Offshore Wind Development in Nova Scotia

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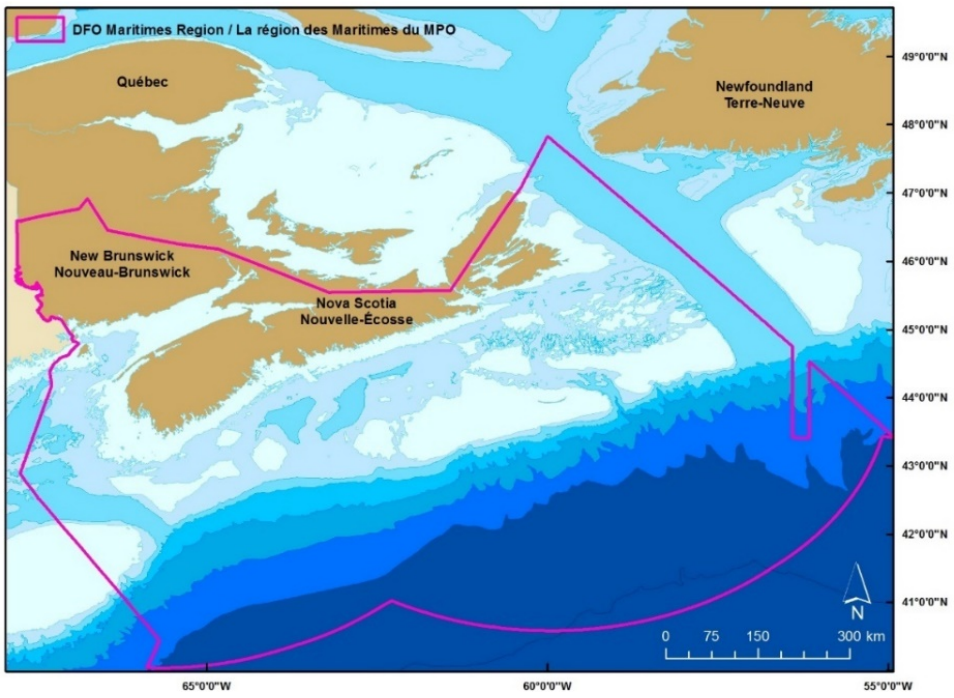
Purpose of Document

This document serves as the response from Fisheries and Oceans Canada (DFO) **Maritimes Region** to the Request for Advice (RFA) submitted by the Impact Assessment Agency of Canada on August 8, 2023. The information is generally provided in tabular or bullet form and includes references to supporting information (i.e., annexes [as supplementary attachments] and appendices [at the end of the document containing tables and figures] throughout). Spatial data (e.g., shapefiles) are also provided as a separate attachment. This response summarizes information from several sources, including published literature as well as input from several subject matter experts.

The information represented here should not be considered comprehensive of the entire Maritimes Region, but rather information that is specific to the topics outlined in the RFA. While every effort was made to respond to the request as it was written, there may be information that is not yet available or provided in a different format than requested. Please note that some information will also be submitted at a later date, per discussions between DFO and the IAAC Secretariat. This is indicated where applicable.



Map of DFO Maritimes Region administrative boundary

1. Fish and Fish Habitat

1.1 Any identified "hotspots" of ecological productivity within the region that may indicate aggregations of other fish or mammal species during certain times of year.

- See: Ward-Paige, C.A., and Bundy, A. 2016. Mapping Biodiversity on the Scotian Shelf and in the Bay of Fundy. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/006. v + 90 p.
    - This report provides maps of 3 measures of biodiversity – Species Richness (the count of species present), exponential of the Shannon-Wiener Index (measure of species richness and evenness) and Heips Evenness Index (measure of species evenness) for 5 time periods
- For most fish species, the "hotpots" that this question refers to are areas with spawning aggregations, and are described in section 1.5: "Identified areas and/or times of year that are important for one or more fish species."
- However, some areas in the Offshore wind RA Study Area are identified as Ecologically and Biologically Significant Areas (EBSAs). Coastal EBSAs are described in Hastings, King, and Allard (2014) while offshore EBSAs are described in King et al. (2016). In addition, there are three Marine Protected Areas (MPAs) in the Study Area – the Gully, St. Ann's Bank, and the Laurentian Channel – that are considered hotspots for ecological and biological productivity, feature unique marine habitats and are important for fish at various times of year (DFO 2017; Ford and Serdynska 2013; S. Lewis et al. 2016). Other areas are under consideration for the establishment of future MPAs; their ecosystem features are described in (King et al. 2021).
    - **Coastal EBSAs:** There are 38 Atlantic coast EBSAs that are within the Offshore Wind RA Study Area (Hastings et al. 2014). Nineteen coastal EBSAs have rationale related to fish species (See Table 1 in Appendix A)
- Additional areas identified as important to finfish in Hastings et al. (2014), but which did not meet the criteria of EBSAs, were: Yankee Bank (fall herring and cod spawning); Taylor Head-Sheet Harbour area (salmon area); St. Peter's Bay-Bay of Rocks (high productivity area with Mackerel, Herring, and White Hake); and Sydney River-Sydney Harbour (spawning, breeding, and feeding area with high fish diversity).
    - **Offshore EBSAs:** There are 15 offshore EBSAs that are within the Offshore Wind RA Study Area (King et al. 2016). Coastal EBSAs have criteria relate to aggregations of fish species. All offshore EBSAs, except the Stone Fence and the Laurentian Fan Cold Seep Communities, have features related to fish species aggregations (see Table 2 in Appendix A).
- **Marine Protected Areas:** The three Marine Protected Areas in the Offshore Wind RA Study Area -- The Gully, St. Anns Bank, and the Laurentian Channel -- overlap with the previously described EBSAs. The rationale for the establishment of the MPAs included the presence of fish species and their seasonal aggregations. Research survey data includes 45 fish species that occur in the Gully, the ten most frequent of which are redfish, American Plaice, White Hake, Witch Flounder, Thorny Skate, Atlantic Cod, Silver Hake, Longfin Hake, and Atlantic Halibut (Harrison and Fenton 1998). The Laurentian Channel includes aggregations of Black Dogfish, Common Grenadier, Northern Wolffish, Turbot, Smooth Skate, Witch Flounder, and Hagfish (Kulka and Templeman 2013). St. Anns Bank includes aggregations of American Plaice, Atlantic Cod, Atlantic Halibut, Atlantic Wolffish, redfish, Smooth Skate, White Hake, Witch Flounder, Capelin, Atlantic Herring,

Atlantic Mackerel, and sharks (Ford and Serdynska 2013). Areas of interest for establishing future MPAs, with relevant ecosystem features, have also been documented (King et al. 2021).

1.2 Chlorophyll-a concentrations and the noted trends in timing and location of blooms within the Study Area.

- This information is forthcoming and will be provided at a later date, per discussions with IAAC.

1.3 Overview of coral and sponge presence and absence within the region, including noted areas of higher density such as Significant Benthic Areas, or rare / unique species such as *Vazella pourtalesii.*

1.3.1 Coral and sponge presence within the region

- For data layers and information on overall presence in the region, please see Annex A.

1.3.2 Gaps in data collection

The multispecies bottom-trawl surveys provide a good overview of the coral and sponge data in the Maritimes in trawlable bottoms until ~500-1000 m depth. Imagery surveys have provided coral and sponge data on canyons and continental slope until 1,500-2000 m depth (though the entire slope has not been surveyed). Data gaps include deeper waters, rocky areas on the continental shelf and the German Bank that is not covered by the multispecies bottom-trawl surveys.

1.3.3 Known vulnerabilities/impacts of climate change

Ocean acidification due to climate change can have a negative effect on corals (e.g. Ross et al. 2020). However, there is not many studies about that and less in cold water corals. Some studies have seen negative effects. For example, Bramanti et al. (2013) evaluated the long-term effects of low pH in the Mediterranean gorgonian Corallium rubrum, grown under two different pH conditions and found a detrimental effect of pH on calcification rates and sclerite morphology. However, Gabay et al. (2014), through the comparison of sclerite morphology in octocorals exposed to different pH levels, found that coral tissue might be involved in the resistance of some species of octocorals to ocean acidification. Another more recent study mentions that some gorgonians (*Eunicea fusca*) could survive well in mid-term ocean acidification conditions expected by the end of this century (Gómez et al. 2015) or that some corals can acclimatize and adapt to different environmental conditions including pCO2 and temperature (Kurihara et al. 2021). However, these studies are related to shallow species, so the effect on deep water corals that live in more stable environment may be different.

For further information, consult the references listed in Annex A.

1.4 Summary of benthic, demersal, and pelagic fish species (including shellfish) that can be found in the Study Area, including noted species at risk (SAR) and of conservation concern (i.e., COSEWIC) and their critical habitat (if identified). This list of species can be derived from DFO RV survey results, or other studies undertaken in the region.

General

- Bundy, A., Will, E., Serdynska, A., Cook, A., and Ward-Paige, C.A. 2017. Defining and mapping functional groups for fishes and invertebrates in the Scotian Shelf Bioregion. Can. Tech. Rep. Fish. Aquat. Sci. 3186: iv + 49 p.

    - This report provides maps of the density of 14 functional groups across the Scotian Shelf for 5 time periods.
    - The data layers developed in these reports should be housed with the other data layers used in the Marxan analyses by the MPC team.

- The DFO Maritimes Region's Ecosystem Survey Program database includes 796 fish species codes based on a systematic listing of species that are found in the Maritimes Region (Losier and Waite 1989). Of these, 304 fish species have been observed on the Scotian Shelf during the survey (Table 3 in Appendix A). A list of demersal and pelagic fish species, documented by the survey, that are either species at risk or of conservation concern are available in Table 4 (Appendix A). Critical habitat, if identified, is included.

Sharks

- There are numerous shark species that either reside in Canadian waters or seasonally migrate to Canadian waters. The majority of information available in the OSW assessment study area is on the following species:
    - Shortfin mako shark (North Atlantic Population; pelagic; COSWEIC: endangered)
    - Porbeagle shark (Northwest Atlantic Population; pelagic; COSWEIC: endangered)
    - Blue shark (North Atlantic Population; pelagic; COSWEIC: not at risk)
    - White shark (Northwest Atlantic Population; pelagic; COSWEIC: endangered; Listed on Schedule 1 of SARA)
    - Greenland shark (North Atlantic and Arctic Population; demersal; COSWEIC: not assessed)
    - Basking shark (Northwest Atlantic Population; pelagic; COSWEIC: special concern)
    - Spiny dogfish (Northwest Atlantic Population; demersal; COSWEIC: special concern)
    - Common thresher shark (Northwest Atlantic Population; pelagic; COSWEIC: not assessed)
- Several other semi-tropical sharks are less commonly found in Canadian waters and would periodically be found in the OSW study area. These include (but are not limited to):
    - Bigeye thresher shark (North Atlantic Population; pelagic; COSWEIC: not assessed)
    - Tiger shark (North Atlantic Population; pelagic; COSWEIC: not assessed)
    - Oceanic whitetip (North Atlantic Population; pelagic; COSWEIC: not assessed)
    - Atlantic sharpnose (North Atlantic Population; pelagic; COSWEIC: not assessed)
    - Dusky shark (North Atlantic Population; pelagic; COSWEIC: not assessed)
- Little information exists about the abundance, population structure, distribution or habitat requirements of demersal and deep-water sharks that would be expected to be found along the edge of the continental shelf and deeper waters in the OSW study area. Species include (but are not limited to):
    - Black dogfish (demersal; COSWEIC: not assessed)
    - Deepsea catshark (demersal; COSWEIC: not assessed)
- Critical Habitat has not been defined for any shark species in Canadian waters, although it is anticipated by 2025 from an ongoing, multi-region collaborative research project for white shark. Research on other species will commence once listing decisions are made. Because of the widespread distribution of all shark species in Canadian waters, Critical Habitat(s) may occur throughout the OSW study area.

Habitat use within the OSW study area varies substantially by species. White shark (Bowlby et al. 2022) and basking shark (Braun et al. 2018) make frequent use of coastal habitats (within the 200m bathymetric contour) during the summer months (primarily June to November) while feeding. Summer seal haul-outs are one feature that white shark tend to aggregate around, where grey and harbour seals are found in groups throughout coastal Nova Scotia and into the Gulf of St. Lawrence, with the largest colony around the Magdalen Islands. Basking sharks are planktonic feeders and would be expected to be found where primary productivity was high. Areas of high primary productivity are not static but would depend on water conditions (currents, temperature, upwelling, etc.) and time of year.

In general, sharks use structure to their advantage while feeding (e.g. Braun et al. 2019). This means that they would be expected to congregate around upwelling features (e.g. the “Hell Hole” off the coast of Nova Scotia) characterized by distinct discontinuities in water temperature, as well as in regions with rough bathymetry, characterized by abrupt changes in depth. Pelagic species use habitats throughout the water column (i.e. vertical habitat use; Andrzejaczek et al. 2022). Several species (e.g. porbeagle) tend to be found closer to the surface at night and in deeper water during the day, following vertically-migrating prey (e.g. Wang et al. 2020). Fishery-dependent data suggests that captures of numerous species (e.g. shortfin mako, blue shark, thresher) tend to be highest along the edge of the continental shelf and in the deep basins (e.g. Emerald Basin) off the coast of Nova Scotia.

The distribution of pelagic sharks is also related to the Gulf Stream current. Both temperate species (e.g. porbeagle) as well as semi-tropical species (e.g. basking shark, blue, tiger, threshers, shortfin mako) seasonally use the warm waters of the Gulf Stream. The majority of satellite tracking data suggests that semi-tropical species may move into the Gulf Stream during the winter months, when leaving Canadian habitats.

The OSW study area represents a small part of the population-level range of the shark species that can be found in Canada. Shark physiology is very adaptable and individuals can use areas with a wide range of environmental characteristics. Pelagic species move 1000s of kilometers in a year and have the potential to distribute throughout the OSW study region. Essentially all of the species considered in this document would be expected to be found (at varying density) throughout the OSW study region during the summer and fall (primarily June to November), with the exception of deep-sea species and Greenland shark. Deepsea and demersal species are likely present all year.

The distribution of sharks within the OSW study region would be primarily related to feeding behaviour. Spawning and pupping areas are less well-known and sharks do not follow defined migration routes when undertaking seasonal movements. Smaller pelagic sharks are piscivorous, primarily eating teleost fish and cephalopod species. Only larger adult shortfin mako and white shark would also feed on marine mammals (seals, porpoises, small whales, etc). Thus, productive fishing grounds for teleost fishes or hotspots for teleost fishes would also be associated with higher densities of numerous species of sharks. These habitats could be found at varying depths and locations throughout the OSW study area.

Seasonal distribution patterns of shortfin mako were recently described in a Recovery Potential Assessment (Bowlby et al. 2022b). Captures by fishing quarter (Figure 1 in Appendix B) and satellite tag tracks by fishing quarter (Figure 2 in Appendix B) are reproduced here as an example of how the distribution of a semi-tropical species may change seasonally. This example demonstrates how wide-spread sharks tend to be and how there is comparatively little information that can be used to evaluate distribution patterns.

Gaps

For the majority of species, there is essentially no fishery-independent data on habitat use or distribution. Even the amount of information from fishery-dependent data changes seasonally, with lower effort during the winter from fisheries that would have higher interaction rates with sharks. This means that our understanding of where pelagic sharks tend to be is heavily influenced by where fisheries are taking place and by shark catchability from the gear types being used (e.g., Figure 1 for pelagic longline). Commercial fisheries in Canada are not targeting sharks and would be expected to avoid shark bycatch if possible. This means that areas of high concentration for numerous shark species (and the environmental characteristics associated with them) may be missed from fishery-dependent data.

Habitat modeling has not been done for any shark species at the scale of the OSW study region. A global analysis for blue shark suggests that high-quality habitat would be found throughout the OSW study region for approximately 6 months of the year (Druon et al. 2022).

There is extremely little information on spawning and pupping locations for the majority of the shark species found in Canadian waters. The distribution of young-of-the-year shortfin mako suggests that pupping occurs throughout the OSW study region (Natanson et al. 2020).

There is extremely little information on the historical distribution of any shark species in Canadian waters. Prior to 2001, species identification was poor for morphologically similar species that were captured by fisheries (e.g. shortfin mako, porbeagle; Bowlby et al. 2022b). Pelagic shark bycatch was inconsistently recorded in commercial logbooks and detailed shark monitoring was only implemented in 2010 by at-sea observers. Deepwater species are rarely captured and have no potential to be monitored using available electronic tagging technology, given depth limitations of the tags. Much of what is currently known about shark distribution patterns has been determined since the advent of satellite tagging technologies (early 2000s onward).

It is not only distribution patterns or habitat use of sharks that may be affected by the OSW installation. Sharks have the ability to sense electromagnetic signals in the water through specialized cells in their snouts. Numerous species are attracted to or affected by electromagnetic signals (Hutchinson et al. 2020). Instances where sharks have been attracted to the electromagnetic field given off by lithium batteries include: (1) attacks on ocean gliders deployed by the Ocean Tracking network in Canadian waters, and (2) preferential interaction with GoPro cameras during fieldwork even in the presence of bait. The potential for an OSW installation to influence shark behaviour should be considered, in that some species may be attracted and some repelled to the area.

1.5 Identified areas and/or times of year that are important for one or more fish species (e.g., spawning areas, aggregation areas, migration routes, etc.).

American Lobster

Overview

The American lobster (*Homarus americanus*) is a crustacean species that has been commercially fished since the early 1800's. In the Maritimes region of DFO the American lobster fishery, which is one of the most important fisheries in Canada from a social, economic and cultural standpoint, occurs in the

nearshore (<100m) areas throughout this study area (SA). In westerly section of the area of there are also important mid-shore and offshore (>100m) lobster fisheries.

This decapod has a complex life cycle characterized by several phases from eggs, larvae, juvenile, and adults, and relies on moulting its exoskeleton for an increase in size. Typically, the mature females mate after moulting in late summer, and extrude eggs the following summer. The eggs are attached to the underside of the tail to form a clutch and are carried for another 10-12 months hatching in June - August. The eggs hatch into a pre-larvae or prezoea, and through a series of moults become motile larvae. These larvae spend 30-60 days feeding and moulting in the upper water column before the post-larvae settle to the ocean floor seeking shelter. For the first few years of life, juvenile lobsters remain in or near this sheltered environment to avoid predation, spending more time outside of the shelter as they grow (Lavalli and Lawton 1996). Nova Scotia lobsters can take up to 8-10 years to reach a minimum commercial size of 82.5 mm carapace length (CL). Moulting frequency begins to decrease from 1 moult per year (at about 0.45 kg individual weight) to moulting every 2 or 3 years for lobsters above 1.4 kg (Aiken and Waddy 1980).

Lobster of all life stages and sizes make use of the nearshore and mid-shore areas throughout the study area. Typically larger lobster migrate from the inshore to the offshore areas, although there is evidence of juvenile lobster in the offshore.

Lobster are distributed in coastal waters from Maryland USA to southern Labrador in Canada, with the most concentrated fisheries located in the waters between the Gulf of Maine and Gulf of St. Lawrence. In addition to the coastal habitat used by American lobster, there are offshore areas in the Gulf of Maine and along the outer edge of the Scotian Shelf from North Carolina to Sable Island which contain commercial concentrations (Pezzack et al. 2015). It is presumed the presence of lobsters in the offshore areas is due to the year-round warm water that maintains suitable temperatures in the slope and deep basins in the Gulf of Maine and western Scotian Shelf. This warm deep water is not a prevailing oceanographic feature on the eastern Scotian Shelf, the outer Gulf of St Lawrence or off Newfoundland, where lobsters do not typically occur in commercial densities in the offshore.

The currently defined Lobster Fishing Areas (LFAs) do not represent biological units. They are based on historical boundaries. There is high potential for the exchange of lobster between areas in all life stages, and studies have shown relative strong larval connections between some LFAs (Quinn 2014). It is generally accepted that lobster concentrations are highest in coastal regions with lower concentrations associated with the offshore area.

Fisheries Dependent Spatial Analyses
The most representative spatial analyses of lobster fisheries are found in the draft technical report (Cook et al. in prep. Draft attached). For LFAs 27-32, these figures represent the most accurate depiction of lobster habitat and commercial densities available.

Fisheries Independent Spatial Analyses ***[see Appendix B for figures referred to throughout this section]***
In LFA 34, 35, 36 and 38, various fisheries independent data sets are available to depict the distribution of various life stages of lobster. Figure 3 shows modelled distribution of commercial abundance of lobster following commercial fishing (June-July months) in 2018-2022. There are persistent areas of high density, which also coincide with the fisheries footprint maps shown in the attached draft technical report. Areas of high density of lobster are also prevalent in the offshore LFA 40 and LFA 41.

Figure 4 shows the catch of recruiting lobster (70-82mm carapace length) from scallop dredge surveys. Clear and persistent patterns of high abundance of recruiting lobster can be seen in these figures.

Figure 5 shows the spatial extent and temporal time series of egg bearing (or berried) lobsters from at-sea samples of lobster traps, standardized recruitment trapping projects, bottom trawl surveys and scallop dredges. All data for these figures were subset for just the months of May, June and July, which are important months for mating, egg extrusion, release and moulting. This figure depicts presence / absence only as the various types of gear do not allow for easy comparison of relative abundance (i.e. trap catches ≠ trawl catches). Berried female lobster occupy inshore habitat across the region during the summer months. In addition, there are important offshore areas which are occupied by berried female lobster on a persistent basis.

There are no comprehensive sampling programs for lobster larvae, however sampling does occur on an annual basis in Cape Breton and along Eastern Shore of Nova Scotia (Figures 6-10) by fishing association groups. Plankton tows show that lobster larvae are present during the summer months along the coastal and inshore areas in almost all plankton tows performed. The extent of larval distribution is not known, but given the distribution of berried females during the summer months (when larvae would be released) there is a high likelihood larvae are present in the nearshore waters and are dispersed following the oceanographic currents

Temporal Trends in biomass / abundance
Trends in commercial lobster abundance can be found in the annual stock status updates for each of the LFAs:

- https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41118339.pdf
- https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41107822.pdf,
- https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/4110786x.pdf
- https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41108589.pdf
- https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41108437.pdf

Briefly, trends in commercial biomasses for eastern LFAs (LFA 27-32) are at or near all-time highs for the last several years. In LFA 33, commercial biomass has declined from the high in 2016/2017 but remains high and relatively stable. In LFA 34 and 35, commercial biomass has been declining in the fishery, however survey biomasses appear more stable, but lower than the all-time highs in 2015/2016. LFA 41, commercial biomass is high, but variable.

Gaps
There is a lack of fisheries independent data east of LFA 34 and thus we are largely beholden to the fisheries logbook data to describe changes in biomass and abundance. Although this does present some issues in assessing and modelling populations, the indices generated from the fisheries data do appear to reflect changes in available biomass and the distribution of the lobster stocks.

Atlantic Cod
Atlantic Cod is a demersal species that occurs throughout the Offshore Wind RA Study Area at depths up to 457m (Scott and Scott 1988). There are several relevant stocks of Atlantic Cod: Southern Gulf of St. Lawrence (4T & 4Vn November-April), Sydney Bight/Cabot Strait (4Vn May-October), Eastern Scotian Shelf (4VsW), Bay of Fundy (4X5Y) and Georges Bank (5ZEjm). The Georges Bank stock transboundary and is co-managed with the United States, while the Scotian Shelf and Bay of Fundy stocks are managed domestically. Atlantic Cod are harvested as part of a multi-species groundfish fishery. The Eastern

Scotian Shelf (4VsW) and Sydney Bight (4Vn May-October) fisheries have been under moratorium since 1993 and only bycatch is permitted (DFO 2005a).

Each Atlantic Cod stock has areas and times of year that are important for spawning:

- The Southern Gulf of St. Lawrence (4T & 4Vn November-April) stock overwinters in warm water along the southern slope of the Laurentian Channel and in the Cabot Strait area in 4Vn (Swain et al. 2019). In April and early May, the stock migrates into the Southern Gulf of St. Lawrence to spawn and feed in the Shediac Valley and around the Magdalen Islands from late April to early July (DFO 2005b). In November, it returns to its overwintering grounds.
- The Sydney Bight/Cabot Strait (4Vn May-October) stock is the resident stock in 4Vn. These fish do not migrate to 4T to spawn and feed; instead, summer RV survey data (July-August) has shown spawning aggregations in the Sydney Bight region (Campana et al. 1995).
- The Eastern Scotian Shelf (4VsW) stock is a complex of spawning components including at least two major offshore groups (Western/Sable Banks and Banquereau Bank), smaller offshore groups (Middle Bank and Canso Bank) and smaller coastal spawning groups (DFO 2002b). Several components, including Western Sable Banks and some inshore areas, have both spring and fall spawning (DFO 2002b).
- The Bay of Fundy (4X5Y) stock is another complex of spawning components that includes inshore and offshore groups that mix (D. Clark 2005). Cod in this region spawn in the spring (February-March) on Browns Bank, off Digby Neck and Grand Manan at the mouth of the Bay of Fundy, and in the fall (October-November) along the coast of Nova Scotia from Halifax Harbour to Yarmouth and at the mouth of St. Mary's Bay (D. Clark 2005).
- The Georges Bank (5ZEjm) stock spawns on eastern and western Georges Bank from November to May with peak spawning occurring in February and March (O'Brien et al. 2005).

Atlantic Herring

NOTE: This response is for 4VWX HERRING. Please consult Gulf Region information for 4VTn herring

- An overview of Atlantic Herring in the Maritimes Region is available at this link: Atlantic herring in the Maritimes Region (dfo-mpo.gc.ca)
    - In particular, see Figure 3 for a schematic representation of herring spawning grounds.

- Atlantic Herring (*Clupea harengus*) is a pelagic species found on both sides of the North Atlantic.
- Atlantic herring is a key forage fish species in the Northwest Atlantic and plays an important role in the ecosystem as a main prey species for large fishes, seals, whales, and seabirds.
- Herring spawn in discrete locations to which they have a strong affinity. The majority of Herring in the 4VWX area are fall spawners. These Herring mature in 4VWX and first spawn at three or four years of age, then begin an annual pattern of spawning, over-wintering, and summer feeding. This often involves considerable migration and mixing with members of other spawning components and stocks. See Figure 11 in Appendix B for historic spawning sites.
- Spawning locations on the Scotian Shelf and Gulf of Maine are also shown in Figure 5 of the following research paper: Population integrity and connectivity in Northwest Atlantic herring: a review of assumptions and evidence | ICES Journal of Marine Science | Oxford Academic (oup.com)

- Fishing takes place on dense summer feeding, overwintering, and spawning aggregations. The 4VWX area contains a number of Herring spawning areas, separated to various degrees in space and time. For the purposes of evaluation and management, 4VWX Herring is divided into four stock components (see the Figure 12 in Appendix B for a map of place names):
    - Southwest Nova Scotia/ Bay of Fundy (SWNS/BoF) spawning component (includes German Bank, Scots Bay, Trinity Ledge, Spectacle Buoy, Seal Island, and Browns Bank),
    - Offshore Scotian Shelf spawning component (includes The Patch and Western Hole),
    - Coastal Nova Scotia (NS) spawning component (includes South Shore, Eastern Shore, and Cape Breton), and
    - Southwest New Brunswick (SWNB) migrant juveniles (NB weirs). Each component, except SWNB migrant juveniles, has several spawning areas, and there is mixing of fish among spawning components outside of the spawning period.
- Note: Historically, Georges Bank (NAFO area 5Z) has been included in the 4VWX Herring science update. Due to the absence of information in recent years, there is no basis for evaluating this component
- In 2018, the Southwest Nova Scotia / Bay of Fundy Atlantic herring stock fell below the Limit Reference Point (LRP) for the first time since 2010. The LRP separates the critical and cautious zones in DFO's Precautionary Approach framework. The relative status for the other subcomponents is unknown.
- The decline of forage fish stocks like Atlantic Herring can lead to cascading ecosystem impacts.
- Pelagic fish such as herring often exhibit sporadic recruitment peaks. Recruitment has been generally low or decreasing, and is expected to remain low. Recruitment pulses are possible but depend on an alignment of environmental conditions including water temperature and zooplankton community/availability.
- The likelihood and timeframe for increasing stock biomass may be limited by both environmental conditions and fishing pressures, the degree to which may vary across stocks.
- See also: https://github.com/AllanDebertin/Herring-Landings-Report for current landings report.

Gaps

- There is very little data collected in the Offshore component and Georges Bank Components. The extent of spawning biomass is unknown. Dedicated acoustic surveys are required to provide an index of abundance. Historically, Georges Bank landings were annually estimated to be between 33,000 t to 373,000 t during 1961 to 1977. Scotian Shelf had landings that were between 1 t to as much as 107,000 t during 1961 to 1977. Offshore components landings average about 5 t per year over the last 48 years (Stephenson et al. 1987).
- While there is site fidelity for the majority of spawning herring, there is some mixing among sub-populations of herring among spawning grounds. This makes it challenging to track local population dynamics. (van den Heuvel et al. 2022).
- The exact mechanisms and extent to which changes in weight-at-age, fecundity, and maturation changes due to environmental conditions or fishing pressure remain unclear (DFO 2022a).
- There is evidence to suggest increased natural mortality in recent years, particularly for the 4T herring stocks in the southern Gulf of St. Lawrence (sGSL). The increasing trends in natural mortality of older age classes was correlated with the increase in grey seal and Atlantic Bluefin Tuna abundance over the same time period in the sGSL (Rolland et al. 2022).

- For 4VWX Herring stocks, the extent to which natural mortality and fishing pressure has decreased in recent years remains uncertain (DFO 2022a).

Bluefin tuna and swordfish

There are two stocks of Bluefin tuna that occur in Canadian waters. The eastern stock migrates across the Atlantic as juveniles to feed on small pelagics and appears to reside in our waters most of the year and only leave once they are sufficiently large enough to spawn in the Mediterranean Sea. Spawning of this component of the eastern stock is also believed to occur in the Slope Sea which includes portion of Georges Bank, Browns Bank and the Fundian Channel. The western stock mixes with eastern fish as juveniles and forage until they are large enough to make spawning runs into the Gulf of Mexico. They make this migration annually as larger adults, entering the Gulf of St, Lawrence in July and returning south in November. It is also believed that, prior to spawning in the Gulf of Mexico, the juveniles contribute to spawning in the slope sea.

Recently, large numbers of Bluefin tuna are occurring in NL coastal waters. These fish are generally the largest caught in Canadian waters and either represent a latitudinal shift of western adults to the north and/or large eastern adults returning from the Mediterranean Sea after spawning.

All components of the population forage where large schools of small pelagic fish aggregate. Because of this habit, Bluefin can be found on offshore banks and basins, upwelling areas and in inshore bays and inlets. Their critical habitat is the critical habitat of their prey as well as the routes that connect the numerous foraging areas. Compared to most fish species, the movements of Bluefin tuna are fairly well known given the extensive tagging efforts.

North Atlantic Swordfish also inhabit the Study Area, with the majority of catches occurring between June and October. They are concentrated along the Scotian Shelf break where warm Gulf Stream waters meet the colder Labrador current. Emerald basin represents an additional foraging hotspot but any shelf or canyon where upwelling is also important. Swordfish found in Canadian waters are among the largest in the population and are critical to the overall productivity of the species. Foraging in Canadian waters is followed by a southward migration to spawning areas in the subtropical convergence zone or Caribbean Sea.

Gaps

Data gaps do exist for both Bluefin tuna and Swordfish. These gaps relate to knowledge about their feeding ecology and dependencies on particular forage species and areas for the completion of their life history. It is also not clear how dependent these species are on particular migration routes even when it is generally known where these routes are. Due to less extensive tagging studies, knowledge about swordfish habitat use while in Canadian waters poorly understood than for Bluefin tuna, particularly under a rapidly changing ocean environment.

Offshore Clam

The offshore clam fishery is conducted from large freezer processors using hydraulic dredges on sandy substrates located at 50 to 110 m depth. Species retained in this fishery are: Arctic Surfclam (*Mactromeris polynyma*), Northern Propeller Clam (*Cyrtodaria siliqua*), Greenland Smooth Cockle (*Serripes groenlandicus*), and Ocean Quahog (*Arctica islandica*). There is one licence holder for this fishery and fishing location data is subject to the Rule of Five in public documents. There is a Lophelia Coral conservation area within the Banquereau fishing are that is closed to the clam fishery.

As offshore clams are sessile, so they don't aggregate to spawn or have nursery areas. They are broadcast spawners. Preliminary results for a study on the spawning cycle of Arctic Surfclam (*Mactromeris polynyma*) on Banquereau indicate the potential for spawning to occur year round. We do not know when the other species in the commercial fishery spawn. Arctic Surfclam larval development and growth is temperature dependent. They have a planktonic larval stage of 1–3 weeks, juveniles recruit to inshore or offshore sandy banks where their distribution is limited to benthic substrates with medium to large grain sediments and water temperatures of less than 15˚C. There is a lot of genetic mixing of the inshore and offshore populations.

There was a quahog survey on Sable in 2003 (DFO 2007), and Banquereau was last surveyed in 2010 (Roddick et al. 2010). Coordinates and tow metadata can be provided if needed. The stock status update from 2022 is also available (DFO 2022b). The stock update from 2023 is not yet available.

There is a whelk fishery on Banquereau that is in the process of becoming a commercial fishery (Wilcox 2023). There is currently a limited commercial fishing for Quahog on Sable Bank (one or two trips per year.) This could expand in the future. There is a small (1 or 2 licence holders) inshore commercial ocean quahog fishery. This occurs within the 20 mile limit in Southwest Nova Scotia.

Species lists from the most recent surveys conducted by the clam unit are provided in Annex B.

Gaps
The distribution and life history characteristics of clam species and aggregations elsewhere than on Banquereau are not well known or not known at all. Fishery independent data on these clam, quahog, cockle populations is expensive and time consuming to collect, it is unlikely that new surveys will occur in the future.

Haddock
Haddock is a demersal species that occurs throughout the Offshore Wind RA Study Area, most commonly at depths from 27 to 366m (Scott and Scott 1988). It is most abundant on Georges, Browns, Baccaro, and Sable Banks (Horsman and Shackell 2009; M King et al. 2016; Ricard et al. 2022). There are several relevant stocks of Haddock: Bay of Fundy/Scotian Shelf (NAFO area 4X5Yb), Eastern Georges Bank (5Zjm), and the Eastern Scotian Shelf (4TVW) (DFO 2002a; 2023b; TRAC 2022a). The Georges Bank stock transboundary and is co-managed with the United States, while the Scotian Shelf and Bay of Fundy stocks are managed domestically. Haddock is harvested as part of a multi-species groundfish fishery and makes up a significant portion of the landings and total value each year. The 4TVW Haddock fishery is under moratorium and only bycatch is permitted.

Haddock inhabits inshore and offshore waters, with seasonal movements based on water temperature (Needler 1931; Rogers, Rowe, and Morgan 2016; Perry and Smith 1994). It is a broadcast spawner on Georges, Browns, Emerald, Western and Sable Banks from March to April, but spawning can extend from February to June (Lapolla and Buckley 2005; Page and Frank 1989; Ollerhead 2007; Waiwood and Buzeta 1989).

Pollock
Pollock is a demersal species that occurs throughout the Offshore Wind RA Study Area, most commonly at depths from 110-181m (Scott and Scott 1988). There are two relevant stock components: a larger Western Component (4Xopqrs+5Yb+5Zc) and a smaller Eastern Component (4Xmn+4VW). These stock

components are managed domestically. Pollock is harvested as part of a multi-species groundfish fishery.

Pollock inhabit inshore and offshore waters, with movements tied closely to water temperature (DFO 2023c) Spawning is defined by temperature, starting when waters cool in the late fall (8-10*C) and peaking in early winter (5-6*C) (DFO 2023c). Spawning occurs on areas surrounding Georges Bank and in the offshore, with juveniles spawned offshore migrating to inshore areas during their first summer, where they remain for approximately two years (Clay et al. 1989).

Silver Hake

Silver Hake is a demersal species that occurs throughout the Offshore Wind RA Study Area, at depths up to 910m (Scott and Scott 1988). It occurs most commonly in NAFO areas 4VWX, which is the current assessment unit and the area in which a directed fishery is prosecuted (DFO 2020b). The stock is managed domestically. Silver Hake aggregate along the warm waters of the Scotian Shelf and inside the Emerald and LaHave Basins. From July to September, the species migrates to the shallower and warmer waters around Emerald and Sable Island banks to spawn (Rikhter et al. 2001).

Snow Crab

- The best available knowledge can be found at the below links. These two sources have been internally reviewed by DFO Research Scientists and use methods that have already been vetted through the CSAS Framework document. PDF copies can be provided
    - https://www.biorxiv.org/content/10.1101/2022.12.20.520893v1
    - https://www.biorxiv.org/content/10.1101/2023.02.13.528296v3.full.pdf+html
- In addition, two relevant CSAS documents will soon become available that can help inform this or future assessments:
    - Choi, Jae S. 2023. A framework for the assessment of snow crab (Chionoecetes opilio) in Maritimes Region (NAFO Div 4VWX). CSAS Research Document 2023/077.
    - DFO 2023. Assessment of Scotian Shelf Snow Crab 2022. CSAS Science Advisory Report 2023/XXX

Scallop

- The Scotian Shelf is home to several important scallop species**.** Two notable scallop species in this region are the Atlantic sea scallop (*Placopecten magellanicus*) and the Iceland scallop (*Chlamys islandica*).
- The most recently-published update of stock status of the Georges Bank scallop stock is from the Science Response process of April 2022 which is based on scallop survey and fishery data from 2021 and subsequent advice for the management of the 2022 fishery (DFO, 2022c).
- The most recently published update of stock status of the Browns Bank North scallop stock is from the Science Response process of April 2022 which is based on scallop survey and fishery data from 2021 and subsequent advice for the management of the 2022 fishery (DFO, 2022d).
- There is a Sea Scallop CSAS document in queue for publication and will be updated this winter. Neither were published in time to inform this response.
- A large gap is the lack of a DFO CSAS process for Sea Scallops in the Sable Island Bank area. An assessment is schedule for next year (2024).
- The following links provide good overviews of the inshore and offshore scallop fishery:
    - Assessments Eastern Canada offshore scallop - MSC Fisheries

- Assessments FBSA Canada Full Bay sea scallop - MSC Fisheries

Shrimp

- DFO (2023d) provides a good general overview of the areas fished for shrimp.
- The inshore area of Bad Neighbour Shoal is identified as one of the most prominent areas for juvenile shrimp and is the main source of replenishment to the northern shrimp stock in the area. The organically rich bottom sediment in this area, LaHave Clay, is one of the main reasons for recruitment/juvenile presence.
- The Chedabucto Bay area has a northern shrimp trap fleet that fishes there year-round. This sector is unique to our fishery and is only active within Chedabucto Bay.
- Additional information on the shrimp fishery, including shrimp fishing areas on the Scotian Shelf, can be found in the attached Marine Stewardship Council document entitled "Canada Scotian Shelf Northern Prawn trawl and trap – Second Surveillance Report."

Yellowtail flounder

Yellowtail Flounder is a demersal flatfish species that occurs through most of the Offshore Wind RA Study Area, most commonly at depths from 37 to 91m (Scott and Scott 1988). It occurs at higher abundances on the eastern half of the Scotian Shelf, and on Browns and Georges Banks (Horsman and Shackell 2009; M King et al. 2016; Ricard et al. 2022). There are three managed stocks: Scotian Shelf (4VW), Bay of Fundy (4X) and Georges Bank (5ZEjm). The Georges Bank stock transboundary and is co-managed with the United States (TRAC 2022b), while the Scotian Shelf Shelf and Bay of Fundy stocks are managed domestically (DFO 2002b). Yellowtail flounder is a bycatch species in the 4VWX5 and 5Z multi-species groundfish fisheries. Spawning occurs from March to early summer on the Scotian Shelf including on Browns and Emerald Bank (Ollerhead 2007; J. S. Scott 1983). The species exhibits some limited seasonal movements and vertical movements in the water column (Alade and Cadrin 2014; Walsh and Morgan 2004).

1.6 Current knowledge of Atlantic salmon presence / migration through the Study Area.

- This information is forthcoming and will be provided at a later date, per discussions with IAAC.

1.7 Current knowledge of American eel presence / migration through the Study Area.

- This information is forthcoming and will be provided at a later date, per discussions with IAAC.

1.8 General discussion on recent / current trends within the region attributed to climate change, and the general prediction of future trends for fish and fish habitat.

General comments

- Both past and future warming in Canada is, on average, about double the magnitude of global warming. The rate and magnitude of climate change under high versus low emission scenarios project two very different futures for Canada.

- Oceans surrounding Canada have warmed, become more acidic, and less oxygenated, consistent with observed global ocean changes over the past century. Ocean warming and loss of oxygen will intensify with further emissions of all greenhouse gases, whereas ocean acidification will increase in response to additional carbon dioxide emissions.

- Ocean acidification, that can affect how species build their shells and skeletons, has been demonstrated to have negative effects on some commercial species (bivalves, crustaceans). Under all future emission scenarios for the 21st century, ocean acidification is

expected to continue to increase in the upper ocean, but it would be expected to stabilize under the low emission scenario.

- A decline in the amount of subsurface oxygen in the oceans surrounding Canada results in a general reduction of the suitable habitat for fish and other aquatic organisms.

- The following paper may be of interest: https://www.biorxiv.org/content/10.1101/2022.07.19.500650v1.full

Impact on fish species

- Climate change is expected to have wide-ranging impacts on fish abundance and distribution in the North Atlantic Ocean. Key impacts of climate change in the ocean are warming temperatures, acidification, decreased oxygen and changes to primary production which will change the growth, metabolism, condition, survival and abundance of fish.

- Warming is expected to influence commercial species expansion or contraction across the ocean landscape, as populations seek waters that suit their temperature preferences. Atlantic halibut, for example, have increased throughout the Atlantic basin due to warming. Generally, warm-water species may increase throughout Canadian waters, while populations of cold-water species may disappear from their southern range.
- Climate change will reduce biomass of commercial and non-commercial species and impact ecosystem structure in the study area (Guénette, Araújo, and Bundy 2014; Stortini et al. 2015).
- Further, there will be changes to the geographic distribution in response to environmental shifts and shifts in species composition (Boyce, Schleit, and Fuller 2020).
    - For example, it is predicted that Atlantic Cod and Pollock will lose habitat in their thermal niche, but Haddock and Yellowtail will maintain it under short and long-term scenarios (Shackell, Ricard, and Stortini 2014).
- While current species in the area will change distributions, warmer-water species will shift their ranges to adapt, introducing new species into the study area (i.e., Black-bellied Rosefish, John Dory) (DFO 2021; S. A. Lewis et al. 2023).
- Notably, an increase in water temperature has led to changes in nutrient availability and declines in phytoplankton cell size, which will impact most trophic levels and the whole Scotian Shelf food web (Casault et al. 2022; Loder et al. 2013; Stortini et al. 2015).
- The change species distributions will lead to changes in the numbers of transboundary stocks found in regions
- Business-as-usual (no climate mitigation) will mean more stocks will be affected, whereas low emissions means fewer marine species to be impacted with less impacts to fisheries.
- It is difficult to predict and account for all impacts of climate change on the ecosystem as it is a large and complex area with many species interactions and different habitat.

Impacts of climate change on specific species: American eel

Climate change has the potential to impact the species by increasing the frequency and intensity of storms, which may impact eels migrating through the Study Area.

Juvenile American eel larva are transported northward by oceanic currents and many end up entering waters within the Study Area. This larval transport could potentially be affected by changing oceanic temperatures or circulation patterns.

Glass eels entering rivers of the study area Nova Scotia could encounter the influence of climate change through altered thermal and hydrographic regimes in freshwater which may influence survival and habitat use.

Impacts of climate change on specific species: Atlantic cod

The effect of climate change on Atlantic Cod, and on groundfish species in general, is classified as a net negative (Hare et al. 2016). As the ocean has warmed, a northward shift in Atlantic Cod has been observed in the Gulf of Maine and on the Scotian Shelf, and future projections anticipate that this trend will continue (Mieszkowska et al. 2009, 3; Selden et al. 2018). Projections to 2100 indicate that the Georges Bank stock will decline, while spawning sites will shift further north; however, increased temperature will cause growth rates for select stocks to increase (Drinkwater 2005). Habitat will be lost particularly on Georges Bank (Fogarty et al. 2008). The proportion of Atlantic Cod's prey species' ranges that overlaps with their distribution is and will continue to be reduced, as had their top-down control on their prey (Selden et al. 2018). Vulnerability studies classify Atlantic Cod has vulnerable to climate change (Stortini et al. 2015; Hare et al. 2016).

Impacts of climate change on specific species: Bluefin tuna and swordfish

Over the past 10 years both North Atlantic Swordfish and Bluefin tuna have demonstrated shifts in their distribution that can be partially or wholly attributed to changing ocean climate. Northern Swordfish are less likely to be found concentrated along sharp temperature gradients and are more likely to be distributed over the entire study area. They are also more prevalent along the shelf break that is part of the Grand Banks than in the past, perhaps due to the presence of these temperature gradients.

Bluefin tuna are also demonstrating a latitudinal shift in their distribution which has resulted in the larger, older components of the population to shift northwards and a concurrent influx of smaller, younger fish into areas vacated by larger fish. Coupled with this change is the extension of their residency time in Canadian waters to encompass all months of the year. As the climate continues to change, both Swordfish and Bluefin tuna will be particularly sensitive to the availability of key forage species that support their growth, development and productivity.

Climate change is not expected to reduce the current footprint for the Pelagic Longline, Harpoon or rod and reel fisheries. It is likely that as the distribution of the stocks continues to evolve, these fisheries will extended their footprint. With climate change, an expanded Bigeye tuna fishery is expected. It should be noted that for the Pelagic Longline fishery in particular, adequate space must be provided to allow the fleets to deploy their 50 km long drifting lines without potential for entanglement.

Impacts of climate change on specific species: Clam

The impact of climate change on the commercial clam species is largely unstudied. The following information is from Hubley and Heaslip (2018):

- The vulnerability of Arctic Surfclam to ocean warming and acidification have not specifically been studied to date. Other species, such as Ocean Quahog (*Arctica islandica*), Northern Quahog (Mercenaria mercenaria), and Atlantic Surfclam (*Spisula solidissima*) have been identified as exhibiting a high or very high degree of climate vulnerability in a broad examination of the relative vulnerability of fish and invertebrates on the Northeast United States Shelf (Hare et al. 2016). With warming temperatures, a bathymetric shift in the distribution of clam species would be expected, similar to the shift to deeper water observed for inshore Atlantic Surfclams (*Spisula*

solidissima solidissima) off the Mid-Atlantic coast of the USA during a period of unusually warm water (Weinberg 2005). A latitudinal shift is also likely to occur, where depth (e.g., Laurentian Channel) and substrate (e.g., Grand Bank) does not limit suitable habitat. In addition to changes in latitude and depth of species related to bottom temperature, it would also be expected that changes in growth rate, tissue weight, and mortality rates would occur. For additional information.

Impacts of climate change on specific species: Forage fish

Forage fish form a critical trophic link in marine ecosystems, and yet, for many species, there is limited information available. As nations move from single species stock assessments to ecosystem approaches to fisheries management (EAFMs), more information on forage fish will be required.

There has been a general decreasing trend in weight-at-age observed in multiple stocks, especially in older age classes though the trend is observed in younger age classes as well. Given that this declining trend may lead to a reduction of the enhanced reproductive potential of older and larger spawners, there is uncertainty in the reproductive output of herring over time (DFO 2022a).

Changes in environmental conditions may lead to changes in forage fish distributions and abundance/biomass. These can influence growth, condition, recruitment, spawning, spatial and temporal match with prey sources, among others. Spring spawning herring in particular prefer cooler temperatures for spawning and are thus affected by warming ocean waters. Strong recruitment of fall spawning stock occurs when the environmental conditions are slightly warmer and dependent on the abundance of different species of copepods (Boldt et al. 2022; Rolland et al. 2022)

Impacts of climate change on specific species: Haddock

A northward shift in Haddock has been observed since 1960 with the warming of the Gulf of Maine (Wise and Jensen 1960). In a projection to 2060, a 3*C of sea surface warming is expected to have a limited impact on the thermal niche of Haddock (Shackell, Ricard, and Stortini 2014). Over time, the biomass of large invertebrates is predicted to decline and have a negative impact on their predator species, including Haddock (Guénette, Araújo, and Bundy 2014).

Impacts of climate change on specific species: Sharks

The general prediction is that ocean warming will cause pelagic sharks to shift northward in their distribution and to arrive earlier in the season (Hammerschlag et al. 2022). Semi-tropical species may enter the OSW study area earlier in the year and leave later, and/or may be found at higher regional densities. It is more difficult to determine how temperate species and deepwater species might react. Porbeagle and Greenland shark may also shift their distribution northward and/or to deeper waters, but this is unlikely to result in their absence from the OSW study region.

Climate change hypotheses are difficult to validate, given the lack of historical distribution data on sharks (see Gaps). Also, the long evolutionary history of sharks demonstrates their high adaptive capacity to changing conditions, making it very difficult to predict how shark habitats will vary under climate change (Hazen et al. 2013). Other biological components of marine ecosystems would also influence shark habitat use, given that sufficient resources must exist at lower tropic levels to support higher tropic level shark populations. While abiotic conditions may be more conducive to sharks in future years due to climate change, the biological communities that sharks depend on may not be. Finally, numerous shark species have been subject to sustained overfishing at a global level and are currently at risk (e.g. oceanic whitetip, white shark). If recent conservation actions are effective (e.g.

Appendix II listing on CITES; https://cites.org/eng/app/appendices.php), it will be very difficult to distinguish between range expansion as abundance increases versus changes in habitat use under climate change.

Impacts of climate change on specific species: Silver hake

As a species with a preference for warmer waters, climate change – particularly, ocean warming – has had a more positive effect on Silver Hake than it has had on other groundfish. Over the past 40 years, Silver Hake distribution in the Northwest Atlantic has expanded northward with changes to the position of the Gulf Stream (Nye et al. 2011; Selden et al. 2018). The effect of ocean warming has been an expansion of available habitat and an expansion of the overlap between Silver Hake distribution and the distribution of key prey species (Selden et al. 2018)

Impacts of climate change on specific species: Lobster Distribution and Abundance

Lobster distribution has been shifting with climate changes (Goode et al. 2019; https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14778), with decreases in biomass in the most southern extend and increases in the northern extent of the species range. The decreases in the south were partially attributed to warming waters and the increased prevalence of shell disease. Climate has played a role in the current high productivity levels in the center of the species distribution (Gulf of Maine to southern Gulf of St Lawrence). Projected further increases in ocean temperature may change the species distribution, and timing of life history events. Additionally, changes in ocean chemistry (acidification, etc) have been suggested to affect lobster.

Impacts of climate change on specific species: Pollock

Pollock prefer water temperatures below 11°C, so increases in temperatures throughout Georges Bank and the Scotian Shelf could negatively affect their distribution and behaviour. If water temperatures exceed the upper thresholds for Pollock, the habitat available to Pollock may be reduced and its distribution may be limited. However, if colder areas near the lower limits of Pollock temperature preference increase, new habitat may be available and distribution may increase. Further, Pollock spawn in late fall and early winter once temperatures begin to cool. With climate change, temperatures could remain high for longer throughout spawning areas and thus delay the onset of spawning, or force Pollock to seek out new spawning habitat in adjacent areas that may be less suitable for spawning. For additional information see DFO (2023b).

In a vulnerability analysis, Eastern and Western Scotian Shelf Pollock had high vulnerability to climate change in a severe warming scenario (Stortini et al. 2015). Eastern Scotian Shelf Pollock had greater vulnerability than Western Scotian Shelf Pollock (Stortini et al. 2015).

Impacts of climate change on specific species: Yellowtail flounder

A vulnerability assessment of various fish on the Northeast U.S. continental shelf identified Yellowtail Flounder as vulnerable to climate change's impacts (Hare et al. 2016). In a projection to 2060, a 3*C of sea surface warming is expected to cause limited shifts in habitat availability for Yellowtail Flounder (Shackell, Ricard, and Stortini 2014).

1.9 Identified gaps related to data collection within the region (e.g., areas that are data-sparse or poorly understood).

- Provided throughout.

- For information on identified gaps related to DFO Maritimes Ecosystem Surveys, see information provided in section 4.2 on groundfish data collection

1.10 Mapping/data requirements

- Please refer to Annex A for information on requested data.

2. Marine Mammals and Sea Turtles

2.1 Overview / summary of marine mammals and sea turtle species that could be found within the Study Area and the times of year of their presence. This can be grouped under sub-headings such as Baleen Whales, Toothed Whales, Pinnipeds, Sea turtles, etc.

2.1.1 Sea Turtles

Overview

- Four species of sea turtles are found in Atlantic Canada: the leatherback sea turtle (Dermochelys coriacea), loggerhead sea turtle (Caretta caretta), Kemp's ridley sea turtle (Lepidochelys kempii),and green sea turtle (Chelonia mydas).
- Leatherbacks and loggerheads are listed as Endangered under Canada's *Species at Risk Act.*
- Kemp's ridley and green turtle are not listed under SARA; they are globally listed as Critically Endangered and Endangered, respectively.
- All four sea turtle species are found within the Study Area, but leatherbacks and loggerheads are the most abundant.
- There are relatively few data representing live sightings of Kemp's ridley and green sea turtles.

Leatherback Sea Turtle

- Leatherback Sea Turtles are the largest and most reported of sea turtle species found in Atlantic Canada
- The leatherbacks has a broad distribution, and is found in both nearshore and offshore waters.
- SARA Critical Habitat has not yet been formally delineated for leatherbacks
- Important high use (foraging) areas for the leatherback turtle have been identified in Atlantic Canada, including within the Study Area.
- Leatherbacks are seasonally abundant in the summer and fall, but have also been reported from November to May (typically via entanglements in fishing gear).

Loggerhead Sea Turtle

- Juvenile loggerhead sea turtles use Atlantic Canadian waters as foraging habitat.
- Loggerheads are mostly on the outer banks of the continental shelf, shelf slope and offshore waters and less commonly in nearshore waters.
- Sightings of loggerheads have been reported throughout the Study Site, primarily in nearshore areas and along the continental shelf.

Data Availability and Gaps

- Most sea turtles are present in Atlantic Canada from early June through to late October.
- A lot of sea turtle sightings derives from citizen science. Voluntary sightings made by the public are reported to government and non-government entities.
- The Canadian Sea Turtle Network (CSTN; www.seaturtle.ca) maintains a database of sea turtle sightings for Atlantic Canada.

    - See Figures 13 and 14 in Appendix B for sightings from the CSTN and DFO's Whale Sightings Database, respectively
- Despite the efforts made by the CSTN to solicit reports of sightings, reporting effort is variable on a yearly (or seasonal) basis
- Public reports of sea turtle sightings are received from various sources including, but not limited to, recreational boaters, tour boat operators, fisheries, government, and researchers.
- Sightings data also come from aerial and vessel surveys.
- Most public sea turtle sightings are limited to periods of increased recreational boat use and correspond to the tourism season (therefore data is biased to the summer months and nearshore waters).
- Leatherback sea turtles are large and widely distributed and are therefore more likely to be visually detected versus other species.
- Hard-shelled sea turtles are much smaller than leatherbacks and less common in nearshore waters, making them difficult to visually locate.
- Most of the sightings reported for loggerheads represent fisheries interactions or were collected during a seismic exploration survey that spanned one year.
- The lack of sightings in areas outside of those zones where turtles are typically reported by the public should not be interpreted as an absence of turtles. Similarly, concentrated numbers of sightings do not always reflect a large number of individuals in an area.
- DFO Science conducts annual vessel-based surveys for leatherback sea turtles in July and August in a small survey area. This highly biases the volume of reports there. Therefore, we choose to omit this data from the present consideration.
- There are no population abundance estimates for sea turtles in Atlantic Canada. Their distribution in Atlantic Canada is entirely marine (no nesting). Depth utilization varies by species and ranges from surface waters to several hundred metres.

Future Trends

- Climate change is a recognized threat to sea turtles (DFO 2020c).
- Predicted impacts of warming ocean temperature for sea turtle populations include shifts in their spatial and temporal distributions in Atlantic Canada.
- Ocean temperature impacts the distribution of jellyfish, the principal prey of leatherbacks in Canadian Atlantic waters. Planktonic blooms occur earlier with warming temperatures (Hays et al. 2005) which could result in leatherbacks arriving earlier in on their foraging grounds to exploit periods of high jellyfish abundance.
- Most leatherbacks occur in waters >15°C (James et al. 2006). A northward shift in the 15°C isotherm has been documented (McMahon and Hays 2006).

2.1.2 Marine Mammals

A high-level overview of the 28 cetacean species known to occur within the RA study area, based on examination of cetacean sighting records in our Maritimes Region Whale Sightings Database (WSDB) and expert knowledge, are provided below. These are categorized as either baleen whales (6 species) or toothed whales (22 species). For each species we provide the following information, in a tabular format:

- Name of population found in the area
- SARA and COSEWIC status
- Distribution in the Regional Assessment Study Area
- Seasonal occurrence in the Regional Assessment Study Area
- Recent/predicted trends in the Regional Assessment Study Area related to climate change

- Data gaps (relevant to occurrence in the Regional Assessment Study Area)
- Supporting literature is included in the references section (section 7)

The summary information provided is based on a combination of expert knowledge, available data, and a review of the scientific literature. The main data sources on cetacean occurrence off Nova Scotia include, but are not limited to:

- Focused field studies on particular species in some areas (such as northern bottlenose whale studies in the Gully/eastern Scotian Shelf area or North Atlantic right whale studies around the mouth of the Bay of Fundy)
- Large-scale aerial cetacean surveys, usually conducted over a few days every few years (e.g., see Lawson and Gosselin 2009)
- Opportunistically collected cetacean sightings records from various sources (see section 2.7 for more information about the Maritimes Region Whale Sightings Database (WSDB))
- Multispecies long-term passive acoustic monitoring (PAM) efforts

Some general considerations relevant to all species within the Regional Assessment Study Area are as follows:

- There are many knowledge gaps in the abundance, density and fine-scale distribution of most cetaceans throughout the majority of waters off Nova Scotia, and off eastern Canada more generally. While dedicated cetacean research efforts have been occurring, usually focused on particular species in specific areas, there has been relatively limited cetacean research and monitoring efforts over much of the Scotian Shelf.
- Climate change is an important threat to all cetacean populations; however, exactly how climate change is impacting cetaceans and the extent of those impacts remains an area of uncertainty. Cetaceans may be directly impacted by changes to their habitat resulting from climate change, as well as by changes in prey availability caused by climate change. At current time, it is generally not known how climate change is or will impact the occurrence of most cetacean species within the Regional Assessment Study Area and thus recent/predicted trends related to climate change are generally unknown.

Baleen whales

Blue whale (Balaenoptera musculus), Atlantic population

SARA: Endangered
COSEWIC: Endangered

Distribution in the Regional Assessment Study Area

- Occur throughout the Scotian Shelf region, including on-shelf, along the shelf break, and in deeper waters
- Many sightings occurred on-shelf during whaling era
- Entirety of Scotian Slope identified as important habitat in previous CSAS process
- No Critical Habitat yet designated under SARA

Seasonal occurrence in the Regional Assessment Study Area

- Considered seasonal migrants, though some animals overwinter in eastern Canada
- Have been visually/acoustically detected in the region throughout the year
- Most visual detections occur in spring, summer and fall, though this is biased towards times of year when research effort occurs

- Most acoustic detections occur in the winter, though this is biased by the times of year when they produce stereotyped breeding calls which are most easily detected

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- One study observed increased acoustic occurrence in northern-most range from 2004-2014, mostly likely due to climate change

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Many knowledge gaps related to fine-scale distribution and occurrence in specific areas within the Scotian Shelf region remain
- Additional studies are needed to identify additional important habitats that likely exist off eastern Canada in general, including within the Scotian Shelf region

Fin whale (Balaenoptera physalus), Atlantic population

SARA: Special Concern
COSEWIC: Special Concern

Distribution in the Regional Assessment Study Area

- Fin whales occur in coastal, on-shelf and off-shelf waters through waters off Nova Scotia
- Limited visual surveys indicate areas of higher density on the outer Scotian Shelf

Seasonal occurrence in the Regional Assessment Study Area

- Considered a seasonal migrant, with increased abundance in northern latitudes in the summer, but a non-negligible number of the population stays within waters off eastern Canada through the winter
- Have been visually/acoustically detected in the region throughout the year
- Most visual detections occur in spring, summer and fall, though this is biased towards times of year when research effort occurs Most acoustic detections occur in the winter, though this is biased by the times of year when they produce stereotyped breeding calls which are most easily detecte

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- One study observed increased occurrence in northern-most range from 2004-2014, mostly likely due to climate change

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance of fin whales that remain in northern latitudes year-round is unknown
- More baseline monitoring is needed to assess the fine-scale distribution and habitat use of fin whales off Nova Scotia
- Fin whale stock structure is poorly understood, though it has been proposed that fin whale stock populations can be identified by acoustic differences - the occurrence of these fin whales within the study area has not been explicitly studied down to the stock level

Humpback whale (*Megaptera novaeangliae*), Western North Atlantic population

SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Occur throughout the entire Scotian Shelf region, including on-shelf, shelf edge, and deeper waters
- Most visual detections occur on-shelf, in the eastern-most range of the Scotian Shelf

Seasonal occurrence in the Regional Assessment Study Area

- Occur year-round in the Scotian Shelf region
- Most visual detections occur in spring, summer and fall, though this is biased towards times of year when research effort occurs
- Acoustic detections peak in late fall/winter (Oct-Jan) and late spring/summer (Apr-Jul) in most locations around the Scotian Shelf

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Many knowledge gaps related to fine-scale distribution and occurrence in specific areas within the Scotian Shelf region remain
- The movement patterns of species into, out of, and throughout the Scotian Shelf region are unknown
- Additional studies are needed to identify important habitats that exist off eastern Canada in general, including within the Scotian Shelf region

Minke whale (Balaenoptera acutorostrata)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Acoustic and visual observations demonstrate that minke whales occur throughout the Scotian Shelf region, primarily along inshore coastal waters, and on-shelf, but they have also been recorded along the shelf break and in deeper waters
- Minke whales sexually segregate during summer feeding months and it is suggested that females occur in the Gulf of St. Lawrence, while males typically occupy lower latitudes such as in waters off Nova Scotia
- Minke whales are the most common mysticete species found within coastal waters off Nova Scotia, and although listed as 'Not at Risk' under COSEWIC, they are the most common mysticete species reported to the Marine Animal Response Society (MARS) every year due to injury, strandings, and/or death

Seasonal occurrence in the Regional Assessment Study Area

- Longitudinal migrations have been described for North Atlantic minke whales, where they range from Baffin Bay to the Caribbean, and typically spend summer months at higher latitudes including within the study area, and winter months in lower latitudes
- Minke whales are acoustically detected most often from late August to early December, which is biased as we know very little about North Atlantic minke whales' vocal repertoire, including the function of pulse trains, which is their most common call type, as well as what other call types are made by the population, and which individuals are calling

- Minke whale are visually observed most often from early June to early October, which is biased due to increased survey effort during this time of year

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- Based on acoustic monitoring in one study, a relationship between North Atlantic minke whale migrations and the Gulf Stream has been suggested where minke whales follow the warmer surface waters of the Gulf Stream, due to higher prey abundance during their northward migration - a change in water temperature of the Gulf Stream and minke whale migration routes could alter minke whale migration paths within the Scotian Shelf region

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Current acoustic analysis of baleen whales in the Scotian Shelf region does not include systematic analysis of minke whale call occurrence due to a lack of a reliable acoustic detector-classifier for minke whale pulse trains. Therefore, current acoustic presence of minke whales across the region is opportunistic, resulting in a higher likelihood of missing information on their seasonal and daily presence
- Little is known about North Atlantic minke whales' vocal repertoire, such as call types other than pulse trains that may occur, behaviours associated with call types, and which individuals within the population are calling (i.e., males or females)

North Atlantic right whale (*Eubalaena glacialis*)
SARA: Endangered
COSEWIC: Endangered

Distribution in the Regional Assessment Study Area

- The historical geographic distribution of endangered North Atlantic right whales extends from northern Florida to Atlantic Canada, primarily in waters surrounding southern Nova Scotia and more recently in the Gulf of St. Lawrence, with occasional sightings reported off Newfoundland and even further north (Jacobsen et al. 2004, Kraus and Rolland 2007, Mellinger et al. 2011).
- Two known high-use habitats in Atlantic Canada have been designated as Critical Habitat for the population: Grand Manan Basin in the Bay of Fundy and Roseway Basin on the Scotia Shelf (Fig. 1; DFO 2014). Both of these areas are well documented late-summer and autumn feeding habitats (Winn et al. 1986, Kenney et al. 1995).
- North Atlantic right whales have also been observed, both visually and acoustically; in deep basins on the western and central Scotian Shelf (DFO 2014; Mellinger et al. 2007, DFO 2018).
- Over the last decade the distribution of North Atlantic right whales in eastern Canadian waters appears to be shifting, with more individuals occurring in the southern Gulf of St. Lawrence and fewer sightings reported in the Bay of Fundy and off southwest Nova Scotia (DFO 2018). With this shift in distribution many North Atlantic right whales are likely migrating through the Scotia Shelf region.
- A number of factors influence the distribution of NARW in Canadian waters. The primary driver of the presence of NARW is the density and availability of its main prey, the copepod (*Calanus* spp.). There have been significant changes in the abundance of *Calanus* in eastern Canadian waters since 2010. While there is interannual variability, biomass of *Calanus* in most areas has declined, with the greatest declines observed in the Gulf of Maine and on the Scotian Shelf (DFO 2019).

Seasonal occurrence in the Regional Assessment Study Area

- North Atlantic right whales have been observed in all seasons in the Maritimes region and have been acoustically detected throughout a year as well.
- The majority of sightings and acoustics detections occur spring, summer, and autumn months, with the Western Scotian Shelf having a higher number of acoustic detections in comparison to the Eastern Scotian Shelf (Durette-Morin et al. 2019).
- While North Atlantic right whales were acoustically detected on the Scotian Shelf through the year, their detections have been limited to the period of May through December in the Cabot Strait (Durette-Morin et al. 2019).

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- A recent shift in the North Atlantic right whale distribution expanding into the Gulf of St. Lawrence has been attributed to changes in prey distribution caused by warming water temperatures

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Our comprehension of the distribution and long-term presence of North Atlantic right whales in Canadian waters is constrained by the extent of surveying efforts undertaken. Limited monitoring has taken place in several regions, including Scotian Shelf, and in most areas, the available monitoring data is limited to a brief time series.
- There are a number of uncertainties associated with our ability to detect North Atlantic right whales acoustically. These include limited information available on the factors that influence calling rates (e.g., sex, age, group size, behaviour, etc.), as well as detection range that varies with ambient noise, and the sensitivity of the passive acoustic monitoring systems. These uncertainties affect our ability to determine if whales may be present.

Sei whale (*Balaenoptera borealis*), Atlantic population

SARA: Not on Schedule 1 – under consideration for listing
COSEWIC: Endangered

Distribution in the Regional Assessment Study Area

- Occur throughout Scotian Shelf Region, including on-shelf, along the shelf break, and in deeper waters
- Highest acoustic occurrence along shelf break, and in deeper waters; fewer acoustic occurrences on-shelf

Seasonal occurrence in the Regional Assessment Study Area

- Have been acoustically detected in the region throughout the year
- Most visual sightings occur in summer and fall, though this is biased towards times of year when research effort occurs
- Peaks in acoustic occurrence in June and October, with a lull from January to March

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- One study observed increased occurrence in northern-most range from 2004-2014, mostly likely due to climate change

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Many knowledge gaps related to fine-scale distribution and occurrence in specific areas within the Scotian Shelf region remain
- Movement patterns of species into, out of, and throughout the Scotian Shelf are unknown
- Additional studies are needed to identify additional important habitats that likely exist off eastern Canada in general, including within the Scotian Shelf region

Toothed whales

Sperm whale (Physeter macrocephalus)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Sperm whales occur throughout the region, but are most commonly found in deep offshore waters beyond the continental shelf edge
- Occasionally sighted in shallower on-shelf waters

Seasonal occurrence in the Regional Assessment Study Area

- Not well known, but sightings and acoustic detections have occurred in all months of the year

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Seasonal occurrence, fine-scale distribution, and important habitat areas are largely unknown
- Passive acoustic monitoring data collected throughout the region could provide more information on seasonal occurrence, but has not yet been analyzed for sperm whale vocalizations

Dwarf sperm whale (*Kogia simus*)
SARA: Not on Schedule 1
COSEWIC: Data Deficient

Pygmy sperm whale (*Kogia breviceps*)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Both dwarf and pygmy sperm whales typically inhabit offshore tropical to warm-temperate waters and little is known about their range, distribution, or habitat preferences
- In Atlantic Canadian waters, occurrence of these species is known only from occasional strandings in the Maritime provinces, and possible acoustic detections noted in offshore waters beyond the shelf edge

Seasonal occurrence in the Regional Assessment Study Area

- No information available

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- It is unknown whether pygmy or dwarf sperm whales regularly inhabit this region or are occasional visitors
- Passive acoustic monitoring data collected throughout the region could provide more information on spatial and seasonal occurrence, but has not yet been analyzed for pygmy or dwarf sperm whale vocalizations

Northern bottlenose whale (*Hyperoodon ampullatus*), Scotian Shelf population
SARA: Endangered
COSEWIC: Endangered

Distribution in the Regional Assessment Study Area

- Northern bottlenose whales are found primarily in offshore waters along the Scotian Shelf edge and slope
- Critical Habitat areas are designated in the Gully, Shortland, and Haldimand canyons off the eastern Scotian Shelf
- Additional important habitat has been identified in slope areas between approximately 500 m and 2500 m depth

Seasonal occurrence in the Regional Assessment Study Area

- Northern bottlenose whales are present in the study area year-round, with high site fidelity and daily acoustic detections in the Gully and eastern Scotian Shelf canyons
- Sporadic sightings and detections have occurred further west along the shelf edge and slope

Recent/predicted trends in the Regional Assessment Study Area region related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Offshore extent of habitat is poorly understood due to limited effort beyond the shelf slope region

Cuvier's beaked whale (*Ziphius cavirostris*)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area region

- Cuvier's beaked whales inhabit offshore waters beyond the continental shelf edge
- While there are relatively few sighting records within the study area, passive acoustic monitoring has revealed regular presence of Cuvier's beaked whales along the Scotian Shelf edge and slope

Seasonal occurrence in the Regional Assessment Study Area

- Year-round in offshore waters

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Fine-scale distribution, important habitat areas, and trends in occurrence in Canadian waters are poorly understood

Sowerby's beaked whale (*Mesoplodon bidens*)
SARA: Special Concern
COSEWIC: Special Concern

Distribution in the Regional Assessment Study Area

- Sowerby's beaked whales are found primarily in offshore waters along the Scotian Shelf edge and slope
- Acoustic detections and sightings have occurred all along the shelf edge, with the highest rates of occurrence in the Gully and in the southwestern part of the study area off Georges Bank

Seasonal occurrence in the Regional Assessment Study Area

- Sowerby's beaked whales are present in the study area year-round, with nearly daily acoustic detections in the Gully and in the southwestern part of the study area off Georges Bank

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Fine-scale distribution and offshore extent of habitat are poorly understood due to limited data

True's beaked whale (*Mesoplodon mirus*)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Gervais' beaked whale (*Mesoplodon europaeus*)
SARA: Not on Schedule 1
COSEWIC: Not assessed

Blainville's beaked whale (*Mesoplodon densirostris*)
SARA: Not on Schedule 1
COSEWIC: Not at risk
Distribution in the Regional Assessment Study Area

- Like other beaked whales, these species primarily occupy offshore, deep-water habitats beyond the continental shelf edge
- True's beaked whales have been acoustically detected in offshore waters along the Scotian Shelf edge and slope, although their acoustic signals are difficult to distinguish from Gervais' beaked whales, which are not known to occur in Canadian waters
- Blainville's beaked whales have rarely been reported in the region and are not regularly sighted or detected in the study area

Seasonal occurrence in the Regional Assessment Study Area

- True's beaked whales have been detected year-round in offshore waters, particularly in the southwestern part of the study area off Georges Bank
- Gervais' and Blainville's beaked whales may be occasional visitors to the region

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- The geographic range, distribution, seasonality, and habitat preferences of these beaked whale species are poorly understood, particularly in Canadian waters

Beluga whale (*Delphinapterus leucas*), St. Lawrence Estuary population

SARA: Endangered
COSEWIC: Endangered

Distribution in the Regional Assessment Study Area

- Occasional sightings in Nova Scotia waters are generally considered to be vagrants from the St. Lawrence Estuary population (or from other more northern populations)

Seasonal occurrence in the Regional Assessment Study Area

- No information available

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information available

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- The extent to which beluga occur throughout the year in this region is largely unknown

Killer whale (*Orcinus orca*), Northwest Atlantic/Eastern Arctic population

SARA: Not on Schedule 1 - under consideration for listing
COSEWIC: Special Concern

Distribution in the Regional Assessment Study Area

- Opportunistic visual detections throughout the Scotian Shelf region, including on-shelf, along the shelf break, and in deeper waters, but seem to be more common on-shelf
- Occasional sighing have been reported in the Bay of Fundy area

Seasonal occurrence in the Regional Assessment Study Area

- Sightings occurred in all months of the year, with most between May-October
- Limited acoustic data for this region, but most acoustic detections occur in summer and fall

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Distribution not well documented, and habitat preferences are unknown off Nova Scotia

- Some killer whales have been observed feeding on marine mammals (as well as fish) and therefore may be acoustically cryptic

Long-finned pilot whale (*Globicephala melas*)
SARA: Not on Schedule 1
COSEWIC: Not at risk
Distribution in the Regional Assessment Study Area

- Occur throughout the Scotian Shelf region, along inshore coastal waters, on-shelf, along the shelf break, and in deeper waters
- Visual observations show that pilot whales occur mainly along the shelf break and in deeper waters
- A long term study following the Cape Breton population of long-finned pilot whales from 1998 to present, demonstrates their long-term, annual use of the inshore coastal waters off northern Cape Breton

Seasonal occurrence in the Regional Assessment Study Area

- Seasonal occurrence of pilot whales is prevalent, mainly for inshore coastal waters off of northern Cape Breton, where the population of whales returns each summer following prey migrations into inshore areas, from as early as June until late September. In the offshore areas of the region, year-round occurrence of pilot whales is observed.
- The site fidelity and seasonal residency of the Cape Breton population of long-finned pilot whales has also been suggested for other sub-populations of pilot whales in the Scotian Shelf region, such as individuals and social groups who likely return to the Gully MPA each summer, although data is limited for these offshore populations.

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Data is limited for offshore pilot whale populations of the Scotian Shelf region because we currently rely on opportunistic observations of the species which mainly occurs during summer months when research effort is greater.
- There is no current systematic acoustic analysis of pilot whales from our passive acoustic monitoring datasets. It is known anecdotally, that pilot whale calls are often recorded in our datasets and the data is available to gain further insight into how often and where pilot whales occur year-round in our region.

Atlantic white-sided dolphin (*Lagenorhynchus acutus*)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Prefer cool, low-salinity waters deeper than 50 m
- Opportunistic visual detections throughout the Scotian Shelf region, including inshore coastal waters, on-shelf, along the shelf break, and in deeper waters
- Also common in nearshore areas around Cape Breton

Seasonal occurrence in the Regional Assessment Study Area

- Appear to move south from Newfoundland along the continental shelf edge in winter and spring
- Likely expand their range to the north in summer
- Most abundant in June during the summer but are still present in the fall and some may overwinter in the area
- Concentrate in the Great South Channel in the spring, and distributed throughout the Gulf of Maine in the fall

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance, density, fine-scale distribution and movement patterns throughout most of the study area are generally unknown
- Dolphin vocalizations are difficult to distinguish to the species level in most cases; however, continuous acoustic detections of small dolphin species off the Scotian Shelf indicates that the area is suitable habitat for at least some species year-round

Common bottlenose dolphin (*Tursiops truncatus*)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Two populations/stocks that likely occur in the study area, coastal and offshore
- Occasional sightings reported off Nova Scotia
- Opportunistic visual detections seem more common along the shelf break and in deeper waters (including the Gully) than on-shelf, but also include around Sable Island, in Cape Breton, and in the Great South Channel
- Generally prefer warmer waters

Seasonal occurrence in the Regional Assessment Study Area

- Preference for warmer waters in late summer

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance, density, fine-scale distribution and movement patterns throughout most of the study area are generally unknown
- Dolphin vocalizations are difficult to distinguish to the species level in most cases; however, continuous acoustic detections of small dolphin species off the Scotian Shelf indicates that the area is suitable habitat for at least some species year-round

Risso's dolphin (*Grampus griseus*)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Occasional sightings reported off Nova Scotia
- Opportunistic visual detections are more common along the shelf break and in deeper waters (occasionally in the Gully) than on-shelf
- Inhabits deep oceanic and continental slope waters
- May be associated with waters influenced by the Gulf Stream

Seasonal occurrence in the Regional Assessment Study Area

- No information

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance, density, fine-scale distribution and movement patterns throughout most of the study area are generally unknown
- Dolphin vocalizations are difficult to distinguish to the species level in most cases; however, continuous acoustic detections of small dolphin species off the Scotian Shelf indicates that the area is suitable habitat for at least some species year-round

Short-beaked common dolphin (*Delphinus delphis*)

SARA: Not on Schedule 1

COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Prefer warmer, saline, and deep waters
- Opportunistic visual detections throughout the Scotian Shelf region, including on-shelf, along the shelf break, and in deeper waters
- Tend to be associated with slope waters of the Scotian Shelf but have occasionally been seen close to shore
- By far the most common dolphin species sighted in the Scotian Shelf-Gulf of St. Lawrence region during surveys

Seasonal occurrence in the Regional Assessment Study Area

- Found further north in the spring than the fall coinciding with prey distribution
- May move north onto the Scotian Shelf in the summer then south in the early fall
- Very large aggregations on Georges Bank in the fall
- Frequently observed both on and off the Scotian Shelf during November

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance, density, fine-scale distribution and movement patterns throughout most of the study area are generally unknown
- Dolphin vocalizations are difficult to distinguish to the species level in most cases; however, continuous acoustic detections of small dolphin species off the Scotian Shelf indicates that the area is suitable habitat for at least some species year-round

Striped dolphin (Stenella coeruleoalba)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Nova Scotia is the northern limit of their range
- Prefer deep water along the shelf edge and further seaward, and warm waters influenced by the Gulf Stream
- Opportunistic visual detections seem more common along the shelf break and in deeper waters than on-shelf (mostly the Great South Channel)
- In one study, sightings in and around the Gully decreased from 1988-2011

Seasonal occurrence in the Regional Assessment Study Area

- Preference for warmer waters in late summer
- Some stay into the winter months well after the water has cooled
- Strandings on Sable Island from 1970-1998 were all from October to March

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance, density, fine-scale distribution and movement patterns throughout most of the study area are generally unknown
- Dolphin vocalizations are difficult to distinguish to the species level in most cases; however, continuous acoustic detections of small dolphin species off the Scotian Shelf indicates that the area is suitable habitat for at least some species year-round

White-beaked dolphin (Lagenorhynchus albiostris)
SARA: Not on Schedule 1
COSEWIC: Not at risk

Distribution in the Regional Assessment Study Area

- Opportunistic visual detections are more common on-shelf than along the shelf break and in deeper waters (occasionally in the Gully)

Seasonal occurrence in the Regional Assessment Study Area

- Some appear to spend winters in cold waters near ice
- Often seen along the Nova Scotia coastline in early summer, such as off Peggy's Cove and in nearby waters

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Abundance, density, fine-scale distribution and movement patterns throughout most of the study area are generally unknown

- Dolphin vocalizations are difficult to distinguish to the species level in most cases; however, continuous acoustic detections of small dolphin species off the Scotian Shelf indicates that the area is suitable habitat for at least some species year-round

Harbour porpoise (*Phocoena phocoena*), Northwest Atlantic population
SARA: Not on Schedule 1
COSEWIC: Special Concern

Distribution in the Regional Assessment Study Area
- Occurs throughout the Scotian Shelf Regional Assessment Study Area
- Most commonly found in near-shore, shallow (<200m) waters
- Sporadic visual observations in deeper waters out to and including the shelf break

Seasonal occurrence in the Regional Assessment Study Area
- Present year-round in the Regional Assessment Study Area at varying levels
- There is some evidence of seasonal movement of sub-populations within the Regional Assessment Study Area

Recent/predicted trends in the Regional Assessment Study Area related to climate change
- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)
- Spatiotemporally comprehensive acoustic recordings exist for the Regional Assessment Study Area, but have not been assessed for harbour porpoise presence. This presence data could be used to address trends in seasonal occurrence, habitat use, and distribution within the Regional Assessment Study Area
- Knowledge of seasonal occurrence is limited within the Regional Assessment Study Area
- Accurate population estimates are limited due to infrequent visual surveys of the Regional Assessment Study Area

Atlantic spotted dolphin (*Stenella frontalis*)
SARA: Not on Schedule 1
COSEWIC: Not assessed

False killer whale (*Pseudorca crassidens*)
SARA: Not on Schedule 1
COSEWIC: Not assessed

Fraser's dolphin (*Lagenodelphis hosei*)
SARA: Not on Schedule 1
COSEWIC: Not assessed

Distribution in the Regional Assessment Study Area
- Atlantic spotted dolphin opportunistic visual detections are rare but more common along the shelf break and in deeper waters than on-shelf

- False killer whale opportunistic visual detections are rare but include both on-shelf and deeper waters
- Fraser's dolphin opportunistic visual detections are rare but include Misaine Bank and the Gully

Seasonal occurrence in the Regional Assessment Study Area

- No information

Recent/predicted trends in the Regional Assessment Study Area related to climate change

- No information

Data gaps (relevant to occurrence in the Regional Assessment Study Area)

- Many knowledge gaps related to fine-scale distribution and occurrence in specific areas within the Scotian Shelf region remain

2.2 Species listed under SARA (Schedule 1) and COSEWIC, and any associated critical habitat for those species.

- Critical Habitat polyons are available at the following link: https://open.canada.ca/data/en/dataset/db177a8c-5d7d-49eb-8290-31e6a45d786c
- Please see section 2.1.1 for information on sea turtle species
    - Note that SARA Critical Habitat has not yet been formally delineated for leatherback sea turtles
    - Note that SARA Critical Habitat identification is not possible at this time for loggerhead sea turtle because of the limited information currently available.
- See marine mammal section 2.1.2. where this information is provided throughout for each species.

2.3 Other identified key areas or times for marine mammals within the Study Area (e.g., feeding, breeding, nursing, migration, etc.).

- See marine mammal section 2.1.2. where this information is provided throughout for each species.

2.4 Data gaps related to the regional conditions for marine mammals and sea turtles (e.g., caveats around marine mammal sightings data and its use / interpretation).

- See sea turtle section 2.1.1 "Data availability and Gaps"
- See marine mammal section 2.1.2. where this information is provided throughout for each species, where that information is available.
- Please also see section 2.7 for caveats regarding the marine mammal sightings data provided.

2.5 Discussion of recent and predicted future trends of species movements / distribution attributed to climate change factors / influence.

- See sea turtle section 2.1.1 "Future Trends"
- See marine mammal section 2.1.2. where this information is provided throughout for each species.

2.6 Data gaps around marine mammals and sea turtles, including data collection and interpretation, as well as unknown species presence / distribution.

- See sea turtle section 2.1.1 “Data availability and Gaps”
- See marine mammal section 2.1.2. where this information is provided throughout for each species.

2.7 Mapping/data requirements

- See Appendix B, figures 13 and 14, for sightings of sea turtles.
    - Data from the Canadian Sea Turtle Network requires a request directly to that organization.
    - To obtain data from DFO, please contact DFO directly.
- Cetacean sightings records currently available within the DFO Maritimes Region Whale Sightings Database (WSDB) have been provided as an.xlsx file entitled “2023Oct10_WHALESITINGS__IAAC_RA Data Request.xlsx **(Annex I)**
    - Any questions about these data should be directed to the WSDB data manager at xmarwhalesightings@dfo-mpo.gc.ca.

Please note that the caveats and conditions of use for the DFO Maritimes Whale Sightings Database, also saved in a tab within the provided .xlsx file:

Caveats regarding data in the Whale Sightings Database:

1. *The data may contain some erroneous or duplicate records.*
2. *The certainty of species identification and number of animals is sometimes unknown. Until May 2022, best count could have been interpreted using count ranges specified in the archival field ‘confidence level’. Many sightings could not be identified to species but are listed to the smallest taxonomic group possible. Many sightings were collected on an opportunistic basis and may come from contributors with different levels of experience. Accuracy will vary with visibility, sea state, weather conditions, and interpretation.*
3. *Sighting coordinates most often refer to the location of the observer and not the animal. There are observations from shore, but these should not be interpreted as sightings on land.*
4. *Most sightings have been gathered from vessel-based platforms. The inherent problems with negative or positive reactions by cetaceans to the approach of such platforms have not been factored into the data.*
5. *Effort associated with collection of sightings has not been quantified in this database and cannot be used to estimate true species density or abundance for an area. Effort is not consistent among months, years, and areas. Lack of sightings within a particular area/time does not necessarily represent lack of species present but could reflect lack of or limited effort. Seasonal and distribution information should not be considered definitive.*
6. *Comments originally submitted in French were translated using Google Translate, and so may not be accurate.*
7. *Animal Condition is recorded in WSDB as provided. If sighter’s comments do not indicate the animal is ‘alive’ or ‘dead’ this field will be left blank.*

Data Use Conditions:

1. *The following citation format shall be used to reference these data: Whalesightings Database, Team Whale, Fisheries and Oceans Canada, Dartmouth, NS, [yyyymmdd]*
2. *The data may only be used for the intended purpose outlined in the form above. Permission is required for any use other than what is outlined in the data request above.*

3. *Although we do not store effort data in this database, data with associated effort are identified in the DATA_TYPE field. To access effort data, please contact the MAINTAINER directly.*
4. *Team Whale must be invited to review draft publications that use this database to ensure that the publication abides by these data use conditions.*
5. *Team Whale shall be informed of any publication resulting from these data. NOTE: Any publications must clearly reference this database and include the relevant caveats.*
6. *Copyright and ownership of the data remains with DFO in right of her majesty the Queen.*
7. *The data shall not be copied, digitized, scanned, sold, licensed, leased, assigned, or given to a third party for the purpose of reproducing, extracting or marketing the data, without prior approval of DFO.*
8. *The data shall not be included in whole or in part in any commercial products without a licensing agreement with DFO.*
9. *You recognize the limitations of the data and understand that DFO does not warrant or guarantee the accuracy, completeness, or currency of the data for any specific use.*

This database is continuously being revised with new data, and periodically duplicate or erroneous records are identified and removed. We therefore recommend that for the most current and accurate data new data pulls be requested as needed over time, rather than reusing past data pulls. Please contact xmarwhalesightings@dfo-mpo.gc.ca for new data requests.

The WSDB does not contain DFO's aerial cetacean survey data. There have been several DFO aerial surveys that have occurred in the Regional Assessment area since 2007. These data require application of some data quality control measures (e.g., removal of duplicate sighting) before they are ready for sharing and review. For more information around timelines for a finalized multispecies dataset from these efforts, please contact the principle investigator for the aerial survey data is Jean-Francois Gosselin, DFO Quebec Region.

It is known that not all cetacean sightings data available within the Regional Assessment study area have been submitted to the WSDB, thus the data pull from the WSDB should be considered incomplete. There are additional cetacean sightings data for this area that should be considered for mapping products that are available from other existing sources such as the North Atlantic Right Whale Consortium's sightings database (https://www.narwc.org/sightings-database.html). This database contains records not just right whales, but also sightings of many other species of whales, dolphins, sea turtles, seals, and large fishes in the North Atlantic Ocean. Many researchers that conduct work in waters off Nova Scotia submit their data to this database rather than to the WSDB (though there is duplication between these two data sources as some researchers submit sightings to both databases).

In addition to sightings data, DFO Maritimes also has passive acoustic monitoring (PAM) data that can be used to provide information on cetacean occurrence and underwater noise levels in various areas off Nova Scotia. While some of this data is available in the scientific literature referred to in the species summaries below, some of the more recently analyzed data is not yet publicly available though it has still been considered in the species summary information below. The analysis of this data is still underway, and as we complete cetacean validation analyses and publish results, we intend to post our validated data on NOAA's Passive Acoustic Cetacean Map (PACM) website (https://apps-nefsc.fisheries.noaa.gov/pacm/#/). PACM also contains PAM data from within the Regional Assessment study area from other data sources and thus is another valuable tool for exploring cetacean occurrence off Nova Scotia.

3. Commercial, Recreational, and Indigenous Fisheries

General overview of Commercial fishing within the region, including:

3.1 Primary species harvested and the value of key fisheries in the Study Area;

- See Annex C for an overview of commercial fisheries in the study area, including key times, closures, and any noted trends
- Also consult this report for additional information: https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/40885690.pdf
- Information on the landed values of fisheries in Nova Scotia can be found at this link: https://www.dfo-mpo.gc.ca/stats/commercial/sea-maritimes-eng.htm
    - For more specific data requests with specified parameters for Maritimes Region, please send it to: XMARComData@dfo-mpo.gc.ca.

3.2 Mobile and fixed gear types used within the region and distribution of fisheries;

- See Annex C for information on gear type.
- Also consult this report for additional information: https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/40885690.pdf
- Fisheries distribution information is available on the Marine Planning Atlas.

3.3 Identified key areas and times of the year for certain fisheries (e.g., lobster, crab, shrimp, etc.);

- Please see Annex C for information on key times of year for certain fisheries.
- Also see Section 1.5: “Identified areas and/or times of year that are important for one or more fish species (e.g., spawning areas, aggregation areas, migration routes, etc.)”

3.4 Areas currently closed to fishing activity including the reasons for and expected duration of;

- Please see Annex C for key times for each fishery listed.

3.5 General trends in fishing throughout the year (e.g., summer fishing distribution vs winter);

- Please see Annex C for key times for each fishery listed, as well as trends where this information is available.
- Also consult this report for additional information: https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/40885690.pdf
- Information on this topic can also be found in the Marine Planning Atlas.

3.6 Identified new or emerging fisheries that could become more established in the future;

- Please see section 1.8 “General discussion on recent / current trends within the region attributed to climate change, and the general prediction of future trends for fish and fish habitat.”

3.7 Any recent or predicted future effects on fishing activities attributed to climate change.

- There is limited information and data on the emergence of warm water species. Several species more commonly associated with warmer waters south of the Scotian Shelf have been caught in the Summer RV survey in recent years. Some, like Blackbelly Rosefish, are now well established on the Scotian Shelf, while others rarely seen in the past are being caught in increasing numbers more recently. As water temperatures warm on the Scotian Shelf, it is expected that more

southern species will appear in the survey and will become established in the region. The RV survey provides the only source of information on their distribution, abundance, and potential impact to the local ecosystem and to commercial fisheries.

- Also see section 1.8: "General discussion on recent / current trends within the region attributed to climate change, and the general prediction of future trends for fish and fish habitat."

3.8 Summary of commercial – communal licences for Indigenous groups and organizations within the Study Area, including the species under these licences. This should include groups within NS, NB, PEI, NL, and Quebec, if applicable.

- Please see Annex D for a summary of commercial-communal fisheries, including species type, license area and gear type
- **Please note: information about commercial-communal licenses <u>should not</u> be posted publicly. The information provided is for <u>internal use</u> by the Regional Assessment Committee only.**

3.9 Summary of Food, Social, and Ceremonial (FSC) licences within the Study Area.

- Please see Annex E for a summary of FSC licenses in the RA Study Area including target species, gear type and key times
- **Please note the following:**
    - FSC licences do not define an Aboriginal right to fish or its scope; however, it is intended to provide a mechanism, for reasons of proper management, control of the fisheries and conservation and protection of fish.
    - Access is subject to change over time to respond to the evolving needs and interests of Indigenous communities. Given that FSC licences do not define an Aboriginal right to fish or its scope, DFO, Indigenous Affairs, Maritimes Region recommends that the Committee considers consulting with all First Nations and Indigenous Organizations located in Maritimes Region to gain insight on priority areas of interest to determine if there are any potential adverse impacts that Offshore Wind Development may have on rights. A list of First Nations and Indigenous Organizations in Maritimes Region that are issued FSC licenses is provided in Table 5 in Appendix A.
    - **Information about FSC licenses <u>should not be</u> posted publicly. The information provided is for <u>internal use</u> by the Regional Assessment Committee only. Please carefully review the attachment titled "Best Practices FSC Data."**

3.10 Overview of current and anticipated future moderate livelihood fisheries within the Study Area, and the temporal and spatial distribution.

- This information is forthcoming and will be provided at a later date, per discussions with IAAC.

3.11 Any data gaps noted in relation to commercial fishing activities within the Study Area.

- Provided throughout.

4 Additional information

4.1 Cumulative effects

- Cumulative human impact mapping (CIM) combines spatial information on human activities and marine benthic and pelagic habitats with a matrix of vulnerability weights to generate a relative

index that shows where cumulative impacts are greatest and least and quantifies which human activities are driving these impacts.

- To map cumulative impacts in DFO's Maritimes Region (Figure 15, Appendix B), a recently developed ecosystem vulnerability assessment for Atlantic Canadian waters was combined with spatial information on 21 different habitat types and 45 human activities from five different sectors (climate change, land-based, marine-based, coastal, commercial fishing).
- Stressors and activities resulting from climate change and commercial fishing are consistently the largest contributors to cumulative effect (CE) scores across habitats located in depths greater than 30m. Across the region, shelf habitats (hard, soft, and mixed bottom) and shallow pelagic habitat had the highest average CE scores (Figure 16 in Appendix B).
- Climate change stressors and commercial fishing activities largely drove the high average CE scores in shelf habitats with vessel traffic from commercial shipping activity also a contributor. The large average CE score in shallow pelagic habitats was primarily driven by surface temperature change (Figure 16).
- Nearshore habitats were influenced by a wider range of activities from all 5 sectors, despite the overall CE scores in these habitats being much lower. Nearshore habitats had the smallest footprints, resulting in the highest cumulative impact scores when standardized by footprint (CE score km^2).
- Uncertainty in the cumulative impact map was quantified using Monte Carlo simulations and the results were used to identify areas of high and low CE scores that were robust to sources of error introduced in the simulations, which we termed 'hot spots" and "cold spots", respectively.
- Robust cumulative impact hotspots (i.e. cells with CE scores in the upper quartile in over 90% of simulations) covered 0.9% (4,275km2) of the Scotian Shelf bioregion.
- Robust hotspots primarily existed in the coastal zone and were driven by a combination of high intensity activities from all five sectors in which a high percentage of algal (26%), seagrass (21%), or kelp habitats (19%) were located (Figure 17 in Appendix B).
- Fewer hotspots were identified offshore; however, a prominent hotspot exists in Banquereau Bank and several clusters of hotspots are present around German Bank. Smaller offshore hotspots are also present along the shelf break, largely driven by commercial fishing activity (Figure 17).
- Robust cumulative impact cold spots (i.e. cells with CE scores in the lower quartile in over 90% of simulations) covered 3% (14,907km2) of the bioregion and were mostly present offshore. Despite robust cold spots covering over three times the area of hotspots, very few cold spots were identified in the coastal zone (Figure 17).
- A prominent cold spot is located on Sable Island Bank, and two other cold spots exist on the continental slope near the edge of the Maritimes region boundary. While these areas are identified as cold spots, cumulative impacts still occur in these areas. The very low CE scores result from a combination of relatively low stressor intensity in habitats that are not highly vulnerable to the overlapping stressors (Figure 17).
- In addition, an MSP Grants & Contribution agreement between DFO and Laval University was used to conduct a spatial assessment of the cumulative effects of drivers on individual species and at the community level in the Scotian Shelf bioregion. The assessment considered data from 2010 up to today and divided the assessment in two periods, *i.e.* from 2010 to 2015 and from 2016 to 2021.The full report is available here: 7 Results | Cumulative

effects of natural and human drivers on food webs of the Scotian Shelf Bioregion to support Marine Spatial Planning (ecosystem-assessments.github.io). The contact for this work is David Beauchesne: david.beauchesne@hotmail.com

- David et al.'s assessment includes a focus on migratory seabirds. Therefore, it may also be beneficial to coordinate efforts with Sarah Wong from ECCC. Sarah and her team collaborated closely with David, and they may have access to similar data products

4.2 Groundfish data collection within the region and associated gaps (e.g., areas that are data-sparse or poorly understood).

Fisheries-Independent Mapping Data

The main fisheries-independent data source on the regional density of fish species is the DFO Maritimes Region Ecosystem Survey Program (also known as the 'RV Survey') which conducts stratified random mobile gear surveys of the Scotian Shelf, Bay of Fundy, and Georges Bank in the spring (5Z; 1987+) and summer (4VWX – 1970+; 5Z – 2011+). This program publishes annual reports that include distribution plots for commonly caught species; the most recent reports are (DFO 2021; 2022e). The fixed-station Industry-DFO Longline Halibut Survey (1998+) and the Inshore Lobster Trawl Survey (ILTS) (2013+) are additional ongoing surveys that collect data related to the regional density of fish species but that do not publish annual reports (Denton 2020; DFO 2020b). Survey series that covered the Study Area but which have ceased include the stratified random spring 4VsW RV Survey (1986-2010), the fixed-station mobile gear Individual Transferable Quota (ITQ) Survey (1995-2012), and the stratified random 4Vn (1994-2015) and 4VsW (1994-2021) Industry Sentinel Surveys (Claytor et al. 2014; Lambert 2019). Data from these surveys include geographic coordinates and have been used in studies to map the distribution of fish species. For example:

- Hastings, K., M. King, and K. Allard. 2014. "Ecologically and Biologically Significant Areas in the Atlantic Coastal Region of Nova Scotia." DFO Can. Tech. Rep. Fish. Aquat. Sci. 3107.
- Horsman, Tracy, and Nancy Shackell. 2009. "Atlas of Important Habitat for Key Fish Species of the Scotian Shelf, Canada." DFO Can. Tech. Rep. Fish. Aquat. Sci. 2835.
- King, M, D Fenton, J Aker, and A Serdynska. 2016. "Offshore Ecologically and Biologically Significant Areas in the Scotian Shelf Bioregion." DFO Can. Sci. Advis. Sec. Res. Doc. 2016/007.
- Ricard, D., and N. Shackell. 2013. "Population Status (Abundance/Biomass, Geographic Extent, Body Size and Condition), Important Habitat, Depth, Temperature, and Salinity Preferences of Marine Fish and Invertebrates on the Scotian Shelf and Bay of Fundy (1970-2012)." DFO Can. Tech. Rep. Fish. Aquat. Sci. 3012.
- Ricard, Daniel, Catalina Gomez, Jamie Emberley, Catriona Regnier-McKellar, and Ryan Martin. 2022. "Marine Fish and Invertebrate Atlas: Geographic Distribution, Population Indices and Environmental Associations of Marine Species in the Scotian Shelf and Bay of Fundy Derived from the Annual Maritimes Summer Survey (1970-2020)." DFO Can. Tech. Rep. Fish. Aquat. Sci. 3498.
- Waiwood, K. G., and M.-I. Buzeta. 1989. "Reproductive Biology of Southwest Scotian Shelf Haddock (*Melanogrammus Aeglefinus*)." Canadian Journal of Fisheries and Aquatic Sciences 46 (S1): s153–70. https://doi.org/10.1139/f89-286.

Fisheries-Dependent Mapping Data

Fisheries catch distribution data is also available, although it is important to note that catch distribution is highly dependent on fishing effort, regulations, and fisher behaviour. Catch distribution is not a true measure of species density, as a result. An example of the type of information that is available from commercial catch data is as follows: for Pollock, there has been an overall reduction in the distribution of catches over the past 20 years (Figure 18 in Appendix B). In the early 2000s catches predominantly occurred throughout the western portions of the Scotian Shelf and the Bay of Fundy and Georges Bank. However, in more recent years, catches within the Bay of Fundy and the Scotian Shelf have diminished and are mostly aggregated surrounding Georges Bank.

A document with examples of the maps that can be derived from fisheries-dependent data is: Breeze, H, S Coffen-Smout, D Fenton, T Hall, G Herbert, T Horsman, P Mcnab, D Millar, P Strain, and P Yeats. 2005. The Scotian Shelf: An Atlas of Human Activities. Edited by H Breeze and T. Horsman. Dartmouth, NS: Fisheries and Oceans Canada. 0-662-69160-1.

Survey Data

The main sources of data in the region are the DFO Maritimes Region Ecosystem Surveys. The stratified random survey design is robust and adequately samples all areas of the Scotian Shelf, Bay of Fundy, and Georges Bank. Some strata, the geographic units into which the survey area is divided, are sampled more intensively than others because the surveys were originally designed with groundfish stock assessments in mind. As a result, and due to the fact that the surveys employ a bottom trawl, its data best represent benthic and benthopelagic species.

Additional strata have been added to the survey, and as these strata have shorter time series than strata that have been part of the surveys all along, they are the areas that have the least available data. In 1995, new strata (496-498) on the edge of the Scotian Shelf were added to extend the depth coverage to 400 fathoms and ensure that the summer spatial coverage was deep enough to cover the range of redfish stocks (Neilson et al. 1995). In 2011 and 2012, summer coverage was extended to Georges Bank (5Z1, 5Z2, 5Z9) to cover the spatial extent of Pollock off southwestern Nova Scotia (DFO 2013). In 2011, deepwater strata (501-505) that were first surveyed on the 2010 summer survey extended the survey range down to 2000m (Emberley and Clark 2011). Deepwater strata receive minimal sampling in most years (as time permits) with higher sampling about every five years (Clark et al. *in press*)

Exclusion zones where the survey cannot fish are also less understood than areas that are surveyed more frequently. From 1970 to 2013, exclusion zones were based on experiential knowledge and hazards mapped on marine charts (Figure 19 in Appendix B; from Wilson et al. *in press*). From 2014 to the present, exclusion zones have accounted for areas with frequent gear damage, shoal waters, extreme depth changes, rough bottom, conservation areas, shipwrecks, military ordinance, oil and gas production, cables, other scientific research, and other obstructions (Figure 20 in Appendix B; from Wilson et al. *in press*).

In recent years there has also been a lack of full coverage of areas during the summer survey. During 2018, 2021 and 2022 strata within NAFO areas 4V and 4W were not fully sampled. This has resulted in a lack of data for stocks relying on this information to quantify biomass (e.g. Silver Hake and Redfish).

Other Considerations

The Ecosystem Survey covers a large portion of the study area and extends back several decades but there are still gaps in understanding this large and complex ecosystem as a whole. Research efforts have

focused on commercially important species and left gaps in knowledge for invertebrates and the interactions between species and their environment. Additional hydrographic and oceanographic that may fill some of these gaps is available from the Atlantic Zonal Monitoring Program. However, ecosystem knowledge gaps will likely be exacerbated with climate change further altering the Scotian Shelf region.

4.3 Research Vessel (RV) Survey Operations

The Maritimes Region Summer RV Survey of the Scotian Shelf and Bay of Fundy has been conducted annually since 1970 in NAFO Divisions 4VWX5, extending from St. Paul Island off Cape Breton in the Northeast to the Canadian portion of Georges Bank in the Southwest, including the Scotian Shelf, Bay of Fundy and Eastern Gulf of Maine (see Figure 21 in Appendix B). The Maritimes Winter RV Survey has been conducted every year since 1987 on Georges Bank with some years covering areas throughout the Scotian Shelf. The Regional Assessment Study Area for offshore wind development encompasses >95% of the Maritimes Region RV Survey area within Canadian waters.

- Long time-series of fishery-independent data
    - **Summer RV Survey**: 1970 – present (late June – August)
    - **Winter RV Survey**: 1987 – present (February/March)
    - St. Paul Island off Cape Breton to Cape Cod, MA, USA
- Stratified, random sampling design
    - 20m – 2000m depth range with consistent coverage of 20m – 400m
    - Survey area is stratified by depth
    - Station allocation (effort) is generally proportional to strata area (285 planned stations per survey)
    - Key assumption of stratified random sampling is that all portions of the full population have an equal probability of being sampled
- Data from these surveys are used to inform stock assessment and fisheries management, ecosystem assessments, species at risk, marine conservation monitoring, and a variety of research programs.
- For many of the marine species in this area, this survey provides the only source of information on their abundance and distribution, and how these have changed over time.
- Provides a platform for the collection of oceanographic data used by the Atlantic Zonal Monitoring Program.
- The Regional Assessment Study Area for offshore wind development encompasses >95% of the Maritimes Region RV Survey area within Canadian waters.

Potential vulnerabilities or impacts due to offshore wind development

- Potential for vessels to be unable to operate inside turbine areas.
- Potential exclusion of sampling in portions of multiple survey strata, with overlap greater in some strata than others.
- Possible impacts to statistical survey design. May violate statistical assumption of random sampling design – no longer have equal probability to sample the population because:
    - areas no longer accessible are not random (stations would not be randomly “removed”)
    - introduces bias in the abundance estimate
    - prevents accurate understanding of distribution
    - survey strata boundaries would require re-delineation to exclude areas for offshore wind development
- Turbines may directly affect species distribution (e.g. aggregation around turbines).

- Disruptions to 50+ year time series decreases ability to understand and mitigate the effects of climate change
- Greater uncertainty in protected species assessments/recovery programs
- Increased uncertainty in estimates of abundance would impact setting of fishing quotas through application of the precautionary approach
- Increase in more precautionary protected species management measures and the need to include more precautionary mitigation measures
- Impacts to sampling outside of developments by wind energy – induced transit effects that can result in lost sampling time

Important references
CSAS Science Response Reports are published for both summer and winter surveys each year to inform on the distribution, estimates of biomass and length composition for commercially important fish and invertebrate stocks, species at risk, and newly emerging warm water species. Below are the two most recent publications. Reports from the most recent surveys are awaiting translation prior to publishing.

- Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy for 2020: https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/40977328.pdf
- 2021 Maritimes Winter Research Vessel Survey Trends on Georges Bank: https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41041847.pdf

4.4 Marine Conservation Network and marine refuges

Marine Conservation Network
DFO Maritimes is developing a **Marine Conservation Network Plan** on behalf of the Government of Canada that will guide the selection of new MPAs and other conservation areas (such as marine refuges) in the Scotian Shelf-Bay of Fundy Bioregion.

Polygons of the original draft design have been shared in the attached geodatabase file entitled “MAR REGION_Original_Draft_Design.gdb.” However, as the draft network design is currently undergoing revisions, and with engagement on the design planned for the winter of 2024, it is important to note that the design may change. Changes may include boundary revisions of a proposed site within the network to better protect a certain species or habitat, or minimize overlap with certain types of human activities in an effort to reduce potential future socioeconomic impacts. Adjustments could also be made based on the latest research and information available. IAAC is encouraged to contact DFO for the latest information regarding the conservation network.

Furthermore, all MPAs established after April 25, 2019, are subject to the MPA Protection Standard that was formally adopted by the Government of Canada.

Marine Refuges
In addition to *Oceans Act* MPAs, DFO also implements other effective area-based conservation measures (OECMs) to protect species and habitats. Marine refuges are one type of OECM established under the *Fisheries Act* to protect important species, their habitats and ecosystems, including unique and significant aggregations of corals and sponges. Marine refuges in Nova Scotia are listed in Table 6 in Appendix A. For more information on marine refuges, including those that are in place in the Gulf Region, consult the DFO website.

Finally, note that there is an OECM protection standard that is implemented through the 2022 *Guidance for recognizing marine Other Effective Area-Based Conservation Measures* for information on OECMs, including the OECM framework

5 Appendix A - Tables

Table 1. Summary of the coastal EBSA rationales related to fish aggregations in the Offshore Wind RA Study Area. Adapted from Hastings et al. (2014).

Coastal EBSA	Summary of Rationale
Southwest Scotian Shelf	Aggregations and observations of Spiny Dogfish, Atlantic Cod, skates, Atlantic Wolffish, Cusk, Striped Bass, and Atlantic Salmon; aggregations of Winter Flounder, Butterfish, Haddock, Sea Raven, Pollock, Yellowtail Flounder, and Atlantic Halibut; Atlantic Herring and Atlantic Salmon spawning areas; juvenile areas for Atlantic Cod, Winter Flounder, Pollock, sand lance, Atlantic Herring, Lumpfish, Alewife, and Ninespine Stickleback; presence of Mackerel eggs
Lobster Bay Area	Historical importance for Atlantic Salmon and Atlantic Whitefish; spring run of Alewife; juvenile areas for Cunner, Windowpane Flounder, Witch Flounder, and Three-spined Stickleback
Port Joli and Surrounding Areas	Atlantic Herring spawning area; presence of Mackerel eggs
Medway Harbour Area	Watershed includes Atlantic Salmon spawning habitat
LaHave Islands	Watershed includes Atlantic Salmon spawning habitat
Mahone Bay	Watershed includes Atlantic Salmon spawning habitat; juvenile area for sand lance, Atlantic Tomcod, and Northern Pipefish
St. Margaret's Bay	Presence of Bluefin Tuna; spawning area for Atlantic Mackerel
Sambro Ledges	Historical importance for Atlantic Cod; high-use inshore area for Bluefin Tuna, Atlantic Herring overwintering area
Outer Halifax Harbour	High-use inshore area for Bluefin Tuna
Cole Harbour-Lawrencetown	High-use inshore area for Bluefin Tuna; overlaps with the Halifax/Eastern Shore herring spawning area
Musquodoboit Harbour and Surrounding Areas	High-use inshore area for Bluefin Tuna; overlaps with the Halifax/Eastern Shore herring spawning area; watershed includes Atlantic Salmon spawning habitat
The Canso Ledges	Noted abundance and diversity of fish, historic and potential current importance for Atlantic Cod; aggregations of Atlantic Wolffish, Thorny Skate, and Winter Skate; juvenile areas for sand lance, hake, and Grubby; spawning and overwintering areas for Atlantic Herring
Morien Bay	Lagoon ecosystem important as juvenile fish habitat
Lingan Bay-Indian Bay	Atlantic Herring spawning and overwintering area; lagoon ecosystem important as juvenile fish habitat
Bird Islands	High concentration of Winter Skate, Winter Flounder, Shorthorn Sculpin, Longhorn Sculpin; nursery area for Atlantic Cod; overwintering area for Atlantic Herring
Western Sydney Bight	Important summer habitat for Atlantic Cod, American Plaice, Smooth Skate, Thorny Skate, White Hake, Atlantic Herring, and Witch Flounder; area of high finfish species richness; presence of larval American Plaice, Atlantic Cod, redfish, Atlantic Herring and Longhorn Sculpin
Ingonish Bays	Watersheds support spawning Atlantic Salmon
Aspy Bay	Overwintering aggregation of Atlantic Herring; lagoon ecosystem important as juvenile fish habitat
Cabot Strait (between Cape North and St. Paul Island)	Important summer habitat for Atlantic Cod, American Plaice, redfish, Atlantic Wolffish, White Hake, and Witch Flounder; area of high finfish species

	richness; presence of larval American Plaice, Atlantic Cod, redfish, and Atlantic Mackerel; presence of Mackerel eggs

Table 2. Summary of the offshore EBSA features related to fish aggregations in the Offshore Wind RA Study Area. Adapted from King et al. (2016).

Offshore EBSA	Summary of Features
Jordan Basin and the Rock Garden	High fish biomass; high fish species richness; high larval fish genus richness; important habitat for White Hake, Spiny Dogfish, and redfish (summer/fall/spring); important habitat for Cusk
Canadian Portion of Georges Bank	High species diversity; spawning area for Atlantic Cod, Haddock, Herring, Yellowtail Flounder, Winter Skate, and Pollock; nursery area for Atlantic Cod; high larval fish genus richness; important foraging habitat for Bluefin Tuna
Northeast Channel	Aggregations of large pelagic fish; habitat for Cusk; presence of Redfish larvae
Browns Bank	Atlantic Cod and Haddock spawning and nursery area; important habitat for Atlantic Cod and Haddock (summer/fall/spring); Atlantic Herring spawning area; important habitat for Winter Skate (summer); area of high fish biomass; area of high larval fish genus richness
Roseway Basin	Important habitat for redfish, Smooth Skate, American Plaice, Atlantic Cod (summer/fall/spring); high concentrations of juvenile redfish; important habitat for Atlantic Wolffish (fall/spring); habitat for Cusk; area of high fish biomass; area of high fish species richness
Emerald Basin and the Scotian Gulf	Primary residence and nursery area for Silver Hake; important habitat for Silver Hake (summer/fall/spring); high concentrations of zooplankton are an important food source for juvenile Silver Hake; summer residence of tuna and swordfish; area of high fish species evenness; area of high species richness for small fish; important habitat for White Hake (summer/fall/spring); area of high fish biomass; important habitat for sand lance
Emerald-Western-Sable Island Bank Complex	Important habitat for Haddock, Yellowtail Flounder, and Winter Skate (summer/fall/spring); Haddock spawning and nursery area; important habitat for Atlantic Cod and Silver Hake; Atlantic Cod spawning area; Western Bank is important for larval cod; concentrations of Silver Hake eggs and larvae in the summer; presence of Atlantic Herring spawning (fall); concentrations of eggs and larvae of Haddock, Mackerel, Pollock, Silver Hake, and Yellowtail Flounder; Western and Sable Bank have highest larval fish genus diversity on the Scotian Shelf; high fish biomass, richness, and evenness.
Sable Island Shoals	High concentrations of juvenile fish, especially young-of-year and age 1 haddock; high proportional abundance of Haddock, Silver Hake, Atlantic Cod, and Yellowtail Flounder; high fish species evenness
Eastern Scotian Shelf Canyons (The Gully, including the Gully Trough, Shortland, and Haldimand)	High levels of finfish diversity; important habitat for Atlantic Cod, White Hake, Smooth Skate, and redfish (summer/fall/spring); area of high fish biomass, richness, and evenness
Middle Bank	Atlantic Cod spawning and nursery area; important habitat for Atlantic Cod (summer/fall); area of high small fish species richness; high larval abundance and possible spawning area of American Plaice, redfish, Silver Hake, Yellowtail Flounder, and Witch Flounder
Canso Bank and Canso Basin	High larval fish genus richness; high fish species richness and evenness; high small fish richness; important habitat for sand lance; important habitat for American Plaice (summer/fall/spring); high larval abundance and potential spawning area for American Plaice

Misaine Bank	High fish species evenness, high small fish species richness; important habitat for American Plaice (summer/fall/spring); Atlantic Cod spawning area; important habitat for sand lance
Eastern Shoal	Important habitat for Atlantic Cod, Winter Skate, American Plaice, and Thorny Skate (summer/fall/spring); possible Atlantic Cod nursery area; high larval fish genus richness, high fish species evenness; high larval abundance and possible nursery area of Yellowtail Flounder, Silver Hake, Witch Flounder, and Redfish; important habitat for sand lance
Laurentian Channel	Western edge is an overwintering area for multiple populations of Atlantic Cod; overwintering area for White Hake, Dover Sole, Turbot, redfish, Greenland Shark, American Plaice, Witch Flounder, and Thorny Skate; important fish migration route; high fish species richness; important habitat for redfish; high fish biomass
St. Anns Bank	Important habitat for overwintering 4TVn Atlantic Cod, resident 4Vn Atlantic Cod, and year-round occurring 4VsW Atlantic; important habitat for Atlantic Wolffish (summer); includes Big Shoal Atlantic Herring spawning area; important migration route for many fish species; high fish species biomass and evenness, high species richness for small fish.
Scotian Slope	Migratory route for large pelagic fishes; high diversity of finfish; high fish evenness, high species richness for small fishes; overwintering area for shelf fishes including Halibut and Atlantic Mackerel; important habitat for many fish species including Cusk, redfish, White Hake, Thorny Skate, Atlantic Halibut, Longfin Hake, and Atlantic Argentine.

Table 3. Demersal and pelagic fish species that have been observed by DFO's Maritimes Ecosystem Surveys Program in the Offshore Wind RA Study Area.

CODE	SPECIES NAME	COMMON NAME
3	BALISTES CAPRISCUS	GRAY TRIGGERFISH
5	MONACANTHUS CILIATUS	FRINGED FILEFISH
6	STEPHANOLEPIS HISPIDA	PLANEHEAD FILEFISH; HISPIDUS
10	GADUS MORHUA	COD ATLANTIC
11	MELANOGRAMMUS AEGLEFINUS	HADDOCK
12	UROPHYCIS TENUIS	WHITE HAKE
13	UROPHYCIS CHUSS	SQUIRREL OR RED HAKE
14	MERLUCCIUS BILINEARIS	SILVER HAKE
15	BROSME BROSME	CUSK
16	POLLACHIUS VIRENS	POLLOCK
19	MERLUCCIUS ALBIDUS	OFF-SHORE HAKE
25	LOPHOLATILUS CHAMAELEONTICEPS	TILE FISH
28	NEALOTUS TRIPES	BLACK SNAKE MACKEREL
30	HIPPOGLOSSUS HIPPOGLOSSUS	HALIBUT ATLANTIC
31	REINHARDTIUS HIPPOGLOSSOIDES	TURBOT,GREENLAND HALIBUT
39	CHIASMODON NIGER	BLACK SWALLOWER; INCL CHIASMODON BOLANGERI
40	HIPPOGLOSSOIDES PLATESSOIDES	AMERICAN PLAICE
41	GLYPTOCEPHALUS CYNOGLOSSUS	WITCH FLOUNDER
42	MYZOPSETTA FERRUGINEA	YELLOWTAIL FLOUNDER; LIMANDA
43	PSEUDOPLEURONECTES AMERICANUS	WINTER FLOUNDER

CODE	SPECIES NAME	COMMON NAME
44	CITHARICHTHYS ARCTIFRONS	GULF STREAM FLOUNDER
50	ANARHICHAS LUPUS	STRIPED ATLANTIC WOLFFISH
51	ANARHICHAS MINOR	SPOTTED WOLFFISH
52	ANARHICHAS DENTICULATUS	NORTHERN WOLFFISH
60	CLUPEA HARENGUS	HERRING ATLANTIC
61	ALOSA SAPIDISSIMA	SHAD AMERICAN
62	ALOSA PSEUDOHARENGUS	ALEWIFE
63	OSMERUS MORDAX	RAINBOW SMELT
64	MALLOTUS VILLOSUS	CAPELIN
65	SALMO SALAR	SALMON ATLANTIC
70	SCOMBER SCOMBRUS	MACKEREL ATLANTIC
72	XIPHIAS GLADIUS	SWORDFISH
78	HETEROPRIACANTHUS CRUENTATUS	BULLEYE; INCL PRIACANTHUS CRUENTATUS; COOKEOLUS BOOPS
83	REMORA BRACHYPTERA	SPEARFISH REMORA
88	NAUCRATES DUCTOR	PILOTFISH
89	SELAR CRUMENOPHTHALMUS	BIGEYE SCAD
92	SERIOLA DUMERILI	GREATER AMBERJACK
94	SELENE SETAPINNIS	ATLANTIC MOONFISH; INCL SELENE SETAPINNIS; VOMER
102	STENOTOMUS CHRYSOPS	SCUP
103	CYNOSCION REGALIS	WEAKFISH
109	HALARGYREUS JOHNSONII	DAINTY MORA
110	BOREOGADUS SAIDA	ARCTIC COD
111	UROPHYCIS REGIA	SPOTTED HAKE
112	PHYCIS CHESTERI	LONGFIN HAKE; UROPHYCIS
113	ANTIMORA ROSTRATA	BLUE ANTIMORA/HAKE
114	ENCHELYOPUS CIMBRIUS	FOURBEARD ROCKLING
115	GAIDROPSARUS ENSIS	THREEBEARD ROCKLING
116	GAIDROPSARUS ARGENTATUS	SILVER ROCKLING
117	MICROMESISTIUS POUTASSOU	BLUE WHITING
118	GADUS MACROCEPHALUS	GREENLAND COD; OGAC
121	CENTROPRISTIS STRIATA	SOUTHERN SEA BASS
122	TAUTOGOLABRUS ADSPERSUS	CUNNER
123	HELICOLENUS DACTYLOPTERUS	ROSEFISH BLACK BELLY
125	DIAPHUS EFFULGENS	HEADLIGHT FISH
135	HYGOPHUM HYGOMII	HYGOMI
138	LAMPADENA SPECULIGERA	MIRROR LANTERNFISH
140	PLEURONECTES PUTNAMI	SMOOTH FLOUNDER; LIOPSETTA
141	PARALICHTHYS DENTATUS	SUMMER FLOUNDER
142	HIPPOGLOSSINA OBLONGA	FOURSPOT FLOUNDER
143	SCOPHTHALMUS AQUOSUS	BRILL/WINDOWPANE

CODE	SPECIES NAME	COMMON NAME
146	LAMPANYCTUS MACDONALDI	RAKERY BEACONLAMP
147	LAMPANYCTUS PUSILLUS	PYGMY LANTERNFISH
148	BATHYPTEROIS DUBIUS	NOTCH FEELERFISH
149	PARASUDIS TRUCULENTA	LONGNOSE GREENEYE
152	DIAPHUS DUMERILII	DUMERIL'S LANTERNFISH
155	SIGMOPS ELONGATUS	LONGTOOTH ANGLEMOUTH; GONOSTOMA ELONGATUM
156	CHLOROPHTHALMUS AGASSIZI	SHORT-NOSE GREENEYE
157	BENTHOSEMA GLACIALE	GLACIER LANTERNFISH
158	MAUROLICUS MUELLERI	MUELLER'S PEARLSIDES
159	STOMIAS BOA	BOA DRAGONFISH
160	ARGENTINA SILUS	ARGENTINE ATLANTIC
161	ARGENTINA STRIATA	STRIATED ARGENTINE
163	CERATOSCOPELUS MADERENSIS	LANTERNFISH,HORNED
164	BREVOORTIA TYRANNUS	MENHADEN ATLANTIC
165	ALOSA AESTIVALIS	BLUEBACK HERRING
169	CHAULIODUS SLOANI	VIPERFISH
176	BATHYLAGUS EURYOPS	GOITRE BLACKSMELT
177	MALACOSTEUS NIGER	LOOSEJAW
180	MYCTOPHUM PUNCTATUM	SPOTTED LANTERNFISH
182	NOTOSCOPELUS KROYERI	LANTERNFISH KROYER'S; ELONGATUS
183	NOTOSCOPELUS RESPLENDENS	LANTERNFISH PATCHWORK
184	SYMBOLOPHORUS VERANYI	LARGESCALE LANTERNFISH
186	TAANINGICHTHYS MINIMUS	WAISTCOAT LANTERNFISH
190	THUNNUS ALALUNGA	ALBACORE TUNA
200	DIPTURUS LAEVIS	BARNDOOR SKATE
201	AMBLYRAJA RADIATA	THORNY SKATE
202	MALACORAJA SENTA	SMOOTH SKATE
203	LEUCORAJA ERINACEUS	LITTLE SKATE; ERINACEA
204	LEUCORAJA OCELLATA	WINTER SKATE
205	BATHYRAJA SPINICAUDA	SPINYTAIL SKATE
206	ROSTRORAJA EGLANTERIA	BRIER SKATE; RAJA
207	RAJELLA FYLLAE	ROUND SKATE; TERES; ROUND SKATE; RAJELLA FYLLAE
209	AMBLYRAJA JENSENI	SHORTTAIL SKATE
212	RAJELLA BATHYPHILA	ABYSSAL SKATE; RAJA
215	CARCHARIAS TAURUS	SHARK, SAND
216	TETRONARCE NOBILIANA	ATLANTIC TORPEDO; TORPEDO
220	SQUALUS ACANTHIAS	SPINY DOGFISH
221	CENTROSCYLLIUM FABRICII	BLACK DOGFISH
222	MUSTELUS CANIS	SMOOTH DOGFISH
223	CENTROSCYMNUS COELOLEPIS	PORTUGUESE SHARK

CODE	SPECIES NAME	COMMON NAME
224	ETMOPTERUS PRINCEPS	ROUGH SAGRE
228	LEPIDOPHANES GUENTHERI	GUNTHER'S LANTERNFISH
230	LAMNA NASUS	PORBEAGLE,MACKEREL SHARK
233	CETORHINUS MAXIMUS	BASKING SHARK
239	APRISTURUS PROFUNDORUM	DEEPSEA CAT SHARK
240	PETROMYZON MARINUS	SEA LAMPREY
241	MYXINE LIMOSA	NORTHERN HAGFISH; GLUTINOSA
242	HYDROLAGUS AFFINIS	DEEPWATER CHIMAERA
247	HARRIOTTA RALEIGHANA	LONGNOSE CHIMERA
248	RHINOCHIMAERA ATLANTICA	KNIFENOSE CHIMERA
284	LAMPANYCTUS ATER	DUSKY LANTERNFISH
287	NOTOSCOPELUS BOLINI	NOTOSCOPELUS BOLINI LANTERNFISH
300	MYOXOCEPHALUS OCTODECEMSPINOSUS	LONGHORN SCULPIN
301	MYOXOCEPHALUS SCORPIUS	SHORTHORN SCULPIN
302	GYMNOCANTHUS TRICUSPIS	ARCTIC STAGHORN SCULPIN
303	MYOXOCEPHALUS AENAEUS	GRUBBY OR LITTLE SCULPIN
304	TRIGLOPS MURRAYI	MAILED SCULPIN
305	TRIGLOPS NYBELINI	NYBELIN SCULPIN
306	ARTEDIELLUS UNCINATUS	SNOWFLAKE HOOKEAR SCULPIN
307	COTTUNCULUS MICROPS	POLAR SCULPIN
308	COTTUNCULUS THOMSONII	PALLID SCULPIN; THOMPSONI
313	ICELUS BICORNIS	TWOHORN SCULPIN
314	ICELUS SPATULA	SPATULATE SCULPIN
316	MYOXOCEPHALUS SCORPIOIDES	ARCTIC SCULPIN
317	TRIGLOPS PINGELII	RIBBED SCULPIN; PINGELI
320	HEMITRIPTERUS AMERICANUS	SEA RAVEN
330	PRIONOTUS CAROLINUS	NORTHERN,COMMON SEA ROBIN
331	PERISTEDION MINIATUM	ARMORED SEA ROBIN
340	ASPIDOPHOROIDES MONOPTERYGIUS	ALLIGATORFISH
341	ASPIDOPHOROIDES OLRIKII	ARCTIC ALLIGATORFISH; OLRIKI
350	LEPTAGONUS DECAGONUS	ATLANTIC SEA POACHER
356	RONDELETIA LORICATA	REDMOUTH WHALEFISH
361	GASTEROSTEUS ACULEATUS	THREESPINE STICKLEBACK
384	ANTIGONIA CAPROS	DEEPBODY BOARFISH
385	MONOLENE SESSILICAUDA	DEEPWATER FLOUNDER
386	ETROPUS MICROSTOMUS	SMALLMOUTH FLOUNDER
395	STOMIAS LONGIBARBATUS	MACROSTOMIAS
396	PHOTOSTOMIAS GUERNEI	INCL ULTIMOSTOMIAS MIRABILIS
400	LOPHIUS AMERICANUS	MONKFISH,GOOSEFISH,ANGLER
401	CERATIAS HOLBOELLI	DEEPSEA ANGLER

CODE	SPECIES NAME	COMMON NAME
409	MALACOCEPHALUS OCCIDENTALIS	AMERICAN STRAPTAIL GRENADIER
410	NEZUMIA BAIRDII	MARLIN-SPIKE GRENADIER
411	MACROURUS BERGLAX	ROUGHHEAD GRENADIER
412	TRACHYRINCUS MURRAYI	ROUGHNOSE GRENADIER
413	COELORINCHUS CAELORHINCUS	LONGNOSE GRENADIER; CAELORINCHUS
414	CORYPHAENOIDES RUPESTRIS	ROUNDNOSE GRENADIER
422	ARGYROPELECUS AFFINIS	PACIFIC HATCHETFISH
465	LAMPANYCTUS PHOTONOTUS	LAMPANYCTUS PHOTONOTUS LANTERNFISH
478	NOTOSCOPELUS CAUDISPINOSUS	NOTOSCOPELUS CAUDISPINOSUS LANTERNFISH
484	PARALEPIS ELONGATA	PARALEPIS ELONGATA BARRACUDINA
488	EVERMANNELLA INDICA	EVERMANELLA
494	SCOPELOBERYX ROBUSTUS	INCL SCOPELOBERYX NIGRESCENS
498	ANTHIAS NICHOLSI	YELLOWFIN BASS
501	CYCLOPTERUS LUMPUS	LUMPFISH
502	EUMICROTREMUS SPINOSUS	ATLANTIC SPINY LUMPSUCKER
503	LIPARIS ATLANTICUS	ATLANTIC SEASNAIL
504	LIPARIS LIPARIS	STRIPED SEASNAIL
505	LIPARIS FABRICII	SEASNAIL,GELATINOUS
506	LIPARIS TUNICATUS	GREENLAND SEASNAIL
507	CAREPROCTUS LONGIPINNIS	LONGFIN SEASNAIL
508	LIPARIS INQUILINUS	INQUILINE SEASNAIL
511	PARALIPARIS COPEI	BLACKSNOUT SEASNAIL
512	LIPARIS GIBBUS	SEASNAIL,DUSKY
513	LIPARIS COHENI	GULF SEA SNAIL
520	CAREPROCTUS REINHARDTI	SEA TADPOLE
526	MELANOLAGUS BERICOIDES	BATHYLAGUS
532	CUBICEPS GRACILIS	DRIFTFISH
556	MACRORAMPHOSUS SCOLOPAX	LONGSPINE SNIPEFISH; MACRORHAMPHOSUS
557	MELAMPHAES SUBORBITALIS	SHOULDERSPINE BIGSCALE
576	SYNAGROPS BELLUS	BLACKMOUTH BASS; BELLA
586	PARABLENNIUS MARMOREUS	SEAWEED BLENNY
587	EPIGONUS PANDIONIS	BIGEYE
588	SCOPELOSAURUS LEPIDUS	BLACKFIN WARYFISH
594	ALEPOCEPHALUS AGASSIZII	SMOOTHHEAD,AGASSIZ'S
595	CYTTOPSIS ROSEA	RED DORY
596	BAJACALIFORNIA MEGALOPS	BIGEYE SMOOTH-HEAD
599	AMMODYTES AMERICANUS	AMERICAN SAND LANCE
600	ANGUILLA ROSTRATA	AMERICAN EEL
601	SIMENCHELYS PARASITICA	SNUBNOSE EEL, SLIME EEL
602	SYNAPHOBRANCHUS KAUPII	GRAY'S CUTTHROAT EEL; KAUPI

CODE	SPECIES NAME	COMMON NAME
603	LYCENCHELYS VERRILLII	WOLF EELPOUT; VERRILLI
604	NEMICHTHYS SCOLOPACEUS	SNIPE EEL
607	NESSORHAMPHUS INGOLFIANUS	DUCKBILL OCEANIC EEL
608	CONGER OCEANICUS	CONGER EEL
609	OPHICHTHUS CRUENTIFER	SNAKE EEL
610	AMMODYTES DUBIUS	NORTHERN SAND LANCE
612	DERICHTHYS SERPENTINUS	NARROWNECKED OCEANIC EEL
613	SERRIVOMER BEANII	STOUT SAWPALATE; BEANI
614	EURYPHARYNX PELECANOIDES	PELICAN GULPER
615	LIPOGENYS GILLII	BACKFIN TAPIRFISH
616	GYMNELUS VIRIDIS	FISH DOCTOR; GYMNELIS
617	LYCENCHELYS PAXILLUS	COMMON WOLF EEL
619	LYCODES TERRAENOVAE	EELPOUT,NEWFOUNDLAND; INCL LYCODES ATLANTICUS; TERRAENOVA
620	LYCODES LAVALAEI	LAVAL'S EELPOUT
621	PHOLIS GUNNELLUS	ROCK GUNNEL EEL
622	LUMPENUS LAMPRETAEFORMIS	SNAKE BLENNY; LUMPRETAEFORMIS
623	LEPTOCLINUS MACULATUS	DAUBED SHANNY; LUMPENUS
624	STICHAEUS PUNCTATUS	ARCTIC SHANNY
625	ULVARIA SUBBIFURCATA	RADIATED SHANNY
626	EUMESOGRAMMUS PRAECISUS	4-LINE SNAKE BLENNY
627	LYCODES PALLIDUS	PALE EELPOUT
628	LYCODES POLARIS	POLAR EELPOUT
630	CRYPTACANTHODES MACULATUS	WRYMOUTH
631	LUMPENUS FABRICII	SLENDER EELBLENNY
632	ANISARCHUS MEDIUS	STOUT EELBLENNY; LUMPENUS
633	PHOLIS FASCIATA	BANDED GUNNEL
637	FOETOREPUS AGASSIZII	SPOTFIN DRAGONET; AGASSIZI
640	ZOARCES AMERICANUS	OCEAN POUT
641	LYCODES RETICULATUS	ARCTIC EELPOUT
643	LYCODES ESMARKII	VACHON'S EELPOUT; ESMARKI
646	MELANOSTIGMA ATLANTICUM	ATLANTIC SOFT POUT
647	LYCODES VAHLII	SHORTTAILED EELPOUT VAHL
650	LEPOPHIDIUM PROFUNDORUM	FAWN CUSK EEL
677	EPIGONUS DENTICULATUS	PENCIL CARDINAL
681	SCOPELARCHUS ANALIS	SHORT FIN PEARLEYE
684	VINCIGUERRIA NIMBARIA	OCEANIC LIGHTFISH
700	ARGYROPELECUS ACULEATUS	HATCHETFISH, ATLANTIC SILVER
701	PEPRILUS TRIACANTHUS	BUTTERFISH
702	SYNGNATHUS FUSCUS	NORTHERN PIPEFISH
704	ZENOPSIS CONCHIFER	AMERICAN JOHN DORY; OCELLATA

CODE	SPECIES NAME	COMMON NAME
705	ARGYROPELECUS GIGAS	ARGYROPELECUS GIGAS HATCHETFISH
708	POLYIPNUS CLARUS	HATCHETFISH,SLOPE
709	STERNOPTYX DIAPHANA	TRANSPARENT HATCHETFISH
710	ALEPISAURUS FEROX	LONGNOSE LANCETFISH
711	MAGNISUDIS ATLANTICA	SHORT BARRACUDINA; INCL PARALEPIS ATLANTICA KROYER; PARALEPIS
712	ARCTOZENUS RISSO	WHITE BARRACUDINA; NOTOLEPIS RISSOI
714	BENTHODESMUS SIMONYI	SIMONYI'S FROSTFISH
716	BOROSTOMIAS ANTARCTICUS	STRAIGHTLINE DRAGONFISH
717	GRAMMATOSTOMIAS DENTATUS	TORPEDO DRAGONFISH
720	SCOMBERESOX SAURUS	ATLANTIC SAURY,NEEDLEFISH
724	ALEPOCEPHALUS BAIRDII	BAIRDS SMOOTHEAD
725	XENODERMICHTHYS COPEI	ATLANTIC GYMNAST
728	SETARCHES GUENTHERI	CHANNELED ROCKFISH
729	OMOSUDIS LOWII	LOWEI
730	MOLA MOLA	OCEAN SUNFISH
731	ALEPISAURUS BREVIROSTRIS	SHORTNOSE LANCETFISH
732	ANOTOPTERUS PHARAO	DAGGERTOOTH
739	POLYACANTHONOTUS RISSOANUS	SHORTSPINE TAPIRFISH
740	NOTACANTHUS CHEMNITZII	SPINY EEL
742	DIBRANCHUS ATLANTICUS	ATLANTIC BATFISH
743	HYPEROGLYPHE PERCIFORMIS	AMERICAN BARRELFISH
744	POLYMIXIA NOBILIS	STOUT BEARD FISH
746	SPHOEROIDES MACULATUS	NORTHERN PUFFER
749	CONOCARA SALMONEUM	SLICKHEAD; SALMONEA
750	HOWELLA BRODIEI	CARDINALFISH
757	PHYSICULUS FULVUS	LITTLE MORID
758	LOBIANCHIA DOFLEINI	DOFLEINS LANTERNFISH
770	MENIDIA MENIDIA	ATLANTIC SILVERSIDE
771	POLYMIXIA LOWEI	BEARDFISH
774	ANOPLOGASTER CORNUTA	OGREFISH
775	BERYX DECADACTYLUS	ALFONSIN A CASTA LARGA
777	GRAMMICOLEPIS BRACHIUSCULUS	THORNY TINSELFISH
779	HIPPOCAMPUS ERECTUS	LINED SEAHORSE
784	APHANOPUS CARBO	BLACK SCABBARDFISH
785	ARIOMMA BONDI	SILVER-RAG
795	SCOPELOGADUS BEANII	BEANS BLUEBACK
798	MELAMPHAES MICROPS	SMALLEYE BIGSCALE
800	POROMITRA CRASSICEPS	CRESTED BIGSCALE
814	BATHYSAURUS FEROX	DEEPSEA LIZARDFISH
816	SYMPHURUS DIOMEDEANUS	TONGUE FISH

CODE	SPECIES NAME	COMMON NAME
820	CUBICEPS PAUCIRADIATUS	BIGEYE CIGARFISH
824	BENTHODESMUS TENUIS	SLENDER FROSTFISH
833	SAURIDA BRASILIENSIS	LIZARDFISH,LARGESCALE
844	HALIEUTICHTHYS ACULEATUS	BATFISH,SPINY
845	LYCODES EUDIPLEUROSTICTUS	EELPOUT
850	SCOPELOSAURUS MAULI	MAUL'S WARYFISH
862	DICROLENE INTRONIGER	DIGITATE CUSK EEL
863	BATHYPTEROIS QUADRIFILIS	BATHYPTEROIS QUADRIFILIS
865	ALDROVANDIA PHALACRA	ALDROVANDIA PHALACRA
866	XENOLEPIDICHTHYS DALGLEISHI	SPOTTED TINSELFISH
868	PARALIPARIS CALIDUS	SEASNAIL
869	PARALIPARIS GARMANI	SEASNAIL
880	ARTEDIELLUS ATLANTICUS	HOOKEAR SCULPIN,ATL.
883	SIGMOPS BATHYPHILUS	GONOSTOMA BATHYPHILUM
901	ECTREPOSEBASTES IMUS	MIDWATER SCORPIONFISH
914	HOLTBYRNIA ANOMALA	BIGHEAD SEARSID
924	CAREPROCTUS RANULA	SCOTIAN SNAILFISH
935	MANDUCUS MADERENSIS	DIPLOPHOS
942	POLYMETME CORYTHAEOLA	RENDEZVOUS FISH
947	APRISTURUS LAURUSSONII	LAURUSSONI
963	ROULEINA MADERENSIS	SMOOTHHEAD
967	LEUCORAJA GARMANI	SKATE,ROSETTE; RAJA
1006	HOPLOSTETHUS ATLANTICUS	ORANGE ROUGHY
1010	HALOSAURUS GUENTHERI	HALOSAURUS GUENTHERI
1012	BASSOGIGAS GILLII	GILLI
1017	ROULEINA ATTRITA	SOFTSKIN SMOOTH-HEAD
1019	ILYOPHIS BRUNNEUS	MUDDY ARROWTOOTH EEL
1025	VENEFICA PROCERA	VENEFICA PROCERA
1028	HALOSAUROPSIS MACROCHIR	ABYSSAL HALOSAUR
1030	ALDROVANDIA AFFINIS	GILBERT's HALOSAURID FISH
1032	BATHYTROCTES MICROLEPIS	SMALLSCALE SMOOTH-HEAD
1038	BATHYPTEROIS GRALLATOR	BATHYPTEROIS GRALLATOR
1039	BATHYPTEROIS LONGIPES	ABYSSAL SPIDERFISH
1045	BATHYPTEROIS PHENAX	BLACKFIN SPIDERFISH
1050	NEOCYTTUS HELGAE	BLACK OREO
1060	CORYPHAENOIDES CARAPINUS	CARAPINE GRENADIER
1071	SCYLIORHINUS RETIFER	CHAIN CATSHARK
1072	CATAETYX LATICEPS	CATAETYX LATICEPS
1076	LAEMONEMA BARBATULUM	LAEMONEMA BARBATULUM
1106	HOPLOSTETHUS MEDITERRANEUS	SILVER ROUGHY

CODE	SPECIES NAME	COMMON NAME
1264	APRISTURUS MANIS	GHOST CATSHARK
1269	BATHYGADUS MELANOBRANCHUS	VAILLANTS GRENADIER
1270	NEZUMIA AEQUALIS	SMOOTH GRENADIER
1274	LEPIDION SCHMIDTI	SCHMIDT'S COD

Table 4. Demersal and pelagic fish, excluding sharks, that are Species at Risk (SAR) and/or of conservation concern (i.e. COSEWIC) within in the Offshore Wind RA Study Area, and their critical habitat.

Species	Status	Critical Habitat
Acadian Redfish (Atlantic Population)	COSEWIC – Threatened SARA – under consideration	Not on SARA Schedule 1
American Plaice (Maritime Population)	COSEWIC – Threatened SARA – under consideration	Not on SARA Schedule 1
Atlantic Bluefin Tuna	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Atlantic Cod (Laurentian South Population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Atlantic Cod (Southern Population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Atlantic Salmon (Eastern Cape Breton Population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Atlantic Salmon (Gaspe-Southern Gulf of St. Lawrence population)	COSEWIC – Special Concern SARA – under consideration	Not on SARA Schedule 1
Atlantic Salmon (Nova Scotia Southern Upland population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Atlantic Wolffish	COSEWIC – Special Concern SARA – Special Concern	Critical habitat identification is not required for SARA Schedule 1 species of “Special Concern”
Cusk	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Deepwater Redfish (Gulf of St. Lawrence – Laurentian Channel population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Lumpfish	COSEWIC – Threatened SARA – under consideration	Not on SARA Schedule 1
Northern Wolffish	COSEWIC – Threatened SARA – Threatened	Critical habitat on the Scotian Shelf has not been determined (DFO 2020a).
Roundnose Grenadier	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Smooth Skate (Laurentian-Scotian Population)	COSEWIC – Special Concern SARA – under consideration	Not on SARA Schedule 1
Spiny Dogfish (Atlantic population)	COSEWIC – Special Concern; SARA – under consideration	Not on SARA Schedule 1
Spotted Wolffish	COSEWIC – Threatened SARA – Threatened	Critical habitat on the Scotian Shelf has not been determined (DFO 2020a).
Striped Bass (Southern Gulf of St. Lawrence population)	COSEWIC – Special Concern SARA – under consideration	Not on SARA Schedule 1

Thorny Skate	COSEWIC – Special Concern SARA – under consideration	Not on SARA Schedule 1
White Hake (Atlantic and Northern Gulf of St. Lawrence population)	COSEWIC – Threatened SARA – under consideration	Not on SARA Schedule 1
White Hake (Southern Gulf of St. Lawerence population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Winter Skate (Eastern Scotian Shelf – Newfoundland Population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1
Winter Skate (Gulf of St. Lawrence Population)	COSEWIC – Endangered SARA – under consideration	Not on SARA Schedule 1

Table 5. List of First Nations and Indigenous Organizations located within DFO Maritimes Region that are issued Food, Social and Ceremonial authorizations.
Please note that any information about FSC fisheries, including the information in Table 5, cannot be posted publicly under any format. It is only for internal use by the Regional Assessment Committee. Please carefully review the attachment titled "Best Practices FSC Data"

First Nation/ Indigenous Organization	Province
Wasoqopa'q (Acadia First Nation)	Nova Scotia
Annapolis Valley First Nation	Nova Scotia
Bear River First Nation	Nova Scotia
Eskasoni First Nation	Nova Scotia
Fort Folly First Nation	New Brunswick
Glooscap First Nation	Nova Scotia
Kingsclear First Nation	New Brunswick
Membertou First Nation	Nova Scotia
Millbrook First Nation	Nova Scotia
Native Council of Nova Scotia	Nova Scotia
Oromocto First Nation	New Brunswick
Passamaquoddy Recognition Group	New Brunswick
Potlotek First Nation	Nova Scotia
Sipekne'katik First Nation	Nova Scotia
Sitansisk (St. Mary's First Nation)	New Brunswick
Wagmatcook First Nation	Nova Scotia
We'koqma'q First Nation	Nova Scotia
Woodstock First Nation	New Brunswick

Table 6. List of marine refuges on the Scotian Shelf/Nova Scotia waters.

Name	**Description**	**Establishment mechanism**
Corsair and Georges Canyons Conservation Area (restricted bottom fisheries zone)	Conservation objective: to protect cold water corals. Prohibited Activities: Prohibits all commercial bottom-contact fishing gear.	Condition of Licence
Emerald Basin and Sambro Bank Sponge Conservation Areas	Conservation objective: to protect globally unique concentration of Vazella pourtalesi, a structure-forming species of glass sponge. Prohibited Activities: Prohibits all commercial bottom-contact fishing gear.	Variation Order and/or Condition of Licence
Jordan Basin Conservation Area	Conservation objective: to protect cold water corals. Prohibited Activities: Prohibits all commercial bottom-contact fishing gear.	Condition of Licence
Northeast Channel Coral Conservation Area (restricted bottom fisheries zone)	Conservation objective: to protect cold water corals. Prohibited Activities: Prohibits all commercial bottom-contact fishing gear.	Variation Order and/or Condition of Licence
Jordan Basin Conservation Area	Conservation objective: to protect cold water corals.	Jordan Basin Conservation Area
Western/Emerald Banks Conservation Area (restricted fisheries zone)	Conservation objective: Support productivity objectives for groundfish species of Aboriginal, commercial, and/or recreational importance, particularly NAFO Division 4VW haddock; Manage the disturbance of benthic habitat that supports juvenile and adult haddock and other groundfish species. Prohibited Activities: Prohibits all commercial and recreational fisheries using bottom-contact gear and/or gear known to interact with groundfish.	Condition of Licence
Eastern Canyons Conservation Area	Conservation objective: to protect cold-water corals and Lophelia pertusa coral reef. Prohibited Activities: Prohibits all commercial bottom-contact fishing gear.	Variation Order and/or Condition of Licence

6 Appendix B – Figures

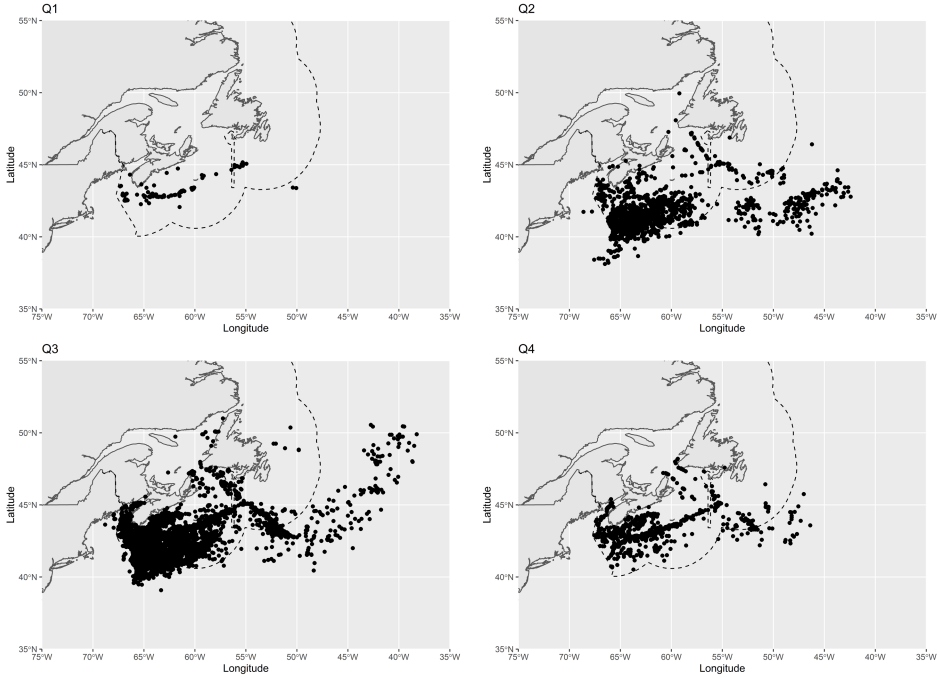


Figure 1. Logbook recorded captures of Shortfin Mako Shark by fisheries from Maritimes and Newfoundland regions during 2001-2019, binned by fishing quarter: 1 – January to March, 2 – April to June, 3 – July to September and 4 – October to December. Reprinted from Bowlby et al. 2022b

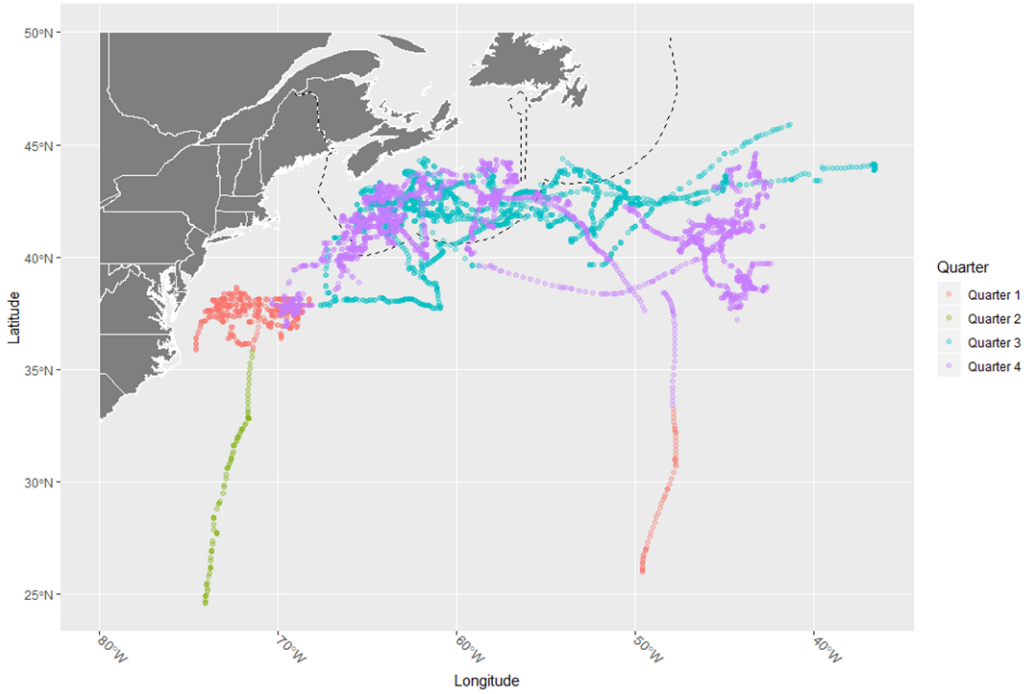


Figure 2. Satellite tracks of tagged Shortfin Mako in the Northwest Atlantic Ocean with positions binned by fishing quarter: 1 – January to March, 2 – April to June, 3 – July to September and 4 – October to December. Reprinted from Bowlby et al. 2022b.

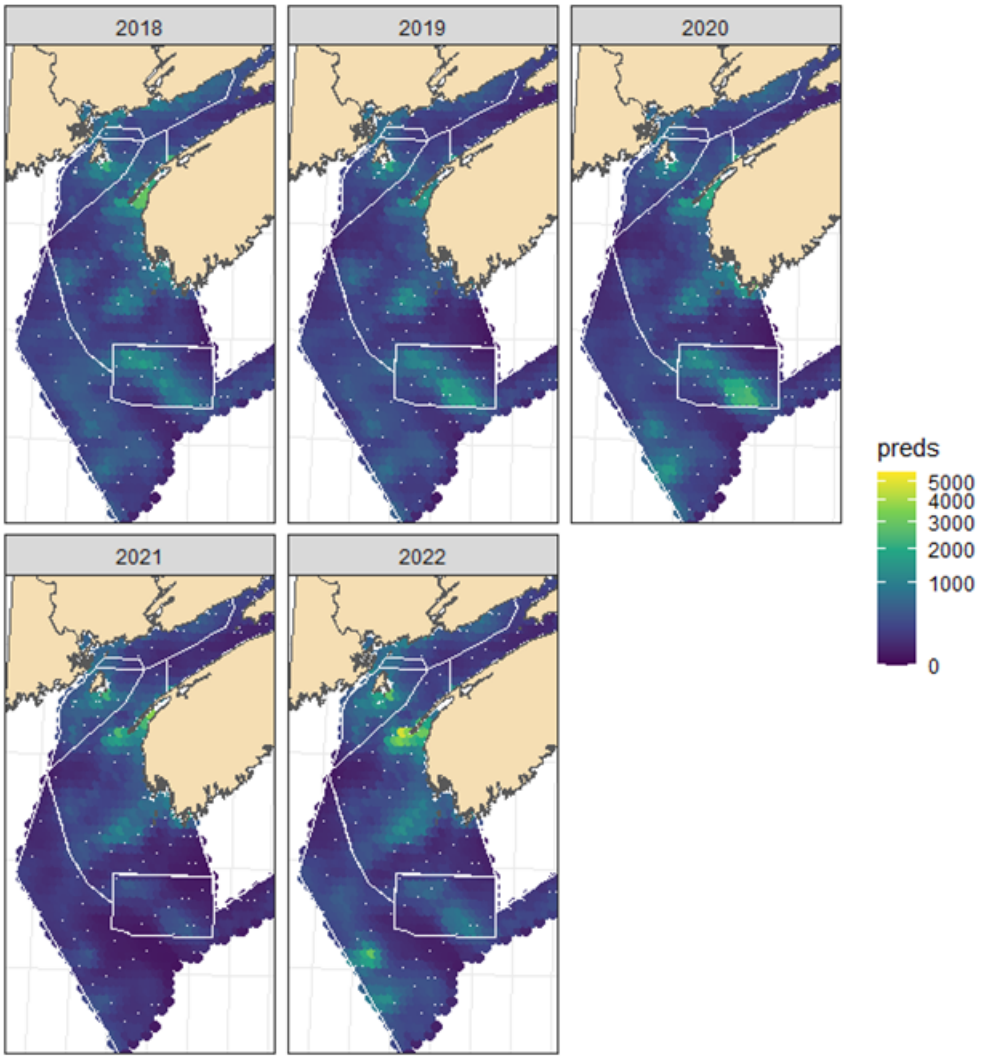


Figure 3: Spatial distribution and abundance of commercial lobster in LFA 34-41 as obtained from a spatial temporal model of trawl survey data.

Note: In LFA 34, 35, 36 and 38, various fisheries independent data sets are available to depict the distribution of various life stages of lobster. Figure 1 shows modelled distribution of commercial abundance of lobster following commercial fishing (June-July months) in 2018-2022. There are persistent areas of high density, which also coincide with the fisheries footprint maps shown in the attached draft technical report. Areas of high density of lobster are also prevalent in the offshore LFA 40 and LFA 41.

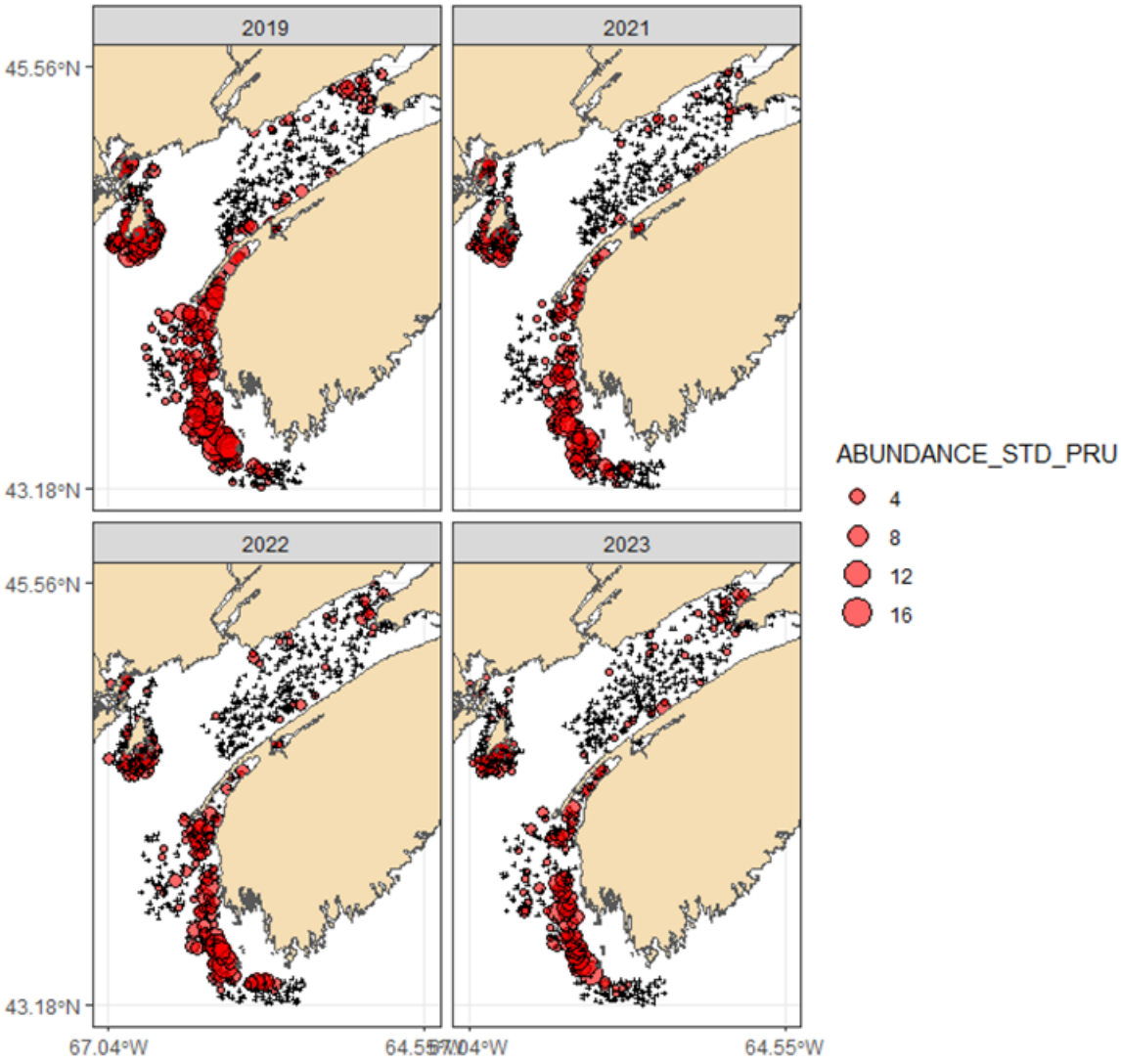


Figure 4: Distribution and relative abundance of recruiting lobster (70-82mm carapace length) catch (numbers per tow) from inshore scallop surveys. Crosses represent stations with no lobster catch.

Figure 4 shows the catch of recruiting lobster (70-82mm carapace length) from scallop dredge surveys. Clear and persistent patterns of high abundance of recruiting lobster can be seen in these figures.

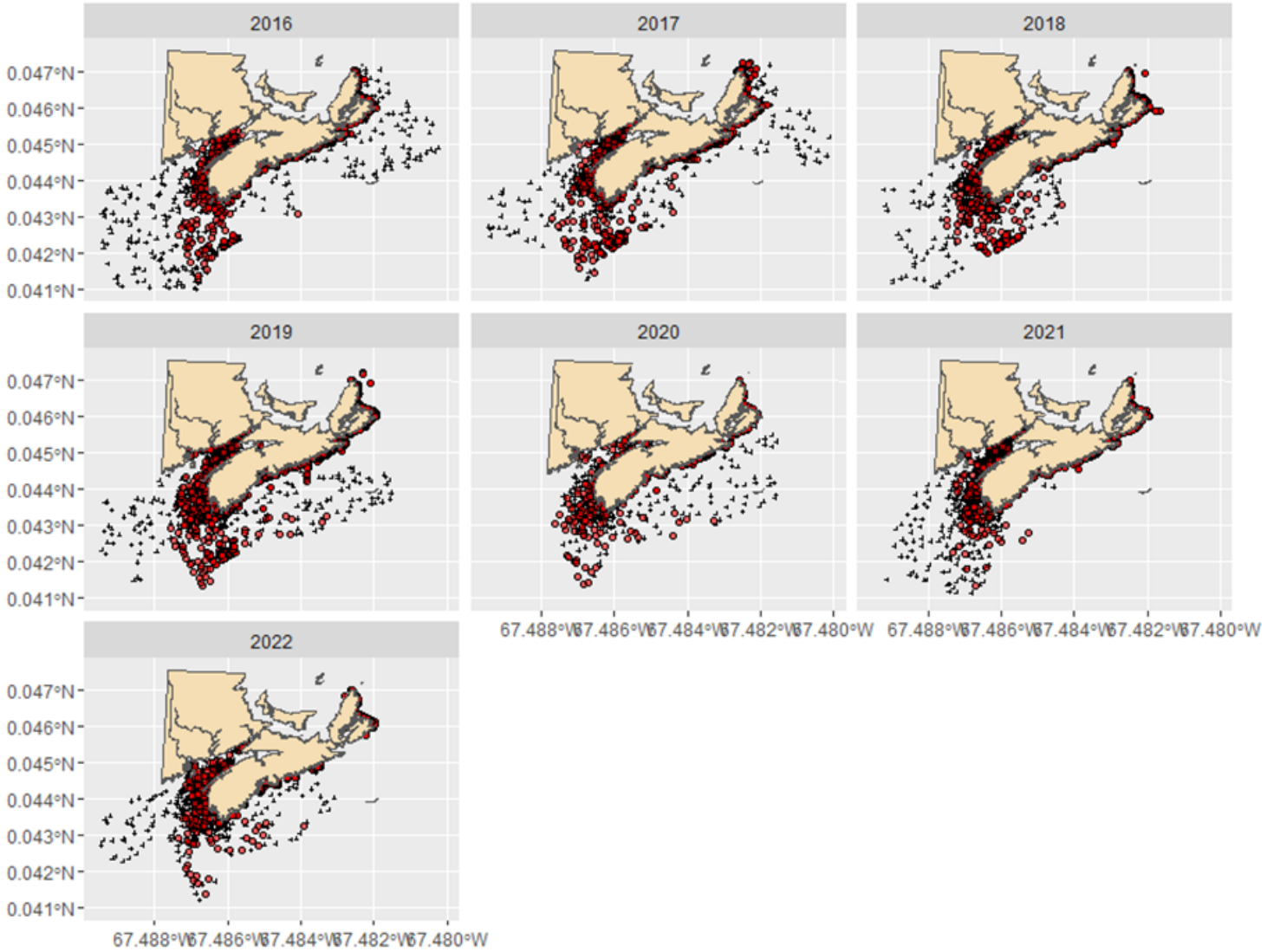


Figure 5: Distribution of berried lobster (egg bearing) during the summer months (May-July) from trap samples, trawl and dredge surveys. Crosses indicate locations without berried females.

Figure 5 shows the spatial extent and temporal time series of egg bearing (or berried) lobsters from at-sea samples of lobster traps, standardized recruitment trapping projects, bottom trawl surveys and scallop dredges. All data for these figures were subset for just the months of May, June and July, which are important months for mating, egg extrusion, release and moulting. This figure depicts presence / absence only as the various types of gear do not allow for easy comparison of relative abundance (i.e. trap catches ≠ trawl catches). Berried female lobster occupy inshore habitat across the region during the summer months. In addition, there are important offshore areas which are occupied by berried female lobster on a persistent basis.

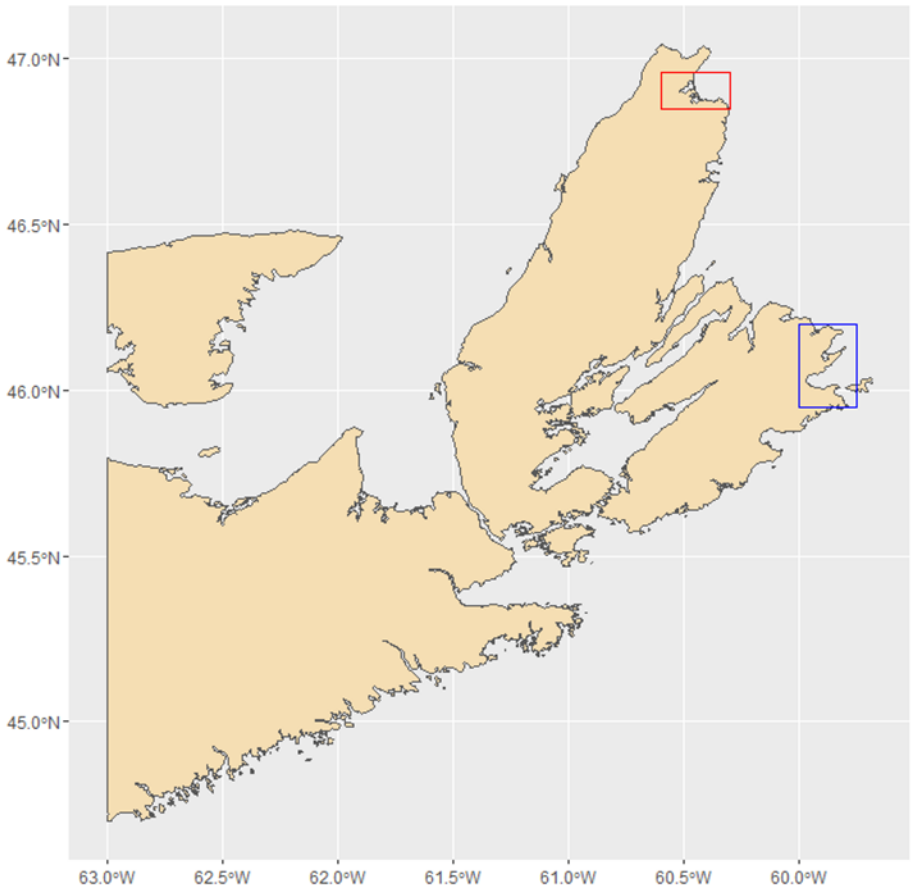


Figure 6: Sites of plankton tows completed by Cape Breton Fish Harvesters Association (CBFHA). Blue box represents False Bay site and red represents Dingwall.

There are no comprehensive sampling programs for lobster larvae, however sampling does occur on an annual basis in Cape Breton and along Eastern Shore of Nova Scotia (Figures 4-8) by fishing association groups. Plankton tows show that lobster larvae are present during the summer months along the coastal and inshore areas in almost all plankton tows performed. The extent of larval distribution is not known, but given the distribution of berried females during the summer months (when larvae would be released) there is a high likelihood larvae are present in the nearshore waters and are dispersed following the oceanographic currents.

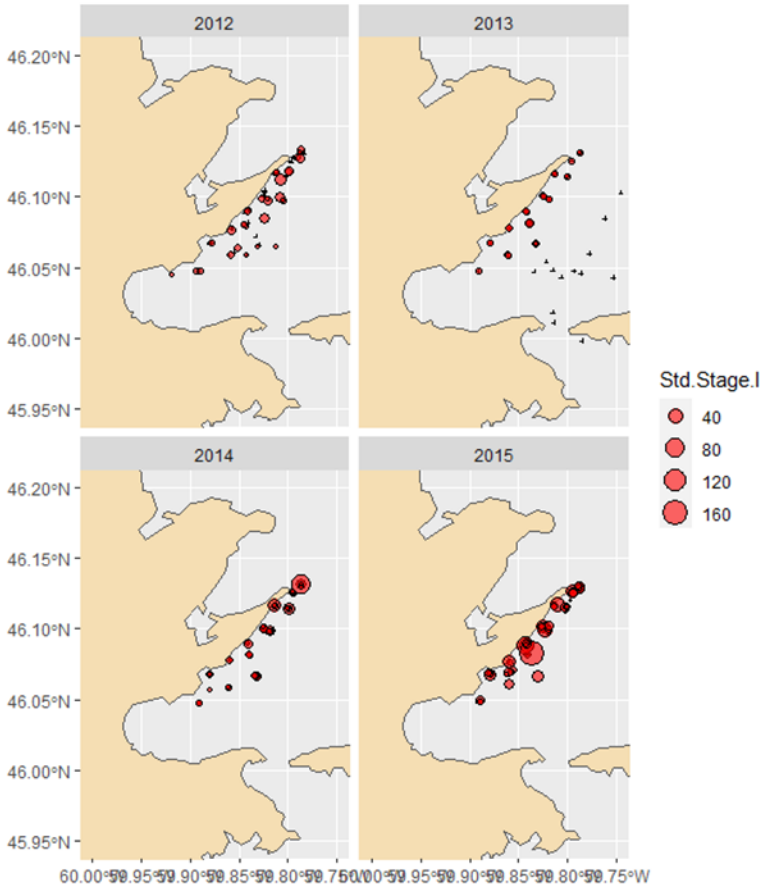


Figure 7: Distribution and standardized abundance of stage one lobster larvae collected during summer of 2012 to 2015 in False Bay (blue box Figure 4) by CBFHA. Crosses indicate locations without lobster larvae.

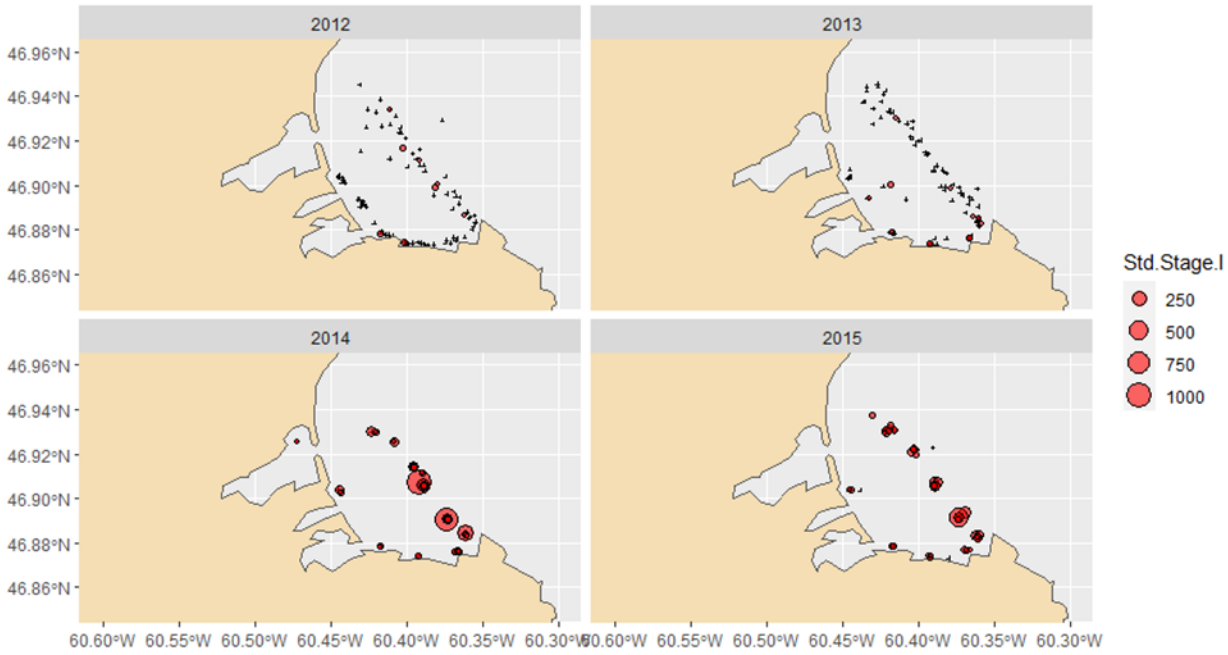


Figure 8: Distribution and standardized abundance of stage one lobster larvae collected during summer of 2012 to 2015 in Dingwall (red box Figure 6) by CBFHA. Crosses indicate locations without lobster larvae.

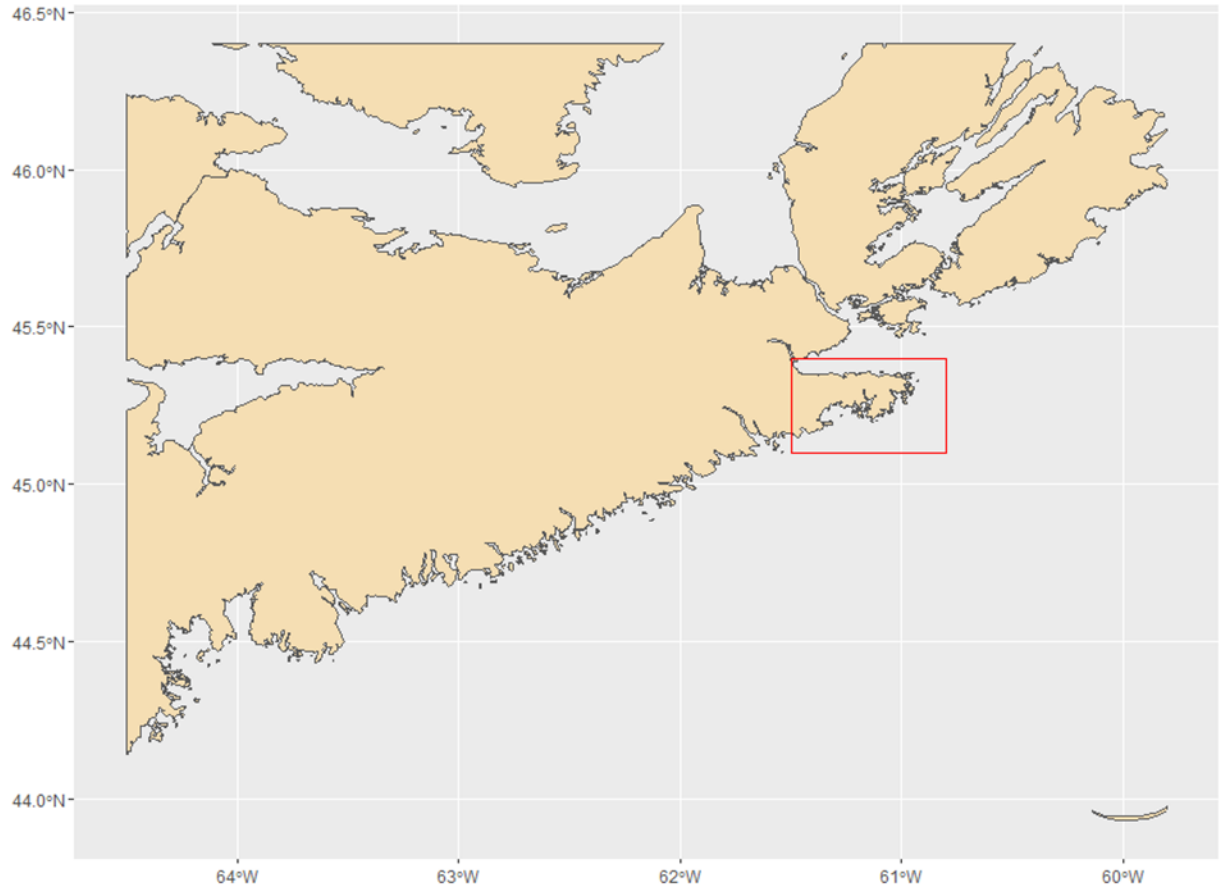


Figure 9: Location of plankton sampling (red box) performed by Guysborough County Inshore Fishermen's Association (GCIFA).

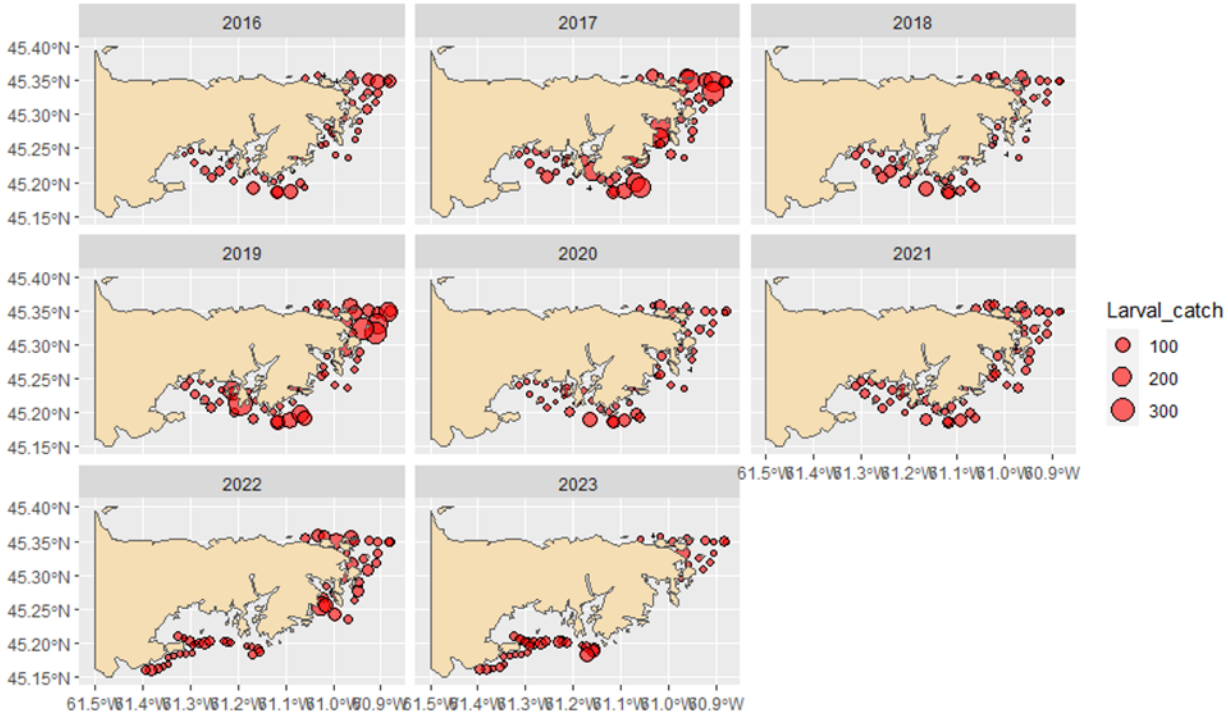


Figure 10: Distribution and density of lobster larvae collected by plankton tows during the summer months by Guysborough County Inshore Fishermen's Association (GCIFA). Crosses indicate tows with no lobster larvae.

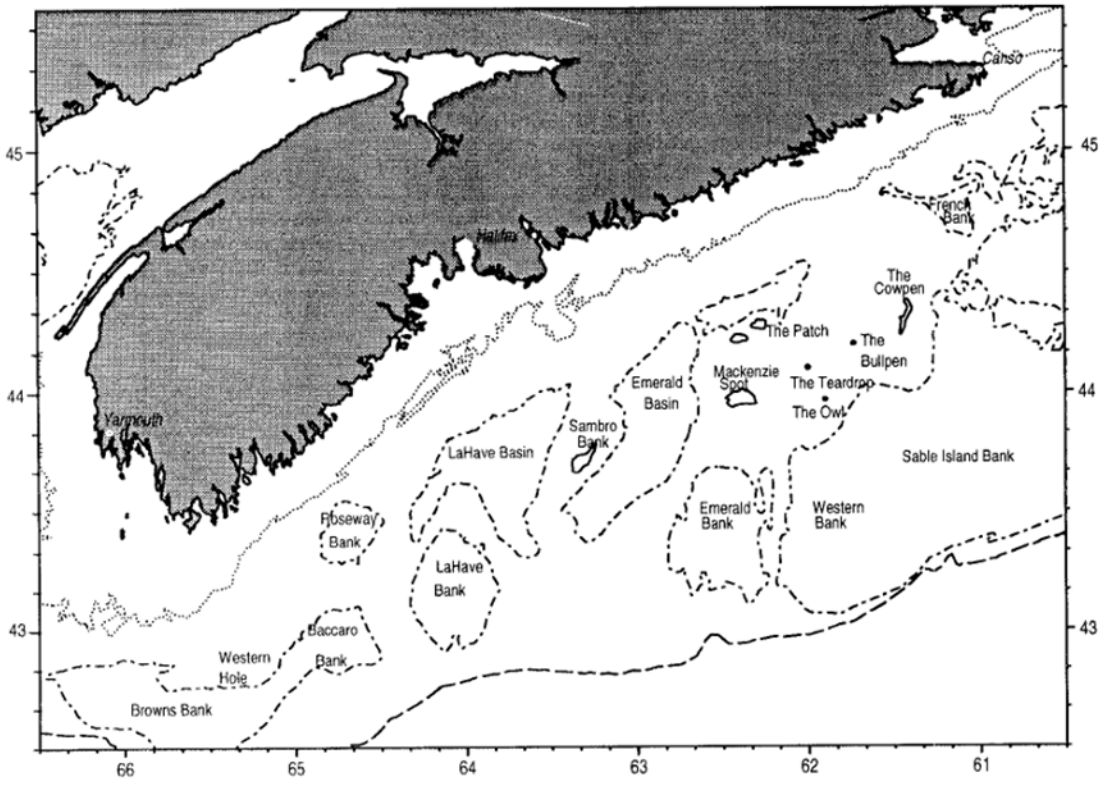


Figure 10. Offshore fishing locations for herring on the Scotian Shelf.

Figure 11: Dotted lines indicate historic herring spawning sites. From Harris and Stephenson (1999).

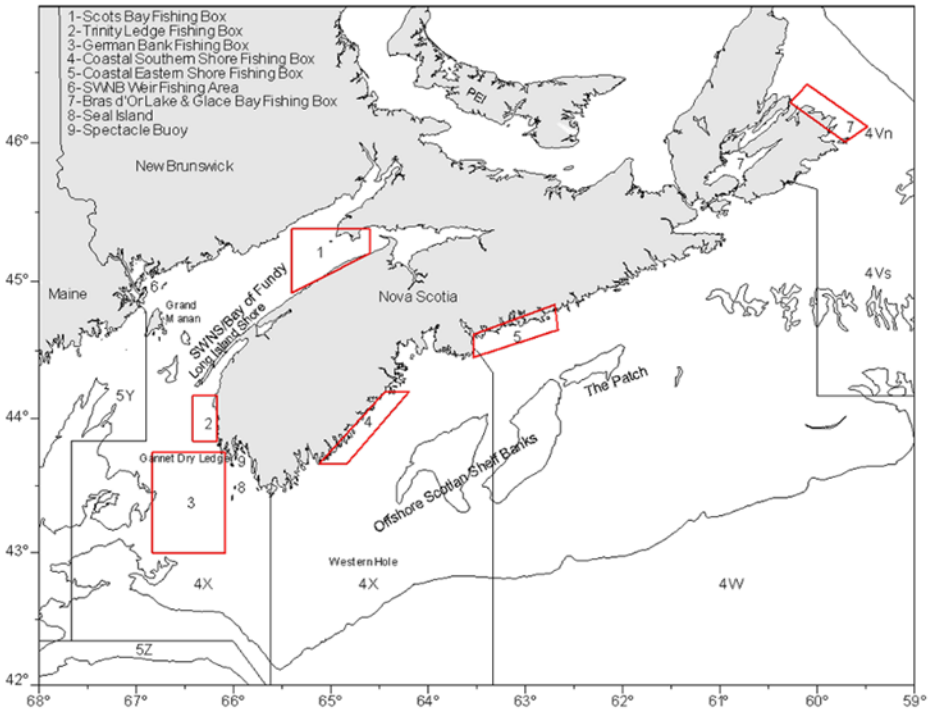


Figure A1. Place names and fishing locations for Southwest Nova Scotia/Bay of Fundy, Coastal NS (South Shore, Eastern Shore, Cape Breton), Offshore Scotian Shelf, and SWNB weirs. The vertical line between the two 4X labels indicates the outer boundary of the Southwest Nova Scotia/Bay of Fundy (SWNS/BoF) stock component.

Figure 12: Place names and fishing locations of four stock components for 4VWX Herring. From DFO (2023a).

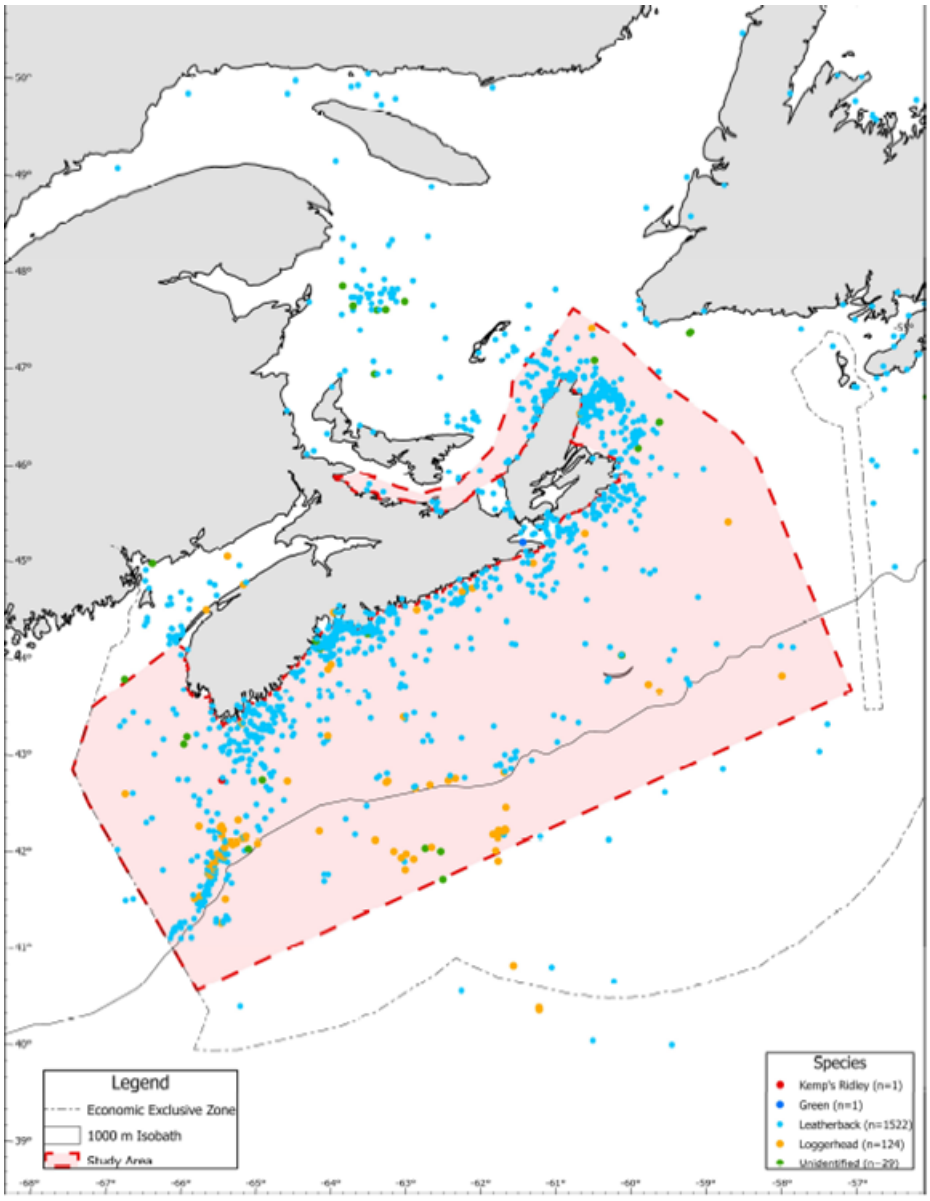


Figure 13. Public sightings of sea turtles reported to the Canadian Sea Turtle Network (1971-2023). Source: Canadian Sea Turtle Network.

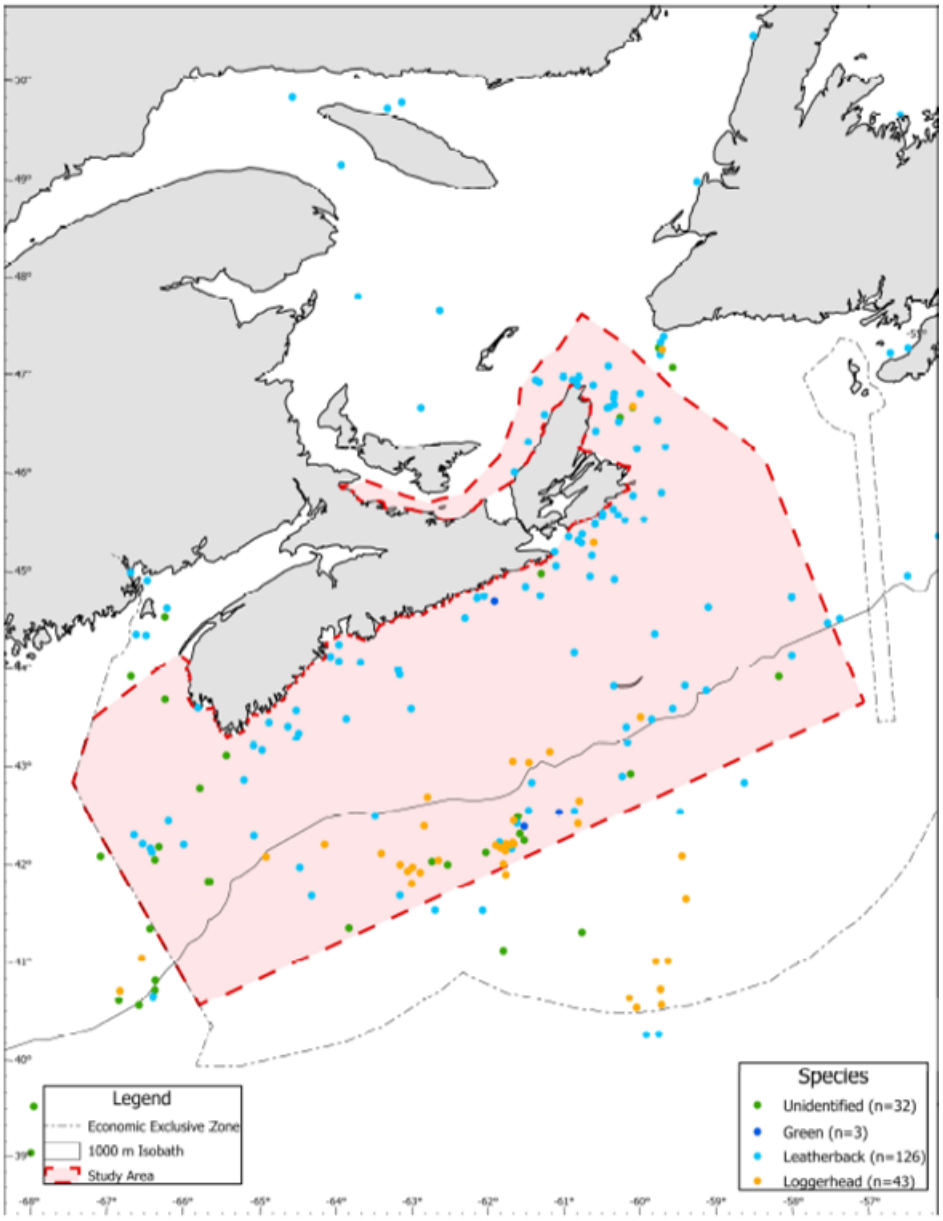


Figure 14. Sightings of sea turtles reported to Whale sightings Database (WSDB), Team Whale, Fisheries and Oceans Canada, Dartmouth, NS, [20230927].

Caveats from the WSDB: The data may contain some erroneous or duplicate records. The certainty of species identification and number of animals is sometimes unknown. Until May 2022, best count could have been interpreted using count ranges specified in the archival field 'confidence level'. Many sightings could not be identified to species but are listed to the smallest taxonomic group possible. Many sightings were collected on an opportunistic basis and may come from contributors with different levels of experience. Accuracy will vary with visibility, sea state, weather conditions, and interpretation. Sighting coordinates most often refer to the location of the observer and not the animal. There are observations from shore, but these should not be interpreted as sightings on land. Most sightings have been gathered from vessel-based platforms. Effort associated with collection of sightings has not been quantified in this database and cannot be used to estimate true species density or abundance for an area. Effort is not

consistent among months, years, and areas. Lack of sightings within a particular area/time does not necessarily represent lack of species present but could reflect lack of or limited effort. Seasonal and distribution information should not be considered definitive.

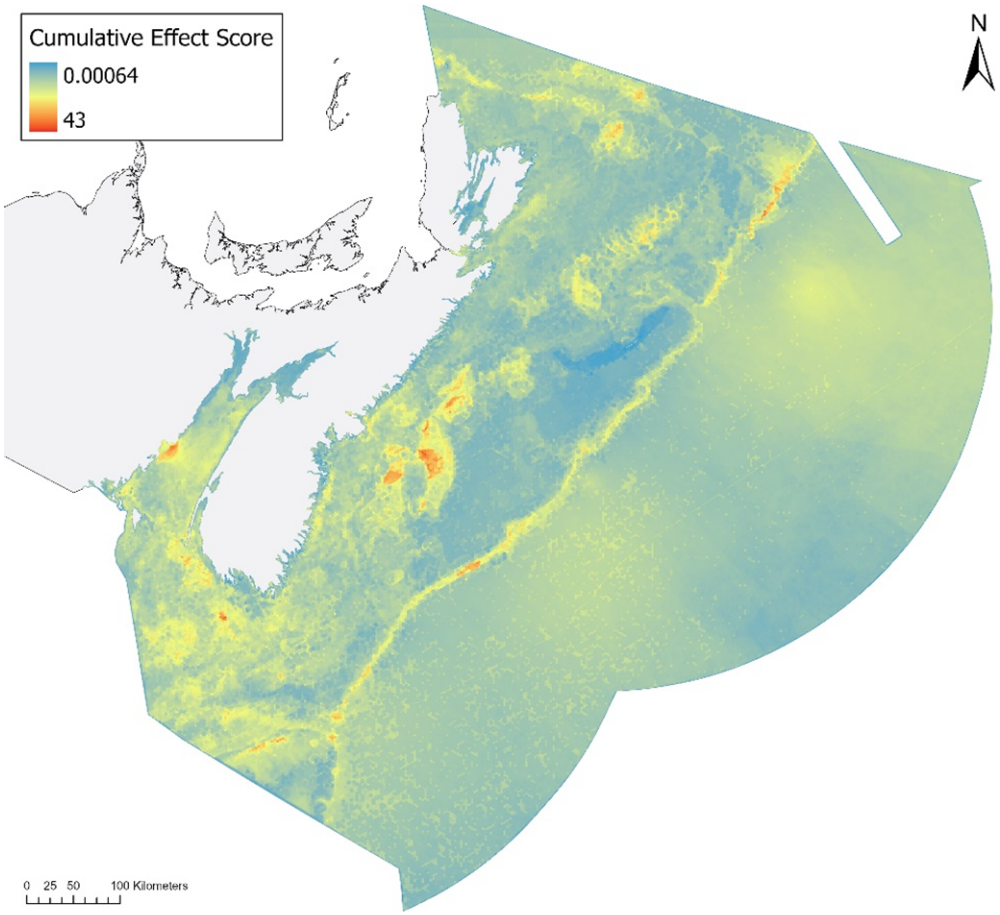


Figure 15. Cumulative impact map for Scotian Shelf bioregion including 45 human activities and 21 habitats.

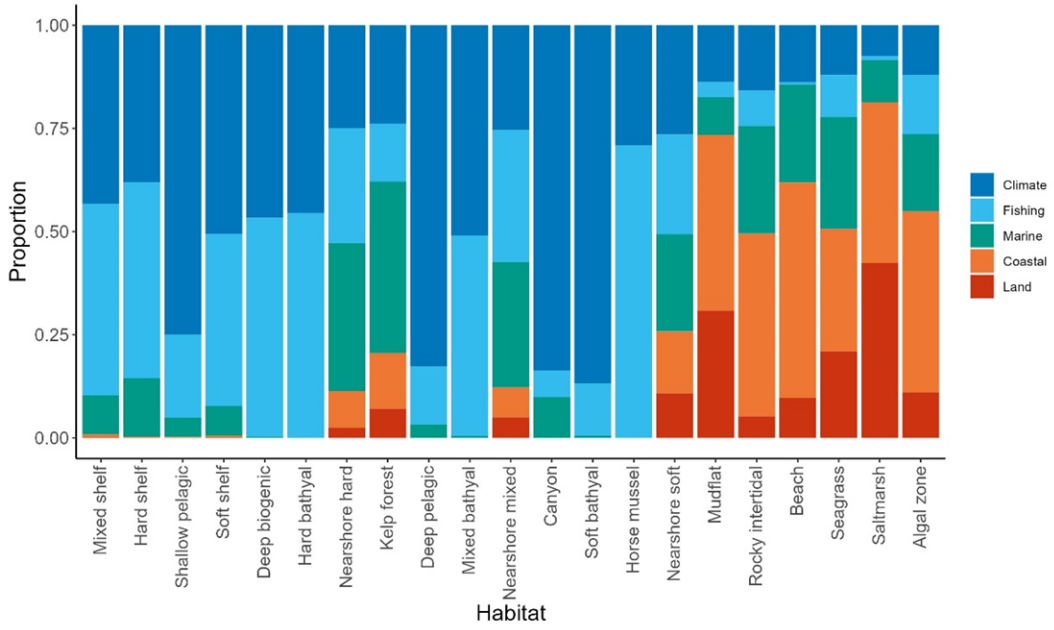


Figure 16. Proportional contribution of each of the five sectors to the mean CE score for each habitat. Habitats are ranked from highest average CE score (left) to lowest (right).

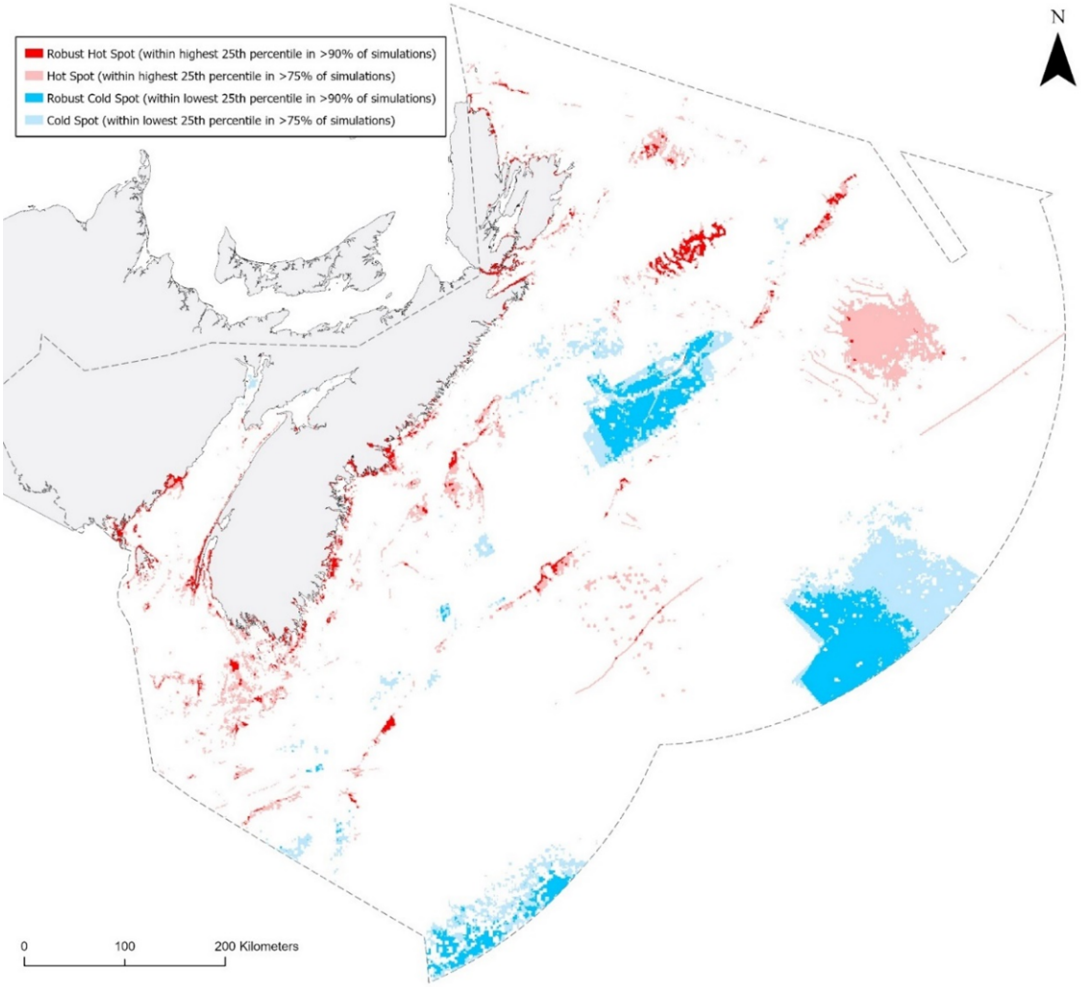


Figure 17. Hot and cold spots of modelled cumulative human impacts. Hot spots are defined as cells where CE scores occur in the highest 25th percentile (CE scores > 13.5) in over 75% of Monte Carlo simulations. Robust hot spots are those cells that occur in over 90% of simulations. Cold spots are defined as cells where CE scores occur in the lowest 25th percentile (CE scores < 8.9) in over 75% of simulations. Robust cold spots are those cells that occur in over 90% of simulations.

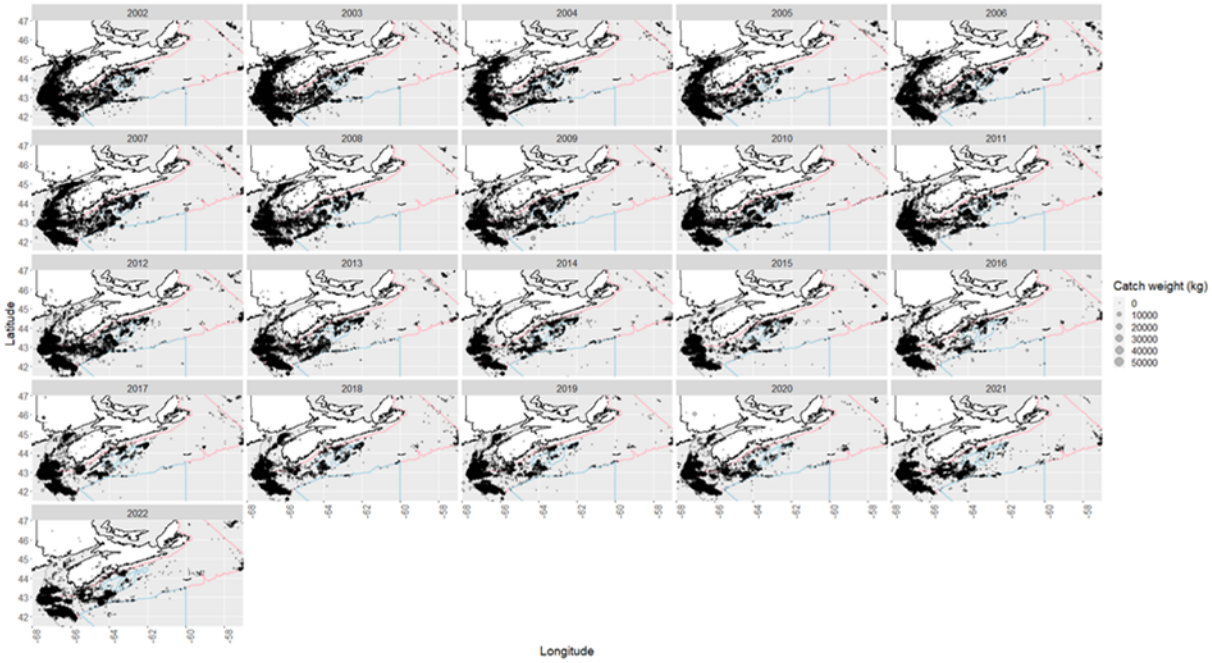


Figure 18. Canadian commercial landing for Pollock within NAFO areas 4VWX5 separated by calendar year.

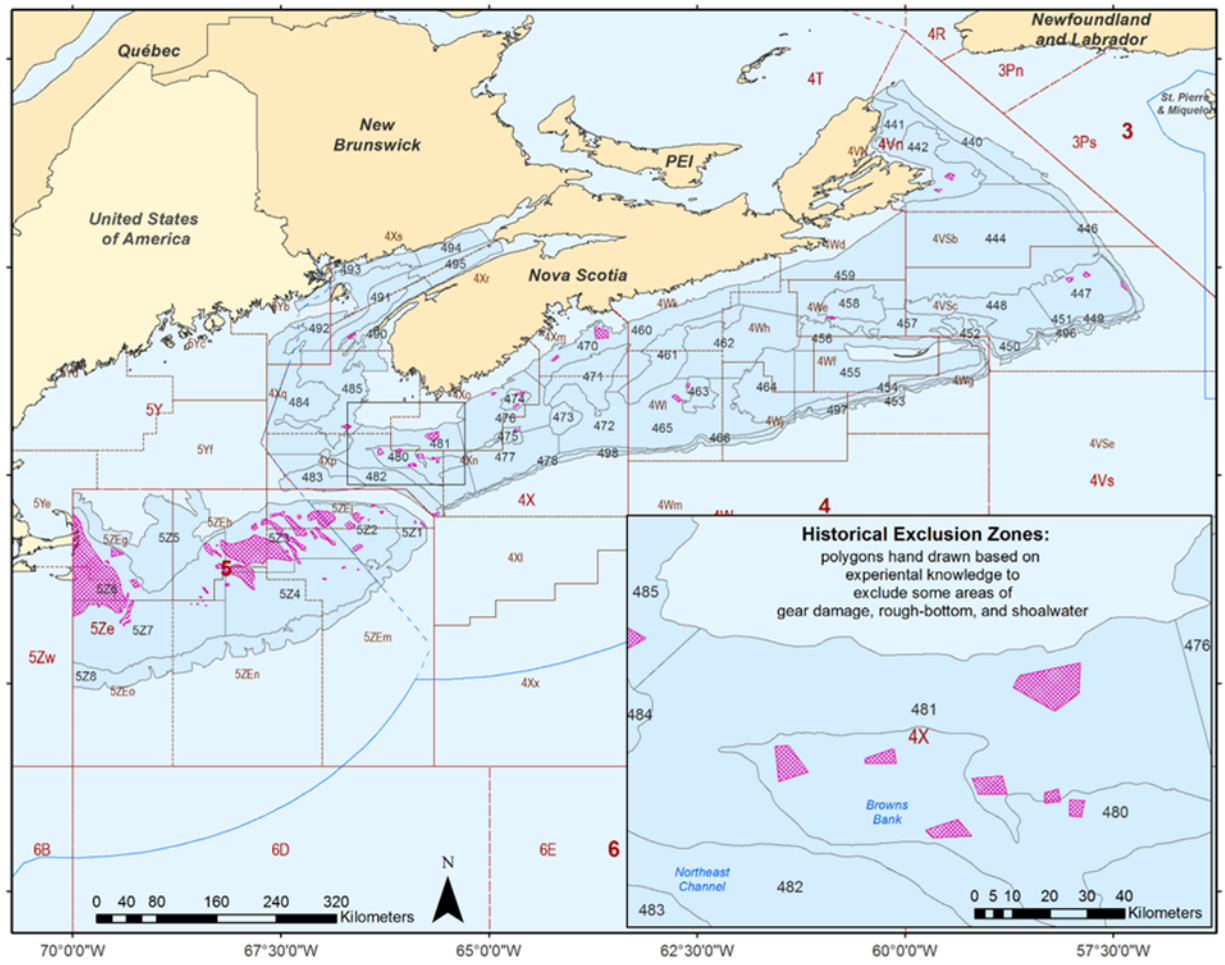


Figure 19. Historical survey exclusion zones, used from 1970 to 2013 (Wilson et al. in press).

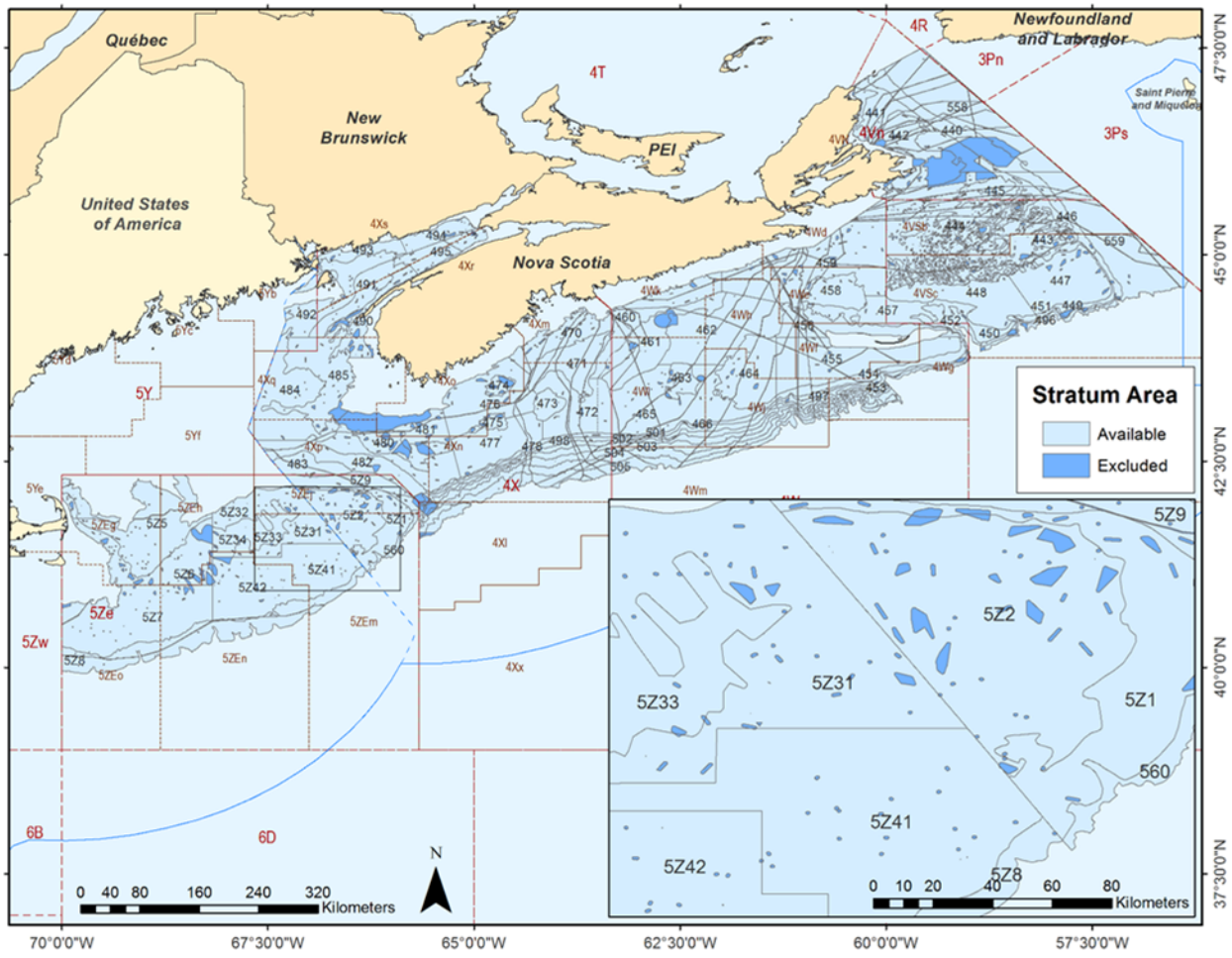


Figure 20. Current exclusion zones (2014 to present), which take into account gear damage, shoal water, depth change, rough bottom, conservation areas, shipwrecks, military ordinance, oil and gas production, cables, other ongoing marine research, and obstructions (Wilson et al. in press).

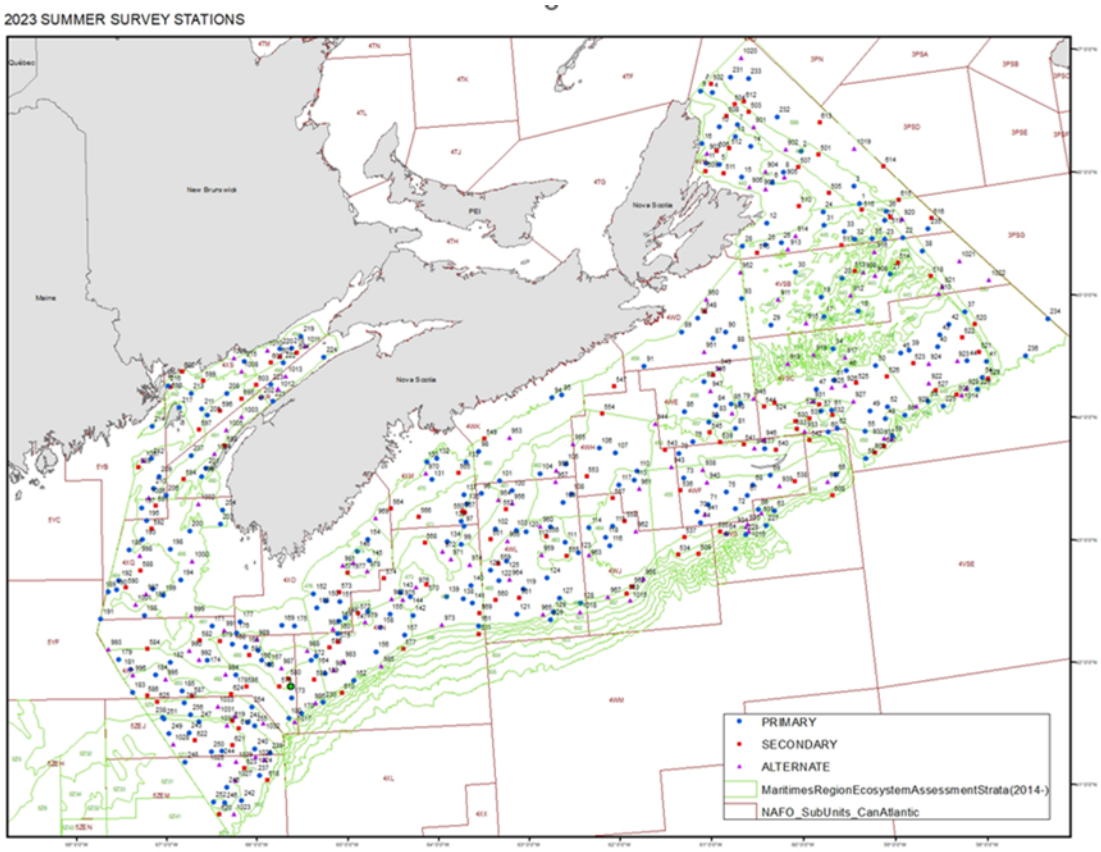


Figure 22. Station allocation for the 2023 Maritimes Region Summer RV survey. The blue points represent primary stations (n=285). Secondary (red) and alternate (purple) stations are also included in the event a primary station is unfishable (e.g. bad bottom). *The Regional Assessment Study Area for offshore wind development encompasses 95% of the Maritimes Region RV Survey area.*

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