

6.0 EXISTING BIOLOGICAL ENVIRONMENT

The existing biological environment of the Regional Assessment Area (RAA) is outlined in this section and includes a description of the existing marine fish and fish habitat, marine and migratory birds, marine mammals and sea turtles, and special areas. Scientific names for species are provided in Appendix G. Within each biological group, species at risk and species of conservation concern (SOCC) are also discussed. Species at risk include species listed under the federal *Species at Risk Act* (SARA) Schedule 1 as:

- Endangered: A species that is facing imminent extirpation or extinction
- Threatened: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction
- Special Concern: A species that may become threatened or endangered because of a combination of biological characteristics and identified threats

Species at risk also include indigenous species, sub-species, and populations listed under the NL *Endangered Species Act* (NL ESA) as:

- Endangered: A species that is facing imminent extirpation or extinction
- Threatened: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction
- Vulnerable: A species that has characteristics which make it sensitive to human activities or natural events

SOCC include species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), or are included in the International Union for Conservation of Nature (IUCN) Red List.

This description of the existing environment is based on a literature review of published research and publicly available datasets, and are discussed at geographic scale appropriate to the specific discipline. It does not include field work activities specific to this EIS. Information sources are cited within each section. Key sources widely used to support this EIS and acknowledged here include the Eastern Newfoundland Strategic Environmental Assessments (SEA) (AMEC 2014), previous environmental assessment (EA) reports prepared for other exploration drilling projects in the Eastern Newfoundland offshore area, surveys by DFO (e.g., research vessel [RV] surveys and marine mammals surveys), surveys conducted in support of industry activities (e.g., marine mammal and seabird observations), surveys by Environment Canada's Programme intégré de recherches sur les oiseaux pélagiques (PIROP) (Lock et al 1994), and surveys conducted for Environment and Climate Change Canada's (ECCC) Eastern Canadian Seabirds at Sea (ECSAS) program (Fifield et al. 2009; Bolduc et al 2018). Data reported from seabird observations recorded in offshore Newfoundland and Labrador (NL), such as observations from production platforms and mobile offshore drilling units (MODUs), are also included within the ECSAS survey data.



6.1 MARINE FISH AND FISH HABITAT

The Project Area and surrounding areas include the shelf and slope areas of the Northeast Grand Bank and the abyssal areas of the Orphan Basin. The shelf slope is an important transition area, supporting regionally important areas of biodiversity and marine productivity and are used by fish and invertebrate species. The abyssal plain supports unique assemblages of deep-sea fishes as well as coral and sponge communities and other invertebrates. The physical characteristics of these areas influence the presence, abundance, and distribution of the marine organisms from primary producers (e.g., phytoplankton) to consumers (e.g., zooplankton, benthic invertebrates, and fish) (AMEC 2014) including species of commercial, cultural, and/or ecological value. Information on the physical characteristics of fish habitat, including surficial sediments and marine water quality, are described in Section 5.0. This chapter describes fish and fish habitat within the Local Assessment Area (LAA), and RAA study areas including characterization of seasonal primary and secondary productivity, species groups and assemblages, benthic organisms and associated habitats, and sensitive features (e.g., corals, sponges, and associated biogenic habitats).

6.1.1 Approach and Key Information Sources

The Project Area lies mainly in the Orphan Basin and falls within the geographic scope of the Eastern Newfoundland SEA and Orphan Basin SEA that provided regional overviews of the offshore marine ecosystem. This includes description of key habitats and descriptions of species life history and distribution descriptions. Associated information from the SEAs on marine fish and fish habitat are summarized in this section and supported with recent relevant datasets. Key information sources related to marine fish and fish habitat in the Project Area and RAA include:

- EAs
 - SEAs (e.g., LGL Limited 2003, AMEC 2014)
 - Seismic and Exploration Drilling EAs (e.g., BP 2018)
- Government Documents
 - SARA / COSEWIC species Status Reports and Plans
 - Northwest Atlantic Fisheries Organization (NAFO) Scientific Council Research and Studies (e.g., Greenan et al. 2010)
 - Fisheries and Oceans Canada (DFO) (Canadian Science Advisory Secretariat) CSAS (e.g., Coté et al. 2019)
- Datasets
 - National Aeronautics and Space Administration (NASA) Satellite Imagery
 - Canadian RV Data
 - Ocean Biogeographic Information System (OBIS)

6.1.2 Trophic Linkages and Community Change

Understanding the ecosystem linkages within marine fish and fish habitat and with other VCs provides insight into potential Project interactions. Primary production in the marine environment is primarily derived from phytoplankton (AMEC 2014; BP 2018) that form the base of the food web. These photosynthetic organisms provide food for primary consumers including zooplankton, planktivorous fish and invertebrates.



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The primary consumers are eaten by larger fish and invertebrates (e.g., plankton-piscivores, piscivores, benthivores), marine birds and mammals (AMEC 2014; BP 2018). Nutrients are cycled back to the marine environment through detritivores that consume dead organisms (BP 2018). Parzanini et al. (2017, 2018) conducted research on the trophic ecology of deep-sea fish assemblages and invertebrates along the western slope of the Orphan Basin from 310 m to 1,413 m. Sponges generally occupy a low trophic level with feeding on bacteria (Parzanini et al. 2018). Suspension feeding cnidarians (e.g., corals, sea anemones) occupy an intermediate trophic level with feeding on pelagic (e.g., fresh phytodetritus, zooplankton) and benthic-based food sources (e.g., resuspended material, sediment, benthic organisms) (Parzanini et al. 2018). Suspension feeding echinoderms (e.g., sea urchin *Phormosoma placenta*, basket star) also occupy intermediate trophic levels with feeding on detritus and copepods (Parzanini et al. 2018). Various seastars, gastropods, and polychaete worms occupied the highest trophic level of assessed benthic invertebrates as predators and scavengers (Parzanini et al. 2018). Fish along the slope were categorized as having primarily pelagic or benthic oriented diets (Parzanini et al. 2017). Meso- and bathypelagic fish in the pelagic trophic pathway include planktivores (e.g., lanternfishes), piscivores (e.g., *Anoplogaster cornuta*) or plankton-piscivores (e.g., *Bathytroctes macrolepis*) (Parzanini et al. 2017). This group also included known benthopelagic feeders (e.g., roundnose grenadier) that primarily fed on pelagic food sources based on isotope signatures. Demersal fishes in the benthic trophic pathway (e.g., threadfin rockling, roughhead grenadier) had highly diverse diets comprising of a variety of benthic invertebrates and fish (Parzanini et al. 2017).

Changes in abundance of any group of organisms may result in changes to other trophic levels and result in shifts in distribution, habitat utilization, and predator-prey ratios (BP 2018). There have been regional shifts in the Northwest Atlantic with a decrease in groundfish abundance and change in community composition (AMEC 2014; Pedersen et al. 2017). Regional community composition was spatially structured in the early 1980s with Greenland halibut and redfish species dominating deeper waters, Atlantic cod dominating middle depths, and American plaice dominating southern shallower waters (NAFO division 3L). The ecosystem structure shifted with a decrease in groundfish stocks between the mid-1980s to early 1990s after decades of overfishing and unfavourable groundfish conditions (i.e., an extended period of cold surface water temperatures) (AMEC 2014; Pedersen et al. 2017; BP 2018). From the mid-1990s to mid-2000s, there was an expansion of Greenland halibut dominated communities and a reduction in cod and redfish dominated communities (Pedersen et al. 2017). The increase from the late 1990s to mid-2000s of shrimp biomass has been attributed to lower predation from the collapse of groundfish stocks (Lilly et al. 2000; Myers and Worm 2003; Frank et al. 2005 in BP 2018) with climate fluctuations potentially partly responsible (Rose et al. 2000 in BP 2018). Additional pelagic fish and invertebrates such as sand lance, herring, shrimp, and snow crab were shown to increase in abundance (Koen-Alonso et al. 2010; Templeman 2010, 2017; Dawe et al. 2012 in BP 2018) with declining groundfish stocks. The lack of forage fish species may have slowed cod recovery in the North Atlantic as invertebrate prey that increased after the groundfish collapse have lower nutritional value (Mullowney and Rose 2014; Pedersen et al. 2017). Rising water temperatures and harvesting restrictions are favoring the return of a groundfish-dominated system in more recent years (Koen-Alonso et al. 2010, Templeman 2007, 2010, Dawe et al. 2012 in BP 2018). Since 2007, there have been signs of recovery with an increase in cod biomass and localized areas of cod dominated communities in shelf waters (Pedersen et al. 2017). Redfish have also increased in biomass with a return to dominance along the shelf edge (Pedersen et al. 2017). The rising sea surface temperatures (SSTs) have also been linked to a northward shift in fish species distribution (Nye et al. 2009 in BP 2018).



6.1.3 Key Marine Assemblages

Marine assemblages are groups of organisms that are adapted to coexist within a specific environment in an ecosystem. This may be defined for fish and invertebrates by their physiological, morphological, trophic characteristics, and life history requirements that define their preferred habitats and associated distribution (AMEC 2014; BP 2018). Temperature and depth, a proxy for other environmental parameters, are key physical parameters in species distributions (Gomes et al. 1992; AMEC 2014; Murillo et al 2016). The Project Area includes two broad functional units: the northeast Newfoundland slope, and the abyssal plain within the Orphan Basin. Each functional unit in this area is characterized by abiotic factors, including temperature, depth, and salinity. This area is strongly influenced by the colder water from the Labrador Current, and therefore warmer water species that can occur on the southern Grand Banks dominated by the warmer Gulf Stream are largely excluded (Coté et al. 2019).

Key assemblages from the continental slope at water depths similar to that of the Project Area (264 m to 2,755 m) have been assessed from experimental trawl surveys (200 m to 2,335 m) and longline surveys (800 m to 3,100 m) (Snelgrove and Haedrich 1985; Murua and De Cárdenas 2005). The upper level and a portion of the middle continental slope are also within the range of Canadian RV surveys (197 m to 1,450 m). The upper slope assemblage is dominated by capelin and Acadian / deepwater redfish. The middle slope (700 m to 2,000 m) is dominated by flatfish (including American plaice, witch flounder, and Greenland halibut) and grenadiers (including roughhead, roundnose, abyssal, and carapine), with blue hake numbers increasing in the deeper portions. Limited information is available in the lower slope and abyssal depths (2,000 m+), but blue hake, grenadiers, and skate species are commonly recorded as well as anglerfish, dragonfish, and lanternfish.

Faunal communities may also be further defined with habitat complexity within depth zones (Baker et al. 2012). Fish and invertebrates may associate with corals, sponges and sea pens that are structure-forming invertebrate species that occur in the Orphan Basin and surrounding areas (e.g., Wareham and Edinger 2007; Kenchington et al. 2013, 2016; DFO 2015). DFO has designated some cold-water coral and sponge grounds to be Significant Benthic Areas (SiBAs), while the United Nations Food and Agriculture Organization (FAO) has designated some of these areas as Vulnerable Marine Ecosystems (VMEs) (DFO 2017a) (see Section 6.4). These SiBAs play important roles in biogeochemical cycling, nutrient recycling, and add habitat complexity to a relatively homogenous sea floor (DFO 2017a). DFO has identified four SiBA types based on the dominant taxa: sponge grounds (phylum Porifera), sea pens (order Pennatulacea), small gorgonians (order Alcyonacea), and large gorgonians (order Alcyonacea) (See Section 6.4 for details on SiBAs) (DFO 2017a).

In the following sections, key species from each taxonomic group are identified. In most cases, key species were based on either numerical dominance (based on the existing and available datasets), biomass dominance, Indigenous importance or their conservation status.

6.1.4 Plankton, Plants, and Macroalgae

Plankton are free-floating organisms, including bacteria, fungi, phytoplankton, invertebrate zooplankton, and ichthyoplankton (i.e., fish eggs and larvae), that comprise the basis of the pelagic marine ecosystem (Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) 2003; see Sections 6.1.4.1 to 6.1.4.5). Areas of enhanced plankton production or biomass, such as from nutrient enrichment from



bottom upwelling and/or water mass convergence fronts, tend to host aggregations of feeding fishes, seabirds, and/or marine mammals (see Section 6.4, Special Areas) (C-NLOPB 2003). Within the RAA, plankton production is greatest along the Newfoundland Shelf, edge of the northern and southern Grand Bank, and outer edge of the Labrador Current, including the Orphan Basin and Knoll (Northern Associates 1977, MacLaren Plansearch 1981a, 1981b, Dalley and Anderson 1998, and Dalley et al. 2000 in C-NLOPB 2003). Plankton dynamics within the Orphan Basin and Newfoundland Shelf and bank areas are variable and can fluctuate year-to-year (Dalley et al. 2000, and Pepin and Maillet 2000 in C-NLOPB 2003) in association with environmental and physical factors, such as climate and seasonal nutrient concentrations, particularly nitrogen (Buchanan and Foy 1980a, 1980b, and Pepin and Maillet 2000 in C-NLOPB 2003).

6.1.4.1 Bacterial Communities / Microbes

Bacterial communities are comprised of free-living, pelagic, single-celled prokaryotes (i.e., bacteria and archaea) (BP 2018). Most bacteria are heterotrophs (metabolize organic material for energy), while others are photoautotrophs (use light for energy and obtain carbon from carbon dioxide) or photoheterotrophs (use light for energy and obtain carbon from organic material) (DFO 2011a in BP 2018). Bacterial communities on the Orphan Basin and Orphan Knoll vary spatially and inter-annually, with regional concentrations typically increasing from west to east and the highest abundance occurring on and near the Orphan Knoll, particularly the Knoll's summit (Greenan et al. 2010). A reliance on organic material by the majority of bacterial communities results in a positive correlation with the abundance of phytoplankton, particularly within the upper water column where most phytoplankton occurs (DFO 2011a in BP 2018). Bacteria within the photic zone consume waste produced by phytoplankton consumers and metabolize material from plankton cells, cell autolysis (self-digestion), and viral lysis (DFO 2011a in BP 2018). Below the photic zone, bacteria primarily consume dissolved organic matter (BP 2018).

Microbes, as the main proponent driving the ocean's biogeochemical cycles, are essential for regulating global nutrient cycles (Zorz et al. 2019). Marine microbial communities are regionally influenced by location, depth, hydrographic features, and seasonality, and their study is important in determining potential effects of climate change on marine ecosystem (Zorz et al. 2019). Microbial communities are also affected by the availability of nutrients, including those occurring naturally or from spills of hydrocarbons, such as crude or refined oil (ASM 2011). Most, if not all, microbial communities (i.e., bacteria and/or fungi) feature individuals that produce oil-degrading enzymes and are capable of metabolizing oil into carbon dioxide and water through a process called biodegradation (ASM 2011). Such microbes, which include bacteria from more than 79 genera (Tremblay et al. 2017), are always present throughout the world's marine waters, even in areas with low background oil levels, and tend to quickly proliferate in response to an influx of hydrocarbons into the ecosystem (ASM 2011). Microbes that have evolved to preferentially consume hydrocarbons relative to other energy sources (e.g., *Alcanivorax* sp., *Cycloclasticus* sp., *Oleiphilus* sp., *Oleispira* sp., *Thalassolituus* sp., *Planomicrobium* sp.) increase in abundance more quickly in response to a spill than generalist bacteria (e.g., *Alteromonas* sp.), which must activate the necessary metabolic processes to allow them to take advantage of a new hydrocarbon food source (ASM 2011; Tremblay et al. 2017). Although certain bacteria can degrade several types or a class of hydrocarbons, no individual bacterium is able to break down all oil components (e.g., alkanes, polycyclic aromatic hydrocarbons [PAHs], and alkylated PAHs) (ASM 2011). Microbes can evolve improved abilities for degrading oil, including via horizontal gene transfer, whereby microbes share genetic instructions for producing oil-degrading enzymes among each other and to other microbe species previously unable to degrade oil components (ASM 2011).



6.1.4.2 Phytoplankton

Phytoplankton are single-celled photosynthetic organisms that inhabit the upper water column and carry out primary production - the metabolism of sunlight and nutrients (e.g., nitrogen, phosphorus, and silicon) into carbon (C-NLOPB 2003; Archambault et al. 2010 in BP 2018). As the base of the marine food web, phytoplankton abundance affects higher trophic levels (Worcester and Parker 2010 in BP 2018). Phytoplankton production and growth is influenced by light, stratification, predation, location (e.g., shelf versus deep basin regions), and nutrient concentrations within the upper water column which are largely governed by vertical mixing (Melle et al. 2014 in BP 2018; Harrison et al. 2013 in Coté et al. 2019; Harrison and Li 2008 in LGL Limited 2018). Most primary production within the RAA occurs within the upper 200 m of the water column, although some is transferred to the lower water column via sinking organic matter (Legendre and Rassoulzadegan 1995 and Licandro et al. 2015 in BP 2018) and downwelling (C-NLOPB 2003; LGL Limited 2018).

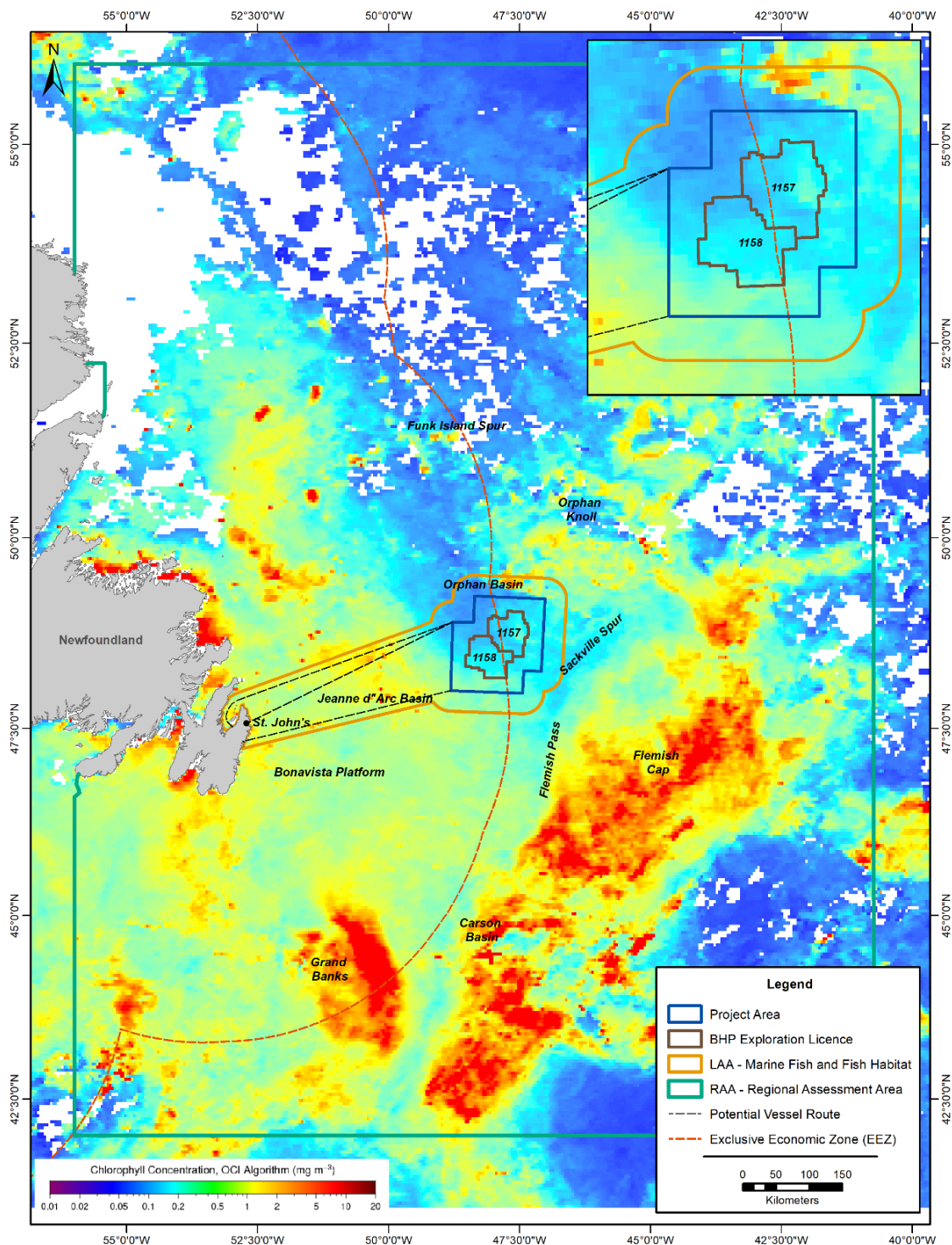
Phytoplankton blooms are possible during periods of water column stability, when phytoplankton can occupy surface waters with high light and nutrient levels (DFO 2018a). Peak phytoplankton abundance within the RAA usually occurs during the spring (April / May / June) and, to a lesser extent, the fall (September / October / November), with increasing concentrations latitudinally progressing from south to north (C-NLOPB 2003; LGL Limited 2018). Chlorophyll *a* satellite imagery data indicate the secondary plankton bloom within the RAA occurred during the winter rather than the fall during recent years (NASA 2019; Figures 6-1 to 6-5). High-intensity northwestern atmospheric flows result in, or are correlated with, greater vertical mixing within the water column, a broader extent of sea ice, colder, fresher marine conditions, and increased nutrient flux with associated higher primary and secondary productivity levels (i.e., zooplankton; see Section 6.1.4.3). This process is known as the North Atlantic Oscillation (NAO) (Harrison et al. 2013 in BP 2018). Phytoplankton species within the RAA have been influenced by a variable NAO during recent decades, exhibiting an overall decrease in abundance since a peak during the 1990s, which was preceded by a decline during the 1970s (Maillet et al. 2004, and Head and Sameoto 2007 in AMEC 2014; DFO 2018a).

At least 60 species of phytoplankton, ranging from 0.2 to 200 µm in size, have been identified within the RAA (Movchan 1963, Buchanan and Foy 1980a, 1980b, Buchanan and Browne 1981, and Tremblay and Anderson 1984 in C-NLOPB 2003; Archambault et al. 2010 in BP 2018). Phytoplankton biomass within the RAA predominately consists of microflagellates and diatoms, at least during the warm months of the year (Bieger et al. 1997, C NLOPB 200, Ramos et al. 2003). Fall bloom plankton is mainly comprised of dinoflagellates within Conception Bay, in the western portion of the LAA (Bieger et al. 1997). Diatoms and dinoflagellates are also common north of the RAA, with recent large-scale blooms in the Labrador Sea region mainly consisting of mucous-forming algal colonies, such as *Phaeocystis* spp. (Coté et al. 2019).



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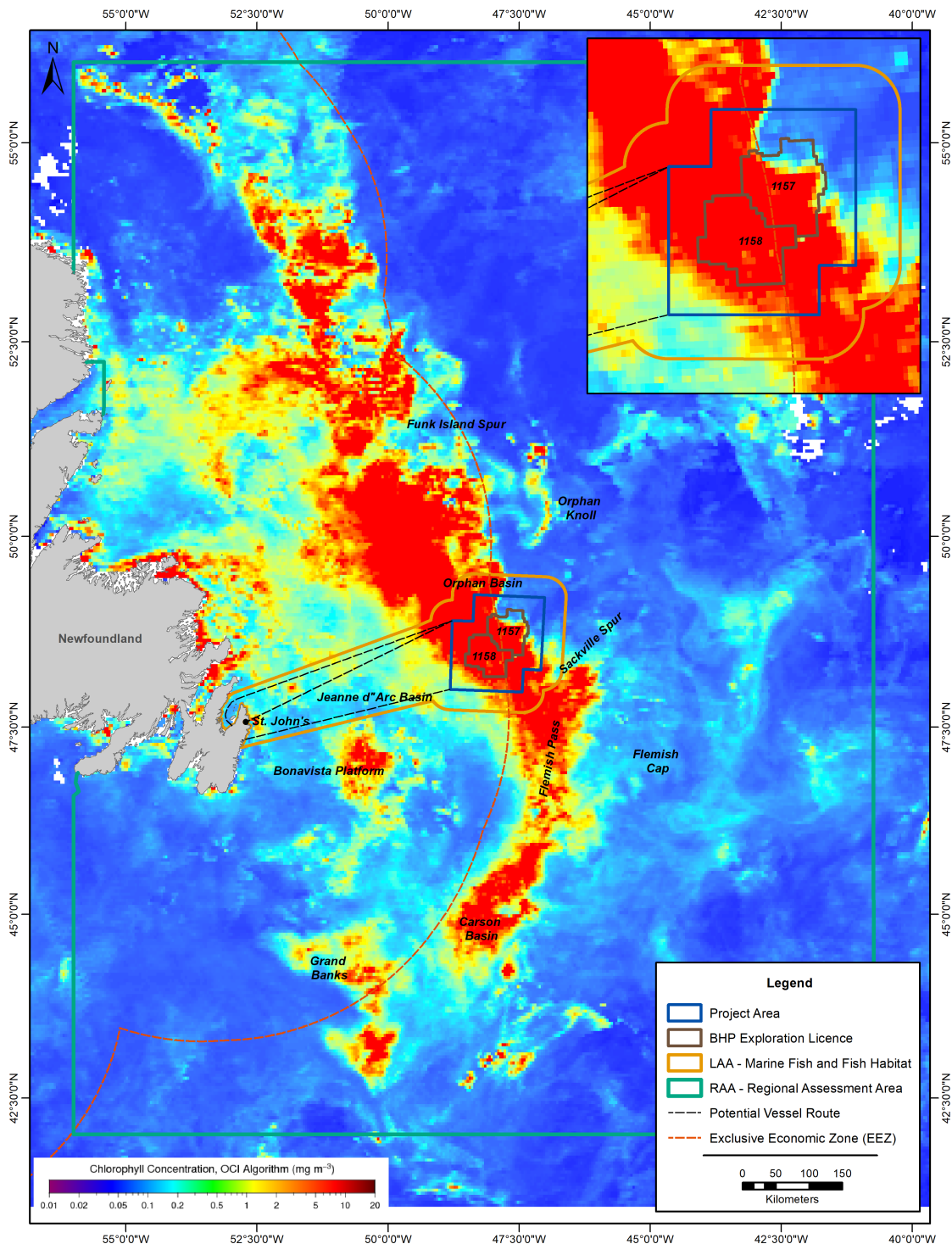
Source: ASA 2019

Figure 6-1 Chlorophyll a Concentration within the Project Area and RAA from NASA MODIS-Aqua Satellite Imagery, Winter 2017 / 2018



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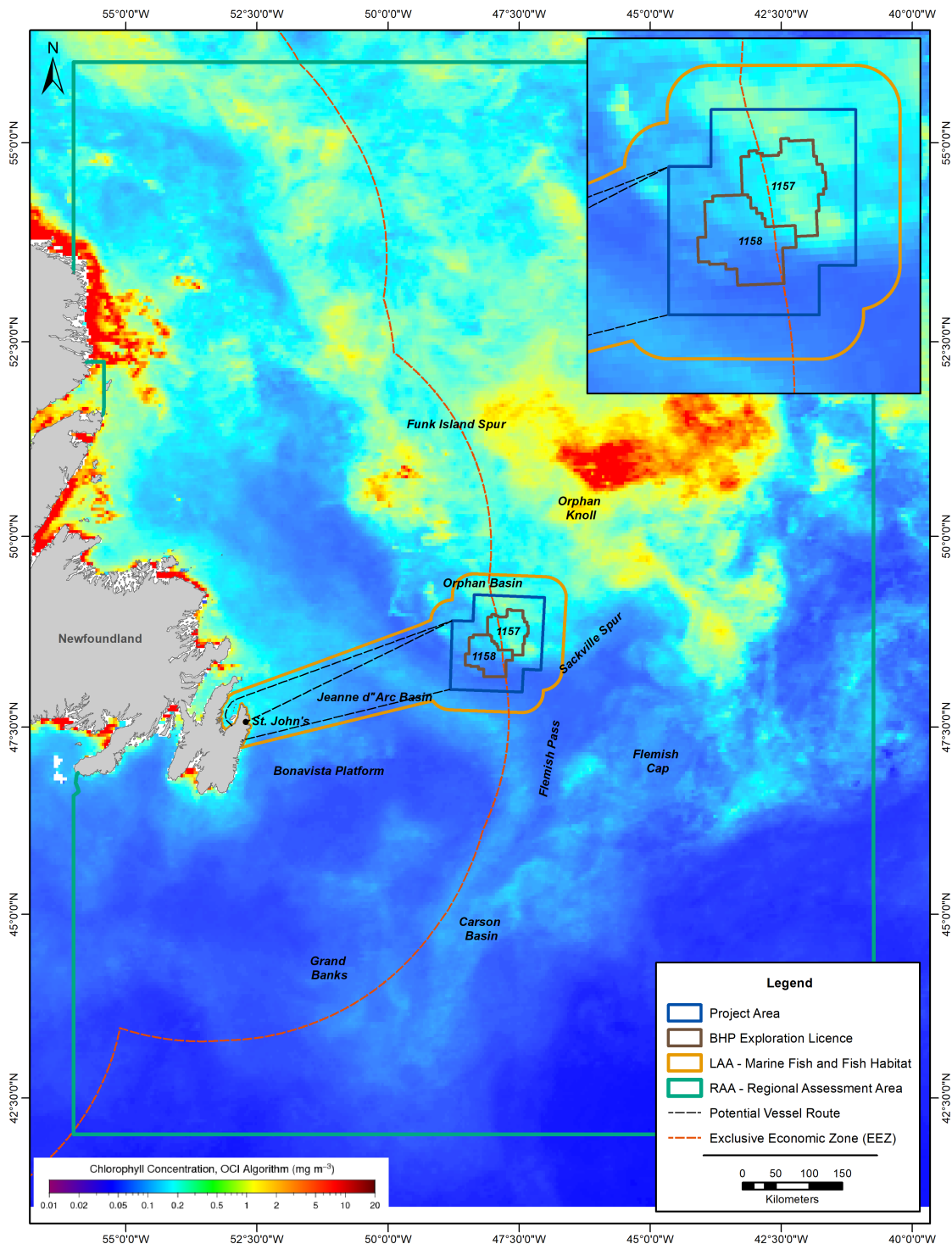
Source: NASA 2019

Figure 6-2 Chlorophyll a Concentration within the Project Area and RAA from NASA MODIS-Aqua Satellite Imagery, Spring 2018



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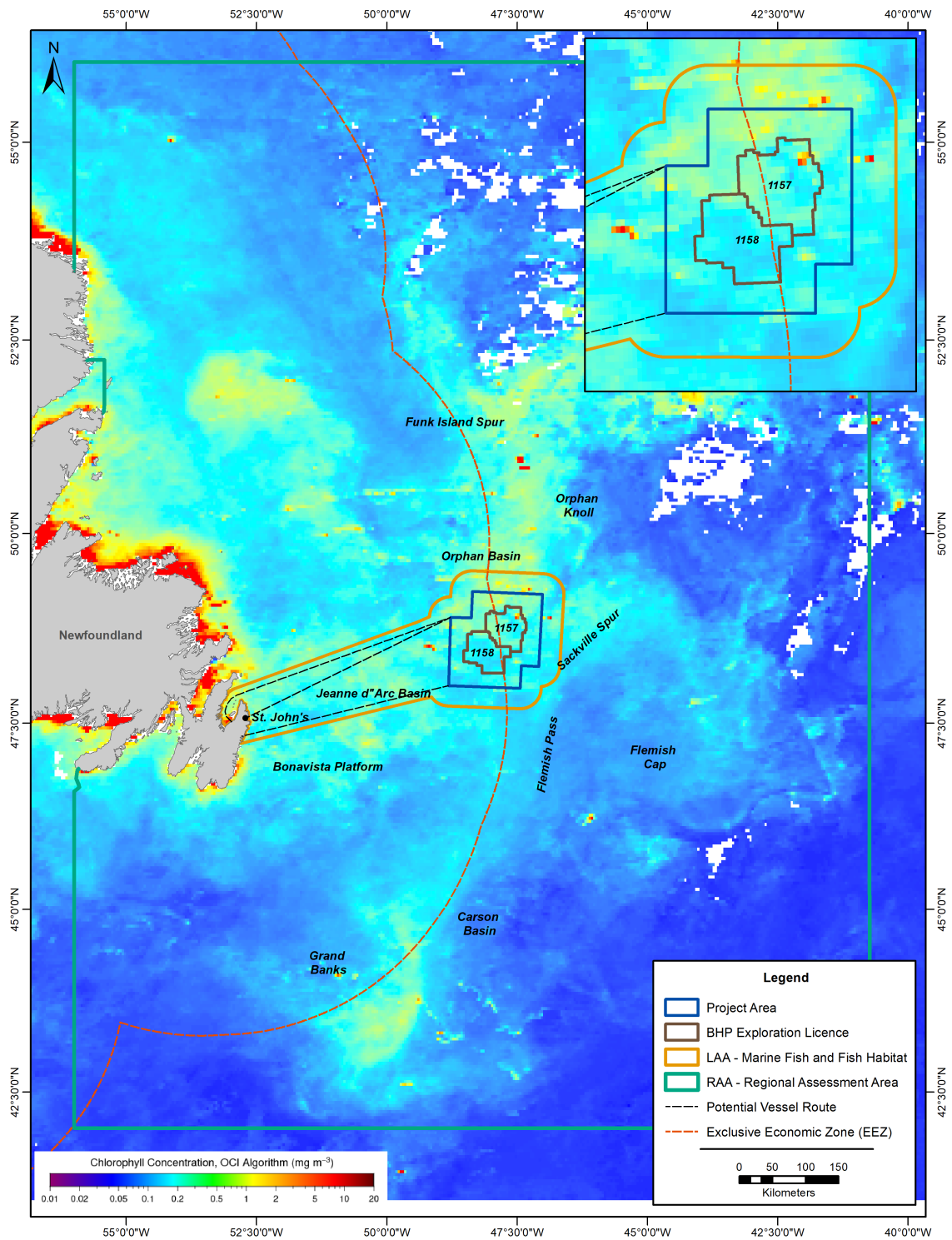
Source: NASA 2019

Figure 6-3 Chlorophyll a Concentration within the Project Area and RAA from NASA MODIS-Aqua Satellite Imagery, Summer 2018



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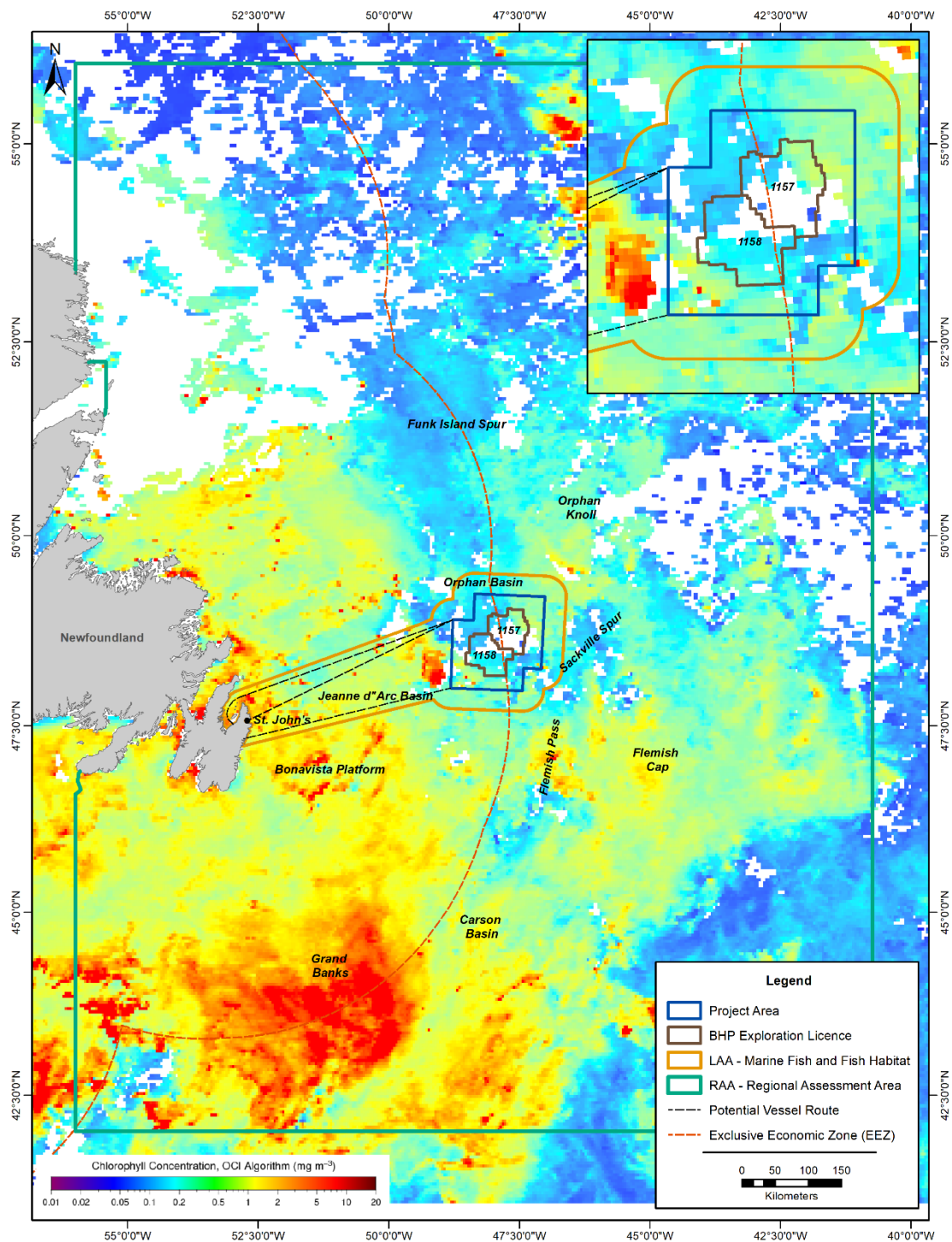
Source: NASA 2019

Figure 6-4 Chlorophyll a Concentration within the Project Area and RAA from NASA MODIS-Aqua Satellite Imagery, Fall 2018



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Source: NASA 2019

Figure 6-5 Chlorophyll a Concentration within the Project Area and RAA from NASA MODIS-Aqua Satellite Imagery, Winter 2018 / 2019



6.1.4.3 Zooplankton

Zooplankton are important components of pelagic and benthic marine communities, as they are predators of primary producers and prey for higher trophic levels, linking marine food webs. Zooplankton also play a role in driving carbon, nutrient, and sedimentation cycles (Coté et al. 2019). Herbaceous zooplankton feed on phytoplankton (see Section 6.1.4.2), a process termed secondary production (C-NLOPB 2003). Tertiary production occurs as herbaceous zooplankton are consumed by predators, such as predacious zooplankton (e.g., jellyfishes and chaetognaths), and as zooplankton are consumed by higher order predators, including fishes, invertebrates, seabirds, and marine mammals (C-NLOPB 2003; Kjellerup et al. 2015 in BP 2018).

Zooplankton are categorized by size to include microzooplankton (20–200 µm), mesozooplankton (0.2 to 2.0 mm), and macrozooplankton (>2 mm) (BP 2018). Microzooplankton include ciliates, tintinnids, and ichthyoplankton (see Section 6.1.4.4); mesozooplankton include copepods, larvaceans, pelagic molluscs, and larval benthic organisms; and macrozooplankton include larger and/or gelatinous organisms, such as krill (euphausiids), tunicates, and salps (BP 2018). Zooplankton are also categorized by life history into holoplankton and meroplankton. Holoplankton are permanent members of the plankton and remain unattached to any substrate for their entire lives (e.g., copepods). Meroplankton are only planktonic for a portion of their life cycle, typically during the larval stage (e.g., larval sea stars and urchins) (Rogers and Thorp 2015).

Zooplankton abundance is generally positively correlated with that of phytoplankton, with peaks typically following the spring and fall phytoplankton blooms (C-NLOPB 2003). The boreal larvacean appendicularian species *Oikopleura vanhoffeni* (Subphylum Tunicata) is a major secondary producer in Conception Bay, where it matures at its maximum body size during the spring bloom (Choe and Deibel 2011). The total abundances of *Fritillaria borealis* and *O. labradoriensis* boreal appendicularians are also related to phytoplankton biomass in Conception Bay, attaining their highest levels after the spring maximum of chlorophyll *a* concentration (Choe and Deibel 2008). The reproductive cycles of the chaetognath *Parasagitta elegans* and mysid shrimp *Mysis mixta* are similarly synchronized with the spring bloom in Conception Bay, when their lipid and/or carbohydrate levels reach peak levels (Choe et al. 2003; Richoux et al. 2004).

Plankton surveys on the NL Shelf and Grand Bank demonstrate a north-south gradient in zooplankton biomass, which mainly includes copepods, cladocerans, limacine, larvaceans, and larval bivalves (Dalley and Anderson 1998 in AMEC 2014; Dalley et al. 2001 in BP 2018). Zooplankton biomass in the NL Shelf region is dominated by three *Calanus* copepods: *C. finmarchicus*, *C. glacialis*, and *C. hyperboreus* (Greenan et al. 2010). *Calanus finmarchicus* is distributed throughout the North Atlantic, north of the Gulf Stream, and has a one-year life cycle, maturing, reproducing and developing at the surface of NL Shelf waters during spring and summer. Once their phytoplankton prey has been depleted, they winter as pre-adults in deep-water locations off the Shelf (Greenan et al. 2010; AMEC 2014). A simulation model by Bandara et al. (2018) of a hypothetical copepod species approximating *C. finmarchicus* indicated that this species likely exhibits a behavioural tradeoff between survival, growth, and reproductive timing. When there is low visual predation risk (i.e., low likelihood of visual detection by a predator), *C. finmarchicus* undertakes fewer diel vertical migrations, earlier seasonal vertical migrations, and earlier reproduction. In the presence of high visual predation risk, it attains higher growth by delaying reproduction and taking advantage of



higher phytoplankton concentrations and water temperatures. *C. glacialis* and *C. hyperboreus* are arctic species that distribute into southerly latitudes with influxes of cold, Arctic water (Greenan et al. 2010). The latter two species have multi-year life cycles, with the young stages overwintering at depth for two or more years before reproducing during the spring or late winter, depending on inter-annual fluctuations in reproduction timing related to water temperatures and plankton blooms (Greenan et al. 2010).

Depth-stratified plankton tows during 2008 and 2009 indicated an abundance of *Oithona atlantica*, *O. similis*, and *Microcalanus* sp. copepods in the Orphan Basin and Orphan Knoll regions, with the highest concentrations observed within the upper 100 m of the water column (Greenan et al. 2010). During the spring and summer, the zooplankton communities in the Flemish Cap region have historically been comprised of *C. finmarchicus*, followed by *O. similis* and *O. atlantica* (Anderson 1990). North of the Project Area, predominant zooplankton taxa in the offshore Labrador Sea include copepods (*Oithona* spp., *Microcalanus* sp., *Scolecithricella minor*, *C. finmarchicus*, *C. hyperboreus*, and *Metridia* sp.), krill, and amphipods (e.g., *Themisto libellula*) (Head et al. 2013, and Pepin 2013 in Coté et al. 2019).

The abundances of *C. finmarchicus* on the NL Shelves and of *C. glacialis* and *C. hyperboreus* on the Flemish Cap and Southeast Grand Bank are currently in decline. However, the abundance of small and warm-water copepods (e.g., *Pseudocalanus* spp.) and non-copepod zooplankton (mainly gelatinous and carnivorous species) have increased in the region during recent years, with record highs since 2014 (DFO 2018a; Pepin et al. 2015 in LGL Limited 2018; DFO 2017a, and Pepin et al. 2017 in Coté et al. 2019). Overall, the region's zooplankton biomass has reduced since a peak during 2007 (Coté et al. 2019), which may indicate an important change at the base of the marine food web and have consequences for higher trophic levels (DFO 2018a). Climate change is thought to be a key factor driving this decline, as early ice retreat can promote early phytoplankton blooms, which ultimately reduces zooplankton productivity and subsequent prey availability for tertiary predators as zooplankton are not present to feed on the bloom (DFO 2018a). This cycle can negatively affect the abundance and ecological success of keystone species for ecosystem maintenance, such as capelin and herring, because their growth and spawning are dependent on zooplankton productivity (DFO 2018a).

6.1.4.4 Ichthyoplankton

Ichthyoplankton mostly occur within near-surface waters (i.e., ≤ 200 m depth) and are a key component of planktonic communities, preying on smaller plankton and serving as an important food source for larger animals (National Oceanographic and Atmospheric Administration [NOAA] 2014). Known as 'meroplankton', ichthyoplankton are only planktonic during the early stages of their life cycles (NOAA 2014 in BP 2018). Eggs passively drift within oceanic water currents, while larval fish are virtually incapable of directed movement until they are sufficiently developed to become active swimmers (NOAA 2014). A literature review by Bradbury and Snelgrove (2001) indicated that fish larvae tend to be faster swimmers than larval invertebrate zooplankton, suggesting that ichthyoplankton have a greater potential for dispersal potential. As fish larvae develop and grow, their spatial distribution is increasingly influenced by their behaviour and ability to swim (Bradbury et al. 2003). Ichthyoplankton dispersal is otherwise regulated by salinity and oceanographic processes, including near- and subsurface currents, gyres, upwelling zones, and thermoclines (Pepin and Anderson 1997; Frank et al. 1992, Bradbury et al. 2008, and Ings et al. 2008 in AMEC 2014). Such hydrodynamic features can serve to regionally retain ichthyoplankton, such as larvae



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on the Orphan Knoll (CBD 2015), or the Northwest Atlantic northern cod complex within NAFO Division(s) (Div.) 3KNO and the Gulf of St. Lawrence (Ruzzante et al. 1998).

Many fish species increase the survivorship of their offspring by synchronizing their spawning periods with plankton blooms, thereby providing larvae with access to a seasonally abundant food source (LGL Limited 2018). Within the RAA, redfish have been known to release their larvae to coincide with the spring reproductive timing of *C. finmarchicus*, the larvae's preferred prey (Anderson 1994). Regulators monitor ichthyoplankton to serve as an indicator of abundance and growth trends of adult spawning populations (NOAA 2014). Ichthyoplankton can also reveal the general health of a marine ecosystem, as the density and species composition can vary inter-annually, temporally, and spatially (Frank et al. 1992, Dalley and Anderson 1998, and Bradbury et al. 1999, 2008 in AMEC 2014) due to various environmental factors (e.g., climate change; see Section 6.1.4.3).

Historically, most ichthyoplankton within much of the RAA was comprised of redfish larvae (Serebryakov et al. 1987 in DFO 2014a), particularly throughout the Flemish Cap area (Andersen and Akenhead 1981; Anderson 1994). During the 1990s, large-scale trawl surveys were conducted of the NL marine pelagic environment within the RAA (in NAFO Div. 2J and 3KLNO), including a measure of larval (i.e., "0-group"; fish <1 year old) abundance (Dalley et al. 1999). The most recent 0-group surveys, conducted during 1997–1998, indicated that ichthyoplankton assemblages on the Northeast Newfoundland Shelf mainly consisted of capelin, sand lance, lanternfish, and Arctic cod eggs and larvae (Dalley and Anderson 1998, and Dalley et al. 1999 in AMEC 2014; LGL Limited 2018). Squid larvae were prevalent throughout the Grand Banks and Newfoundland Shelf, while some species predominantly occurred on the inner Shelf of the Grand Banks (e.g., blennies, sculpins, squid, sea snails, and alligatorfish) and others on the Grand Banks (e.g., sand lance and hake) (Dalley and Anderson 1998 in AMEC 2014). Other ichthyoplankton species observed within the RAA during the 0-group surveys included (in descending order of relative abundance) Atlantic cod, redfish, wolffish, American plaice, haddock, witch flounder, Greenland halibut, hake, and yellowtail flounder (Dalley and Anderson 1998, and Dalley et al. 1999 in AMEC 2014). Ichthyoplankton surveys in Conception Bay during 1990 and 1991 caught up to 26 species, the most abundant of which were Atlantic cod, American plaice, Atlantic and variegated snailfish, winter flounder, radiated and Arctic shanny, Arctic cod, and blennies (Pepin et al. 1995). A data gap for more recent surveys exists within the RAA for ichthyoplankton. Other than the 0-group studies, historical ichthyoplankton surveys were typically opportunistic. There have been few ichthyoplankton studies since the 1990s (e.g., a larval capelin ecological study in White Bay, Notre Dame Bay, and Trinity Bay, NL during 2015-2016 (Shikon 2018), and DFO is not currently conducting dedicated ichthyoplankton research (G. Rayner, Biologist, LGL Limited, pers. comm., 2 August 2019).

6.1.4.5 Marine Plants and Macroalgae

Marine plants, such as sea grasses (e.g., eelgrass), and macroalgae (e.g., kelp) contribute to biodiversity and serve as important habitats for various marine species (Coté et al. 2001, 2013 in AMEC 2014). Marine plants and macroalgae within the RAA produce energy via photosynthesis, limiting their distribution to areas with sunlight penetration (Dayton 1985, and Anderson et al. 2002 in AMEC 2014). Other than some notable exceptions, such as coralline algae (DFO 2014a), most marine plants and macroalgae within the RAA occur in depths <303 m to 50 m, with their distributions limited by light and nutrient levels, the availability of hard substrates (including anthropogenic structures, such as drill rigs), sedimentation, currents, salinity,



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temperature, and predation (e.g., by sea urchins) (Himmelman and Steele 1971, and Dayton 1985 in AMEC 2014; Gregory and Anderson 1997, and Anderson et al. 2002 in BP 2018). Some highly productive locations within the RAA, such as the Virgin Rocks (southwestern portion of the RAA), host coralline algae (*Leptophyllum laeve*) in excess of 70 m depth (R. Hooper, pers. comm. in AMEC 2014) and are important spawning areas for several groundfish species (e.g., Atlantic cod, American plaice, and yellowtail flounder) (Ollerhead et al. 2004 in Templeman 2007). Other macroalgae on the Virgin Rocks include large kelp (e.g., *Laminaria digitata*, *Alaria esculenta*, *Saccharina longicuris*, and *Agarum clathratum*), understory seaweeds (i.e., undergrowth below the larger seaweed canopy; e.g., *Desmarestia viridis*, *D. aculeata*, *Palmaria* sp., *Ptilota* sp., *Phycodrys* sp., *Membranoptera* sp., and *Polysiphonia* sp.), and other coralline seaweeds (e.g., *Lithothamnion lemoineae*, *Lithothamnion* sp., *Clathromorphum compactum*, *C. circumscriptum*, and *Corallina* sp.) (R. Hooper, pers. comm. in AMEC 2014). Some macroalgae can be found at depths up to 100 m on the Grand Banks, although such areas typically feature low algal diversity and biomass (R. Hooper, pers. comm. in AMEC 2014).

Eelgrass (*Zostera marina*) is a coastal, marine, flowering marine plant that is an Ecologically Significant Species in Atlantic Canada under DFO's Ecosystem Approach and Canada's *Oceans Act* (DFO 2006, 2018a). Eelgrass can form large beds that serve as indicators of ecosystem health because of their sensitivity to pollutants or disturbance (DFO 2018a). Although eelgrass can tolerate a relatively wide range of salinity and temperature, it requires clear water and will die if smothered by algae in waters polluted with too many nutrients or if its root system is disturbed (DFO 2018a). Eelgrass beds are one of the most productive nursery habitats in the world for various recreational and commercial fish species, including Atlantic cod, white hake, and American lobster, as they filter seawater, stabilize sediments, and serve as a host for bacteria and other small organisms that are preyed upon by small invertebrates (White et al. 2012; DFO 2018a). The health and availability of eelgrass beds for juvenile cod have been positively correlated with the abundance of adult cod (DFO 2018a). Disturbance to eelgrass beds, such as from the destruction caused by scallop dredging or the foraging and burrowing behaviours of the invasive European green crab, excess nutrients, poor oxygen levels, sedimentation, or warming water conditions beyond their tolerable range, can adversely affect cod populations (Matheson et al. 2016; DFO 2018a). Although eelgrass beds have declined or disappeared in some Atlantic Canadian areas beyond the RAA, such as the southern Gulf of St. Lawrence and eastern Nova Scotia, eelgrass cover in areas not impacted by established green crab populations has recently increased in NL, likely because of warming waters and reduced winter sea ice (DFO 2018a).

Large, brown macroalgae kelp species (e.g., *Saccharina* spp., *L. digitata*, *A. esculenta*, and *A. clathratum*) form dense beds in rocky subtidal zones within the RAA (DFO 2018a). Kelp thrive in cooler and more wave exposed areas and are susceptible to warming waters and invasive biofouling species, such as the European Coffin Box bryozoan, that crust over kelp tissue and cause brittleness and reduced photosynthesis or reproduction (DFO 2018a). Healthy kelp beds are highly productive, offering important nursery and feeding grounds and protection from predators for fishes and invertebrates, such as commercially important Atlantic cod, white hake, American lobster, rock crab, and Jonah crab species (DFO 2018a). Kelp beds also play a role in the deep-sea marine food web by assisting the transport of organic material to the offshore and storing and cycling oceanic carbon (DFO 2018a).



6.1.5 Pelagic Invertebrates

Pelagic macroinvertebrates include jellyfish, cephalopods (e.g., squid and octopus), and crustaceans (e.g., shrimp) that inhabit or swim up from the benthic zone to the pelagic zone to feed. Jellyfish, including pelagic cnidarians, ctenophores (e.g., comb jellies), and pelagic tunicates, actively swim and passively drift through the water column and are possible contributors to the pelagic biological pump process (i.e., carbon and nitrogen cycling) (Gregar et al. 2015; Sweetman and Chapman 2015). Although they are mainly (>95%) composed of water and have a relatively low energy density, jellyfish are simple to digest, may form dense aggregations (“blooms”), have a negligible escape response, and are easily captured prey for leatherback sea turtles, seabirds, >100 species of fish, and other organisms (Arai et al. 2003, Arai 2005, Dawson and Hamner 2009, Hamner and Dawson 2009, and Pauly et al. 2009 in Gregar et al. 2015). Within the RAA, jellyfish blooms typically occur during late summer in shelf areas and early summer in open ocean areas, in association with optimal SSTs and/or prey abundance, with the greatest concentrations on the Flemish Cap and shelf of the southern Grand Banks (Gibbons and Richardson 2009). Most jellyfish are carnivorous and progressively prey on phytoplankton, zooplankton, ichthyoplankton, and adult fish as they develop and grow, while others obtain their energy from photosynthetic symbionts (zooxanthellae) (Gibbons and Richardson 2009). Common cnidarian pelagic species within the RAA include lion’s mane and moon jellyfishes. North Atlantic pelagic tunicates are gelatinous, free-floating, filter feeding individuals or colonies, such as salps (e.g., *Cyclosalpa pinnata*, *Pegea bicaudata*, *P. confoederata*, *P. socia*, *Salpa cylindrica*, and *S. maxima*), pyrosomes, and doliolids that are prey to Atlantic bluefin tuna, ocean sunfish, and leatherback sea turtles (Dragovich 1970, Madin 1982, Fromentin and Powers 2005, Eckert 2006, Dodge et al. 2011, Potter and Howell 2011, and Statoil Canada Ltd. 2017 in BP 2018).

Cephalopods are carnivorous, consuming small invertebrates as juveniles and pelagic fishes and large invertebrates as adults. Northern shortfin squid is the most prevalent cephalopod in the Flemish Cap region (Vásquez et al. 2013) and is also common in Conception Bay and other coastal areas of Newfoundland (e.g., Brown and Threlfall 1968). It is a highly migratory commercial species that is considered a single stock from Newfoundland to Cape Hatteras, North Carolina (Hendrickson and Holmes 2004). During its less than one-year life span, which is common to many squid species within the RAA, northern shortfin squid migrate onto the continental shelf in the spring and off the shelf during late fall to virtually unknown overwintering spawning sites south of Cape Hatteras (Hendrickson and Holmes 2004; Dawe et al. 2007). An unknown portion of the stock also inhabits waters beyond the shelf (Hendrickson and Holmes 2004). The collection of a viable egg mop (i.e., eggs laid in communal sites on the seabed) off southern Newfoundland during the early 2000s indicated the most northerly known spawning site for this species (Dawe et al. 2007). Northern shortfin squid abundance and distribution in the Northwest Atlantic reacts rapidly to changing environmental conditions (Dawe et al. 2000). Their abundance is positively correlated with weak winter northwesterly winds (i.e., a negative NAO index), higher water temperatures, and a southerly shift in the Gulf Stream and shelf/offshore slope waters (Dawe et al. 2000). Most squid species within the RAA have high natural mortality rates and a protracted spawning season, introducing overlapping micro-cohorts into the population each year with variable growth rates (Caddy 1991, and Jackson 1994 in Hendrickson and Holmes 2004). Other cephalopods observed in the Flemish Cap region during Canadian and European Union (EU) surveys (1977-2012) include squid (*Histioteuthis reversa*, *H. bonnellii*, *H. sp.*, *Semirossia sp.*, *Gonatus fabricii*, and *Onychoteuthis banksii*) and octopus (*Bathypolypus arcticus*) species (Vásquez et al. 2013). *B. arcticus* is a small, slow growing, relatively inactive, deep-sea octopus with low



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fecundity (Wood 2000). Unlike most cephalopods within the RAA, *B. arcticus* has a relatively long lifespan (approximately three to over six years) and tends to consume low-quality prey items, including brittle stars (Wood 2000).

The most prevalent pelagic crustacean observed in the Flemish Cap region during Canadian and EU surveys from 1977 to 2012 was the northern shrimp (Vásquez et al. 2013), a commercially important species within the RAA. The occurrence of northern shrimp within the 1977-2012 survey trawls declined during the later survey years (Vásquez et al. 2013), which coincides with a reduction in commercial shrimp catch and Total Allowable Catch (TAC) limits within NAFO Div. 3LNO during recent years (LGL Limited 2018). EU-Spain bottom trawl surveys by the Spanish Institute of Oceanography within Div. 3LNO during summer 2017 confirmed that northern shrimp biomass has remained low in Div. 3NO and 3L since 2004 and 2009, respectively, with the 2017 3L survey catch and biomass among the lowest levels observed for that area in the historical data series (Casas et al. 2017). No directed fishing for shrimp may occur within Div. 3NO, and a ban was enacted during 2015 for Div. 3L (within which the Project Area is located), which remains in effect (NAFO 2019). Northern shrimp biomass has been increasing within Div. 3M during recent years (Casas 2015 in LGL Limited 2018), with progressively greater total biomass indexes observed for stratified random bottom trawl surveys on the Flemish Cap during 2015-2018 (Casas 2018). Although the northern shrimp stock near the Flemish Cap has now improved beyond the collapse zone, recruitment remains impaired as few shrimp aged ≤ 2 years are being caught during the trawl surveys and there has not been a strong year-class since 2004 (Casas 2018). In addition to fishing pressure, northern shrimp are affected by warming water temperatures and fluctuations in their phytoplankton prey sources, as evidenced by the decreased carapace lengths, size at sex transition, and overall maximum size observed in the region during the 1990s (Koeller et al. 2007). Apart from northern shrimp, at least 13 other shrimp species have been observed near the Flemish Cap (Vásquez et al. 2013). Deep-water shrimp species, such as *Acantheephyra pelagica* and *Pasiphaea tarda*, are typically more prevalent in the deeper portions of the RAA (DFO 2016a in BP 2018).

Canadian DFO RV surveys occurred within the southern portion of the Project Area during June and November–December from 2013 to 2017. Most of the pelagic macroinvertebrate catch weight consisted of jellyfish species, which were caught at a mean depth of 259 m and a maximum depth up to 1,385 m (Table 6.1). Unspecified cephalopods, octopi, and squids, along with *Illex* and *Gonatus* squid species, were caught in depths up to 1,385 m, within mean depths of 162 m to 1,379 m. Fourteen species of shrimp were observed during these surveys, with northern shrimp comprising most of the total crustacean catch weight. Shrimp were caught in depths up to 1,385 m, with mean depths ranging from 73 m to 902 m. Krill and arrow worms were also caught in the Project Area.



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Table 6.1 Pelagic Macroinvertebrates Observed in the Project Area during Canadian RV surveys, 2013-2017

Species	Catch Weight (t)	Mean Catch Depth (m)
Jellyfish		
Jellyfish sp.	0.16	259
Cephalopods		
Cephalopod sp.	<0.01	162
Cephalopod (Rossiinae)	<0.01	N/A
Squid		
• Squid (Teuthoidea)	<0.01	N/A
• Squid (Illex sp.)	<0.01	171
• Squid (Gonatus sp.)	<0.01	556
Octopus		
• Octopus (Octopoda)	<0.01	194
• Octopus (Octopodidae)	<0.01	1,379
Crustaceans		
Shrimp		
• Northern Shrimp	0.04	77
• <i>Acanthephyra pelagica</i>	0.01	241
• <i>Sergestes arcticus</i>	0.01	241
• <i>Pasiphaea tarda</i>	<0.01	345
• Pink Glass Shrimp	<0.01	301
• <i>Atlantopandalus propinquus</i>	<0.01	N/A
• <i>Sergia robusta</i>	<0.01	121
• Friendly Blade Shrimp	<0.01	73
• <i>Pasiphaea</i> sp.	<0.01	N/A
• Norwegian Shrimp	<0.01	605
• Sars Shrimp	<0.01	N/A
• <i>Lebbeus polaris</i>	<0.01	N/A
• Gennadas sp.	<0.01	N/A
• Grooveback Shrimp	<0.01	902
• Krill (Euphausiid)	<0.01	278
Other		
Arrow Worm	<0.01	N/A
Source: Canadian RV Survey Data, 2013-2017. Note: N/A = Not Available		



6.1.6 Benthic Invertebrates and Habitat

There are three categories of benthic invertebrates: infaunal organisms (live on or in soft substrates; e.g., bivalves, polychaetes, amphipods, sipunculids, ophiuroids, and some gastropods); sessile organisms (live attached to hard substrates; e.g., barnacles, tunicates, bryozoans, holothurians, and some anemones); and epibenthic species (active swimmers that remain closely associated with the seabed; e.g., mysids, amphipods, and decapods) (LGL Limited 2018). Benthic invertebrates are an important energy source for higher order taxa, such as fish, seabirds, and marine mammals, and provide a mechanism for nutrient cycling and the completion of biochemical processes within the marine food web (C-NLOPB 2003; Barrio Froján et al. 2012; Beazley and Kenchington 2015; Murillo et al. 2016). Deep-sea benthic invertebrates are generally slow-growing and late to mature, with low metabolic rates and relatively long lifespans (Beazley et al. 2013; McClain and Schalcher 2015; Murillo et al. 2016). Because of their life history, deep-sea benthic invertebrates (especially sessile species) can be particularly sensitive to anthropogenic disturbance. Some species require a lengthy recovery period following disturbance (Schalcher et al. 2014; Clark et al. 2016; Vanreusel et al. 2016), and some individual colonies, such as cold-water corals (see Section 6.1.6.1) are unable to recover once their holdfasts are disturbed.

Benthic invertebrate community composition, structure and production in high latitudes are mainly influenced by water mass differences, sediment characteristics, ice scour, the sedimentation rate of organic detritus (in shelf and deeper waters), and seasonal phytoplankton activity (Carey 1991, and Desrosiers et al. 2000 in LGL Limited 2018). Because of this dependence on environmental factors, there are typical benthic invertebrate assemblages associated with different depth zones within the RAA rather than a general collection of species (Equinor 2017).

The Orphan Basin area includes continental shelf and slope environments and abyssal habitats, with depths ranging from 100 m to >4,000 m (C-NLOPB 2003). It receives influxes of cold Arctic and sub-Arctic waters and warmer North Atlantic waters, which also influence the edges of the Grand Banks within the RAA (C-NLOPB 2003). The surficial sediment of the Orphan Basin and surrounding RAA ranges from fine (mud and clay) to coarse (boulder and bedrock) (C-NLOPB 2003; Tripsanas et al. 2008). Sediment cores indicate that the fine surficial sediment of the Orphan Basin and other abyssal habitats within the RAA is typified by tan, foram-rich mud that contains rare pebbles and cobbles (Tripsanas et al. 2008). Slope habitats within the RAA generally consist of coarse sediment along with a thick sand layer thought to be deposited from the Labrador Current (Tripsanas et al. 2008). Much of the surficial sediment of the NL shelf portion of the RAA is composed of sand (Gilkinson et al. 2013 in LGL Limited 2018). A combination of hard and soft substrates occur in Conception Bay, with soft substrate (i.e., mud and mud-sand) mostly occurring in the deeper, central portions of the bay, and hard or coarse substrate predominating in the shallower regions around the bay's perimeter, including the shorelines (Dawe et al. 2010). Most of the seabed in Long Pond, Conception Bay, is covered by silt with a high organic content (Christie 1966). Some benthic invertebrates, including cold-water corals or sponges, provide complex and important habitat structure for other invertebrate or fish species within the RAA (see Section 6.1.6.1).

At least 32 species of annelids, 18 species of amphipods, and a small number of molluscs were collected during a benthic grab sample survey in Conception Bay during August 1975, the most abundant of which were deposit-feeding annelids (Kennedy 1985). Other invertebrates collected during this survey included foraminiferans, cnidarians, nematodes, arthropods, cumaceans, echinoderms, holothurians, ophiuroids,



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and hemichordates (sister group of echinoderms) (Kennedy 1985). Infaunal saltwater clams (*Macoma* sp. and *Mya* sp.) and polychaetes (*Polycirrus* sp.), epifaunal mussels (*Mytilus* sp.) and sea snails (*Littorina* sp.) comprised the majority of sampled biomass during a dredge survey in Long Pond, Conception Bay, during 1964 / 1965 (Christie 1966).

A total of 455 macrofaunal benthic taxa representing 12 phyla were identified from grab samples collected from approximately 60 to 160-m depth on the NL Shelf (southern Labrador Shelf, northern Grand Bank, and Grand Bank Proper) during the DFO Newfoundland and Labrador Expended Research on Ecosystem-relevant but Under-surveyed Splicers (NEREUS) surveys in the late-2000s (Gilkinson 2013 in LGL Limited 2018; DFO 2019). Most benthic invertebrates were of the Annelida (e.g., polychaetes), Arthropoda (e.g., amphipods), and Mollusca (e.g., gastropods and bivalves) phyla. Invertebrate benthic biomass within NAFO Div. 3LNO was found to predominantly consist of sponges, sea anemones, snow crab, and echinoderms, with more sponges typically occurring within 3L (which contains the Project Area) than 3NO (Gilkinson 2013 in LGL Limited 2018). Snow crab is the most commercially important benthic invertebrate within the RAA and occurs from Greenland to the Gulf of Maine (DFO 2018b), including coastal areas such as Conception Bay (Dawe et al. 2010). Fall RV bottom trawl surveys within the RAA during 1995-2000 indicated that male snow crab ranged from the southern Labrador Shelf to the eastern slope of the continental shelf and Tail of the Grand Bank (Dawe et al. 2002). Mean carapace size increased with catch depth beyond the 200-m isobath, and the largest and smallest males tended to also segregate in accordance with water temperature, particularly within the northern portion of the RAA and on the northern Grand Bank (Dawe et al. 2002). Overall recruitment and exploitable biomass of snow crab have reached historical lows within the RAA in recent years, while total mortality within the exploitable biomass has increased or reached nearly time-series highs (DFO 2018b). Except for a spike during 2014, there has been little change in recruitment or exploitable biomass during the past decade within the northern portion of the RAA (Div. 2HJ), while levels have reached or neared historical lows within the central and southern portion of the RAA, including within the Project Area (Div. 3NO and 3L inshore and offshore) (DFO 2018b). After reaching a historical low during 2015/2016, there were slight improvements in snow crab recruitment and exploitable biomass during 2017 within Div. 3K, north of the Project Area (DFO 2018b).

Grab samples by Houston and Haedrich (1984 in LGL Limited 2018) from the southeastern Grand Banks, near the edge and slope of Carson Canyon mainly consisted of polychaetes, hooded shrimp, sipunculid worms, amphipods, echinoderms, isopods, and bivalves. Polychaetes were among the most abundant fauna in all substrate types sampled, including sandy, gravelly, and silty habitats. Murillo et al. (2016) recently sampled epibenthic invertebrates via bottom trawls on the Tail and southern Nose of the Grand Bank beyond the Canadian 200-nm limit and the Flemish Cap region and identified 12 assemblages within three regional-scale faunal groups, including: the continental shelf of the Tail of the Grand Bank (predominated by orange-footed sea cucumbers and sand dollars); upper slope of the Grand Bank and top of the Flemish Cap (mainly sponges [*Radiella hemisphaerica*] and sea stars [*Ceramaster granularis*]); and lower slope of the Grand Bank and Flemish Cap (mostly sea urchins [*Phormosoma placenta*] and sea pens [*Anthoptilum grandiflorum* and *Funiculina quadrangularis*]). The Tail of the Grand Bank faunal group was mainly associated with coarse sediments in depths <200 m and cold water associated with the Labrador Current, and the lower Grand Bank and Flemish Cap group was generally found in/on muddy sediments and relatively warm, saline waters within depths of 500 m to 600 m (LGL Limited 2018).



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Carter et al. (1979) sampled benthic sediments and took photographs along four transects within and north of the Project Area, ranging from the shelf break (300 m to 350 m depth) and slope to the 3,000-m isobath, and characterized benthic invertebrates within four habitat categories. Benthic invertebrates within the shallow slope (300 m to 700 m) mainly consisted of polychaetes, bivalves (e.g., *Nuculana* sp., *Cuspidaria* sp., and *Dentalium* sp.), and echinoderms (i.e., sand dollars, sea urchins, and brittle stars) on/within soft sediments, along with sponges, bryozoans, and brachiopods on hard substrates. The middle slope (700 m to 2,000 m) predominantly hosted sea anemones (e.g., *Cerianthus* sp.), tube-dwelling polychaetes, gastropods, brittle stars, tusk shell (a shelled marine mollusc; *Dentalium* sp.), sand dollars, and sea urchins on the seabed, and bivalves within soft substrate (e.g., *Nucula* sp., *Nuculana* sp., and *Cylichna* sp.). Macrofauna on the deep slope (2,000 m to 2,500 m and >2,500 m) was relatively scarce, and mainly included tube-dwelling polychaetes, brittle stars, and molluscs (e.g., *Nucula* sp. and *Cuspidaria* sp.). Sponges and brachiopods also affixed to cobbles within the 2,000 m to 2,500-m portion of the deep slope.

A remotely operated vehicle (ROV) survey was conducted in July 2010 on the Orphan Seamount and Knoll to collect substrate samples, high-definition video, oceanographic data, and multibeam imagery (Meredyk 2017). Crinoids and brittle stars were the most abundant benthos observed and were located between 2,000 m to 2,250 m and 2,000 m to 3,000 m, respectively. Shrimp were prevalent throughout the surveyed areas, although less abundant than brittle stars. Squat lobsters were occasionally observed at depths >2,200 m, mostly in association with bedrock, and sea cucumbers and sea urchins were mainly found on fine sediment.

A ROV survey was conducted during 2013 near Chevron Canada's Margaree A-49 well site, in approximately 2,500-m water depth within the northeastern portion of the Project Area (Penney-Belbin and Christian 2013). The observed surficial sediment was sandy/silty and relatively level and featured sporadic boulders. Benthic biota were generally only sighted on or near the boulders, and, other than corals and sponges (see Section 6.1.6.1), observed macroinvertebrates mainly included giant stalked ascidians (tunicates), followed by parasitic hydroids, a sea anemone, sea stars, and deep-sea squat lobsters.

Benthic invertebrates (other than corals and sponges; see Section 6.1.6.1) caught during Canadian RV surveys within the southern portion of the Project Area during June and November-December, 2013-2017, predominantly included unspecified sea anemones and sea stars (Table 6.2). Other benthos included gastropods, sea urchins, bivalves, nudibranchs, polychaetes, sessile tunicates, and decapods.

Table 6.2 Benthic Macroinvertebrates Observed in the Project Area during Canadian RV surveys, 2013-2017

Species	Catch Weight (t)	Mean Catch Depth (m)
Sea Anemone sp.	0.42	269
Sea Stars		
• Rigid Cushion Star	0.1	149
• Sand Sifting Star	<0.01	230
• <i>Novodinia americana</i>	<0.01	N/A
• Mud Star	<0.01	247
• Brittle Star (<i>Ophiura sarsi</i>)	<0.01	58



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Table 6.2 Benthic Macroinvertebrates Observed in the Project Area during Canadian RV surveys, 2013-2017

Species	Catch Weight (t)	Mean Catch Depth (m)
• Sunstar (<i>Crossaster papposus</i>)	<0.01	301
• Northern Cushion Star	<0.01	119
• Henricia sp.	<0.01	216
• Daisy Brittle Star	<0.01	215
• Rigid Pink Star	<0.01	N/A
• Basket Star	<0.01	237
• Long Arm Star	<0.01	N/A
• Sea Porania	<0.01	474
Gastropods		
• <i>Aporrhais occidentalis</i>	<0.01	N/A
• Whelk (<i>Buccinum</i> sp.)	<0.01	172
• Whelk (<i>Neptunea</i> sp.)	<0.01	N/A
Sea Urchins		
• Green Sea Urchin	<0.01	290
• Soft Deep Sea Urchin	<0.01	345
Clam (<i>Myidae</i>)	<0.01	N/A
Lamp Shell (<i>Terebratulina</i> sp.)	<0.01	556
Nudibranch sp.	<0.01	N/A
Polychaetes		
• Polychaete NS	<0.01	556
• Sea Mouse	<0.01	382
Sessile Tunicates		
• Ascidiacea	<0.01	397
• <i>Boltenia</i> sp.	<0.01	474
Decapods		
• Snow Crab	<0.01	132
• Toad Crab (<i>Hyas coarctatus</i>)	<0.01	316
• Toad Crab (<i>Hyas</i> sp.)	<0.01	N/A
• Malacostraca (<i>Stereomastis sculpta</i>)	<0.01	N/A
• Sea Spider (<i>Pycnogonida</i>)	<0.01	N/A
Source: Canadian RV Survey Data, 2013-2017. Note: N/A = Not Available		



6.1.6.1 Corals and Sponges

Corals

Several coral groups occur within the RAA, including scleractinians (solitary stony corals), antipatharians (black wire corals), alcyonaceans (soft corals, including large and small gorgonians, and bamboo coral), and pennatulaceans (sea pens) (Wareham and Edinger 2007; Wareham 2009). Coral and sponge distributions are influenced by factors such as temperature, salinity, currents, depth, and substrate type (DFO 2018a). As current speed determines the vertical and horizontal transmission of food particles, corals and sponges are generally associated with areas of higher bottom currents (Genin et al. 1986, Ginn et al. 2000, and Klitgaard et al. 1997 in Beazley et al. 2018). Sea pens and stony corals (e.g., cup corals) typically occur on fine substrates (e.g., mud or sand), while soft and black corals tend to adhere to hard substrates (e.g., gravel, boulders, and bedrock), particularly along the NL Shelf and Slope (Edinger et al. 2007; Wareham and Edinger 2007), within canyons, and along channel edges (Breeze et al. 1997) in water depths from 200 m to 3,000 m (DFO 2018a; LGL Limited 2018). Soft corals are distributed throughout the RAA, while hard corals are restricted to deeper water (LGL Limited 2018). Corals occur in dense aggregations off Labrador and are referred to as coral “forests” or “fields” (LGL Limited 2018). Recent fatty acid analyses suggest that some deep-sea coral groups exhibit a degree of prey selectivity (Salvo et al. 2017), which may further influence distribution. Dietary lipid investigation by Salvo et al. (2017) indicated a likely reliance by soft corals and gorgonians on phytodetritus from algae, macrophytes, and/or foraminifera; a possible preference for diatoms and/or herbivorous zooplankton by most sea pens; a tendency towards carnivory on zooplankton by the black coral *Stauropathes arctica*; and the omnivorous consumption of phytoplankton and zooplankton by the stony cup coral *Flabellum alabastrum*.

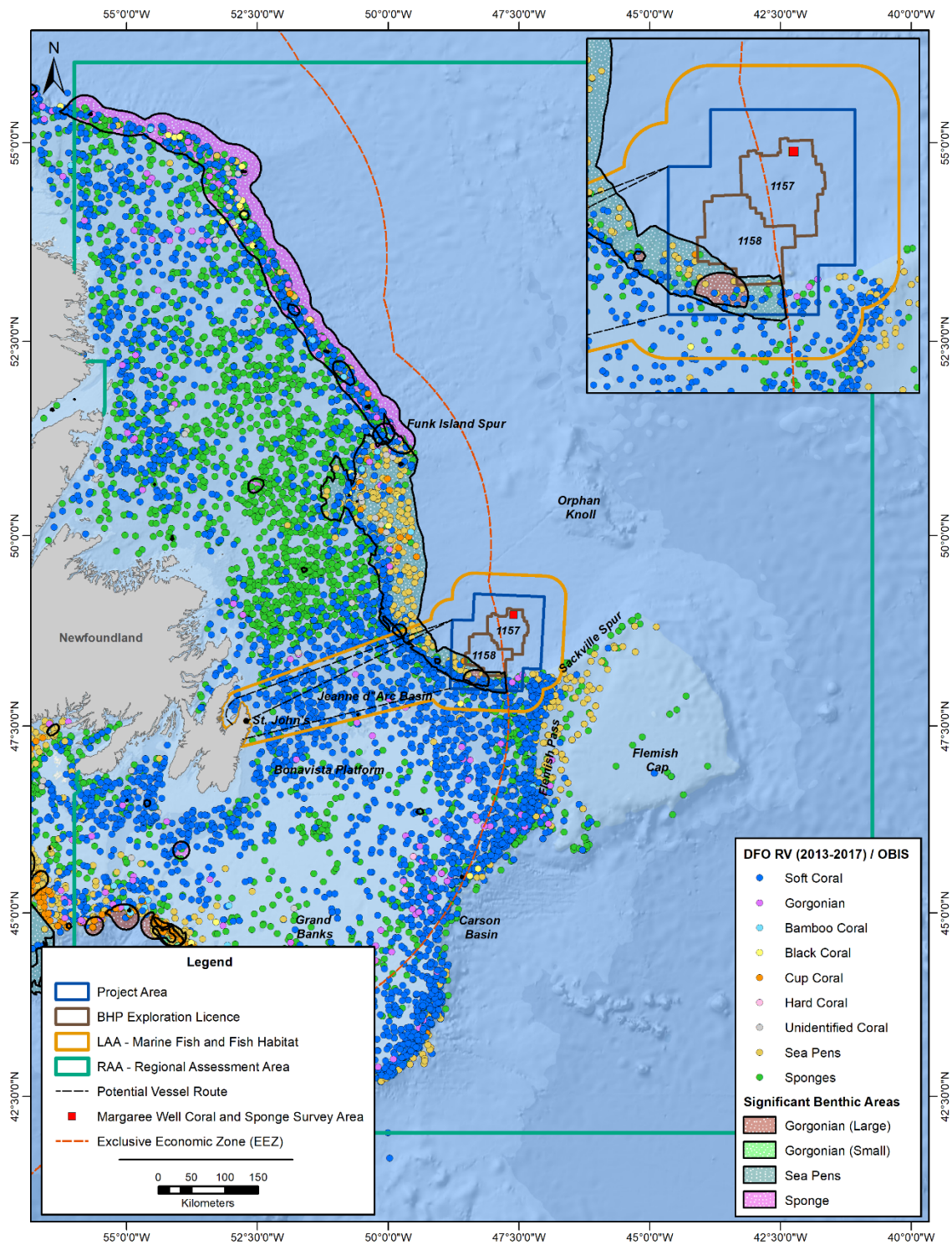
There are approximately 40 known species of coral throughout eastern Canada (DFO 2018a), most of which occur within the RAA (Wareham 2009; Murillo et al. 2011). With at least 34 species identified, the Flemish Cap supports the highest known deep-water coral species diversity within the RAA, along with 22 coral species observed on the Flemish Pass and Nose of the Grand Banks (Murillo et al. 2011). Prominent corals within the RAA, as determined by Wareham (2009) and Kenchington et al. (2016) from Canadian RV survey, DFO Arctic multispecies survey, and northern shrimp survey data, and information provided by commercial fishers, include soft corals (e.g., *Gersemia rubiformis*, *Anthomastus grandiflorus*, *Duva florida*, and *Neptheid* spp.); large gorgonians (e.g., *Keratoisis grayi*, *Paragorgia arborea*, and *Paramuricea* spp.); small gorgonians (e.g., *Acanthogorgia armata*, *Acanella arbuscula*, *Radicipes gracilis*, and *Anthothela grandiflora*); stony corals (e.g., *Flabellum alabastrum*, *F. macandrewi*, *Javania cailleti*, and *Dasmosmilia lymani*); and sea pens (e.g., *Protoptilum carpenteri*, *Anthoptilum grandiflorum*, *Halipteris finmarchica*, *Pennatula grandis*, *P. phosporea*, *Distichoptilum gracile*, and *Funiculina quadrangularis*).

Canadian RV surveys conducted within the RAA during 2013-2017 collected soft, black, stony, and unidentified corals on the continental shelf and slope and Flemish Pass (Figure 6-6).



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Source: Penney-Belbin and Christian (2013); Canadian RV Survey Data, 2013–2017; Guijarro-Sabaniel et al. (2019); OBIS (2019).

Figure 6-6 Corals and Sponges within the Project Area and RAA



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Soft corals (e.g., *Gersemia rubiformis*, *Capnella florida* and gorgonians) occurred throughout the western portion of the RAA and within the southern portion of the Project Area, particularly on and relatively near the shelf edge. Bamboo corals (*Keratoisis ornata*; a type of soft coral) were located along the slope in the northwestern and southwestern portions of the RAA and southwestern slope of the Flemish Pass. Black corals were also observed on or near the continental slope, with one catch location approximately 22 km south of the southwestern boundary of the Project Area. Common cup corals (stony coral) were along the continental slope, mainly in the southwestern and central portions of the RAA, with one catch location in the southwestern portion of the Project Area, and two spider hazard coral (stony coral) harvest locations were on the eastern Grand Banks. Sea pens (e.g., *Umbellula lindahli*, *Distichoptilum gracile*, *Pennatula phosphorea*, *P. grandis*, *Anthoptilum grandiflorum*, and *Funiculina quadrangularis*) occurred at depths between 100 m and 2,000 m in the central and southwestern portions of the RAA, including the southern portion of the Project Area. Numerous unidentified corals were caught throughout the shelf and slope survey regions.

Alcyonacean (i.e., soft coral) catch locations from the OBIS (2019) database similarly occurred throughout the NL Shelf and Slope, including the southern portion of the Project Area, along with the Flemish Pass, Flemish Cap, and western and northern slopes of the Flemish Cap (Figure 6-6). Soft corals also occurred in the northern portion of Conception Bay (OBIS 2019). A single soft coral catch record within the OBIS (2019) database specified gorgonian coral, located on the southern Grand Banks, in the southwestern portion of the RAA. Sea pen OBIS (2019) records predominantly occur on the eastern NL Slope, both north of and within the southern and southwestern portions of the Project Area, on the Flemish Pass and western and northern slopes of the Flemish Cap, and along the slope of the southern Grand Banks.

Recent ROV surveys on the Orphan Seamount identified at least 18 coral groups (Meredyk 2017). Notable among these were sea pens, which were limited in distribution to softer sediment at depths >2,700 m; bamboo coral (Isididae), found on bedrock at a 22° slope 110 m below the seamount crest; *Acanthogorgia armata* (gorgonian), observed on bedrock; *Gersemia* spp. (soft corals), which were only located on the seamount crest; and *Chrysogorgia* spp. (gorgonian corals), found on the outer edge of bedrock outcrop at 2,750-m depth. ROV surveys on the Orphan Knoll mounds found *Chrysogorgia* spp. at 2,645-m depth on the north side, concentrations of *A. armata* on the crest, and bamboo corals throughout the southeast mounds; 11 coral types on the northeast mounds (predominantly *Bathypathes* spp. and *Flabellum* spp. with a lesser concentration of sea pens); four coral species on fine and fine-medium sediment of the southern Orphan Knoll flat (*Acanella arbuscula*, *Anthomastus grandiflorus*, bamboo coral, and *Stauropathes arctica*); *Chrysogorgia* spp. between 2,280-m and 2,285-m depth, *Vaughanella margaritata* and *Bathypathes* spp. throughout, and *A. arbuscula* and *Umbellula encrinus* at a single site on the eastern Orphan Knoll flat; and *Anthomastus grandiflorum* along the 2,300-m depth contour on an 11° slope on the western Orphan Knoll flat (Meredyk 2017).

Over 340 gorgonians (*Chrysogorgia* sp.) were observed during a 2013 ROV survey conducted in approximately 2,500-m water depth near Chevron Canada's Margaree A-49 well site, within the northeastern portion of the Project Area (Figure 6-6; Penney-Belbin and Christian 2013). At least 20 soft corals (e.g., *Anthomastus* sp., *Heteropolypus* cf. *insolitus*, Neptheidae, and bamboo), four black corals (*Bathypathes patula* and *Bathypathes* sp.), and nine unidentified corals were also observed during this survey.



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Sponges

Sponges are filter feeders that mainly consume dissolved organic matter and are composed of a silicified skeleton. Sponges are important contributors to the marine nitrogen, carbon, and silicon cycles (DFO 2018a). Photographic transect surveys within the western slope of the Flemish Cap (444–940 m depth) and southern Flemish Pass (1,328 m to 1,411 m depth) were dominated by sponges and brittle stars (see Section 6.1.6; Beazley et al. 2013). Axinellid and polymastid sponges mainly occurred on the slope of the Flemish Cap, while geodid and *Asconema* sp. sponges predominated the southern Flemish Pass. Using Canadian and EU-Spain RV survey data, sediment box-core/dredge samples, and seabed video data, Knudby et al. (2013) determined that the distribution of *Geodia* sp. sponges are mainly influenced by depth and salinity, and created a model that predicted a high probability of *Geodia* sp. sponge occurrence within the Project Area and along the slopes of the NL Shelves, southern Grand Banks, and Flemish Pass and Cap.

Canadian RV surveys during 2013-2017 collected sponges on the continental shelf and slope throughout the western portion of the RAA, including the southern portion of the Project Area (Figure 6-6). Sponges were especially prevalent along the slope edges and on the shelf northeast of Newfoundland and off Labrador during these surveys. This distribution is also evident from the OBIS (2019) database, with similar observation locations within the Project Area and RAA, including sightings further eastwards onto the Flemish Cap and surrounding slopes and a single sighting in the northern portion of Conception Bay. An ROV survey in July 2010 on the Orphan Seamount and Knoll found *Polymastia* spp. and glass sponges ranging from the crest of the Orphan Seamount down to 2,500-m and 2,750-m depths, respectively, particularly on bedrock and boulder substrate (Meredyk 2017). Concentrations of unidentified sponges (Porifera) were observed 120 m from the crest of the Orphan Seamount, on a 16°-slope at 2000-m depth (Meredyk 2017). On the southeast mounds of the Orphan Knoll, unidentified Porifera and glass sponges were found on fine sediment with a granular overlay and glass vase sponges were prevalent throughout, particularly on the mound crests. Glass sponges were abundant on bedrock on the northeast mounds of the Orphan Knoll, while relatively few occurred on the southern Orphan Knoll deep-sea flats. *Polymastia* sp. and glass sponges were observed on fine and medium-grained sediment within the eastern Orphan Knoll deep-sea flats. Porifera and glass sponges occurred together throughout much of the western Orphan Knoll deep-sea flats, except for the southeastern portion where no sponges were present (Meredyk 2017). Porifera, Desmospongia, and glass vase sponges were observed near Chevron's Margaree A-49 well site within the northeastern portion of the Project Area during a 2013 ROV survey, in association with sporadic boulders located throughout the area that otherwise consisted of fine (sandy/silty) surficial sediment (Penney-Belbin and Christian 2013).

Summary of Corals and Sponges within the Project Area and ELs

Coral and sponge data are limited within the Project Area and ELs, with current survey coverage encompassing the southern portion of the Project Area, including the southern and southwestern-most portions of EL 1158, and the Margaree well site area within the northern portion of EL 1157 (see Figure 6- 6). The known and potential occurrences of corals and sponges within the ELs are provided in Table 6.3.



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Table 6.3 Known and Potential Coral and Sponge Occurrence within ELs 1157 and 1158

Exploration Licence	Known Occurrence	Potential Occurrence
EL 1157	Corals	<ul style="list-style-type: none"> • <i>Anthomastus grandiflorus</i> (soft coral) and <i>Stauropathes arctica</i> (black coral) may occur on fine/fine-medium sediment, because they are present on the Southern Orphan Knoll flat (Meredyk 2017) • <i>Vaughanella margaritata</i> (stony coral) and <i>Umbellula encrinus</i> (sea pen) may occur within the Project Area, as they were present on the eastern Orphan Knoll flat (Meredyk 2017) • High probability of <i>Geodia</i> sp. (sponge) within the Project Area (Knudby et al. 2013) • <i>Polymastia</i> sp. (sponge) may occur on fine/medium-grained sediment, bedrock and/or boulders, given their presence within the Orphan Seamount region and eastern Orphan Knoll deep-sea flats (Meredyk 2017)
	Gorgonian	
	<i>Chrysogorgia</i> sp.	
	Soft	
	<i>Anthomastus</i> sp.	
	<i>Heteropolypus</i> cf. <i>insolitus</i>	
	Neptheidae	
	Bamboo	
	Black	
	<i>Bathypathes patula</i>	
	<i>Bathypathes</i> sp.	
	Sponges	
	Porifera	
Desmospongia		
Glass Vase		
EL 1158	Corals	
	Gorgonian	
	<i>Acanella arbuscula</i>	
	<i>Acanthogorgia armata</i>	
	<i>Paragorgia arborea</i>	
	Soft	
	<i>Capnella florida</i>	
	<i>Capnella</i> sp.	
	<i>Gersemia rubiformis</i>	
	Sea Pen	
	<i>Anthoptilum grandiflorum</i>	
	<i>Anthoptilum</i> sp.	
	<i>Pennatula grandis</i>	
	<i>Pennatula phosphorea</i>	
	Cup/Hard/Stony	
	<i>Flabellum alabastrum</i>	
	Sponges	
Porifera		
Source: Knudby et al. (2013); Penney-Belbin and Christian (2013); Canadian RV Survey Data, 2013-2017; Meredyk (2017); Guijarro-Sabaniel et al. (2019); OBIS (2019).		



Environmental Importance of Corals and Sponges

Corals and sponges are one of the only sources of complex habitat structure on the seafloor within the RAA (DFO 2018a). They form the basis of biodiverse deep-water ecosystems, providing various benthic species with important (although not necessarily obligatory) egg and nursery habitat and areas for resting, feeding, spawning, and protection from predators (Edinger et al. 2009; DFO 2018a). A positive correlation exists between some deep-sea benthic organisms and corals on the southern Grand Banks, such as the presence of roundnose grenadier and large skeletal and cup corals, roughhead grenadier and large gorgonians / antipatharians and soft corals, and marlin-spike grenadier and small gorgonians (Baker et al. 2012 in LGL Limited 2018). Several corals, especially sea pens, in the Laurentian Channel and on the southern Grand Banks have been found to host eggs and/or larvae for two redfish species (Acadian and deepwater), a lanternfish (*Benthosema glaciale*), and greater eelpout (Baillon et al. 2012 in LGL Limited 2018). Sponge grounds / reefs have been found to support increased biodiversity relative to abiotic, structurally complex seafloor habitats where no sponges are present (Beazley et al. 2013). Several demersal fish taxa tend to associate with *Geodia*-dominated sponge grounds on the continental slopes of the Grand Banks and Flemish Cap, including roughhead, roundnose, and common grenadier, blue hake, longnose and shortnose snipe eels, Greenland halibut, black dogfish, deep-sea cat shark, lanternfishes, goiter blacksmelts, eelpout, Spinytail and white skates, and deepwater chimaera (Kenchington et al. 2013). Other organisms commonly associated with sponges/sponge grounds include marine worms, bryozoans, juvenile rockfish (use sponges for nursery habitat), and other higher trophic level fauna (DFO 2010a in LGL Limited 2018).

Deep-sea corals and sponges are sensitive to anthropogenic activities, including bottom-contact fisheries and resource extraction (DFO 2018a). Species with limited temperature ranges are also vulnerable to altered water temperatures resulting from climate change (DFO 2018a). Guijarro et al. (2016) and Guijarro-Sabaniel et al. (2019) used a random forest distribution modelling approach with data from Canadian RV, DFO/industry northern shrimp, and European Union-Spain surveys to predict the occurrence and abundance of corals and sponges within the NL Region and identify SiBAs. Because of their life histories and vulnerability to disturbance, SiBAs comprised of aggregations of deep-water corals and sponges are considered to represent high-seas VMEs (FAO 2009 in Guijarro et al. 2016), which NAFO uses to enact protective closure areas from bottom-contact fishing gears (Kenchington et al. 2019) (see Section 6.4.1). SiBAs for large gorgonians and sea pens occur within the southern and southwestern portions of the Project Area, and along the continental slope of the NL Shelf in the central and southwestern portions of the RAA (Figure 6-6). SiBAs for large gorgonians are also located south of Placentia Bay, NL, in the southwestern portion of the RAA and on the eastern Grand Banks, southwest of the Project Area. Several SiBAs for small gorgonians are along the slope in the northwestern and southwestern portions of the RAA, one is on the eastern Grand Banks, and one is east of Newfoundland's Northern Peninsula. A large SiBA extends along the slope from the northwest to central portions of the RAA, and several others are on the NL shelf and eastern edge of the Grand Banks. NAFO has established several VME closure areas within the eastern, southeastern, and southwestern portions of the RAA, including 14 Coral and Sponge Closures (13 Coral and Sponge closure areas and the 3O Coral Closure) and three Seamount Closures (NAFO 2019; see Section 6.4). None of the NAFO VME closure areas are within the Project Area. Additional VMEs or modified VME boundaries may be established when NAFO reviews its VME protections in 2020 (NAFO 2015 in Guijarro et al. 2016).



6.1.7 Finfish (Demersal and Pelagic Species)

Finfish are an abundant and diverse group that is well represented in the Project Area. They play a wide variety of roles in the ecosystem, from planktivorous capelin to large carnivorous sharks, and can play different roles at different points in their life history. Many juvenile finfish live as ichthyoplankton for a portion of their lives and may use different habitats than their adults inhabit. Many finfish species are of commercial, Indigenous, and ecological importance.

This section describes key finfish species in the LAA and breaks them down by their habitat and depth. Within the LAA for marine fish and fish habitat, depth ranges from the intertidal to 2,910 m. Carter et al. (1979) describes depth zonation within the Orphan Basin based on depositional environment, which inside the LAA range from the continental shelf (<300 m), the upper slope (300 m to 700 m), the middle slope (700 m to 2,000 m), the lower slope (2,000 m to 2,500 m), and the rise (2,500 m to 3,000 m). These breakdowns will be used to summarize assemblages for marine fish species inside the LAA based on trawl data and other records. Key assemblages are drawn from standardized scientific RV surveys down to approximately 1,450 m (the deepest trawl depth). Below that depth, scientific literature and deep-water longline surveys are used to describe dominant species.

6.1.7.1 Continental Shelf

The potential Project support vessel (PSV) routes is mainly on the continental shelf and includes coastal waters stretching from Long Pond and Bay Bulls, Newfoundland, to the Project Area. This area is predominantly continental shelf species and differs greatly from the slope and deep-sea species present in the Project Area. This area has previously been characterized in the Eastern Newfoundland SEA (AMEC 2014). Depths within the potential PSV routes range from essentially 0 m to 2,025 m, and so species found on the upper and lower slopes of the Northeast Newfoundland Slope are also found here (see Section 6.1.7.2). Predominant species in this area are those common to the Grand Banks, such as capelin, American plaice, sand lance, cod (arctic and Atlantic), sculpins, and many other shallow water species (AMEC 2014). On the continental shelf the main planktivores are capelin and sand lance, which are important forage fish for a wide variety of fish, birds, and marine mammals. American plaice, sculpins, and skates are the predominant benthivores, consuming invertebrates on the sea floor. Important predatory fish, piscivores, are Atlantic cod, Greenland halibut, and large migratory species (see Section 6.1.7.5). Redfish and Arctic cod have a mixed plank-piscivore feeding group, consuming both plankton and other fish. Further details on these species can be found in the Eastern Newfoundland SEA (AMEC 2014). Although key LAA species selected are focused on the deeper areas of the LAA, many common shelf species are included in Section 6.1.7.4 as key species.

6.1.7.2 Northeast Newfoundland Slope

Canadian RV surveys captured 72 fish species between 197 m and 1,379 m within the LAA, with 68 species found in the upper slope (197 m to 700 m) and 14 species in the middle slope (701 m to 1,379 m). Fishing effort was much higher on the upper slope, with 93 trawls taking place from 2012 to 2017, and 12 trawls in the middle slope during the same time period. Dominant species (species that together comprise 95% of the catch) were then broken out by abundance (Table 6.4) and biomass (Table 6.5) per trawl. Contributions



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of a fish species to a survey is based on the abundance or biomass of that species divided by the total abundance or biomass of all species multiplied by 100 and reported as a percentage.

Table 6.4 Dominant Fish Species by Abundance within the LAA (Canadian RV surveys, 2012-2017)

Depth Zone	Functional Group	Common Name	Scientific Name ^A	Mean Abundance (# / tow)	Contribution ^B (%)
Upper Slope (197 m to 700 m) (93 trawls)	Planktivore	Capelin	<i>Mallotus villosus</i>	4,852	72
	Plank-piscivore	Deepwater Redfish	<i>Sebastes mentella</i>	699	10
	Planktivore	Lanternfishes	Myctophidae (F)	397	6
	Planktivore	Sand Lance	<i>Ammodytes dubius</i>	99	1
	Large benthivore	American plaice	<i>Hippoglossoides platessoides</i>	98	1
	Plank-piscivore	Arctic cod	<i>Boreogadus saida</i>	51	1
	Medium benthivore	Blue hake	<i>Antimora rostrata</i>	47	1
	Medium benthivore	Eelpouts (NS)	Zoarcidae (F)	40	1
	Piscivore	Atlantic cod	<i>Gadus morhua</i>	36	1
	Piscivore	Black dogfish	<i>Centroscyllium fabricii</i>	31	<1
	Piscivore	Greenland halibut	<i>Reinhardtius hippoglossoides</i>	27	<1
Middle Slope (701 m to 1,379 m) (12 trawls)	Medium benthivore	Witch flounder	<i>Glyptocephalus cynoglossus</i>	43	20
	Piscivore	Greenland halibut	<i>Reinhardtius hippoglossoides</i>	41	19
	Large benthivore	Roughhead grenadier	<i>Macrourus berglax</i>	41	19
	Large benthivore	American plaice	<i>Hippoglossoides platessoides</i>	41	18
	Small benthivore	Roundnose grenadier	<i>Coryphaenoides rupestris</i>	36	16
	Plank-piscivore	Deepwater redfish	<i>Sebastes mentella</i>	4	2
	Medium benthivore	Deepsea cat shark	<i>Apristurus profundorum</i>	3	1
	Large benthivore	Jensen's skate	<i>Amblyraja jenseni</i>	3	1

^A Taxonomic group: F – family
^B Contribution is the abundance for a given species, divided by total abundance for all species and multiplied by 100



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Table 6.5 Dominant Fish Species by Biomass within the LAA (Canadian RV surveys, 2012-2017)

Depth Zone	Functional Group	Common Name	Scientific Name ^A	Mean Biomass (kg / tow)	Contribution ^B (%)
Upper Slope (197 m to 700 m) (93 trawls)	Plank-piscivore	Deepwater Redfish	<i>Sebastes mentella</i>	273	49
	Planktivore	Capelin	<i>Mallotus villosus</i>	96	17
	Piscivore	Black dogfish	<i>Centroscyllium fabricii</i>	35	6
	Piscivore	Atlantic halibut	<i>Hippoglossus hippoglossus</i>	22	4
	Large benthivore	American plaice	<i>Hippoglossoides platessoides</i>	15	3
	Piscivore	Atlantic cod	<i>Gadus morhua</i>	15	3
	Large Benthivore	Thorny skate	<i>Raja radiata</i>	14	3
	Large benthivore	Roughhead grenadier	<i>Macrourus berglax</i>	13	2
	Piscivore	Greenland halibut	<i>Reinhardtius hippoglossoides</i>	9	2
	Plank-piscivore	Golden redfish	<i>Sebastes norvegicus</i>	9	2
	Large benthivore	Northern wolffish	<i>Anarhichas denticulatus</i>	7	1
	Large benthivore	Spinytail skate	<i>Bathyraja spinicauda</i>	7	1
	Large benthivore	Spotted wolffish	<i>Anarhichas minor</i>	4	1
	Medium benthivore	Common lumpfish	<i>Cyclopterus lumpus</i>	4	1
	Medium benthivore	Witch Flounder	<i>Glyptocephalus cynoglossus</i>	4	1
	Large benthivore	Atlantic wolffish	<i>Anarhichas lupus</i>	3	1
Middle Slope (701 m to 1,379 m) (12 trawls)	Piscivore	Greenland shark	<i>Somniosus microcephalus</i>	1000	89
	Piscivore	Greenland halibut	<i>Reinhardtius hippoglossoides</i>	36	3
	Medium Benthivore	Witch flounder	<i>Glyptocephalus cynoglossus</i>	20	2
	Large Benthivore	Roughhead grenadier	<i>Macrourus berglax</i>	19	1

^A Taxonomic group: F – family
^B Contribution is the biomass for a given species, divided by total biomass for all species and multiplied by 100

For the upper slope, 11 species make up 95% of the catch by abundance, and 16 species by biomass (Tables 6.4 and 6.5). By abundance, capelin alone make up 72% of the catch at these depths, followed by



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Acadian / deepwater redfish (10%) and lanternfishes (6%), with the remainder made up of five species. By biomass, deepwater redfish make up 49% of the catch, followed by capelin (17%) and black dogfish (6%), with the remainder made up of 13 species.

For the middle slope, eight species make up 95% of the catch by abundance, and four species by biomass (Tables 6.4 and 6.5). By abundance, witch flounder make up 20% of the catch, followed by roughhead grenadier and Greenland halibut each making up 19%, American plaice (18%), roundnose grenadier (16%), with the remainder made up of three species. By biomass, one Greenland shark made up 89% of the catch, with three species making up the remainder.

Important species by both abundance and biomass for the upper slope include capelin and deepwater redfish, which together make up 82% of the catch by abundance and 66% by biomass. Although the middle slope biomass is dominated by a single Greenland shark, important species include Greenland halibut, witch flounder, and roughhead grenadier which together make up 58% of the catch by abundance and 6% by biomass.

6.1.7.3 Orphan Basin Abyssal Plain

As RV trawl surveys are not able to survey the deep portions of the Newfoundland slope (>1,450 m) and the abyssal plain, comparatively little is known about the dominant species, their assemblages, and life histories. Many deep-sea species have slow-growth, late maturity, and low reproductive rates. Devine et al. (2006) examined five deep-sea species (blue hake, roughhead and roundnose grenadiers, spinytail skate, and spiny eel) caught in Canadian RV trawls over a 17-year period and found declines in weighted number per tow of over 87%. These species are either the target (roundnose and roughhead grenadiers) or by-catch of continental slope fisheries for Greenland halibut and redfish. Though consistently applied RV trawls are not available for the Orphan Basin below 1,450 m, available information on finfish presented here is taken from scientific literature and other available reports. As few records exist within the LAA, supporting deep-sea records from nearby areas are used to describe potentially important species. Past studies have found that the dominant components of deep-sea areas in the North Atlantic to be fairly homogenous across large spatial scales, with similar finding in the Labrador Sea, the mid-Atlantic Ridge, East Greenland, and off New England (Coté et al. 2018).

Records within the LAA

As part of the environmental monitoring program for Chevron's Margaree A-49 well site located in the southern Orphan Basin and in the Project Area, an ROV was used to survey six transects (approximately 626 m) and a baited station deployed for 24-h (Penney-Belbin and Christian 2013). Fish occurrences were assessed by minimum individuals in the video frame to avoid potential repeated counting of individuals. This survey took place within the LAA at approximately 2,500 m depth. ROV benthic transects observed four species of fish: blue hake (minimum 20 individuals), threebeard rockling (minimum 3 individuals), grenadier (*Coryphaenoides* sp.; minimum 20 individuals), and unidentified fish (likely hake or grenadier; min. 5 individuals). As fish swam in and out of frame and may be difficult to see clearly, these numbers are likely underestimated. The baited station was observed by ROV for 182 minutes over the 24-h period. Table 6.6 presents the observed fish species and minimum number of individuals (likely underestimated). As in the ROV transects, blue hake and grenadier species were the most abundantly encountered species.



Table 6.6 Species and Minimum Number of Individuals Observed at the Baited Station at Chevron’s A-49 Well Site

Common Name	Scientific Name	Minimum Number of Individuals
Blue hake	<i>Antimora rostrata</i>	20
Abyssal grenadier	<i>Coryphaenoides armatus</i>	20
Threebeard rockling	<i>Gaidropsarus ensis</i>	3
Chimaera rabbitfish	<i>Hydrolagus affinis</i>	2
Spinytail skate	<i>Bathyraja spinicauda</i>	2
Unidentified fish	Possibly eel, blenny or gunnel	2
Grenadier	<i>Coryphaenoides</i> sp.	1

Notes: Adapted from Penney-Belbin and Christian (2013)
Minimum number of individuals in the video frame is the greatest number visible within any one frame, to avoid potential repeated counting of individuals
Survey took place at approximately 2,500 m depth, with 182 minutes surveyed at a baited station over 24-h

The OBIS is an open source data repository with records globally from various sources (OBIS 2019). As such, records may be duplicated from Canadian RV trawls or other sources, and all species and the number of records for each is presented in Table 6.7. Records reported in Table 6.7 are for depths below the range of Canadian RV trawls as few records exist. Unidentified ray-finned fishes (Class Actinopterygii, which is the largest class of extant fishes) are the most common records for both the middle-deep slope (1,400 to 2,000 m) and the abyssal plain (2,000 to 2,475 m). Other common records for the middle-deep slope are blue hake, spinytail skate, roundnose and roughhead grenadier, and Greenland halibut. Atlantic cod have three records from a telemetry study at this depth but as this is below the deepest depth range for cod these are likely caught in mid-water column or the result of an imprecise coordinate. Records for a variety of uncommon deep-sea species are reported for this depth range, including viperfish, dragonfish, and spiny eels.

Table 6.7 Fish Species by Depth Zone from OBIS Records (1950-2015)

Depth Zone	Common Name	Scientific Name ^A	Number of Records
Middle-Deep Slope (1,400 m to 2,000 m)	Ray-finned fishes	Actinopterygii (C)	5
	Blue hake	<i>Antimora rostrata</i>	3
	Spinytail skate	<i>Bathyraja spinicauda</i>	3
	Roundnose grenadier	<i>Coryphaenoides rupestris</i>	3
	Atlantic cod	<i>Gadus morhua</i>	3
	Roughhead grenadier	<i>Macrourus berglax</i>	3
	Greenland halibut	<i>Reinhardtius hippoglossoides</i>	3
	Goiter blacksmelt ^B	<i>Bathylagus euryops</i>	2
	Sloane's viperfish	<i>Chauliodus sloani</i>	2
	Black swallower	<i>Chiasmodon niger</i>	2
	Rockling	<i>Gaidropsarus</i> sp.	2



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Table 6.7 Fish Species by Depth Zone from OBIS Records (1950-2015)

Depth Zone	Common Name	Scientific Name ^A	Number of Records
	Shortnose loosejaw	<i>Malacosteus niger</i>	2
	Lanternfishes ^B	Myctophidae (F)	2
	Slender snipe-eel	<i>Nemichthys scolopaceus</i>	2
	Marlin spike	<i>Nezumia bairdii</i>	2
	Deep-sea spiny eels	Notacanthidae (F)	2
	Stout sawpalate	<i>Serrivomer beanii</i>	2
	Boa dragonfish	<i>Stomias boa boa</i>	2
	Longnose eel	<i>Synaphobranchus kaupii</i>	2
	Roughnose grenadier	<i>Trachyrincus murrayi</i>	2
	Slickheads ^B	Alepocephalidae (F)	1
	Baird's slickhead ^B	<i>Alepocephalus bairdii</i>	1
	Daggertoosts	Anotopteridae (F)	1
	Deepsea cat shark	<i>Apristurus profundorum</i>	1
	Stareater	<i>Astronesthes</i> sp.	1
	Deep-sea smelt ^B	<i>Bathylagus</i> sp.	1
	Arctic cod	<i>Boreogadus saida</i>	1
	Greenland manefish	<i>Caristius fasciatus</i>	1
	Black dogfish	<i>Centroscyllium fabricii</i>	1
	Portuguese dogfish	<i>Centroscymnus coelolepis</i>	1
	Snubnosed spiny eel	<i>Notacanthus chemnitzii</i>	1
	Barracudinas ^B	Paralepididae (F)	1
Eelpouts	Zoarcidae (F)	1	
Abyssal plain (2,000 m to 2,475 m)	Ray-finned fishes	Actinopterygii (C)	6
	Goiter blacksmelt ^B	<i>Bathylagus euryops</i>	3
	Straightline dragonfish	<i>Borostomias antarcticus</i>	3
	Roundnose grenadier	<i>Coryphaenoides rupestris</i>	3
	Unnamed Anglerfish	<i>Dolopichthys allector</i>	3
	Atlantic cod	<i>Gadus morhua</i>	3
	Mirror lanternfish ^B	<i>Lampadena speculigera</i>	3
	Blacktail netdevil	<i>Linophryne coronata</i>	3
	Short-rod anglerfish	<i>Microlophichthys microlophus</i>	3
	Slickhead ^B	<i>Alepocephalus</i> sp.	2
	Whalehead dreamer	<i>Lophodolos acanthognathus</i>	2
	Swordfish ^C	<i>Xiphias gladius</i>	2
	Silver smelt ^C	<i>Argentina silus</i>	1



Table 6.7 Fish Species by Depth Zone from OBIS Records (1950-2015)

Depth Zone	Common Name	Scientific Name ^A	Number of Records
Abyssal plain (2,000 m to 2,475 m) (cont'd)	Atlantic herring ^C	<i>Clupea harengus</i>	1
	Silver hake	<i>Merluccius bilinearis</i>	1
	Marlin spike	<i>Nezumia bairdii</i>	1
	Greenland halibut	<i>Reinhardtius hippoglossoides</i>	1
	Redfish	<i>Sebastes</i> sp.	1
	Bigeye tuna ^C	<i>Thunnus obesus</i>	1
	White hake	<i>Urophycis tenuis</i>	1
^A Taxonomic groups: C – Class, F – family ^B Deepwater pelagic fish ^C Assumed to be found in upper water column Number of records is a count of how many times a given species has been recorded in the OBIS database			

Records for the abyssal plain (2,000 m to 2,475 m) are fewer and include both deep-sea species as well as surface records (Table 6.7). Species with three records include goiter blacksmelt, straightline dragonfish, and roundnose grenadier. Several species records exist for dreamer anglerfish (Family Oneirodidae), as well as the blacktail netdevil. Pelagic species typically found in the upper water column are reported in this depth range as well and were likely caught near the surface and not at depth in the trawl. These include swordfish, bigeye tuna, silver smelt, and Atlantic herring.

Supporting Records in the RAA

Though outside the LAA area, Murua and De Cárdenas (2005) summarized findings from the deep-water longline survey in 1996. This survey extended from depths of 800 m to 3,100 m within the Flemish Pass and deeper waters near the tail of the Grand Banks. From the shallow-middle slope depths (<800 m) the survey was dominated by Greenland halibut and skate species (99% of catch). The middle-deep slope (800 m to 1,500 m) was dominated by roughhead grenadier, with blue hake increasing in abundance in the deeper depths. The deep slope (1,500 m to 2,000 m) was dominated by blue hake and chimaera rabbitfish. Catch yields below 2,000 m declined considerably (less than 50% compared to the deep slope) and were dominated by the abyssal grenadier.

Snelgrove and Haedrich (1985) conducted experimental trawling near Carson Canyon (approximately 400 km south of the LAA) between 1980 and 1982. Trawls were conducted within the canyon and the deeper slope outside, using a shrimp trawl with a 2.5 cm cod end. The predominant species in the shallow (200 m to 1,475 m) trawls were roundnose and roughhead grenadiers, with relative abundance of greater than 73% combined for both species and a combined biomass of greater than 48%; roundnose grenadiers were more abundant than roughhead grenadiers (Table 6.8). Blue hake was the third most common species by abundance and biomass in the shallow depth range, despite being generally considered a deep-sea species. For the deep (1,712 m to 2,335 m) trawls, blue hake represented more than half of the total catch by abundance and 74.1% of the biomass (Table 6.8). Snelgrove and Haedrich (1985) encountered species rarely noted in Canadian RV trawls (which are restricted to depths shallower than 1,450 m), including various grenadiers such as the abyssal, carapine, and shortbeard grenadiers, as well as a genus of



slickheads. Longnose eels were found in low numbers at both depth ranges in this survey. Though outside the LAA area, species documented here in the deep range appear consistent with those in the LAA and other deep-sea areas off the Grand Banks.

Table 6.8 Percent of Species Abundance and Biomass from Research Trawls Conducted near Carson Canyon by Snelgrove and Haedrich (1985)

Depth	Common Name	Scientific Name	Number (%)	Biomass (%)
Shallow (200 m to 1,475 m)	Roundnose Grenadier	<i>Coryphaenoides rupestris</i>	59.1	26.5
	Roughhead grenadier	<i>Macrourus berglax</i>	14.2	21.4
	Blue hake	<i>Antimora rostrata</i>	8.2	12.8
	Marlin spike	<i>Nezumia bairdii</i>	5.3	3.6
	Redfish	<i>Sebastes</i> sp.	4.1	3.8
	Longnose eel	<i>Synaphobranchus kaupii</i>	3.4	2.0
Deep (1,712 m to 2,335 m)	Blue hake	<i>Antimora rostrata</i>	53.3	74.1
	Abyssal grenadier	<i>Coryphaenoides armatus</i>	12.5	6.1
	Shortbeard grenadier	<i>Coryphaenoides brevibarbis</i>	10.0	6.5
	Carapine grenadier	<i>Coryphaenoides carapinus</i>	10.0	0.9
	Slickhead	<i>Alepocephalus</i> sp.	6.7	9.4
	Longnose eel	<i>Synaphobranchus kaupii</i>	3.3	1.6

Notes: Adapted from Snelgrove and Haedrich (1985) with currently accepted species names
Percent numbers and biomass are the abundance or biomass, respectively, for a given species divided by the total catch multiplied by 100

6.1.7.4 LAA Key Species Information

Species-specific information is presented here on species found to be dominant through Canadian RV trawl data and scientific literature within the deeper areas of the LAA (50 km around the Project Area). Additional details for SAR are presented in Section 6.1.8, with species-specific information on wolffish (Atlantic, spotted, and northern), white shark, as well as species of Indigenous importance, the American eel and Atlantic salmon. Species examined here are those found to compose the largest portion (>85%) of the abundance or biomass for Canadian RV trawls where data are available (>1,450 m depth) or were predominant in deep-water surveys undertaken in the LAA (See Sections 6.1.7.1 and 6.1.7.2). These include capelin, redfish (Acadian, golden, and deepwater), lanternfish, grenadier (roughhead, roundnose, abyssal, and carapine), witch flounder, Greenland halibut, American plaice, and blue hake. Greenland shark was the dominant species in the middle slope by biomass, but as only a single specimen was caught it will not be discussed further (Tables 6.4 and 6.5). Though less data are available below 1,450 m, scientific studies are used to characterize the dominant species present.



Capelin

Capelin are a schooling planktivorous fish that is central ecologically and an important commercial and indigenous species. They eat plankton such as copepods, amphipods, and euphausiids, and undertake diel vertical migrations while offshore to feed (Maxner et al. 2016). They are an important prey species for a wide variety of piscivorous fish, marine mammals, and seabirds (Davoren and Montevecchi 2003, Rose 2005, Maxner et al. 2016). They undertake spawning migrations from offshore to inshore waters, and this migration is shadowed by piscivorous predatory species (Maxner et al. 2016). Capelin eggs are externally fertilized and demersal, sticking to bottom substrate (Nakashima and Wheeler 2002).

Capelin are widely distributed across the Grand Banks, with the highest concentrations along the shelf (Figure 6-7). As capelin are a pelagic species, abundances noted here are likely not truly representative and should be used largely as presence / absence data. Within the core LAA capelin are the dominant species in the upper slope depths (225 m to 700 m), representing 74% of the total catch by abundance, and 19% by biomass (Tables 6.4 and 6.5). The deepest record inside the LAA for capelin was 403 m, with the majority found above 300 m. Aside from the shallow southwest portion of the core LAA, capelin are unlikely to be present in the majority of the LAA area or the Project Area. The highest catch in a single tow inside the core LAA was 52,480 individuals weighing 1,321 kg. Capelin are likely to be the dominant species within the potential PSV routes as well, as they are abundance on the continental shelf and in inshore waters during spawning (AMEC 2014).

Redfish (Acadian, Golden, Deepwater)

Three species of redfish, Acadian, golden, and deepwater, are known to inhabit the LAA based on Canadian RV trawl surveys. No differentiation is made between Acadian and deepwater redfish due to the difficulty in distinguishing the individual species in the trawl survey. Redfish are present in high abundances along the edges of the Grand Banks, NL slope, and Flemish Cap areas (Figures 6-8 and 6-9). Redfish are an important commercial species, though declines in their stocks have led COSEWIC to list Acadian and deepwater redfish as Threatened (COSEWIC 2010a). Their primary threats are by-catch mortality, overfishing, predation, and unfavorable conditions for groundfish. Additional details on their status as a SAR is presented in Section 6.1.8. Redfish do not undertake spawning migrations like many fish species, though they engage in daily vertical migrations and are thus considered planktivorous and piscivorous (Scott and Scott 1988, Ollerhead et al. 2017). Redfish use internal fertilization, and their larvae are found primarily in the upper 200 m of the water column feeding on fish eggs, invertebrates, and zooplankton (COSEWIC 2010a, Coad and Reist 2018).

Within the core LAA, deepwater redfish contribute 10% of total fish abundance and 49% of biomass in the upper slope area (197 m to 700 m depth) (Tables 6.4 and 6.5). Golden redfish are present in the upper slope of the LAA but contribute less than 1% of abundance and 2% of biomass. These records are predominantly from the upper slope area, with the deepest record for deepwater redfish at 769 m and for golden at 584 m within the LAA. Acadian and deepwater redfish are found from 138 m to 1,200 m, with high abundance beyond the edge of the shelf potentially including within the Project Area (Nogueira et al. 2017) (Figure 6-8). Golden redfish are found from 130 m to 631 m, and typically inhabit shallow slope portions of the NL shelf and are therefore unlikely to be within the Project Area but are likely to be present within the potential PSV routes (Nogueira et al. 2017) (Figure 6-9).



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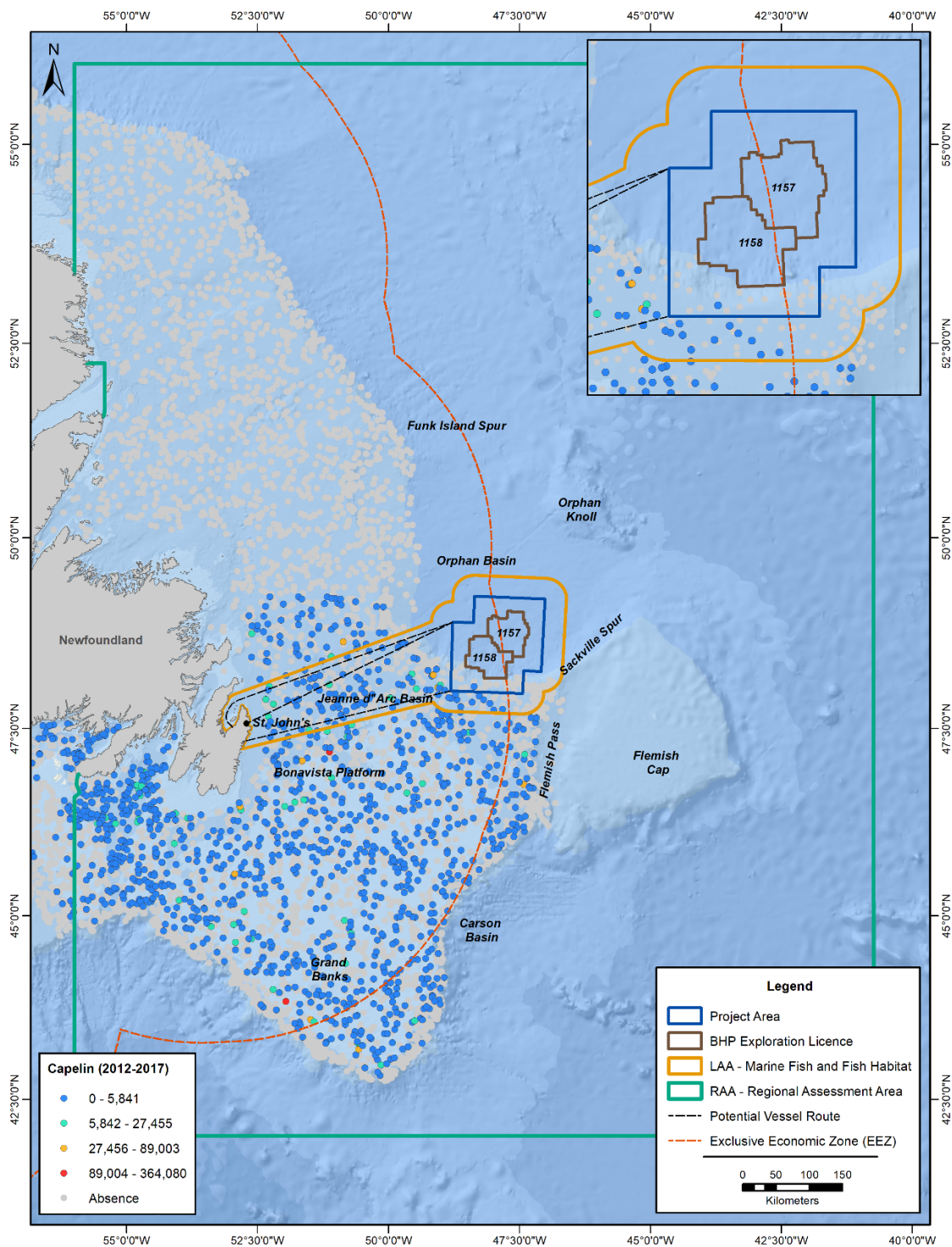


Figure 6-7 Capelin Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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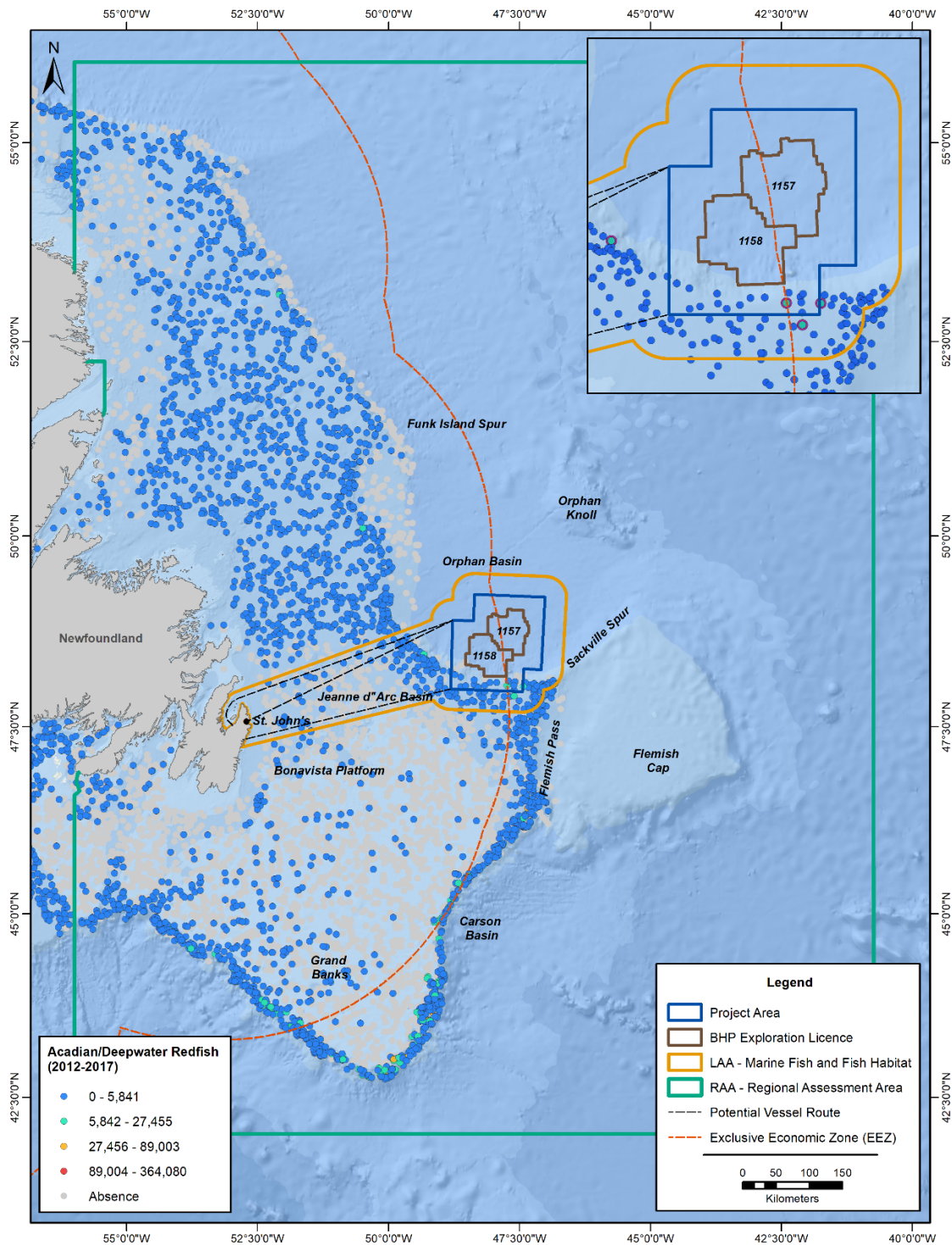


Figure 6-8 Acadian / Deepwater Redfish Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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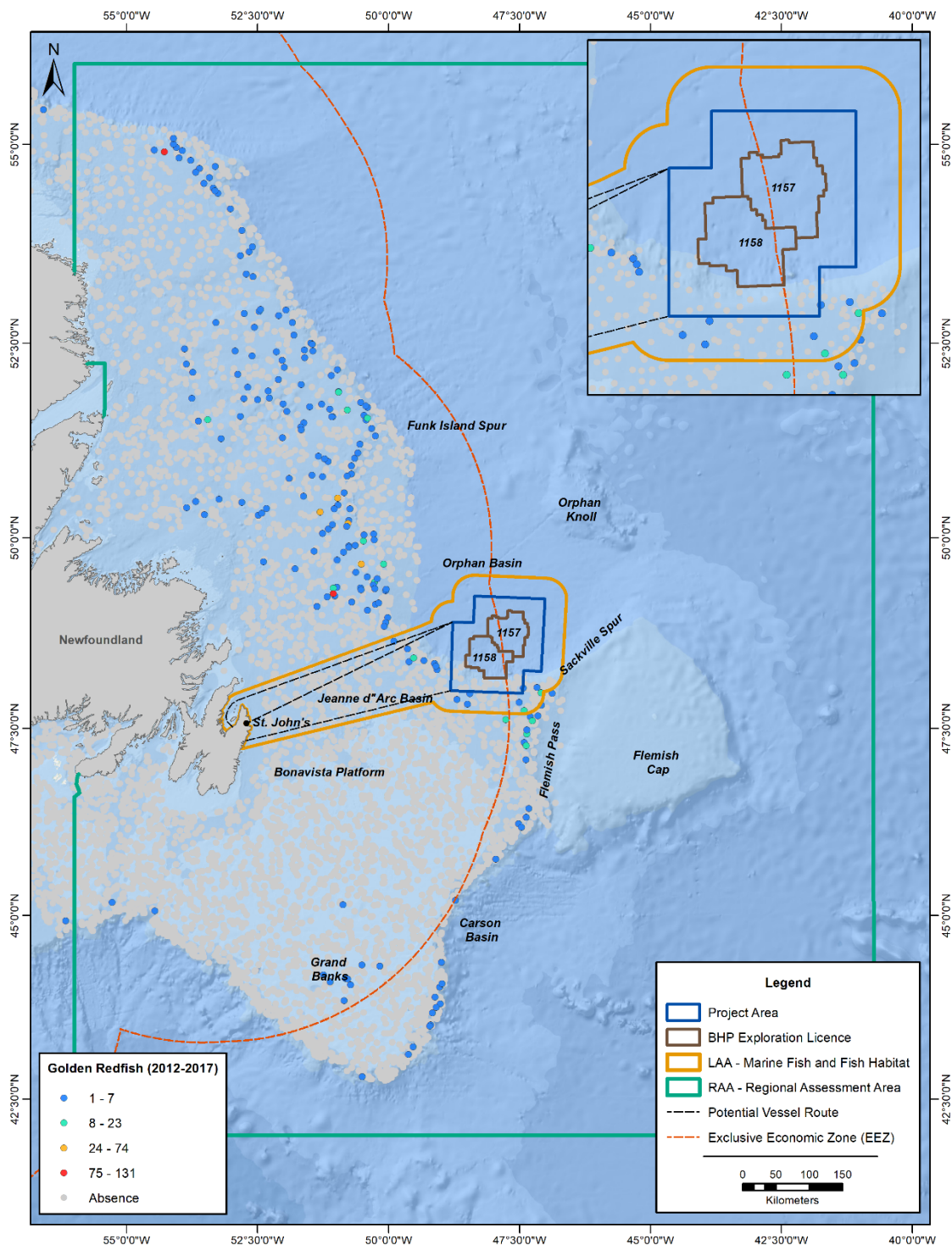


Figure 6-9 Golden Redfish Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



Lanternfish

Lanternfish (family Myctophidae) are small, pelagic fish characterized by having light-producing organs on their bodies (Scott and Scott 1988). They are suggested to supplant capelin as the dominant planktivore in the Labrador Sea and deeper waters north of the Grand Banks (Coté et al. 2019), and thus are key linkages in the food web as prey. They undertake daily migrations to surface waters to feed on plankton before returning to deeper waters (Dypvik et al. 2012). They primarily consume copepods, in addition to amphipods, ostracods, hyperiids, and fish eggs (Halliday et al. 2015). They are short-lived and have a high growth rate with a small size at maturity (García-Seoane et al. 2014). Due to difficulties in identifying lanternfish in the field no specific species are reported in Canadian RV trawls within the LAA, though the glacier lanternfish is predominant among myctophids caught on the Grand Banks (Halliday et al. 2015). While ecologically important as prey, lanternfish are not commercially important and are not listed by COSEWIC or SARA.

Within the LAA, lanternfish represent 6% of the catch by abundance, and less than 1% by biomass in the upper slope (197 m to 700 m) (Tables 6.4 and 6.5). Lanternfish catch is predominantly along the edge of the Grand Banks, the Flemish Pass, and the northeast Newfoundland slope (Figure 6-10). This may be an under-representation of lanternfish, as specific species such as the glacier lanternfish are not included in Figure 6-10. Records from Canadian RV trawls in the LAA are within the upper slope depths (197 m to 700 m). OBIS records from deeper waters (1,400 m to 2,475 m) show lanternfish are present, including the mirror lanternfish (OBIS 2019) (Table 6.7). Various lanternfish species are therefore likely to be found throughout the LAA, potential PSV routes, and Project Area at all depth zones.

Grenadiers (Roughhead, Roundnose, Abyssal, Carapine)

Grenadiers are slow-growing, deep-sea species that are important parts of the slope and abyssal assemblages. Their diet and feeding habits are dependent on size, as young grenadiers feed on zooplankton, and become more piscivorous with age (COSEWIC 2009a; Parzanini et al. 2017). For example, Parzanini et al. (2017) report young roundnose grenadiers consuming planktonic crustaceans and chaetognaths while pelagic, while adults will feed on shrimp, small fish such as myctophids, and squid (COSEWIC 2009a). Roughhead and roundnose grenadier are targeted commercial species, and due to depleted stocks the roundnose grenadier is listed by COSEWIC as Endangered and the roughhead grenadier was previously listed as Special Concern (currently not at risk) (COSEWIC 2009a). Improvements in by-catch rates by application of management plans for Greenland halibut and population improvements led to the change in status for the roughhead grenadier in 2018. Further details for SAR can be found in Section 6.1.8.



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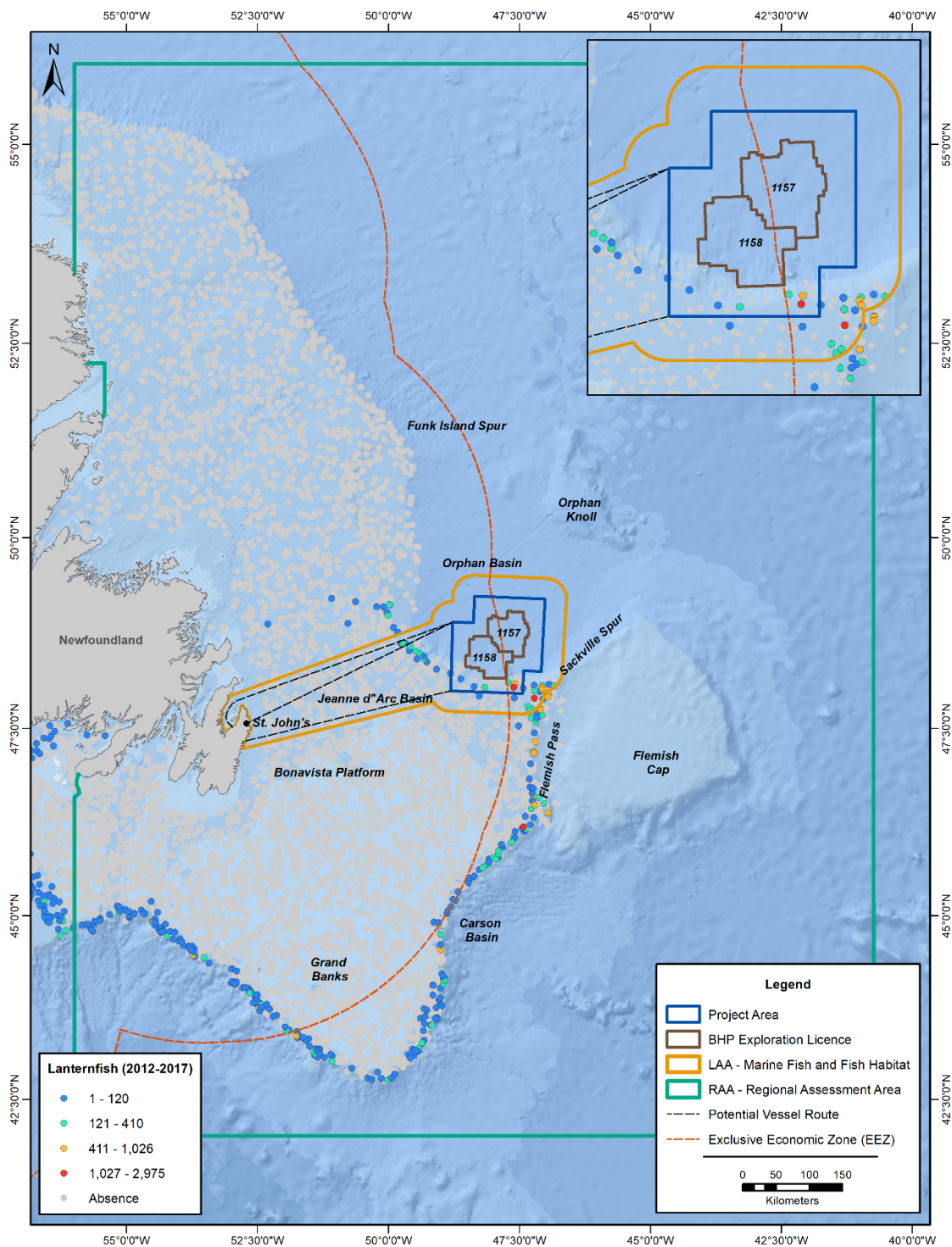


Figure 6-10 Lanternfish Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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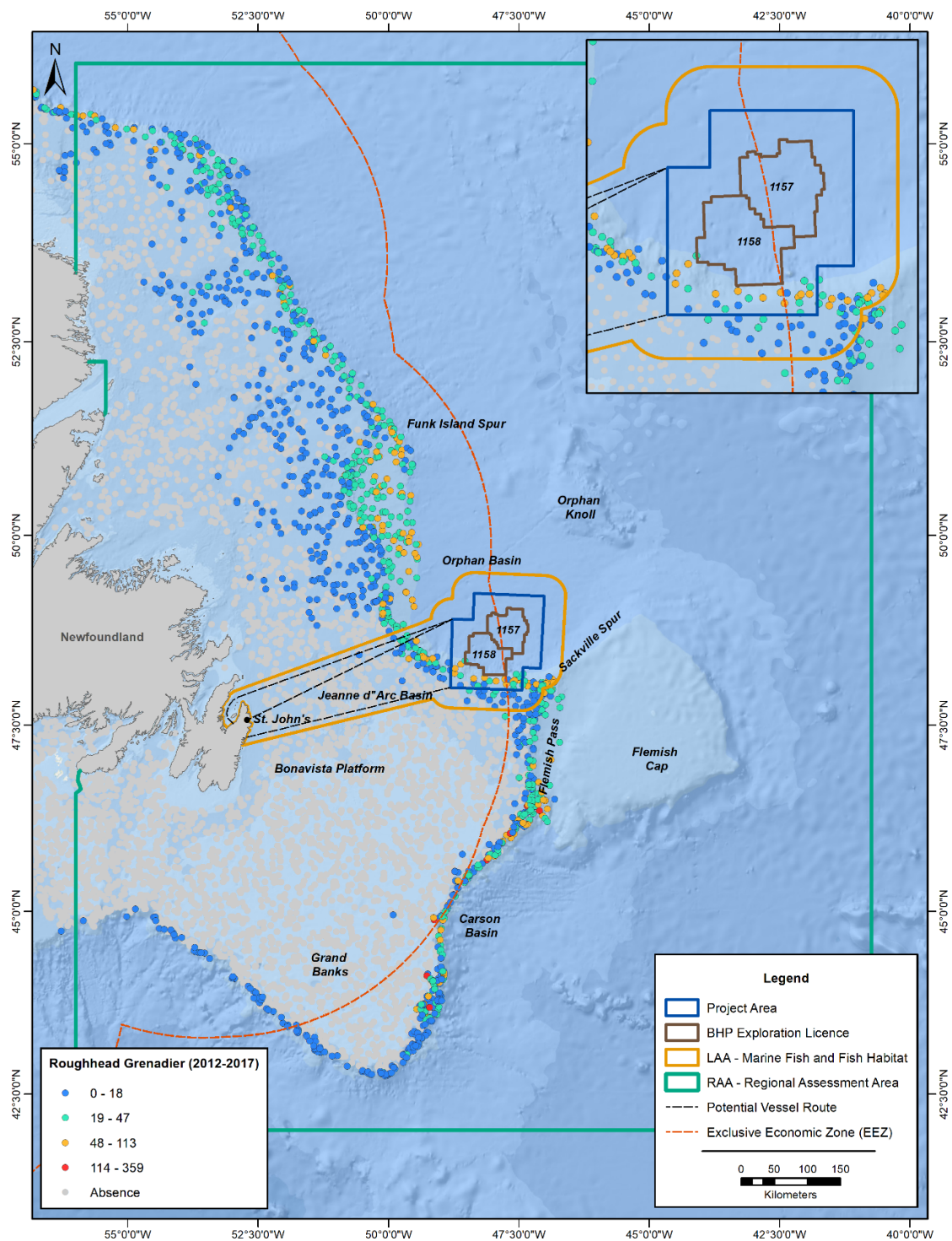


Figure 6-11 Roughhead Grenadier Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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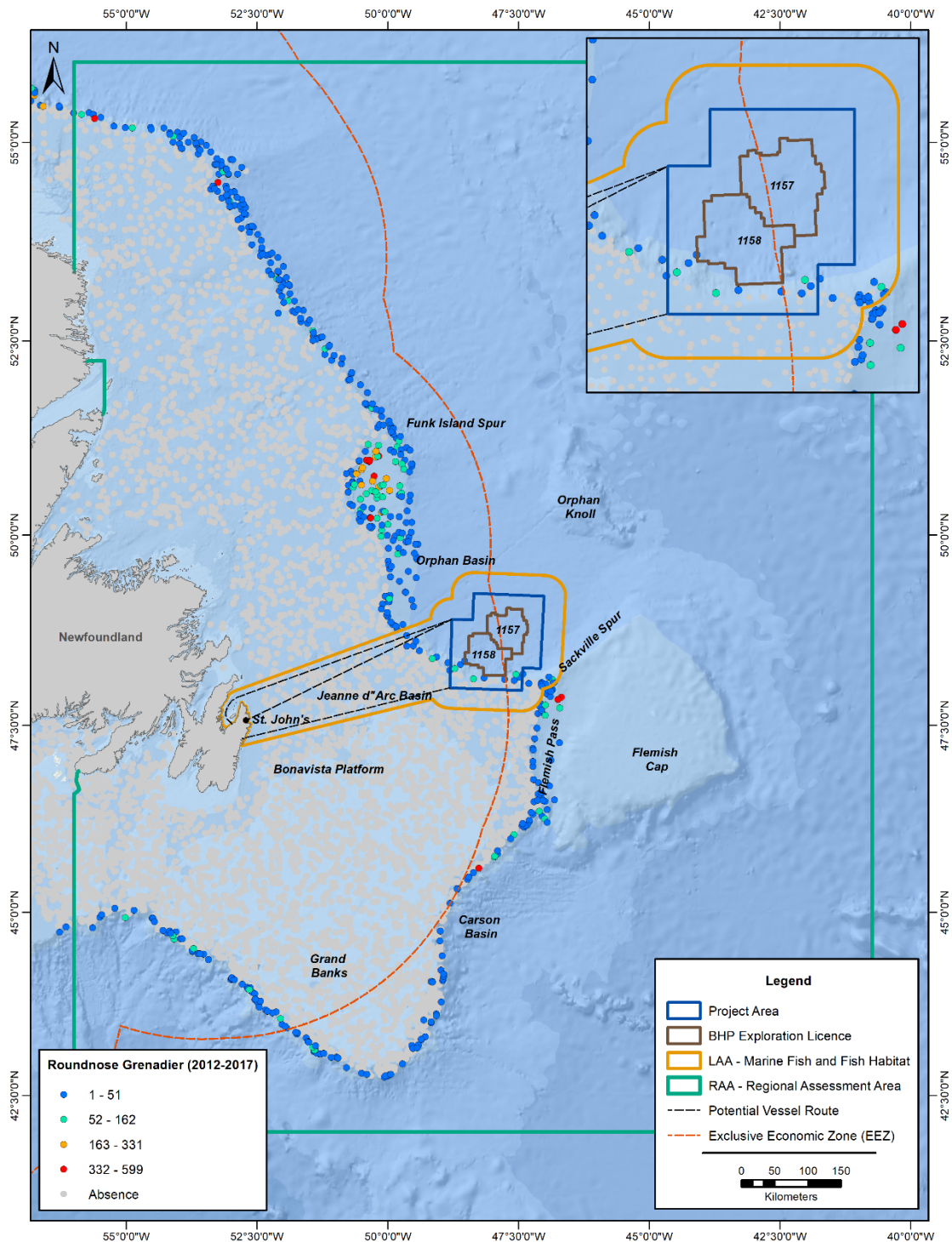


Figure 6-12 Roundnose Grenadier Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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Roughhead grenadiers have been captured from 200 m to 2,000 m, with roundnose grenadier occupying similar depths (180 m to 2,200 m), with both typically found between 400 m and 1,200 m (Snelgrove and Haedrich 1985, COSEWIC 2009a). Though less well studied, the abyssal grenadier has been caught between 257 m and 5,180 m and the carapine grenadier between 384 m and 5,610 m, with the abyssal grenadier typically below 2,500 m and the carapine grenadier above 2,400 m (Coad and Reist 2018). Abyssal and carapine grenadier are not found in Canadian RV trawl survey data, while the roughhead and roundnose grenadier both are found in trawls along the slopes of the Grand Banks and NL Shelf (Figures 6-11 and 6-12).

Within the LAA RV trawls, the roughhead and roundnose grenadier represent 19% and 16% of the total catch by abundance, respectively, within the middle slope range (701 m to 1,400 m). In terms of biomass, the roughhead grenadier is 2% of the total catch in the upper slope (225 m to 700 m depth) range and 1% in the middle slope range, with the roundnose grenadier less than 1% in both depth ranges. Both species were caught between 236 m and 1,379 m in Canadian RV trawls (Figures 6-11 and 6-12) and are therefore likely present in the southwest corner of the Project Area. OBIS records show both roughhead and roundnose grenadier between 1,400 m and 2,000 m depth inside the LAA, and roundnose grenadier between 2,000 m and 2,475 m. Snelgrove and Haedrich (1985) found abyssal and carapine grenadiers between 1,712 m and 2,335 m. Penney-Belbin and Christian (2013) found abyssal grenadier and unidentified grenadiers at 2,500 m depth using baited camera, and so both species are likely present throughout the Project Area. Both species are also likely to be present in the deeper portions of the potential PSV routes.

Witch Flounder

Witch flounder are a cold, deep-water species distributed from Georgia to Greenland and across in the Barents Sea. They have been caught from 18 m to 1,569 m deep, but typically prefer depths of 100 m to 400 m, and waters colder than 10°C (Coad and Reist 2018). They are benthivores that live and feed on the sea floor, consuming polychaetes and other small invertebrates (Link et al. 2002). They spawn in deep, relatively warmer waters such as channels and produce floating eggs. Larvae live pelagically for up to one year before metamorphosing and returning to the bottom (Coad and Reist 2018). Though limited data are available, declines in weight at length from the 1970s to the 1990s was cause for concern, though large recruitment pulses in the 1990's and increasing weight at size since are positive signs (DFO 2016b). As a long-lived and slow-growing species, they are vulnerable to by-catch as part of other fisheries.

Within the LAA, witch flounder made up 20% of the total fish abundance from Canadian RV trawls in the middle slope range (701 m to 1,400 m), and 1% and 2% of the total biomass at the upper (225 m to 700 m) slope and middle slope ranges, respectively (Tables 6.4 and 6.5). They were caught between 228 m and 769 m within the core LAA area and are therefore only likely to be present in the southwest corner of the LAA and within the potential PSV routes and not within the Project Area (Figure 6-13). Canadian RV trawl data indicate witch flounder along the edge of the Grand Banks, the Flemish Pass, and Northeast Newfoundland slope, though the southwest Grand Banks and northern Newfoundland shelf had abundant catches on the continental shelf as well (Figure 6-13).



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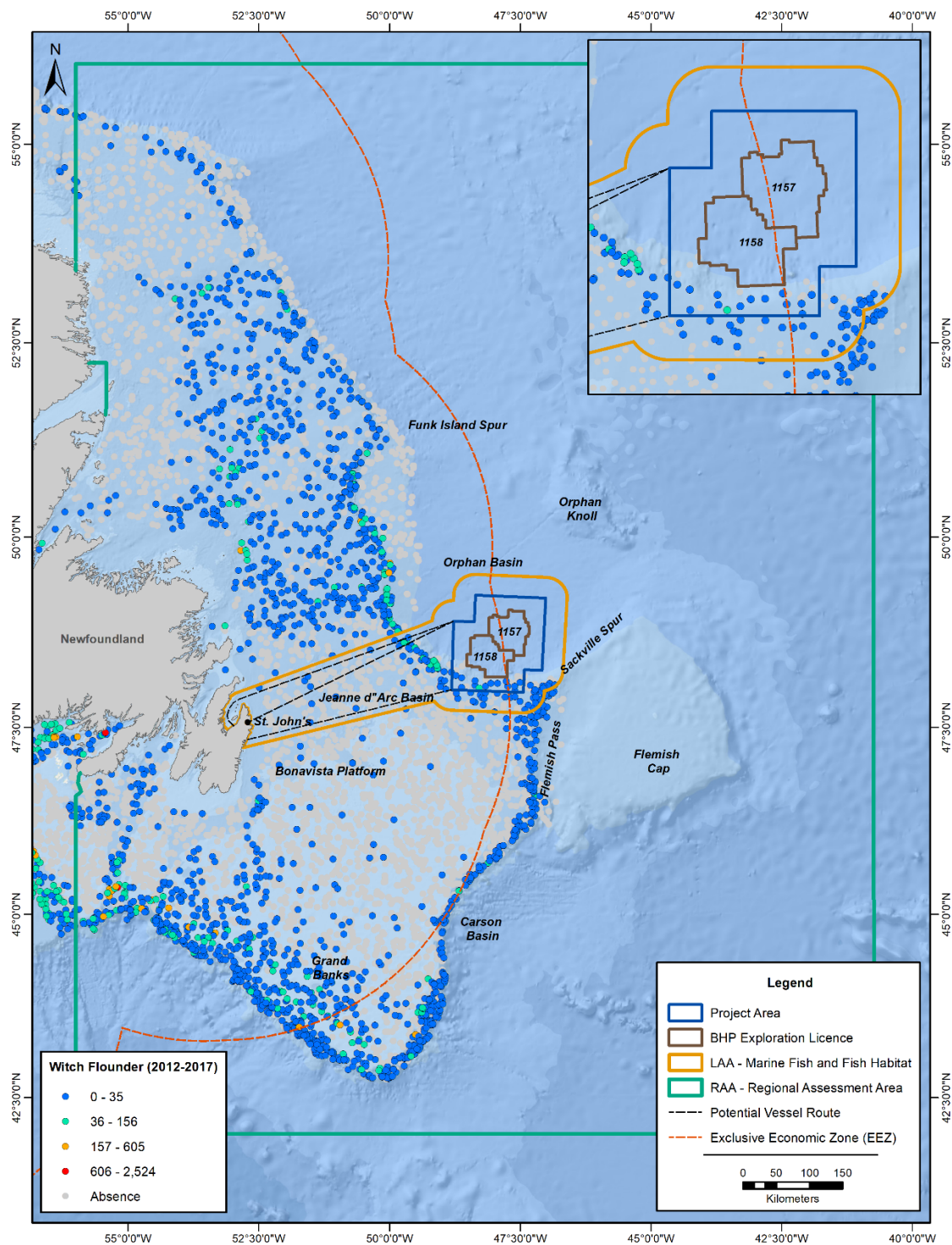


Figure 6-13 Witch Flounder Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



Greenland Halibut

Greenland halibut are commercially important predatory flatfish, considered one of the top predators in the northwest Atlantic since the collapse of Atlantic cod stocks. They have been caught from 14 m to 2,000 m, preferring ranges of 50 m to 650 m deep with larger, older fish living deeper (Bowering and Chumakov 1989). Compared to other flatfishes they spend little time on the seafloor, spending considerable time feeding pelagically on a variety of fish and invertebrates (Morgan et al. 2013). The population in the north Atlantic appear genetically homogenous, and individuals tagged in White Bay, Newfoundland have been tracked to Baffin Island indicating the capacity for large spawning migrations (Vis et al. 1997, Coad and Reist 2018). The eggs and larvae can drift for months after spawning before settling into nursery habitats along the coast of Greenland and possibly the Baffin Bank (Coad and Reist 2018).

Within the LAA, Greenland halibut made up 19% of the total catch from Canadian RV trawls by abundance in the middle slope range (701 m to 1,400 m) (Table 6.3). The biomass of Greenland halibut made up 2% of the total catch in the upper slope (225 m to 700 m) range and 3% in the middle slope range (Table 6.4). They were caught from 229 m to 1,379 m within the core LAA and are likely present within the deeper portions of the potential PSV routes (Figure 6-14). OBIS has three records within the 1,400 to 2,000 range, and one record within the 2,000 to 2,475 range, and so they are likely present throughout the Project Area (OBIS 2019). Murua and De Cárdenas (2005) found Greenland halibut as the predominant species in the long line survey at depths shallower than 800 m.

American Plaice

American plaice is a demersal continental-shelf, deep-water flatfish widespread in the northwest Atlantic (Scott and Scott 1988). On the Grand Banks, they are typically found between 91 m and 140 m deep, though in winter they avoid colder inshore water by moving to deeper waters (183 m to 229 m) (Coad and Reist 2018). American plaice are benthivores that prey on invertebrates and fish and are an important prey source for larger species. They produce floating eggs dispersed by the currents, and settled juveniles will inhabit shallow waters of 100 m to 200 m on fine substrates where they can bury themselves (Scott and Scott 1988; COSEWIC 2009b). They are currently listed as Threatened by COSEWIC, with past overfishing, current by-catch, and increases in natural mortality as the primary threats (COSEWIC 2009b). While the population in Newfoundland appears to be stabilizing and improving (Nogueira et al. 2016), they remain below a precautionary threshold (COSEWIC 2009b).

Within the LAA, American plaice contribute 1% to the total abundance from the Canadian RV trawls in the upper slope (225 m to 700 m), and 18% in the middle slope (701 m to 1,400 m) (Table 6.3). In terms of total biomass, they contribute to 3% in the upper slope, and less than 1% in the middle slope (Table 6.4). They were caught between 228 m and 769 m deep within the core LAA (Figure 6-15). They are abundant throughout the Grand Banks and northern Newfoundland shelf and are therefore likely to be within the potential PSV routes but are absent from deeper portions of the slopes and the Flemish Pass and are therefore unlikely to be found within the Project Area (Figure 6-15).



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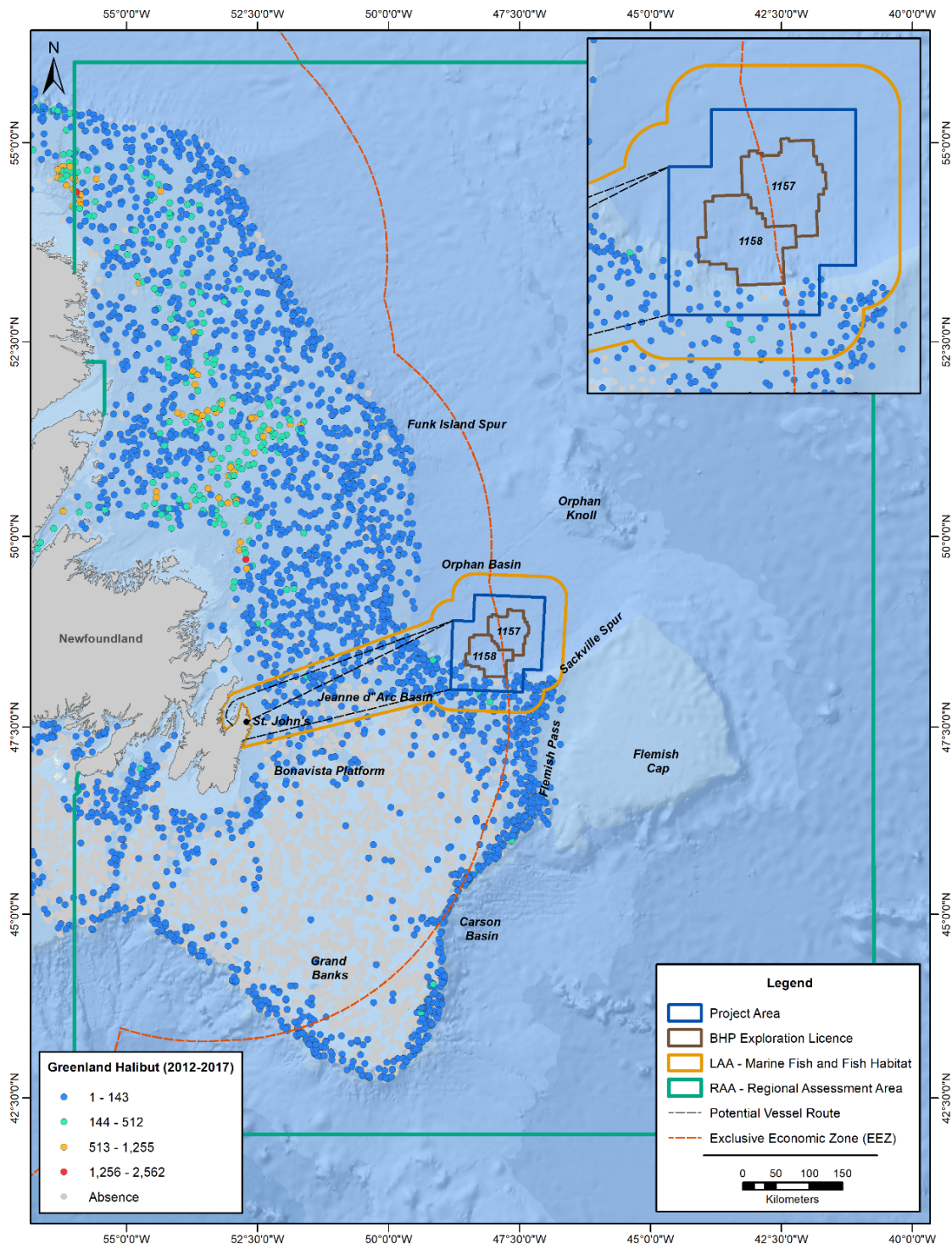


Figure 6-14 Greenland Halibut Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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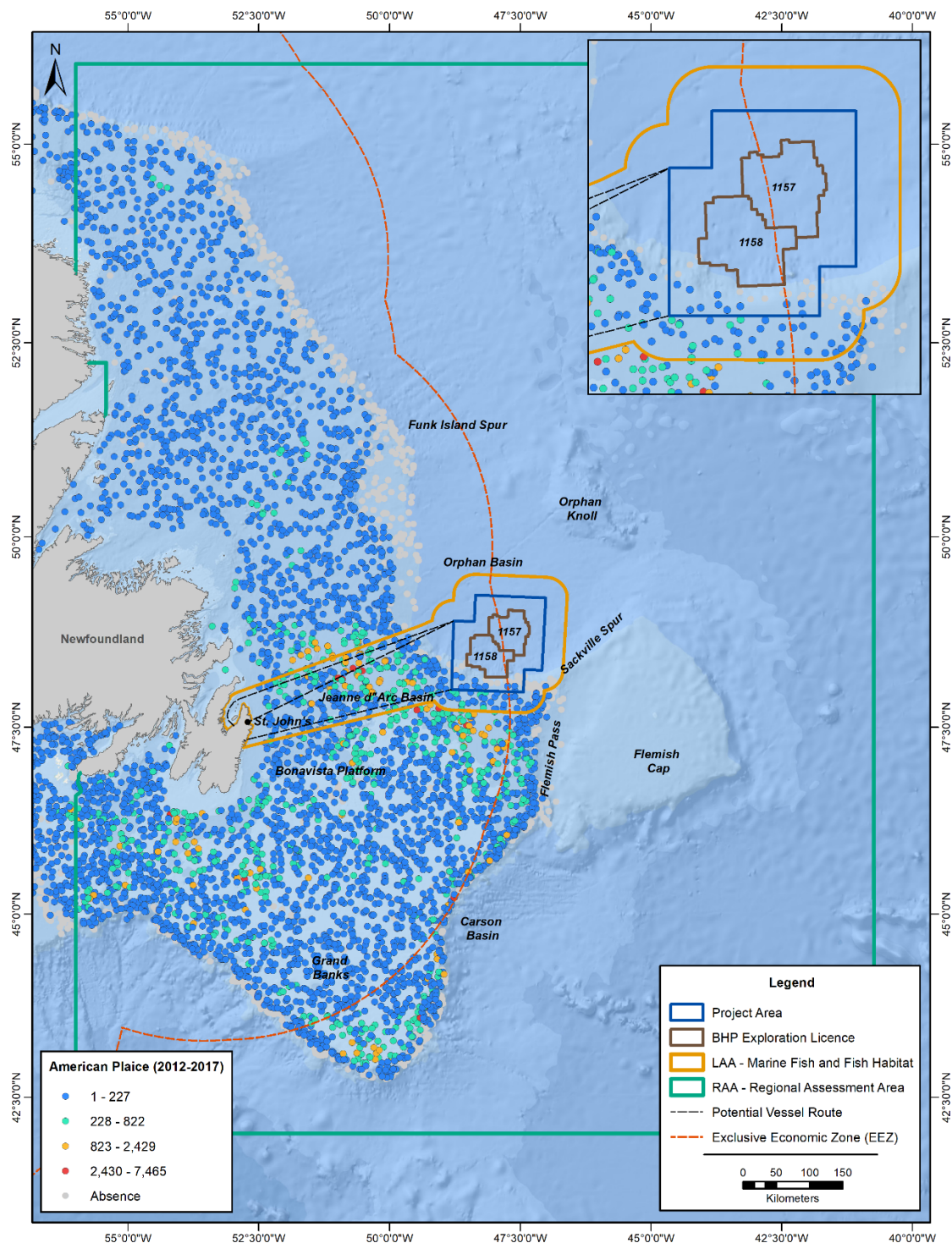


Figure 6-15 American Plaice Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



Blue Hake

Blue hake is a deep-sea, benthopelagic species present in all oceans except the North Pacific and Central Arctic (White et al. 2011). They have been caught at depths from 200 m to 3,277 m but prefer depths below 1,400 m and temperatures of 3°C to 5°C (Coad and Reist 2018). They are benthivores, feeding on chaetognaths, polychaetes, copepods, and amphipods (Parzanini et al. 2017). They are an important component of deep-sea assemblages, and one of the most abundant fishes from a depth of 1,300 m to 2,200 m (Kulka et al. 2003, Murua and De Cárdenas 2005). Larger blue hake live in deeper waters, though fish in Canadian waters have not been found with eggs and with few maturing gonads (Kulka et al. 2003). Though sometimes caught as by-catch, they are not utilized commercially as their flesh is described as soft and watery (Coad and Reist 2018).

Within the LAA, blue hake composed 1% of total catch by abundance in the upper slope (225 m to 700 m), and less than 1% by biomass, with none caught in the middle slope (701 m to 1,400 m). They were caught from 481 m to 632 m deep in Canadian RV trawls (Figure 6-16). OBIS has three records of blue hake between 1,400 m and 2,000 m deep within the LAA (OBIS 2019). Penney-Belbin and Christian (2013) conducted radial lines and baited stations and blue hake was one of the dominant fish species observed (alongside the abyssal grenadier). Though outside the LAA, Murua and De Cárdenas (2005) summarized findings from the deep-water long line survey in 1996 and found blue hake were the most abundant species from 1,500 m to 2,000 m and began increasing in abundance at the lower ends of the 800 m to 1,500 m stations. Snelgrove and Haedrich (1985) found similar results from a deep-water trawling survey near Carson Canyon, with blue hake dominant from 1,712 m to 2,335 m, and the third most abundant species from 200 m to 1,475 m. Blue hake is therefore likely present throughout the LAA, the deep portion of the potential PSV routes, and Project Area.

6.1.7.5 Migratory and Transient Species

Within the LAA, there are both resident and transient pelagic species that live or use the water column. Resident species, such as capelin and lanternfish, are present year-round while migratory species, such as tunas, swordfish, and several shark species, are typically present only during the warmer summer and fall months. While trawl data are not ideal for pelagic species, lanternfish and capelin are well-represented in RV survey data. For instance, lanternfish have daily migrations to feed in the upper water column but return to benthic habitats and are likely a key prey species in both areas (Dypvik et al. 2012). While capelin are the dominant planktivore on most of the Grand Banks, lanternfish appear to be dominant in deeper waters off Labrador (Coté et al. 2019).

Migratory non-resident species in the waters off Newfoundland tend to be large-bodied predators that travel from warm southern waters to feed in the north. Tracked blue shark and Atlantic bluefin tuna typically remain in the Gulf Stream, and so are unlikely to intersect with the Project Area as it is predominantly exposed to the Labrador Current (Walli et al. 2009; Vandeperre et al. 2014). The organization Ocearch has tracked white sharks on the Grand Banks and the Flemish Cap, though they prefer warmer waters and are unlikely to travel further north (Ocearch 2019). Swordfish are generally associated with thermal fronts (Dewar et al. 2011), which may be present south of the LAA where the Gulf Stream and Labrador current meet but are likely to be present in the LAA.



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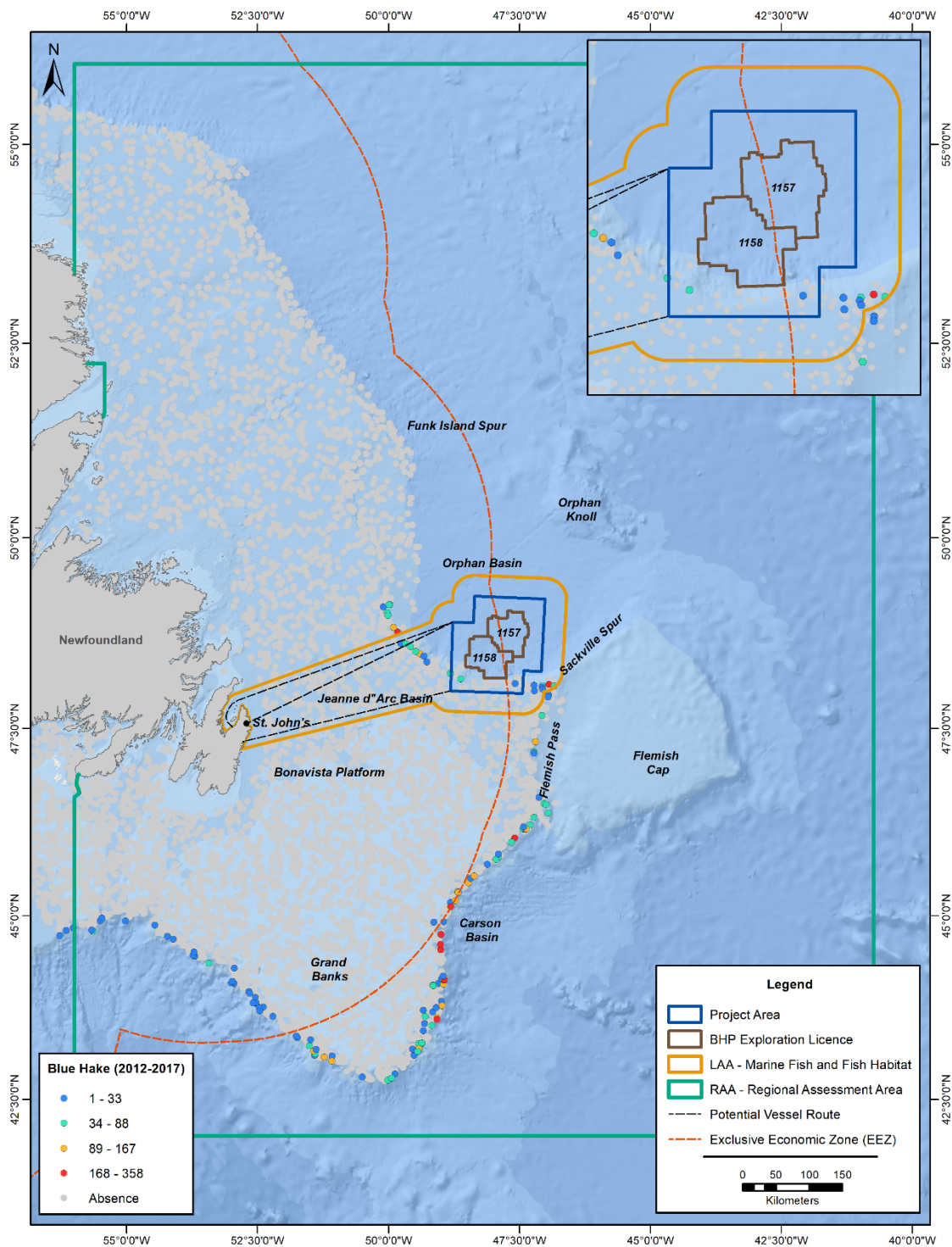


Figure 6-16 Blue Hake Distribution and Abundance per Tow Compiled from Canadian RV Trawl Survey Data (2012-2017)



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American eel and Atlantic salmon also are potential transient visitors to the waters of the Project Area. American eels are a catadromous species that migrate from their freshwater habitats to the Sargasso Sea to spawn. Pelagic eggs hatch into larvae that migrate up the coast of North America by drifting in currents and directional swimming (Rypina et al. 2016). Before reaching estuarine habitats; they metamorphose into glass eels, and eventually the juveniles will migrate into freshwater habitats (Rypina et al. 2016). American eels inhabit rivers further north than the Project Area but are likely to restrict their migrations to the shelf, and so their presence in the Project Area would be short term. As American eels are a SAR and of cultural importance, additional details are given in Section 6.1.9.

Atlantic salmon are mostly anadromous, living as adults in the marine environment and returning to freshwater to breed. Adults typically spend one to four years at sea before breeding, though some populations of Atlantic salmon do not migrate to sea and are typically referred to as Ouananiche (COSEWIC 2015). Distribution and movement at sea are complex and largely come from fisheries, trawl catches, and tagging studies (Reddin and Friedland 1993, Reddin 2006). Post-smolt Atlantic salmon from most of their range in North America are found in the Labrador Sea, where they feed and overwinter (Reddin and Friedland 1993). Atlantic salmon are not reported in the Canadian RV trawl data or OBIS records in the area, and so presence in the LAA would be migratory / transient in nature (OBIS 2019). As Atlantic salmon are of commercial, Indigenous and cultural importance, additional details are given in Section 6.1.9.2.

Small numbers of Atlantic herring are reported in the Canadian RV trawl catch data within the LAA but are of minor importance compared to demersal catches (AMEC 2014). Mackerel are not reported in trawl catches but may be present in small numbers. Additional details for these species and others (e.g. alewife) can be found in the Eastern Newfoundland SEA (AMEC 2014).

6.1.8 Species at Risk

Several fish species identified as at risk or of special conservation concern are known to occur, or likely to occur, in the LAA (Table 6.9). This includes species that are formally designated by the SARA or the NL ESA, or those identified as being of conservation concern by either COSEWIC or the IUCN. The categories of protection designation under SARA and the NL ESA are listed in Section 6.0.

The information presented here is current as of the time of writing, but species status can be updated at any time, and so it is important to refer to the public SARA registry (www.sararegistry.gc.ca) for the most current information.

The IUCN is a membership union composed of many organizations that provides environmental data and recommendations for species from a global perspective. They maintain a Red List of threatened species (<https://www.iucnredlist.org/>) and monitor global population trends and research and assigns the following designations: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct.

There are 30 species with conservation designations occurring in the western North Atlantic with potential to overlap with the RAA. Further species information is presented below based on current SAR designation, Indigenous importance, range overlap with the Project Area, or a combination of these reasons. The American eel is the only species listed under the NL ESA and is designated vulnerable. Four species are listed under SARA: Atlantic wolffish (Special Concern), northern wolffish (Threatened), spotted wolffish



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(Threatened), and white shark (Endangered). While the white shark is a rare migratory visitor to Atlantic Canadian waters, the three wolffish species have ranges that overlap with the LAA. In addition to the American eel, the Atlantic salmon are further described below due to their social, cultural, and traditional importance. Species that may occur in the Project Area are further described in Table 6.10. Additional details on these species can be found in the Eastern Newfoundland SEA (AMEC 2014). Within the RAA, the only species for which critical habitat has been proposed are the spotted and northern wolffish. Some portions of this critical habitat overlap with the southwestern portion of the LAA (see Section 6.1.8.1).

Table 6.9 Fish Species at Risk or of Conservation Concern with Potential to Occur within the LAA

Species		Status / Designation ^{A, B}				Relevant Population (Where Applicable)
Common Name	Scientific Name	NL ESA	SARA	COSEWIC	IUCN	
Acadian redfish	<i>Sebastes fasciatus</i>			T	E	Atlantic (COSEWIC); Global (IUCN)
Albacore tuna	<i>Thunnus alalunga</i>				NT	Global (IUCN)
American eel	<i>Anguilla rostrata</i>	V		T	E	Global (IUCN)
American plaice	<i>Hippoglossoides platessoides</i>			T		Newfoundland and Labrador (COSEWIC)
Atlantic bluefin tuna	<i>Thunnus thynnus</i>			E	E	Global (IUCN)
Atlantic cod	<i>Gadus morhua</i>			E	V	Newfoundland and Labrador (COSEWIC); Global (IUCN)
Atlantic halibut	<i>Hippoglossus hippoglossus</i>				E	Global (IUCN)
Atlantic salmon	<i>Salmo salar</i>			T		South Newfoundland
				SC		Quebec Eastern North Shore
				SC		Quebec Western North Shore
				E		Anticosti Island
				SC		Inner St. Lawrence
				SC		Gaspé-Southern Gulf of St. Lawrence
				E		Eastern Cape Breton
				E		Nova Scotia Southern Upland
				E		Outer Bay of Fundy Population
	LC		Global (IUCN)			
Atlantic wolffish	<i>Anarhichas lupus</i>		SC	SC		
Barndoor skate	<i>Dipturus laevis</i>				E	Global (IUCN)
Basking shark	<i>Cetorhinus maximus</i>			SC	V	Atlantic (COSEWIC); Global (IUCN)
Bigeye tuna	<i>Thunnus obesus</i>				V	Global (IUCN)
Blue shark	<i>Prionace glauca</i>				NT	Atlantic (COSEWIC); Global (IUCN)
Common Lumpfish	<i>Cyclopterus lumpus</i>			T		Atlantic (COSEWIC)
Cusk	<i>Brosme brosme</i>			E		



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Table 6.9 Fish Species at Risk or of Conservation Concern with Potential to Occur within the LAA

Species		Status / Designation ^{A, B}				Relevant Population (Where Applicable)
Common Name	Scientific Name	NL ESA	SARA	COSEWIC	IUCN	
Deepwater redfish	<i>Sebastes mentella</i>			T	LC	Northern (COSEWIC); Global (IUCN)
Greenland Shark	<i>Somniosus microcephalus</i>				NT	Global (IUCN)
Haddock	<i>Melanogrammus aeglefinus</i>				V	Global (IUCN)
Little skate	<i>Leucoraja erinacea</i>				NT	Global (IUCN)
Northern wolffish	<i>Anarhichas denticulatus</i>		T	T		
Porbeagle	<i>Lamna nasus</i>			E	V	Global (IUCN)
Roundnose grenadier	<i>Coryphaenoides rupestris</i>			E	CE	Atlantic and Arctic (COSEWIC); Global (IUCN)
Shortfin mako	<i>Isurus oxyrinchus</i>			E	V	Atlantic (COSEWIC); Global (IUCN)
Smooth skate	<i>Malacoraja senta</i>			E	E	Funk Island Deep (COSEWIC); Global (IUCN)
Spiny dogfish	<i>Squalus acanthias</i>			SC	V	Atlantic (COSEWIC); Global (IUCN)
Spinytail skate	<i>Bathyraja spinicauda</i>				NT	Global (IUCN)
Spotted wolffish	<i>Anarhichas minor</i>		T	T		
Thorny skate	<i>Amblyraja radiata</i>			SC	V	Canada (COSEWIC); Global (IUCN)
White hake	<i>Urophycis tenuis</i>			T		Atlantic and Northern Gulf of St. Lawrence (COSEWIC)
White shark	<i>Carcharodon carcharias</i>		E	E	V	Atlantic (COSEWIC/SARA); Global (IUCN)
Winter Skate	<i>Leucoraja ocellata</i>			E	E	Eastern Scotian Shelf – Newfoundland (COSEWIC); Global (IUCN)

^A Least Concern (LC), Vulnerable (V), Near Threatened (NT), Special Concern (SC), Threatened (T), Endangered (E), Critically Endangered (CE)
^B Multiple designations refer to multiple populations or sub-populations.
 Data Sources: SARA/COSEWIC (www.sararegistry.gc.ca), IUCN (<https://www.iucnredlist.org/>), NL ESA (<https://www.flr.gov.nl.ca/wildlife/endangeredspecies/index.html>).



Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Acadian redfish	<ul style="list-style-type: none"> • Year-round resident within potential PSV routes and LAA • Primarily along continental slopes and in deep channels, from 150 m to 300 m • Larvae prefer surface waters, where they feed on copepods and fish eggs • Slow growth and long lifespan; they can live up to 75 years • Ovoviviparous, females keep their fertilized eggs inside their brood chamber until the larvae have hatched • Larvae are released between the end of spring to early summer 	COSEWIC 2010a
Albacore tuna	<ul style="list-style-type: none"> • Pelagic, oceanic species found world-wide (migratory / transient within potential PSV routes and LAA) • Can form mixed schools with other tuna species, and can associate with floating objects (e.g., Sargassum weed) • Spawning occurs in warm (24 °C) waters • Can tolerate waters as cold as 9.5 °C but prefer temperatures above 13.5 °C • Important commercial species world-wide and in the North Atlantic 	Collette et al. 2011a
American eel	<ul style="list-style-type: none"> • Found on the western side of the Atlantic Ocean from the Caribbean Sea north to Greenland and Iceland (migrates through potential PSV routes and LAA) • Spawns in the Sargasso Sea and eggs hatch within roughly one week • Larvae drift passively, and are widely dispersed by surface currents of the Gulf Stream • Larvae, elvers or mature adults may pass through the LAA during migrations to or from spawning areas • Culturally significant to Indigenous peoples • See Section 6.1.9.1 for more details 	Jacoby et al. 2017
American plaice	<ul style="list-style-type: none"> • Benthic flatfish that occurs along the continental shelves on both sides of the North Atlantic • Settled juveniles prefer depths of 100-200 m • Adults typically prefer depths of 100-300 m, but have been found as deep as 1,400 m • Likely present within the potential PSV routes, LAA, and Project Area • Spawning occurs on the Newfoundland Shelf in April or May • Commercially important 	COSEWIC 2009b
Atlantic bluefin tuna	<ul style="list-style-type: none"> • Two discrete and evolutionarily significant populations, Gulf of Mexico (western population) and Mediterranean Sea (eastern population) • Majority of the fish found in Canadian waters are thought to be from the western population • Specific habitat requirements have not been defined for Atlantic bluefin tuna • No spawning or rearing occurs within Canadian waters • Majority of fishery captures are in Gulf of St. Lawrence and off Nova Scotia • Likely migratory / transient within potential PSV routes and LAA 	COSEWIC 2011a



Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Atlantic cod	<ul style="list-style-type: none"> • Atlantic cod inhabit waters overlying the continental shelves of the Northwest and the Northeast Atlantic Ocean • Occurs in offshore waters (typically at depths less than 500 m), can also be found throughout the coastal, inshore waters • Likely present in shallow portions of the potential PSV routes and LAA, though may be present pelagically in deeper waters • Broadcast spawner • Known to spawn extensively throughout the inshore, nearshore, and offshore waters from April to October • Northeast Newfoundland Shelf cod migrate from offshore waters to inshore coastal waters in spring and may spawn inshore • Eggs, and then larvae, present in the upper water column (10 m to 50 m) • Mature slower in Newfoundland Shelf, eastern Labrador and Barents Sea; mature later than more southern populations • Commercial species harvested by several countries 	COSEWIC 2010b
Atlantic halibut	<ul style="list-style-type: none"> • Eggs and larvae are pelagic, while the juveniles move to deeper waters • Distribution of pelagic Atlantic halibut larvae is mostly between 5 m and 50 m • Juveniles and adults are closely associated with the seabed. Typically found at depths of 100 m to 700 m, though may be present at depths up to 1,000 m • May be present within LAA, likely present in the potential PSV routes • Commercially important 	Sobel 1996a, COSEWIC 2011b
Atlantic salmon	<ul style="list-style-type: none"> • Atlantic salmon originally occurred in every country whose rivers flow into the North Atlantic Ocean and Baltic Sea • Canadian range is roughly one-third the area of the total global range • Life history begins in freshwater and may involve extensive migrations through freshwater and marine environments before returning to fresh water to spawn • Growth in ocean is rapid relative to that in fresh water • In spring, adult salmon are generally concentrated in abundance off the eastern slope of the Grand Bank and less abundantly in the southern Labrador Sea and over the Grand Bank • During summer to early fall, adult, non-maturing salmon are concentrated in the West Greenland area and less abundantly in the northern Labrador Sea (may migrate or feed within the potential PSV routes and LAA) • Culturally significant to Indigenous peoples 	COSEWIC 2015
Atlantic wolffish	<ul style="list-style-type: none"> • The species is widely distributed across the North Atlantic • The centre of its western Atlantic distribution is off the coast of northeast Newfoundland • Inhabits the cold (1.5 °C to 4 °C), deep (up to 900 m) waters of the continental shelf • Likely present within the potential PSV routes and LAA but unlikely to be within Project Area • Spawn in September, larvae are pelagic while adult Atlantic wolffish are relatively sedentary • Atlantic wolffish can conduct seasonal migrations between offshore waters and shallow waters (<120 m deep) for spawning 	COSEWIC 2013a



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Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Barndoor skate	<ul style="list-style-type: none"> • Found from Cape Hatteras (North Carolina) to the Grand Banks of Newfoundland • Most commonly found on Georges Bank and the western Scotian Shelf in Canada • Prefer 3 °C to 11 °C water • Typically caught from 38 m to 351 m with the deepest confirmed catch at 1174 m • May be present in potential PSV routes and LAA, but would be at the edge of its range • Migration and spawning not well understood, generation time estimated to be 13 years 	COSEWIC 2011c
Basking shark	<ul style="list-style-type: none"> • Circumglobal, temperate, migratory pelagic species • Have been observed throughout Atlantic waters including the Gulf of St. Lawrence, Bay of Fundy, Scotian Shelf and Grand Banks, generally during the summer months. • Encountered at the surface during summer months in the potential PSV routes and LAA (migratory / transient species) • May target areas of high zooplankton concentrations • Speculated individuals hibernated in deep shelf or slope waters during the winter • Annual southern migration associated with a change in seasons from late summer to winter 	COSEWIC 2010c
Bigeye tuna	<ul style="list-style-type: none"> • Migratory, pelagic oceanic species that is found in 13 to 29 °C water • Mostly found in depths shallower than 500 m but can dive deeper • Potentially occur in the potential PSV routes and LAA generally during warm water seasons (migratory / transient species) • Commercially important 	Collette et al. 2011b
Blue shark	<ul style="list-style-type: none"> • Distributed worldwide in temperate and tropical oceans, primarily in surface waters and offshore • Range in Canada includes Gulf Stream-associated waters off Nova Scotia and Newfoundland • Found at depths from surface to at least 600 m depth • Prefers temperatures of 12 to 20 °C, potentially only occurs in the potential PSV routes and LAA during summer (migratory / transient species) 	COSEWIC 2006a
Common Lumpfish	<ul style="list-style-type: none"> • Distribution ranges from southwest Greenland and Baffin Island, along the coasts of Newfoundland and Labrador, the Flemish Cap, down to the Gulf of St. Lawrence, Nova Scotia, and New Brunswick. • Occur in waters ranging from less than 20 m to over 300 m • Tolerate low salinity waters • Females lay on average approximately 100,000 eggs per spawning season • Spawning occurs in nearshore and inshore areas • Likely present within the potential PSV routes, unlikely to be present within the LAA or Project Area 	COSEWIC 2019



Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Cusk	<ul style="list-style-type: none"> • Northern species found in the Subarctic and boreal shelf waters of the North Atlantic Ocean • Temperate species typically found at depths of 150 m to 400 m with relatively warm water temperatures of 6 to 10 °C, occasionally found at depths up to 1185 m. • Slow moving, sessile species that does not undergo extensive local movements, seasonal, or spawning migrations • Spawning occurs over banks during spring/summer • Unlikely to be present within the potential PSV routes, LAA, or Project Area 	COSEWIC 2013b
Deepwater redfish	<ul style="list-style-type: none"> • Generally, live at depths from 350 m to 500 m • Likely present within the potential PSV routes, LAA, and Project Area • Larvae prefer surface waters, where they feed on copepods and fish eggs • Slow growth and long lifespan; they can live up to 75 years • Ovoviviparous, females keep their fertilized eggs inside their brood chamber until the larvae have hatched • Larvae are released between the end of spring to early summer 	COSEWIC 2010a
Greenland Shark	<ul style="list-style-type: none"> • Restricted to the North Atlantic and Arctic • Typically found from 0 m to 1,200 m, but observed as deep as 2,200 m • Likely present throughout the potential PSV routes, LAA, and Project Area • Has been recorded in 0.6 °C to 12 °C water • Very little is known of their reproduction, one report found 10 young in a female • Limited fisheries exist for this species outside Canada and they are occasionally caught as by-catch in other fisheries (e.g. Greenland halibut) 	Kyne et al. 2006
Haddock	<ul style="list-style-type: none"> • Found in the northwest and northeast Atlantic • Commonly seen from 80 m to 200 m deep • Prefer temperatures between 4 and 10 °C • Eggs are pelagic and young remain in the water column until approximately 50 mm in length • Important commercial species • Unlikely to be present in LAA or Project Area, may be present in the potential PSV routes 	Scott and Scott 1988, Sobel 1996b
Northern wolffish	<ul style="list-style-type: none"> • The Northern wolffish inhabits boreal and sub-Arctic waters on both sides of the North Atlantic and in the Arctic • It is most abundant on the shelf off northeastern Newfoundland and in the Labrador Sea with highest densities at temperatures between 2 and 5 °C • Found between 38 m and 1504 m, but mainly between 500 m and 1,000 m • Likely present within the potential PSV routes, LAA, and Project Area • Spawns September through November • Larvae and young of the year are pelagic • Project Area overlaps with recently proposed critical habitat. This is further discussed in Section 6.1.8.1. 	COSEWIC 2013c



Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Porbeagle	<ul style="list-style-type: none"> • Coastal and oceanic shark that lives in cold to temperate waters • Juveniles most common and continental shelves but can occur well offshore • Most can be found at temperatures ranging from 5 °C to 10 °C • Mating occurs in the northwest Atlantic occurs in the Grand Banks, south of Newfoundland and at the mouth of the Gulf of St. Lawrence • Females give birth to live young outside Canadian waters • Rarely found between January and June in the RAA • Potentially only occurs in the potential PSV routes and LAA during warm water season (migratory / transient species) 	COSEWIC 2014a
Roundnose grenadier	<ul style="list-style-type: none"> • Globally found along the continental slope and mid-Atlantic ridge of the North Atlantic Ocean • In Canadian waters, it is most abundant in the northern part of the range (Labrador and Northeast Newfoundland shelves, Davis Strait) • Its range extends beyond the 200-mile limit • Has been reported at depths between 200 m and 2600 m, most abundant at depths greater than 800 m and 1000 m • Likely present within the potential PSV routes, LAA, and Project Area • Spawning may occur along the northern Mid-Atlantic Ridge, developing eggs and larvae are transported by currents and the young settle on the continental slopes off Baffin Island, Labrador and eastern Newfoundland 	COSEWIC 2009a
Shortfin mako	<ul style="list-style-type: none"> • Circumglobally distributed in temperate and tropical waters • Canadian waters represent the northern fringe of the Shortfin Mako range • Preferred water temperature is between 17-22 °C usually associated with the Gulf Stream • Appears as if females migrate to latitudes of 20 to 30 °N to give birth • Migratory / transient within potential PSV routes and LAA 	COSEWIC 2018
Smooth skate	<ul style="list-style-type: none"> • Captures in Canadian RV surveys of the LAA were restricted to depths less than 500 m • May be present in the potential PSV routes • Resident species but not numerically dominant in Canadian or NAFO waters in the LAA • Lays 40 to 100 large egg capsules per year • Not commercially important in the region 	COSEWIC 2013d
Spiny dogfish	<ul style="list-style-type: none"> • Occurs world-wide on the continental shelf in temperate and boreal waters • Northwest Atlantic's highest abundance is between Nova Scotia and Cape Hatteras (North Carolina) • Range from the intertidal to 730 m depth • Wide salinity tolerance and prefers 5°C to 15°C water • Internal fertilization, after 18 to 24 months gestation females give birth to an average of 6 pups • Commercial catches around Nova Scotia and the Bay of Fundy average 2,500 mt annually • May be present within the potential PSV routes and LAA but represents northern edge of their range 	COSEWIC 2010d



Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Spinytail skate	<ul style="list-style-type: none"> • Found throughout the North Atlantic and Arctic • Primarily a deep-water species, occurs from 140 m to 1,650 m but are likely deeper as well • Recorded in temperatures <7.5 °C • Spawning observed off Greenland in June and July, but very little is known of their spawning behavior • Minor by-catch species in deep-water fisheries • Likely present throughout the potential PSV routes, LAA, and Project Area 	Kulka et al. 2009
Spotted wolffish	<ul style="list-style-type: none"> • Found on both sides of the North Atlantic and in the Arctic • Eggs are deposited on the bottom, the larvae are pelagic, and the juveniles and adults occupy bottom waters • Typically occupy depths between 200 and 750 m on the continental shelf or in deep trenches • Likely present within the potential PSV routes and LAA and unlikely within the Project Area • Fertilization is internal and mating probably occurs in the summer • DFO recently proposed critical habitat for spotted wolffish, which is located within the RAA and further discussed in Section 6.1.8.1 	COSEWIC 2013e
Thorny skate	<ul style="list-style-type: none"> • Globally found on both sides of the North Atlantic • Distributed continuously from Baffin Bay, Davis Strait, Labrador Shelf, Grand Banks, Gulf of St. Lawrence, Scotian Shelf and Bay of Fundy to Georges Bank, over a wide range of depths. • Inhabit a wide range of depths (primarily 18 m to 1200 m) and typically in water temperatures of 0 °C to 10 °C • Likely within the potential PSV routes, LAA and, Project Area • Spawning appears to occur in the fall and winter • Egg cases are often deposit deposited on sandy or muddy flats 	COSEWIC 2013f
White hake	<ul style="list-style-type: none"> • Main distribution is from North Carolina to the Grand Banks • Benthic species preferring mud substrate and 4°C to 8°C water • Unlikely to be present in the potential PSV routes, LAA, or Project Area • Lay buoyant eggs that spend 2 to 3 months in the upper water layer before settling • Spawn in the spring/summer, with two spawning periods in some areas • No directed fishery, but commonly caught as by-catch 	COSEWIC 2014b
White shark	<ul style="list-style-type: none"> • Circumglobally distributed in sub-polar to tropical seas of both hemispheres • Has been recorded from the Northeast Newfoundland Shelf to the Bay of Fundy • Canadian waters represent the northern fringe of the white shark's range (migratory / transient within the potential PSV routes and LAA) • Depth from just below the surface to just above the bottom, down to a depth of at least 1,200 m • Recorded in water temperatures from 5 to 27°C, preferred temperature's above 11°C • Possible white shark pupping areas in the Atlantic Ocean include the Mid-Atlantic Bight 	COSEWIC 2006b



Table 6.10 Summary of the Distribution, Habitat, and Ecology of Species at Risk

Species	Distribution, Habitat, Ecology	Data Source
Winter Skate	<ul style="list-style-type: none"> • Globally restricted to the northwest Atlantic • Found from southern Newfoundland to the Canada/ United States border • >90% of individuals are caught in less than 150 m of water, may occur as deep as 400 m • Unlikely to be present within LAA, as it represents the northern edge of their range, but likely present within the potential PSV routes • Found over sandy or gravelly bottoms • Eggs deposited throughout the year in its southern range, eggs deposited in late summer to fall off Newfoundland 	COSEWIC 2017

6.1.8.1 Wolffish (Atlantic, Spotted, Northern)

Atlantic (or striped) wolffish is designated as Special Concern, and the northern and spotted wolffish are Threatened under both COSEWIC and SARA (Schedule 1). These species are long-lived and slow-growing, and as such they are vulnerable to stressors. In Canadian waters, populations declined for the three species prior to the mid-1990’s, where a small upward trend began (COSEWIC 2013a, 2013c, 2013e). Principal threats for wolffish are commercial by-catch and habitat alteration or destruction. As part of the Recovery Strategy and Management Plans for the spotted and northern wolffish, critical habitat has been identified along the northeast shelf and slopes of the Grand Banks, which overlaps with the southwestern portion of the LAA (overlap of 8,551 km² and 3,659 km², respectively) (Figures 6-17 and 6-18). These identified critical habitats were proposed based on known depth and sea bottom temperatures for these species, and so while the entire area may not represent used habitat areas, they do represent areas containing features that allow for the recovery and survival of these species based on current information (DFO 2018c). No critical habitat is set out for the Atlantic wolffish, as it is not a requirement for Special Concern designation. Additional details on their biology can be found in Table 6.10.

The three wolffish species are found in RV trawls on the shelf and slope of the Grand Banks of Newfoundland. Areas of high abundance for the wolffish species occur on the slopes of the Grand Bank. The Atlantic wolffish has the highest aggregations in these slope areas, though they are also distributed in lower numbers throughout the shelf. Spotted wolffish mainly occur below 600 m depth along the shelf of the Grand Banks and Flemish Pass (Figure 6-17). Northern wolffish in RV data had the highest abundance between 250 m to 600 m along the northeast slope and NL shelf areas (Figure 6-18).



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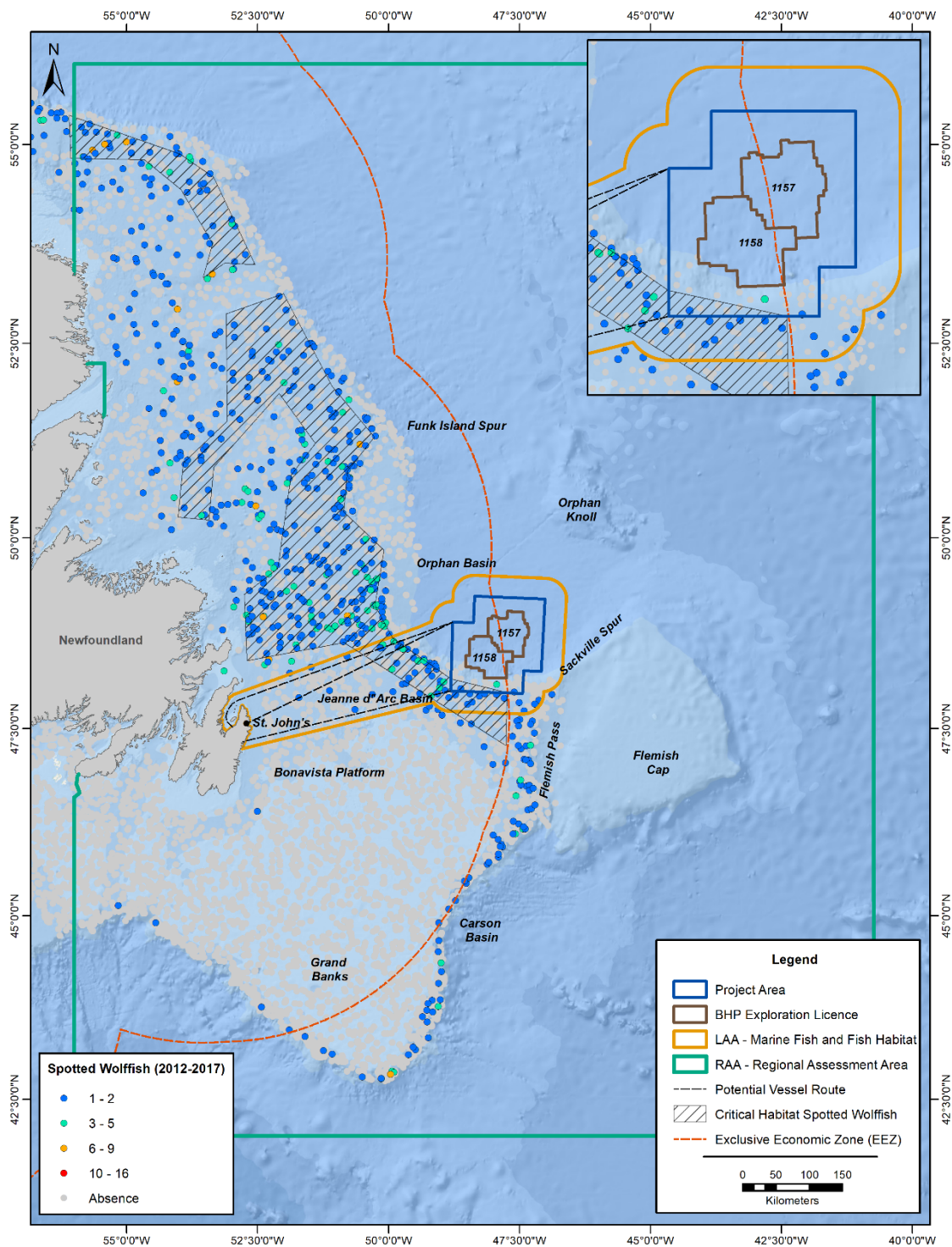


Figure 6-17 Spotted Wolffish Distribution and Abundance Compiled from Canadian RV Trawl Survey Data (2012-2017) with Proposed Critical Habitat



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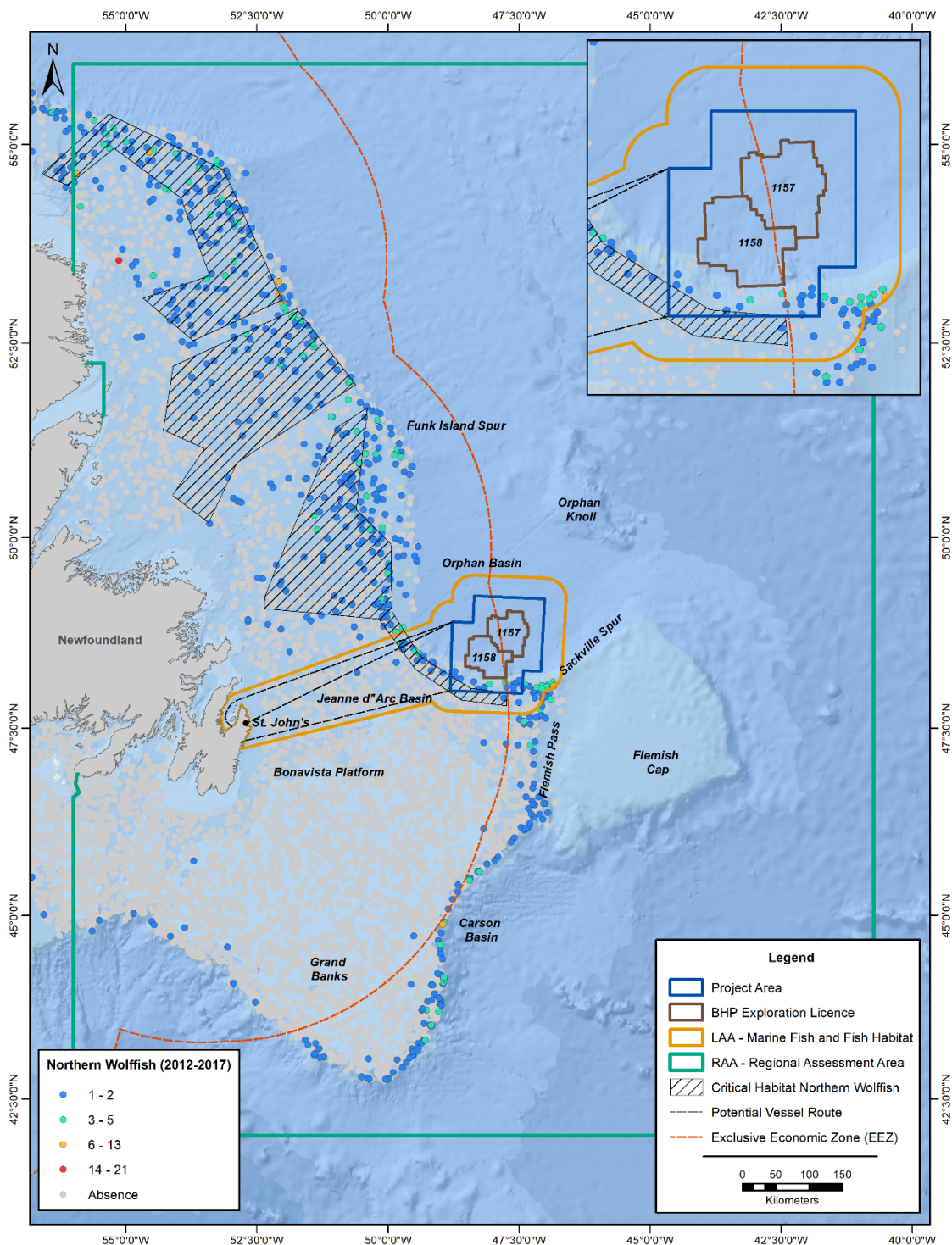


Figure 6-18 Northern Wolffish Distribution and Abundance Compiled from Canadian RV Trawl Survey Data (2012-2017) with Proposed Critical Habitat



6.1.8.2 White Shark

The white shark is listed as Endangered by COSEWIC and SARA (Schedule 1). They are uncommon visitors to Canadian waters, with low abundances compared to more southerly regions (COSEWIC 2006b). Though not targeted by the Canadian fishery, they are threatened by fisheries due to by-catch. No critical habitat has been established in Canada for this species (COSEWIC 2006b). Additional details on white shark biology can be found in Table 6.10.

White sharks have been observed in the western Atlantic from the Grand Banks to the Gulf of Mexico but are primarily found along the east coast of the United States (COSEWIC 2006b). They migrate seasonally to the southeastern US in the winter months and travel further north in the spring and summer (Curtis et al. 2014). Ocearch (2019) has tagged several white sharks with satellite tags, and every year individual sharks travel to the Grand Banks and the Flemish Cap, though typically not further north and not inside the potential PSV routes or LAA (Figure 6-19).

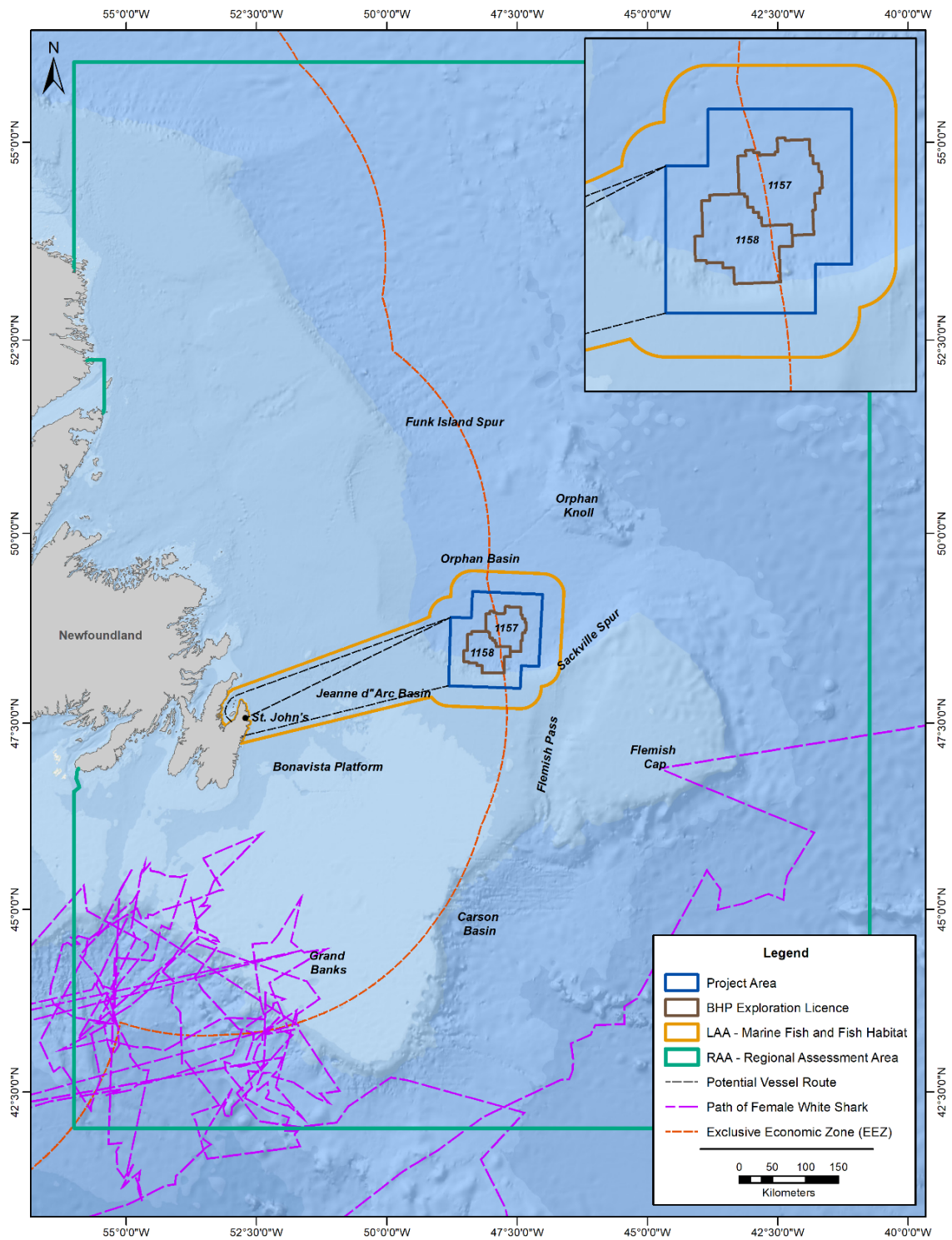
6.1.9 Species of Indigenous Importance

The waters off Newfoundland and Labrador contain a variety of species commercially harvested or used for food, social, or ceremonial (FSC) purposes by Indigenous groups. Commercial communal licences have been issued within the RAA for capelin, groundfish, herring, mackerel, seal, shrimp, snow crab, tuna, and whelk. These fishing activities are covered further in Section 7.4. Species harvested for FSC include alewife (gaspereau), trout, Atlantic salmon, bass, American eel, shad, Arctic charr, blue shark, American lobster, and many others. Many species are harvested in freshwater, estuarine, or intertidal areas and are not present within the LAA, though they may be present in the potential PSV routes. However, two migratory fish species in particular, the American eel and the Atlantic salmon, have been highlighted during Indigenous engagement as being of concern. These species are catadromous and anadromous, respectively, and may migrate through the potential PSV routes and LAA. The American eel has been identified as key to Aboriginal right-based, Treaty rights-based, and commercial fisheries, particularly to the Mi'kmaq peoples (Denny and Kavanagh 2018). Atlantic salmon have traditionally been a staple food for Indigenous peoples, although today, due to a lack of abundance and concern for local populations, it is often reserved for special occasions (Denny and Fanning 2016). These species, including their potential for occurrence in the potential PSV routes, LAA, and RAA, are described in Sections 6.1.9.1 and 6.1.9.2. Further discussion on these species, with more focus on significance to FSC fisheries can be found in Section 7.4.



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Source: Ocearch 2019

Figure 6-19 Tracked Movements of a Female White Shark in the North Atlantic

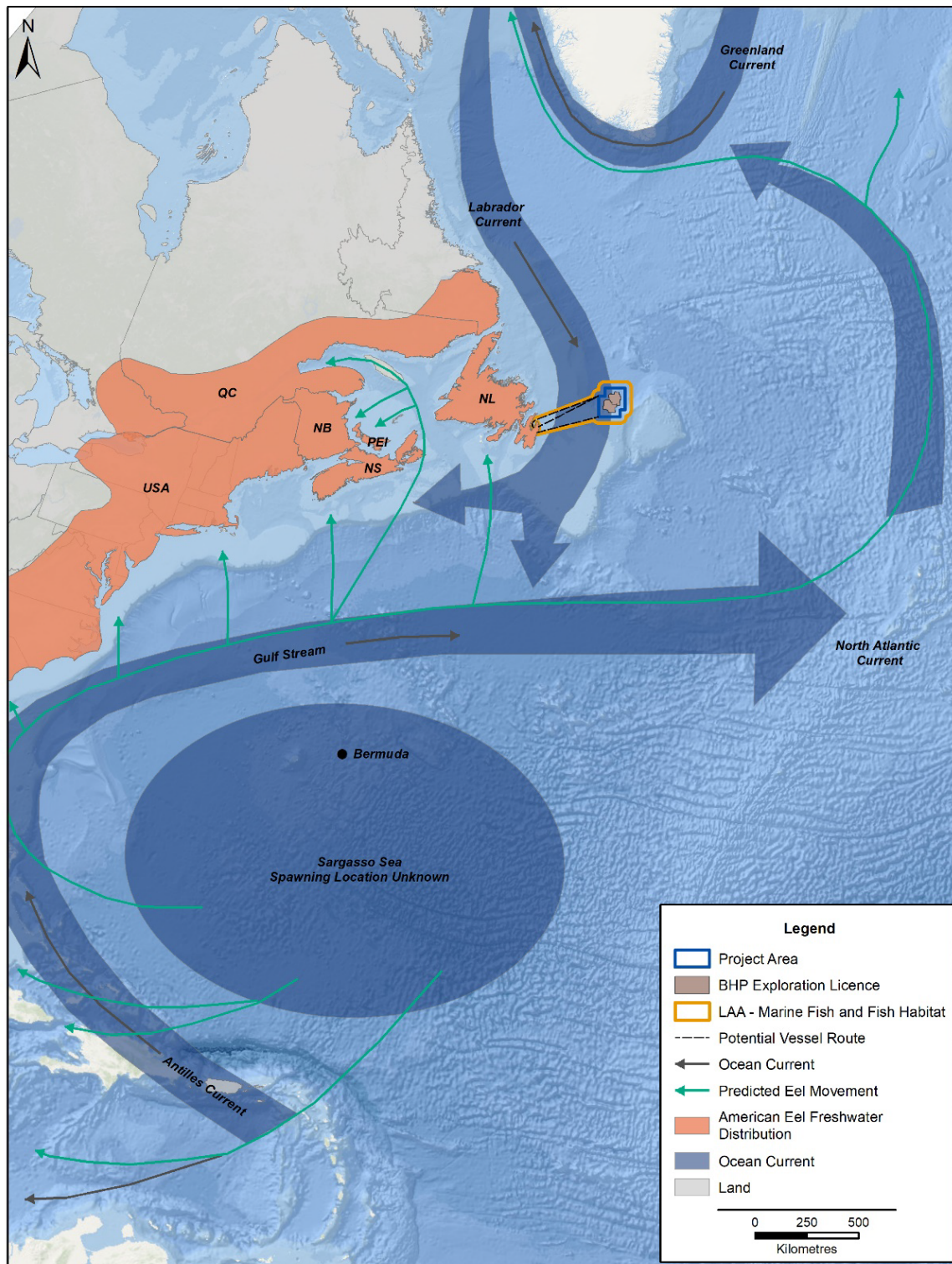


6.1.9.1 American Eel

The American eel is a catadromous species, spawning at sea and living primarily in freshwater or estuarine environments. They are found along the Western Atlantic from the Caribbean Sea to Iceland; however, they form a single breeding population as they return to the Sargasso Sea to spawn (COSEWIC 2012). The American eel is listed as Vulnerable under the NL ESA and Threatened by COSEWIC. Populations across Canada have declined since the 1950's, with the greatest decline for the Lake Ontario and St. Lawrence River fish (COSEWIC 2012). Threats are varied, and include barriers to migration and mortality from turbines, fisheries take, bioaccumulation of contaminants, parasites, and changing environmental conditions (COSEWIC 2012; Cairns et al. 2014). Additional details on American eel biology are provided in Table 6.10.

Spawning migrations for American eels in Canada occur in the fall, where eels leave freshwater and begin to travel to the Sargasso Sea (COSEWIC 2012). Eels will travel along the continental shelf before cutting across deeper waters to reach the Sargasso Sea (Béguer-Pon et al. 2015). Spawning takes place from February to April, after which adult eels will die (Cairns et al. 2014; Rypina et al. 2016). After hatching, the larvae will drift north along the Gulf Stream and eventually metamorphose into glass eels (COSEWIC 2012) (Figure 6-20). Glass eels gain pigmentation before reaching estuarine or freshwater environments and are then known as yellow eels, the stage in which sexual differentiation occurs (Rypina et al. 2016). When they are ready to migrate to breed again, they are known as silver eels, though this generation time can vary from 9 to 22 years depending on habitat (COSEWIC 2012, Westerberg et al. 2017).





Source: DFO 2016c

Figure 6-20 Predicted Larval Migratory Path of American Eel from the Sargasso Sea



6.1.9.2 Atlantic Salmon

Information presented here is drawn from Statoil Canada Ltd. (2017) and Nexen (2018).

North American Atlantic salmon breed and spend the early part of their life cycle in freshwater systems throughout Atlantic Canada, eastern Québec, and the northeastern seaboard of the United States (Figure 6-21). The genetic structure and life history traits of Atlantic salmon tend to vary among river populations. This variation among salmon rivers tends to increase with geographic distance. As a result, DFO manages groups of salmon rivers as metapopulations, called Designatable Units (DUs), based on geography and unique genetic and life history traits (COSEWIC 2010e).



Source: DFO 2017b

Figure 6-21 Inland Range of Atlantic Salmon in Canada

DFO manages Atlantic salmon populations under 16 DUs (Table 6.11; Figure 6-22). Among these DUs, COSEWIC has identified five as Endangered (Outer Bay of Fundy, Inner Bay of Fundy, Southern Uplands, Eastern Cape Breton, and Anticosti Island metapopulations; Table 6.11). These Atlantic salmon populations, except the Inner Bay of Fundy population, have the potential to occur in the Project Area, although most likely as a transient presence during migration or feeding at the southern extent of the Labrador Sea when conditions are favorable. The Lake Ontario metapopulation is considered Extinct.



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Table 6.11 Federal Conservation Status of Canada’s Atlantic Salmon Designatable Units (DUs)

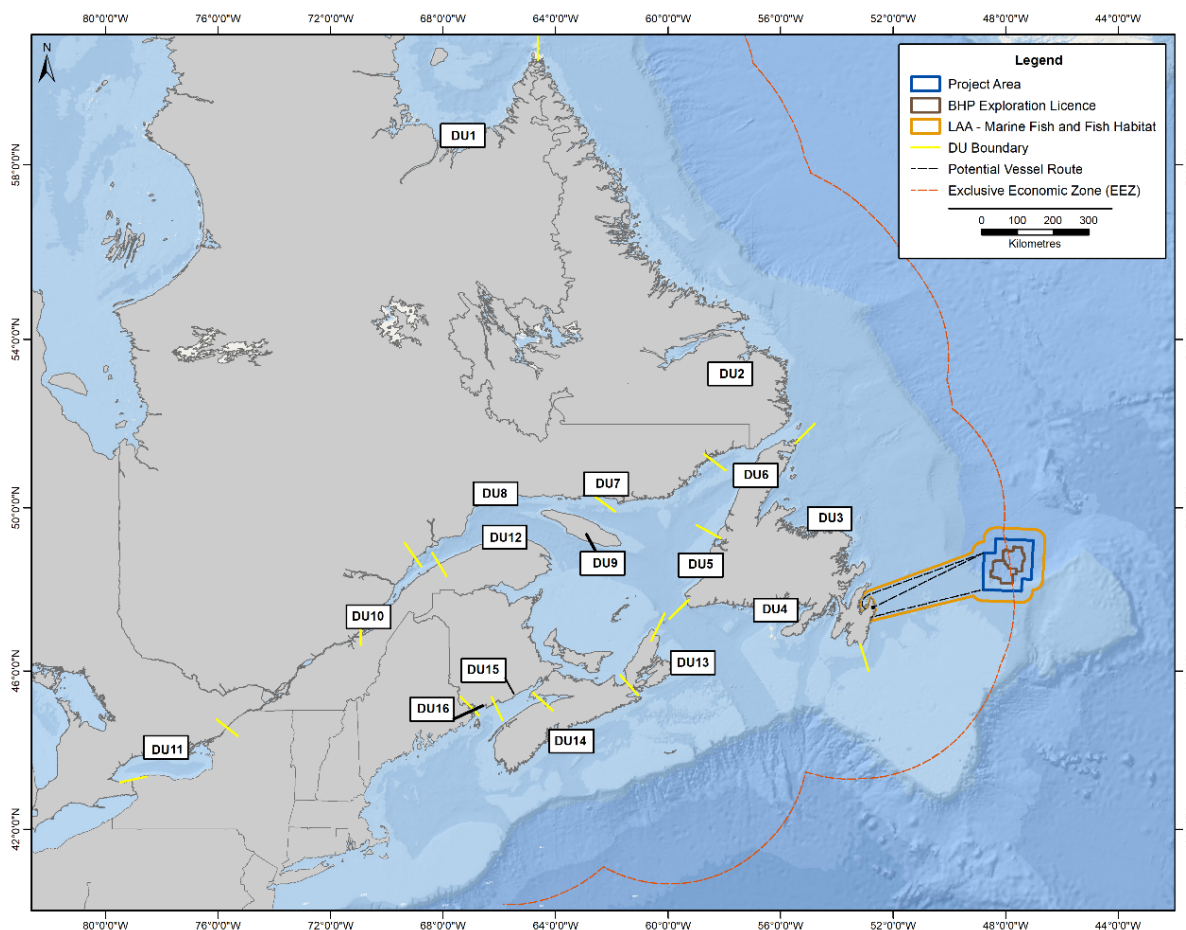
Region	Metapopulation	Metapopulation Name	Range	COSEWIC	SARA Status
Nunavik and Labrador	1	Nunavik	Quebec, Atlantic Ocean	Data Deficient	No Status
	2	Labrador	Labrador, Atlantic Ocean	Not at Risk	No Status
Insular Newfoundland	3	Northeast Newfoundland	Newfoundland, Atlantic Ocean	Not at Risk	No Status
	4	South Newfoundland	Newfoundland, Atlantic Ocean	Threatened	No Status
	5	Southwest Newfoundland	Newfoundland, Atlantic Ocean	Threatened	No Status
	6	Northwest Newfoundland	Newfoundland, Atlantic Ocean	Not at Risk	No Status
Gulf of St. Lawrence	7	Quebec Eastern North Shore	Quebec, Atlantic Ocean	Special Concern	No Status
	8	Quebec Western North Shore	Quebec, Atlantic Ocean	Special Concern	No Status
	9	Anticosti Island	Quebec, Atlantic Ocean	Endangered	No Status
	10	Inner St. Lawrence	Quebec, Atlantic Ocean	Special Concern	No Status
	11	Lake Ontario	NA	Extinct	No Status
	12	Gaspé-Southern St. Lawrence	Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Atlantic Ocean	Special Concern	No Status
Eastern – Southern Nova Scotia and Outer Bay of Fundy	13	Eastern Cape Breton	Nova Scotia, Atlantic Ocean	Endangered	No Status
	14	Southern Uplands	Nova Scotia, Atlantic Ocean	Endangered	No Status
	16	Outer Bay of Fundy	New Brunswick, Nova Scotia, Atlantic Ocean	Endangered	No Status
Inner Bay of Fundy	15	Inner Bay of Fundy	New Brunswick, Nova Scotia, Atlantic Ocean	Endangered	Schedule 1; Endangered

Source: DFO 2017b



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Source: Reproduced from COSEWIC 2010e

Figure 6-22 Designatable Units (DU) for Atlantic Salmon in Eastern Canada

The Inner Bay of Fundy metapopulation is the only Atlantic salmon DU with legal protection as a listed species (Endangered) on Schedule 1 of SARA. Consultation documents were distributed for inclusion of the Outer Bay of Fundy (DFO 2011a), Southern Uplands (DFO 2011b), Anticosti Island (DFO 2013) and Eastern Cape Breton (DFO 2011c) DUs in Schedule 1 of SARA. DFO is in the process of developing SARA listing recommendations to include Outer Bay of Fundy, Southern Uplands, and Eastern Cape Breton DUs (DFO 2016a).

Atlantic salmon occur in approximately 2,500 rivers flowing into the North Atlantic Ocean and despite extensive research on the freshwater portion of their life history, less is known about their life history once they leave their natal rivers and undertake migrations in the North Atlantic Ocean (Spares et al. 2007; COSEWIC 2010e; Lefevre et al. 2012; Windsor et al. 2012; Soto et al. 2018). Anadromous Atlantic salmon typically leave their natal rivers during May / June as smolt where they spend from one to four years in the marine environment before returning to spawn as adults (Gardner 1976; COSEWIC 2010e). During their first winter at sea, young salmon are called post-smolt; after their first winter they are called adult salmon regardless of the number of subsequent winters at sea before returning to their home river. Adults returning



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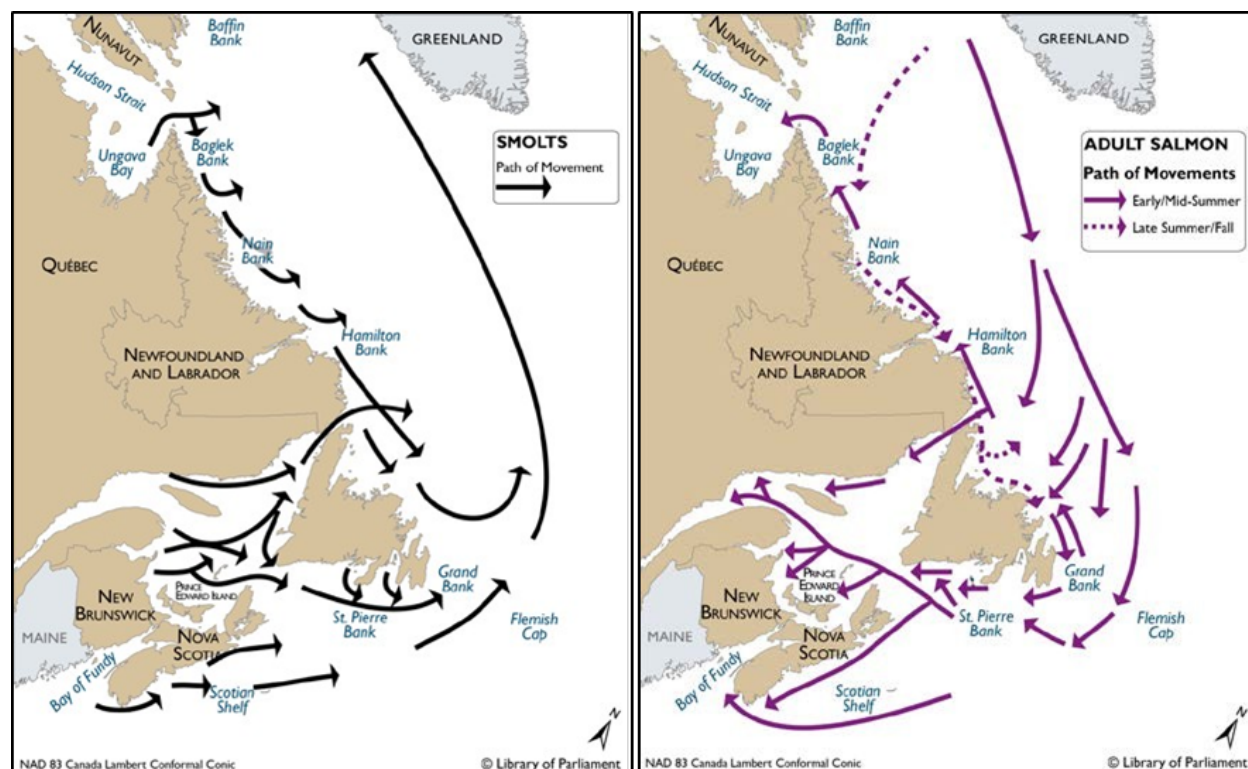
to spawn after only one year at sea are called “one sea-winter” (1SW) salmon. One sea-winter salmon may migrate back to their natal rivers to spawn the following summer or they may migrate to ocean foraging grounds and overwinter for another season. Salmon that spend more than one year at sea are called “multi sea-winter” (MSW). Fish that are successful at spawning typically overwinter in freshwater and return to the ocean the following spring. Thus, at any given time there are multiple age classes of salmon expected to be using ocean environments.

The marine distribution and habitat requirements of salmon at sea have generally been inferred from commercial catch data, RV surveys, telemetry studies, as well as tracer studies such as stable isotopes and Cesium 137 (¹³⁷Cs) (Reddin 2006; Spares et al. 2007; COSEWIC 2010e; Lacroix 2013; Soto et al. 2018). While there is a general understanding of the spatial and temporal distribution of salmon at sea, the resolution of this information is low (Reddin and Friedland 1993; Reddin 2006; COSEWIC 2010e, Soto et al. 2018). The available results of past and ongoing research provide some insight to patterns of migration, food resources, distribution and abundance but also associations to environmental factors (Reddin and Shearer 1987, Reddin and Friedland 1993, Reddin 2006). This is further complicated by evidence of possible climate-induced salmon prey population changes that may be actively changing salmon distribution patterns within the North Atlantic Ocean over time (Spares et al. 2007; Mills et al. 2013; Caesar et al. 2018) and possible changes in nearshore post-smolt survival (Soto et al. 2018). Although it is an active area of current research, the potential variation in ocean distribution within and among salmon DUs is not well described and it is generally thought that the open-ocean distribution of many DUs overlap (Spares et al. 2007; Bradbury et al. 2015, 2016).

Salmon post-smolt and adults feed opportunistically on various plankton, crustaceans, and larval fish (Lacroix and Knox 2005, Sheehan et al. 2012) in the upper water layers (Reddin and Friedland 1993). Both post-smolt and adult salmon tend to spend most of their time within the upper water layers, generally in the upper 5 m (Reddin and Shearer 1987; Reddin and Friedland 1993; Strøm et al. 2017; Hedger et al. 2017); however, recent research is indicating that adults may utilize deeper water as well (European salmon have been recorded making dives up to 900 m) (Windsor et al. 2012; Strøm et al. 2017; Hedger et al. 2017).

Atlantic salmon smolt are generally considered to be energy-deficient with low energy reserves for somatic growth upon leaving their natal river and during the early marine phase (Jonsson and Jonsson 2005). Post-smolt are therefore likely distributed according to prevailing surface currents either close to shore or in open waters and that strong currents act as transportation vectors that facilitate migration to marine feeding areas (Jonsson et al. 1993) to reduce energy needs. Therefore, the migration routes of post-smolt may be determined by general ocean currents near its confluence with the ocean (Figure 6-23).





Source: Standing Committee on Fisheries and Oceans 2017)

Figure 6-23 General Ocean Distribution and Migratory Patterns of Canadian Atlantic Salmon

In general, there are concentrations of both post-smolt and adult salmon in the Labrador Sea throughout the year where they feed and overwinter (general location shown in Figure 6-24). Reddin and Friedland (1993) indicate that post-smolt were observed in the Labrador Sea in autumn of all study years and that they were most abundant between 56°N and 58°N (i.e., northern Labrador Sea area). Post-smolt in the Labrador Sea originate from rivers over much of the geographical range of salmon in North America and most post-smolt overwinter in the southern portion of the Labrador Sea (Reddin and Friedland 1993). Catch data in Reddin and Friedland (1993) indicate that post-smolt do not overwinter in the Grand Bank area during the period 23 December to 21 March. Reddin (2006) notes that post-smolt may overwinter off the Grand Bank but states that corroborative evidence from directed research or indirectly by commercial vessels fishing during the winter is lacking. It should be noted that overwintering areas have not been definitively established and some individual salmon may overwinter in other areas than those shown in Figure 6-24. Overwintering areas may also shift to some extent with oceanic conditions.



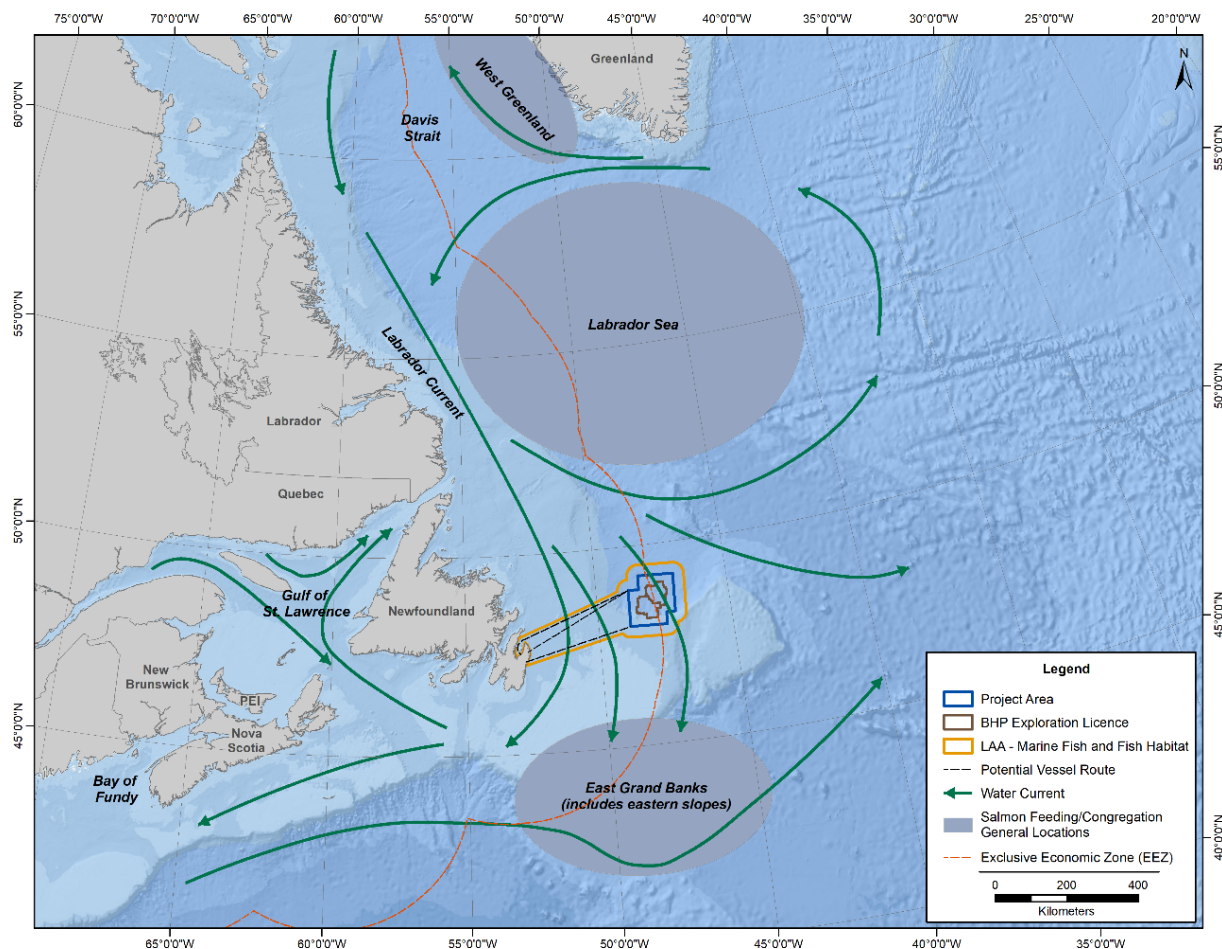
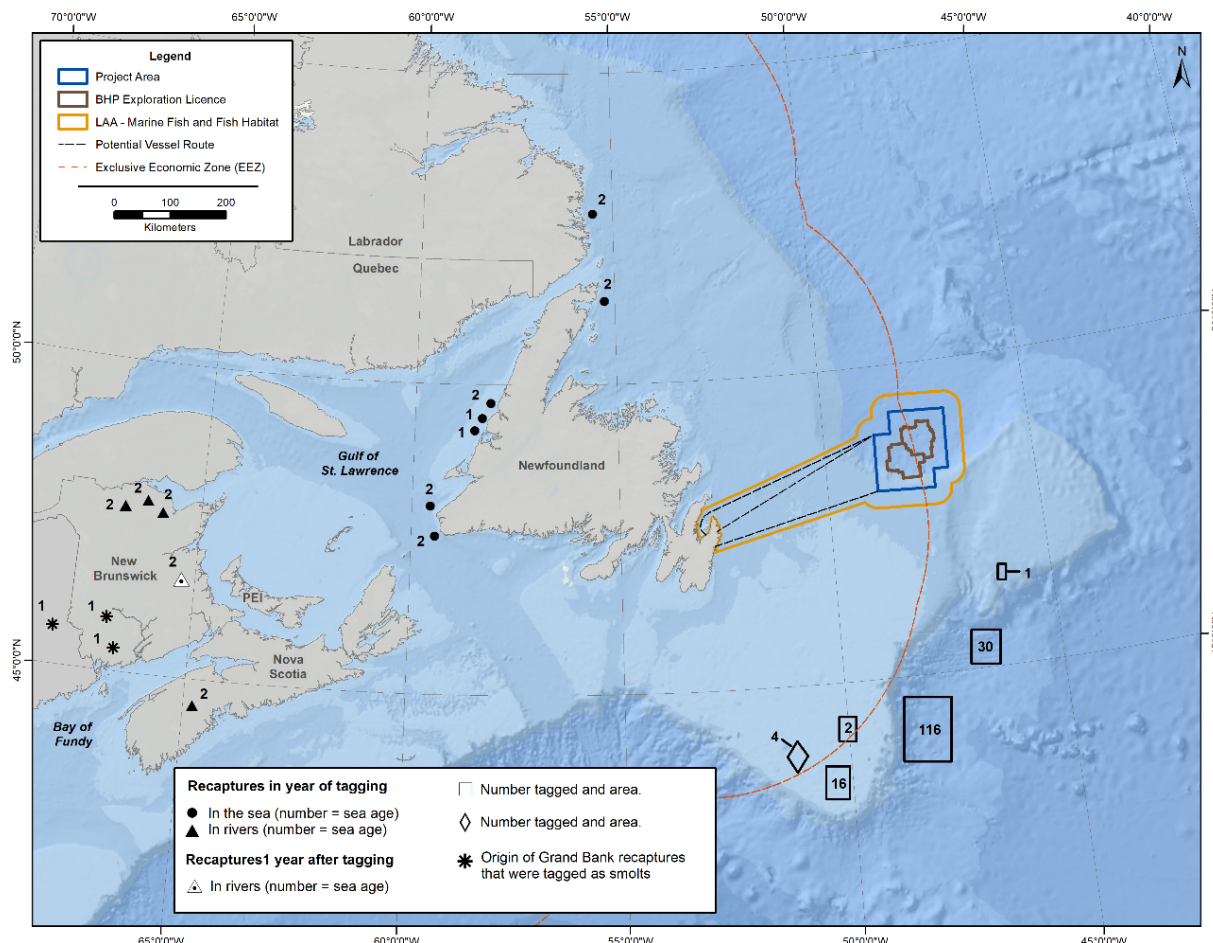


Figure 6-24 General Location of Ocean Currents and Summary of Geographic Locations

Adult salmon, primarily multi-sea-winter (MSW) fish, are also found off west Greenland in the summer and fall. Prior to their spring spawning migration to their home rivers, adult salmon have been found congregating in two general offshore locations; approximately 480 km east of the Strait of Belle Isle and slightly east of the 200 m isobath (depth contour) along the eastern edge of the Grand Bank (Reddin and Friedland 1993). These general locations are shown in Figure 6-24. Based on catch data provided in (Reddin and Shearer 1987) (see Figure 6-25), the area of congregation on the eastern edge of the Grand Bank would be located south of the Flemish Pass. RV surveys have caught salmon within the Project Area in the spring (Reddin and Shearer 1987; Figure 6-25). There is no specific information for the Project Area with respect to the relative DU composition of individuals that may inhabit the area; however, catch data indicate low abundances (i.e., >0.0 to 1.0 per nautical gillnet-hour) in the spring, likely during migration. There is no information with regards to salmon overwintering in relation to the LAA.



Source: Reproduced from Reddin and Shearer 1987

Figure 6-25 RV Catches of Atlantic salmon, 1965-1985

Scales from post-smolt salmon can indicate the general geographic location of their natal river; younger post-smolt (i.e., those smolt that leave their natal river at a younger age) are typically from more southern rivers (Lear and Misra 1978). For example, Labrador mainly produces smolt of river age four and older while Newfoundland smolt typically have river ages of three and four. Rivers to the south of Newfoundland in Nova Scotia, Bay of Fundy, and the United States typically produce smolt of river ages one and two (Reddin 1985). Age data, as well as river recaptures of salmon tagged off the Grand Bank, indicate that salmon that congregate along the eastern Grand Bank are generally from more southern regions such as the Maritimes (Reddin 1985).

The physiological temperature range of Atlantic salmon is quite broad (approximately 0°C to 20°C); however, data suggest individuals are more common in waters ranging from 4°C to 12°C. Research to date provides an overview of general habitat use but also a description of suitable, preferred environmental conditions for salmon survival and growth. Changes in environmental conditions can spatially alter typical distributions and migration routes (Reddin and Shearer 1987) as well as marine survival (Reddin 2006). For example, catch data suggest that salmon modify movements at sea depending on SST. Reddin and



Shearer (1987) and Reddin and Friedland (1993) found a significant and marked relationship between commercial catch rates and the boundary limit of the 4°C isotherm. Few salmon were located at lower temperatures and none below 3°C. The most appropriate temperature range for salmon, based on catch/abundances, has been determined to be 4°C to 12°C SST in the Northwest Atlantic with an optimum between 4°C to 8°C (Reddin and Friedland 1993). Reddin and Burfitt (1984) examined the relationships between salmon catch rate, SST and prey abundance and concluded that SST is the main predictor of Atlantic salmon distribution in the marine environment. Reddin and Shearer (1987) found that low SST appeared not only capable of deflecting Atlantic salmon from recognized migratory paths, but modified movements such that fish would avoid cold water even though warmer water was beyond. This avoidance behavior was shown to affect fish habitat use during years when cold water extended south by forcing salmon to move further south as well (Reddin and Friedland 1993).

A 2018 study used stable isotope signatures of carbon ($\delta^{13}\text{C}$) in scales of returning Atlantic salmon to the Saint John River, New Brunswick over a long time series (approximately 1980-2011) to estimate marine feeding areas of 1SW and MSW adults (Soto et al. 2018). The study concluded that salmon from Saint John River were most closely correlated to feeding areas in the western North Atlantic (Irminger Sea near Iceland, southwest Greenland or Labrador / Newfoundland), the southern North Sea, and northern Norwegian Sea areas; however, they suggest the western North Atlantic region is the more likely feeding region for these fish (Figure 6-26). This area (darker green and bluish) is off the coast of Labrador and northern Newfoundland (Labrador Sea area). The Project Area is very near the southern extent of this identified area. Spares et al. (2007) also found, using ^{137}Cs bioaccumulation, that migration of Canadian MSW salmon showed a feeding distribution in the Labrador and Irminger Seas; however, data from 1SW salmon indicated greater trans-Atlantic migrations.

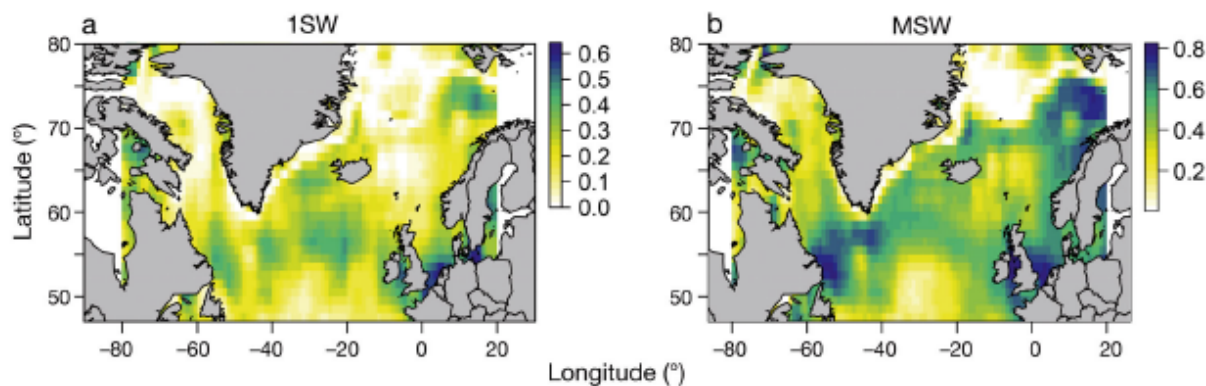


Fig. 4. Probable marine summer feeding locations derived from correlations of LOESS-fit scale $\delta^{13}\text{C}$ and yearly median sea surface temperature (SST) for Atlantic salmon after spending (a) 1 winter at sea (1SW) or (b) multiple winters at sea (MSW) and returning successfully to the St. John River during the period 1982–2011. Colours indicate the degree of correlation (R^2)

Source: Reproduced from Soto et al. 2018

Figure 6-26 Locations of Probably Marine Summer Feeding Locations of 1SW and MSW Salmon

Ocean distribution and migration information for the Atlantic salmon DUs are provided below. The information available for specific DUs is limited. Where data do exist, it is based on tagging studies of salmon from a limited sample of river systems (Hedger et al. 2009; Jacobs 2011; Lefevre et al. 2012; Lacroix 2013; Strøm et al. 2017; Soto et al. 2018) or it is inferred from the genetic composition of commercial



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fisheries catch data (Bradbury et al. 2015, 2016). The general information provided below is inferred from the general understanding of salmon distribution when DU-specific information is not available. This information is subject to change as future studies are completed.

Labrador, Nunavik DUs

The Labrador DU includes 91 known salmon rivers extending from the northern tip of Labrador southward to the Napitipi River, Quebec. The Nunavik DU includes five known salmon rivers extending from the tip of Labrador westward into Ungava Bay, Quebec – the northwestern extent of the species' current range (COSEWIC 2010e). There have been no Atlantic salmon commercial fishery activities since 2000. Indigenous peoples continue to fish in several salmon rivers for FSC purposes. Catch and release and limited retention recreational fishing is still authorized on some rivers under restrictive conservation management restrictions.

Limited work has been conducted on the ocean distribution of salmon from the Labrador and Nunavik DUs. A high proportion of salmon from these DUs are identified in the Labrador subsistence and west Greenland fisheries (Bradbury et al. 2015, 2016), suggesting salmon from these DUs likely feed in the Labrador Sea gyre and the western coast of Greenland, moving into the southern Labrador Sea to overwinter. Migration routes back to these DUs are thought to be like the routes out to sea. Genetic analysis of Atlantic salmon captured in coastal Labrador by Labrador Aboriginal and subsistence fisheries indicated that the majority (85% to 98%) of individuals harvested over 2006 to 2011 were of Labrador origin and that those intercepted from more southern, non-local populations (e.g., Maritimes and Gaspé Peninsula) were rare and occurred primarily in southern Labrador, consistent with discrete migrations pathways through the Strait of Belle Isle (CSAS 2015). Therefore, it is not expected that many individuals of this metapopulation would be in the immediate Project Area.

Insular Newfoundland

There are a total of 305 rivers with known salmon populations in Newfoundland (Reddin et al. 2010). River age data suggests that salmon along the eastern edge of the Grand Bank would at least be partially of Newfoundland origin (particularly the southern portion of the Island). There have been no Atlantic salmon commercial fishery activities since 2000. Indigenous peoples continue to fish in several salmon rivers for FSC purposes. Catch and release and limited retention recreational fishing is still authorized on some rivers under restrictive conservation management restrictions.

Catch and age data indicate that salmon of Newfoundland origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Bank in spring before completing their spawning migration back to their natal rivers. Catch data indicate that post-smolt do not appear to overwinter in the Flemish Pass area (Reddin and Friedland 1993; Reddin 2006). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, prevailing currents along eastern Newfoundland and the Grand Bank are generally a southern flow, therefore smolt energy expenditure would be higher particularly in the higher southerly flows of the Flemish Pass. It is likely that smolt would avoid these offshore areas of increased southern flow while migrating north to the Labrador Sea and follow a generally more coastal route (CSAS 2013) before moving offshore. Acoustic tracking of smolt and kelt (CSAS 2013) from Conne River Newfoundland confirms this route. Based on tag recaptures,



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post-smolt from rivers in Newfoundland migrate near the coast of eastern Newfoundland, arriving in the southern Labrador Sea in early August (Reddin and Friedland 1993). Tagging studies show that adult salmon migrating southward from feeding and overwintering areas to southern Newfoundland rivers in the spring first move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993).

The summary of available data regarding insular Newfoundland populations indicates that a portion of 1SW and MSW adults, primarily from the southern Newfoundland population, congregate off the east Grand Bank before their spring spawning migration back to their natal river. Since the majority of known post-smolt feeding and overwintering occurs in the Labrador Sea, movement to the east Grand Bank area during homeward spawning migrations must occur; however, the exact migration route is not known and may be influenced by SST during the time of migration. It is expected that large numbers of salmon would only occur if high concentrations of prey items circulated through the Project Area during the spring/summer feeding season. However, given the large expanse of known salmon feeding grounds, it is not expected that many individuals would be in the immediate Project Area at any given time.

Inner St. Lawrence, Quebec Western North Shore, Quebec Eastern North Shore, Anticosti Island, Gaspé-Southern Gulf of St. Lawrence DUs

The Inner St. Lawrence DU consists of nine known salmon rivers located along the northern and southern banks of the St. Lawrence River between the communities of Grondines and Tadoussac, Quebec. The Quebec Western North Shore DU consists of 25 known salmon rivers located approximately from the community of Tadoussac to Natashquan. The Quebec Eastern North Shore DU consists of 20 known salmon rivers located approximately from the community of Natashquan to rivers just east of Pakuashipi. Members of the Anticosti Island metapopulation originate from the 25 known salmon rivers on Anticosti Island (DFO 2017b). The Gaspé-Southern Gulf of St. Lawrence DU includes 78 known salmon rivers extending from the western Gaspé to the northern tip of Cape Breton, including Prince Edward Island (COSEWIC 2010e; DFO 2013). There have been no Atlantic salmon commercial fishery activities since 2000. Indigenous peoples continue to fish in several salmon rivers for FSC purposes. Catch and release recreational fishing is still authorized on some rivers under restrictive conservation management restrictions.

As noted above, post-smolt are distributed according to prevailing surface currents and that strong currents act as transportation vectors that facilitate migration to marine feeding areas to reduce energy needs (Jonsson et al. 1993). This process appears to influence the migratory pathway for post-smolt within the Gulf of St. Lawrence region. For example, post-smolt from the north shore of the Gulf of St. Lawrence, as well as the Miramichi, Restigouche, and Cascapedia rivers, follow the coast eastward and use the Strait of Belle Isle as their major pathway during emigration to the North Atlantic (Lefevre et al. 2012). Post-smolt from other rivers farther south on the Gaspé Peninsula have been recaptured near both the Strait of Belle Isle and Cabot Strait.

Caron (1983) and Dutil and Coutu (1988) concluded that some Gulf of St. Lawrence stocks delayed migration from the Gulf and that at least some post-smolt remained there until late autumn. Post-smolt have been captured as bycatch in herring gear in the northern Gulf of St. Lawrence in late summer (COSEWIC 2010e; CSAS 2012) and the winter destination of these late migrations remains unknown. Post-smolt within



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the Gulf of St. Lawrence were also recorded as spending more time in near-shore coastal habitat than smolt from other regions, which spend very little time in or near estuary habitat (COSEWIC 2010e). Once moving to open sea, post-smolt from the Gulf tend to head in a general northward direction (COSEWIC 2010e). This information suggests that post-smolt from the Gulf of St. Lawrence travel to the Labrador Sea primarily in a northerly route through the Strait of Belle Isle and eastward around the Island of Newfoundland. They may also delay migration away from estuary habitat and the Gulf in general until late fall and may overwinter in the Gulf area for their first winter.

CSAS (2012) indicates that the west Greenland fishery has captured salmon from Gulf of St. Lawrence rivers with an estimated harvest of 3% to 10% of total sea winter salmon being from the region (2006 to 2011). River age data suggest that salmon migrating along the eastern edge of the Grand Bank (see Figures 6-23 and 6-24) would at least be partially of Gulf of St. Lawrence origin (particularly the southern portion of the Gulf of St. Lawrence).

Similar to Atlantic salmon from the Southern Newfoundland population, salmon of Gulf of St. Lawrence origin would likely feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Bank in spring before completing their spring spawning migration back to natal rivers. Post-smolt from this region would also be similar to those of insular Newfoundland in that they would not overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a generally coastal route along Newfoundland before moving offshore (Reddin and Friedland 1993; CSAS 2013). Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993; Bradbury et al. 2016). All age groups of salmon at sea are represented in the Labrador Sea, where they also probably spend the winter. It is not expected that many individuals of this metapopulation would be in the immediate Project Area.

Outer Bay of Fundy, Southern Uplands and Eastern Cape Breton DUs

Outer Bay of Fundy metapopulation breeds in rivers along the New Brunswick shores of the Bay of Fundy, from the US border to the Saint John River (DFO 2011a), with 17 rivers identified as containing (or historically containing) Atlantic salmon (Gibson et al. 2016). There have been no recreational fisheries or FSC allocations in this Salmon Fishing Area since 1998. All rivers remained closed to salmon fishing in 2015 (DFO 2016a).

The Southern Uplands metapopulation breeds in rivers from northeastern mainland Nova Scotia, along the Atlantic coast and into the Bay of Fundy as far as Cape Split (DFO 2011b, 2011c), with 72 rivers identified as containing (or historically containing) Atlantic salmon (Gibson and Bowlby 2013). All rivers within Salmon Fishing Area 20 and 21 have been closed to recreational fishing and FSC allocations since 2010 (DFO 2016a).

The Eastern Cape Breton metapopulation breeds in rivers on Cape Breton Island that drain into the Bras d'Or Lakes and Atlantic Ocean (DFO 2011c), with 46 rivers identified as containing (or historically containing) Atlantic salmon (DFO 2014b). Except for Middle River, Baddeck River, and North River, all



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rivers in this DU were closed to salmon fishing in 2015. In 2015, FSC allocations were available from these three rivers; however, no FSC harvests were recorded from these three rivers in 2015 (DFO 2016a).

In terms of marine use and distribution data, the Eastern – Southern Nova Scotia and Outer Bay of Fundy Atlantic salmon populations cannot be differentiated from that of Southern Newfoundland or the Gulf of St. Lawrence populations. Post-smolt migrating to the Labrador Sea and adults returning to natal streams in the spring would follow similar patterns of movement as described above; however, there's no evidence that post-smolt would show delayed migration to the Labrador Sea like some Gulf of St. Lawrence metapopulations.

Salmon of this region would feed and overwinter in the Labrador Sea and a portion of them may congregate off the eastern edge of the Grand Bank in spring before completing their spring spawning migration back to natal rivers. Post-smolt from this region would not overwinter in the Flemish Pass area (Reddin and Friedland 1993). In terms of initial post-smolt migration from their natal river to feeding areas in the Labrador Sea, it would also be likely that they follow a more coastal route along the coast of Newfoundland (Reddin and Friedland 1993; CSAS 2013; Lacroix 2013). Returning adults to the Gulf of St. Lawrence in the spring would also tend to move into Newfoundland coastal waters and then move coastwise in a southerly and then westerly direction along the Newfoundland coast (Reddin and Friedland 1993). Available information does not allow the resolution to determine if salmon from these DUs would be commonly found in the Project Area. It is expected that large numbers of salmon would only occur if high concentrations of prey items circulated through the Project Area during the spring/summer feeding season. However, given the large expanse of known salmon feeding grounds, it is not expected that many individuals would be in the immediate Project Area.

Inner Bay of Fundy Salmon DU

As the only Atlantic salmon DU afforded legal protection under SARA, the spatial and temporal distribution of Inner Bay of Fundy salmon are relatively well understood. Existing data suggest that the distribution of Inner Bay of Fundy salmon at sea is unique relative to other DUs. Studies tracking the movement of post-smolts, salmon that have not yet spent a full winter at sea, suggest that most of the population stays within the Northern Gulf of Maine in their first summer (Marshall 2014). It is unclear where the minority of post-smolts that do leave the northern Gulf of Maine go, and their overwintering distribution is not known. However, Inner Bay of Fundy kelts (salmon that have returned to the ocean following spawning) seem to follow migratory patterns similar to that of post-smolts. Kelt overwintering data suggest that the majority remain in the northern Gulf of Maine through the colder winter months, with some venturing into the warmer Scotian Shelf waters (Lacroix 2013). The existing information suggests that Inner Bay of Fundy salmon are not known to inhabit North Atlantic Ocean waters near the Orphan Basin or the Grand Banks. Thus, with respect to the Project Area, the presence of Inner Bay of Fundy salmon is not expected at any life history stage or season.

6.1.10 Summary of Key Areas and Times

Within the potential PSV routes and LAA, key times and areas are closely tied with the plankton bloom in the spring/early summer. Warming waters and nutrient availability gives rise to the phytoplankton bloom, with subsequent growth in zooplankton and their predators. Many species synchronize breeding to allow



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juveniles to be present for this bloom, and so ichthyoplankton and invertebrates increase in abundance. Table 6.12 shows spawn timing for key LAA species, with many breeding and releasing larvae in the spring / summer months. This spike in available prey attracts pelagic predators (e.g., tuna, swordfish, sharks) from southerly waters to feed.

Deep-sea and lower slope species are less well tied to the spring bloom, and many show very limited seasonal synchronicity. For instance, the roundnose grenadier is known to breed year-round, while the carapine grenadier spawns in the winter months (COSEWIC 2009a) (Table 6.12). While the nutrients from the bloom make their way to deep-water ecosystems through marine snow or migratory species, the timing is likely less crucial. Species that may migrate to breed, such as the Greenland halibut, have similar breeding periods as shallower-water species. Key areas for deep-sea species are more likely to be microhabitats such as boulder outcrops and areas of high coral and sponge density (Baker et al. 2012; Beazley et al. 2013).

Within and near the LAA are several biologically key areas for important species. The northeast shelf and slope is designated as an Ecologically or Biologically Significant Area (EBSA) due to the high abundance, biomass, and richness of finfish in the area (further discussed in Section 6.4). This area has diverse available habitats, strong primary production, and well-mixed nutrient-rich seawater due to the meeting of the Labrador Current and the Gulf Stream. This area is a known breeding area for witch flounder, and critical habitat has been established along the shelf for both spotted and northern wolffish (see Section 6.1.8.1).

Corals and sponges are sessile benthic invertebrates that play important roles in deep-sea ecosystems by providing habitat in relatively homogenous environments, nutrient cycling, and as part of the food web. They are used as spawning grounds and nursery habitat for a variety of species, including those of commercial interest. The Orphan Basin and surrounding slope has high abundance and diversity of corals and sponges, and these communities are an important component of the EBSA on the northeast shelf. Limited data are available within the Project Area, but corals and sponges are noted from an ROV survey (Penney-Belbin and Christian 2013) and other data sources (e.g., OBIS 2019). See Section 6.1.6.1. for more details on corals and sponges.

A variety of spawning strategies are pursued by key fish species in the LAA, including broadcast spawning (e.g., American plaice), ovoviviparous spawning (e.g., redfish), and depositing externally fertilized eggs (e.g., capelin). Fish species may also spawn throughout their range or undertake migrations to freshwater rivers (e.g., Atlantic salmon), tropical waters (e.g., swordfish), or Arctic waters (e.g., Greenland halibut). For shelf species and those of commercial importance, reproductive timing and behavior may be better studied, while deep slope and abyssal species are relatively poorly understood. A summary of known spawning times and locations for key species discussed in Section 6.1.7.4 is presented in Table 6.12.



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Table 6.12 Spawning Periods and Locations of Key Fish Species

Common Name	Scientific Name	Spawning Time												Known Spawning Locations	
		J	F	M	A	M	J	J	A	S	O	N	D		
Capelin	<i>Mallotus villosus</i>														Coastal waters of NL, southeast shoal of Grand Banks
Acadian Redfish	<i>Sebastes fasciatus</i>														Flemish Cap, Southwest shelf edge and slope
Golden Redfish	<i>Sebastes norvegicus</i>														Flemish Cap, Southwest shelf edge and slope
Deepwater Redfish	<i>Sebastes mentella</i>														Flemish Cap, Southwest shelf edge and slope
Glacial Lanternfish	<i>Benthosema glaciale</i>														Location, if any, not known
Roughhead grenadier	<i>Macrourus berglax</i>														Southern and Southeastern Grand Bank
Roundnose grenadier	<i>Coryphaenoides rupestris</i>														Throughout species range
Abyssal grenadier	<i>Coryphaenoides armatus</i>														Spawning not known, potentially semelparous
Carapine grenadier	<i>Coryphaenoides carpinus</i>														Location, if any, not known
Witch flounder	<i>Glyptocephalus cynoglossus</i>														Labrador Shelf and Northwest Newfoundland Shelf
Greenland halibut	<i>Reinhardtius hippoglossoides</i>														Davis Strait, Flemish Pass
American plaice	<i>Hippoglossoides platessoides</i>														Grand Bank
Blue hake	<i>Antimora rostrata</i>														Not known to spawn in Canadian waters

Notes: Spawn timing and locations drawn primarily from Scott and Scott (1988), and Coad and Reist (2018), as well as Kulka et al. (2003) (blue hake), COSEWIC (2010a) (Acadian / deepwater redfish), and (Nakashima and Wheeler 2002) (capelin)
Grey cells indicate lack of information on spawn timing (abyssal grenadier).



6.2 MARINE AND MIGRATORY BIRDS

The marine waters off eastern Newfoundland provide a vast area of important breeding, migrating, and wintering habitat for marine-associated birds. The upwelling of the cold Labrador Current flowing upon meeting the Grand Banks, the Flemish Cap and the North Atlantic Drift brings vital mineral nutrients from the depths to the surface. The phytoplankton nourished by this upwelling form the basis for substantial biomass production, culminating in globally important numbers of seabirds in parts of the region in each season (Brown 1986; Lock et al. 1994; Fifield et al. 2009).

6.2.1 Approach and Key Information Sources

The distribution and abundance of seabirds in the Project Area and RAA has been characterized by various survey programs conducted by the Canadian Wildlife Service (CWS) and oil industry related seabird monitoring. From 1969 to 1983 and 1984 to 1992 data were collected by CWS through PIROP that employed a line transect in counting birds to unlimited distance (Brown 1986; Lock et al. 1994). From the late 1990s, the oil industry has collected data from offshore installations and supply vessels on the northeast Grand Banks (Baillie et al. 2005; Burke et al. 2005). However, few data were collected in Orphan Basin, the northern slope of the Grand Banks or the Flemish Cap. Beginning in the mid-2000s, at-sea surveys were conducted from vessels conducting geophysical surveys within the RAA by the oil industry to fulfill marine bird monitoring required by the C-NLOPB (Moulton et al. 2005; Abgrall et al. 2008; Jones et al. 2010; Jones and Lang 2013; Holst and Mactavish 2014; Lang 2016). These surveys were conducted using a fixed-width strip transect, which enables the determination of seabird densities based on the recommendations of a report funded by Environmental Studies Research Funds (ESRF) (Moulton and Mactavish 2004). Starting in 2005, CWS has again been conducting at-sea surveys with the ECSAS program, partly funded by ESRF, with a mandate to improve knowledge of the abundance and distribution of seabirds at-sea in areas of oil industry activity in eastern Canada (Fifield et al. 2009; Bolduc et al. 2018). This program introduced the distance sampling technique into the surveys to improve the accuracy of density estimates for less detectable seabird species. In 2018, ECSAS density maps derived from these data collected from 2006 to 2016 were published at the on-line “Atlas of Seabirds at Sea in Eastern Canada” and the shapefiles were made available on an open data site (Bolduc et al. 2018). These maps are used here to illustrate and describe current marine bird distribution and abundance in the Project Area. In this Atlas, the year is divided into three seasons: April to July (spring migration and nesting period of species whose young leave the nest soon after hatching [nidifugous]), August to November (moult, chick-rearing period of nidifugous species, and second half of the nesting period of species whose young remain in the nest [nidicolous]), and December to March (fall migration and wintering).



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Several tracking studies of marine birds have been published recently and were consulted for details of bird movements between nesting colonies and wintering areas and to characterize the use of the RAA by breeding, wintering and migrating red-necked phalaropes, common and thick-billed murrelets, dovekies, black-legged kittiwakes, ivory gulls, Sabine's gulls, Ross's gulls, arctic terns, great skuas, long-tailed jaegers, sooty shearwaters, and Leach's storm-petrels (Egevang et al. 2010; Gilg et al. 2010; Hedd et al. 2011; Sittler et al. 2011; Frederiksen et al. 2012; Hedd et al. 2012; Magnúsdóttir et al. 2012; Fort et al. 2013; McFarlane Tranquilla et al. 2013; Pollet et al. 2014; Smith et al. 2014; Maftai et al. 2015; McFarlane Tranquilla et al. 2015; Davis et al. 2016; Frederiksen et al. 2016; van Bemmelen et al. 2017; Hedd et al. 2018).

Censuses of breeding pairs in seabird nesting colonies are conducted by CWS regularly in Newfoundland and Labrador. Some data have been published (Wilhelm et al. 2015; Wilhelm et al. 2016). Unpublished data were obtained from CWS current to the 2018 breeding season. Data published by the Important Bird Areas in Canada program (IBA), many of which are major nesting colonies, were also consulted (Bird Studies Canada 2015). Summaries of data collected under the Atlantic Canada Shorebird Survey (ACSS) program in the Statoil drilling EIS were also consulted (Statoil Canada Ltd. 2017).

Nomenclature and species sequence used in this EIS follow the American Ornithological Society's "Checklist of North American Birds" (Chesser et al. 2018).

6.2.2 Seabirds

Marine bird habitats in the RAA are comprised of coastal waters, continental shelf, slope, and deep waters. Concentrations of these birds sometimes occur at the upwellings at oceanographic features. Spawning capelin attract large concentrations of marine birds to coastal waters for a few weeks in summer. Millions of marine birds breed at nesting colonies in coastal northeastern Newfoundland, and forage for their young on the Grand Banks and other shelf areas during summer (Table 6.13). Thousands of non-breeding seabirds occur in the RAA during the summer months. For example, most of the world's population of great shearwater and large numbers of sooty shearwater migrate to Newfoundland waters to moult and feed upon completion of their breeding period in the Southern Hemisphere. Thousands of sub-adult seabirds of species that nest north of the RAA remain in the RAA during the summer, especially northern fulmar and black-legged kittiwake. In the fall, migration of marine birds that have bred in the Arctic and subarctic of eastern Canada and Greenland brings them to the RAA to spend the winter. Other marine and migratory species also pass through the RAA during spring and fall migration.



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Table 6.13 Numbers of Marine Birds Nesting at Major Colonies in the RAA (46°N to 52°N) (from Most Recent Censuses)

Species	Northern Groais Island	Wadham Islands	Coleman Island	Funk Island	Cape Freels / Cabot Island	Bonavista Peninsula	Baccalieu Island	Witless Bay Islands	Mistaken Point	Cape St. Mary's	Middle Lawn Island	Corbin Island	Green Island	Grand Colombier Island	Miquelon Cape
Northern Fulmar	-	-	-	40p ^a	-	-	-	52p ^a	-	Present ^a	-	-	-		
Manx Shearwater	-	-	-	-	-	-	-	-	-	-	7p ^f	-	-		
Leach's Storm-Petrel	-	200p ^a -	2,906p ^a	150p ^a	8,200p ^a	60p ^a	1,950,000p ^k	314,020p ^a	-	-	8,773p ^a	100,000p ^a	48,000p ^a	363,787p ^g	
Northern Gannet	-	-	-	10,964p ^a	-	-	3,241p ^a	-	-	14,598p ^a	-	-	-		
Herring Gull	-	-	5p ^a	-	250p ^a	993i ^a	46p ^a	2,266p ^a	-	39p ^a	20p ^a	50p ^a	Present ^a	60p ^h	265p ^j
Great Black-backed Gull	-	-	-	75i ^a	14p ^a	1,000i ^a	2p ^a	15p ^a	-	Present ^a	6p ^a	25p ^a	-	10p ^h	
Black-legged Kittiwake	1,050p ^b	-	5p ^a	95p ^a	43p ^a	1,000i ^a	5,096p ^a	11,696p ^a	4,170p ^e	10,000p ^a	-	50p ^a	-	196p ^h	2,415p ^j
Arctic and Common Terns	-	22p ^b	4p ^a	-	1,420i ^a	17i ^a	-	-	-	-	-	-	Present ^a		
Common Murre	-	-	-	472,259p ^{b,d}	9,897p ^a	-	1,440p ^a	250,000p, 14,599i ^a	84p ^a	15,484p ^a	-	-	-	7,176p ⁱ	
Thick-billed Murre	-	-	-	250p ^a	-	-	73p ^a	240p ^a	-	1,000p ^e	-	-	-		
Razorbill	-	273p ^c	1,346p ^a	200p ^a	35p ^a	-	406p ^a	380p, 231i ^a	22p ^e	100p ^a	-	-	-	1,443p ⁱ	
Black Guillemot	-	50p ^a	25i ^a	1p ^a	4p ^a	25i ^a	113p ^a	1p, 13i ^a	Present ^a	Present ^a	-	-	-	95p ⁱ	Present ⁱ
Atlantic Puffin	-	6,190p ^c	12,649p ^a	2,000p ^a	755p ^a	4,870p ^a	75,000p ^e	304,042p ^{a,d}	79p ^e	-	-	-	-	9,543p ⁱ	
TOTAL	1,050p	6,735p	16,915p, 25i	485,959p, 75i	20,618p	4,930p, 3,035i	2,063,109p	882,712p, 14,843i	4,355p	41,221p	8,806p	100,125p	48,000p	382,310p	2,680p

Sources: ^a ECCC-CWS unpublished data ; ^b Thomas et al. (2014a); ^c Robertson and Elliot (2002); ^d Wilhelm et al. (2015); ^e Parks and Natural Areas Division, unpublished data; ^f Fraser et al. (2013); ^g Lormée et al. (2012); ^h Lormée (2008); ⁱ Lormée et al. (2015); ^j Cairns et al. (1989); ^k Wilhelm et al. (2019);
p = number of pairs, i = number of individuals



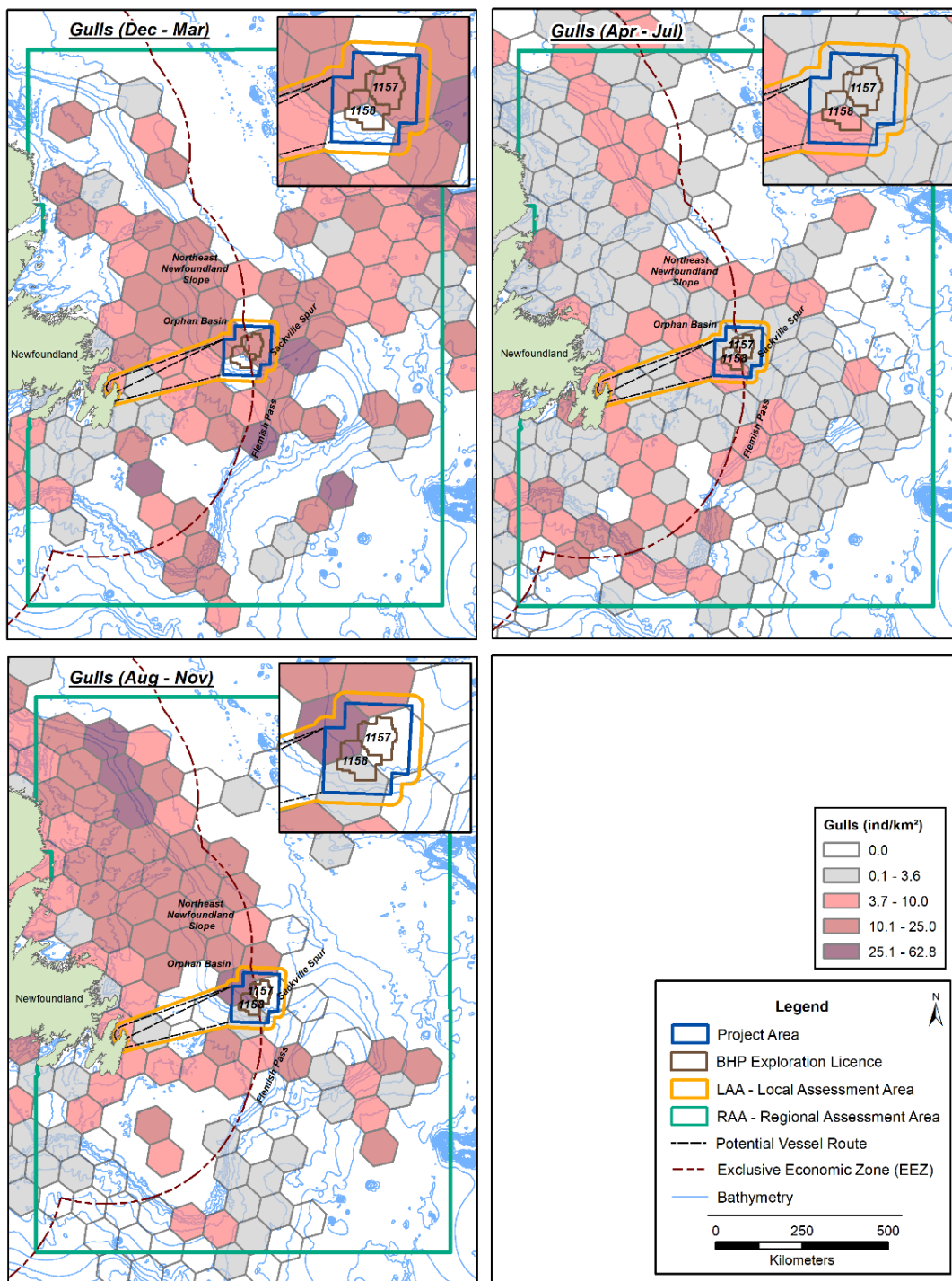
6.2.2.1 Phalaropes

Both red and red-necked phalaropes nest in freshwater ponds in the Arctic and Subarctic, and winter in pelagic waters of the tropics and sub-tropics. During the pelagic portion of their annual cycle these species are thought to forage primarily at areas of upwelling caused by ocean currents conflicting with shelf edges, shorelines and other currents feeding on zooplankton at the surface (Rubega et al. 2000; Tracy et al. 2002). Red-necked phalarope is designated a Species of Special Concern on Schedule 1 of SARA (see Section 6.2.4). Phalaropes occur in the RAA and Project Area as passage migrants during spring and fall (Moulton et al. 2006; Smith et al. 2014). However, it has not been possible to calculate densities in the Project Area or the RAA because they are seldom recorded during at-sea surveys due to their low density and they are often seen only in flight (Moulton et al. 2006; Bolduc et al. 2018). However, these species have been observed in small numbers off-transect from mid-May to early June and during August and September (Moulton et al. 2006).

6.2.2.2 Gulls

Gull species are an abundant part of the avifauna off eastern Newfoundland. The primary species are herring, great black-backed and ring-billed gull and black-legged kittiwake. They nest in the RAA and, except for the ring-billed gull, also winter. Only the black-legged kittiwake is a truly pelagic species. In Atlantic Canada, greater than two-thirds of the breeding gulls nest in NL; almost half of these birds are kittiwakes (Cotter et al. 2012). The populations of coastal gull species decreased after the closure of the groundfish fishery and the closure of municipal sanitary landfills but appear to be recovering (Cotter et al. 2012). Arctic and Subarctic breeding coastal species are common during the winter in the RAA (glaucous and Iceland gulls). The Arctic nesting pelagic species Sabine's gull is a passage migrant in the RAA whereas ivory and Ross's gull winter in the RAA. Ivory gull is designated endangered on Schedule 1 of SARA and the Newfoundland and Labrador *Endangered Species Act* (NL ESA), and Ross's gull is designated threatened on Schedule 1 of SARA. Black-headed gull is a rare breeder in the RAA and lesser black-backed gull migrates through the RAA in small numbers. Laughing gull and mew (common) gull occur only as rare annual vagrants in the RAA (Moulton et al. 2006; Mactavish et al. 2016). Gull species other than kittiwake are found in the Project Area in density categories of 0.1-3.6 to 3.7-10.0 birds/km² in the April to July period, 0 to 25.1-62.8 birds/km² in the August to November period, and 0 to 10.1-25.0 birds/km² in the December to March period, although there were no surveys conducted in the northern or southern extent of the Project Area during the latter period (Figure 6-27). Gulls feed primarily by picking food from the surface or plunge-diving from a low height.





Source: Bolduc et al. 2018

Figure 6-27 Seasonal Distribution and Abundance of ECSAS Gull Observations, Excluding Kittiwakes, in the Waters Off Eastern Newfoundland (2005-2016)



Black-legged Kittiwake

From April to August, this pelagic gull nests by the thousands in large and small colonies in eastern Newfoundland, foraging on pelagic fish that spawn in shallow, inshore waters (Table 6.13). There are also small numbers of non-breeding sub-adult black-legged kittiwakes in offshore waters during this period (Lock et al. 1994; Holst and Mactavish 2014; Bolduc et al. 2018). However, many kittiwake nesting colonies are declining (Frederiksen et al. 2012). During April to July, densities in the Project Area range from 0.1 to 2.3 birds/km² (Holst and Mactavish 2014). Adults and fledglings abandon the colony in August and begin to arrive in the offshore parts of the RAA. During the August to November period densities in the Project Area fall into density categories ranging from 0 to 7.6-20.0 birds/km² (Figure 6-28); however, no kittiwakes were observed on-transect in the Project Area during a seismic monitoring program (Holst and Mactavish 2014)). During December through March, densities range from 0 to 7.6-20.0 birds/km² (Figure 6-28; Bolduc et al. 2018). Tracking kittiwakes with geolocators showed that 80% of the 4.5 million adult kittiwakes nesting in the Atlantic, including most European colonies, spend the winter from the shelf edges off Newfoundland, including the RAA, and offshore areas extending to the Mid-Atlantic Ridge and the Labrador Sea (Frederiksen et al. 2012). Black-legged kittiwake is designated Vulnerable on International Union for Conservation of Nature's (IUCN's) Red List of globally threatened species (Birdlife International 2019).

Ivory Gull

Ivory gull forages in sea ice between breeding seasons. When the sea ice arrives on the Northeast Newfoundland Shelf in late winter and early spring this species can be found in low densities the northwest corner of the RAA (Gilg et al. 2010; Spencer et al. 2016). At that time, it occasionally occurs along the coast of the Northern Peninsula (Stenhouse 2004; NL Department of Environment and Conservation [NLDEC] 2016). Ivory gull is designated Endangered under both SARA (Schedule 1) and the NL ESA (see Section 6.2.4).

Small Gulls

Sabine's gull migrates through the pelagic waters of Labrador Sea on its way between nesting grounds in the Canadian Arctic and wintering areas in the pelagic waters of the tropics (Davis et al. 2016). This species is a passage migrant in the offshore areas of the RAA. Small numbers have been observed in Orphan Basin from late May to late September during geophysical surveys (Moulton et al. 2005; Moulton et al. 2006; Abgrall et al. 2008; Mactavish et al. 2012; Holst and Mactavish 2014) and Flemish Pass (Jones and Lang 2013).

Ross's gull winters in very small numbers offshore from the Labrador Sea to Orphan Basin after migrating from nesting areas in the Canadian Arctic (Maffei et al. 2015). This species is designated Threatened on SARA Schedule 1 (see Section 6.2.4).

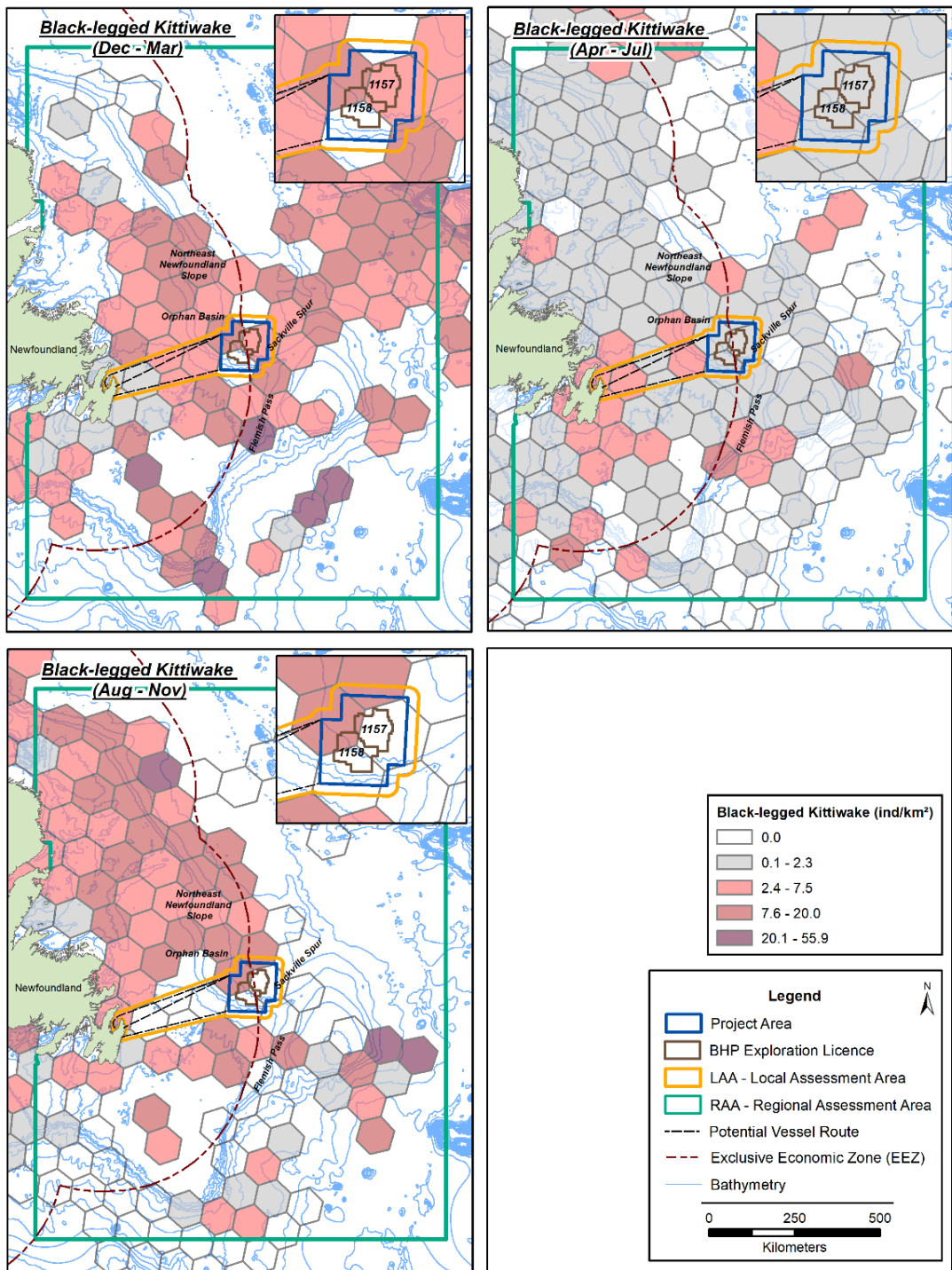
Black-headed gull nests in the RAA at Ladle Cove in small numbers and outside the RAA (Cotter et al. 2012; B. Mactavish, 2019, pers. comm.). It winters at scattered locations along the Newfoundland coastline (B. Mactavish, 2019, pers. comm.). Although it is primarily coastal in its distribution it has occasionally been recorded in Orphan Basin (Hauser et al. 2010).

Densities of small and large gull species (except black-legged kittiwake) in the Project Area are discussed under large gulls below.



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Source: Bolduc et al. 2018

Figure 6-28 Seasonal Distribution and Abundance of ECSAS Black-legged Kittiwake Observations in the Waters Off Eastern Newfoundland (2005-2016)



Large Gulls

Great black-backed, herring and ring-billed gull nest along the coast in the RAA. Ring-billed gull nest in a few large colonies but great black-backed and herring gulls nest alone or in small to large colonies (Statoil Canada Ltd. 2017). Nesting populations of major nesting colonies in eastern Newfoundland are presented in Table 6.13. These species are coastal year-round. Many of the great black-backed gulls move at least 50 km offshore after the breeding season (Good 1998). During fall, this species concentrates in large numbers at offshore Newfoundland oil platforms (Baillie et al. 2005; Burke et al. 2012) where those birds feed on prey attracted to the surface at night by light from the platforms (Burke et al. 2005; Montevecchi 2006). Ring-billed gull is common along the coast but is rare offshore but have been recorded during geophysical surveys (Moulton et al. 2006; Abgrall et al. 2008).

Iceland gull is numerous in the RAA during winter along the coastline and is present in smaller numbers offshore (B. Mactavish, 2019, pers. comm.). Smaller number of glaucous gulls are also present in coastal and offshore areas of the RAA (B. Mactavish, 2019, pers. comm.).

Lesser black-backed gull is found in the RAA in small numbers after leaving breeding colonies in southwest Greenland and migrating to wintering areas in southern Canada and the United States (Moulton et al. 2006; Abgrall et al. 2008; Hauser et al. 2010; Jones et al. 2012; Mactavish et al. 2012; Jones and Lang 2013; Holst and Mactavish 2014, B. Mactavish, 2019, pers. comm.).

Densities of large and small gulls (except black-legged kittiwake) in the Project Area during the April to July period fall into density categories ranging from 0.1-3.6 to 3.7-10.0 birds/km² (Figure 6-27). During the August to November period, densities range from 0 to 25.1-62.8 birds/km². During the December to March period, densities range from 0 to 10.1-25.0 birds/km².

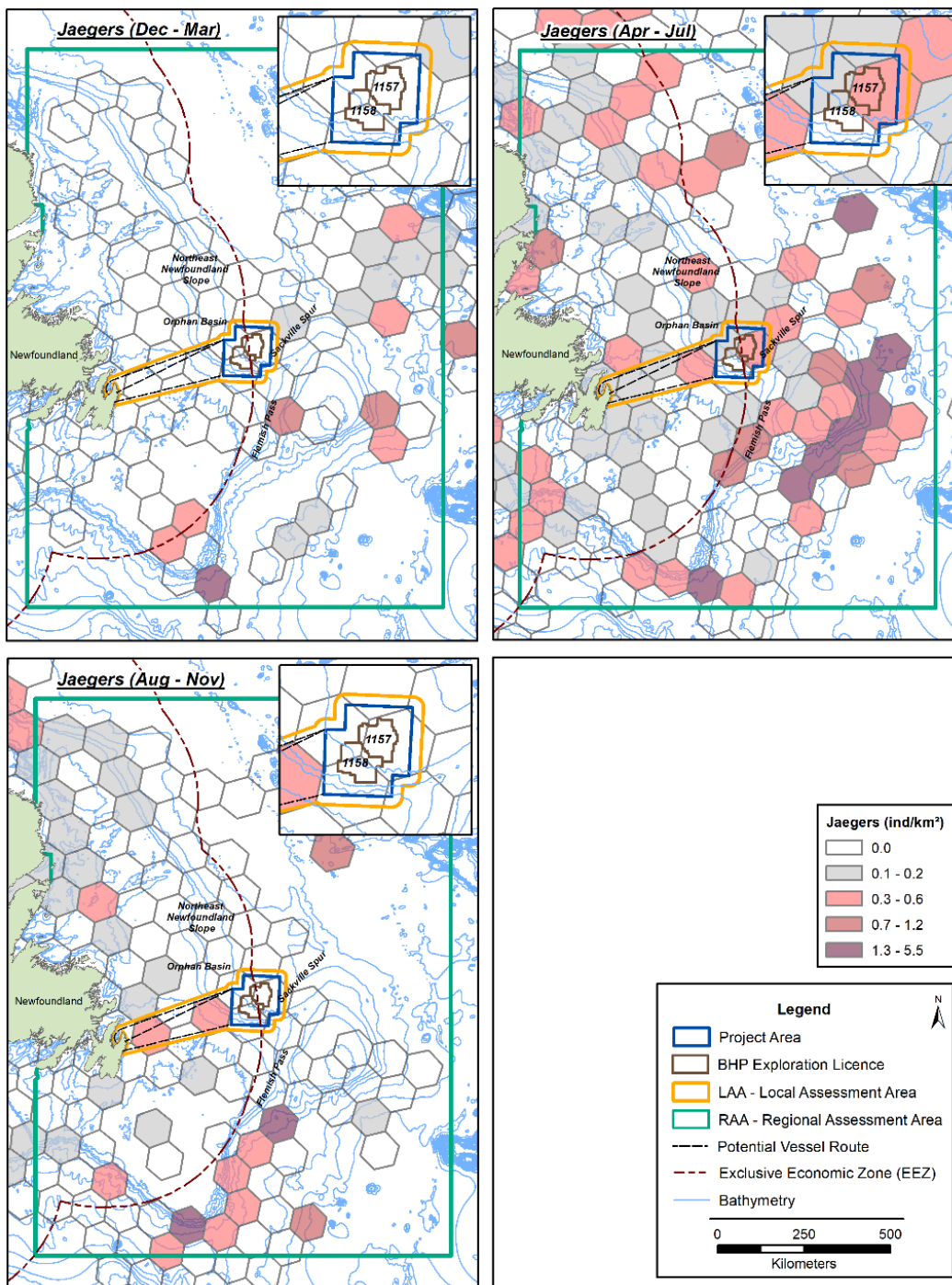
6.2.2.3 Terns

Terns occur in the waters of the RAA from late May to early September. Both Common and Arctic terns breed in eastern Newfoundland in numerous colonies (Statoil Canada Ltd. 2017). Caspian tern nested in the RAA on the Wadham Islands in the past (CWS, unpublished data). Between nesting seasons, Arctic tern is found in pelagic waters (Hatch 2002). In the offshore portion of the RAA, Arctic tern is fairly common in small flocks or individually as a passage migrant during spring and fall (Moulton et al. 2006; Hauser et al. 2010; Mactavish et al. 2012; Holst and Mactavish 2014). Common and Caspian terns are rare offshore but have been recorded in Orphan Basin (Jones et al. 2012; Mactavish et al. 2012; Jones and Lang 2013). Terns were not recorded on-transect during ECSAS surveys in the Project Area (Bolduc et al. 2018). These species capture prey by plunge-diving (Cuthbert and Wires 1999; Hatch 2002; Nisbet 2002).

6.2.2.4 Skuas and Jaegers

The three species of jaeger are passage migrants in the pelagic waters of the RAA on their way between Arctic breeding grounds and wintering areas in the pelagic waters of the tropics. They migrate individually or in small, single-species flocks. They have been recorded on ECSAS surveys in the Project Area during the April to July period in density categories ranging from 0.1-0.2 to 0.3-0.6 birds/km² in the northeast part of the Project Area but were not recorded on-transect in the remainder of the area (Figure 6-29). They were not recorded on-transect during the August to November period or the December to March period.





Source: Bolduc et al. 2018

Figure 6-29 Seasonal Distribution and Abundance of ECSAS Jaeger (Pooled Pomarine, Parasitic, Long-tailed, and Unidentified) Observations in the Waters Off Eastern Newfoundland (2005-2016)



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Great skua migrates through and winters in the southeastern quadrant of the RAA after arriving from nesting areas in northern Europe and Iceland. A large proportion of the Iceland population winters in the waters off eastern Canada (Magnusdottir et al. 2012). South polar skua nests in the South Atlantic and spends the austral winter in the pelagic waters of the Northwest Atlantic. South polar skua was recorded from geophysical survey vessels in Orphan Basin in densities ranging from 0.02 birds/km² during late August to 0.3 birds/km² during mid-August (Moulton et al. 2006; Jones et al. 2012; Jones and Lang 2013; Holst and Mactavish 2014). ECSAS surveys observed skuas in the east part of the Project Area in densities of 0 to 0.2 birds/km² during the April to July period (Figure 6-30). During the August to November period they were recorded in the southern part of the Project Area in the density category 0.3-0.7 birds/km², and during the December to March period in density categories ranging from 0 to 0.3-0.7 birds/km² in the western part of the Project Area (Figure 6-30).

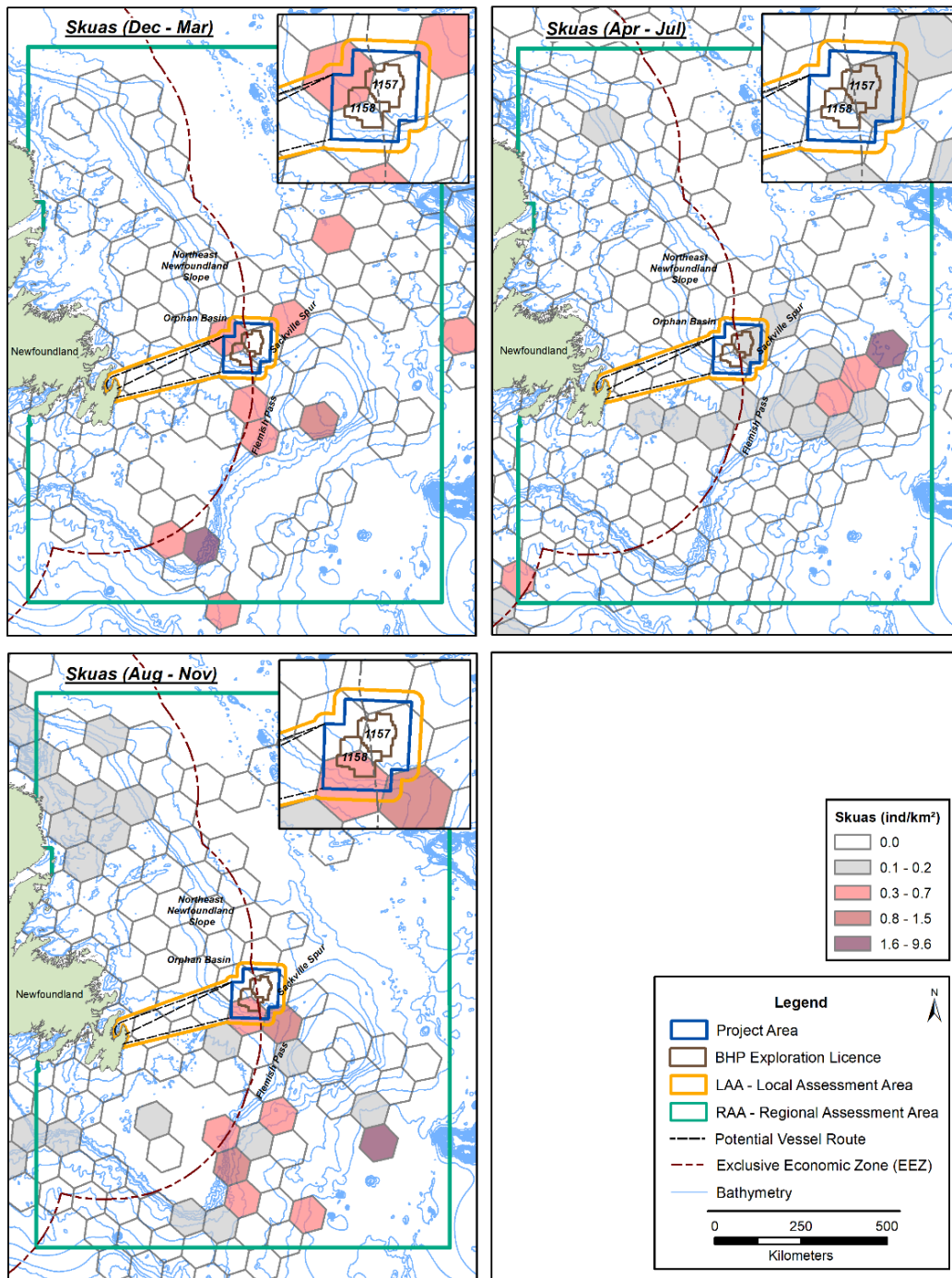
During geophysical surveys in Orphan Basin, both jaegers and skuas have been recorded off-transect during spring and fall migration (Moulton et al. 2006; Hauser et al. 2010; Jones and Lang 2013; Holst and Mactavish 2014). During the pelagic part of their annual cycle, jaegers and skuas procure much of their food via kleptoparasitism (piracy on other seabirds) (Wiley and Lee 1998, 1999, 2000).

6.2.2.5 Auks (Dovekie, Murres, Puffins, Razorbill, and Guillemots)

Six species of the Alcidae use the RAA at some time of the year: dovekie, common murre, thick-billed murre, razorbill, Atlantic puffin, and black guillemot. Common murre nests in the RAA in large numbers and winters in the southern parts of the RAA. Dovekie winters in the RAA, migrating from Arctic nesting colonies. The remaining species nest in both the Arctic and the RAA, although razorbill nests only in small numbers in the RAA. Thick-billed murre and black guillemot winter in the RAA, but razorbill and puffin winter mostly south of the RAA. Species that nest in the RAA arrive at nesting colonies in April and May, and generally leave them by late August (Statoil Canada Ltd. 2017). These species forage primarily in coastal waters during the nesting period. The populations at major nesting colonies in eastern Newfoundland are presented in Table 6.13.

Alcids use pursuit diving to forage for small fish (e.g., capelin and sand lance) and invertebrates primarily in the shelf waters of the RAA. Dovekies primarily eat copepods, predominantly *Calanus* species (Fort et al. 2012), whereas the other alcids feed primarily on fish. Alcids use their wings for propulsion during pursuit diving. As a result, their wing morphology is a compromise between underwater flight and aerial flight. Because their wings are relatively inefficient for aerial flight, alcids spend a larger proportion of their time on the sea surface than gulls and petrels and are thus considered at greater risk from oil pollution (Weise and Ryan 2003; Wilhelm et al. 2007; Fifield et al. 2009). Their vulnerability increases during the annual moult in late summer during which they are flightless for several weeks (Gaston and Hipfner 2000; Ainley et al. 2002; Montevecchi and Stenhouse 2002; Lavers et al. 2009).





Source: Bolduc et al. 2018

Figure 6-30 Seasonal Distribution and Abundance of ECSAS Skua (Pooled Great, South Polar and Unidentified) Observations in the Waters Off Eastern Newfoundland (2005-2016)



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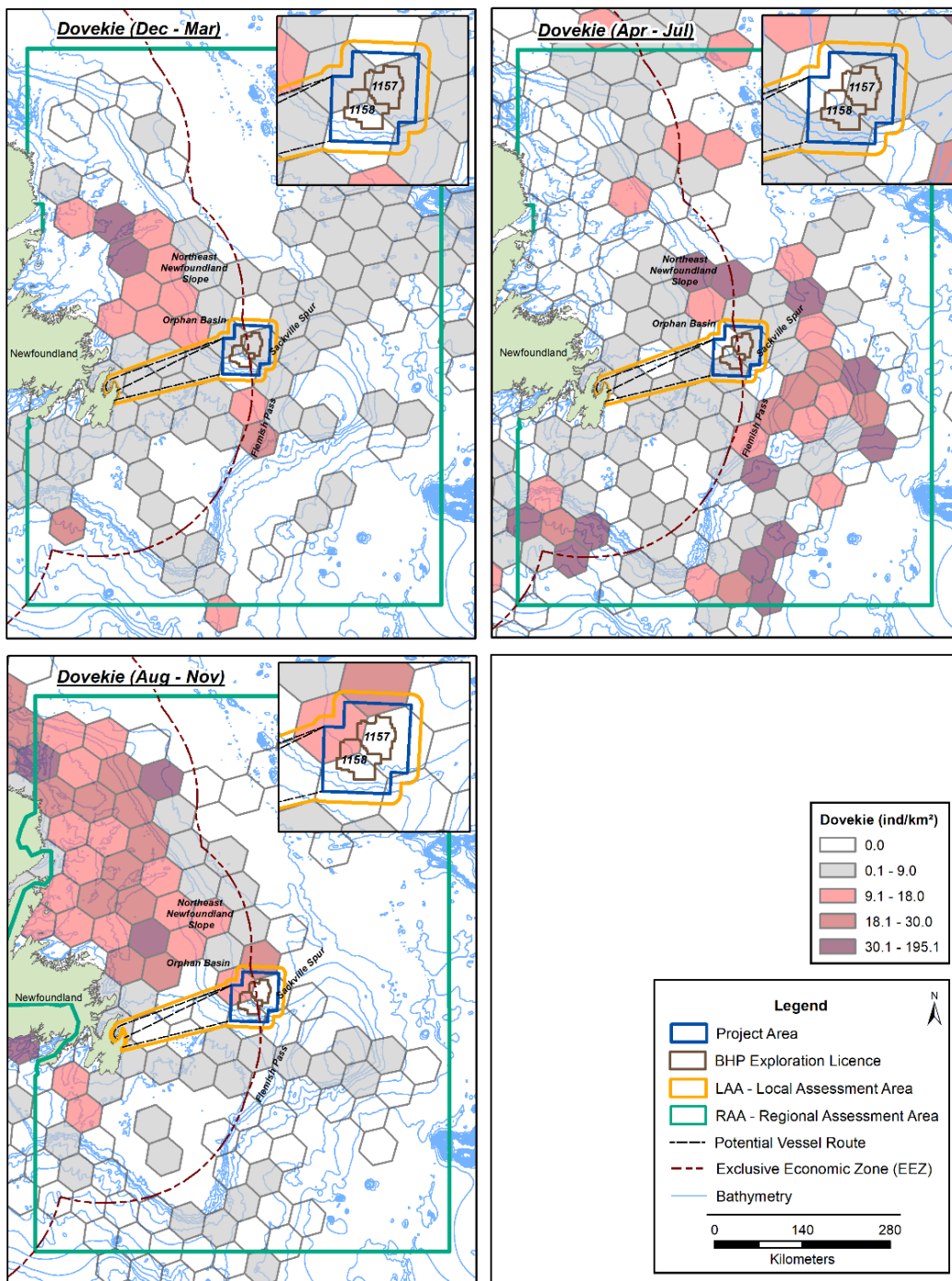
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During winter, alcids concentrate in the RAA mostly around relatively productive areas such as the continental shelf slope of the Labrador Shelf and Grand Banks (Figures 6-31 and 6-32) (Gaston et al. 2011; Hedd et al. 2011; Montevecchi et al. 2012a). Such habitat in offshore Newfoundland and Labrador waters attracts globally significant numbers of alcids during winter. During winter, the core distribution of the 30 million dovekies that nest along the west and east coasts Greenland is off eastern Newfoundland, including Orphan Basin (Fort et al. 2013). For the common murre breeding at nesting colonies in North America, offshore Newfoundland waters, including the RAA, are their core wintering area (McFarlane Tranquilla et al. 2015). Part of the winter distribution of the thick-billed murre that nest in North America also lies within the RAA, with the core wintering range being the Labrador Sea and Grand Banks, making the RAA part of one of the most important wintering areas for North Atlantic thick-billed murre breeding populations (Frederiksen et al. 2016). These wintering birds originate mostly from nesting colonies on Baffin Bay and Hudson Bay, with a minority from Spitsbergen. Following breeding, females nesting on Baffin Bay migrate rapidly to the Newfoundland-Labrador Shelf, whereas males accompanied by fledglings depart the colonies more gradually starting in mid-September. The core winter distribution of Atlantic puffins is not known because they are not seen offshore in large numbers (Fifield et al. 2009). Atlantic puffin is designated Vulnerable by IUCN due to declines in the number of birds nesting at European colonies (BirdLife International 2019). Razorbills largely congregate in the Bay of Fundy during winter (Huetteman et al. 2005). Black guillemots are limited to coastal waters throughout the year (Butler and Buckley 2002).

Dovekie densities during the April to July period fall into categories ranging from 0 to 0.1-9.0 birds/km² in the Project Area (Figure 6-31). However, they are very rare by June, having departed for Arctic nesting colonies (Moulton et al. 2006). During the August to November period they fall into density categories ranging from 0 to 18.1-30.0 birds/km², though they likely arrive throughout the RAA in October. Dovekies arrive in Orphan Basin in October, when post-breeding birds migrate to the area (Holst and Mactavish 2014). During the December to March period densities fall into categories ranging from 0 to 0.1-9.0 birds/km²; no ECSAS surveys were conducted in the western part of the Project Area.

Pooled common murre and thick-billed murre densities during the April to July period in the southern end of the Project Area range from 4.3 to 20.0 birds/km² and from 0.1 to 4.2 birds/km² in the northern part (Figure 6-32). Densities during the August to November and December to March period fell into categories ranging from 0 to 0.1-4.2 birds/km² in the Project Area (Figure 6-6).





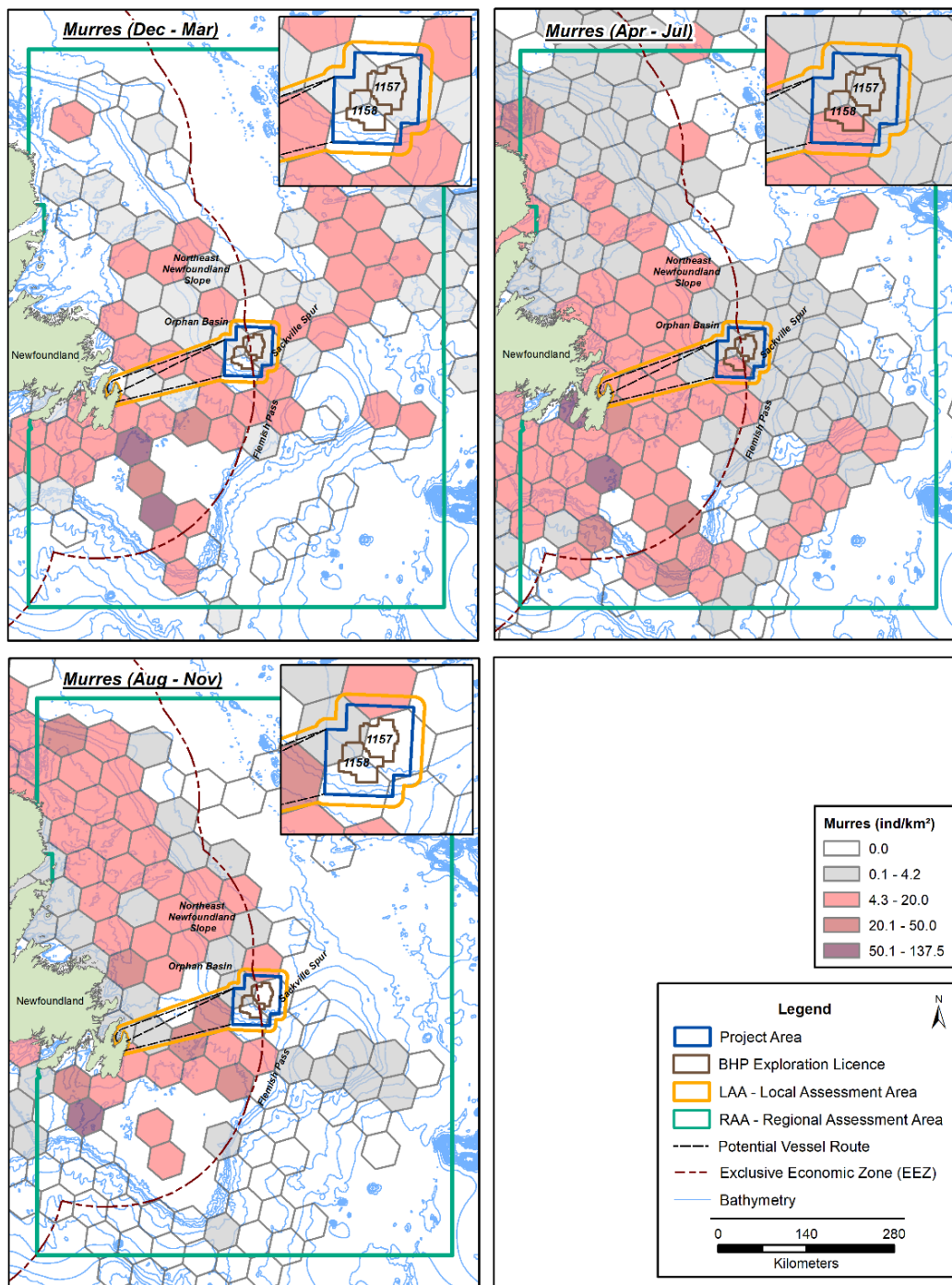
Source: Bolduc et al. 2018

Figure 6-31 Seasonal Distribution and Abundance of ECSAS Dovekie Observations in the Waters Off Eastern Newfoundland (2005-2016)



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Source: Bolduc et al. 2018

Figure 6-32 Seasonal Distribution and Abundance of ECSAS Murre (Pooled Common, Thick-billed, and Unidentified) Observations in the Waters Off Eastern Newfoundland (2005-2016)



Migrant murre arrive in Orphan Basin in October (Holst and Mactavish 2014). During the December to March period murre densities in the Project Area range from >0 to 4.2 birds/km². During this period, murre densities in the RAA are highest on the Grand Banks, ranging up to 41.6 to 63.5 birds/km² (Figure 6-32). During the April to July period, razorbill densities range from 0 to 0.3 bird/km², in the southeast corner of the Project Area. Most razorbills are inshore near nesting colonies from April to August (Bolduc et al. 2018). Razorbill was not recorded on-transect in the Project Area August to March. Puffin was not recorded on-transect during ECSAS surveys in the Project Area. Most Atlantic puffins are near their coastal breeding colonies April to August. During the December to March period the highest densities of puffin recorded in the RAA were up to 5.4 birds/km² along the southern coast of the Avalon Peninsula (Bolduc et al. 2018).

6.2.2.6 Fulmarine Petrels, Shearwaters, and Gadfly Petrels

Of the Procellariidae, northern fulmar and four species of shearwaters use the RAA during some portion of the year. Northern fulmar and Manx shearwater nest in Newfoundland in small numbers (Table 6.13) and non-breeding sub-adults summer offshore (Lock et al. 1994). Large numbers of fulmars from Arctic and sub-Arctic nesting colonies in Canada, Greenland, and Europe winter from the Labrador Sea to New England, including the RAA (Huetmann and Diamond 2000; Mallory et al. 2008). Great and sooty shearwaters from nesting colonies in the Southern Hemisphere spend the austral winter in the RAA. Most of the world's population of great shearwater migrates to offshore Newfoundland waters to feed and moult their flight feathers (Brown 1986). Most of these sooty shearwaters moult in the deep, warm waters west of the Mid-Atlantic Ridge from April to early June before moving into the cooler waters of the Grand Banks for the June to October period. (Hedd et al. 2012). Great and sooty shearwaters are the primary bird species that consume of fish on the Grand Banks at this time of year (Hedd et al. 2012). These species spend most of their time on the wing near the sea surface during migration and breeding, relying on dynamic soaring to remain aloft with little energy expenditure. However, tracking of sooty shearwaters shows that they spend most of their time on the water during their residence in the Northwest Atlantic, making them more vulnerable to oil pollution at this time of the year (Hedd et al. 2012). Great shearwaters and non-breeding, sub-adult fulmars are also more susceptible to contact with oil pollution because they undergo the annual moult of their flight feathers during the summer while in the waters of the RAA (Lock et al. 1994; Huetmann and Diamond 2000). Northern fulmars usually forage on the surface, whereas shearwaters forage by pursuit plunging to capture fish, squid, and offal (Statoil Canada Ltd. 2017).

The only confirmed North American nesting colony of Manx shearwater lies off the Burin Peninsula. It nests in small numbers at Middle Lawn Island but has been recorded in larger numbers prospecting for nest sites (Roul 2010). Manx shearwater forages near the breeding colony during the nesting period (Onley and Scofield 2007). However, this species has been recorded in August in Orphan Basin in small numbers (Jones et al. 2012; Jones and Lang 2013). Manx shearwater is considered a widespread uncommon species on the shelf waters of Newfoundland from April to October (Mactavish et al. 2016)

Non-breeding Cory's shearwaters spend the summer off Eastern Canada (Brown 1986). They originate from nesting colonies on Berlengas, Madeira, Desertas, Salvages, Azores, and Canary Islands (Onley and Scofield 2007). They are found in small numbers in Gulf Stream waters from the edge of the Scotian Shelf to the edge of the southern Grand Banks (Brown 1986) and east of the Grand Banks (Bolduc et al. 2018).



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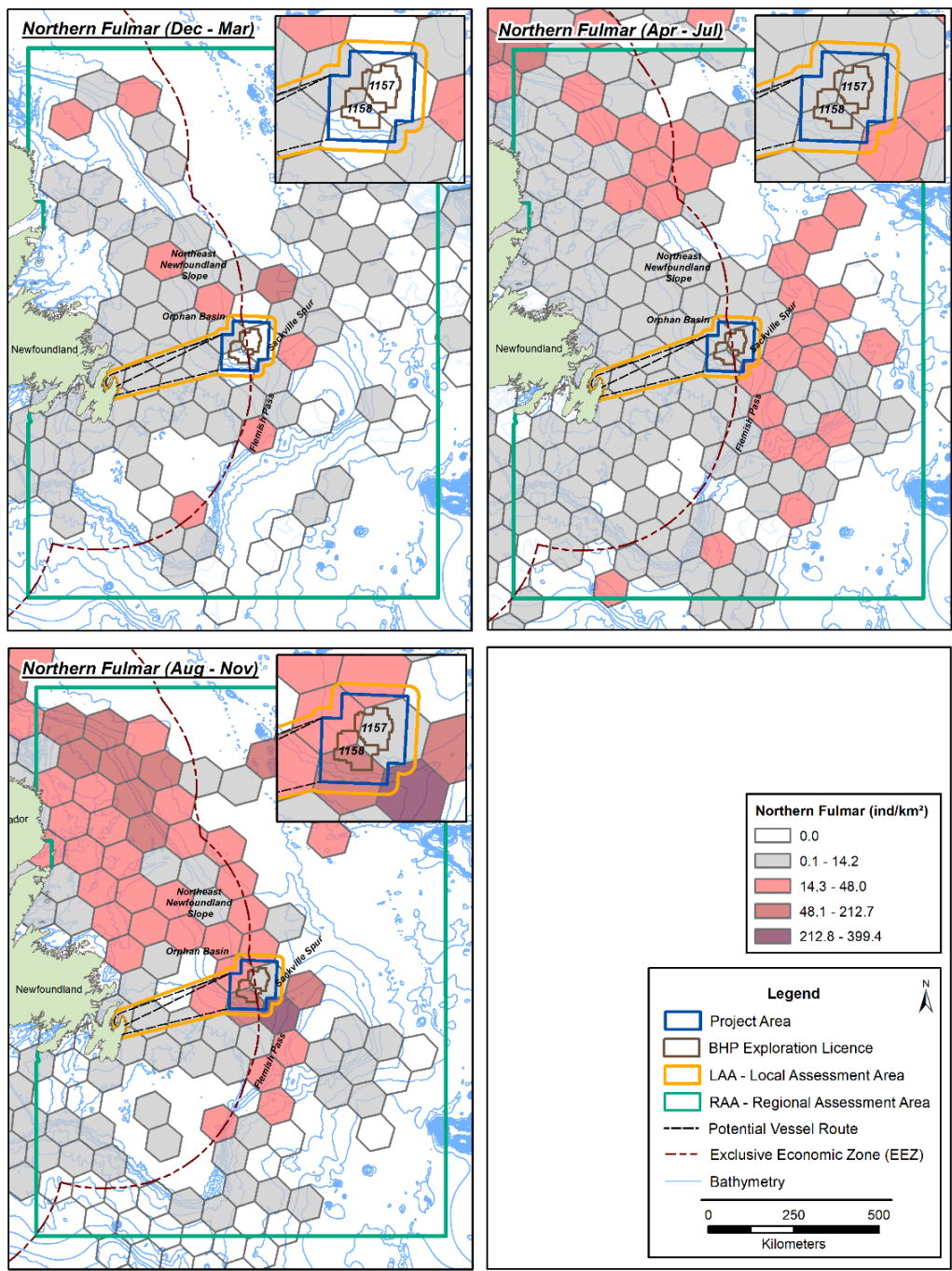
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Three species of gadfly petrel (*Pterodroma* spp.) designated globally Threatened on the IUCN Red List of Threatened Species occur in the RAA during fall and winter. The three species have a low worldwide population and are at the northern limit of their range in the southern most reaches of the RAA. Bermuda petrel is designated Endangered by IUCN (BirdLife International 2019). Data loggers placed on individuals of this species have shown presence on the southern Grand Banks and to the south and east within the RAA (Madeiros et al. 2014). Zino's petrel and Desertas (Bugio) petrel have been tracked in the RAA in the warm waters off the southeast Grand Banks (Ramirez et al. 2013; Ramos et al. 2016). Zino's petrel is also designated Endangered by IUCN (BirdLife International 2019). Desertas petrel is designated Vulnerable by IUCN (BirdLife International 2019).

Northern fulmar occurs in the Project Area during the April to July period in densities of 0.1 to 14.2 birds/km² (Figure 6-33). However, many of these birds migrate north by June to Arctic nesting colonies (Moulton et al. 2006; Holst and Mactavish 2014). During the August to November period, densities in the Project Area fall into the density category 0.1-14.2 birds/km² in the northeast part of the Project Area and fall into the category 48.1-212.7 birds/km² in the south part (Figure 6-7). Most of these birds arrive in the Project Area in September or October (Moulton et al. 2006; Holst and Mactavish 2014). During the December to March period, densities in the Project Area fall into density categories ranging from 0 to 0.1-14.2 birds/km² (Figure 6-7). However, densities are higher elsewhere in the RAA, ranging up to 48.1-212.7 birds/km² at Orphan Knoll and 14.2-48.0 birds/km² on the Tail of the Bank, the Nose of the Bank, the Sackville Spur, Orphan Knoll, and two areas of the Northeast Newfoundland Shelf (Figure 6-33).

Shearwater densities in the Project Area during April to July fall into density categories ranging from 0.1-4.2 birds/km² in the northeast corner of the Project Area to 4.3-15.2 birds/km² in the west side (Figure 6-34). During August to November, densities fall into categories ranging from 0.1-4.2 birds/km² to 15.3-35.0 birds/km². However, the majority are present only from June to September (Abgrall et al. 2008; Holst and Mactavish 2014). During the December to March period, no shearwaters were recorded on-transect during ECSAS surveys in the Project Area.

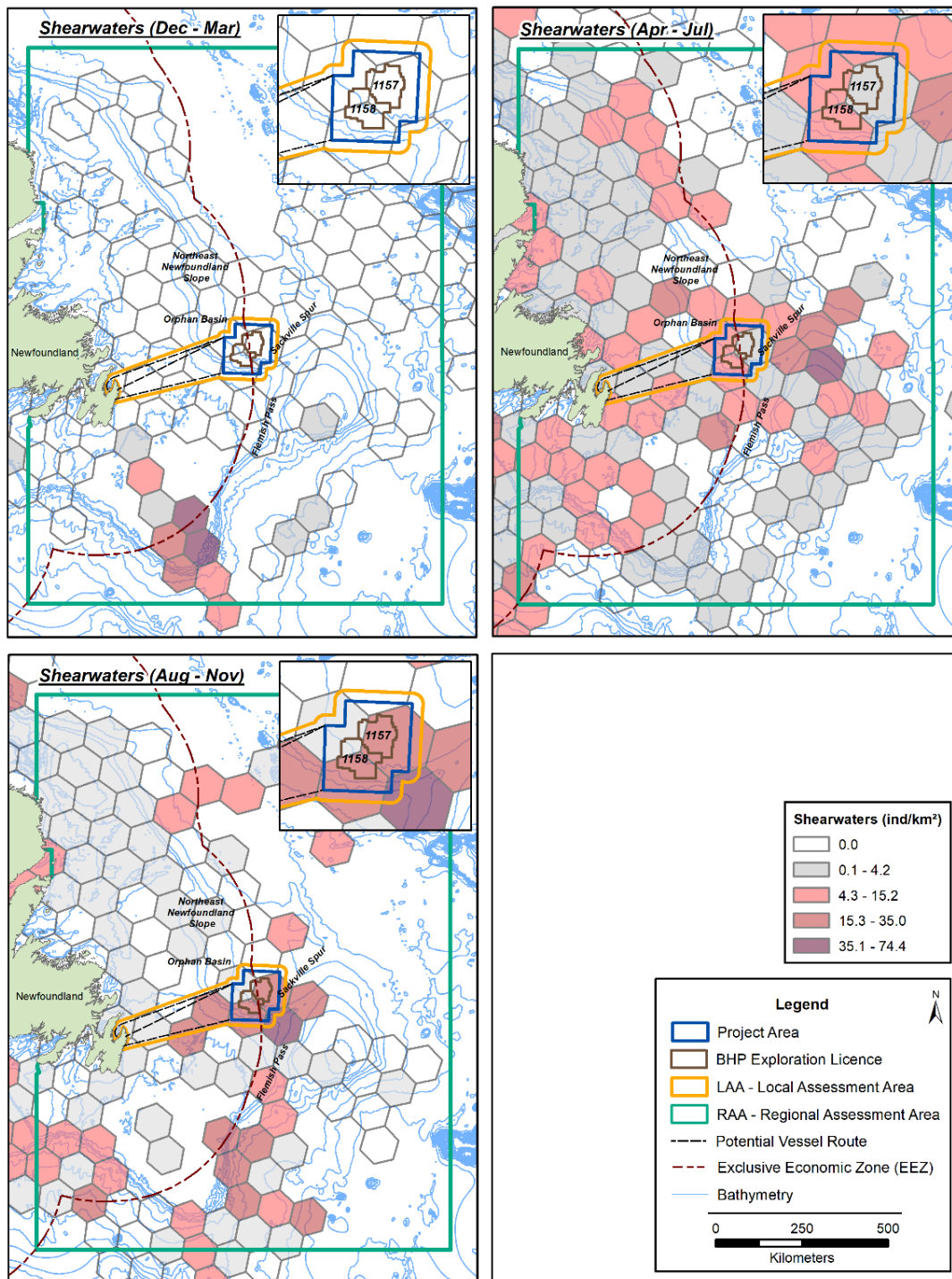




Source: Bolduc et al. 2018

Figure 6-33 Seasonal Distribution and Abundance of ECSAS Northern Fulmar Observations in the Waters Off Eastern Newfoundland (2005-2016)





Source: Bolduc et al. 2018

Figure 6-34 Seasonal Distribution and Abundance of ECSAS Shearwater (Pooled Great, Sooty, Manx, and Unidentified) Observations in the Waters Off Eastern Newfoundland (2005-2016)



6.2.2.7 Northern and Southern Storm-Petrels

Among the northern storm-petrels, only Leach's storm-petrel occurs regularly in the RAA, and among the southern storm-petrels, only the Wilson's storm-petrel occurs in the RAA. The nesting distribution of the Leach's storm-petrel on the Atlantic Ocean includes Atlantic Canada (Nova Scotia, New Brunswick and NL), Iceland, Scotland and Norway. Leach's storm-petrels winter in pelagic waters of the tropics (Onley and Scofield 2007). Some individuals may occasionally remain in the vicinity of the RAA for the winter, as suggested by the presence of a tracked individual southeast of Newfoundland in winter (Pollet et al. 2018). Wilson's storm-petrel nests in sub-Antarctic and Antarctic regions and winters in the Northern Hemisphere up to 77°N in the North Atlantic (Onley and Scofield 2007). Leach's and Wilson's storm-petrels feed by picking food items from the surface. During the nesting season, the Leach's storm-petrel commutes from the island nesting colonies to forage in deep water beyond the shelf (Pollet et al. 2014a; Hedd et al. 2018). They feed on lower mesopelagic (>400 m deep) crustaceans and small fish (e.g., lanternfish) that undergo diel vertical migration to the surface at night (Steele and Montevecchi 1994). Wilson's storm-petrel's diet while in the Northern Hemisphere is poorly known but likely includes crustaceans, small fish, molluscs, other invertebrates, and fish oil, which it picks from the surface (Brooke 2004).

Leach's storm-petrel is the most numerous nesting seabird in Newfoundland (Table 6.13). In excess of two million pairs of Leach's storm-petrel nest on the Avalon Peninsula. The population size of Newfoundland Leach's storm-petrels is undergoing a significant decline. Results from a 2013 survey of nesting Leach's storm-petrel on Baccalieu Island, the largest breeding colony of Leach's storm-petrels in the world, give an estimate of 1.95 million pairs, a decline of 42% from the previous survey in 1984 (Wilhelm et al. 2019). The drop of Leach's storm-petrels nesting in forest habitat was 70% between 1984 and 2013. The cause of this decline in the use of forest habitat and the general decrease in population of the Baccalieu Island Leach's Storm-petrels is not known. Baccalieu Island is at the mouth of Conception Bay, near a potential PSV route from Long Pond. The results of surveys of nesting Leach's storm-petrels on Gull Island in the Witless Bay Ecological Reserve indicated a decline from 352,000 breeding pairs in 2001 to 180,000 pairs in 2012, a decrease of 51% (CWS unpublished data). The number of nesting pairs at the Great Island colony, also in the Witless Bay Ecological Reserve, has declined by 55% from approximately 300,000 in 1979 to 134,000 in 2011 (Wilhelm et al. 2015). This Ecological Reserve is near a potential PSV routes from the Bay Bulls marine base. A 2015 population estimate update for Green Island, Fortune Bay (near St. Pierre et Miquelon), was 48,000 pairs (CWS unpublished data), down from a previous estimate of 103,833 pairs (Russell 2008). The cause of the Leach's storm-petrel population decline has not yet been determined. Tracking studies show that Leach's storm-petrels nesting at the Baccalieu Island and Gull Island colonies forage in the Project Area during the incubation stage of nesting (Hedd et al. 2018). It is likely that millions of these storm-petrels use the RAA during the April to October period, some of which will use the LAA and Project Area. Tracking studies show an increased presence of Leach's storm-petrels in the Project Area as they begin their migration across the Atlantic in a southeast direction to their wintering grounds (Pollet et al. 2014b). This species is designated Vulnerable by IUCN (BirdLife International 2019). Wilson's storm-petrel is found in Orphan Basin in small numbers during summer (Moulton et al. 2006; Mactavish et al. 2012; Holst and Mactavish 2014). An additional species of storm-petrel, band-rumped, occasionally occurs in the RAA in warm waters southeast of the Grand Banks. It nests on East Atlantic archipelagos. From May to August, it ranges west to Gulf Stream waters as far north as the RAA (Howell 2012; BirdLife International 2019).



Leach's storm-petrel densities in the Project Area during the April to July period fall within the category 1.6-5.7 birds/km², except for the northwest corner where they fall into the category 5.8-25.0 birds/km² (Figure 6-35). During the August to November period, densities in the Project Area range from 0.1-1.5 to 1.6-5.7 birds/km². The species was not recorded on-transect in the Project Area during the December to March period.

6.2.2.8 Northern Gannet

Northern gannet is found primarily in continental shelf waters (Garthe et al. 2007a; Fifield et al. 2014). It nests in large, dense colonies in the RAA (Table 6.13). Adults return to colonies in mid-March, followed a few weeks later by subadults (Statoil Canada Ltd. 2017). Juveniles migrate southward in September; adults and older immature birds may travel north from the colonies to feed along the southern Labrador Coast before southward migration (Statoil Canada Ltd. 2017). Gannets feed by plunge diving from a height of 10 m to 40 m above the surface, descending to depths of 15 m. They may travel over 200 km from breeding colonies like Funk Island to coastal waters to forage on pelagic fish (herring, mackerel and capelin) that spawn in the shallows (Garthe et al. 2007b). Most individuals winter along the Atlantic coast of the US and Gulf of Mexico (Fifield et al. 2014).

Gannets are most likely to be present in the RAA from March to November (Mowbray 2002; Montevecchi et al. 2012b). However, only small numbers wander off the continental shelf to the Project Area (Moulton et al. 2006, Abgrall et al. 2008, Holst and Mactavish 2014). Gannets were not recorded on-transect during ECSAS surveys in the Project Area but were recorded inshore and offshore south of the Avalon Peninsula (potential passage migrants) during the April to July and August to November periods (Figure 6-36).

6.2.2.9 Cormorants

Great and double-crested cormorants both breed in coastal Newfoundland (Table 6.13). The two species are often found in mixed colonies (Hatch et al. 2000). Cormorants are restricted to coastal areas throughout the year, except for vagrants (Hatch et al. 2000; Dorr et al. 2014). Cormorants return to the nesting colony as early as late February (Hatch et al. 2000; Dorr et al. 2014). Most double-crested cormorants leave Newfoundland colonies and migrate southward between late August and mid-October (Hatch et al. 2000; Dorr et al. 2014). Small numbers remain in coastal Newfoundland in winter (Mactavish et al. 2016). Great cormorant is present throughout the year-round, but some individuals migrate south (Hatch et al. 2000; Dorr et al. 2014).

Cormorants were recorded on-transect during ECSAS surveys only during the August to November period and only in the southwest corner of the RAA; this is attributable to the lack of sampling of coastal waters (Bolduc et al. 2018).



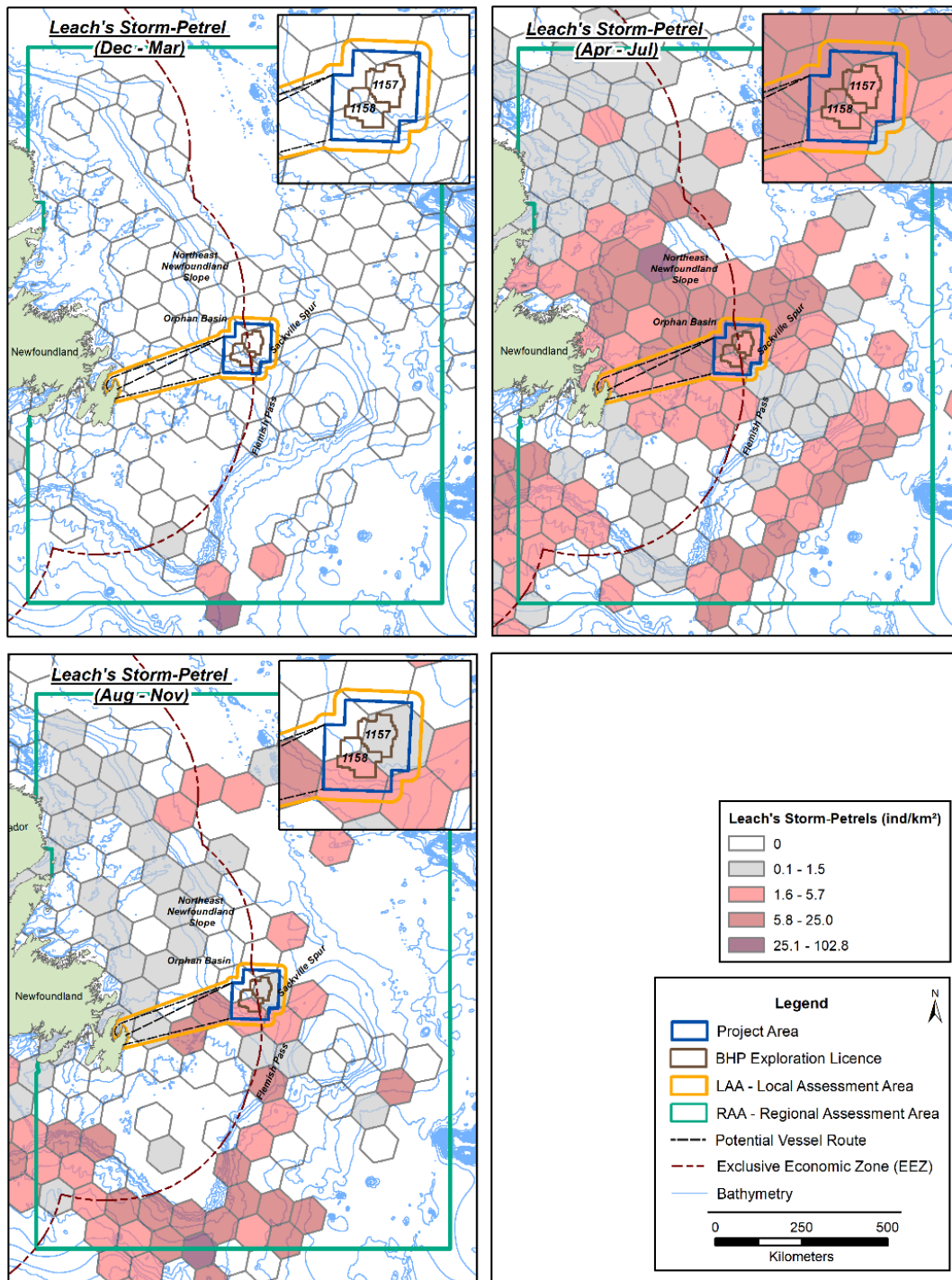


Figure 6-35 Seasonal Distribution and Abundance of ECSAS Leach's Storm-petrel Observations in the Waters Off Eastern Newfoundland (2005-2016)



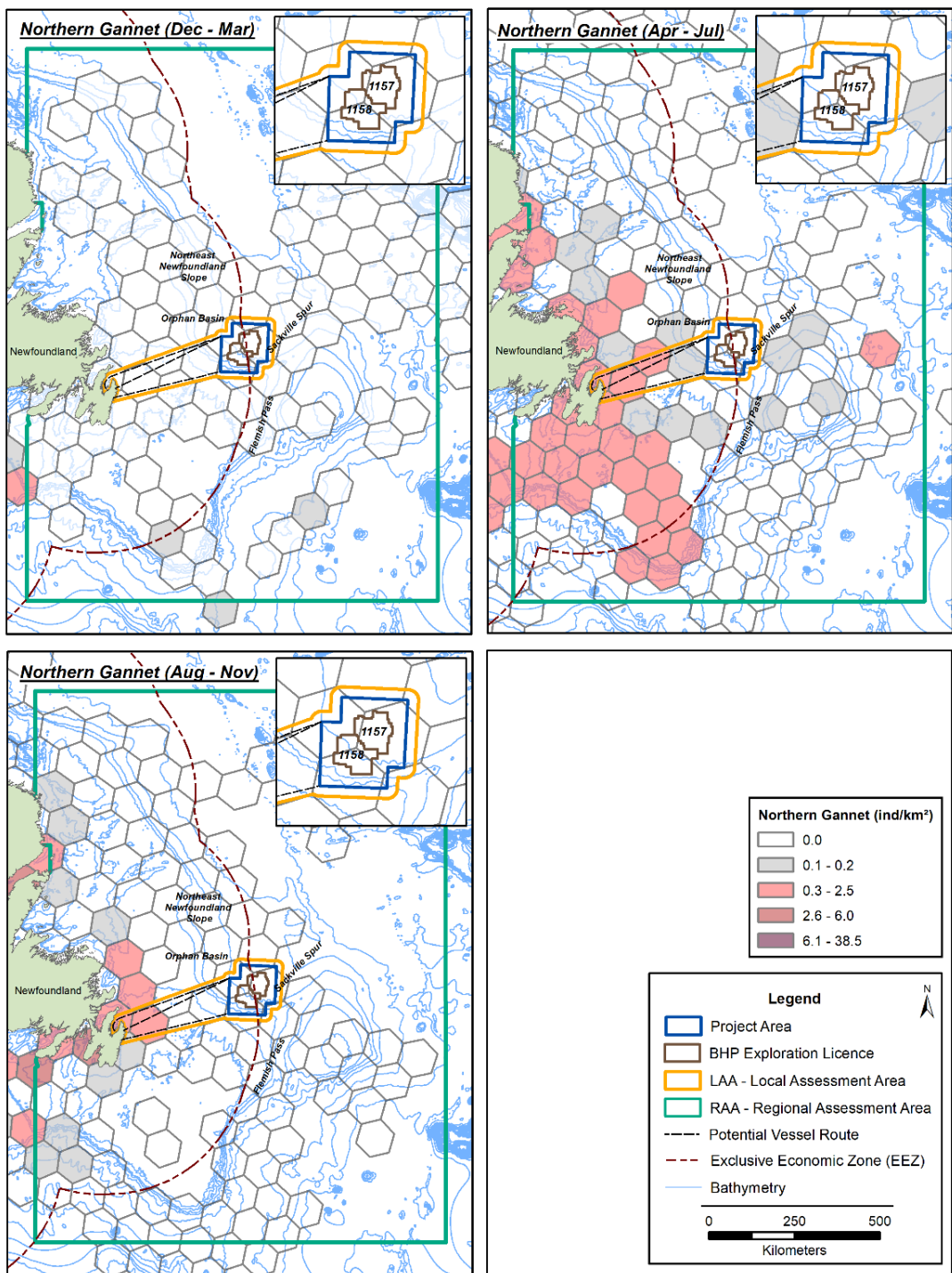


Figure 6-36 Seasonal Distribution and Abundance of ECSAS Northern Gannet Observations in the Waters Off Eastern Newfoundland (2005-2016)



6.2.3 Other Marine-associated Avifauna

Waterfowl nest in coastal Newfoundland in relatively small numbers but winter in large numbers (Lock et al. 1994). They are rarely observed beyond coastal waters. Some species of loons and grebes also winter in coastal Newfoundland waters. Some shorebird (plovers, turnstones, and sandpipers) species nesting in the Arctic make trans-oceanic flights during fall migration from eastern North America to South America (Williams and Williams 1978; Richardson 1979). As a result, small numbers are observed in offshore areas of the RAA.

6.2.3.1 Waterfowl, Loons, and Grebes

Waterfowl (ducks, geese and swans), loons, and grebes are susceptible to oil pollution because, like alcids, they spend a most of their time feeding or resting on or under the sea. These species are rarely out of sight of the coastline. A total of 32 species have occurred in Newfoundland (Statoil Canada Ltd. 2017), but only 24 species regularly occur in the marine waters of the RAA (see Table 6.14 for a list of these species). Two of these are species of conservation concern (harlequin duck and Barrow’s goldeneye) (Section 6.2.4).

Table 6.14 Waterfowl, Loons, and Grebes Likely to Occur in the Marine Waters of the RAA

Group	Species
Geese	Canada goose
Dabbling ducks	Eurasian wigeon
	American wigeon
	American black duck
	Mallard
	Northern pintail
	Green-winged teal
Diving ducks	Tufted duck
	Greater scaup
Sea ducks	King eider
	Common eider
	Harlequin duck*
	Surf scoter
	White-winged scoter
	Black scoter
	Long-tailed duck
	Barrow’s goldeneye*
Common goldeneye	
Mergansers	Red-breasted merganser
	Common merganser



Table 6.14 Waterfowl, Loons, and Grebes Likely to Occur in the Marine Waters of the RAA

Group	Species
Loons	Red-throated loon
	Common loon
Grebes	Pied-billed grebe
	Red-necked grebe
* Species with conservation designation (see Section 6.24)	

Large flocks of eider, scoter, and long-tailed duck winter along the coast in eastern NL (Lock et al. 1994). The largest numbers concentrate between the Cape Freels coastline IBA and nearby Wadham Islands IBA, and at Grates Point IBA, Cape St. Francis IBA (near a potential PSV route from Long Pond), Witless Bay SER/IBA, Mistaken Point IBA, Cape St. Mary’s SER / IBA, and Placentia Bay EBSA (Bird Studies Canada 2016). IUCN designates long-tailed duck Vulnerable (BirdLife International 2019). Flock sizes of coastal waterfowl along eastern Newfoundland increase in late winter as the southeastward movement of winter sea ice forces those flocks along the north coast of the island to move in the same direction. The most numerous species is common eider. The largest concentration of the eastern population of harlequin duck wintering in Canada is found at Cape St. Mary’s (Bird Studies Canada 2016). Barrow’s goldeneye has wintered in small numbers at Port Blandford, Newman Sound in Terra Nova National Park, Traytown Bay, St. Mary’s Bay, and Spaniard’s Bay (Schmelzer 2006, in Statoil Canada Ltd. 2017).

Ducks were recorded during ECSAS surveys in coastal areas but only PIROP surveys recorded waterfowl in the RAA (August to November) (Lock et al. 1994; Bolduc et al. 2018). Individual ducks have been observed on rare occasions from geophysical survey vessels well offshore during migration (Abgrall et al. 2008; Jones and Lang 2013; Holst and Mactavish 2014). During ECSAS surveys, the most commonly observed species of waterfowl, loons, or grebes were, in decreasing order of abundance, common eider, long-tailed duck, loons (common and red-throated), scoters (all three species), and a handful of other duck species (Statoil Canada Ltd. 2017).

6.2.3.2 Shorebirds

In total, 26 species of plovers, turnstones, and sandpipers use Newfoundland during breeding, passage migrants, or in winter (Mactavish et al. 2016, see a list of these species in Table 6.15). Of these species piping plover, spotted sandpiper, and willet nest along marine coastlines. Piping plover is designated Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and on Schedule 1 of SARA and under the provincial ESA (Section 6.2.4). However, piping plover and willet nest only at sites in southwestern and western Newfoundland, including Stephenville Crossing, Cheeseman Provincial Park and Burgeo, well outside the RAA (Statoil Canada Ltd. 2017), although there is a historical nesting record of piping plover from the Cape Freels coastline (Bird Studies Canada 2016). Approximately 15 species are common during fall migration along the coastlines in the RAA (Mactavish et al. 2016). ACSS data show migration stopovers in the RAA at Witless Bay, Renewes, Long Beach, St. Shotts, Spaniard’s Bay, and Bellevue Beach, Cape Freels, and Cape Bonavista (Environment Canada 2009; Bird Studies Canada 2016). Purple sandpiper winter (November to April) along rocky shorelines, offshore rocks, and



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islands along southern and eastern Newfoundland, including at Cape Spear, Witless Bay, Ferryland, Cape St. Francis, and Mistaken Point in the RAA (Environment Canada 2009; Bird Studies Canada 2016). A small number of ruddy turnstones have overwintered at Mistaken Point, the northernmost site in this species' usual wintering range (Bird Studies Canada 2016).

Table 6.15 Shorebird Species Likely to Occur Over the Marine Waters of the RAA

Group	Species
Plovers	Black-bellied plover
	American golden-plover
	Semipalmated plover
	Piping plover, <i>melodus</i> ssp.*
Sandpipers	Whimbrel
	Hudsonian godwit
	Ruddy turnstone
	Red knot, <i>rufa</i> ssp.*
	Sanderling
	Dunlin
	Purple sandpiper
	Least sandpiper
	White-rumped sandpiper
	Buff-breasted sandpiper
	Pectoral sandpiper
	Semipalmated sandpiper
	Wilson's snipe
	Lesser yellowlegs
Greater yellowlegs	

* Species of conservation concern (see Section 6.24)

During fall, shorebird species such as American golden-plover, whimbrel, semipalmated sandpiper, white-rumped sandpiper, and red knot depart from staging sites in Atlantic Canada to migrate southward over the Atlantic Ocean to South America (Morrison 1984; Harrington et al. 1991; Baker et al. 2013). At least seven species of shorebirds, including red knot and buff-breasted sandpiper (Endangered and Special Concern, respectively, on Schedule 1, SARA) have been sighted in small numbers from geophysical survey and offshore supply vessels in Orphan Basin and adjacent areas (Moulton et al. 2005; Abgrall et al. 2008; Hauser et al. 2010; Jones and Lang 2013; Holst and Mactavish 2014). However, much of this trans-oceanic migration appears to pass to the west of the Project Area (Baker et al. 2013; Lamarre et al. 2017) and at relatively high altitudes (Burger et al. 2011). Consequently, only small numbers may be expected at sea level in the Project Area during fall migration (primarily July to October).



6.2.3.3 Landbirds

Landbirds such as raptors and songbirds associated with coastal habitats may be encountered in coastal areas of the RAA (Statoil Canada Ltd. 2017). Landbird species nesting in eastern Canada occasionally drift out to sea during migration and land on vessels in the RAA; several species have been recorded on offshore platforms and vessels (Thomas et al. 2014b; Statoil 2015a, 2015b, unpublished migratory bird salvage reports provided by Statoil). Nocturnally migrating species are often attracted to artificial lighting on vessels, especially when fog or rain sets in after the night’s nocturnal migration has begun (Gauthreaux and Belser 2006). These species are most often seen during spring migration (April to June) and fall migration (August to November).

6.2.4 Species at Risk

In total, nine species designated at risk provincially or federally, or of conservation concern as assessed by COSEWIC, have the potential to occur in the RAA or the Project Area (Table 6.16). These species are comprised of two coastal waterfowl species, three shorebird species, one phalarope species, two gull species, and one raptor species. Other shorebird and landbird species at risk in Newfoundland are not likely to occur in the RAA or Project Area.

Table 6.16 Marine and Migratory Bird Species of Conservation Interest Likely to Occur in the RAA

Species	NL ESA Status	Federal Status		IUCN Red List
		SARA Listing	COSEWIC Assessment	
Harlequin duck (eastern pop.)	Vulnerable	Special Concern (Schedule 1)	Special Concern	None
Long-tailed duck	None	None	None	Vulnerable
Barrow’s goldeneye (eastern pop.)	Vulnerable	Special Concern (Schedule 1)	Special Concern	None
Piping plover (<i>melodus</i> ssp.)	Endangered	Endangered (Schedule 1)	Endangered	Near threatened
Red knot (<i>rufa</i> ssp.)	Endangered	Endangered (Schedule 1)	Endangered	Near threatened
Buff-breasted sandpiper	None	Special Concern (Schedule 1)	Special Concern	Near threatened
Red-necked phalarope	None	Special Concern (Schedule 1)	Special Concern	None
Black-legged kittiwake	None	None	None	Vulnerable
Ivory gull	Endangered	Endangered (Schedule 1)	Endangered	Near threatened
Ross’s gull	None	Threatened (Schedule 1)	Threatened	None
Peregrine falcon <i>anatum</i> / <i>tundrius</i>	Vulnerable	Special Concern (Schedule 1)	Special Concern	None
Leach’s storm-petrel	None	None	None	Vulnerable
Bermuda petrel	None	None	None	Endangered
Desertas petrel	None	None	None	Vulnerable
Zino’s petrel	None	None	None	Endangered



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Harlequin duck (eastern population) is designated a species of Special Concern on Schedule 1 of SARA and Vulnerable under the NL ESA. Threats to harlequin duck (eastern population) are thought to include chronic oil pollution in marine waters from illegal oil discharge, insect control programs adjacent to breeding rivers, breeding habitat loss or degradation from hydroelectric development, forestry, mineral resource extraction, gillnet bycatch on the Greenland coast (one of the wintering areas), aquaculture operations in overwintering areas, human disturbance via shipping, recreational boating and angling, and illegal hunting (Environment Canada, 2007a). This species occurs in the marine waters of the RAA between its nesting seasons (on rivers inland). It disperses to rocky coastlines, subtidal ledges, and exposed headlands to moult in summer and to winter (NLDEC 2016). Cape St. Mary's is the stronghold of wintering harlequin ducks in Newfoundland where numbers have increased steadily from 242 individuals in 2005 to 636 in 2013 (Environment Canada 2013a). Some non-breeding individuals may be found year-round, making this location one of the few known moulting sites in the province (Bird Studies Canada 2016; NLDEC 2016). Small numbers are also reported from scattered locations on the Avalon Peninsula and the south coast of Newfoundland during migration and in winter (B. Mactavish, 2019, pers. comm.). This species is likely to occur in the Project Area only rarely as a vagrant during migration. A harlequin duck was seen in Orphan Basin from a geophysical vessel on 29 September 2016 (Lang 2016).

Barrow's goldeneye (eastern population) is designated a species of Special Concern on Schedule 1 of SARA and Vulnerable under the NL ESA. Threats to Barrow's goldeneye, eastern population, that are of a high level of concern and a medium to high causal certainty consist of: logging and fish stocking, but the severity of these threats is unknown (Environment Canada. 2013b). Hydrocarbon spills are of a medium level of concern and medium causal certainty, but the severity of this threat is unknown. Hunting causes a medium level of concern but low causal certainty and has an unknown severity. This species moults and winters in coastal estuaries in the Gulf of St. Lawrence, mainly in Quebec and New Brunswick, often with common goldeneye (Schmelzer 2006). A few individuals winter in the RAA along the north coast of insular Newfoundland and St. Mary's Bay (Schmelzer 2006). The eastern population of this species is susceptible to oil pollution because some wintering concentrations are in important shipping corridors (Schmelzer 2006).

Piping plover, *melodus* subspecies, is designated Endangered on Schedule 1 of SARA and Endangered under the NL ESA. Identified threats to piping plover, *melodus* subspecies, that cause a high level of concern, have a high level of severity, and a high causal certainty consist of: predation of adults, eggs, and young, disturbance or harm from recreational beach use and vehicle operation on beaches, habitat loss or degradation from human disturbance, and coastal development (Environment Canada 2012). Threats causing a medium level of concern, with a moderate to high level of severity and a high causal certainty consist of: habitat loss or degradation due to oil or contaminant spills, flooding and extreme weather events, and pollution due to oil spills. This species occurs in Newfoundland during the nesting season primarily along the coasts of southwestern and western portions of the island on sandy beaches (NLDEC 2016; Bird Studies Canada 2016). However, in 2013, breeding was reported at Deadman's Bay near the Cape Freels Coastline IBA in northeastern Newfoundland (Bird Studies Canada 2016). Nesting has not been reported at that location since 2013, nor has this species been recorded by the ACSS in the RAA. This species is not likely to migrate through the RAA or to be affected by typical Project activities, although accidental spills near breeding habitat could potentially be harmful (Amirault-Langlais et al. 2007; Statoil Canada Ltd. 2017).



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The red knot, *rufa* subspecies, is designated Endangered on Schedule 1 of SARA and Endangered under the NL ESA. Identified threats to red knot, *rufa* subspecies, consist of harvesting of horseshoe crab in Delaware Bay, US, the eggs of which are critical to meet the energetic requirements of the final leg of the *rufa* subspecies' spring migration, and industrial and military effluents (ECCC 2017). This species occurs in Newfoundland during fall migration (1 August to 30 October) on open sandy inlets, coastal mudflats, sand flats, salt marshes, sandy estuaries and areas with rotting kelp deposits (Garland and Thomas 2009; NLDEC 2016). Most of the migration takes place to the west of the RAA, however, small numbers are regular around almost the entire coast of Newfoundland (Baker et al. 2013). ACSS data indicate that this species is a regular or occasional migrant during fall migration at Bellevue Beach, Cape Freels, and the Codroy Valley Estuary, and is a rare to uncommon visitor at a number of other survey sites (Environment Canada 2009). Red knot has been sighted at-sea in the RAA (Jones and Lang 2013).

Buff-breasted sandpiper is designated a species of Special Concern on Schedule 1 of SARA. Threats to buff-breasted sandpiper include habitat loss, fragmentation and degradation on the nesting grounds due to climate change and mineral and energy resource development (COSEWIC 2012). Threats at migration staging areas and wintering grounds consist of agriculture. Other threats may include agrochemicals, changing agricultural practices, wind energy developments, more frequent and intense storms during fall migration, and more frequent and severe droughts on the Prairies resulting in decreased food availability during spring migration. This species nests in the central and western Arctic of North America. Most of the migration passes through the Great Plains, but small numbers pass through eastern Canada during fall migration (McCarty et al. 2017). It occurs in Newfoundland during fall migration and is very uncommon in the province (likely to be found annually in appropriate season / habitat) (Mactavish et al. 2016). This species is occasionally observed at Cape Race, Cape Freels and at Cape Bonavista and is reported as a rare visitor at other survey sites (ACSS data; Environment Canada 2009). It is rarely sighted in Orphan Basin in fall migration (Abgrall et al. 2008; Jones and Lang 2013).

Red-necked phalarope is designated a species of Special Concern on SARA Schedule 1 due to a large decrease in the numbers staging during fall migration in the Bay of Fundy. It is a surface feeder, often congregating in areas such as upwellings which are associated with higher prey densities (Statoil Canada Ltd. 2017). No recovery strategy or action plans for this species have been prepared yet. Potential threats to this species may include climate change with its associated changes to habitat and food-web (COSEWIC 2014). Threats on the Arctic nesting grounds may include build-up of contaminants, increased industrial development, and denuding of vegetation by growing snow goose populations. In the non-breeding season threats may include changes in ocean temperature, salinity, and currents due to climate change, decline in the availability of prey at traditional staging areas and over-wintering sites, increased disturbance from shipping traffic, change in water quality, chronic oil pollution, point-source oil spills, and ingestion of microplastics. Red-necked phalarope is difficult to distinguish from red phalarope at sea. However, the former is seen in small numbers in the RAA. It is reported as a rare visitor at Cape Spear and Bonavista / Cape Bonavista ACSS sites (Environment Canada 2009). Red-necked phalaropes are observed annually during spring migration feeding in small flocks in the surf on the Avalon Peninsula at headlands like Cape Spear, Ferryland Head, Cape Race and St. Shotts (B. Mactavish, 2019, pers. comm.). A male tagged with a geolocator at its nest site in Scotland migrated in fall through the RAA on its way to its wintering area and back again in the following spring (Smith et al. 2014). This raises the possibility that the RAA may lie along the regular migration route of some nesting populations of red-necked phalarope.



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Ivory gull is designated Endangered on Schedule 1 of SARA and Endangered under the NL ESA. Threats to ivory gull causing a high level of concern, high severity, and medium to high causal certainty consist of: illegal shooting and predation on nests (Environment Canada 2014). Threats of a medium level of concern, medium severity, and low to medium level of certainty are industrial activities and contaminant pollution. Climate change is anticipated to become a threat to ivory gull. Tracking studies showed that ivory gulls nesting in the Canadian Arctic and Greenland and fitted with satellite transmitters wintered from Baffin Bay to the Northeast Newfoundland Shelf (Gilg et al. 2010; Spencer et al. 2016). This area has global significance for this species because individuals from these two populations make up most of the world's population. Ivory gulls were recorded twice during bird surveys at the Bay de Verde Well site on the Northeast Newfoundland Shelf in the winter of 2014-2015 (Statoil 2015a). Ivory gull can be expected to occur in small numbers in the portion of the RAA north of 50°N during periods when sea ice is present (i.e., late winter and early spring). It probably occurs irregularly south of 50°N among the ice pack during heavier ice years.

Ross's gull is designated Threatened on Schedule 1 of SARA and Threatened by COSEWIC. Threats to Ross's gull that have been identified consist of: human disturbance at nests at Churchill, Manitoba; predation by gulls, jaegers, Arctic fox, weasels and polar bears; habitat loss and destruction from flooding on nesting grounds; and from oil drilling and waste disposal at fall migration stopover sites (Environment Canada 2007b). The Ross's gull nesting in the Canadian Arctic have been tracked to a wintering area that reaches from the Labrador Sea to Orphan Basin (Maffei et al. 2015). As a result, this species has the potential to occur in very small numbers in the RAA and the Project Area during winter.

Peregrine falcon, *anatum* and *tundrius* subspecies, is designated a species of Special Concern on Schedule 1 of SARA and Vulnerable under the NL ESA. This species migrates along the coast of Newfoundland during the fall, including the Bonavista and Avalon peninsulas, preying on concentrations of migrating shorebirds (White et al. 2002). This species is seen regularly in small numbers well offshore during migration landing on vessels and oil drilling and production facilities (Moulton et al. 2006; Lang et al. 2008). This species is a strong flyer, crossing large bodies of water during migration. However, it may be attracted to vessels and platforms for the opportunity to rest or to prey on seabirds and on landbirds that seek refuge on and near those vessels and platforms during migration.

6.2.5 Summary of Key Areas and Times

The marine waters of the RAA are important to many marine-associated and migratory bird species during some portion of the year (Table 6.17). During summer large numbers of seabirds are concentrated in the vicinity of coastal nesting colonies (Fifield et al. 2009). This includes globally important numbers of Atlantic puffin, common murre, Leach's storm-petrel, and northern gannet, and continentally important numbers of black-legged kittiwake, and smaller numbers of other species (Bird Studies Canada 2016). Most of these birds forage relatively close to their colonies on pelagic fish that have migrated to the shallow waters to spawn. The exception is Leach's storm-petrel, which commutes over the continental shelf to forage for itself and its nestlings in deep waters off the shelf, such as Orphan Basin and Flemish Pass, which is the nearest deep-water area to the largest nesting colony in the world of this species (i.e., Baccalieu Island).



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Table 6.17 Summary of Seasonal Presence of Marine-associated Birds in the Project Area

Presence and Relative Abundance													
Common Name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	
Ducks, Geese, and Swans													
Waterfowl (passage migrants)			VS	VS					VS	VS			
Plovers and Sandpipers													
Shorebirds (passage migrants)							S	S	S	S			
Phalaropes													
Red-necked phalarope*					S	S	S	S	S				
Red phalarope					S	S	S	S	S	S			
Gulls and Terns													
Black-legged kittiwake	C	C	C	C	C	C	C	C	C	C	C	C	
Ivory gull*	VS	VS	VS	VS									
Sabine's gull					VS	VS		VS	VS				
Ross's gull*	VS	VS	VS	VS	VS					VS	VS	VS	
Herring gull	U	U	U	U	U	S	S	S	S	S	S	S	
Iceland Gull	S	S	S	S						S	S	S	
Lesser black-backed gull					VS	VS	VS	VS	VS	VS	VS	VS	
Glaucous gull	S	S	S	S						S	S	S	
Great black-backed gull	U	U	U	U	U	S	S	U	C	C	U	U	
Arctic tern					S	S	S	S	S				
Skuas and Jaegers													
Great skua					S	S	S	S	S	S			
South polar skua					S	S	S	S	S	S			
Pomarine jaeger				S	S	S	S	S	S	S			
Parasitic jaeger					S	S	S	S	S	S			
Long-tailed jaeger					S	S	S	S	S				
Auks, Murres, Puffins, and Guillemots													
Dovekie	C	C	C	C	U	VS	VS	VS	S	C	C	C	



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Table 6.17 Summary of Seasonal Presence of Marine-associated Birds in the Project Area

Presence and Relative Abundance												
Common Name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Common murre	S-U	S-U	S-U	C	C	C	C	C	C	C	C	C
Thick-billed murre	C	C	C	C	C	S-U	S-U	S-U	U-C	C	C	C
Razorbill				S	S	S	S	S	S	S	S	
Atlantic puffin				S	S	S	S	S	U	U	U	U
Fulmarine Petrels, Shearwaters, and Gadfly Petrels												
Northern fulmar	C	C	C	C	C	C	C	C	C	C	C	C
Great shearwater					U	C	C	C	C	C	S	
Sooty shearwater					S	S-U	S-U	S-U	S-U	S-U	S	
Manx shearwater					S	S	S	S	S	S		
Cory's shearwater							VS	VS	VS			
Bermuda petrel		VS	VS	VS	VS							
Zino's petrel				VS	VS	VS	VS	VS	VS	VS		
Desertas petrel	VS	VS	VS								VS	VS
Storm-Petrels												
Leach's storm-petrel					U-C	C	C	C	C	C	S	
Band-rumped storm-petrel					VS	VS	VS	VS				
Wilson's storm-petrel							S	S	S	S		
Gannets												
Northern gannet				S	S	S	S	S	S	S		
Cormorants												
Great and double-crested cormorants				VS	VS				VS	VS		
Landbirds												
Landbirds (vagrant migrants)				VS	VS			VS	VS	VS		
Notes: * Species with conservation designation (see Section 6.2.4). C = Common, present daily in moderate to high numbers; U = Uncommon, present daily in small numbers; S = Scarce, present, regular in very small numbers; VS = Very Scarce, very few individuals or absent. Blank spaces indicate not expected to occur in that month.												



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Summer concentrations of non-breeding, sub-adult northern fulmars are also found in deep waters off the shelf. During summer, the Grand Banks also host species that migrate from nesting areas in the South Atlantic, including globally important numbers of great shearwater, large numbers of sooty shearwater, and smaller numbers of Wilson's storm-petrel, and south polar skua.

Upon completion of nesting, the species that were abundant in coastal areas of the RAA largely move offshore or south. Continentally significant numbers of wintering common eider, nationally important numbers of harlequin duck (Special Concern, SARA Schedule 1) and large numbers of other species of sea duck, and large numbers of Iceland gulls occur in coastal areas in winter (Bird Studies Canada 2016). Other Arctic-breeding species arrive to winter along the continental shelf break and adjacent areas. These include globally significant numbers of black-legged kittiwake, dovekie, and thick-billed murre, and large numbers of northern fulmar. Great black-backed gulls also move offshore. Newfoundland waters are also an important wintering area for the great skua population nesting in Iceland. In the northwest quarter of the RAA, the Northeast Newfoundland Shelf is part of a globally significant wintering area for ivory gull (Endangered, SARA Schedule 1). The ECSAS program has identified 'hotspots' in the offshore areas of the RAA where these species concentrate in winter and in fall migration. These consist of: Orphan Basin and Sackville Spur, Flemish Cap and Pass, the northeast section of the Grand Banks, the northeast Newfoundland Shelf, and the Labrador Shelf / Labrador Sea (Fifield et al. 2009).

Several coastal areas have been designated as IBAs because of seabirds that concentrate to nest, stage, or winter. The program was initiated and is coordinated by BirdLife International and is administered in Canada by the Canadian Nature Federation and Bird Studies Canada. The program uses internationally standardized criteria to identify sites of national and international importance. These criteria consist of one or more of: the presence of species at risk, species with restricted range, habitats holding representative species assemblages, or a congregation of a significant proportion of a species' population during one or more seasons. There are 21 IBA sites in eastern Newfoundland and 10 of these include marine waters of the RAA (Figure 6-37). These are summarized in Table 6.18. Some of these IBAs are also designated federal Migratory Bird Sanctuaries (MBS) or provincial Seabird Ecological Reserves, e.g., Baccalieu Island and Witless Bay Islands (Table 6.18). These two IBAs/SERs are near potential PSV routes, the former at the mouth of Conception Bay and the latter near the Bay Bulls marine base. Seabird Ecological Reserves are protected from industrial development and other activities that can cause disturbance to breeding seabirds pursuant to the *Seabird Ecological Reserve Regulations, 2015*.

EBSAs have also been identified in the RAA (Figure 6-37, Table 6.19). The criteria for selection and ranking of EBSAs included importance to seabird biodiversity, density, reproduction, and survival.

More information on special areas of importance to Marine Birds (e.g., MBS, EBSAs) is included in Section 6.4 (Special Areas).



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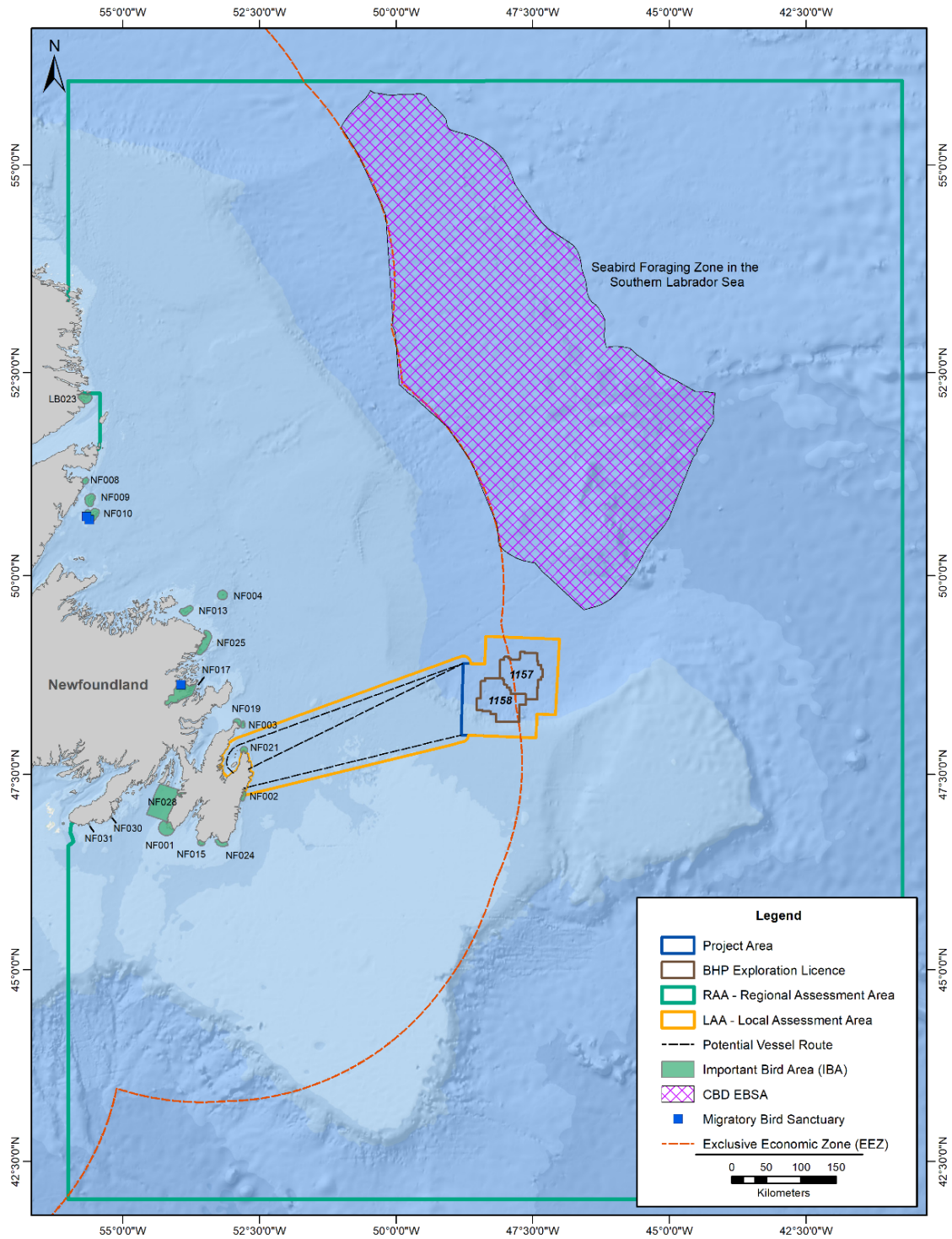


Figure 6-37 Important Bird Areas, Migratory Bird Sanctuaries, and Seabird Ecologically or Biologically Significant Area Locations



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Table 6.18 Important Bird Areas on Marine Waters of Eastern Newfoundland

IBA Name and IBA Number*	Importance to Marine and Migratory Birds
St. Peter Bay (LB023)	Harlequin duck ^S premoult ^N ; common eider major moulting area ^C
Fischot Islands (NF008)	Common eider wintering ^G
Northern Groais Island (NF009)	Black-legged kittiwake nesting colony ^C ; common eider wintering
Bell Island South Coast (NF010)	Common eider nesting colony ^C ; includes federal Île aux Canes MBS
Funk Island (NF004)	Nesting ^G common murre, nesting ^G northern gannet; provincially protected SER ^E ; overlaps Fogo Shelf EBSA ^E
Wadham Islands and adjacent Marine Area (NF013)	Wintering ^C common eider; nesting ^C Atlantic puffin, nesting Leach's storm-petrel and razorbill; overlaps Fogo Shelf EBSA ^E
Cape Freels Coastline and Cabot Island (NF025)	Wintering ^C common eider; nesting ^C black-headed gull; nesting common murre, razorbill, Atlantic puffin, and common / Arctic tern; overlaps Fogo Shelf EBSA ^E
Terra Nova National Park (NF017)	Wintering ^C black-headed gull; wintering ^C dovekie; shorebirds, gulls and waterfowl on tidal flats at Big Brook and Newman Sound; large nos. nesting common / Arctic terns; includes federal Terra Nova MBS
Grates Point (NF019)	Wintering ^C common eiders; wintering black-legged kittiwake, thick-billed murre, dovekie; summer use Atlantic puffin, northern Gannet
Baccalieu Island (NF003)	Nesting ^G Leach's storm-petrel and Atlantic puffin; nesting ^C black-legged kittiwake, large nos. nesting northern gannet; other nesting species; SER; at the mouth of Conception Bay.
Cape St. Francis (NF021)	Fall migration ^C dovekie; fall migration ^C Manx shearwater; large nos. wintering common eider; wintering purple sandpiper; at the mouth of Conception Bay.
Witless Bay Islands (NF002)	Nesting ^G Atlantic puffin, common murre, razorbill, and Leach's storm-petrel; nesting ^C black-legged kittiwake and herring gull; staging waterfowl; SER; overlaps Eastern Avalon Coast EBSA ^E ; near Bay Bulls marine base.
Mistaken Point (NF024)	Wintering common eider; wintering ^C purple sandpiper; nesting black-legged kittiwake, common murre and razorbill; spring ^C , summer and fall Manx shearwater; Provincial Ecological Reserve and United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site (fossil deposits)
Cape Pine and St. Shotts Barren (NF015)	Nesting razorbill; large nos. fall staging American golden-plover and whimbrel; overlaps Placentia Bay EBSA ^E
Cape St. Mary's (NF001)	Nesting ^G northern gannet; nesting ^C black-legged kittiwake, wintering ^N and moulting harlequin duck ^S ; nesting common and thick-billed murre, razorbill, black guillemot, herring and great black-backed gull, great and double-crested cormorant, wintering waterfowl; overlaps Placentia Bay EBSA ^E
Placentia Bay (NF028)	Great shearwater summering ^G ; dovekie wintering ^C ; Manx shearwater summering ^C ; overlaps Placentia Bay EBSA ^E
Corbin Island (NF030)	Leach's storm-petrel nesting ^G ; herring gull nesting ^C ;
Middle Lawn Island (NF031)	Manx shearwater summering ^C ; Leach's storm-petrel nesting ^G

^C Continentally Significant concentration of birds (IBA criteria), ^E EBSA, ^G Globally Significant concentration, ^N Nationally Significant concentration, ^P Provincial Seabird Ecological Reserve (SER), ^S Species of Conservation Concern

* Locations illustrated in Figure 6-11



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Table 6.19 Ecologically or Biologically Significant Areas of Importance to Marine Birds

EBSA	Importance to Marine Birds
Southwest Shelf Edge and Slope	Highest density of pelagic marine birds foraging within the Placentia Bay / Grand Banks Large Ocean Management Area
Placentia Bay Extension	Important foraging area for many breeding marine bird species from spring to fall. Includes IBAs: Cape Pine and St. Shotts Barren, Cape St. Mary's.
Eastern Avalon Coast	Important foraging area for many breeding marine bird species from spring to fall. Includes IBA: Witless Bay Islands.
Southeast Shoal and Tail of the Bank	Important seasonal foraging area for marine birds
Virgin Rocks	High aggregations of capelin and other spawning groundfish such as Atlantic cod, American plaice, and yellowtail flounder. Seabird feeding area.
Northeast Shelf and Slope	Seabird concentrations year-round.
Fogo Shelf	Funk Island, the largest common murre colony in the western North Atlantic and the only northern gannet breeding colony in the Newfoundland and Labrador Shelves Bioregion. Other bird species aggregations also, due to abundance of beach and sub-tidal capelin spawning areas. Includes IBAs: Cape Freels Coastline and Cabot Island, Wadham Islands and adjacent Marine Area, Funk Island.
Notre Dame Channel	Frequented by several species of seabirds.
Grey Islands	Important for waterfowl and seabirds in coastal areas and on the shelf. Common eider and harlequin duck occur in high concentrations. Important breeding colonies for great black-backed gulls, herring gulls, and terns. High diversity of seabird species that aggregate along the inner shelf area. Includes IBAs outside of the Regional Assessment Area: Fischot Islands, Northern Groais Island, Bell Island South Coast.
Labrador Marginal Trough	Important for seabirds including murre, black-backed kittiwake, great black-backed gull, herring gull, northern fulmar, Atlantic puffin, skuas, jaegers, sooty shearwater, and the SARA-listed ivory gull.
Seabird Foraging Zone in the Southern Labrador Sea	Important for 40 million seabirds from 20 populations including wintering kittiwakes, thick-billed murre, and breeding Leach's storm-petrels.
Source: From Templeman (2007), DFO (2012, 2016), Secretariat of the Convention on Biological Diversity (2014), Wells (2017), and environmental monitoring reports (seabirds and marine mammals) of geophysical surveys (various years)	



6.3 MARINE MAMMALS AND SEA TURTLES

Thirty-two marine mammal species could potentially occur in the Project Area and RAA, including 26 cetacean species (whales, dolphins, and porpoises) and six seal species. Seven of the cetacean species are considered to be extralimital (i.e., outside their normal ranges); however, sightings / detections have been or could be made within the RAA. Most marine mammals use the area seasonally; the region likely offers important foraging habitat for many species. Four species of sea turtle could also occur within or near the Project Area.

6.3.1 Approach and Key Information Sources

Descriptions of marine mammals and sea turtles in offshore waters off eastern Newfoundland were presented in the Eastern Newfoundland SEA (Section 4.2.3 of AMEC 2014) as well as project-specific exploration drilling and seismic EAs off the east coast of Newfoundland (Section 4.5 of LGL 2015, 2016; Section 6.3 of Statoil 2017 and ExxonMobil 2017). An overview of marine mammals and sea turtles that occur in or near the Project Area is provided below, based on the aforementioned documents. New information that was not included in the SEA or project-specific EAs, including from COSEWIC species assessments and status reports, DFO research and scientific documents, peer-reviewed publications, and technical reports, is also summarized below. The main sources of information regarding the occurrence of marine mammals and sea turtles, their distribution, and abundance within or near the Project Area are summarized below:

- The DFO cetacean and sea turtle sightings database for Newfoundland and Labrador (NL) is compiled from various sources by DFO, St. John's (J. Lawson, DFO Research Scientist, pers. comm., April 2019) and was made available by DFO to describe sightings within the Project Area. As the data are collected opportunistically, they do not include information on survey effort. Therefore, the data indicate what species have occurred in the Project Area at various times of the year, but they cannot reliably predict the distribution, abundance, or fine-scale habitat use of species in the area. Data from 1945 to 2015 were used for the sighting summary tables and mapping. The caveats that should be considered when using sightings from the DFO database were described in Section 4.5.1.1 of LGL (2015).
- Incidental sightings of marine mammals and sea turtles made during geophysical surveys and drilling programs by Equinor Canada were compiled for 2008 to 2015. Data included those from LGL (2009, 2014), Fugro (2015), PAL (2015), and other Equinor Canada activities off eastern Newfoundland (Equinor Canada, unpublished data). Marine mammal sightings were provided to the C-NLOPB.
- The C-NLOPB database includes sighting data for marine mammals and sea turtles during various geophysical surveys in the waters off Newfoundland from 2004 to 2017. Except for sightings from 2016 and 2017, these records are included in the DFO cetacean and sea turtle database. Sightings of marine mammals near the Project Area that were recorded during two programs for Fugro (in 2017) and three programs for MKI (in 2016) are included in this database.



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- Sea turtle records from a global open-access database (OBIS; <http://seamap.env.duke.edu/>) were mapped, as they include records of bycatch during pelagic fisheries which are not included in the DFO cetacean and sea turtle database. Marine mammal sightings from OBIS were not mapped, as most records are included in the DFO database. Similar to the DFO database, there is no information on survey effort in the OBIS database.
- As part of an ESRF study, *Acoustic Monitoring Along Canada's East Coast: August 2015 to July 2017* (Delarue et al. 2018), 20 acoustic recorders were deployed over two years between northern Labrador and the southwestern Scotian Slope to record marine mammal vocalizations. The closest recorder (Stn 19) to the Project Area was deployed at Sackville Spur, 40 km to the east during July 2016 to July 2017, and 40 km to the west during August 2015 to July 2016. The next closest recorder to the Project Area was located 120 km to the south.
- The Trans North Atlantic Sightings Survey (TNASS) was a large-scale survey for marine mammals and sea turtles that covered Canadian waters between northern Labrador and the Scotian Shelf during July and August 2007 (Lawson and Gosselin 2009). Sightings of marine mammals made during these surveys were used to calculate abundance estimates for various regions, including Newfoundland.

6.3.2 Overview of Species Occurrence

The potential time of occurrence and conservation status for marine mammal and sea turtle species that could occur within the Project Area are summarized in Tables 6.20 and 6.21, respectively. Sightings of cetaceans and sea turtles in the Project Area and RAA within the temporal scope of the Project (year-round) are summarized in Table 6.22, based on available sightings databases. Sightings include baleen whales (mysticetes); large toothed whales, dolphins, and porpoises (odontocetes); and sea turtles.



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Table 6.20 Marine Mammals that May Occur in the Project Area and Regional Assessment Area

Common Name	SARA Schedule 1 Status ^A	COSEWIC Designation ^{B, C}	Potential Timing of Presence	Sources
Mysticetes (Baleen Whales)				
Blue Whale (Atlantic population)	Endangered	Endangered	Year-round (highest numbers from early spring through winter)	COSEWIC (2002a) ; Waring et al. (2011) ; Lesage et al. (2016)
Fin Whale (Atlantic population)	Special Concern	Special Concern	Year-round	COSEWIC (2005); DFO (2017a); Hayes et al. (2018)
Sei Whale (Atlantic population)	Not Listed	Endangered	Seasonal (summer)	COSEWIC (2003a); Hayes et al. (2017)
Humpback Whale (Western North Atlantic population)	Not Listed (Special Concern on Schedule 3)	Not at Risk	Year-round (highest concentration from spring through winter)	Lawson and Gosselin (2009); Bettridge et al. (2015)
Common Minke Whale (North Atlantic subspecies)	Not Listed	Not at Risk	Year-round (highest concentration spring through fall)	Risch et al. (2014) ; Hayes et al. (2018)
North Atlantic Right Whale	Endangered	Endangered	Summer	COSEWIC (2013); Hayes et al. (2018)
Bowhead Whale ⁴ (Eastern Canada-West Greenland population)	Not Listed	Special Concern	Unknown	Ledwell et al. (2007); COSEWIC (2009a); CBC (2014)
Odontocetes (Toothed Whales)				
Sperm Whale	Not Listed	Not at Risk; Mid-priority Candidate	Year-round	Waring et al. (2015)
Pygmy sperm whale ^{D, E}	Not Listed	Not at Risk	Unknown	Hayes et al. (2017)
Northern Bottlenose Whale (1: Scotian Shelf population/ 2: Davis Strait-Baffin Bay-Labrador Sea population)	1. Endangered 2. Not Listed	1. Endangered 2. Special Concern	Year-round	COSEWIC (2011); DFO (2016a)
Sowerby's Beaked Whale	Special Concern	Special Concern	Unknown	COSEWIC (2006a); DFO (2017b)
Cuvier's Beaked Whale ^{D, E}	Not Listed	Not at Risk; High-priority Candidate	Unknown	Waring et al. (2014)



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Table 6.20 Marine Mammals that May Occur in the Project Area and Regional Assessment Area

Common Name	SARA Schedule 1 Status ^A	COSEWIC Designation ^{B, C}	Potential Timing of Presence	Sources
Killer Whale (Northwest Atlantic/Eastern Arctic population)	Not Listed	Special Concern	Year-round	COSEWIC (2009b); Waring et al. (2015)
False Killer Whale ^D	Not Listed	Not Listed	Unknown	Waring et al. (2015)
Long-finned Pilot Whale	Not Listed	Not at Risk	Year-round	Fullard et al. (2000) ; Hayes et al. (2017)
White-beaked Dolphin	Not Listed	Not at Risk	Year-round	Waring et al. (2007)
Atlantic White-sided Dolphin	Not Listed	Not at Risk	Year-round	Hayes et al. (2018)
Common Dolphin (Short-beaked)	Not Listed	Not at Risk	Seasonal (summer through fall)	Hayes et al. (2018)
Risso's Dolphin	Not Listed	Not at Risk	Year-round	Hayes et al. (2018)
Common Bottlenose Dolphin	Not Listed	Not at Risk	Seasonal (May to September)	Hayes et al. (2017)
Atlantic Spotted Dolphin	Not Listed	Not Listed	Unknown	Waring et al. (2014)
Spinner Dolphin ^D	Not Listed	Not Listed	Unknown	Waring et al. (2014)
Striped Dolphin	Not Listed	Not at Risk	Seasonal (summer)	Waring et al. (2014)
Harbour Porpoise (Northwest Atlantic population)	Not Listed (Threatened on Schedule 2)	Special Concern	Year-round	COSEWIC (2006b)
Beluga Whale ^D (St. Lawrence Estuary population)	Endangered	Endangered	Unknown	COSEWIC (2014)
Narwhal ^D	Not Listed	Special Concern	Unknown	COSEWIC (2004)
Phocids (Seals)				
Harbour Seal (Atlantic and Eastern Arctic subspecies)	Not Listed	Not at Risk	Year-round	Hayes et al. (2018)
Harp Seal	Not Listed	Not Listed; Low-priority Candidate	Year-round (highest concentrations in winter)	DFO (2012); AMEC (2014); Waring et al. (2014)



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Table 6.20 Marine Mammals that May Occur in the Project Area and Regional Assessment Area

Common Name	SARA Schedule 1 Status ^A	COSEWIC Designation ^{B, C}	Potential Timing of Presence	Sources
Hooded Seal	Not Listed	Not at Risk; Mid-priority Candidate	Seasonal (highest concentrations in winter)	Waring et al. (2007); Andersen et al. (2009, 2012, 2013, 2014)
Grey Seal	Not Listed	Not at Risk	Year-round	Lesage and Hammill (2001); Hayes et al. (2018)
Ringed Seal	Not Listed	Not at Risk	Year-round	SEM (2008)
Bearded Seal	Not Listed	Data Deficient; Mid-priority Candidate	Year-round	SEM (2008)
<p>Notes:</p> <p>^A SARA = Canadian <i>Species at Risk Act</i>.</p> <p>^B COSEWIC = Committee on the Status of Endangered Wildlife in Canada.</p> <p>^C None of these marine mammal or sea turtle species are currently listed under the Newfoundland and Labrador <i>Endangered Species Act</i> (NL ESA).</p> <p>^D These species are considered extralimital in the RAA and are not considered further.</p> <p>^E Although no confirmed visual detections have been made near the Project Area, sightings have been made within the RAA, and these species were detected acoustically near the Project Area during the ESRF acoustic study (Delarue et al. 2018).</p> <p>Additional Sources: Husky Energy (2012), AMEC (2014), BP (2016).</p>				



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Table 6.21 Sea Turtle Species that May Occur in the Project Area and Regional Assessment Area

Common Name	SARA Schedule 1 Status	COSEWIC Designation	Potential Timing of Presence	Sources
Leatherback Sea Turtle (Atlantic population)	Endangered	Endangered	Seasonal (spring through fall)	COSEWIC (2012a)
Loggerhead Sea Turtle	Endangered	Endangered	Seasonal (spring through fall)	Brazner and McMilan (2008); COSEWIC (2010)
Green Sea Turtle	Not Listed	Not Listed	Seasonal (summer and fall)	James et al. (2004)
Kemp's Ridley Sea Turtle ^A	Not Listed	Not Listed	Seasonal	National Marine Fisheries Service (NMFS) et al. (2011)
Notes: ^A This species is considered extralimital in the RAA. Additional Sources: Husky Energy (2012), AMEC (2014), and BP (2016).				

Table 6.22 Cetacean and Sea Turtle Sightings in the Project Area and Regional Assessment Area based on Compiled Data

Species	Regional Assessment Area			Project Area		
	Number Sightings	Number Individuals	Months Sighted	Number Sightings	Number Individuals	Months Sighted
Mysticetes (Baleen)						
Fin Whale	4,653	7,137	Feb-Dec	45	68	May-Oct
Blue Whale	210	246	Mar-Oct	0	0	–
Sei Whale	294	578	Feb, May-Dec	23	39	May-Oct
Humpback Whale	6,277	28,475	Jan-Dec	83	148	Jan-Feb, May-Sep, Nov
Minke Whale	2,296	6,778	Jan, Mar-Dec	26	34	Jan, Jun-Sep, Nov
North Atlantic Right Whale	6	10	Jun, Aug-Sep	1	2	Jun
Bowhead Whale	1	1	May	0	0	–
Fin / Sei Whale	53	86	Apr-Oct, Dec	10	16	Jun-Sep
Unidentified Baleen Whale	456	601	May-Dec	47	69	May-Nov
Odontocetes						
Sperm Whale	421	960	Jan-Dec	81	152	Jan-Dec
Pygmy Sperm Whale	1	2	Jun	0	0	–



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Table 6.22 Cetacean and Sea Turtle Sightings in the Project Area and Regional Assessment Area based on Compiled Data

Species	Regional Assessment Area			Project Area		
	Number Sightings	Number Individuals	Months Sighted	Number Sightings	Number Individuals	Months Sighted
Northern Bottlenose Whale	140	440	Mar-Dec	24	66	May-Sep, Oct
Sowerby's Beaked Whale	3	12	Sep, Nov	0	0	–
Cuvier's Beaked Whale	1	1	Jul	0	0	–
Narwhal	7	10	Jun-Jul	0	0	–
Beluga	22	4,051	Apr-Sep	1	1	Jul
White-beaked Dolphin	488	4,490	Jan-Dec	6	38	May-Jul, Oct-Nov
Atlantic White-sided Dolphin	667	12,117	Jan-Dec	33	726	Feb, Jun-Nov
Bottlenose Dolphin	14	35	Apr-Jun, Aug-Oct	5	24	May-Jun, Sep
Atlantic Spotted Dolphin	2	13	Jul	0	0	–
Risso's Dolphin	19	69	Jun-Nov	0	0	–
False Killer Whale	1	2	Jun	0	0	–
Common Dolphin	425	6,390	Jan, Mar-Apr, Jun-Dec	11	517	Jul, Sep-Nov
Striped Dolphin	10	482	Aug-Sep	2	15	Aug
Killer Whale	496	2,786	Jan, Mar-Dec	6	21	May-Aug, Oct
Long-finned Pilot Whale	1,300	24,571	Jan-Dec	157	2,722	May-Nov
Harbour Porpoise	460	2,096	Feb-Dec	17	65	Jun-Jul, Sep
Unidentified Dolphin	1,194	20,529	Jan-Dec	110	1,425	Mar-Nov
Unidentified Beaked Whale	4	5	Jun, Aug-Sep	0	0	–
Unidentified Toothed Whale	20	51	Jun-Sep	2	4	Jul-Aug
Others						
Unidentified Whale	19	37	May-Nov	4	7	Oct-Nov
Unidentified Cetacean	1,795	7,276	Jan-Dec	103	173	Jan-Oct, Dec
Sea Turtles						
Leatherback Sea Turtle	1,252	1,308	Jan, Mar, May-Dec	0	0	–
Loggerhead Sea Turtle	1,284	1,286	May-Oct	0	0	–



Table 6.22 Cetacean and Sea Turtle Sightings in the Project Area and Regional Assessment Area based on Compiled Data

Species	Regional Assessment Area			Project Area		
	Number Sightings	Number Individuals	Months Sighted	Number Sightings	Number Individuals	Months Sighted
Green Sea Turtle	58	58	May-Nov	0	0	–
Unidentified Sea Turtle	15	31	Jan-Mar	0	0	–

Sources for marine mammals: Lawson and Gosselin (2009); C-NLOPB database, DFO database; Equinor Canada database. Sources for turtles: Halpin et al. (2009); DFO database.

6.3.3 Mysticetes (Baleen Whales)

Excluding extralimital species, six species of baleen whale could occur in the Project Area. Although baleen whales occur in offshore waters of Newfoundland year-round, most migrate to lower latitudes for the winter (AMEC 2014). Blue whales, North Atlantic right whales, and fin whales are described in Section 6.3.7 as they have status under Schedule 1 of SARA. Species not listed under Schedule 1 of SARA are described in the following sections.

6.3.3.1 Humpback Whale

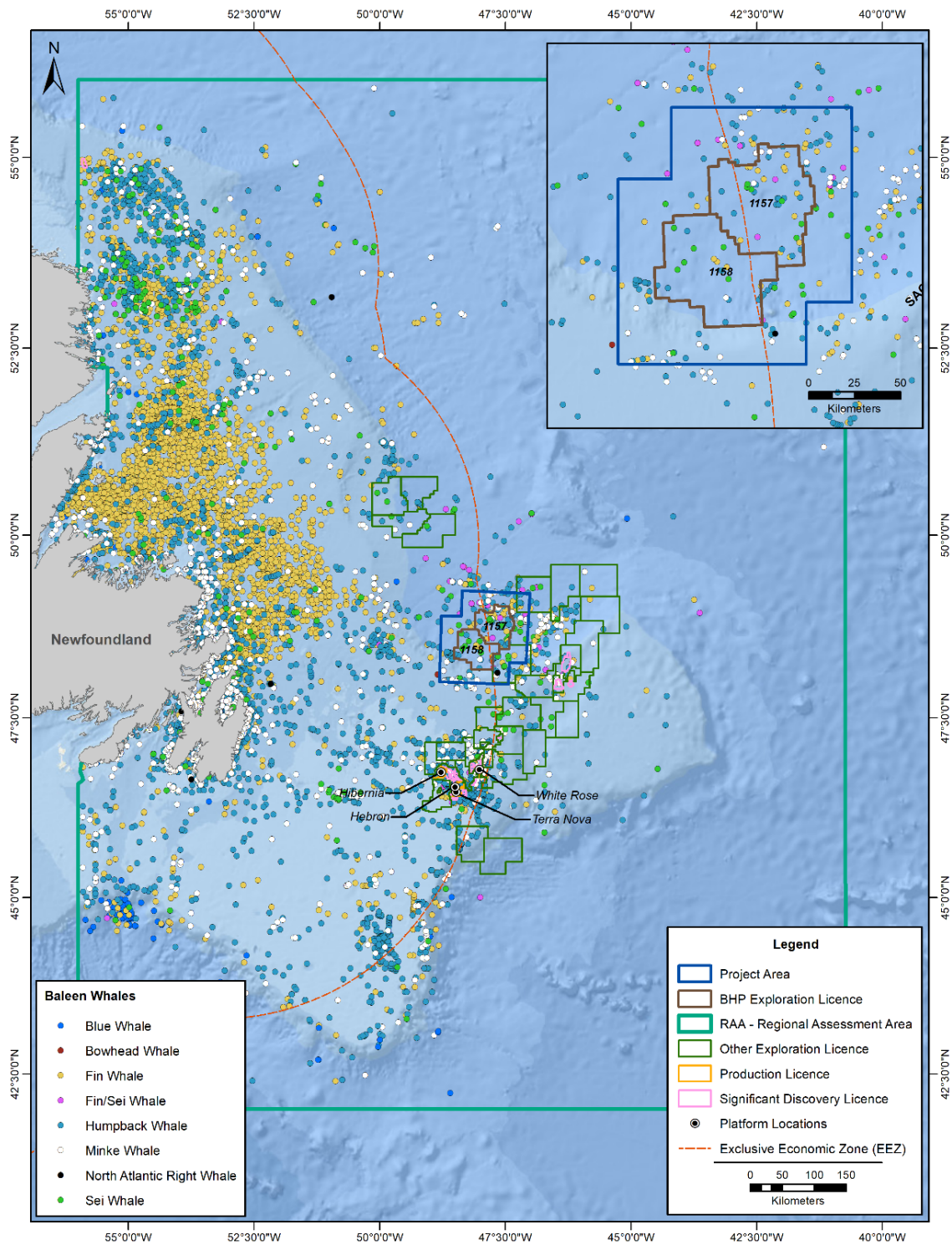
The humpback whale is listed as special concern under SARA (Schedule 3; Government of Canada 2019) and is considered not at risk by COSEWIC (COSEWIC 2003b). Humpbacks that occur in the waters of Newfoundland belong to the stock that breeds in the West Indies; this Western North Atlantic population numbers approximately 12,312 whales (Bettridge et al. 2015). For Newfoundland waters, Lawson and Gosselin (2009) estimated an abundance of 1,427 humpbacks (95% Confidence Interval [CI]: 952-2,140). The abundance was estimated at 3,712 whales when corrected for perception and availability biases (Lawson and Gosselin 2011). Humpback whales were the most frequently seen whale species during the 2007 TNASS (Lawson and Gosselin 2009) and the most common baleen whale in the Project Area based on compiled sightings (83 sightings; 148 individuals). Although humpback whales occur in the area year-round (Table 6.22; Figure 6-38), they are considered most common during late spring and summer.

Humpbacks were detected acoustically in the RAA throughout the year during monitoring in August 2015-July 2017; the highest rates of detection in the RAA occurred on the Grand Banks from summer through winter, and off Labrador during the winter and fall (Delarue et al. 2018). Acoustic detections were also recorded 40 km to the east of the Project Area during July-December 2016 and January-March 2017, when detection rates in the area were the highest (Delarue et al. 2018). Detections were also reported at stations 40 km to the west of the Project Area during August-December 2015 and January-March 2016. Based on modeling, the highest densities of humpbacks occur in the northeastern portion of the RAA during the summer; relatively high densities were also shown near the Project Area on the Grand Banks and Flemish Cap (Mannocci et al. 2017). Humpbacks are common in the Project Area.



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Source: Lawson and Gosselin (2009); C-NLOPB database, DFO database; Equinor Canada database.

Figure 6-38 Baleen Whale Sightings in the Project Area and Regional Assessment Area



6.3.3.2 Minke Whale

The minke whale does not have status under SARA (Government of Canada 2019) and is considered not at risk in Atlantic Canada by COSEWIC (COSEWIC 2019). Hayes et al. (2018) reported an abundance estimate of 2,591 whales (Coefficient of Variation, CV = 0.81) for the Canadian East Coast stock, based on surveys conducted in 2011. The previously reported abundance estimate based on the 2007 TNASS was substantially greater for this stock (4,691 whales; Lawson and Gosselin 2011), but was derived from an initial estimate of 1,315 (95% CI: 855-2,046; Lawson and Gosselin 2009), which is too old to be reliable (Hayes et al. 2018). According to Risch et al. (2014), the minke whale is common in the area from spring through fall. Based on the compiled sightings, 26 sightings (34 individuals) have been reported within the Project Area, with sightings mainly during late spring and summer (Table 6.22; Figure 6-38).

During opportunistic surveys of the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area (candidate NMCA) in July 2018, minke whales were seen within the candidate NMCA to the east of the Flemish Cap (Wakefield 2018). Minke whales were only detected acoustically south of Newfoundland and off Nova Scotia during monitoring within the RAA and near the Project Area during August 2015-July 2017 (Delarue et al. 2018). Modeling studies showed that the highest densities in the RAA occurred on the Grand Banks near to the Project Area (Mannocci et al. 2017). Minke whales are common in the Project Area.

6.3.3.3 Sei Whale

The sei whale has no status under SARA in the Canadian Atlantic (Government of Canada 2019). COSEWIC recently (May 2019) changed its status from data deficient to endangered, as few whales have been reported during surveys in Atlantic Canada in 2007 and 2016 (Government of Canada 2019). The population likely consists of fewer than 1,000 mature individuals (Government of Canada 2019). Two stocks (one on the Scotian Shelf and one in the Labrador Sea) likely occur in eastern Canada; however, there is little evidence to support the definition of a Labrador Sea stock (COSEWIC 2003a). Huijser et al. (2018) reported that there is low divergence among North Atlantic sei whales, thereby suggesting a single stock, but the genetic data have a high degree of uncertainty. Hayes et al. (2018) provided an abundance estimate of 357 whales (CV = 0.52) for the Nova Scotia stock. There is currently no estimate of abundance for the Labrador Sea stock (COSEWIC 2003a).

Sei whales occur in Newfoundland waters seasonally, with an increase in presence during the summer (COSEWIC 2003a). A total of 23 sightings (39 individuals) have been reported in the Project Area; sightings occurred from May through October (Table 6.22; Figure 6-38). Tagged sei whales traveled north of the Flemish Pass from the Azores en route to foraging areas in the Labrador Sea (Prieto et al. 2014). Acoustic detections of sei whales were made in the RAA throughout the year during August 2015-July 2017; however, no detections were made near the Project Area during winter (Delarue et al. 2018). Delarue et al. (2018) noted that sei whales appear to prefer deeper slope waters. Habitat-density modeling showed the highest densities in the northern portion of the RAA during summer, as well as in Flemish Pass and the southern Grand Banks (Mannocci et al. 2017). Sei whales are expected to occur in the Project Area regularly, but in small numbers.



6.3.4 Odontocetes (Toothed Whales)

Excluding extralimital species, 13 toothed whale species could occur in the Project Area, including nine delphinid species (Table 6.20). There is limited information about the distribution and abundance of these species, but several only occur in the Project Area seasonally. There are two populations of northern bottlenose whales in Canada, both of which could occur in the Project Area (Dalebout et al. 2006). It is also possible that bottlenose whales in the Project Area belong to a separate population. The Scotian Shelf population is listed as endangered under Schedule 1 of SARA (profiled in Section 6.3.7, Species at Risk), whereas the Davis Strait-Baffin Bay-Labrador Sea population is not listed by SARA. None of the delphinids that inhabit the Project Area are listed under SARA (Table 6.20).

6.3.4.1 Sperm Whale

The sperm whale has no status under SARA (Government of Canada 2019), and although it is designated not at risk by COSEWIC, it is considered a mid-priority candidate species (COSEWIC 2019). Hayes et al. (2018) provided an abundance estimate for the North Atlantic of 2,288 individuals (CV = 0.28). During the summer 2007 TNASS, 11 sightings of sperm whales were made in the waters of Newfoundland (Lawson and Gosselin 2009). The sperm whale is the second most frequently sighted cetacean in the Project Area, with 81 sightings of 152 individuals; sightings have been made year-round (Table 6.22; Figure 6-39).

Sperm whale sightings were reported within the candidate NMCA east of the Flemish Cap in July 2013 during surveys of the North Atlantic Current and Evlanov Seamount candidate NMCA (Wakefield 2018). Sperm whale clicks were detected acoustically in the RAA and near the Project Area year-round during August 2015-July 2017 monitoring (Delarue et al. 2018). There was a seasonal decline in detection rates, except at locations in and adjacent to the Flemish Pass which had year-round high detection rates, indicating that this region may be important to sperm whales. Based on modeling, year-round densities of sperm whales were highest in deep waters of the RAA, including Flemish Pass and the Orphan Basin (Mannocci et al. 2017). Sperm whales are expected to be common in the Project Area.

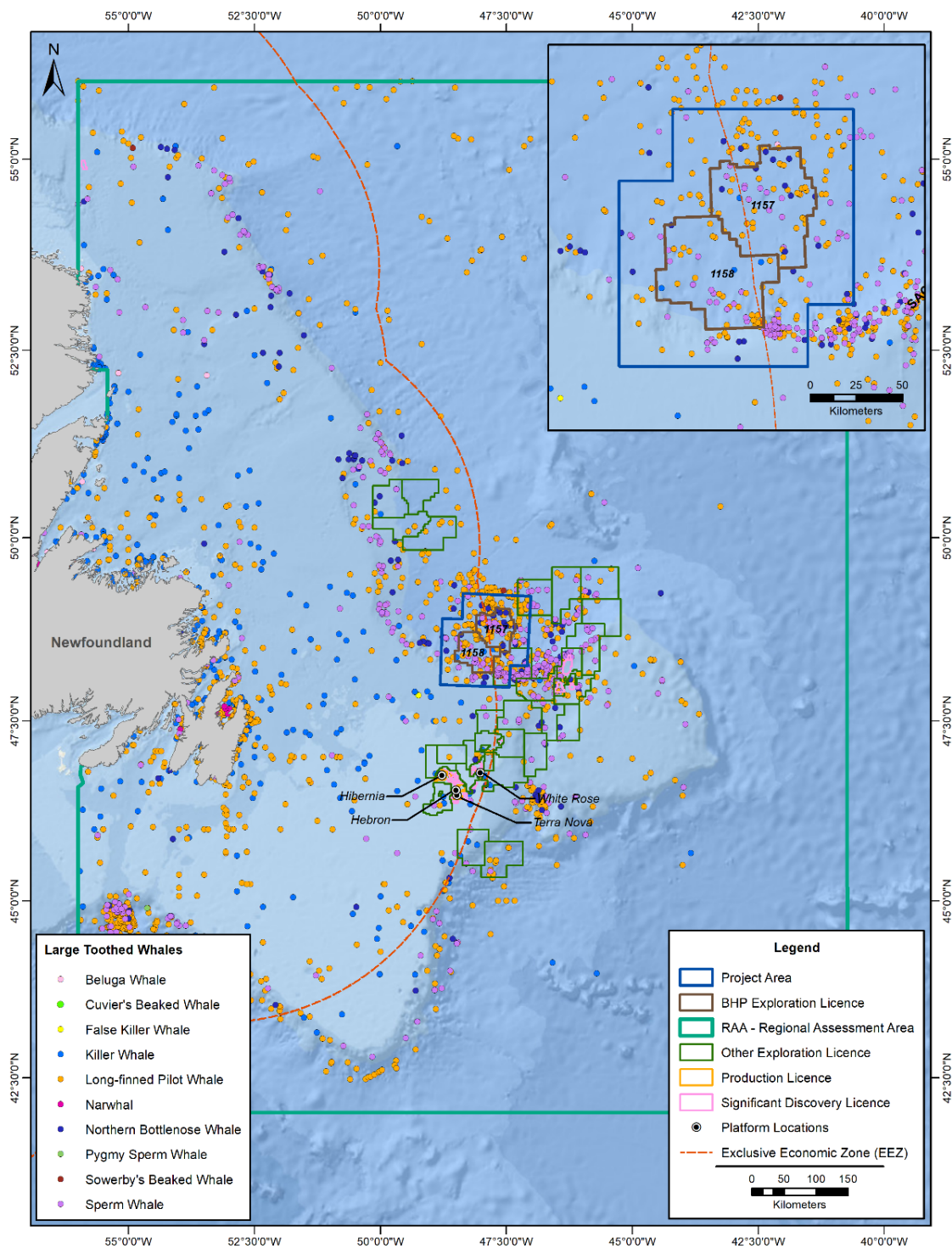
6.3.4.2 Northern Bottlenose Whale

The Davis Strait-Baffin Bay-Labrador Sea population does not have status under SARA (Government of Canada 2019) but is considered special concern under COSEWIC (COSEWIC 2011). There is no current population estimate (COSEWIC 2011). Northern bottlenose whales have been observed in low numbers in the Project Area (Table 6.22). Details on the Scotian Shelf population and northern bottlenose whale distribution in general are provided in Section 6.3.7.



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Source: Lawson and Gosselin (2009); C-NLOPB database, DFO database; Equinor Canada database.

Figure 6-39 Toothed Whale Sightings in the Project Area and Regional Assessment Area



6.3.4.3 Striped Dolphin

There are approximately 54,807 striped dolphins (CV = 0.3) in the western North Atlantic (Hayes et al. 2018); an abundance estimate for Canadian waters is not available. Two sightings (15 individuals) have been reported in the Project Area (Table 6.22; Figure 6-40). Sightings were also made within the candidate NMCA east of the Flemish Cap during July 2013, and along the shelf edge of the Grand Banks during opportunistic surveys of the North Atlantic Current and Evlanov Seamount candidate NMCA (Wakefield 2018). Habitat-density modeling showed the highest densities in deep offshore waters of the RAA, in particular in the southern portion of the RAA, such as Flemish Pass (Mannocci et al. 2017). Striped dolphins are likely to be rare in the Project Area.

6.3.4.4 Atlantic Spotted Dolphin

The abundance for the western North Atlantic has been estimated at 44,715 individuals (CV = 0.43) (Hayes et al. 2018); no estimate is available for Canadian waters. There have not been sightings of Atlantic spotted dolphins in the Project Area (Table 6.22; Figure 6-40). Based on modeling, low densities are expected in the RAA year-round, with higher densities in deeper waters of the southern portion of the RAA (Mannocci et al. 2017). Atlantic spotted dolphins are likely to be rare in the Project Area.

6.3.4.5 Short-beaked Common Dolphin

Based on surveys conducted in 2011, the best abundance estimate for the Western North Atlantic stock of short-beaked common dolphin is 70,184 individuals (CV = 0.28; Hayes et al. 2018). For Newfoundland, the abundance based on the 2007 TNASS was estimated at 576 dolphins (95% CI: 314 to 1,056) (Lawson and Gosselin 2009). There have been 11 sightings of 517 common dolphins in the Project Area during summer and fall (Table 6.22; Figure 6-40). One group of 10 individuals was made to the southeast of the Project Area in October during Equinor Canada's 2018 Seabed Survey (Mactavish and Penney-Belbin 2018). Short-beaked common dolphins were seen within the North Atlantic Current and Evlanov Seamount candidate NMCA east of the Flemish Cap during July 2013 (Wakefield 2018). Based on modeling, the highest year-round densities in the RAA occur along the edge of the Grand Banks and Flemish Pass (Mannocci et al. 2017). The short-beaked common dolphin is likely to be common in the Project Area.

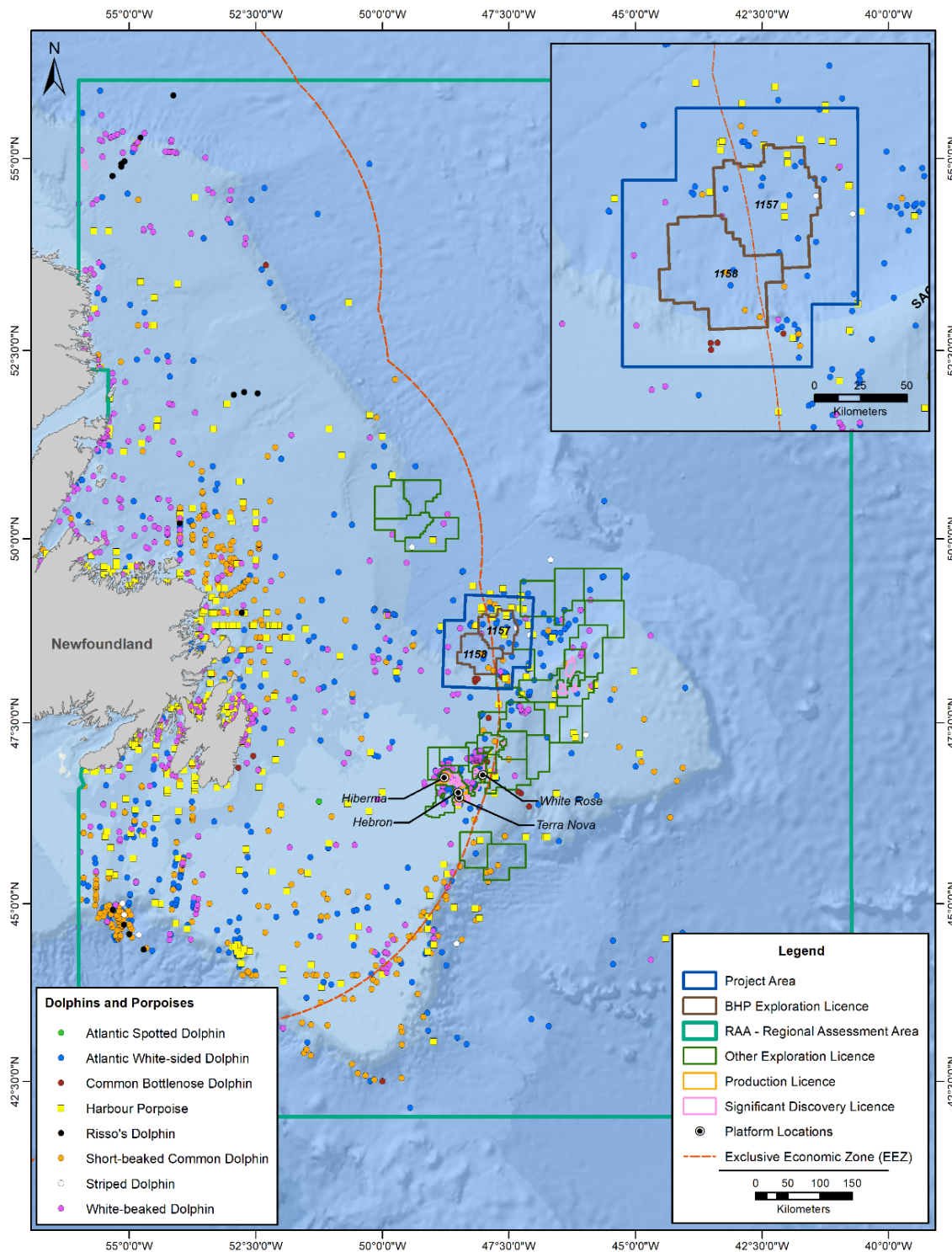
6.3.4.6 White-beaked Dolphin

Lawson and Gosselin (2009) estimated an abundance of 1,842 white-beaked dolphins (95% CI: 1,188 to 2,854) for waters of Newfoundland; the abundance corrected for perception and availability biases was estimated at 15,625 dolphins (Lawson and Gosselin 2011). Six sightings totaling 38 white-beaked dolphins have been seen in the Project Area from spring through fall (Table 6.22; Figure 6-40) and is expected to occur in the Project Area.



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Source: Lawson and Gosselin (2009); C-NLOPB database, DFO database; Equinor Canada database.

Figure 6-40 Dolphin and Porpoise Sightings in the Project Area and Regional Assessment Area



6.3.4.7 Atlantic White-sided Dolphin

Three stocks of Atlantic white-sided dolphin may inhabit the Northwest Atlantic: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea (Palka et al. 1997). The abundance estimate for the Northwest Atlantic is estimated at 48,819 individuals (CV = 0.61) (Hayes et al. 2018). Lawson and Gosselin (2009) estimated a total of 1,507 Atlantic white-sided dolphins (95% CI: 968 to 2,347) for Newfoundland waters, which was subsequently corrected and estimated at 3,384 (Lawson and Gosselin 2011). There have been 33 sightings (726 individuals) of white-sided dolphins in the Project Area, with most sightings in the summer (Table 6.22; Figure 6-40). Based on modeling, relatively high densities are expected to occur near the Project Area throughout the year (Mannocci et al. 2017). The Atlantic white-sided dolphin is expected to be common in the Project Area.

6.3.4.8 Common Bottlenose Dolphin

In the Western North Atlantic, there are two morphologically and genetically distinct stocks of common bottlenose dolphins – the coastal and offshore forms (Hoelzel et al. 1998). The abundance for the offshore stock is estimated at 77,532 dolphins (CV = 0.40) (Hayes et al. 2018). Five sightings totaling 24 bottlenose dolphins have been reported in the Project Area during September (Table 6.22; Figure 6-40). Based on modeling, low densities are expected in the RAA throughout the year (Mannocci et al. 2017). The common bottlenose dolphin is likely to be rare in the Project Area.

6.3.4.9 Risso's Dolphin

Risso's dolphin occurs in temperate and tropical waters around the globe. In the Northwest Atlantic, it occurs from Florida to eastern Newfoundland (Hayes et al. 2018). The abundance was estimated at 18,250 individuals (CV = 0.46) (Hayes et al. 2018). There have not been sightings of Risso's dolphins in the Project Area (Table 6.22; Figure 6-40). Based on modeling, the highest densities in the RAA occur in deep water along the edge of the Grand Banks, including near the Project Area (Mannocci et al. 2017). However, Risso's dolphin is likely to be rare in the Project Area.

6.3.4.10 Killer Whale

Although the Northwest Atlantic/Eastern Arctic killer whale population does not have status under SARA (Government of Canada 2019), it is considered special concern by COSEWIC (COSEWIC 2008). The Northwestern Atlantic / Eastern Arctic population size is unknown. There have been six sightings of 21 killer whales in the Project Area during the spring and fall (Table 6.22; Figure 6-39). Killer whale vocalizations were detected mostly during the summer and fall within the RAA during August 2015-July 2017 monitoring, including south of the Project Area (Delarue et al. 2018). Killer whales are likely to be uncommon in the Project Area.

6.3.4.11 Long-finned Pilot Whale

The long-finned pilot whale occurs throughout the North Atlantic and is abundant in the waters of Newfoundland and Labrador year-round (Nelson and Lien 1996). Based on surveys conducted in 2011 from Virginia to the lower Bay of Fundy, the abundance for the western North Atlantic is estimated at 5,636 individuals (CV = 0.63). As the surveys did not cover the Scotian Shelf where high densities are known to



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occur, this estimate is considered to be low (Hayes et al. 2017). Based on the 2007 TNASS, the abundance estimate for the Gulf of St. Lawrence and Scotian Shelf was 6,134 individuals (95% CI: 2,774 to 10,573) (Lawson and Gosselin 2009). Long-finned pilot whales are the most commonly recorded cetacean (157 sightings; 2,722 individuals) in the Project Area; sightings were reported nearly year-round, but primarily during summer (Table 6.22; Figure 6-39).

During surveys of the North Atlantic Current and Evlanov Seamount candidate NMCA during July 2013, pilot whales were sighted within the candidate NMCA east of the Flemish Cap; pilot whales were also sighted along the shelf edge of the Grand Banks (Wakefield 2018). Acoustic detections of pilot whales were made in the RAA year-round during August 2015-July 2017, including south of the Project Area, but in particular on the southern Grand Banks and off the Scotian Shelf, where the detection rates were highest (Delarue et al. 2018). Generally, pilot whales were absent during winter and spring north of the Flemish Pass (Delarue et al. 2018). Densities are expected to be highest in the northeastern portion of the RAA, but also in deep water along the edge of the Grand Banks and in Flemish Pass (Mannocci et al. 2017). Long-finned pilot whales are likely to be common in the Project Area.

6.3.4.12 Harbour Porpoise

The harbour porpoise is considered threatened (Schedule 2) by SARA (Government of Canada 2019) and special concern by COSEWIC (COSEWIC 2006b) in the Northwest Atlantic. At least three populations are recognized in the region: eastern Newfoundland and Labrador, Gulf of St. Lawrence, and Gulf of Maine/Bay of Fundy (Palka et al. 1996). The Gulf of Maine / Bay of Fundy stock consists of 79,883 porpoises (CV = 0.32) (Hayes et al. 2018). Lawson and Gosselin (2009) estimated an abundance of 1,195 porpoises (95% CI: 639 to 2,235) for Newfoundland; the abundance estimate corrected for perception and availability biases was 3,326 individuals (Lawson and Gosselin 2011). Seventeen sightings (65 individuals) of harbour porpoises have been made in the Project Area during spring and summer (Table 6.22; Figure 6-40).

Harbour porpoises were detected acoustically year-round in the southern portions of the RAA, including south of the Project Area and on the Grand Banks during August 2015-July 2017 (Delarue et al. 2018). In the RAA, the highest rates of detection occurred in the summer and fall off northeastern Newfoundland. However, the highest detection rates were recorded on the Scotian Shelf and in the Strait of Belle Isle. The harbour porpoise is generally considered uncommon in the Project Area, although modeling studies by Mannocci et al. (2017) indicated relatively high densities on the Grand Banks and Flemish Cap, adjacent to the Project Area.

6.3.5 Phocids (Seals)

Six seal species could occur in the Project Area and waters of the RAA (Table 6.20); none are listed under SARA (Government of Canada 2019). Three species are considered candidate species by COSEWIC; the bearded and hooded seals are considered mid-priority candidate species, whereas the harp seal is a low-priority candidate species (COSEWIC 2019). All seal species are harvested by Indigenous groups in Newfoundland and Labrador (see Section 7.4). Sealing generally occurs between late March and mid-May, but varies by species, and environmental conditions (DFO 2011).

Harp seals are expected to be common in the Project Area, especially during winter. The Northwest Atlantic population consists of approximately 7.4 million seals (95% CI: 6,475,800 to 8,273,600); the population size



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appears to have levelled off since 2008 (Hammill et al. 2015). Harp seals may whelp farther to the north if there is a substantial decline in sea ice associated with climate change (Stenson and Hammill 2014). During August 2015-July 2017 acoustic monitoring, harp seal calls were primarily detected during February and March on the northeastern edge of the Grand Banks and off Labrador (Delarue et al. 2018).

Hooded seals are likely to be common in the Project Area. Hooded seals outfitted with data loggers showed movements throughout the waters near the Project Area in the spring and late-fall/winter during 2004-2008 (Andersen et al. 2012, 2013, 2014). Andersen et al. (2012) suggested that hooded seals likely prefer areas with topographic and oceanographic conditions that lead to good feeding conditions in the waters off Newfoundland. During autumn/winter, females spent more time feeding along the Labrador Shelf, whereas males showed greater search effort in locations with complex seabed relief, including the Flemish Cap. Juveniles were tracked between the Grand Banks and the Flemish Cap during spring.

Grey and harbour seals are likely uncommon in the Project Area as they prefer nearshore waters. The 2014 population size of grey seals was estimated at 505,000 individuals (Hammill et al. 2014). The 2012 estimate of abundance for harbour seals in the western North Atlantic was 75,834 (CV = 0.15) (Hayes et al. 2018). Harbour seals are known to haul out in small numbers on the Avalon and Burin peninsulas (Templeman 2007; B. Mactavish, pers. comm., 2018). Ringed and bearded seals are expected to be uncommon in the Project Area, as they generally do not occur south of Labrador and northern Newfoundland.

6.3.6 Sea Turtles

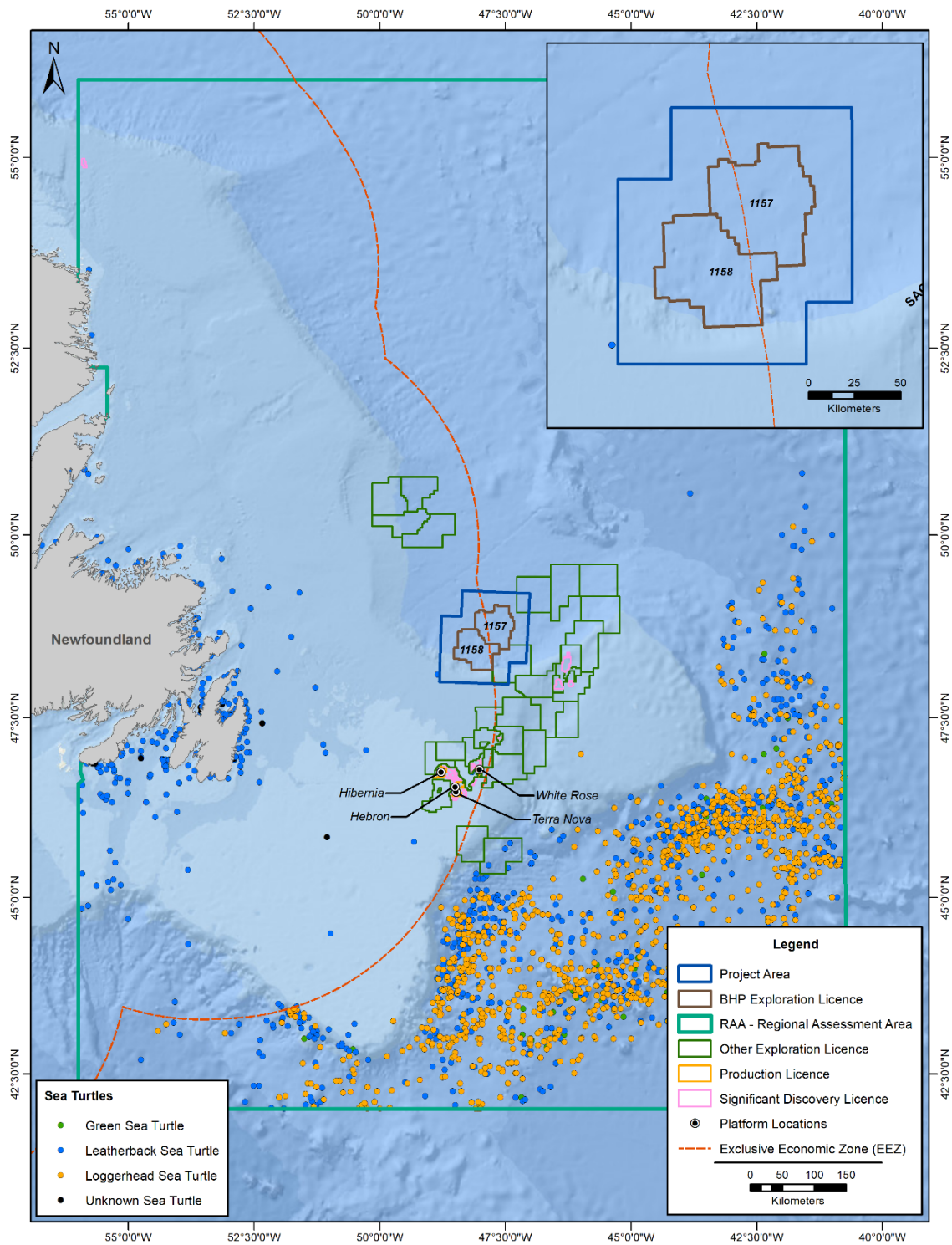
Although four species of sea turtles have been reported in the waters of Newfoundland, only the leatherback and loggerhead turtles are likely to occur near the Project Area. The four turtle species are likely to be rare in the Project Area, although the leatherback and loggerhead turtles are expected to be uncommon in the RAA. Sightings of Kemp's Ridley turtles within the RAA would be extremely rare, and green turtles are expected to be rare in the RAA. Although there have not been sightings of green sea turtles in the Project Area, there are numerous records east and south of the Flemish Cap (Figure 6-41). Information on the seasonal occurrence and conservation status for the four sea turtle species near the Project Area and within the RAA is summarized in Table 6.21. Sea turtle sightings that have been made in the RAA are shown in Table 6.22 and Figure 6-41.

The leatherback and loggerhead sea turtles are listed as endangered under Schedule 1 of SARA and are included in Section 6.3.7, Species at Risk. Green sea turtles are expected to be rare in the Project Area. Although no sightings have been made in the Project Area, there are two records for July in deep water southeast of the Project Area near the Flemish Cap, with additional records to the south and east of the Flemish Cap (Figure 6-41).



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Source: Halpin et al. (2009); DFO database.

Figure 6-41 Sea Turtle Sightings in the Project Area and Regional Assessment Area



6.3.7 Species at Risk

Five species / populations of marine mammals and two species of sea turtles that could occur in the Project Area are listed under Schedule 1 of SARA: (1) blue whale (Atlantic population); (2) fin whale; (3) North Atlantic right whale; (4) northern bottlenose whale (Scotian Shelf population); (5) Sowerby's beaked whale; (6) leatherback sea turtle; and (7) loggerhead sea turtle.

6.3.7.1 Blue Whale

The Atlantic population of blue whales is listed as endangered on Schedule 1 of SARA (Government of Canada 2019) as well as COSEWIC (COSEWIC 2002a, 2012b). The proposed Action Plan for the Atlantic population listed recovery objectives intended to increase the knowledge of the population, its habitat and threats, and implement measures to mitigate threats including vessel collisions, underwater sound, and spills (DFO 2018a). Critical habitat has not been designated for this population.

The blue whale population in the North Atlantic was depleted during the industrial whaling era; densities are still relatively low. Hayes et al. (2018) reported a minimum population size of 440 individuals for the western North Atlantic. Lesage et al. (2016) suggested that seamounts and deep ocean structures along the shelf edge may provide important habitat for blue whales. The continental shelf edge off Nova Scotia, southern Newfoundland, and the Grand Banks are considered important blue whale foraging area (Lesage et al. 2018; DFO 2018b). Moors-Murphy et al. (2019) also suggested that that slope waters off the Scotian Shelf, Grand Banks, and deep water of the Laurentian Channel provide potentially important habitat. The most suitable blue whale habitats and priority areas for monitoring on the Scotian Shelf and the shelf break off southern Newfoundland overlap with anthropogenic activities (Gomez et al. 2017).

Although there have not been sightings of blue whales in the Project Area, blue whales in the RAA were recorded during spring, summer, and fall; peak numbers occurred in July and August (Table 6.22). Seasonal detections have been made near the Project Area, but acoustic detections have been made year-round south of the Project Area (e.g., Simard et al. 2016; Delarue et al. 2018; Moors-Murphy et al. 2019). Acoustic detections were made to the east of the Project Area from August to January (Delarue et al. 2018). Blue whales are likely uncommon in the Project Area.

6.3.7.2 Fin Whale

The Atlantic population of fin whale is listed as special concern under Schedule 1 of SARA (Government of Canada 2019) and COSEWIC (COSEWIC 2005). For the Western North Atlantic, the abundance estimate is 1,618 whales (CV = 0.33), based on surveys in 2011 primarily in US waters (Hayes et al. 2018). For Newfoundland, the abundance was estimated at 1,352 whales (95% CI: 821 to 2,226) based on 2007 TNASS (Lawson and Gosselin 2009); the corrected estimate resulted in 1,555 individuals (Lawson and Gosselin 2011). The objective of the management plan that was released in 2017 is to ensure that anthropogenic threats do not reduce the current distribution range or cause the population to decline (DFO 2017a). There could be many as four stocks of fin whales in the Northwest Atlantic based on geographic differences in fin whale vocalizations (Delarue et al. 2014).

Fin whales are the second most common recorded baleen whale in the Project Area based on compiled sightings (45 sightings; 68 individuals), with most sightings reported in summer (Table 6.22; Figure 6-38).



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The highest densities occur in offshore waters off Newfoundland during June-August (Edwards et al. 2015). Mannocci et al. (2017) showed relatively high year-round densities near the Project Area along the edge of the Grand Banks and in Flemish Pass.

Fin whale sightings have also been made within the North Atlantic Current and Evlanov Seamount candidate NMCA to the east of the Flemish Cap during July 2018 (Wakefield 2018). Fin whale calls were detected year-round in the RAA during August 2015-July 2017, including south of the Project Area (Delarue et al. 2018).

6.3.7.3 North Atlantic Right Whale

The North Atlantic right whale is listed as endangered on Schedule 1 of SARA (Government of Canada 2019) and by COSEWIC (COSEWIC 2003c, 2013). The objectives of the recovery strategy are to reduce mortality and injury from vessel collisions and entanglement and increase survey effort in offshore regions such as the Flemish Pass and Flemish Cap (DFO 2019). An action plan detailing how to achieve the population and distribution objectives outlined in the recovery strategy has also been proposed (DFO 2016b).

The size of North Atlantic right whale population remains low even though it was the first whale species to receive total international protection from hunting in 1937. The population has been declining since 2010 (Pace et al. 2017; Corkeron et al. 2018; Pettis et al. 2018); at the end of 2017, the population size was estimated at 411 whales (Pettis et al. 2018). Approximately 100 reproductive females are thought to exist (Baumgartner et al. 2017; Pennisi 2017). Low reproductive rates are thought to primarily be caused by high mortality rates of adult females (Corkeron et al. 2018). The recovery of this population is being hindered by falling calving rates (down 40% since 2010) and increases in human-caused mortality (Kraus et al. 2016). No calves were born in 2018, and only five calves were born in 2017 (Pettis et al. 2018). For 2019, seven calves have been reported as of 23 May (CBC 2019).

For the North Atlantic right whale population, 17 mortalities were reported in 2017 and three in 2018 (Pettis et al. 2018). Twelve of the reported 17 mortalities in 2017 occurred in the Gulf of St. Lawrence and five in the US; in 2018, the three mortalities were reported in the US (National Marine Fisheries Service [NMFS] 2019). As of early July, six mortalities have been reported for 2019 (NOAA 2019). Twelve dead North Atlantic right whales were reported from 6 June to 15 September 2017 in the Gulf of St. Lawrence (Daoust et al. 2017; DFO 2019). The deceased whales ranged in age from 2 to 37 years and included eight males and four females. Necropsies determined that four whales had died due to blunt trauma and two drowned due to entanglement (Daoust et al. 2017; DFO 2019). An additional five entanglements occurred between 5 July and 28 August 2017; two whales were disentangled, one managed to shed the gear on its own, and two whales could not be disentangled (Daoust et al. 2017).

Northern right whale calls have not been detected within or near the Project Area (Delarue et al. 2018), although vocalizations were recorded in slope waters off southern Newfoundland (Delarue et al. 2018). The North Atlantic right whale is rare in the RAA. Based on the compiled sightings, one group of two right whales has been reported in the Project Area during June (Figure 6-38).



6.3.7.4 Northern Bottlenose Whale

The Scotian Shelf population is considered to be endangered under Schedule 1 of SARA (Government of Canada 2019) and COSEWIC (COSEWIC 2002b, 2011). It consists of approximately 143 whales (O'Brien and Whitehead 2013); there are no abundance estimates for the entire Northwest Atlantic (COSEWIC 2011). An amended recovery strategy (DFO 2016a) and an action plan included updated critical habitat measures for this population (DFO 2017c). The Gully, Shortland, and Haldimand submarine canyons at the eastern edge of the Scotian Shelf have been designated critical habitat for the Scotian Shelf population (DFO 2016a). Northern bottlenose whales tend to prefer water deeper than 500 m and in particular along the 1,000 m isobath (DFO 2016a).

Individuals from the Scotian Shelf population do not appear to migrate; there is no information on movements of the Davis Strait-Baffin Bay population (COSEWIC 2011). A total of 24 sightings (66 individuals) were made in the Project Area, based on the compiled sightings; most sightings were made in the summer (Table 6.22; Figure 6-39). Northern bottlenose whales were observed in Orphan Basin during geophysical survey monitoring programs in 2004 (three sightings of nine individuals; Moulton et al. 2005) and 2005 (seven sightings of 21 whales; Moulton et al. 2006). Based on preliminary photo-ID studies, at least 78 different individuals occurred in the Grand Banks, Flemish Pass, and Flemish Cap area during 2016-2017 (L.J. Feyrer, pers. comm., 2018). Results are not yet available to indicate whether individuals in that area were from the Scotian Shelf or Davis Strait-Baffin Bay-Labrador Sea populations (L.J. Feyrer, pers. comm., 2018). It is possible, that there could be more than two populations of northern bottlenose whales in Atlantic Canadian waters.

Acoustic detections of northern bottlenose whales were made throughout the year in the RAA, including near the Project Area, during August 2015-July 2017 (Delarue et al. 2018). Most detections occurred off eastern Newfoundland, with the highest detection rates near the Project Area, and off Labrador (Delarue et al. 2018). Northern bottlenose whales were detected acoustically throughout the year, with nearly daily detections, at the "Sackville Spur" recorder site, 40 km east of the Project Area (as well as a Labrador Shelf acoustic recorder) (Delarue et al. 2018). Similarly, northern bottlenose whale presence was detected year-round in slope waters off the mid-Labrador coast ("Stn 13", in 1,750 m water depth) (Delarue et al. 2018). Available information on sightings and acoustic recordings indicates that northern bottlenose whales regularly occur in and near the Project Area, and that the Sackville Spur area may provide important habitat for this species. Other deep-water areas offshore Newfoundland, including slope waters off Labrador and the Orphan Basin, may also provide important habitat for northern bottlenose whales.

Entanglement in fishing gear, oil and gas activities, and acoustic disturbance are the primary threats for northern bottlenose whales (COSEWIC 2011; DFO 2017c). Contaminant levels in whale tissues, which may be related to oil and gas development activities, vessel strikes, and changes to the food supply are also of concern (COSEWIC 2011; DFO 2017c). Sightings in and north of Flemish Pass, as well as acoustic detections at the Sackville Spur indicate that this region, including the Project Area, is a high priority area for enhanced monitoring for northern bottlenose whales, as are the edges of the eastern Scotian Shelf and Newfoundland and Labrador shelves, canyons, and deep basins; these areas overlap with anthropogenic activities (Gomez et al. 2017).



6.3.7.5 Sowerby's Beaked Whale

Sowerby's beaked whale is considered as special concern under Schedule 1 of SARA (Government of Canada 2019) and COSEWIC (COSEWIC 2006a). The objectives of the management plan released in 2017 are to maintain a stable population in Atlantic waters and measure and mitigate the effects of threats (DFO 2017b). There is a paucity of information on the occurrence of Sowerby's beaked whale in waters off Newfoundland and Labrador. Most of the available information is based on stranding records (Lien and Barry 1990, in Husky 2012). It is difficult to detect Sowerby's beaked whales as they have short surface durations, offshore distribution, and faint blows (Hooker and Baird 1999a, in Husky 2012). Sowerby's beaked whales appear to prefer deep waters, continental shelf edges, or slopes (Kenney and Winn 1987, in Husky 2012; COSEWIC 2006a), where they dive deep to forage on squid (COSEWIC 2006a).

Although there have been no reported visual sightings in the Project Area (Table 6.22), four whales were sighted during a seismic survey in Orphan Basin just to the north of the Project Area in September 2005 (Figure 6-39; Moulton et al. 2006). Sowerby's beaked whale vocalizations were detected year-round in the RAA during August 2015-July 2017 (Delarue et al. 2018). Just to the east of the Project area, detections were made from spring through fall. Sowerby's beaked whale clicks were concentrated along the edge of the Scotian Shelf, and high detection rates also occurred along the shelf edge of the Grand Banks (Delarue et al. 2018). Sowerby's beaked whale is likely to be rare in the Project Area.

6.3.7.6 Leatherback Sea Turtle

The leatherback sea turtle is listed as endangered under SARA (Schedule 1; Government of Canada 2019) and COSEWIC (COSEWIC 2012a). The proposed action plan outlines measures to address threats and monitor recovery (DFO 2018c). New information on the foraging behaviour and movements of leatherbacks has recently been obtained from studies in Atlantic Canada using satellite telemetry and camera tags (DFO 2016c). Recordings of leatherbacks searching for, capturing, and handling prey were captured; the footage revealed that leatherbacks find their prey visually and primarily feed in the top 30 m during daylight hours (DFO 2016c).

Leatherback turtle records have been reported for waters offshore Nova Scotia and Newfoundland (Stewart et al. 2013; Dodge et al. 2014; Archibald and James 2016; Chambault et al. 2017). Mosnier et al. (2019) also reported sightings off Nova Scotia and Newfoundland (including within the RAA) from June through November, but most records occurred during August and September. The majority of sightings were made on the shelf off southern and eastern Newfoundland and on the Scotian Shelf. Opportunistic sightings were also made south of the Flemish Cap during July (Mosnier et al. 2019). Hamelin and James (2018) outfitted leatherback sea turtles with tags in Nova Scotia between 1999 and 2016; they reported the occurrence of turtles within the southern portion of the RAA. Lalire and Gaspar (2019) reported that juveniles are transported by currents past southern Newfoundland on their way to the eastern Atlantic.

The population size for the North Atlantic is estimated at 34,000 to 94,000 adults (Turtle Expert Working Group 2007). Thousands of individuals occur in Canadian Atlantic waters, but the number of seasonal foragers in Atlantic Canada is unknown (COSEWIC 2012a). Archibald and James (2016) suggested that Canadian waters may have the highest density of foraging leatherbacks throughout their range. Wallace et al. (2018) surmised that foraging areas off Nova Scotia are important to population growth in the Northwest



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Atlantic Ocean, as the region supports a large portion of the turtle's energy budget. The Grand Banks likely also provide important habitat for leatherbacks (Mosnier et al. 2019). Leatherback turtle distribution in eastern Canada has been correlated with environmental characteristics; turtle occurrence increases in regions where sea surface temperatures are greater than 15°C, over flat bottoms, and in areas with low primary productivity (Mosnier et al. 2019). Sea surface height was also correlated with sea turtle occurrence (Mosnier et al. 2019). As both sunfish and leatherback turtles prey on gelatinous prey, the presence of sunfish has also been shown to be a predictor of leatherback occurrence, but not densities (Mosnier et al. 2019). Jellyfish presence can predict leatherback occurrence in Atlantic Canada, particularly on the Scotian Shelf (Nordstrom 2018).

Although no critical habitat has been designated for leatherbacks in Atlantic Canada (Atlantic Leatherback Turtle Recovery Team 2006), important foraging habitat has been identified as critical habitat in the proposed recovery strategy (DFO 2016d). Three critical habitats have been proposed: Southwestern Scotian Slope Area, Gulf of St. Lawrence-Laurentian Channel Area, and Placentia Bay Area (DFO 2016d). The primary threat facing leatherbacks in Canadian waters is fisheries bycatch; globally, threats include ship strikes, marine debris, and oil and gas exploration (COSEWIC 2012a). Hamelin et al. (2017) reported several incidental captures in fishing gear off Newfoundland, including the Grand Banks.

Leatherbacks are rare in the Project Area (Table 6.22). There have been no reported sightings of leatherback turtles within the Project Area, although one record has been reported just off the southwestern corner of the Project Area (Figure 6-41).

6.3.7.7 Loggerhead Sea Turtle

The loggerhead sea turtle is listed as endangered under SARA (Schedule 1; Government of Canada 2019) and COSEWIC (COSEWIC 2010). The population size is unknown in Atlantic Canada (DFO 2010). Mansfield et al. (2014) reported that neonate loggerhead turtles equipped with satellite tags at Florida beaches travelled to the southeast of Newfoundland after release. A satellite-tagged juvenile loggerhead turtle that was released in the Canary Islands was tracked to southeast of Newfoundland (Vero-Cruz et al. 2016). Wakefield (2018) reported a sighting along the shelf edge of the Grand Banks during an opportunistic survey in July 2013. No sightings of loggerheads have been made in the Project Area (Figure 6-41). Two sightings were made to the south of the Project Area, near the Flemish Cap, in water depth >4,000 m during May and July.

In the Northwest Atlantic, the biggest threats faced by loggerhead turtles include bycatch, harvesting, and artificial lights at nesting beaches (DFO 2017d). The Canadian Atlantic pelagic longline fleet reported 701 incidental captures of loggerheads between 1999 and 2006 (Brazner and McMilan 2008). Although observer coverage of the area was extensive, no turtles were sighted northeast of the Grand Banks (Brazner and McMilan 2008). Encounters with loggerhead sea turtle in the longline fishery have occurred south of the Flemish Cap during 2002-2008 (Paul et al. 2010). Loggerhead turtles are rare in the Project Area with recorded sightings occurring well south and east of the Project Area (Figure 6-41).



6.3.8 Summary of Key Areas and Times

A summary of important seasons and areas for marine mammals and sea turtles was included in the Eastern Newfoundland SEA (Section 4.2.3.6 of AMEC 2014). While most cetaceans are sighted year-round in the RAA, they are more frequently sighted during June-September within the Project Area. Summer is an important season for cetaceans and sea turtles in Newfoundland waters. At this time, migratory species come to feed in the region before traveling to southerly latitudes for the winter. Pinnipeds are more common during winter and spring. Concentrations in certain areas at certain times may be an artifact of the survey effort that occurred in these locations. Similarly, low sightings in other areas may be attributable to low survey effort. Several (EBSAs provide important ecological functions for marine mammals and sea turtles in the RAA, including important habitat for overwintering, refuge, and foraging. An overview of the relevance of EBSAs to marine mammals and sea turtles is shown in Table 4.102 of the Eastern Newfoundland SEA (AMEC 2014) and presented under the Special Areas (Section 6-4).

6.4 SPECIAL AREAS

A number of marine offshore and coastal areas in Newfoundland and Labrador are protected under federal, provincial, international and/or other legislations or agreements due to their ecological, historical or socio-cultural characteristics and importance. This section identifies and describes the designated special areas that overlap with the RAA, offering context for the potential interaction of the Project with the surrounding marine and coastal environment. Special areas intersecting the LAA are the focus of the effects assessment (Chapter 11), which also identifies the shortest linear distances from special areas to Project components. Special areas outside the Project RAA may be illustrated in figures for context but are not described in this section.

6.4.1 Federal Designations and Their Management

Special areas include protected areas designated under Canadian legislation (Table 6.23) and other special or sensitive areas that are designated federally, but not protected by legislation (Figure 6-42). The latter includes EBSAs and SiBAs. The presence or absence of critical habitat identified in the RAA is discussed in relevant sections of Marine Fish and Fish Habitat (Section 6.1), Marine and Migratory Birds (Section 6.2) and Marine Mammals and Sea Turtles (Section 6.3).

Table 6.23 Federal Legislation Related to Special Areas within the RAA

Legislation	Type of Area	Department / Division	Purpose
<i>Oceans Act, 1996, c. 31</i>	Marine Protected Areas	DFO / Ecosystems and Ocean Science	Conserve and protect fish, marine mammals and their habitats; unique areas; areas of high productivity or biological diversity
<i>Fisheries Act, 1985, c. F-14</i>	Fisheries Closure Areas, Marine Refuges	DFO / Fisheries and Harbour Management	Conserve and protect fish and fish habitat; to manage inland fisheries (among other purposes)
Bill C-68: <i>Fisheries Act</i> (s.43.3), following Royal Assent	Marine Refuges	DFO / Fisheries and Harbour Management	Amendments would enable long-term fishing restrictions to conserve and protect marine biodiversity



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Table 6.23 Federal Legislation Related to Special Areas within the RAA

Legislation	Type of Area	Department / Division	Purpose
<i>Canada Wildlife Act, 1985, c. W-9</i>	Migratory Bird Sanctuaries	ECCC / CWS	Conserve and protect habitat for migratory bird species
<i>National Marine Conservation Areas Act, 2002, c. 18</i>	National Marine Conservation Areas	Parks Canada	Protect and conserve representative ecosystems and key features within each of Canada's 29 marine regions
<i>National Parks Act, 2000, c. 32</i>	National Parks	Parks Canada	Protect representative examples of Canada's 39 National Parks Natural Regions
<i>Historic Sites and Monuments Act, 1985, c. H-6</i>	National Historic Sites	Parks Canada	Protects sites related to national historic interest or significance
Sources: DFO 2019a, 2019b, 2019c; CWS 2019; Parks Canada 2016, 2019			

6.4.1.1 Federal Bioregional Network

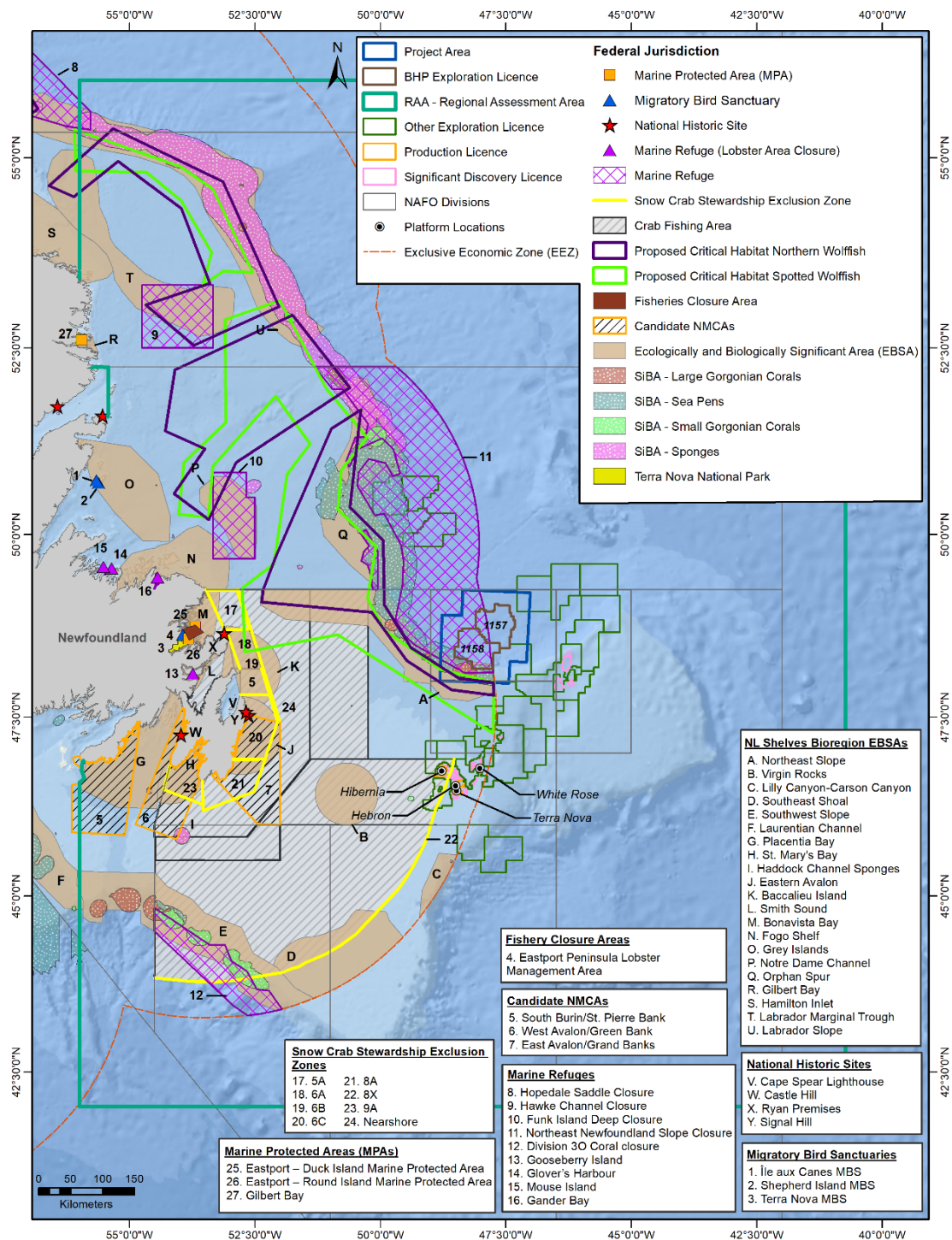
DFO has identified 13 bioregions in Canadian waters (DFO 2002; Government of Canada 2011). Each bioregion is designated based on oceanographic and bathymetric properties and is identified to define ecological uses for marine habitat and facilitate better ocean management decisions (DFO 2005). The Project Area and RAA are within the Newfoundland-Labrador Shelves Bioregion.

Five Integrated Management Areas (IMAs) have been established throughout Canada: three on the Atlantic coast; one in the Arctic; and one on the Pacific coast (DFO 2018a). The Atlantic coast IMAs are: Placentia Bay / Grand Banks (PB / GB) IMA; Gulf of St. Lawrence IMA; and the Scotian Shelf, Atlantic Coast and the Bay of Fundy IMA. Each IMA is governed by a Secretariat including representatives of federal government departments and agencies, Indigenous groups and stakeholders such as coastal communities, which have regulatory or economic interests within the area. The PB / GB IMA Secretariat has prepared an integrated management plan that addresses ecological, social, cultural, and economic considerations regarding resource use within the area (Placentia Bay Grand Banks-Large Ocean Management Area Secretariat 2012). The RAA intersects a large portion of the PB / GB IMA.



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Source: Eastport Marine Protected Areas Advisory Committee (EMPAAC) 2013; DFO 2015, 2019a, 2019b, 2019c; Environment and Natural Resources 2017; Parks Canada 2016, 2018; CPAWS 2018; Government of Canada 2018

Figure 6-42 Federally Designated Special Areas within the RAA



6.4.1.2 Marine Protected Areas

Under the *Oceans Act*, DFO has established a national network of Marine Protected Areas (MPAs) within the Federal Bioregional Network. MPAs promote long-term conservation in areas of high biodiversity, important habitats for marine species and unique bathymetric features such as underwater canyons and hydrothermal vents (DFO 2002). MPAs can also protect areas with spiritual or cultural importance, including archaeological sites, shipwrecks and areas traditionally used by Indigenous and non-Indigenous communities. Canada’s MPAs provide a high level of environmental protection by prohibiting four industrial activities: oil and gas activities, mining, ocean dumping and bottom trawling within all MPAs (DFO 2019e).

Four MPAs are located off Newfoundland and Labrador and three are within the RAA (Table 6.24). These include Eastport Round Island and Eastport Duck Islands (the Eastport MPAs), and Gilbert Bay (Figure 6-42).

Table 6.24 Marine Protected Areas within the RAA

MPA	Rationale for Identification / Designation
Eastport Round Island MPA Eastport Duck Islands MPA	Established in 2005 to limit fishing, to maintain a viable American lobster population, and to protect other threatened or endangered species. Area: 2.1 km ²
Gilbert Bay	Established in 2005 to conserve one of the few coastal concentrations of northern cod in the Newfoundland region and to indirectly protect other species and habitats. Area: 60 km ²
Source: DFO 2019a	

6.4.1.3 National Marine Conservation Areas

Though the *National Marine Conservation Areas Act, 2002*, Parks Canada has been mandated to establish a network of National Marine Conservation Areas (NMCAs) within each of Canada’s 29 marine regions (Parks Canada 2019). No NMCAs have yet been established in the RAA. Candidate NMCAs, which have been identified within the Grand Banks Marine Region, fall within the RAA (Figure 6-42). These areas include: South Burin / St. Pierre Bank, West Avalon / Green Bank and East Avalon / Grand Banks (Parks Canada 2019). Detailed descriptions of these areas are not yet publicly available.

6.4.1.4 Marine Refuges and Lobster Area Closures

As of April 2019, DFO had designated 14 Marine Refuges in NL waters, 11 of which are in the NL Shelves Bioregion (DFO 2019b). Marine refuges are classified as other effective area-based management measures, which distinguishes them from MPAs. Through the process of establishing marine refuges, the Government of Canada has considered industrial activities where such activities do not pose a threat to conservation objectives of the relevant area. Where oil and gas extraction activities are permitted in a marine refuge, the area where this activity takes place will be excluded from Canada’s international marine conservation target of 10% of marine and coastal areas by 2010 (DFO 2016, 2019e).

Nine Marine Refuges are within RAA (Table 6.25). Four of these are Lobster Closure Areas, which protect important lobster spawning habitat in rocky coastal areas (Figure 6-42).



Table 6.25 Marine Refuges within the RAA

Marine Refuge	Rationale for Identification / Designation
Northeast Newfoundland Slope Closure	High density of corals and sponges; high biodiversity. Bottom contact fishing activities are prohibited to protect corals and sponges and contribute to long-term biodiversity conservation. Area: 55,353 km ²
Division 30 Coral Closure	Presence of large and small gorgonian corals and sea pens. Visited by leatherback sea turtles, redfish and Atlantic cod. Bottom fishing activities are prohibited to protect corals and sponges. Area: 10,422 km ² (portion inside EEZ)
Gooseberry Island Lobster Area Closure	Key lobster spawning habitat. Lobster fishing is prohibited to increase lobster spawning and egg production. The seven Lobster Area Closures total an area of 94 km ²
Glovers Harbour Lobster Area Closure	
Mouse Island Lobster Area Closure	
Gander Bay Lobster Area Closure	
Funk Island Deep Closure	Benthic habitat important to Atlantic cod and smooth skate Funk Island Deep population (assessed as endangered by COSEWIC). Substantial concentrations of groundfish and other fish species. Important feeding area for mammals. Bottom trawl, gillnet and longline fishing activities are prohibited to conserve benthic habitat and Atlantic cod habitat. Area: 7,274 km ²
Hawke Channel Closure	Benthic habitat important to Atlantic cod and Atlantic wolffish. Bottom trawl, gillnet and longline fishing activities are prohibited to conserve benthic habitat and Atlantic cod habitat. Area: 8,837 km ²
Hopedale Saddle Closure	High density of corals and sponges. High biodiversity. Overwintering area of Eastern Hudson Bay Beluga. Bottom-contact fishing activities are prohibited to protect corals and sponges and contribute to long-term biodiversity conservation. Area: 15,411 km ²
Source: DFO 2019b	

6.4.1.5 Migratory Bird Sanctuaries

Under the *Migratory Birds Convention Act* (1994), CWS manages migratory bird sanctuaries (MBSs) established under the *Canada Wildlife Act* for the protection and conservation of migratory birds. The sanctuaries protect habitat that is optimal for breeding, nesting or hunting. Activities that could harm migratory birds, their nests or eggs is prohibited (Government of Canada 2010). The *Migratory Bird Sanctuary Regulations* and *Migratory Bird Regulations* also apply to MBS.

Three MBSs have been established in NL at Shepherd Island, Île aux Canes and Terra Nova; all are within the RAA (Table 6.26). Shepherd Island and Île aux Canes are located off the coast of Newfoundland’s Northern Peninsula; the Terra Nova sanctuary is in the estuarian waters of Terra Nova National Park in Bonavista Bay (Figure 6-42).



Table 6.26 Migratory Bird Sanctuaries within the RAA

MBS	Rationale for Identification / Designation
Terra Nova	Designated in 1967 to protect an area adjacent to Terra Nova National Park used by approximately 30 shorebird, waterfowl and seabird species. It is an important sanctuary during fall migration. Shorebirds frequent the tidal flats during summer and early fall. Newman Sound is an important area for waterfowl species year-round. Area: 11.78 km ²
Shepherd Island	Designated in 1991 to protect one of the largest breeding sites (together with Île aux Canes) for common eider in insular Newfoundland. Area: 0.18 km ²
Île aux Canes	Designated in 1991 to protect nesting colonies of common eider. Together with Shepherd Island, it is one of the largest breeding sites for the common eider in insular Newfoundland. Area: 1.62 km ²
Source: Environment and Natural Resources 2019	

6.4.1.6 Significant Benthic Areas

SiBAs are defined in DFO’s Ecological Risk Assessment Framework as “significant areas of cold-water corals and sponge dominated communities” (DFO 2013). These areas are not protected; however, they identify key marine species distribution and may indicate areas of future restoration activities. DFO has defined four types of SiBAs in the NL Shelves Bioregion - aggregations of sea pens, sponges, small gorgonian corals and large gorgonian corals that form habitat for other species. The definition excludes non-aggregating species such as black corals and bryozoans. Sea pens are feather-like, soft suspension feeders that anchor to soft bottom substrates (DFO 2017a). Sponges are found at depths of 3,000 m or less along continental shelves, slopes, canyons and deep fjords. While the distribution of deep-water corals is patchy and influenced by various conditions, gorgonians grow mainly on stable boulders and bedrock but may also anchor in soft sediments (DFO 2018c).

Prior to 2000, the known distribution of benthic species was based on reports from fish harvesters. Currently, DFO conducts surveys using deep-sea trawls and remotely operated vehicles to identify important benthic areas (DFO 2018b). DFO also uses modelling to predict SiBAs in Eastern Canada including the NL Shelves Bioregion. In recent modelling exercises, most of the shelf and slope off Labrador were classified as likely to have sponge presence with the highest predicted sponge presence probabilities along the Labrador Slope and Saglek Bank. The highest predicted presence probability for sea pens occurred in the Laurentian Channel and on the slope of the Northeast Newfoundland Shelf. The highest predicted presence probability of large gorgonian corals occurred of the edge of Saglek Bank and Slope in Northern Labrador. The highest predicted small gorgonian presence probabilities occur along the southwest slope of the Grand Banks (Kenchington et al 2014). SiBAs identified for sponges, sea pens, small gorgonian corals and large gorgonian corals are within the RAA (Figure 6-42). Detailed descriptions are not yet publicly available.

6.4.1.7 Ecologically or Biologically Significant Areas

EBSAs are identified by DFO to emphasize marine areas with high ecological or biological activity relative to their surrounding environment (DFO 2005). Criteria for EBSA designation include: uniqueness (how distinct the ecosystem is compared with surrounding areas); aggregation (which species convene or populate within the area); and fitness consequences (how the area is critical to the life history of the species



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found within it). Many of the EBSAs have been redefined and information provided by DFO in 2019 did not include area measurements.

In total, 25 EBSAs have been designated within the NL Shelves Bioregion. Twenty-one of these are found within the RAA (Table 6.27; Figure 6-42).

Table 6.27 Canadian EBSAs within the RAA

EBSA	Key Features
Bonavista Bay	Significant aggregations of eelgrass, salmon, killer whale, harbour seal, Mysticetes and duck functional groups. Important area for capelin and sea lamprey spawning. Significant foraging area for black-legged kittiwake and tern species.
Smith Sound	Expansive eelgrass bed. Hosts aggregations of killer whale, mysticetes and small cetacean functional groups. Capelin spawning area; significant colonies of and foraging area for Atlantic puffin, black-legged kittiwake and tern species.
Baccalieu Island	Noted aggregations of killer whales, capelin, shrimp, planktivores, spotted wolffish and seabird functional groups. Capelin spawning area. Important foraging area for Atlantic puffin, black-legged kittiwake and razorbill.
Eastern Avalon	Location of colonies of Atlantic puffin, common murre, thick-billed murre and northern fulmar. Significant aggregations of eelgrass, capelin, American plaice, killer whale; Mysticetes functional group; seabird functional groups. Capelin spawning area. Important foraging area for Atlantic puffin, common murre, razorbill, thick-billed murre, black-legged kittiwake and northern fulmar.
St. Mary's Bay	Significant colonies and foraging area for common murre, northern gannet, razorbill and black-legged kittiwake. Aggregations of harlequin duck (species of Special Concern under SARA), salmon, capelin, common eider, Mysticetes functional group, hooded seal, leatherback turtle.
Northeast Slope	Diverse area with significant aggregations of shrimp, Greenland halibut, Atlantic wolffish northern wolffish, spotted wolffish, roughhead grenadier, witch flounder, American plaice, Atlantic cod, thorny skate, smooth skate, other fish species (including piscivores, planktivores and benthivores), large gorgonian corals, sea pens, black corals, soft corals, sponges, common murre, thick-billed murre and hooded seal.
Virgin Rocks	Unique geomorphological features and habitat. Aggregations of sand lance, American plaice, capelin, sooty shearwater, thick-billed murre, killer whale.
Lilly Canyon-Carson Canyon	Winter feeding and refuge area for cetaceans and pinnipeds. Aggregations of snow crab, Greenland halibut, American plaice, redfish, roughhead grenadier, thorny skate, small benthivores (fish), common murre, sooty shearwater, various seabirds, blue whale, harp seals, soft corals and sponges.
Southeast Shoal	Highest benthic biomass of the Grand Banks. Spawning and / or nursery habitats for capelin, American plaice spawning and yellowtail flounder. Reproduction of striped wolffish. Aggregations of sand lance, yellowtail flounder, witch flounder, American plaice, Atlantic cod, Atlantic wolffish, northern wolffish, thorny skate, white hake, benthivores and seabirds.
Southwest Slope	Critical to a wide variety of seabirds; high density of pelagic seabird feeding. Many marine mammals and leatherback sea turtles aggregate in summer. Aggregations of witch flounder, Atlantic halibut, American plaice, Atlantic cod, northern wolffish, redfish, roundnose grenadier, smooth skate, thorny skate, white hake, winter skate, benthivores, seabirds, blue whale, black corals, small and large gorgonian corals, stony cup corals, sea pens. Important spawning area for haddock, redfish and American plaice.



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Table 6.27 Canadian EBSAs within the RAA

EBSA	Key Features
Haddock Channel Sponges	Largest sponge SiBA on the shelf in the study area. Important aggregations of capelin and American plaice.
Fogo Shelf	Includes Funk Island, the largest common murre colony in the western North Atlantic and the only northern gannet breeding colony in the NL Shelves Bioregion. Other bird species aggregations are present, including Atlantic puffin, common eider, greater shearwater, terns and more. Abundance of beach and sub-tidal capelin spawning areas. Important area for Atlantic salmon migration, feeding and spawning, as well as cetacean feeding. Several areas of marine mammals' presence.
Gilbert Bay	Genetically distinct resident population of Atlantic cod. Aggregations of Atlantic salmon, Arctic char, capelin, soft corals and diverse seabird species. Capelin spawning areas present. An MPA has been established in Gilbert Bay since 2005.
Grey Islands	Important for waterfowl and seabirds in coastal areas and on the shelf. Common eider and harlequin duck occur in high concentrations. Important breeding colonies for great black-backed gulls, herring gulls and terns. High diversity of seabird species, as well as high concentrations of soft corals and small gorgonians in the inner shelf area.
Hamilton Inlet	An area of high overall productivity. Caplin spawning beaches. Area of high Atlantic salmon productivity and density. Large Atlantic puffin and razorbill colonies. High diversity of seabirds, including large Atlantic puffin and razorbill colonies. Significant concentrations harlequin duck, murre, dovekie, skua, jaeger, sooty shearwater and other seabirds. Winter feeding area for ringed seals. The main harp seal whelping concentration usually forms on pack ice in this EBSA.
Labrador Marginal Trough	High densities of shrimp, snow crab, Greenland halibut, American plaice, witch flounder and capelin. Potential corridor for several fish and mammal species and includes part of the area of highest probability of use for harp seal whelping and feeding. Aggregations of plankton piscivores and small and medium benthivores. Aggregations of cetaceans in summer and fall. Important for seabirds including murre, black-backed kittiwake, great black-backed gull, herring gull, northern fulmar, Atlantic puffin, skuas, jaegers, sooty shearwater and the SARA-listed (endangered) ivory gull.
Labrador Slope	High diversity of corals, sponges, core species and fish functional groups. Several rare or endangered species, including Atlantic, spotted and northern wolffish, roundnose grenadier and skates have significant concentrations within the area. Also, significant concentrations of northern shrimp, Greenland halibut, redfish, Atlantic cod and American plaice. Juvenile and female hooded seals, as well as a variety of cetaceans and seabirds frequent the area in high relative numbers for feeding.
Notre Dame Channel	Significant area of cetacean feeding and migration. Skates (including smooth skate and thorny skate, designated as endangered and special concern by COSEWIC, respectively) occur in high densities throughout the area. Frequented by several species of seabirds. Significant concentrations of capelin, American plaice, Greenland halibut, snow crab and shrimp. Important winter-feeding area for harp seals.
Orphan Spur	Area of high diversity. High concentrations of corals, marine mammals and seabirds. Densities of sharks and species of conservation concern (e.g., northern, spotted and striped wolffish, skates, roundnose grenadier, American plaice, redfish). Aggregations of several fish functional groups.
Laurentian Channel	One of only two known porbeagle mating grounds. Aggregations of northern wolffish and leatherback sea turtle. Critical feeding area and migration route into and out of the Gulf of St. Lawrence for whales and dolphins. Significant coral and sea pen populations, representing sensitive benthic habitats. Highest sea pen concentrations within the entire Newfoundland and Labrador Shelves Bioregion.



Table 6.27 Canadian EBSAs within the RAA

EBSA	Key Features
Placentia Bay	High level of biodiversity. Supports important seabird breeding areas and a high biomass of birds and mammals. High aggregation of cetaceans and leatherback sea turtles in the spring and summer. Otters and harbour seals use area year-round. Important feeding area from spring to fall for many seabird species and cetaceans (especially humpbacks and porpoises). Important for reproduction of many seabird species, harbour seals and otters. Possible migratory path for leatherback turtles.
Source: DFO 2013, 2019c	

6.4.1.8 Fisheries Closure Areas within Canada’s EEZ

Within the Canadian EEZ, marine areas off eastern NL have been closed to specific fishing activities through various means including voluntary closures, co-management approaches, licensing restrictions and/or under the *Fisheries Act*. Fisheries Closure Areas (FCAs) are intended to protect and conserve productive fish and shellfish habitat for commercially important species and to permit ongoing monitoring and research (DFO 2007, 2014, 2015, 2017b; EMPAAC 2013). Aside from the noted fishing restrictions, no other resource extraction activities are prohibited in these areas. The Funk Island Deep Box (closed to gillnetting, small vessel bottom trawling, and the large shrimp fleet), Hawke Channel Closure (closed to gillnetting, bottom trawl, and longline fishing) and lobster area closures were designated as Marine Refuges in 2019 (Section 6.4.1.4).

FCAs include areas closed to various types of fishing (Table 6.28). The Eastport Peninsula Lobster Management Area and Snow Crab Stewardship Exclusion Zones are within the RAA (Figure 6-42).

Table 6.28 Fisheries Closure Areas within the RAA

Closure Area	Rationale for Identification / Designation
Eastport Peninsula Lobster Management Area	In 1995, Eastport Peninsula lobster fishers voluntarily limited lobster fishing in an area of Bonavista Bay to protect prime lobster habitat. In 1997, DFO provided protection through the <i>Fisheries Act</i> and designated two portions of the area as MPAs under the <i>Oceans Act</i> . Area: 400 km ²
Crab Fishing Area 5A	Snow crab fishing is prohibited in various Stewardship Exclusion Zones within NAFO 3LNO to provide a refuge area for snow crab. These Exclusion Zones are 0.5 or 1.0 nautical mile-wide corridors along the length of crab fishing area boundaries that delineate fishing areas.
Crab Fishing Area 6A	
Crab Fishing Area 6B	
Crab Fishing Area 8X	
Crab Fishing Area 9A	
Near Shore	
Source: DFO 2007, 2014, 2015, 2017b; EMPAAC 2013	

6.4.1.9 National Parks and Historic Sites

Parks Canada establishes National Parks under the *National Parks Act* to protect representative examples of Canada’s 39 National Parks Natural Regions. Four National Parks have been established in NL: Gros Morne and Terra Nova in Newfoundland, Torngat Mountains National Park in northern Labrador and the Mealy Mountains National Park Reserve in southeastern Labrador (Parks Canada 2018). Terra Nova



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National Park, along with various National Historic Sites designated through the *Historic Sites and Monuments Act*, are in coastal areas of NL (Parks Canada 2016).

Gros Morne, Mealy Mountain and Torngat Mountain National Parks are outside the RAA (Figure 6-42). Terra Nova National Park, as well as Signal Hill, Castle Hill, the Ryan Premises and Cape Spear Lighthouse National Historic Sites are within the RAA (Table 6.29).

Table 6.29 Coastal National Parks and Historic Sites within the RAA

National Park/Historic Site	Rationale for Identification / Designation
Cape Spear National Historic Site	Restored historical lighthouse and lighthouse keeper's home on most easterly point of North America.
Signal Hill National Historic Site	Historic site of wireless communication and military defence of St. John's Harbour.
Ryan Premises National Historic Site	Restored merchant's premises, displaying artifacts focusing on traditional NL seafaring life.
Castle Hill National Historic Site	Remains of French and British fortifications and outworks from the late 17 th to early 19 th centuries.
Terra Nova National Park	Protects boreal forest and rocky coastlines as a representative example of Natural Region 35: Eastern NL Atlantic Region. Area: 399 km ²

Source: Parks Canada 2016, 2018

6.4.1.10 Proposed Critical Habitat for Northern and Spotted Wolffish

Northern wolffish and spotted wolffish are listed as Threatened under Schedule 1 of SARA. These species have declined in abundance and size of range area since the 1970s or 1980s when research surveys were initiated. Though some recovery has been recorded, the population of both species is low compared to initial research surveys (Government of Canada 2018).

Limited information is available on northern and spotted wolffish habitats particularly in the offshore. The results of research surveys indicate that habitat preference may be related to sea bottom temperature and depth. Based on these criteria, proposed critical habitat areas have been identified (Figure 6-42). While the entire areas are not considered to be critical habitat, they contain sufficient habitat for survival or recovery (Government of Canada 2018).

6.4.2 Provincial Designations and Their Management

Seven types of protected areas are designated by the Government of NL: Public Reserves; Provincial Parks; Ecological Reserves; Wilderness Reserves; Special Management Areas; Wildlife Reserves; and Wildlife Parks. Parks are managed by the NL Department of Tourism, Culture, Industry and Innovation; Natural Areas fall under the management of the NL Department of Fisheries and Land Resources (Government NL 2019).

Three types of provincially protected areas occur within the RAA (Table 6.30). Eight provincial parks are located on the coast and within the RAA: Bellevue Beach Provincial Park, Chance Cove Provincial Park, Deadman's Bay Provincial Park, Dildo Run Provincial Park, The Dungeon Provincial Park, Gooseberry Cove Provincial Park, Marine Drive Provincial Park and Windmill Bight Provincial Park (Figure 6-43). Two



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provincial historic sites (Heart's Content Cable Station and Cape Bonavista Lighthouse) are located on the coast within the RAA.

Table 6.30 Parks and Natural Areas within the RAA

Legislation	Type of Area	Department / Division	Purpose
<i>Wilderness and Ecological Reserves Act (1980)</i>	Ecological Reserve	Fisheries and Land Resources / Parks Natural Areas	Representative examples of ecosystems or ecoregions to protect unique, rare or endangered plants, animals or other natural heritage. Includes botanical, fossil and seabird ecological reserves.
<i>Provincial Parks Act (1970)</i>	Provincial Park	Fisheries and Land Resources / Parks	Outdoor recreation including day use and camping. Protection of natural features and species.
<i>Historic Resources Act</i>	Historic Site	Tourism, Culture, Industry and Innovation / Heritage	Historical or architectural significance.

Source: Government of NL 2019

Many of the designated provincial ecological reserves include portions of the marine environment. These areas may also be protected under the Newfoundland and Labrador *Wilderness and Ecological Reserves Act (1980)*. Seven ecological reserves are within the RAA (Figure 6-43). Most of these ecological reserves are protected to conserve important seabird species and their habitat and / or fossils; Mistaken Point Ecological Reserve is also a World Heritage Site protected for its fossils (Table 6.31).

Table 6.31 Provincial Ecological Reserves within the RAA

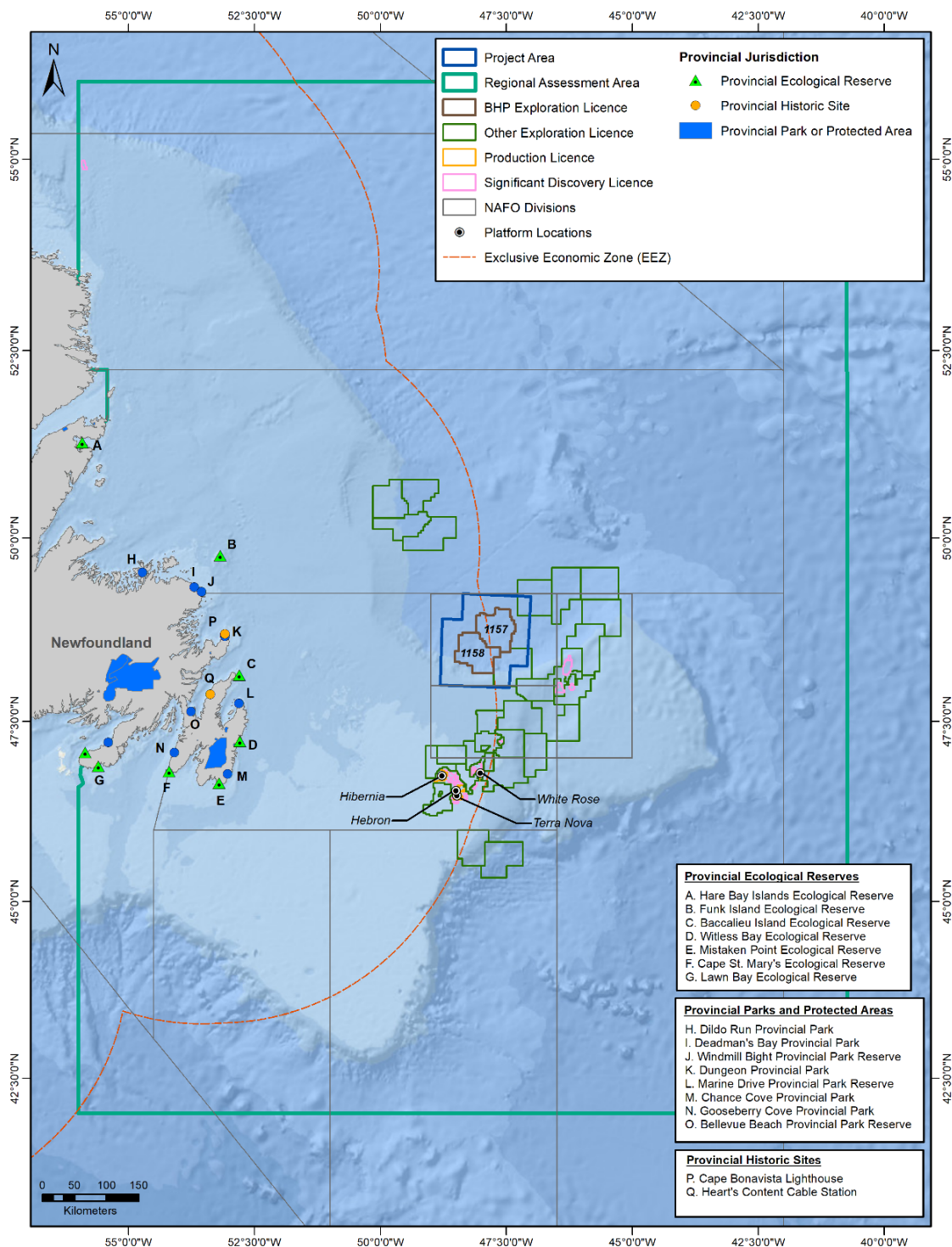
Ecological Reserve	Rationale for Identification / Designation
Baccalieu Island	Contains the largest Leach's storm-petrel colony in the world and is the largest protected seabird island in the province. Area: 23 km ²
Cape St. Mary's	One of the best and most accessible places in the world to see nesting seabirds. Area: 64 km ²
Funk Island	Home to more than 1,000,000 common murres, making it the largest colony of common murre in the western North Atlantic. Area: 5.2 km ²
Hare Bay Islands	Created to protect breeding habitat of the common eider. Area: 31 km ²
Lawn Bay	The only known location in North America where manx shearwaters (<i>Puffinus puffinus</i>) are known to breed. The reserve includes Middle Lawn Island, Colombier Island, and Swale Island. Area: 4 km ²
Witless Bay	Witless Bay Ecological Reserve contains North America's largest Atlantic puffin colony and the second largest Leach's storm-petrel colony in the world. Area: 31 km ²
Mistaken Point	Mistaken Point Ecological Reserve holds a significant assemblage of Ediacaran fossils (580 to 560 million years old). Area: 5.7 km ²

Source: Government of NL 2019



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Source: Government of NL 2011, 2019

Figure 6-43 Provincially Designated Special Areas within the RAA



6.4.3 International Designations and Their Management

In addition to areas identified and designated under applicable Canadian (federal and/or provincial) legislation and processes, various special areas have also been identified by international jurisdictions and processes. As well, some coastal and inland areas of Eastern Newfoundland have been identified as globally, continentally or nationally significant. These internationally designated special areas are outlined in the next sections. No special areas identified by the Convention on Wetlands of International Importance, Western Hemisphere Shorebird Reserve Network or United Nations Educational, Scientific and Cultural Organization (UNESCO) World Biosphere Reserve Program are located in the RAA (ECCC 2018).

6.4.3.1 Vulnerable Marine Ecosystems

VMEs are generalized areas outside of the Canadian EEZ with benthic environments that are sensitive to bottom fishing (FAO 2019). The sensitivity of the environment is due to the presence of species (e.g., large gorgonian corals, sponges and sea pens) that are unique and important for biodiversity. A number of VMEs in the offshore area are within the RAA (Figure 6-44). Detailed descriptions are not yet publicly available.

6.4.3.2 NAFO Vulnerable Marine Ecosystem Closures

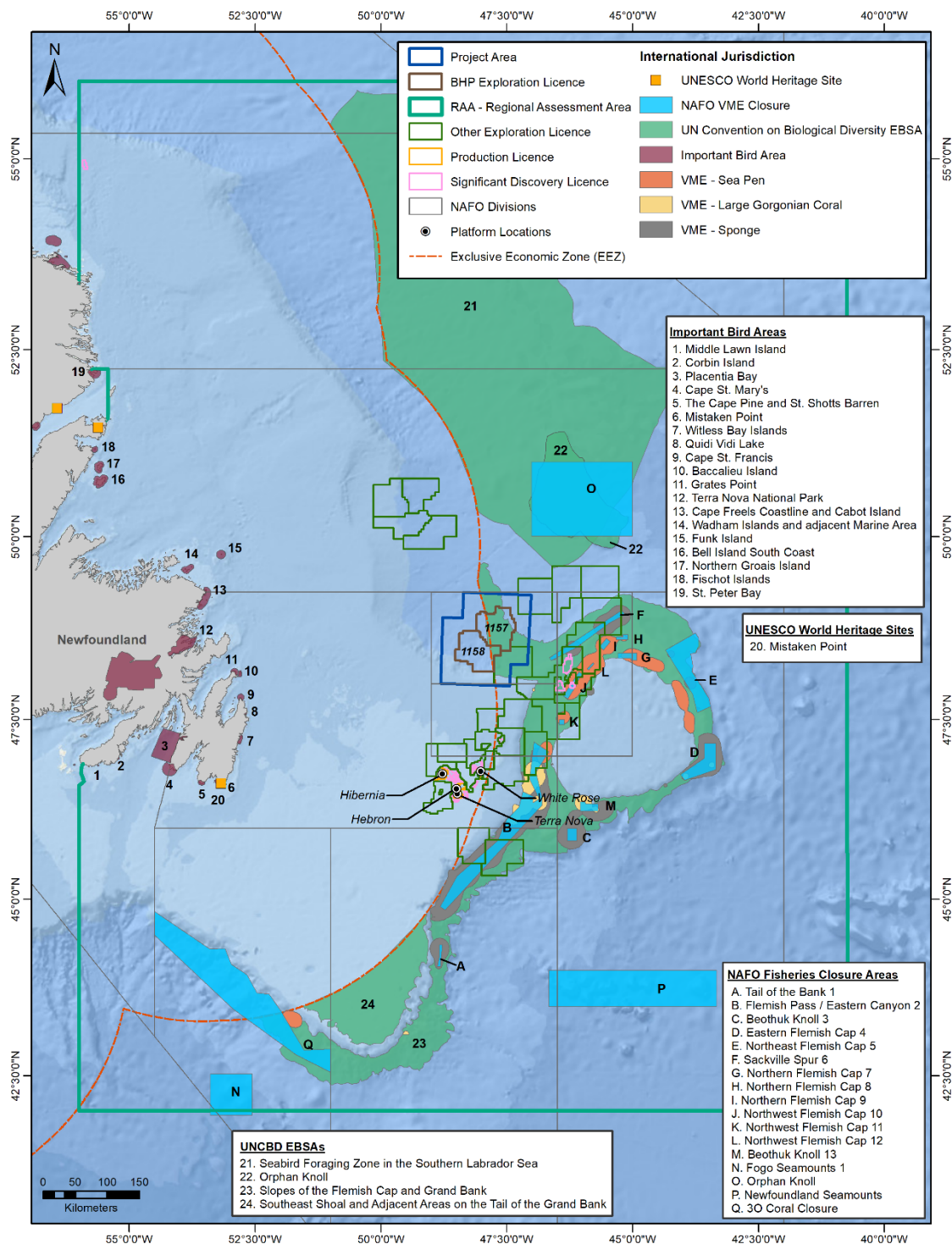
Canada is signatory to international agreements such as United Nations (UN) Convention on the Law of the Sea (UNCLOS) and the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. Within the EEZ, DFO manages Canada's NAFO commitments through the *Fisheries Act* by restricting one or more types of bottom contact fishing gear in portions of VMEs. Outside of Canadian jurisdiction, DFO is responsible for the fishing activities of the Canadian fleet within the NAFO regulatory area; other fishing vessels are administered by their respective country or flag state (FAO 2019).

NAFO has established various closure areas within VMEs off eastern Newfoundland to help conserve ocean species, habitats and biodiversity from the effects of bottom fishing as well as for research purposes. NAFO reviews and updates VME closures on a regular basis and amends boundaries of existing areas or removes / adds protected areas. Seventeen NAFO VME Closures are located within the RAA (Table 6.32).



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Source: NAFO 2008, 2019; UNCBD 2017; UNESCO 2017; IBA Canada 2019

Figure 6-44 Internationally Designated Special Areas within the RAA



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Table 6.32 NAFO VME Closures within the RAA

VME Closure	Rationale for Identification / Designation
Tail of the Bank (1)	<ul style="list-style-type: none"> • Closed to protect high coral and sponge concentrations. • A small closure area on the continental slope of the tail of the Grand Banks straddling the fishing footprint around 2,000 m in depth. • Deep-sea sponge grounds are aggregations of large sponges that develop under certain geological, hydrological and biological conditions to form structural habitat. More recent studies to the south of this closure identified significant concentrations of erect bryozoans, large sea squirts (<i>Boltenia ovifera</i>) and small gorgonian VME indicator species, along with crinoids and cerianthids. • Closure period: January 1, 2010 to December 31, 2020 • Area: 144 km²
Flemish Pass / Eastern Canyon (2)	<ul style="list-style-type: none"> • Closed to protect extensive sponge grounds. • Area was expanded to protect large gorgonian corals in the Flemish Pass. • Approximately 1,200 m deep and separates the Flemish Cap from the Grand Banks. Includes canyons on the eastern slope of the Grand Banks, a portion of Flemish Pass in the south, and western slope of the Flemish Cap. Straddles the 2,000 m NAFO fishing footprint on the slopes except on Flemish Cap. • The Flemish Pass contains sandy muds with accumulations of pebbles and stones apparently deposited by icebergs floating along this course. The area has complex hydrography owing to the occurrence of two water masses. VME indicator elements include canyons and shelf-indenting canyons. • Biological composition is like that of the Sackville Spur. These sponge grounds have been shown to house high species diversity compared with non-sponge ground habitat at similar depths. Some sponge, large gorgonians and sea pen VMEs have also been identified outside the closure. • Closure period: January 1, 2010 to December 31, 2020 • Area: 5,418 km²
Beothuk Knoll (3)	<ul style="list-style-type: none"> • Closed to protect high coral and sponge concentrations. • A discrete steep-sided plateau that forms an abrupt projection from the southwest edge of the Flemish Cap. Adjacent sediment drifts consist of sands. Beothuk Knoll has an iceberg turbate with isolated deep-water scours. Knolls are recognized as VME indicator elements. • Sponge and large gorgonian VMEs have been identified outside this closure. • Closure period: January 1, 2010 to December 31, 2020 • Area: 309 km²
Eastern Flemish Cap (4)	<ul style="list-style-type: none"> • Closed to protect high coral and sponge concentrations. • See Northern, Northwest and Northeast Flemish Cap. High densities of the stalked crinoids <i>Gephyrocrinus grimaldii</i> together with several structure-forming sponges inside the closure. A sponge and large gorgonian VME indicator element has been identified outside the closure. Crinoids and cerianthids have also been found in this area. • Closure period: January 1, 2010 until December 31, 2020 • Area: 1,563 km²
Northeast Flemish Cap (5)	<ul style="list-style-type: none"> • Closed to protect high coral and sponge concentrations. • See Northern and Northwest Flemish Cap. The complexity of the bottom is increased along the southern slope of the Flemish Cap by numerous submarine canyons and steep cliffs. Steep flanks are the important VME indicator element in this area. The closure straddles the NAFO fishing footprint. • This closure encompasses a gradient of benthic communities, transitioning from coral dominated communities at approximately 2,450 m depth, corals intermixed with sponges around 2,000 m, sponge dominated grounds at 1,500 m, and a diverse community of corals, sponges and other benthic taxa at approximately 1,300 m depth. • Closure period: January 1, 2010 until December 31, 2020 • Area: 2,892 km²



Table 6.32 NAFO VME Closures within the RAA

VME Closure	Rationale for Identification / Designation
Sackville Spur (6)	<ul style="list-style-type: none"> • Closed to protect high coral and sponge concentrations. • An elongate sediment drift feature that extends from the Grand Banks across the northern limit of the Flemish Pass and along the northern slope of the Flemish Cap. Its southern flank gently slopes toward the 900-m isobath in the Flemish Pass, and steeper northern flank extends to the floor of the Orphan Basin at 2,500 m depth. • Dominant sponge species are demosponges of the order Astrophorida. Geodiids (mostly <i>Geodia barretti</i>), <i>Stelletta normani</i> and <i>Stryphnus ponderosus</i> occur in the deeper water. These large-sized sponges sometimes grow to more than 25 cm in diameter. The upper limit of the sponges is at approximately 1,300 m depth and extends down to approximately 1,800 m. These sponge grounds host a high diversity and abundance of associated megafaunal species. • Closure period: January 1, 2010 to December 31, 2020 • Area: 992 km²
Northern Flemish Cap (7)	<ul style="list-style-type: none"> • Together identified as NAFO Coral Closures, these areas were closed to protect high coral and sponge concentrations.
Northern Flemish Cap (8)	<ul style="list-style-type: none"> • A plateau of approximately 200 km radius at the 500-m isobath, with depths of < 150 m at its centre and separated from the Grand Banks by the approximately 1,200 m deep Flemish Pass.
Northern Flemish Cap (9)	<ul style="list-style-type: none"> • Flemish Cap has a patch of sand at its centre, in the shallower water, but most of the Cap is covered with muddy sand and sandy mud.
Northwest Flemish Cap (10)	<ul style="list-style-type: none"> • Sea pens are key biophysical components of soft-bottom VME indicator elements in the NAFO regulatory area. Aggregations of sea pens, known as “fields”, provide important structure in low-relief sand and mud habitats where there is little physical habitat complexity. Fields provide refuge for small planktonic and benthic invertebrates that may be preyed upon by fish. A system of sea pen VME indicator species has been identified extending around the edge of the Flemish Cap. Crinoids and cerianthids and black corals have been found associated with this sea pen system. Sponges, sea pens, cerianthids and crinoids are also found outside the closure.
Northwest Flemish Cap (11)	
Northwest Flemish Cap (12)	<ul style="list-style-type: none"> • Closure period: January 1, 2010 to December 31, 2020 except Northwest Flemish Cap (12), which is January 1, 2014 to December 31, 2020 • Areas: 259 km²; 98 km²; 128 km²; 317 km²; 61 km²; 35 km²
Beothuk Knoll (13)	<ul style="list-style-type: none"> • Closed to protect high coral and sponge concentrations. • Physical VME indicator elements include the Beothuk Knoll, steep flanks and canyons with heads > 400 m. • Closure period: January 1, 2015 until December 31, 2020 • Area: 340 km²
30 Coral Closure	<ul style="list-style-type: none"> • Closed to protect corals. • Located on the continental slope from 800 m and is the only closure that straddles national and international waters. The area includes mostly soft bottoms with rocky outcrops. • Sea pen and small gorgonian VME indicator species have been identified near the closure and species distribution models indicate a high probability of sea pens. • VME indicator elements are present: shelf-indenting canyons and canyons with heads of > 400 m in depth in the closure have potential to have VME indicator species. • Closure period: January 1, 2008 to December 31, 2020 • Area: 13,995 km²
Fogo Seamounts 1	<ul style="list-style-type: none"> • Closed to protect seamounts. • Two of the Fogo Seamounts, both below 4,000 m depth, were closed by NAFO as VME indicator elements, with high probability of containing VME indicator species. • Two seamounts located on oceanic crust southwest of the Grand Banks, which form a broad zone of basaltic volcanoes. Most of the Fogo seamounts are deeper than 2,000 m. • Closure period: January 1, 2009 to December 31, 2020 • Areas: 4,522 km², 4,616 km²



Table 6.32 NAFO VME Closures within the RAA

VME Closure	Rationale for Identification / Designation
Newfoundland Seamounts	<ul style="list-style-type: none"> • Closed to protect seamounts. • The Newfoundland Seamounts include six seamount peaks each with summits deeper than 2,400 m, with most of the area being deeper than 3,500 m. These seamounts were volcanically active in the late Cretaceous period. • Seamounts are uniquely complex habitats that rise into bathyal and epi-pelagic depths. In general, seamounts owing to their isolation tend to support endemic populations and unique faunal assemblages. • Closure period: January 1, 2007 until December 31, 2020 • Area: 15,494 km²
Orphan Knoll	<ul style="list-style-type: none"> • Closed to protect seamounts. • Orphan Knoll is a single peak, with depths of a minimum of 1,800 m. Mounds are found at depths of between 1,800 and 2,300 m. Einarsson Mound is 1,500 to 2,000 m wide and 300 m tall, and Nader Mound is between 400 and 800 m wide and 300 m tall, including the height of the base which is covered in sediment. • Physical properties indicate that mid-depth waters above Orphan Knoll are in a boundary region between outflow from the Labrador Sea (subpolar gyre) and northward flow of the North Atlantic Current (subtropical gyre). • A west-east gradient in nutrients is likely related to water mass differences between the Orphan Basin and the area east of the Orphan Knoll. • The Orphan Basin-Orphan Knoll region is biologically rich and complex, and strongly influenced by local processes and advection. Coral, including stony coral, and sponges observed on the flanks. Near-bottom anti-cyclonic circulation could have important implications for the benthic community. • Closure period: January 1, 2007 until December 31, 2020 • Area: 15,815 km²

Source: FAO 2019; NAFO 2016, 2018

6.4.3.3 United Nations Convention on Biological Diversity Ecologically and Biologically Significant Areas

In 1992, Canada ratified the United Nations Convention on Biological Diversity (UNCBD), which became effective in December 1993 (UNCBD 2017). This Convention is considered an important step towards conservation of global biodiversity and includes ocean habitat areas off eastern NL. These areas have been identified for the presence sensitive species and / or important habitats for various types of marine species (Table 6.33). Four UNCBD EBSAs are within the RAA (Figure 6-44).

Table 6.33 UN Convention on Biological Diversity EBSAs within the RAA

EBSA	Rationale for Identification / Designation
Seabird Foraging Zone in the Southern Labrador Sea	Supports globally significant populations of marine vertebrates, including an estimated 40 million seabirds annually. Important foraging habitat for seabirds, including 20 populations of over-wintering black-legged kittiwakes, thick-billed murrelets and breeding Leach’s storm-petrels. Encompasses the pelagic zone of the Orphan Basin, continental shelf, slope and offshore waters inside and outside the Canadian EEZ. Area: 152,841 km ²
Orphan Knoll	Seamounts typically support endemic populations and unique faunal assemblages. This seamount is an island of hard substratum with uniquely complex habitats that rise from the seafloor of the surrounding deep, soft sediments of the Orphan Basin. Although close to the adjacent continental slopes, Orphan Knoll is much deeper and appears to have distinctive fauna. Fragile and long-lived corals and sponges have been observed and a Taylor Cone circulation provides a mechanism for retention of larvae. Area: 12,742 km ²



Table 6.33 UN Convention on Biological Diversity EBSAs within the RAA

EBSA	Rationale for Identification / Designation
Slopes of the Flemish Cap and Grand Bank	Contains most of the aggregations of indicator species for VMEs in the NAFO Regulatory Area. Includes NAFO closures to protect corals and sponges and a component of Greenland halibut fishery grounds in international waters. A high diversity of marine taxa, including Threatened and listed species, are found within the EBSA. Area: 87,817 km ²
Southeast Shoal and Adjacent Areas on the Tail of the Grand Banks	The Southeast Shoal is a shallow, relatively warm, sandy habitat that supports an offshore capelin-spawning ground, a nursery ground for yellowtail flounder and spawning areas for depleted American plaice, depleted Atlantic cod and striped wolffish. The Tail of the Grand Banks hosts abundant forage fish and is an important feeding area for a number of cetaceans, including humpback and fin whales, and is frequented by large numbers of seabirds. Area: not provided
Source: UNCBD 2019	

6.4.4 Other Identified Marine Special Areas

Canada is signatory to various international conventions that identify important wildlife habitats, including those in coastal and offshore marine areas. These areas may be protected in whole or in part through provincial and national legislation.

6.4.4.1 UNESCO World Heritage Sites and Global Geoparks

In 1992, UNESCO adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage, which recognizes outstanding cultural and natural heritage sites that hold value to humankind. Four UNESCO World Heritage sites have been designated in Newfoundland and Labrador: Red Bay Basque Whaling Station, L'Anse aux Meadows, Gros Morne National Park, and Mistaken Point Provincial Ecological Reserve, the latter of which is within the RAA (Figure 6-44). The Mistaken Point Ecological Reserve is designated because its seaside cliffs contain 580-560 million-year-old fossils. It is believed to be one of the largest fossil collections of Ediacara biota, the oldest complex life forms found anywhere on Earth (UNESCO 2017). The provincial ecological reserve does not have protected marine ecosystem components but is within the coastal environment.

In summer 2019, two UNESCO evaluators and a national site observer visited the Discovery Aspiring Geopark on the Bonavista Peninsula for possible certification as a UNESCO Global Geopark. The Aspiring Geopark features rocks over half a billion years old and exceptionally preserved Ediacaran fossils. A public announcement on the result of the UNESCO evaluation is expected in spring 2020. The Geopark area falls within the RAA but is not expected to include protected marine ecosystem components (Canadian Geoparks 2019; Parsons 2019).

6.4.4.2 Important Bird Areas (IBAs)

In Canada, 597 IBAs are recognized as having worldwide, continental or national significance. IBAs are discrete sites that support specific groups of birds: threatened birds, large groups of birds, and / or birds restricted by range or by habitat (IBA Canada 2019). Some IBAs overlap with protected areas such as Migratory Bird Sanctuaries (Section 6.4.1.5) or provincial Ecological Reserves (Section 6.4.2). Newfoundland and Labrador has 41 IBAs, 19 of which occur within the RAA (Figure 6-44). These areas are identified for a wide variety of marine and migratory habitats (Table 6.34).



Table 6.34 Important Bird Areas within the RAA

Important Bird Area	Rationale for Identification / Designation
Cape St. Mary's	<ul style="list-style-type: none"> • Supports a large colony of breeding seabirds, including 2% of the eastern North America population of common murre, 4% to 5% of the western Atlantic breeding population of black-legged kittiwake, and up to 12% of the North American breeding population of northern gannet. • Large numbers of migrant sea ducks, including the eastern population of the nationally endangered harlequin duck. • Includes Provincially designated Seabird Ecological Reserve. • Area: 34 km²
Witless Bay Islands	<ul style="list-style-type: none"> • Globally significant numbers of breeding seabirds, including more than half of the eastern North American population of Atlantic puffin and almost 10% of the global Leach's storm-petrel population. • Large numbers of nesting common murre, black-legged kittiwake and herring gull. • Great black-backed gull, northern fulmar, thick-billed murre, razorbill, and black guillemot nest in smaller numbers. • Surrounding marine area important to sea ducks (e.g., white-winged scoter, surf scoter, long-tailed duck and common eider for fall migration). • Includes Provincially designated Seabird Ecological Reserve. • Area: 6 km²
Baccalieu Island	<ul style="list-style-type: none"> • Greatest seabird abundance and diversity in eastern North America. • World's largest colony of Leach's storm-petrels, including 70% of the North American population. • Significant numbers of breeding Atlantic puffin, black-legged kittiwake and northern gannet • Smaller numbers of nesting common murre, thick-billed murre, razorbill, black guillemot, northern fulmar, herring gull and great black-backed gull. • Includes a Provincially designated Seabird Ecological Reserve • Area: 5 km²
Funk Island	<ul style="list-style-type: none"> • Major concentration of nesting seabirds • Globally significant common murre population • Large numbers of northern gannets • Includes a Provincially designated Seabird Ecological Reserve. • Area: 14 km²
Fischot Islands	<ul style="list-style-type: none"> • Large population of common eider ducks. • Area: 57 km²
Northern Groais Island	<ul style="list-style-type: none"> • Important coastline for breeding and overwintering birds. • Large numbers of black-legged kittiwake and common eider ducks. • Area: 173 km²
Bell Island South Coast	<ul style="list-style-type: none"> • Largest colony of nesting common eider duck on insular Newfoundland • Includes the Migratory Bird Sanctuaries Shepherd Island and Île aux Canes • Potentially significant site for harlequin ducks • Area: 282 km²
Wadham Islands and adjacent Marine Area	<ul style="list-style-type: none"> • Globally significant number of wintering common eider (approximately 25,000 counted in a 1995 survey) • Large numbers of nesting Atlantic puffin, Leach's storm-petrel and razorbill. • Area: 16 km²
Cape Pine and St. Shotts Barren	<ul style="list-style-type: none"> • Large, possibly globally significant numbers of American golden-plover during their fall migration (August to mid-October). • Dozens of whimbrel during fall migration. • Area: 6 km²



Table 6.34 Important Bird Areas within the RAA

Important Bird Area	Rationale for Identification / Designation
Terra Nova National Park	<ul style="list-style-type: none"> • Numerous forest species nest here, including two subspecies with restricted ranges: the federally-listed NL red crossbill (<i>percna</i> ssp.) and ovenbird (<i>furvoir</i> ssp.). • Shorebirds, gulls and waterfowl can be seen on the tidal flats at the outlet of Big Brook, as well as Newman Sound. • At least six tern colonies (common and Arctic tern), totaling between 1,000 and 1,500 pairs. • Includes a Federally designated Migratory Bird Sanctuary (MBS) and National Park. • Area: 66 km²
Grates Point	<ul style="list-style-type: none"> • Large number of wintering common eiders (up to 12,000 individuals, but typically around 2,800) • Other wintering species include black-legged kittiwake, thick-billed murre, and dovekie. • Atlantic puffin and northern gannet are present in the summer months. • Area: 7 km²
Cape St. Francis	<ul style="list-style-type: none"> • Winter congregation area for common eider; up to 5000 individuals recorded. • Purple sandpipers regularly observed along the rocky shoreline in the winter • Area: 7 km²
Quidi Vidi Lake	<ul style="list-style-type: none"> • Important daytime resting site for gulls from late fall to early spring, including significant numbers of herring, great black-backed, Iceland, glaucous, and black-headed gulls. • Locally rare mew gull and lesser black-backed gull occasionally reported. • Waterfowl including American black duck, mallard, and northern pintail are common here in the winter, subsisting on food handouts from people. • Area: 1 km²
Mistaken Point	<ul style="list-style-type: none"> • Important wintering area for up to 12,000 common eiders • Continentally significant numbers of wintering purple sandpiper (more than 1% of North American population). • Nesting black-legged kittiwake, common murre, and razorbill. • Includes a Provincially designated Fossil Ecological Reserve and UNESCO World Heritage Site. • Area: 11 km²
Cape Freels Coastline and Cabot Island	<ul style="list-style-type: none"> • Up to 25,000 wintering common eiders have been reported between the Cape Freels coastline and Wadham Islands. • Large numbers of nesting common murres, as well as some pairs of razorbills. • Historic records of breeding Atlantic puffins, although none were recorded in recent ECCC-CWS surveys. • Area: 34 km²
Placentia Bay	<ul style="list-style-type: none"> • Large number of shearwaters, particularly greater shearwater and Manx shearwater. • Local breeding seabirds, including northern gannet, black-legged kittiwake and common murres from Cape St. Mary's feed on caplin in Placentia Bay. • Wintering common eiders often congregate around the Virgin Rocks. • Area: 1,398 km²
Corbin Island	<ul style="list-style-type: none"> • Likely supports a globally significant colony of Leach's storm-petrels. • Large population of herring gulls. • Area: 5 km²
Middle Lawn Island	<ul style="list-style-type: none"> • Supports the largest concentration of nesting manx shearwaters in North America. • Significant nesting populations of Leach's storm-petrels. • Area: 4 km²



Table 6.34 Important Bird Areas within the RAA

Important Bird Area	Rationale for Identification / Designation
St. Peter Bay	<ul style="list-style-type: none"> • Harlequin ducks (designated as nationally endangered) have been observed in relatively large numbers. • Major moulting area for common eiders. • Area: 171 km²
Source: IBA Canada 2019	

6.5 REFERENCES

6.5.1 Marine Fish and Fish Habitat

- AMEC (AMEC Environment and Infrastructure). 2014. Eastern Newfoundland and Labrador Offshore Area Strategic Environmental Assessment. Final Report. Submitted to Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL. 527 pp. + appendices. Available at: <http://www.cnlopbc.ca/sea/eastern.php>
- Anderson, J.T. 1990. Seasonal development of invertebrate zooplankton on Flemish Cap. Mar. Ecol. Prog. Ser. 67: 127-140.
- Anderson, J.T. 1994. Feeding ecology and condition of larval and pelagic juvenile redfish *Sebastes* spp. Mar. Ecol. Prog. Ser. 104: 211-226.
- Anderson, J.T. and S.A. Akenhead. 1981. Distribution and abundance of redfish and cod larvae on Flemish Cap in 1978 and 1979. NAFO Sci. Coun. Studies 1: 57-63.
- ASM (American Society for Microbiology). 2011. Microbes & oil spills. FAQ Series, American Academy of Microbiology, Washington, DC. 13 Pp. Available at <https://www.dfo-mpo.gc.ca/science/coe-cde/cooger-crpgee/faq-eng.html>.
- Baillie, S.M., and Canadian Wildlife Service Editors). 2005. Seabird Data Collected by the Grand Banks Offshore Hydrocarbon Industry 1999-2002: Results, Limitations and Suggestions for Improvement. Mount Pearl, Newfoundland and Labrador.
- Baker, K.D., R.L. Haedrich, P.V.R. Snelgrove, V.E. Wareham, E.N. Edinger, and K.D. Gilkinson. 2012. Small-scale patterns of deep-sea fish distributions and assemblages of the Grand Banks, Newfoundland continental slope. Deep Sea Research Part I: Oceanographic Research Papers 65: 171-188.
- Bandara, K., Ø. Varpe, R. Ji, and K. Eiane. 2018. A high-resolution modeling study on diel and seasonal vertical migrations of high-latitude copepods. Ecological Modelling 368: 357-376.
- Barrio Froján, C.R., K.G. MacIsaac, A.K. McMillan, M. del Mar Sacau Cuadrado, P.A. Large, A.J. Kenny, E. Kenchington, and E. de Cárdenas González. 2012. An evaluation of benthic community structure in and around the Sackville Spur closed area (Northwest Atlantic) in relation to the protection of vulnerable marine ecosystems. ICES J. Mar. Sci. 69(2): 213-222.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Beazley, L.I., E.L. Kenchington, F.J. Murillo, and M. Sacau. 2013. Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the Northwest Atlantic. *ICES J. Mar. Sci.* 70: 1471-1490.
- Beazley, L.I. and E.L. Kenchington. 2015. Epibenthic megafauna of the Flemish Pass and Sackville Spur (Northwest Atlantic) identified from in situ benthic images transects. *Can. Tech. Rep. Fish. Aquat. Sci.* 3127. v + 496 pp.
- Beazley, L., J. Guijarro, C. Lirette, Z. Wang, and E. Kenchington. 2018. Characteristics of environmental data layers for use in species distribution modelling in the eastern Canadian Arctic and sub-arctic regions. *Can. Tech. Rep. Fish. Aquat. Sci.* 3248. vii + 488 pp.
- Béguer-Pon, M., M. Castonguay, S. Shan, J. Benchetrit, and J.J. Dodson. 2015. Direct observations of American eels migrating across the continental shelf to the Sargasso Sea. *Nature Communications* 6: 8705.
- Bieger, T., T.A. Abrajano and J. Hellou. 1997. Generation of biogenic hydrocarbons during a spring bloom in Newfoundland coastal (NW Atlantic) waters. *Org. Geochem.* 26(3/4): 207-218.
- Bolduc, F., F. Rousseau, C. Gjerdrum, D. Fifield, and S. Christin. 2018, November 21. Atlas of Seabirds at Sea in Eastern Canada 2006 - 2016. <http://data.ec.gc.ca/data/species/assess/atlas-of-seabirds-at-sea-in-eastern-canada-2006-2016/>.
- Bowering, W.R. and A.K. Chumakov. 1989. Distribution and relative abundance of Greenland halibut (*Reinhardtius hippoglossoides* (Walbaum)) in the Canadian Northwest Atlantic from Davis Strait to the northern Grand Bank. *Fish. Res.* 7: 301-327.
- BP. 2018. Newfoundland Orphan Basin Exploration Drilling Program Environmental Impact Statement. Prepared by Stantec Consulting, St. John's, NL for BP Canada Energy Group ULC, Halifax, NS.
- Bradbury, I.R. and P.V.R. Snelgrove. 2001. Contrasting larval transport in demersal fish and benthic invertebrates: the roles of behavior and advective processes in determining spatial pattern. *Can. J. Fish. Aquat. Sci.* 58: 811-823.
- Bradbury, I.R., P.V.R. Snelgrove, and P. Pepin. 2003. Passive and active behavioural contributions to patchiness and spatial pattern during the early life history of marine fishes. *Mar. Ecol. Prog. Ser.* 257: 233-245.
- Bradbury, I.R., L.C. Hamilton, G. Chaput, M.J. Robertson, H. Goraguer, A. Walsh, V. Morris, D.G. Reddin, J.B. Dempson, T.F. Sheehan, T. King, and L. Bernatchez. 2016. Genetic mixed stock analysis of an interceptory Atlantic salmon fishery in the Northwest Atlantic. *Fish. Res.* 174: 234-244.
- Bradbury, I.R., L.C. Hamilton, S. Rafferty, D. Meerburg, R. Poole, J.B. Dempson, M.J. Robertson, D.G. Reddin, V. Bourret, M. Dionne, G. Chaput, T.F. Sheehan, T.L. King, J.R. Candy, and L. Bernatchez. 2015. Genetic evidence of local exploitation of Atlantic salmon in a coastal subsistence fishery in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci.* 72: 83-95.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Breeze, H., D.S. Davis, M. Butler, and V. Kostylev. 1997. Distribution and status of deep-sea corals off Nova Scotia. Ecology Action Centre, Marine Issues Committee Special Publication 1. 58 pp.
- Brown, E.L. and W. Threlfall. 1968. Helminth parasites of the Newfoundland short-finned squid, *Illex illecebrosus* (LeSueur) (Cephalopoda: Decapoda). Can. J. Zool. 46: 1059-1070.
- Caesar, L., S. Rahmstorf, A. Robinson, G. Feulner, and V. Saba. 2018. Observed fingerprint of a weakening Atlantic Ocean overturning circulation. Nature 556: 191-196.
- Cairns, D.K., G. Chaput, L.A. Poirier, T.S. Avery, M. Castonguay, A. Mathers, J.M. Casselman, R.G. Bradford, T. Pratt, G. Verreault, K. Clarke, G. Veinott, and L. Bernatchez. 2014. Recovery potential assessment for the American eel (*Anguilla rostrata*) for eastern Canada: life history, distribution, reported landings, status indicators, and demographic parameters. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/134: xiv + 157 pp.
- Caron, F. 1983. Migration vers l'Atlantique des post-saumoneaux (*Salmo salar*) du Golfe du Saint-Laurent. Le Naturaliste Canadien 110:223–227.
- Carter, L., C.T. Schafer, and M.A. Rashid. 1979. Observations on depositional environments and benthos of the continental slope and rise, east of Newfoundland. Can. J. Earth Sci. 16: 831-846.
- Casas, J.M. 2018. Northern shrimp (*Pandalus borealis*) on Flemish Cap surveys 2018. NAFO/ICES *Pandalus* Assessment Group – October 2018. Serial No. N6879. NAFO SCR Doc.18/062. 21 pp.
- Casas, J.M., E. Román, and M. Álvarez. 2017. Northern shrimp (*Pandalus borealis*) from EU-Spain bottom trawl survey 2017 in NAFO Div. 3LNO. NAFO/ICES *Pandalus* assessment group meeting – September 2017. Serial No. N6745. NAFO SCR Doc.17/065. 12 pp.
- CBD (Convention on Biological Diversity). 2015. Ecologically or Biologically Significant Areas (EBSAs) – Orphan Knoll. Available at <https://chm.cbd.int/database/record?documentID=204103>.
- Choe, N. and D. Deibel. 2011. Life history characters and population dynamics of the boreal larvacean *Oikopleura vanhoeffeni* (Tunicata) in Conception Bay, Newfoundland. J. Mar. Biol. Assoc. U.K. 91(8): 1587-1598.
- Choe, N., D. Deibel, R.J. Thompson, S.H. Lee and V.K. Bushell. 2003. Seasonal variation in the biochemical composition of the chaetognath *Parasagitta elegans* from the hyperbenthic zone of Conception Bay, Newfoundland. Mar. Ecol. Prog. Ser. 251: 191-200.
- Christie, P.M.P. 1966. Some aspects of the ecology of benthic invertebrates in Long Pond, Conception Bay, Newfoundland. Master of Science Thesis, Memorial University of Newfoundland. 110 pp. + appendices.
- Clark, M.R., F. Althaus, T.A. Schalcher, A. Williams, D.A. Bowden, and A.A. Rowden. 2016. The impacts of deep-sea fisheries on benthic communities: A review. ICES J. Mar. Sci. 73(Suppl. 1): i51-i69.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2003. Orphan Basin Strategic Environmental Assessment. LGL Rep. SA767. Rep. by LGL Limited, St. John's, NL for Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL. 229 pp.

Coad, B.W. and J.D. Reist, editors. 2018. Marine Fishes of Arctic Canada. University of Toronto Press, Toronto, ON.

Collette, B., A. Acero, A.F. Amorim, A. Boustany, C. Canales Ramirez, G. Cardenas, K.E. Carpenter, S.-K. Chang, N. de Oliveira Leite Jr., A. Di Natale, D. Die, W. Fox, F.L. Fredou, J. Graves, A. Guzman-Mora, F.H. Viera Hazin, M. Hinton, M. Juan Jorda, C. Minte Vera, N. Miyabe, R. Montano Cruz, R. Nelson, H. Oxenford, V. Restrepo, E. Salas, K. Schaefer, J. Schratwieser, R. Serra, C. Sun, R.P. Teixeira Lessa, P.E. Pires Ferreira Travassos, Y. Uozumi, and E. Yanez. 2011a. *Thunnus alalunga*. The IUCN Red List of Threatened Species, e.T21856A9325450. <http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T21856A9325450.en>. Downloaded on 04 July 2019.

Collette, B., A. Acero, A.F. Amorim, A. Boustany, C. Canales Ramirez, G. Cardenas, K.E. Carpenter, S.-K. Chang, W. Chiang, N. de Oliveira Leite, Jr., A. Di Natale, D. Die, W. Fox, F.L. Fredou, J. Graves, F.H. Viera Hazin, M. Hinton, M. Juan Jorda, C. Minte Vera, N. Miyabe, R. Montano Cruz, R. Nelson, H. Oxenford, V. Restrepo, K. Schaefer, J. Schratwieser, R. Serra, C. Sun, R.P. Teixeira Lessa, P.E. Pires Ferreira Travassos, Y. Uozumi, and E. Yanez. 2011b. *Thunnus obesus*. The IUCN Red List of Threatened Species, e.T21859A9329255. <http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T21859A9329255.en>. Downloaded on 04 July 2019.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006a. COSEWIC Assessment and Status Report on the Blue Shark (Atlantic and Pacific Populations) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006b. COSEWIC assessment and status report on the White Shark *Carcharodon carcharias* (Atlantic and Pacific populations) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009a. COSEWIC Assessment and Status Report on the Roundnose Grenadier *Coryphaenoides rupestris* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009b. COSEWIC Assessment and Status Report on the American Plaice *Hippoglossoides platessoides* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010a. COSEWIC Assessment and Status Report on the Deepwater Redfish/Acadian Redfish complex *Sebastes mentella* and *Sebastes fasciatus*, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010b. COSEWIC Assessment and Status Report on the Atlantic Cod *Gadus morhua* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010c. COSEWIC Assessment and Status Report on the Basking Shark Atlantic population in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010d. COSEWIC Assessment and Status Report on the Spiny Dogfish *Squalus acanthias*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010e. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. vii + 136 pp. Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011a. COSEWIC Assessment and Status Report on the Atlantic Bluefin Tuna *Thunnus thynnus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011b. COSEWIC assessment and status report on the Atlantic Halibut *Hippoglossus hippoglossus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011c. COSEWIC Assessment and Status Report on the Barndoor Skate *Dipturus laevis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012. COSEWIC assessment and status report on the American Eel *Anguilla rostrata* in Canada. Page xii + 109 pp. Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013a. COSEWIC Status Report on the Atlantic Wolffish (*Anarhichas lupus*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013b. COSEWIC Assessment and Status Report on the Cusk *Brosme brosme* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013c. COSEWIC Status Report on the Northern Wolffish (*Anarhichas denticulatus*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013d. COSEWIC assessment and status report on the Smooth Skate *Malacoraja senta* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013e. COSEWIC Status Report on the Spotted Wolffish (*Anarhichas minor*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013f. COSEWIC assessment and status report on the Thorny Skate *Amblyraja radiata* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014a. COSEWIC Assessment and Status Report on the Porbeagle Shark *Lamna nasus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014b. COSEWIC assessment and status report on the White Hake *Urophycis tenuis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2015. COSEWIC Assessment and Status Report on the Atlantic Salmon *Salmo salar* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2017. COSEWIC assessment and status report on the Winter Skate *Leucoraja ocellata*, Gulf of St. Lawrence population, Eastern Scotian Shelf - Newfoundland population and Western Scotian Shelf - Georges Bank population in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2018. COSEWIC Assessment and status report on the Shortfin Mako (*Isurus oxyrinchus*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2019. COSEWIC Assessment and Status Report on the Lumpfish *Cyclopterus lumpus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Coté, D., K. Heggland, S. Roul, G. Robertson, D. Fifield, V. Wareham, E. Colbourne, G. Maillet, B. Devine, L. Pilgrim, C. Pretty, N. Le Corre, J. W. Lawson, C. Fuentes-Yaco, and A. Mercier. 2019. Overview of the biophysical and ecological components of the Labrador Sea Frontier Area. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/067: v + 59 pp.

CSAS (Canadian Science Advisory Secretariat). 2012. Stock status of Atlantic salmon (*Salmo salar*) in DFO Gulf Region (Salmon Fishing Areas 15 to 18). Fisheries and Oceans Canada, Ecosystems and Oceans Science, Newfoundland and Labrador Region.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- CSAS (Canadian Science Advisory Secretariat). 2013. Recovery potential assessment for the south Newfoundland Atlantic salmon (*Salmo salar*) Designatable Unit. Fisheries and Oceans Canada, Ecosystems and Oceans Science, Newfoundland and Labrador Region.
- CSAS (Canadian Science Advisory Secretariat). 2015. Stock assessment of Newfoundland and Labrador salmon - 2013. Fisheries and Oceans Canada, Ecosystems and Oceans Science, Newfoundland and Labrador Region.
- Curtis, T.H., C.T. McCandless, J.K. Carlson, G.B. Skomal, N.E. Kohler, L.J. Natanson, G.H. Burgess, J.J. Hoey, and H.L. Pratt, Jr. 2014. Seasonal distribution and historic trends in abundance of white sharks, *Carcharodon carcharias*, in the western North Atlantic Ocean. PLoS ONE 9: e99240.
- Dalley, E.L., J.T. Anderson, and D.J. Davis. 1999. Plankton and nekton of the Northeast Newfoundland Shelf and Grand Banks in 1998. DFO Can. Stock Assess. Sec. Res. Doc. 99/142: 37 pp.
- Davoren, G.K., and W.A. Montevecchi. 2003. Signals from seabirds indicate changing biology of capelin stocks. Mar. Ecol. Prog. Ser. 258: 253-261.
- Dawe, E.G. and E.B. Colbourne. 2002. Distribution and demography of snow crab (*Chionoecetes opilio*) males on the Newfoundland and Labrador Shelf. p. 577-594 In A.J. Paul, E.G. Dawe, R. Elner, G.S. Jamieson, G.H. Kruse, R.S. Otto, B. Sainte-Marie, T.C. Shirley, and D. Woodby (eds.), Crabs in Cold Water Regions: Biology, Management, and Economics. Alaska Sea Grant College Program, University of Alaska, Fairbanks. doi: 10.4027/ccwr/bme.2002.42.
- Dawe, E.G., E.B. Colbourne, and K.F. Drinkwater. 2000. Environmental effects on recruitment of short-finned squid (*Illex illecebrosus*). ICES J. Mar. Sci. 57: 1002-1013.
- Dawe, E.G., L.C. Hendrickson, E.B. Colbourne, K.F. Drinkwater, and M.A. Showell. 2007. Ocean climate effects on the relative abundance of short-finned (*Illex illecebrosus*) and long-finned (*Loligo pealeii*) squid in the northwest Atlantic Ocean. Fish. Oceanog. 16(4): 303-316.
- Dawe, E.G., S.J. Walsh and E.M. Hynick. 2010. Capture efficiency of a multi-species survey trawl for snow crab (*Chionoecetes opilio*) in the Newfoundland region. Fish. Res. 101: 70-79.
- Denny, S. and L. Fanning. 2016. A Mi'kmaw perspective on advancing salmon governance in Nova Scotia, Canada: Setting the stage for collaborative co-existence. The International Indigenous Policy Journal 7.
- Denny, S. and S. Kavanagh. 2018. Review of the Timing of the American Eel Migratory Journey off Nova Scotia. Window of Sensitivity Defined for the American Eel.
- Devine, J.A., K.D. Baker, and R.L. Haedrich. 2006. Deep-sea fishes qualify as endangered. Nature 439:29.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Dewar, H., E.D. Prince, M.K. Musyl, R.W. Brill, C. Sepulveda, J. Luo, D. Foley, E.S. Orbesen, M.L. Domeier, N. Nasby-Lucas, D. Snodgrass, R. Michael Laurs, J.P. Hoolihan, B.A. Block, and L.M. Mcnaughton. 2011. Movements and behaviors of swordfish in the Atlantic and Pacific Oceans examined using pop-up satellite archival tags. *Fish. Oceanog.* 20: 219-241.
- DFO (Fisheries and Oceans Canada). 2006. Identification of ecologically significant species and community properties. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/041.
- DFO (Fisheries and Oceans Canada). 2011a. Response Statement - Atlantic Salmon, Outer Bay of Fundy Population.
- DFO (Fisheries and Oceans Canada). 2011b. Response Statement - Atlantic Salmon, Nova Scotia Southern Upland Population.
- DFO (Fisheries and Oceans Canada). 2011c. Response Statement - Atlantic Salmon, Eastern Cape Breton Population.
- DFO (Fisheries and Oceans Canada). 2013. Recovery potential assessment for the Anticosti Island Atlantic salmon metapopulation. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/070: 24 pp.
- DFO (Fisheries and Oceans Canada). 2014a. Science review of the Eastern Newfoundland Strategic Environmental Assessment (SEA). DFO Can. Sci. Advis. Sec. Sci. Resp. 2014/035.
- DFO (Fisheries and Oceans Canada). 2014b. Recovery potential assessment for Eastern Cape Breton Atlantic salmon. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/072:39 pp.
- DFO (Fisheries and Oceans Canada). 2015. Coral and Sponge Conservation Strategy for Eastern Canada 2015.
- DFO (Fisheries and Oceans Canada). 2016a. Stock status update of Atlantic salmon in Salmon Fishing Areas (SFAs) 19-21 and 23. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/029:17 pp.
- DFO (Fisheries and Oceans Canada). 2016b, December 19. Witch Flounder. <https://dfo-mpo.gc.ca/species-especes/profiles-profil/witch-flounder-plie-grise-eng.html>.
- DFO (Fisheries and Oceans Canada) Statistical Services. 2016c. American Eel. Accessed from <https://dfo-mpo.gc.ca/species-especes/profiles-profil/eel-anguille-eng.html> on 19-Aug-2019.
- DFO (Fisheries and Oceans Canada). 2017a. Guidance on the level of protection of significant areas of coldwater corals and sponge-dominated communities in Newfoundland and Labrador waters. *Can. Sci. Advis. Sec. Sci. Advis. Rep.*, 2017/030.
- DFO (Fisheries and Oceans Canada). 2017b. Recovery potential assessment for the Anticosti Island Atlantic salmon metapopulation. *Can. Sci. Advis. Sec. Sci. Advis. Rep.* 2013/070.
- DFO (Fisheries and Oceans Canada). 2018a. Canada's Oceans Now: Atlantic Ecosystems 2018. Fisheries and Oceans Canada. 42 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- DFO (Fisheries and Oceans Canada). 2018b. Assessment of Newfoundland and Labrador (Divisions 2HJ3KLNOP4R) snow crab. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/024. 32 pp.
- DFO (Fisheries and Oceans Canada). 2018c. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada [proposed]. Page vii + 82 pp. Ottawa, ON.
- DFO (Fisheries and Oceans Canada). 2019. Ecosystem Research Initiative (ERI) – NEREUS Program. Terms of Reference, Newfoundland and Labrador, Regional Advisory Process. Fisheries and Oceans Canada, Government of Canada. Available at http://www.dfo-mpo.gc.ca/csas-sccs/Schedule-Horraire/2012/01_17-19-eng.html.
- Dutil, J.-D., and J.M. Coutu. 1988. Early marine life of Atlantic salmon, *Salmo salar*, postsmolts in the northern Gulf of St. Lawrence. Fish. Bull. 86: 197-212.
- Dypvik, E., A. Røstad, and S. Kaartvedt. 2012. Seasonal variations in vertical migration of glacier lanternfish, *Benthosema glaciale*. Mar. Biol. 159: 1673-1683.
- Edinger, E.N., V.E. Wareham, K. Baker, and R.L. Haedrich. 2009. Relationships between deep-sea corals and groundfish. Pp.39-55 In: K. Gilkinson and E. Edinger (eds.). The Ecology of Deep-sea Corals of Newfoundland and Labrador Waters: Biogeography, Life History, Biogeochemistry, and Relation to Fishes. Can. Tech. Rep. Fish. Aquat. Sci. 2830: vi + 136 pp.
- Edinger, E.N., V.E. Wareham, and R.L. Haedrich. 2007. Patterns of groundfish diversity and abundance in relation to deep-sea coral distributions in Newfoundland and Labrador waters. Bull. Mar. Sci. 81, no. 3: 101-122
- Equinor (Canada Ltd.; formerly Statoil Canada Ltd.). 2017. Flemish Pass Exploration Drilling Program – Environmental Impact Statement. Prepared by AMEC Foster Wheeler and Stantec Consulting, St. John's, NL, for Equinor Canada Ltd.
- Fifield, D.A., K.P. Lewis, C. Gjerdrum, G.J. Robertson, and R. Wells. 2009. Offshore Seabird Monitoring Program.
- García-Seoane, E., A. Bernal, and F. Saborido-Rey. 2014. Reproductive ecology of the glacier lanternfish *Benthosema glaciale*. Hydrobiologia 727: 137-149.
- Gardner, M.L.G. 1976. A review of factors which may influence the sea-age and maturation of Atlantic salmon, *Salmo salar* L. J. Fish Biol. 9: 289-327.
- Gibbons, M.J. and A.J. Richardson. 2009. Patterns of jellyfish abundance in the North Atlantic. Hydrobiologia 616: 51-65.
- Gibson, A.J.F. and H.D. Bowlby. 2013. Recovery potential assessment for Southern Upland Atlantic salmon: Population dynamics and viability. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/142: iv + 129 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Gibson, A.J.F., R.A. Jones, and G.J. MacAskill. 2016. Recovery potential assessment for Outer Bay of Fundy Atlantic salmon (*Salmo salar*): Population dynamics and variability. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/032: v + 88 pp.
- Gomes, M.C., R.L. Haedrich, and J.C. Rice. 1992. Biogeography of groundfish assemblages on the Grand Bank. J. NW Atl. Fish. Sci. 14: 13-27.
- Government of Canada. 2014, June 11. Species at Risk public registry: glossary of terms. <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/glossary-terms.html>.
- Government of Newfoundland and Labrador. 2019, July 31. Fisheries and Land Resources: Species at Risk. <https://www.flr.gov.nl.ca/wildlife/endangeredspecies/index.html>.
- Greenan, B.J.W., I. Yashayaev, E.J.H. Head, W.G. Harrison, K. Azetsu-Scott, W.K.W. Li, J.W. Loder, and Y. Geshelin. 2010. Interdisciplinary oceanographic observations of Orphan Knoll. NAFO Scientific Council Meeting 10/19. Department of Fisheries and Oceans, Maritimes Region, Bedford Institute of Oceanography, Dartmouth, NS. 32 p.
- Gregg, E.J., R. Gryba, M.C. James, L. Brotz, and S.J. Thornton. 2015. Information relevant to the identification of critical habitat for leatherback sea turtles (*Dermochelys coriacea*) in Canadian Pacific waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2015/079. vii + 32 pp.
- Guijarro, J., L. Beazley, C. Lirette, E. Kenchington, V. Wareham, K. Gilkinson, M. Koen-Alonso, and F.J. Murillo. 2016. Species distribution modelling of corals and sponges from research vessel survey data in the Newfoundland and Labrador region for use in the identification of significant benthic areas. Can. Tech. Rep. Fish. Aquat. Sci. 3171. vi + 125 pp.
- Guijarro-Sabaniél, J., L. Beazley, C. Lirette, E. Kenchington, V. Wareham-Hayes, K. Gilkinson, M. Koen-Alonso, and J. Murillo-Perez. 2019. Species distribution modelling of corals and sponges from research vessel survey data in the Newfoundland and Labrador Region for use in the identification of significant benthic areas. Mendeley Data, v1. Available at <https://data.mendeley.com/datasets/zwv3xx3rc/1#folder-3ce4b2f8-c8cf-4156-8541-cec2d8ead3ee>.
- Halliday, R.G., K.J. Clark, and D.E. Themelis. 2015. The biology of *Benthoosema glaciale* and *Ceratoscopelus maderensis* (Myctophidae) in the Slope Sea off Nova Scotia, Canada. J. NW Atl. Fish. Sci. 47: 73-87.
- Hedger, R.D., D. Hatin, J.J. Dodson, F. Martin, D. Fournier, F. Caron, and F.G. Whoriskey. 2009. Migration and swimming depth of Atlantic salmon kelts *Salmo salar* in coastal zone and marine habitats. Mar. Ecol. Prog. Ser. 392: 179-192.
- Hedger, R.D., A.H. Rikardsen, J.F. Strøm, D.A. Righton, E.B. Thorstad, and T. Næsje. 2017. Diving behaviour of Atlantic salmon at sea: effects of light regimes and temperature stratification. Mar. Ecol. Prog. Ser. 574: 127-140.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Hendrickson, L.C. and E.M. Holmes. 2004. Essential Fish Habitat Source Document: Northern shortfin squid, *Illex illecebrosus*, life history and habitat characteristics (Second Edition). NOAA Technical Memorandum NMFS-NE-191. 38 pp.
- Jacobs, K. 2011. The migration, survival and movements of Atlantic salmon (*Salmo salar*) kelts originating from the Miramichi River system, NB. M.Sc. Thesis McGill University, Montreal, QC.
- Jacoby, D., J. Casselman, M. DeLucia, and M. Gollock. 2017. *Anguilla rostrata* (amended version of 2014 assessment). The IUCN Red List of Threatened Species, e.T191108A121739077. <http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T191108A121739077.en>. Downloaded on 04 July 2019.
- Jonsson, B. and N. Jonsson. 2005. Factors affecting marine production of Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci. 61: 2369-2383.
- Jonsson, N., L.P. Hansen, and B. Jonsson. 1993. Migratory behaviour and growth of hatchery-reared post-smolt Atlantic salmon *Salmo salar*. J. Fish Biol. 42: 435-443.
- Kenchington, E., L. Beazley, C. Lirette, F.J. Murillo, J. Guijarro, V. Wareham, K. Gilkinson, M. Koen-Alonso, H. Benoît, H. Bourdages, B. Sainte-Marie, M. Treble, and T. Siferd. 2016. Delineation of Coral and Sponge Significant Benthic Areas in Eastern Canada Using Kernel Density Analyses and Species Distribution Models. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/093: vi + 178 pp.
- Kenchington, E., D. Power, and M. Koen-Alonso. 2013. Associations of demersal fish with sponge grounds on the continental slopes of the northwest Atlantic. Mar. Ecol. Prog. Ser. 477: 217-230.
- Kenchington, E., Z. Wang, C. Lirette, F.J. Murillo, J. Guijarro, I. Yashayaev, and M. Maldonado. 2019. Connectivity modelling of areas closed to protect vulnerable marine ecosystems in the Northwest Atlantic. Deep-Sea Research Part I 143: 85-103.
- Kennedy, V.S. 1985. A summer benthic survey in Conception Bay, Newfoundland, emphasizing zoogeography of annelids and amphipods. Can. J. Zool. 63: 1863-1869.
- Knudby, A., E. Kenchington, and F.J. Murillo. 2013. Modeling the distribution of *Geodia* sponges and sponge grounds in the Northwest Atlantic. PLoS ONE: e82306. doi: 10.1371/journal.pone.0082306.
- Koeller, P.A., C. Fuentes-Yaco, and T. Platt. 2007. Decreasing shrimp (*Pandalus borealis*) sizes off Newfoundland and Labrador – environment or fishing? Fish. Oceanog. 16(2): 105-115.
- Koen-Alonso, M., P. Pepin, and F. Mowbray. 2010. Exploring the role of environmental and anthropogenic drivers in the trajectories of core fish species of the Newfoundland-Labrador marine community. NAFO SCR Doc. Serial No. N5795:16.
- Kulka, D.W., N.C. Antle, and J.M. Simms. 2003. Spatial Analysis of 18 Demersal Species in Relation to Petroleum Licence Areas on the Grand Bank (1980-2000). Can. Tech. Rep. Fish. Aquat. Sci. 2473.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Kulka, D.W., A.M. Orlov, J.A. Devine, K.D. Baker, and R.L. Haedrich. 2009. *Bathyraja spinicauda*. The IUCN Red List of Threatened Species, e.T161366A5407318.
<http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T161366A5407318.en>. Downloaded on 04 July 2019.
- Kyne, P.M., S.A. Sherill-Mix, and G.H. Burgess. 2006. *Somniosus microcephalus*. The IUCN Red List of Threatened Species, e.T60213A12321694.
<http://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T60213A12321694.en>. Downloaded on 04 July 2019.
- Lacroix, G.L. 2013. Population-specific ranges of oceanic migration for adult Atlantic salmon (*Salmo salar*) documented using pop-up satellite archival tags. *Can. J. Fish. Aquat. Sci.* 70: 1011-1030.
- Lacroix, G.L., and D. Knox. 2005. Distribution of Atlantic salmon (*Salmo salar*) postsmolts of different origins in the Bay of Fundy and Gulf of Maine and evaluation of factors affecting migration, growth, and survival. *Can. J. Fish. Aquat. Sci.* 62: 1363-1376.
- Lear, W.H., and R.K. Misra. 1978. Clinal Variation in Scale Characters of Atlantic Salmon (*Salmo salar*) Based on Discriminant Function Analysis. *J. Fish. Res. Bd. Can.* 35: 43-47.
- Lefevre, M.A., M.J.W. Stokesbury, F.G. Whoriskey, and M.J. Dadswell. 2012. Atlantic salmon post-smolt migration routes in the Gulf of St. Lawrence. *ICES J. Mar. Sci.* 69: 981-990.
- LGL Limited. 2003. Orphan Basin Strategic Environmental Assessment. Available at:
https://www.cnlopb.ca/wp-content/uploads/ob_ea.pdf
- LGL Limited. 2005. Orphan Basin Exploration Drilling Program Environmental Assessment.
- LGL Limited. 2018. Environmental Assessment of Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023. LGL Rep. FA0106A. Rep. by LGL Limited, St. John's, NL for Multiklient Invest AS, Oslo, Norway, and TGS-NOPEC Geophysical Company ASA, Houston, TX. 233 pp. + Appendix.
- Lilly, G.R., D.G. Parsons, and D.W. Kulka. 2000. Was the Increase in Shrimp Biomass on the Northeast Newfoundland Shelf a Consequence of a Release in Predation Pressure from Cod? *J. NW Atl. Fish. Sci.* 27: 45-61.
- Link, J.S., K. Bolles, and C.G. Milliken. 2002. The Feeding Ecology of Flatfish in the Northwest Atlantic. *J. NW Atl. Fish. Sci.* 30: 1-17.
- Marshall, T.L. 2014. Inner Bay of Fundy (iBoF) Atlantic Salmon (*Salmo salar*) Marine Habitat: Proposal for Important Habitat. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2013/071: vi + 69 pp.
- Matheson, K., C.H. McKenzie, R.S. Gregory, D.A. Robichaud, I.R. Bradbury, P.V.R. Snelgrove, and G.A. Rose. 2016. Linking eelgrass decline and impacts on associated fish communities to European green crab *Carcinus maenas* invasion. *Mar. Ecol. Prog. Ser.* 548: 31-45.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Maxner, E., N.M. Halden, J.D. Roth, and G.K. Davoren. 2016. Intrinsic factors influence the timing of arrival of capelin (*Mallotus villosus*) to spawning grounds in coastal Newfoundland. *Fish. Res.* 179: 202-212.
- McClain, C.R. and T.A. Schalcher. 2015. On some hypotheses of diversity of animal life at great depths on the sea floor. *Mar. Ecol.* 36: 849-872.
- Meredyk, S.P. 2017. Physical characterization and benthic megafauna distribution and species composition on Orphan Knoll and Orphan Seamount, NW Atlantic. M.Sc. Thesis, Environmental Science, Memorial University of Newfoundland, St. John's, NL.
- Mills, K.E., A.J. Pershing, T.F. Sheehan, and D. Mountain. 2013. Climate and ecosystem linkages explain widespread declines in North American Atlantic salmon populations. *Global Change Biology* 19: 3046-3061.
- Morgan, M.J., D. Garabana, R.M. Rideout, E. Román, A. Perez-Rodriguez, and F. Saborido-Rey. 2013. Changes in distribution of Greenland halibut in a varying environment. *ICES J. Mar. Sci.* 70: 352-361.
- Mullowney, D.R J. and G.A. Rose. 2014. Is recovery of northern cod limited by poor feeding? The capelin hypothesis revisited. *ICES J. Mar. Sci.* 71: 784-793.
- Murillo, F.J., P.D. Muñoz, A. Altuna, and A. Serrano. 2011. Distribution of deep-water corals of the Flemish Cap, Flemish Pass, and the Grand Banks of Newfoundland (Northwest Atlantic Ocean): Interaction with fishing activities. *ICES J. Mar. Sci.* 68(2): 319-332.
- Murillo, F.J., A. Serrano, E. Kenchington, and J. Mora. 2016. Epibenthic assemblages of the Tail of the Grand Bank and Flemish Cap (Northwest Atlantic) in relation to environmental parameters and trawling intensity. *Deep-Sea Research Part I: Oceanographic Research Papers* 109: 99-122.
- Murua, H. and E. De Cárdenas. 2005. Depth-distribution of deepwater species in Flemish Pass. *J. NW Atl. Fish. Sci.* 37: 1-12.
- Myers, R.A. and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. *Nature* 423: 280-283.
- NAFO (Northwest Atlantic Fisheries Organization). 2019. Conservation and enforcement measures 2019. Serial No. N6901. NAFO/COM Doc. 19-01. 86 pp. + Annexes.
- Nakashima, B.S. and J.P. Wheeler. 2002. Capelin (*Mallotus villosus*) spawning behaviour in Newfoundland waters - The interaction between beach and demersal spawning. *ICES J. Mar. Sci.* 59: 909-916.
- NASA (National Aeronautics and Space Administration). 2019. Level-3 browser. OceanColor WEB. EARTHDATA, NASA. Available at <https://oceancolor.gsfc.nasa.gov/l3/>.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Nexen (Nexen Energy ULC). 2018. Nexen Energy ULC Flemish Pass Exploration Drilling Project (2018-2028). Environmental Impact Statement. Pursuant to the Requirements of the *Canadian Environmental Assessment Act, 2012*.
- NOAA (National Oceanic and Atmospheric Administration). 2014. What are ichthyoplankton? Southwest Fisheries Science Center, NOAA Fisheries. Available at <https://swfsc.noaa.gov/textblock.aspx?Division=FRD&ParentMenuId=436&id=6210>.
- Nogueira, A., D. González-Troncoso, and N. Tolimieri. 2016. Changes and trends in the overexploited fish assemblages of two fishing grounds of the Northwest Atlantic. *ICES J. Mar. Sci.* 73: 345-358.
- Nogueira, A., X. Pax, and D. González-Troncoso. 2017. Demersal groundfish assemblages and depth-related trends on Flemish Cap (NAFO Division 3M): 2004–2013. *Fish. Res.* 186: 192-204.
- OBIS. 2019, July 29. Ocean Biogeographic Information System. Available at <https://obis.org/>.
- Ocearch. 2019. Global Shark Tracker. Accessed July 29, 2019.
- Ollerhead, L.H.N., M. Gullage, N. Trip, and N. Wells. 2017. Development of Spatially Referenced Data Layers for Use in the Identification and Delineation of Candidate Ecologically and Biologically Significant Areas in the Newfoundland and Labrador Shelves Bioregion. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/036: v + 38 pp.
- Parzanini, C., C.C. Parrish, J.-F. Hamel, and A. Mercier. 2017. Trophic ecology of a deep-sea fish assemblage in the Northwest Atlantic. *Mar. Biol.* 164: 206.
- Parzanini, C., C.C. Parrish, J.-F. Hamel, and A. Mercier. 2018. Trophic relationships of deep-sea benthic invertebrates on a continental margin in the NW Atlantic inferred by stable isotope, elemental, and fatty acid composition. *Prog. Oceanog.* 168: 279-295.
- Pedersen, E.J., P.L. Thompson, R.A. Ball, M.-J. Fortin, T.C. Gouhier, H. Link, C. Moritz, H. Nenzen, R.R.E. Stanley, Z.E. Taranu, A. Gonzalez, F. Guichard, and P. Pepin. 2017. Signatures of the collapse and incipient recovery of an overexploited marine ecosystem. *Royal Soc. Open Sci* 4: 170215.
- Penney-Belbin, S.N., and J. Christian. 2013. Orphan Basin subsea environmental monitoring program for Chevron's Margaree A-49 well site. Page 22 p. + appendices. Report by LGL Limited, St. John's, NL, for Chevron Canada Limited, Calgary, AB., LGL Limited Report SA1209.
- Pepin, P. and J.T. Anderson. 1997. Scale-dependent variations in the precision of larval fish abundance estimates: a study of *Sebastes* sp. on Flemish Cap. *Can. J. Fish. Aquat. Sci.* 54: 1111-1120.
- Pepin, P., J.A. Helbig, R. Laprise, E. Colbourne and T.H. Shears. 1995. Variations in the contribution of transport to changes in planktonic animal abundance: a study of the flux of fish larvae in Conception Bay, Newfoundland. *Can. J. Fish. Aquat. Sci.* 52: 1475-1486.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Ramos, C.S., C.C. Parrish, T.A.O. Quibuyen and T.A. Abrajano. 2003. Molecular and carbon isotopic variation in lipids in rapidly settling particles during a spring phytoplankton bloom. *Org. Geochem.* 34(2): 195-207.
- Reddin, D.G. 1985. Atlantic Salmon (*Salmo salar*) On and East of the Grand Bank. *J. NW Atl. Fish. Sci.* 6.
- Reddin, D.G. 2006. Perspectives on the marine ecology of Atlantic salmon (*Salmo salar*) in the Northwest Atlantic. *Can. Sci. Advis. Sec. Res. Doc.* 2006/018.
- Reddin, D.G. and R.F. Burfitt. 1984. A new feeding area for Atlantic salmon (*Salmo salar* L.) to the east of the Newfoundland continental shelf. *Conseil International pour l'Exploration de la Mer* 1984/M:13: Copenhagen, Denmark.
- Reddin, D.G. and K.D. Friedland. 1993. Marine environmental factors influencing the movement and survival of Atlantic salmon. Pp. 79-103. In: *Atlantic Salmon Federation, Salmon in the Sea and New Enhancement Strategies*, Fishing News Books/Blackwell Publishing, ON.
- Reddin, D.G., R.J. Poole, G. Clarke, and N. Cochrane. 2010. Salmon rivers of Newfoundland and Labrador. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2009/46: iv + 24 pp.
- Reddin, D.G. and W.M. Shearer. 1987. Sea-Surface Temperature and Distribution of Atlantic salmon in the Northwest Atlantic Ocean. *Am. Fish. Soc. Symp.* 1: 262–275.
- Richoux, N.B., D. Deibel, R.J. Thompson and C.C. Parrish. 2004. Seasonal changes in the lipids of *Mysis mixta* (Mysidacea) from the hyperbenthos of a cold-ocean environment (Conception Bay, Newfoundland). *Can. J. Fish. Aquat. Sci.* 61(10): 1940-1953.
- Rogers, D.C. and J.H. Thorp. 2015. Collecting, preserving, and culturing invertebrates. *In: Thorp and Covich's Freshwater Invertebrates (Fourth Edition)*. Available at <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/holoplankton>.
- Rose, G.A. 2005. Capelin (*Mallotus villosus*) distribution and climate: a sea “canary” for marine ecosystem change. *ICES J. Mar. Sci.* 62: 1524-1530.
- Ruzzante, D.E., C.T. Taggart, and D. Cook. 1998. A nuclear DNA basis for shelf- and bank-scale population structure in northwest Atlantic cod (*Gadus morhua*): Labrador to Georges Bank. *Molecular Ecol.* 7: 1663-1680.
- Rypina, I.I., L.J. Pratt, and M.S. Lozier. 2016. Influence of ocean circulation changes on the inter-annual variability of American eel larval dispersal. *Limnol. Oceanog.* 61: 1574-1588.
- Salvo, F, D. Hamoutene, V.E. Wareham Hayes, E.N. Edinger, and C.C. Parrish. 2017. Investigation of trophic ecology in Newfoundland cold-water deep-sea corals using lipid class and fatty acid analyses. *Coral Reefs* 37(1): 157-171.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Schalcher, T.A., A.R. Baco, A.A. Rowden, T.D. O'Hara, M.R. Clark, C. Kelley, and J.F. Dower. 2014. Seamount benthos in a cobalt-rich crust region of the central Pacific: Conservation challenges for future seabed mining. *Diversity and Distributions* 20(5): 491-502.
- Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. *Can. Bull. Fish. Aquat. Sci.* 219: 731.
- Sheehan, T.F., D.G. Reddin, G. Chaput, and M.D. Renkowitz. 2012. SALSEA North America: a pelagic ecosystem survey targeting Atlantic salmon in the Northwest Atlantic. *ICES J. Mar. Sci.* 69: 1580-1588.
- Shikon, V. 2018. An analysis of larval fish community structure and capelin (*Mallotus villosus*) early life dynamics on the northeast coast of Newfoundland. Master's Thesis, Memorial University of Newfoundland, St. John's, NL.
- Snelgrove, P.V.R., and R.L. Haedrich. 1985. Structure of the deep demersal fish fauna off Newfoundland. *Mar. Ecol. Prog. Ser.* 27: 99-107.
- Sobel, J. 1996a. *Hippoglossus hippoglossus*. The IUCN Red List of Threatened Species, e.T10097A3162182. <http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T10097A3162182.en>. Downloaded on 04 July 2019.
- Sobel, J. 1996b. *Melanogrammus aeglefinus*. The IUCN Red List of Threatened Species, e.T13045A3406968. <http://dx.doi.org/10.2305/IUCN.UK.1996.RLTS.T13045A3406968.en>. Downloaded on 04 July 2019.
- Soto, D.X., C.N. Trueman, K.M. Samways, M.J. Dadswell, and R.A. Cunjak. 2018. Ocean warming cannot explain synchronous declines in North American Atlantic salmon populations. *Mar. Ecol. Prog. Ser.* 601: 203-213.
- Spares, A.D., J.M. Reader, M.J.W. Stokesbury, T. McDermott, L. Zikovsky, T.S. Avery, and M.J. Dadswell. 2007. Inferring marine distribution of Canadian and Irish Atlantic salmon (*Salmo salar* L.) in the North Atlantic from tissue concentrations of bio-accumulated caesium 137. *ICES J. Mar. Sci.* 64: 394-404.
- Standing Committee on Fisheries and Oceans. 2017. Wild Atlantic salmon in Eastern Canada. Page 37 pp. January 2017, 42nd Parliament, 1st session, Report of the Standing Committee on Fisheries and Oceans.
- Statoil Canada Ltd. 2017. Flemish Pass Exploration Drilling Program - Environmental Impact Statement. St. John's, NL, Canada. Prepared by AMEC Foster Wheeler and Stantec Consulting.
- Strøm, J.F., E.B. Thorstad, G. Chafe, S.H. Sørbye, D. Righton, A.H. Rikardsen, and J. Carr. 2017. Ocean migration of pop-up satellite archival tagged Atlantic salmon from the Miramichi River in Canada. *ICES J. Mar. Sci.* 74(5): 1356–1370, <https://doi.org/10.1093/icesjms/fsw220>



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Sweetman, A. Kv., and A. Chapman. 2015. First assessment of flux rates of jellyfish carcasses (jelly-falls) to the benthos reveals the importance of gelatinous material for biological C-cycling in jellyfish-dominated ecosystems. *Frontiers in Mar. Sci.* 2: 47
- Templeman, N.D. 2007. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/052: 15 pp.
- Templeman, N.D. 2010. Ecosystem Status and Trends Report for the Newfoundland and Labrador Shelf. Can. Sci. Advis. Sec. Res. Doc. 2010/026: 78.
- Tremblay, J., E. Yergeau, N. Fortin, S. Cobanli, M. Elias, T.L. King, K. Lee, and C.W. Greer. 2017. Chemical dispersants enhance the activity of oil- and gas condensate-degrading marine bacteria. *The ISME Journal* 11: 2793-2808.
- Tripsanas, E.K., D.J.W. Piper, and D.C. Campbell. 2008. Evolution and depositional structure of earthquake-induced mass movements and gravity flows: Southwest Orphan Basin, Labrador Sea. *Mar. Petrol. Geol.* 25(7): 645-662.
- Vandeperre, F., A. Aires-da-Silva, J. Fontes, M. Santos, R. S. Santos, and P. Afonso. 2014. Movements of blue sharks (*Prionace glauca*) across their life history. *PLoS ONE* 9: e103538.
- Vanreusel, A., A. Hilario, P.A. Ribeiro, L. Menot, and P.M. Arbizu. 2016. Threatened by mining, polymetallic nodules are required to preserve abyssal epifauna. *Scientific Reports* 6: 26808.
- Vásquez, A., J.M. Casas, W.B. Brodie, F.J. Murillo, M. Mandado, A. Gago, R. Alpoim, R. Bañón, and A. Armesto. 2013. List of species as recorded by Canadian and EU bottom trawl surveys in Flemish Cap. NAFO Sci. Coun. Res. Doc. 13/005: 1-13.
- Vis, M.L., S.M. Carr, W.R. Bowering, and W.S. Davidson. 1997. Greenland halibut (*Reinhardtius hippoglossoides*) in the North Atlantic are genetically homogeneous. *Can. J. Fish. Aquat. Sci.* 54: 1813-1821.
- Walli, A., S.L.H. Teo, A. Boustany, C.J. Farwell, T. Williams, H. Dewar, E. Prince, and B.A. Block. 2009. Seasonal Movements, Aggregations and Diving Behavior of Atlantic Bluefin Tuna (*Thunnus thynnus*) Revealed with Archival Tags. *PLoS ONE* 4: e6151. doi:10.1371/journal.pone.0006151.
- Wareham, V.E., and E.N. Edinger. 2007. Distribution of deep-sea corals in the Newfoundland and Labrador region, Northwest Atlantic Ocean. *Bull. Mar. Sci.* 81: 289-313.
- Wareham, V.E. 2009. Updates on deep-sea coral distributions in the Newfoundland and Labrador and Arctic Regions, Northwest Atlantic. pp.4-22 *In*: K. Gilkinson and E. Edinger (eds.), *The ecology of deep-sea corals of Newfoundland and Labrador waters: Biogeography, life history, biogeochemistry, and relation to fishes.* Can. Tech. Rep. Fish. Aquat. Sci. 2830: vi + 136 pp.
- Westerberg, H., S. Pacariz, L. Marohn, V. Fagerström, K. Wysujack, M.J. Miller, M. Freese, D. Pohlmann, and R. Hanel. 2017. Modeling the drift of European (*Anguilla anguilla*) and American (*Anguilla rostrata*) eel larvae during the year of spawning. *Can. J. Fish. Aquat. Sci.* 999: 1-11.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- White, T.A., H.A. Fotherby, P.A. Stephens, and A.R. Hoelzel. 2011. Genetic panmixia and demographic dependence across the North Atlantic in the deep-sea fish, blue hake (*Antimora rostrata*). *Heredity* 106: 690.
- White, S., S. Bleicher, E. Pierce, G. Kidder, and J. Disney. 2012. Lobster (*Homarus americanus*) size distribution in relation to proximity to eelgrass (*Zostera marina*) beds in Frenchman Bay. *The Bulletin, MDI Biological Laboratory* 51: 35-38.
- Windsor, M.L., P. Hutchinson, P. Hansen, and D.G. Reddin. 2012. Atlantic salmon at sea: Findings from recent research and their implications for management. NASCO document CNL (12)60 Edinburgh, UK: 20 pp.
- Wood, J.B. 2000. The natural history of *Bathypolypus arcticus* (Prosch), a deep-sea octopus. Ph.D. Thesis, Department of Biology, Dalhousie University, Halifax, NS. xiv + 181 pp. + Appendices.
- Zorz, J., C. Willis, A.M. Comeau, M.G.I. Langille, C.L. Johnson, W.K.W. Li, and J. LaRoche. 2019. Drivers of regional bacterial community structure and diversity in the Northwest Atlantic Ocean. *Frontiers in Microbiol.* 10: 281. doi: 10.3389/fmicb.2019.00281.

6.5.2 Marine and Migratory Birds

- Abgrall, P., B.D. Mactavish, and V.D. Moulton. 2008. Marine Mammal and Seabird Monitoring of Orphan Basin Controlled Source Electromagnetic Survey Program, 2006-2007. Rep. No. LGL Rep. SA904/939. Rep. by LGL Ltd., St. John's, NL, for ExxonMobil Canada Ltd., St. John's, NL. 96 pp. + Appendices.
- Ainley, D.G., Nettleship, D.N., Carter H.R., and A.E. Storey. 2002. Common Murre (*Uria aalge*). In: P.G. Rodewald (ed.). *The Birds of North America*. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/commur>.
- Amirault-Langlais, D.L., P.W. Thomas and J. McKnight. 2007. Oiled piping plovers (*Charadrius melodus melodus*) in eastern Canada. *Waterbirds*, 30: 271-274.
- Baker, A., P. Gonzalez, R.I.G. Morrison and B.A. Harrington. 2013. Red Knot (*Calidris canutus*), version 2.0. In: P. G. Rodewald (ed.). *The Birds of North America*, Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://doi.org/10.2173/bna.563>.
- Baillie, S.M., G.J. Robertson, F.K. Wiese, and U.P. Williams. 2005. Seabird data collected by the Grand Banks offshore hydrocarbon industry 1999-2002: results, limitations and suggestions for improvement. *Canadian Wildlife Service Technical Report Series* 434. v + 47 pp.
- Bird Studies Canada. 2016. Important Bird Areas of Canada Database. Bird Studies Canada, Port Rowan, ON. <http://www.ibacanada.org> Accessed: 8 March 2018.
- Birdlife International. 2019. IUCN Red List for Birds. <http://www.birdlife.org> Accessed: 20 June 2019.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Bolduc, F., F. Rosseau, C. Gjerdrum, D. Fifield, and S. Christin. 2018. Atlas of Seabirds at Sea in Eastern Canada 2006 - 2016. Environment and Climate Change Canada, Canadian Wildlife Service, <https://open.canada.ca/data/en/dataset/f612e2b4-5c67-46dc-9a84-1154c649ab4e> Accessed: 23 April 2019.
- Brooke, M. 2004. Albatrosses and petrels across the world. In: Bird Families of the World, Oxford University Press, New York. 499 pp.
- BP Canada (BP Canada Energy Group ULC). 2018. Newfoundland Orphan Basin Exploration Drilling Program – Environmental Impact Statement. Report for BP Canada Energy Group ULC, Halifax, NS, Prepared by Stantec Consulting, St. John's, NL.
- Brown, R.G.B. 1986. Revised atlas of Eastern Canadian seabirds. 1. Shipboard surveys. Bedford Institute of Oceanography and Canadian Wildlife Service, Dartmouth, NS, and Ottawa, ON. 111 pp.
- Burger, J., C. Gordon, J. Lawrence, J. Newman, G. Forcey and L. Vlietstra. 2011. Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. *Renewable Energy*, 36: 338-351.
- Burke, C.M., W.A. Montevecchi, and F.K. Wiese. 2012. Inadequate environmental monitoring around offshore oil and gas platforms on the Grand Bank of Eastern Canada: Are risks to marine birds known? *J. Environ. Mgmt*, 104: 121-126.
- Burke, C.M., G.K. Davoren, W.A. Montevecchi, and F.K. Wiese. 2005. Seasonal and spatial trends of marine birds along support vessel transects and at oil platforms on the Grand Banks. Pp. 587-614, In: S.L. Armsworthy, P.J. Cranford, and K. Lee (eds.), *Offshore Oil and Gas Environmental Effects Monitoring Approaches and Technologies*, Battelle Press, Columbus, OH.
- Butler, R.G. and D.E. Buckley. 2002. Black Guillemot (*Cepphus grylle*). In: P.G. Rodewald (ed.). *The Birds of North America*. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/blkgui>.
- Cairns, D.K., W.A. Montevecchi, and W. Threlfall. 1989. Researcher's guide to Newfoundland seabird colonies. Second edition, Memorial Univ. Newfoundland Occ. Pap. Biol. No. 14. 43 pp.
- Chesser, R.T., K.J. Burns, C. Cicero, J.L. Dunn, A.W. Kratter, I.J. Lovette, P.C. Rasmussen, J.J.V. Remsen, D.F. Stotz, B.M. Winger, and K. Winker. 2018. Check-list of North American Birds (online). American Ornithological Society, <http://checklist.aou.org/taxa> Accessed: 20 June 2019.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012. COSEWIC assessment and status report on the Buff-breasted Sandpiper *Tryngites subruficollis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. x + 44 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014. COSEWIC assessment and status report on the Red-necked Phalarope (*Phalaropus lobatus*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. x + 52 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Cotter, R.C., J.-F. Rail, A.W. Boyne, G.J. Robertson, D.V.C. Weseloh, and K.G. Chaulk. 2012. Population status, distribution, and trends of gulls and kittiwakes breeding in eastern Canada, 1998-2007. Environment Canada Canadian Wildlife Service Occasional Paper 120. 93 pp.
- Cuthbert, F.J., and L.R. Wires. 1999. Caspian Tern (*Hydroprogne caspia*). In: P. G. Rodewald (ed.). The Birds of North America, Cornell Laboratory of Ornithology, Ithaca, NY. Available at: <https://doi.org/10.2173/bna.403>.
- Davis, S.E., M. Maftai, and M.L. Mallory. 2016. Migratory Connectivity at High Latitudes: Sabine's Gulls (*Xema sabini*) from a Colony in the Canadian High Arctic Migrate to Different Oceans. PLOS ONE, 11: e0166043.
- DFO (Fisheries and Oceans). 2012. State of the Ocean for the Placentia Bay - Grand Banks Large Ocean Management Area. Can. Man. Rep. Fish. Aquat. Sci., 2983. viii + 34 pp.
- DFO (Fisheries and Oceans Canada). 2016. Marine Protected Areas and Areas of Interest. Available at: <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm-aoi-sieng.html>.
- Dorr, B.S., Hatch, J.J. and D.V. Weseloh. 2014. Double-crested Cormorant (*Phalacrocorax auritus*). In: P.G. Rodewald (ed.). The Birds of North America. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/SpeciesAccount/bna/species/doccor>.
- Egevang, C., I.J. Stenhouse, R.A. Phillips, A. Petersen, J.W. Fox, and J.R.D. Silk. 2010. Tracking of Arctic terns *Sterna paradisaea* reveals longest animal migration. Proc. Nat. Acad. Sci., US, 107: 2078-2081.
- ECCC (Environment and Climate Change Canada). 2017. Recovery Strategy and Management Plan for the Red Knot (*Calidris canutus*) in Canada. Environment and Climate Change Canada *Species at Risk Act* Recovery Strategy Series, Ottawa, ON. ix + 67 pp.
- Environment Canada. 2007a. Management Plan for the Harlequin Duck (*Histrionicus histrionicus*) Eastern Population, in Atlantic Canada and Québec. Environment Canada, *Species at Risk Act* Management Plan Series, Ottawa, ON. vii + 32 pp.
- Environment Canada. 2007b. Recovery Strategy for the Ross's Gull (*Rhodostethia rosea*) in Canada. *Species at Risk Act* Recovery Strategy Series, Environment Canada, Ottawa, ON. iv + 18 pp.
- Environment Canada. 2009. Atlantic Canada Shorebird Surveys Site Catalogue. Environment Canada. Atlantic Region. viii + 253 pp.
- Environment Canada. 2012. Recovery Strategy for the Piping Plover (*Charadrius melodus melodus*) in Canada. Environment Canada *Species at Risk Act* Recovery Strategy Series, Ottawa, ON. v + 29 pp.
- Environment Canada. 2013a. Report of Harlequin Surveys in Eastern Canada in 2013. Environment Canada, Canadian Wildlife Service. Atlantic Region.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Environment Canada. 2013b. Management Plan for the Barrow's Goldeneye (*Bucephala islandica*), Eastern Population, in Canada. Environment Canada *Species at Risk Act* Management Plan Series, Ottawa, ON. iv + 16 pp.
- Environment Canada. 2014. Recovery strategy for the Ivory Gull (*Pagophila eburnea*) in Canada. *Species at Risk Act* Recovery Strategy Series, Environment Canada, Ottawa, ON. iv + 21 pp.
- Fifield, D.A., K.P. Lewis, C. Gjerdrum, G.J. Robertson, and R. Wells. 2009. Offshore Seabird Monitoring Program. Environmental Studies Research Funds ESRF Report 183. 68 pp.
- Fifield, D.A., W.A. Montevecchi, S. Garthe, G.J. Robertson, U. Kubetzki and J.-F. Rail. 2014. Migratory tactics and wintering areas of Northern Gannets (*Morus bassanus*) breeding in North America. *Ornithological Monographs*, 79: 1-63.
- Fraser, G.S., J. Russell, G.J. Robertson, R. Bryant, and D.A. Fifield. 2013. Prospects for the Manx Shearwater colony on Middle Island, Newfoundland, Canada. *Mar. Ornithol.*, 41: 137-140.
- Fort, J., G. Beaugrand, D. Grémillet and R.A. Phillips. 2012. Biologging, Remotely-Sensed Oceanography and the Continuous Plankton Recorder Reveal the Environmental Determinants of a Seabird Wintering Hotspot. *PLoS ONE*, 7(7): e41194.
- Fort, J., B. Moe, H. Strøm, D. Grémillet, J. Welcker, J. Schultner, K. Jerstad, K.L. Johansen, R.A. Phillips, and A. Mosbech. 2013. Multicolony tracking reveals potential threats to little auks wintering in the North Atlantic from marine pollution and shrinking sea ice cover. *Diversity and Distributions*, 19: 1322-1332.
- Frederiksen, M., S. Descamps, K.E. Erikstad, A.J. Gaston, H.G. Gilchrist, D. Grémillet, K.L. Johansen, Y. Kolbeinsson, J.F. Linnebjerg, M.L. Mallory, L.A. McFarlane Tranquilla, F.R. Merkel, W.A. Montevecchi, A. Mosbech, T.K. Reiertsen, G.J. Robertson, H. Steen, H. Strøm, and T.L. Thórarinsson. 2016. Migration and wintering of a declining seabird, the thick-billed murre *Uria lomvia*, on an ocean basin scale: Conservation implications. *Biol. Conservation*, 200: 26-35.
- Frederiksen, M., B. Moe, F. Daunt, R.A. Phillips, R.T. Barrett, M.I. Bogdanova, T. Boulinier, J.W. Chardine, O. Chastel, L.S. Chivers, S. Christensen-Dalsgaard, C. Clément-Chastel, K. Colhoun, R. Freeman, A.J. Gaston, J. González-Solís, A. Goutte, D. Grémillet, T. Guilford, G.H. Jensen, Y. Krasnov, S.-H. Lorentsen, M.L. Mallory, M. Newell, B. Olsen, D. Shaw, H. Steen, H. Strøm, G.H. Systad, T.L. Thórarinsson, and T. Anker-Nilssen. 2012. Multicolony tracking reveals the winter distribution of a pelagic seabird on an ocean basin scale. *Diversity and Distributions*, 18: 530-542.
- Garland, S. and Thomas, P. 2009. Recovery Plan for Red Knot, *rufa* subspecies (*Calidris canutus rufa*), in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL. iv + 12 pp.
- Garthe, S., W.A. Montevecchi, and G.K. Davoren. 2007a. Flight destinations and foraging behaviour of northern gannets (*Sula bassana*) preying on a small forage fish in a low-Arctic ecosystem. *Deep Sea Research II*, 54: 311-320.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Garthe, S., W.A. Montevecchi, G. Chapdelaine, J.-F. Rail and A. Hedd. 2007b. Contrasting foraging tactics by northern gannets (*Sula bassana*) breeding in different oceanographic domains with different prey fields. *Mar. Biol.*, 151: 687-694.
- Gaston, A.J. and J.M. Hipfner. 2000. Thick-billed Murre (*Uria lomvia*) In: P.G. Rodewald (ed.). *The Birds of North America*. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/thbmur>.
- Gaston, A.J., Smith, P.A., McFarlane Tranquilla, L., Montevecchi, W.A., Fifield, D.A., Gilchrist, H.G., Hedd, A., Mallory, M.L., Robertson, G.J., and Phillips, R.A., 2011. Movements and wintering areas of breeding age Thick-billed Murre *Uria lomvia* from two colonies in Nunavut, Canada. *Polar Biol.* 158: 1929-1941.
- Gauthreaux, S.A., Jr. and C.G. Belser. 2006. Effects of artificial night lighting on migrating birds. Pp. 67-93. In: C. Rich and T. Longcore (eds.). *Ecological Consequences of Artificial Night Lighting*, Island Press, Washington, DC.
- Gilg, O., H. Strøm, A. Aebischer, M.V. Gavrilov, A.E. Volkov, C. Miljeteig, and B. Sabard. 2010. Post-breeding movements of northeast Atlantic ivory gull *Pagophila eburnea* populations. *J. Avian Biol.* 41: 532-542.
- Good, T.P. 1998. Great Black-backed Gull (*Larus marinus*). In: A. Poole and F. Gill (editors), *The Birds of North America*, No. 330, The Birds of North America, Inc., Philadelphia, PA. 32 p.
- Harrington, B.A., F.J. Leeuwenberg, S.L. Resende, B. McNeil, T. Thomas, J.S. Grear and E.F. Martinez. 1991. Migration and mass change of white-rumped sandpipers in North and South America. *Wilson Bull.*, 103: 621-636.
- Hatch, J.J. 2002. Arctic Tern (*Sterna paradisaea*). In: A. Poole and F. Gill (eds.). *The Birds of North America*, No. 707, The Birds of North America, Inc., Philadelphia, PA. 40 pp.
- Hatch, J.J., Brown, K.M., Hogan, G.G. and R.D. Morris. 2000. Great Cormorant (*Phalacrocorax carbo*), In: P.G. Rodewald (ed.). *The Birds of North America*, Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/SpeciesAccount/bna/species/grecor>.
- Hauser, D.D.W., A.L. Lang, B.D. Mactavish, and V.D. Moulton. 2010. Marine mammal and seabird monitoring of the Orphan Basin controlled source electromagnetic survey program, 2009. Rep. No. SA1049. Rep. by LGL Ltd., St. John's, NL, for ExxonMobil Canada Ltd., St. John's, NL. 96 pp. + Appendices.
- Hedd, A., W.A. Montevecchi, L. McFarlane Tranquilla, C.M. Burke, D.A. Fifield, G.J. Robertson, R.A. Phillips, C. Gjerdrum, and P.M. Regular. 2011. Reducing uncertainty on the Grand Bank: tracking and vessel surveys indicate mortality risks for common murre in the North-West Atlantic. *Animal Conserv.* 14: 630-641.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Hedd, A., W.A. Montevecchi, H. Otley, R.A. Phillips, and D.A. Fifield. 2012. Trans-equatorial migration and habitat use by sooty shearwaters *Puffinus griseus* from the South Atlantic during the nonbreeding season. *Mar. Ecol. Prog. Ser.* 449: 277-290.
- Hedd, A., I.L. Pollet, R.A. Mauck, C.M. Burke, M.L. Mallory, L.A. McFarlane Tranquilla, W.A. Montevecchi, G.J. Robertson, R.A. Ronconi, D. Shutler, S.I. Wilhelm, and N.M. Burgess. 2018. Foraging areas, offshore habitat use, and colony overlap by incubating Leach's storm-petrels *Oceanodroma leucorhoa* in the Northwest Atlantic. *PLoS One*, 13: e0194389.
- Howell, S.N.G. 2012. *Petrels, Albatrosses, and Storm-Petrels of North America: A Photographic Guide*. Princeton University Press, Princeton, NJ. 520 pp.
- Huettmann, F. and A.W. Diamond. 2000. Seabird migration in the Canadian Northwest Atlantic Ocean: moulting locations and movement patterns of immature birds. *Can. J. Zool.* 78: 624-647.
- Huettman, F., Diamond, A.W., Dalzell, B. and K. MacIntosh. 2005. Winter distribution, ecology and movements of Razorbills *Alca torda* and other auks in the outer Bay of Fundy, Atlantic Canada. *Mar. Ornithol.* 33: 161-171.
- Holst, M., and B. Mactavish. 2014. Marine mammal, sea turtle and seabird monitoring of MKI/PGS's seismic program off the Northeast Newfoundland Slope, June-November 2013. Rep. No. SA1221A. Rep. by LGL Ltd., St. John's, NL, for PGS, Houston, TX. 7 pp. + Appendices.
- Jones, C.G., and A.L. Lang. 2013. Marine mammal, sea turtle, and seabird monitoring and mitigation for Statoil's Flemish Pass and Orphan Basin seismic program, 2012. Rep. No. SA1172. Rep. by LGL Ltd., St. John's, NL, for Statoil, St. John's, NL. 60 pp. + Appendices.
- Jones, C.J., D.D.W. Hauser, A.L. Lang, and V.D. Moulton. 2010. Marine mammal and seabird monitoring of GX Technology's 2009 2-D seismic program offshore of Northeast Greenland. pp. 33, St. John's Calgary, AB.
- Jones, C.J., A.L. Lang and N.J. Patenaude. 2012. Marine Mammal, Sea Turtle, and Seabird Monitoring and Mitigation for Statoil's Flemish Pass and Orphan Basin Seismic Program, 2011. Rep. No. SA1138. Rep. by LGL Ltd., St. John's, NL, for Statoil Canada Limited, St. John's, NL. 64 pp. + Appendices.
- Lamarre, J.-F., J. Bêty, E. Reed, R. Lanctot, O. Love, G. Gauthier, O.W Johnson, K. Overduijn, J. Liebezeit, R. Bentzen, M. Russell, L. McKinnon, L. Kolosky, P. Smith, S. Flemming, N. Lecomte, M.-A. Giroux, S. Bauer and T. Emmenegger. 2017. Year-round migratory connectivity in American Golden-Plover (*Pluvialis dominica*). Arctic Change 2017 Conference, 11-15 December 2017, Quebec City, QC.
- Lang, A.L., V.D. Moulton and R. A. Buchanan. 2008. Marine Mammal and Seabird Monitoring of Husky Energy's 3-D Seismic Program in the Jeanne d'Arc Basin, 2005. Rep. No. SA887. St. John's, NL, for Husky Energy Inc., Calgary, AB. 57 pp. + Appendices.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Lang, A. L. 2016. Marine mammal, sea turtle, and seabird monitoring during WesternGeco's multi-client 3D seismic program, Newfoundland offshore area, May-October 2016. Rep. No. FA0086. Rep. by LGL Ltd., St. John's, NL, for WesternGeco Canada, Calgary, AB. 6 pp. + Appendices.
- Lavers, J., Hipfner, J.M. and G. Chapdelaine. 2009. Razorbill (*Alca torda*). In: P.G. Rodewald (ed.). The Birds of North America. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/razorb>.
- Lock, A.R., R.G.B. Brown, and S.H. Gerriets. 1994. Gazetteer of Marine Birds in Atlantic Canada: An Atlas of Seabird Vulnerability to Oil Pollution. Canadian Wildlife Service Atlantic Region. 137 pp.
- Lormée, H., K. Delord, and B. Letournel. 2008. Dénombrement des oiseaux marins nicheurs sur l'île du Grand Colombier (Saint Pierre and Miquelon). Report for St. Pierre and Miquelon Direction de l'Agriculture et de la Forêt. Saint Pierre, Saint Pierre et Miquelon.
- Lormée, H., K. Delord, B. Letournel, and C. Barbraud. 2012. Population survey of Leach's Storm-Petrels breeding at Grand Colombier Island, Saint-Pierre and Miquelon archipelago. Wilson J. Ornithol. 124(2): 245-252.
- Lormée, H., C. Barbraud and B. Letournel. 2015. Étude des populations d'oiseaux marins nicheurs sur l'île du Grand Colombier (Saint Pierre et Miquelon). Rapport interne.
- Mactavish, B.D., J.A. Beland, and M. Holst. 2012. Marine mammal, sea turtle, and seabird monitoring and mitigation for Chevron's North Grand Banks regional seismic program. Rep. No. SA1124. Rep. by LGL Ltd., St. John's, NL, for Chevron Canada Limited, Calgary, AB. 54 pp. + Appendices.
- Mactavish, B., J. Clarke, J. Wells, A. Buckley, and D. Fifield. 2016. Checklist (2016) of the Birds of Insular Newfoundland. Nature Newfoundland & Labrador, St. John's, NL.
- Madeiros, J., B. Flood and K. Zufelt. 2014. Conservation and at-sea range of Bermuda Petrel (*Pterodroma cahow*). North American Birds, 67: 547-557.
- Maftai, M., S.E. Davis, and M.L. Mallory. 2015. Confirmation of a wintering ground of Ross's Gull *Rhodostethia rosea* in the northern Labrador Sea. Ibis, 157: 642-647.
- Magnusdottir, E., E.H.K. Leat, S. Bourgeon, H. Strom, A.E. Petersen, R.A. Phillips, S.A. Hanssen, J.O. Bustnes, P. Hersteinsson, and R. W. Furness. 2012. Wintering areas of Great Skuas *Stercorarius skua* breeding in Scotland, Iceland and Norway. Bird Study, 51: 1-9.
- Mallory, M., J. Akearok, D. Edwards, K. O'Donovan, and C. Gilbert. 2008. Autumn migration and wintering of northern fulmars (*Fulmarus glacialis*) from the Canadian high Arctic. Polar Biol., 31: 745-750.
- McCarty, J.P., L.L. Wolfenbarger, C.D. Laredo, P. Pyle and R.B. Lanctot. 2017. Buff-breasted Sandpiper (*Calidris subruficollis*), version 2.0. In: P.G. Rodewald (ed.). The Birds of North America, Cornell Laboratory of Ornithology, Ithaca, NY. Available at: <https://doi.org/10.2173/bna.bubsan.02>



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- McFarlane Tranquilla, L.A., W.A. Montevecchi, A. Hedd, D.A. Fifield, C.M. Burke, P.A. Smith, P.M. Regular, G.J. Robertson, A.J. Gaston, and R.A. Phillips. 2013. Multiple-colony winter habitat use by murrens *Uria* spp. in the Northwest Atlantic Ocean: Implications for marine risk assessment. *Mar. Ecol. Prog. Ser.*, 472: 287-303.
- McFarlane Tranquilla, L., W.A. Montevecchi, A. Hedd, P.M. Regular, G.J. Robertson, D.A. Fifield, and R. Devillers. 2015. Ecological segregation among thick-billed murrens (*Uria lomvia*) and common murrens (*Uria aalge*) in the Northwest Atlantic persists through the nonbreeding season. *Can. J. Zool.*, 93: 447-460.
- Montevecchi, W.A. 2006. Influences of artificial light on marine birds. Pp. 94-113. In: C. Rich and T. Longcore (eds.), *Ecological Consequences of Artificial Night Lighting*, Island Press, Washington, D.C.
- Montevecchi, W.A. and I.J. Stenhouse. 2002. Dovekie (*Alle alle*) In: P.G. Rodewald (ed.). *The Birds of North America*. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/doveki>.
- Montevecchi, W.A., A. Hedd, L. McFarlane Tranquilla, D.A. Fifield, C.M. Burke, P.M. Regular, G.K. Davoren, S. Garthe, G.J. Robertson and R.A. Phillips. 2012a. Tracking seabirds to identify ecologically important and high risk marine areas in the western North Atlantic. *Biol. Conserv.*, 156: 62-71.
- Montevecchi, W., D. Fifield, C. Burke, S. Garthe, A. Hedd, J.-F. Rail and G. Robertson. 2012b. Tracking long-distance migration to assess marine pollution impact. *Biology Letters*, 8: 218-221.
- Morrison, R.I.G. 1984. Migration systems of some New World shorebirds. Pp. 125-202. In: J. Burger and B. L. Olla (eds.). *Behavior of Marine Animals*, Plenum Press, New York, NY.
- Moulton, V.D., and B.D. Mactavish. 2004. Recommended seabird and marine mammal observational protocols for Atlantic Canada. Pp. 71. In: *Environmental Studies Research Funds No. 156*. Environmental Studies Research Funds, Calgary, AB.
- Moulton, V.D., B.D. Mactavish, and R.A. Buchanan. 2005. Marine mammal and seabird monitoring of Chevron Canada Resources' 3-D seismic program on the Orphan Basin. Rep. No. SA817. Rep. by LGL Ltd., St. John's, NL, for Chevron Canada Resources, and Imperial Oil Resources Ventures, Calgary, AB, and St. John's, NL. 90 pp. + Appendices.
- Moulton, V.D., B.D. Mactavish, R.E. Harris, and R.A. Buchanan. 2006. Marine mammal and seabird monitoring of Chevron Canada Resources' 3-D seismic program on the Orphan Basin, 2005. Rep. No. SA843. Rep. by LGL Ltd., St. John's, NL, for Chevron Canada Limited, ExxonMobil Canada Ltd., Shell Canada Limited, Imperial Oil Resources Ventures Ltd., Calgary, AB, and St. John's, NL. 111 pp. + Appendices.
- Mowbray, T.B. 2002. Northern Gannet (*Morus bassanus*). In: A. Poole and F. Gill (eds.). *The Birds of North America*, No. 693, The Birds of North America, Inc., Philadelphia, PA. 28 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Nisbet, I.C.T. 2002. Common Tern (*Sterna hirundo*). In: A. Poole and F. Gill (eds.). The Birds of North America, No. 618, The Birds of North America, Inc., Philadelphia, PA. 40 pp.
- NLDEC (Newfoundland and Labrador Department of Environment and Conservation). 2016. Newfoundland and Labrador Department of Environment and Conservation Species at Risk information sheets. <http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/birds.html>
Accessed: 20 June 2019.
- Onley, D. and P. Scofield. 2007. Albatrosses, Petrels and Shearwaters of the World. Princeton University Press, Princeton, NJ. 240 pp.
- Pollet, I.L., R.A. Ronconi, I.D. Jonsen, M.L. Leonard, P.D. Taylor, and D. Shutler. 2014a. Foraging movements of Leach's storm-petrels *Oceanodroma leucorhoa* during incubation. J. Avian Biol., 45: 305-314.
- Pollet, I.L., A. Hedd, P.D. Taylor, W.A. Montevecchi, and D. Shutler. 2014b. Migratory movements and wintering areas of Leach's Storm-Petrels tracked using geolocators. J. Field Ornithol., 85: 321-328.
- Pollet, I.L., R.A. Ronconi, M.L. Leonard and D. Shutler. 2018. Migration routes and stopover areas of Leach's Storm Petrels *Oceanodroma leucorhoa*. Mar. Ornithol., 47: 53-63.
- Ramírez, I, V.H. Paiva, D. Menezes, I. Silva, R.A. Phillips, J.A. Ramos and S. Garthe. 2013. Year-round distribution and habitat preferences of the Bugio petrel. Mar. Ecol. Prog. Ser., 476: 269-284.
- Ramos, R., I. Ramírez, V.H. Paiva, T. Militão, M. Biscoito, D. Menezes, R.A. Phillips, F. Zino, and J. González-Solís. 2016. Global spatial ecology of three closely-related gadfly petrels. Scientific Reports (Nature Lond.), 6: 23447.
- Richardson, W.J. 1979. Southeastward shorebird migration over Nova Scotia and New Brunswick in autumn: a radar study. Can. J. Zool., 57: 107-124.
- Robertson, G.J., and R.D. Elliot. 2002. Changes in seabird populations breeding on Small Island, Wadham Islands, Newfoundland. Canadian Wildlife Service Atlantic Region Technical Report Series No. 381.
- Roul, S. 2010. Distribution and status of the Manx Shearwater (*Puffinus puffinus*) on islands near the Burin Peninsula, Newfoundland. Honours Thesis, Memorial University of Newfoundland, St. John's, NL. 38 pp.
- Rubega, M.A., D. Schamel, and D.M. Tracy. 2000. Red-necked Phalarope (*Phalaropus lobatus*). In: A. Poole and F. Gill (ed.). The Birds of North America, No. 538, The Birds of North America, Inc., Philadelphia, PA.
- Russell, J. 2008. Population estimate for the colony of Leach's Storm-Petrels (*Oceanodroma leucorhoa*) breeding on Green Island, Fortune Bay, southeastern Newfoundland in 2008. DFO internal report.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Schmelzer, I. 2006. A management plan for Barrow's Goldeneye (*Bucephala islandica*; Eastern population) in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation. Corner Brook, NL.
- Secretariat of the Convention on Biological Diversity. 2014. Report of the North-west Atlantic Regional Workshop to facilitate the description of Ecologically or Biologically Significant Marine Areas. United Nations Environment Programme UNEP/CBD/EBSA/WS/2014/2/4. 122 pp.
- Sittler, B., A. Aebischer, and O. Gilg. 2011. Post-breeding migration of four Long-tailed Skuas (*Stercorarius longicaudus*) from North and East Greenland to West Africa. *J. Ornithol.*, 152: 375-381.
- Smith, M., M. Bolton, D.J. Okill, R.W. Summers, P. Ellis, F. Liechti, and J.D. Wilson. 2014. Geolocator tagging reveals Pacific migration of red-necked phalarope *Phalaropus lobatus* breeding in Scotland. *Ibis*, 156: 870-873.
- Spencer, N.C., H.G. Gilchrist, H. Strøm, K.A. Allard, and M.L. Mallory. 2016. Key winter habitat of the ivory gull *Pagophila eburnea* in the Canadian Arctic. *Endangered Species Res.*, 31: 33-45.
- Statoil Canada Ltd. 2015a. Ice Overview and Bird and Mammal Data Summary - Bay de Verde Well Site, West Hercules: November 4, 2014 to February 8, 2015. Report prepared by PAL (Provincial Aerospace Ice and Environmental Services) for Statoil Canada Ltd., April 2015.
- Statoil Canada Ltd. 2015b. Ice Overview and Bird and Mammal Data Summary - Bay du Nord L-76, West Hercules: May 2 to September 12, 2015. Report prepared by PAL (Provincial Aerospace Ice and Environmental Services) for Statoil Canada Ltd., October 2015.
- Statoil Canada Ltd. 2017. Flemish Pass Exploration Drilling Program – Environmental Impact Statement. Prepared by AMEC Foster Wheeler and Stantec Consulting Ltd., St. John's, NL Canada. 1378 pp.
- Steele, D.H., and W.A. Montevecchi. 1994. Leach's storm-petrels prey on lower mesopelagic (Mysidacea and Decapoda) crustaceans: Possible implications for crustacean and avian distributions. *Crustaceana*, 66: 212-218.
- Stenhouse, I.J. 2004. Canadian management plan for the Ivory Gull (*Pagophila eburnea*). Canadian Wildlife Service, St. John's, NL. 22 p.
- Templeman, N.D. 2007. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Res. Doc., 2007/052: 15 pp.
- Thomas, P.W., L.A.M. Tranquilla, B.E. Toms, A.W. Boyne, G.J. Robertson, P.M. Regular, and S.I. Wilhelm. 2014a. Second census of terns, gulls, kittiwakes and cormorants along the coast of insular Newfoundland, 2005-2007. CWS Technical Report Series No. 531.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Thomas, T.A., Fitzgerald, M. and A.L. Lang. 2014b. Marine mammal, sea turtle, and seabird monitoring and mitigation: Statoil's 2014 Bay du Nord 3-D seismic program. LGL Report FA0010. Report by LGL Limited, St. John's, NL for Statoil Canada Limited, St. John's, NL. 58 pp. + Appendices.
- Tracy, D.M., D. Schamel, and J. Dale. 2002. Red Phalarope (*Phalaropus fulicarius*). In: A. Poole and F. Gill (ed.). The Birds of North America, No. 698, The Birds of North America, Inc., Philadelphia, PA. 32 pp.
- van Bemmelen, R., B. Moe, S.A. Hanssen, N.M. Schmidt, J. Hansen, J. Lang, B. Sittler, L. Bollache, I. Tulp, R. Klaassen, and O. Gilg. 2017. Flexibility in otherwise consistent non-breeding movements of a long-distance migratory seabird, the long-tailed skua. *Mar. Ecol. Prog. Ser.*, 578: 197-211.
- Wells, N.J., G.B. Stenson, P. Pepin and M. Koen-Alonso. 2017. Identification and Descriptions of Ecologically and Biologically Significant Areas in the Newfoundland and Labrador Shelves Bioregion. DFO Can. Sci. Advis. Sec. Res. Doc., 2017/013: 87 pp.
- White, C.M., Clum, N.J., Cade, T.J. and W.G. Hunt. 2002. Peregrine Falcon (*Falco peregrinus*). In: P.G. Rodewald (ed.). The Birds of North America, Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/perfal>.
- Wiese, F.K. and P.C. Ryan. 2003. The extent of chronic marine oil pollution in southeastern Newfoundland waters assessed through beached-bird surveys 1984-1999. *Mar. Poll. Bull.*, 46: 1090-1101.
- Wilhelm, S.I., J.-F. Rail, P.M. Regular, C. Gjerdrum, and G.J. Robertson. 2016. Large-Scale Changes in Abundance of Breeding Herring Gulls (*Larus argentatus*) and Great Black-Backed Gulls (*Larus marinus*) Relative to Reduced Fishing Activities in Southeastern Canada. *Waterbirds*, 39: 136.
- Wilhelm, S.I., Robertson, G.J., Ryan, P.C. and D.C. Schneider. 2007. Comparing an estimate of seabirds at risk to a mortality estimate from the November 2004 Terra Nova FPSO oil spill. *Mar. Poll. Bull.*, 54: 537-544.
- Wilhelm, S.I., J. Mailhiot, J. Arany, J.W. Chardine, G.J. Robertson, and P.C. Ryan. 2015. Update and trends of three important seabird populations in the western North Atlantic using a geographic information system approach. *Mar. Ornithol.*, 43: 211-212.
- Wilhelm, S.I., A. Hedd, G.J. Robertson, J. Mailhiot, P.M. Regular, P.C. Ryan, and R.D. Elliot. 2019. The world's largest breeding colony of Leach's Storm-petrel (*Hydrobates leucorhous*) has declined. *Bird Conservation International*, 1-18. Doi:10.1017/S0959270919000248.
- Wiley, R.H. and D.S. Lee. 1998. Long-tailed Jaeger (*Stercorarius longicaudus*). In: P.G. Rodewald (ed.). The Birds of North America. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/lotjae>.
- Wiley, R.H. and D.S. Lee. 1999. Parasitic Jaeger (*Stercorarius parasiticus*). In: P.G. Rodewald (ed.). The Birds of North America. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/parjae>.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

Wiley, R.H. and D.S. Lee. 2000. Pomarine Jaeger (*Stercorarius pomarinus*). In: P.G. Rodewald (ed.). The Birds of North America. Cornell Lab of Ornithology, Ithaca, NY. Available at: <https://birdsna.org/Species-Account/bna/species/pomjae>.

Williams, T.C. and J.M. Williams. 1978. An oceanic mass migration of land birds. Scientific American, 239: 166-176.

6.5.3 Marine Mammals and Sea Turtles

6.5.3.1 Personal Communications for Marine Mammals and Sea Turtles

L.J. Feyrer, Ph.D. Candidate, Dalhousie University, pers. comm., 5 February 2018

J. Lawson, DFO Research Scientist, pers. comm., April 2019

B. Mactavish, LGL Ltd. Bird Researcher, pers. comm., 2018

6.5.3.2 Literature for Marine Mammals and Sea Turtles

AMEC (AMEC Environment and Infrastructure). 2014. Eastern Newfoundland and Labrador Offshore Area Strategic Environmental Assessment. Final Report. Submitted to Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL. 527 pp. + Appendices. Available at: <http://www.cnlopb.ca/sea/eastern.php>

Andersen, J.M., Y.F. Wiersma, G. Stenson, M.O. Hammill, and A. Rosing-Asvid. 2009. Movement patterns of hooded seals (*Cystophora cristata*) in the Northwest Atlantic Ocean during the post-moult and pre-breed seasons. J. NW Atl. Fish. Sci., 42: 1-11.

Andersen, J.M., G.B. Stenson, M. Skern-Mauritzen, Y.F. Wiersma, A. Rosing-Asvid, M.O. Hammill and L. Boehme. 2014. Drift diving by hooded seals (*Cystophora cristata*) in the Northwest Atlantic Ocean. PLoS ONE, 9(7): e103072. doi:10.1371/journal.pone.0103072.

Andersen, J.M., M. Skern-Mauritzen, L. Boehme, Y.F. Wiersma, A. Rosing-Asvid, M.O. Hammill and G.B. Stenson. 2013. Investigating annual diving behaviour by hooded seals (*Cystophora cristata*) within the Northwest Atlantic Ocean. PLoS ONE, 8(11): e80438. doi:10.1371/journal.pone.0080438.

Andersen, J.M., Y.F. Wiersma, G.B. Stenson, M.O. Hammill, A. Rosing-Asvid and M. Skern-Mauritzen. 2012. Habitat selection by hooded seals (*Cystophora cristata*) in the Northwest Atlantic Ocean. ICES J. Mar. Sci., 69: 1-13.

Archibald, D.W. and M.C. James. 2016. Evaluating inter-annual relative abundance of leatherback sea turtles in Atlantic Canada. Mar. Ecol. Prog. Ser., 547: 233-246.

Atlantic Leatherback Turtle Recovery Team. 2006. Recovery Strategy for Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, ON, NL. vi + 45 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Baumgartner, M., S. Kraus, A. Knowlton, P. Corkeron and T. Wimmer. 2017. Life on the Edge: Status and Conservation Concerns for the North Atlantic Right Whale. Panel Discussion, Wednesday, October 25, 2017. Presented at the 22nd Biennial Conference on the Biology of Marine Mammals, Halifax, Canada.
- Bettridge, S., Baker, C.S., Barlow, J., Clapham, P.J., Ford, M., Gouveia, D., Mattila, D.K., Pace, III, R.M., Rosel, R.E., Silber, G.K. and P.R. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. NOAA Technical Memo. NMFS-SWFSC-540. Nat. Mar. Fish. Service, Southwest Fish. Sci. Center, La Jolla, CA. 240 pp.
- BP. 2016. Scotian Basin Exploration Drilling Project – Environmental Impact Statement. Prepared by Stantec Consulting Ltd.
- Brazner, J.C. and J. McMilan. 2008. Loggerhead turtle (*Caretta caretta*) bycatch in Canadian pelagic longline fisheries: relative importance in the western North Atlantic and opportunities for mitigation. Fish. Res., 91: 310-324.
- CBC. 2014. Rare bowhead whale spotted in Trinity Bay. Accessed on 26 August 2019 at <https://www.cbc.ca/news/canada/newfoundland-labrador/programs/centralmorning/rare-bowhead-whale-spotted-in-trinity-bay-1.2739504>.
- CBC. 2019. Right whales return early to Atlantic Canada – while babies seen in US waters. Accessed on 9 August at <https://www.cbc.ca/news/canada/newfoundland-labrador/right-whales-return-to-atlantic-canada-1.5145026>.
- Chambault, P., F. Roquet, S. Benhamou, A. Baudena, E. Pauthenet, B. de Thoisy, M. Bonola, V/ Dos Reis, R. Crasson, M. Brucker, Y. Le Baho and D. Chevallier. 2017. The Gulf Stream frontal system: A key oceanographic feature in the habitat selection of the leatherback turtle? Deep-Sea Research Part I, 123: 35-47.
- Corkeron, P., Hamilton, P., Bannister, J., Best, P., Charlton, C., Groch, K.R., Findlay, K., Rowntree, V., Vermeulen, E. and R.M. Pace III. 2018. The recovery of North Atlantic right whales, *Eubalaena glacialis*, has been constrained by human-caused mortality. Royal Society Open Science 5 : 180892. <https://doi.org/10.1098/rsos.180892>.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002a. COSEWIC Assessment and Update Status Report on the Blue whale *Balaenoptera musculus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vi + 32 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002b. COSEWIC Assessment and Update Status Report on the Northern Bottlenose Whale *Hyperodon ampullatus* Scotian Shelf Population in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vi + 22 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2003a. COSEWIC Assessment and Status Report on the Sei Whale *Balaenoptera borealis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vii + 27 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2003b. COSEWIC Assessment and Update Status Report on the Humpback Whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 25 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2003c. COSEWIC Assessment and Update Status Report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 28 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2004. COSEWIC Assessment and Update Status Report on the Narwhal *Monodon monoceros* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vii + 50 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2005. COSEWIC Assessment and Update Status Report on the Fin Whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. ix + 37 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006a. COSEWIC Assessment and Update Status Report on the Sowerby's Beaked Whale *Mesoplodon bidens* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vi + 20 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006b. COSEWIC Assessment and Update Status Report on the Harbour Porpoise *Phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vii + 32 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2008. COSEWIC Assessment and Update Status Report on the Killer Whale *Orcinus orca*, Southern Northern Population, Northern Resident Population, West Coast Transient Population, Offshore Population and Northwest Atlantic / Eastern Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. vii + 65 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009a. COSEWIC Assessment and Status Report on the Bowhead Whale *Balaena mysticetus*, Bering-Chukchi-Beaufort Population and Eastern Canada-West Greenland population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 51 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009b. COSEWIC Assessment and Status Report on the Killer Whale *Orcinus orca* Southern Resident population, Northern Resident population, West Coast Transient population, Offshore population and Northwest Atlantic / Eastern Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 65 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010. COSEWIC Assessment and Status Report on the Loggerhead Sea Turtle *Caretta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. viii + 75 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011. COSEWIC Assessment and Status Report on the Northern Bottlenose Whale *Hyperoodon ampullatus*. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. xii + 31 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012a. COSEWIC Assessment and Status Report on the Leatherback Sea Turtle *Dermochelys coriacea* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. xv + 58 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012b. COSEWIC Status Appraisal Summary on the Blue Whale *Balaenoptera musculus*, Atlantic Population, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 12 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. COSEWIC Assessment and Status Report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 58 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014. COSEWIC assessment and status report on the Beluga Whale *Delphinapterus leucas*, St. Lawrence Estuary population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xii + 64 pp.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2019. Committee on the Status of Endangered Wildlife in Canada. Government of Canada. Available at <https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife.html>
- Dalebout, M.L., D.E. Ruzzante, H. Whitehead and N.I. Øien. 2006. Nuclear and mitochondrial markers reveal distinctiveness of a small population of bottlenose whales (*Hyperoodon ampullatus*) in the western North Atlantic. *Mol. Ecol.*, 15: 3115-3129.
- Daoust, P.-Y., E.L. Couture, T. Wimmer and L. Bourque. 2017. Incident Report: North Atlantic Right Whale Mortality Event in the Gulf of St. Lawrence, 2017. Collaborative Report Produced by: Canadian Wildlife Health Cooperative, Marine Animal Response Society, and Fisheries and Oceans Canada. 256 pp.
- Delarue, J., R. Dziak, D. Mellinger, J. Lawson, H. Moors-Murphy, Y. Simard and K. Stafford. 2014. Western and central North Atlantic fin whale (*Balaenoptera physalus*) stock structure assessed using geographic song variations. *J. Acoust. Soc. Am.*, 135(4): 2240.
- Delarue, J., Kowarski, K.A., Maxner, E.E., MacDonnell, J.T. and S.B. Martin. 2018. Acoustic monitoring along Canada's East Coast: August 2015 to July 2017. Document Number 01279, Environmental Studies Research Funds Report Number 215, Version 1.0. Technical Report by JASCO Applied Sciences for Environmental Studies Research Fund, Dartmouth, NS, Canada. 120 pp. + Appendices.
- DFO (Fisheries and Oceans Canada). 2010. Recovery potential assessment for loggerhead sea turtles (*Caretta caretta*) in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2010/042: 11 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- DFO (Fisheries and Oceans Canada). 2011. 2011-2015 Integrated Fisheries Management Plan for Atlantic Seals. Available at: <http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/reports-rapports/mgtplan-planges20112015/mgtplan-planges20112015-eng.htm>.
- DFO (Fisheries and Oceans Canada). 2012. Current status of Northwest Atlantic harp seals, (*Pagophilus groenlandicus*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/070.
- DFO (Fisheries and Oceans Canada). 2016a. Recovery Strategy for the Northern Bottlenose Whale, (*Hyperoodon ampullatus*), Scotian Shelf Population, in Atlantic Canadian Waters [Final]. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, ON. vii + 70 pp.
- DFO (Fisheries and Oceans Canada). 2016b. Action Plan for the North Atlantic Right Whale (*Eubalaena glacialis*) in Canada: Fishery Interactions [Proposed]. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa, ON. v + 35 pp.
- DFO (Fisheries and Oceans Canada). 2016c. Tracking the Titans: Research on Endangered Leatherback Turtles Informs a Recovery Strategy. Available at <http://www.dfo-mpo.gc.ca/science/publications/article/2016/01-29-16-eng.html>.
- DFO (Fisheries and Oceans Canada). 2016d. Recovery Strategy for the Leatherback Sea Turtle (*Dermochelys coriacea*) in Atlantic Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, ON. vii + 43 pp.
- DFO (Fisheries and Oceans Canada). 2017a. Management Plan for the Fin Whale (*Balaenoptera physalus*), Atlantic Population in Canada. *Species at Risk Act* Management Plan Series, DFO, Ottawa, ON. iv + 38 pp.
- DFO (Fisheries and Oceans Canada). 2017b. Management Plan for the Sowerby's Beaked Whale (*Mesoplodon bidens*) in Canada. *Species at Risk Act* Management Plan Series, DFO, Ottawa, ON. iv + 46 pp.
- DFO (Fisheries and Oceans Canada). 2017c. Action Plan for the Northern Bottlenose Whale (*Hyperoodon ampullatus*), Scotian Shelf population, in Atlantic Canadian waters. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 37 pp.
- DFO (Fisheries and Oceans Canada). 2017d. Threat assessment for loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic population. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/014.
- DFO (Fisheries and Oceans Canada). 2018a. Action Plan for the Blue Whale (*Balaenoptera musculus*), Northwest Atlantic Population, in Canada [Proposed]. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa, ON. iv + 21 p. Available at: http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/Ap-BlueWhaleNWAtlantic-v00-2018Jun-Eng.pdf
- DFO (Fisheries and Oceans Canada). 2018b. Identification of habitat important to the blue whale in the western North Atlantic. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2018/003: 15 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- DFO (Fisheries and Oceans Canada). 2018c. Action plan for the leatherback sea turtle (*Dermochelys coriacea*), in Atlantic Canada. *Species at Risk Act Management Plan Series*, DFO, Ottawa. v + 29 pp.
- DFO (Fisheries and Ocean Canada). 2019. Review of North Atlantic right whale occurrence and risk of entanglements in fishing gear and vessel strikes in Canadian waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2019/028: 38 pp.
- Dodge, K.L., B. Galuardi, T.J. Miller and M.E. Lutcavage. 2014. Leatherback turtle movements, dive behavior, and habitat characteristics in ecoregions of the Northwest Atlantic Ocean. PLoS ONE, 9(3): e91726. doi:10.1371/journal.pone.0091726.
- Edwards, E.F., C. Hall, T.J. Moore, C. Sheredy and J.V. Redfern, 2015. Global distribution of fin whales *Balaenoptera physalus* in the post-whaling era (1980–2012). *Mammal Rev.*, 45(4): 197-214.
- ExxonMobil (ExxonMobil Canada Limited). 2017. ExxonMobil Canada Ltd. Eastern Newfoundland Offshore Exploration Drilling Project (CEAR 80132) Environmental Impact Statement. December 2017. Available at: <http://www.ceaa-acee.gc.ca/050/evaluations/document/121311?culture=en-CA>.
- Fugro EMU Limited. 2015. Bay du Nord Field Canada: Marine Mammal Mitigation Report (Survey Period 02 June – 22 June 2015). Fugro EMU report J/6?05/2858 prepared for Statoil Canada Ltd. iii + 8 pp. + Appendices.
- Fullard, K.J., G. Early, M.P. Heide-Jorgensen, D. Bloch, A. Rosing-ASvid, and W. Amos. 2000. Population structure of long-finned pilot whales in the North Atlantic: a correlation with sea surface temperature? *Molecular Ecol.*, 9(7): 949-958.
- Gomez, C., J. Lawson, A.-L. Kouwenberg, H. Moors-Murphy, A. Buren, C. Fuentes-Yaco, E. Marotte, Y.F. Wiersma and T. Wimmer. 2017. Predicted distribution of whales at risk: identifying priority areas to enhance cetacean monitoring in the Northwest Atlantic Ocean. *Endangered Species Research*, 32: 437-458.
- Government of Canada. 2019. Species at Risk Public Registry. Available at: <http://www.sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1>.
- Halpin, P.N., A.J. Read, E. Fujioka, B.D. Best, B. Donnelly, L.J. Hazen, C. Kot, K. Urrian, E. LaBrecque, A. Dimatteo, J. Cleary, C. Good, L.B. Crowder, and K.D. Hyrenbach. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography*, 22(2):104-115. Data for sea turtles downloaded from OBIS-SEAMAP (<http://seamap.env.duke.edu/>) on 25 August 2019.
- Hamelin, K.M. and M.C. James. 2018. Evaluating outcomes of long-term satellite tag attachment on leatherback sea turtles. *Animal Biotelem.*, 6(1): 18.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Hamelin, K.M., M.C. James, W. Ledwell, J. Huntington, and K. Martin. 2017. Incidental capture of leatherback sea turtles in fixed fishing gear off Atlantic Canada. *Aquat. Conserv.* 27(3): 631-642. doi.org/10.1002/aqc.2733
- Hammill, M.O., C.E. den Heyer and W.D. Bowen, 2014. Grey seal population trends in Canadian waters, 1960-2014. DFO Can. Sci. Advis. Sec. Res. Doc., 2014/037: iv + 44 pp.
- Hammill, M.O., G.B. Stenson, T. Doniol-Valcroze and A. Mosnier. 2015. Conservation of northwest Atlantic harp seals: Past success, future uncertainty? *Biol. Conserv.*, 192: 181-191.
- Hayes, S.A., E. Josephson, K. Maze-Foley and P.E. Rozel (Editors). 2017. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2016. NOAA Tech Memo NMFS NE 241; 274 pp. Available at: <http://nefsc.noaa.gov/publications/> or National Marine Fisheries Service, 166 Water Street, Woods Hole, MA.
- Hayes, S.A., Josephson, E., Maze-Foley, K. and P.E. Rozel (Editors). 2018. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2017: (second edition). NOAA Tech Memo NMFS NE 2415. 371 pp. US Department of Commerce, Woods Hole, MA.
- Hoelzel, A.R., C.W. Potter and P.B. Best. 1998. Genetic differentiation between parapatric 'nearshore' and 'offshore' populations of bottlenose dolphin. *Proc. Royal Soc. London, Biol. Sci.* 265: 1177-1183.
- Huijser, L.A.E., Berube, M., Cabrera, A.A., Prieto, R., Silva, M.A., Robbins, J., Kanda, N., Pastene, L.A., Goto, M., Yoshida, H., Vikingsson, G.A. and P.J. Palsboll. 2018. Population structure of North Atlantic and North Pacific sei whales (*Balaenoptera borealis*) inferred from mitochondrial control region DNA sequences and microsatellite genotypes. *Conserv. Genetics*, 19: 1007-1024.
- Husky Energy. 2012. Husky Energy White Rose Extension Project Environmental Assessment. Prepared by Stantec Consulting Ltd., St. John's, NL, for Husky Energy. St. John's, NL.
- James, M.C., K. Martin, and P.H. Dutton. 2004. Hybridization between a green turtle, *Chelonia mydas*, and loggerhead turtle, *Caretta*, and the first record of a green turtle in Atlantic Canada. *Can. Field-Nat.*, 118(4): 579-582.
- Kraus, S.D., R.D. Kenney, C.A. Mayo, W.A. McLellan, M.J. Moore and D.P. Nowacek. 2016. Recent scientific publications cast doubt on North Atlantic right whale future. *Frontiers in Mar. Sci.*, 3:137.
- Lalire, M. and P. Gaspar. 2019. Modeling the active dispersal of juvenile leatherback turtles in the North Atlantic Ocean. *Movement Ecology*, 7:7. <https://doi.org/10.1186/s40462-019-0149-5>.
- Lawson, J.W. and J.F. Gosselin. 2009. Distribution and preliminary abundance estimates for cetaceans seen during Canada's Marine Megafauna Survey - A component of the 2007 TNASS. DFO Can. Sci. Adv. Sec. Res. Doc., 2009/031. 28 pp.
- Lawson, J.W. and J.F. Gosselin. 2011. Fully-corrected cetacean abundance estimates from the Canadian TNASS survey. (Draft paper available from J. Lawson).



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Ledwell, W., S. Benjamins, J. Lawson, and J. Huntington. 2007. The most southerly record of a stranded bowhead whale, *Balaena mysticetus*, from the North Atlantic Ocean. *Arctic*, 60:17-22.
- Lesage, V. and M.O. Hammill. 2001. The status of the grey seal, *Halichoerus grypus*, in the Northwest Atlantic. *Can. Field-Nat.*, 115(4): 653-662.
- Lesage, V., K. Gavrilchuk, R.D. Andrews and R. Sears. 2016. Wintering areas, fall movements and foraging sites of blue whales satellite-tracked in the Western North Atlantic. *DFO Can. Sci. Advis. Sec. Res. Doc.*, 2016/078: v + 38 pp.
- Lesage, V., Gosselin, J.-F., Lawson, J.W., McQuinn, I., Moors-Murphy, H., Plourde, S., Sears R. and Y Simar. 2018. Habitats important to blue whales (*Baleanoptera musculus*) in the western North Atlantic. *DFO Can. Sci. Advis. Sec. Res. Doc.*, 2016/080: iv + 50 pp.
- LGL Limited. 2009. Marine Mammal and Seabird Monitoring of Statoil Hydro Canada and Husky Energy's 2008 Seismic Program in the Jeanne d'Arc Basin. LGL report SA984 prepared for Statoil Hydro and Husky Energy. xi + 77 pp. + Appendices.
- LGL Limited. 2014. Marine Mammal, Sea Turtle, and Seabird Monitoring and Mitigation: Statoil's Bay du Nord 2014 3-D Seismic Program. LGL Report FA0010 prepared for Statoil Canada Ltd. vii + 62 pp. + Appendices.
- LGL Limited. 2015. Environmental Assessment of WesternGeco's Eastern Newfoundland Offshore Seismic Program, 2015-2024. LGL Rep. FA0035. Prepared by LGL Limited in association with Canning & Pitt Associates Inc., St. John's, NL for WesternGeco (Division of Schlumberger Canada Limited), Calgary, AB. 255 pp. + Appendices.
- LGL Limited. 2016. Environmental Assessment of Seitel's East Coast Offshore Seismic Program, 2016-2025. LGL Rep. FA0071. Prepared by LGL Limited, St. John's, NL for Seitel Canada Ltd., Calgary, AB. 211 pp. + Appendix.
- Mannocci, L., J.J. Roberts, D.L. Miller and P.N. Halpin. 2017. Extrapolating cetacean densities to quantitatively assess human impacts on populations in the high seas. *Conserv. Biol.*, 31(3): 601-614.
- Mansfield, K.L., J. Wyneken, W.P. Porter, and J. Luo. 2014. First satellite tracks of neonate sea turtles redefine the 'lost years' oceanic niche. *Proc. Royal Soc. B*: 281: 20133039.
<http://dx.doi.org/10.1098/rspb.2013.3039>
- Moors-Murphy, H.B., Lawson, J.W., Rubin, B., Marotte, E., Renaud, G. and C. Fuentes-Yaco. 2019. Occurrence of blue whales (*Baleanoptera musculus*) off Nova Scotia, Newfoundland, and Labrador. *DFO Can. Sci. Advis. Sec. Res. Doc.*, 2018/007: iv + 55 pp.
- Mosnier, A., Gosselin, J.-F., Lawson, J., Plourde, S. and V. Lesage. 2019. Predicting seasonal occurrence of leatherback turtles (*Dermochelys coriacea*) in eastern Canadian waters from turtle and sunfish (*Mola mola*) sighting data and habitat characteristics. *Can. J. Zool.*, 97(5): 464-478.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Moulton, V.D., B.D. Mactavish, and R.A. Buchanan. 2005. Marine Mammal and Seabird Monitoring of Chevron Canada Resources' 3-D Seismic Program on the Orphan Basin. Rep. No. SA817. Rep. by LGL Ltd., St. John's, NL, for Chevron Canada Resources, and Imperial Oil Resources Ventures, Calgary, AB, and St. John's, NL. 90 pp. + Appendices.
- Moulton, V.D., B.D. Mactavish, R.E. Harris, and R.A. Buchanan. 2006. Marine Mammal and Seabird Monitoring of Chevron Canada Resources' 3-D Seismic Program on the Orphan Basin, 2005. Rep. No. SA843. Rep. by LGL Ltd., St. John's, NL, for Chevron Canada Limited, ExxonMobil Canada Ltd., Shell Canada Limited, Imperial Oil Resources Ventures Ltd., Calgary, AB, and St. John's, NL. 111 pp. + Appendices.
- Nelson, D. and J. Lien. 1996. The status of the long-finned pilot whale, *Globicephala melas*, in Canada. *Can. Field-Nat.*, 110: 511-524.
- NMFS (National Marine Fisheries Service), US Fish and Wildlife Service, and SEMARNAT. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland. 156 pp. + Appendices.
- NMFS (National Marine Fisheries Service). 2019. 2017-2019 North Atlantic Right Whale Unusual Mortality Event. Available at <https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2019-north-atlantic-right-whale-unusual-mortality-event>. Accessed 9 July 2019.
- NOAA (National Oceanic and Atmospheric Administration) Fisheries, Office of Protected Resources. 2019. 2017-2018 North Atlantic right whale unusual mortality event (updated 3 July 2019). Available at: <https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2018-north-atlantic-right-whale-unusual-mortality-event>.
- Nordstrom, B.F. 2018. Linking jellyfish and leatherback sea turtle distributions in Atlantic Canada. M.Sc. thesis, Dalhousie University, Halifax, NS. 123 pp.
- O'Brien, K. and H. Whitehead. 2013. Population analysis of endangered northern bottlenose whales on the Scotian Shelf seven years after the establishment of a marine protected area. *Endangered Species Res.*, 21(3): 273-284.
- Pace, R.M., III, P.J. Corkeron and S.D. Kraus. 2017. State-space mark-recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecology and Evolution*, 7(21): 8730-8741.
- PAL. 2015. Ice Overview/Bird and Mammal Data Summary Bay du Nord L-76, May 2 – September 12, 2005. PAL document ESD9999-STA-12-07-2015 prepared for Statoil Canada Ltd. iii + 14 pp.
- Palka, D., A. Read and C. Potter. 1997. Summary of knowledge of white-sided dolphins (*Lagenorhynchus acutus*) from the US and Canadian North Atlantic waters. Rep. IWC, 47: 729-734.
- Palka, D., A.J. Read, A.J. Westgate and D.W. Johnston. 1996. Summary of current knowledge of harbour porpoises in US and Canadian Atlantic waters. Rep. IWC, 46: 559-565.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Paul, S.D., A. Hanke, S.C. Mith, and J.D. Neilson. 2010. An examination of loggerhead sea turtle (*Caretta caretta*) encounters in the Canadian swordfish and tuna longline fishery. DFO Can. Sci. Advis. Sec. Res. Doc., 2010/088: vi + 32 pp.
- Pennisi, E. 2017. The North Atlantic right whale faces extinction. Science. doi:10.1126/science.aar4346. Available at: <http://www.sciencemag.org/news/2017/11/north-atlantic-right-whale-faces-extinction>. Accessed January 17, 2018.
- Pettis, H.M., R.M. Pace, III, P.K. Hamilton. 2018. North Atlantic Right Whale Consortium 2018 annual report card. Report to the North Atlantic Right Whale Consortium, October 2017. 17 pp.
- Prieto, R., Silva, M.A., Waring, G.T., and J.M.A. Gonçalves. 2014. Sei whale movements and behaviour in the North Atlantic inferred from satellite telemetry. *Endangered Species Research*, 26(2): 103-113.
- Risch, D., Castellote, M., Clark, C.W., Davis, G.E., Dugan, P.J., Hodge, L.E.W., Kumar, A., Lucke, K., Mellinger, D.K., Nieukirk, S.L., Popescu, C.M., Ramp, C., Read, A.J., Rice, A.N., Silva, M.A., Siebert, U., Stafford, K.M., Verdaat, H., and S.M. Van Parijs. 2014. Seasonal migrations of North Atlantic minke whales: novel insights from large-scale passive acoustic monitoring networks. *Movement Ecology*, 2:24.
- SEM (Sikumiut Environmental Management). 2008. Labrador Shelf Offshore Area Strategic Environmental Assessment. Final Report, 2008. Available at <https://www.cnlopb.ca/sea/labrador/> Accessed 28 June 2019.
- Simard, Y., N. Roy, F. Aulanier, and S. Giard. 2016. Blue whale continuous frequentations of St. Lawrence habitats from multi-year PAM series. DFO Can. Sci. Advis. Sec. Res. Doc., 2016/091: v + 14 pp.
- Statoil Canada Ltd. 2017. Flemish Pass Exploration Drilling Program – Environmental Impact Statement. Prepared by AMEC Foster Wheeler and Stantec Consulting Ltd., St. John's, NL Canada. 1378 pp.
- Stenson, G.B. and M.O. Hammill. 2014. Can ice breeding seals adapt to habitat loss in a time of climate change? *ICES J. Mar. Sci.*, 71(7): 1977-1986.
- Stewart, K.R., M.C. James, S. Roden and P.H. Dutton. 2013. Assignment tests, telemetry and tag-recapture data converge to identify natal origins of leatherback turtles foraging in Atlantic Canadian waters. *J. Animal Ecol.*, 82: 791-803.
- Templeman, N. D. 2007. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Res. Doc., 2007/052: 15 pp.
- Turtle Expert Working Group. 2007. An assessment of the leatherback turtle population in the Atlantic Ocean. NOAA Technical Memorandum. NMFS-SEFSC-555. US Department of Commerce. 116 pp.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

- Vero-Cruz, N., J.A. Bermejo, P. Calabuig, D. Cejudo, B.J. Godley, L.F. López-Jurado, S.K. Pikesley, M.J. Witt, and L.A. Hawkes. 2016. New findings about the spatial and temporal use of the Eastern Atlantic Ocean by large juvenile loggerhead turtles. *Diversity and Distribution* 2016: 1-12. doi:10.1111/ddi.12413.
- Wakefield, E.D. 2018. Transatlantic surveys of seabirds, cetaceans and turtles, July 2013 and July 2018. University of Glasgow, UK. 34 pp.
- Wallace, B.P., Zolkewitz, M. and M.C. James. 2018. Discrete, high-latitude foraging areas are important to energy budgets and population dynamics of migratory leatherback turtles. *Scientific Reports*, 8: 11017. <http://dx.doi.org/10.1038/s41598-18-29106-1>
- Waring G.T., E. Josephson, C.P. Fairfield-Walsh, and K. Maze-Foley (Editors). 2007. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2007. NOAA Tech Memo NMFS NE, 205: 415 pp.
- Waring G.T., E. Josephson, K. Maze-Foley and P.E. Rosel (Editors). 2011. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2010. NOAA Tech Memo NMFS NE, 219: 595 pp.
- Waring G.T., E. Josephson, K. Maze-Foley and P.E. Rosel (Editors). 2014. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2013. NOAA Tech Memo NMFS NE, 228: 464 pp.
- Waring G.T., E. Josephson, K. Maze-Foley and P.E. Rosel (Editors). 2015. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2014. NOAA Tech Memo NMFS NE, 231: 361 pp.

6.5.4 Special Areas

- Canadian Geoparks Network. 2019. Aspiring geoparks. Available at: <http://www.canadiangeoparks.org/aspiring-geoparks.html>.
- CPAWS (Canadian Parks and Wilderness Society). 2018. Special Marine Areas in Newfoundland & Labrador: 2nd edition. Prepared for CPAWS-NL by Nick White; CPAWS contributors Tanya Edwards and Suzanne Dooley. Available at: <https://cpawsnl.org/wp-content/uploads/2018/07/SMA-Guide-FINAL-2018-2-20-compressed-ilovepdf-compressed-1.pdf>
- CWS (Canadian Wildlife Service). 2019. Summary of Migratory Birds Hunting Regulations. Available at: <http://publications.gc.ca>.
- DFO (Fisheries and Oceans Canada). 2002. Canada's Oceans Strategy. Fisheries and Oceans Canada, Ottawa, ON. Available at: <https://waves-vagues.dfo-mpo.gc.ca/Library/264678.pdf>.
- DFO (Fisheries and Oceans Canada). 2005. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Ecosys. Stat. Rep., 2004/006: 15 pp.
- DFO (Fisheries and Oceans Canada). 2007. Northern Shrimp (SFAs) 0-7 and the Flemish Cap: Resource Management Operations - Fisheries and Oceans Canada. Available at: <http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/shrimp-crevette/shrimp-crevette-2007-eng.htm>.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
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- DFO (Fisheries and Oceans Canada). 2013. Identification of Additional Ecologically and Biologically Significant Areas (EBSAs) within the Newfoundland and Labrador Shelves Bioregion. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2013/048.
- DFO (Fisheries and Oceans Canada). 2014. Eastport Marine Protected Area (MPA) Case Study in Support of Ecosystems Goods and Services Valuation. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep., 2014/014.
- DFO (Fisheries and Oceans Canada). 2015. Integrated Fisheries Management, Plan Snow Crab (*Chionoecetes opilio*), Newfoundland and Labrador Region. Effective 6 February 2015.
- DFO (Fisheries and Oceans Canada). 2016. 2020 Biodiversity Goals and Targets for Canada. Available at: <https://www.canada.ca/en/parks-canada/news/2016/12/2020-biodiversity-goals-targets-canada.html>.
- DFO (Fisheries and Oceans Canada). 2017a. Guidance on the level of protection of significant areas of coldwater corals and sponge-dominated communities in Newfoundland and Labrador waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/030.
- DFO (Fisheries and Oceans Canada). 2017b. An assessment of Northern Shrimp (*Pandalus borealis*) in Shrimp Fishing Areas 4-6 and of Striped Shrimp (*Pandalus montagui*) in Shrimp Fishing Area 4 in 2016. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 017/012.
- DFO (Fisheries and Oceans Canada). 2018a. Integrated oceans management. Last updated August 2018. Available at: <https://www.dfo-mpo.gc.ca/oceans/management-gestion/index-eng.html>
- DFO (Fisheries and Oceans Canada). 2018b. Marine Protected Areas (MPAs), Areas of Interest (AOIs) and Other Measures. Available at: <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm-aoi-si-eng.html>.
- DFO (Fisheries and Oceans Canada). 2018c. Canada's Oceans Now: Atlantic Ecosystems 2018. Available at: <https://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2018/atlantic-ecosystems-ecosystemes-atlantiques/index-eng.html>.
- DFO (Fisheries and Oceans Canada). 2019a. Marine Protected Areas (MPA) and their regulations. Available at: <http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/index-eng.html>.
- DFO (Fisheries and Oceans Canada). 2019b. List of Marine Refuges. Available at: <https://www.dfo-mpo.gc.ca/oceans/oeabcm-amcepz/refuges/index-eng.html>.
- DFO (Fisheries and Oceans Canada). 2019c. Unpublished information on EBSAs and SiBAs.
- DFO (Fisheries and Oceans Canada). 2019d. Introducing Canada's modernized *Fisheries Act*. Available at: <https://www.dfo-mpo.gc.ca/campaign-campagne/fisheries-act-loi-sur-les-peches/introduction-eng.html>.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

DFO (Fisheries and Oceans Canada). 2019e. Canada announces new standards for protecting our oceans. Available at: <https://www.canada.ca/en/fisheries-oceans/news/2019/04/canada-announces-new-standards-for-protecting-our-oceans.html>.

EC (Environment Canada). 2018. International Programs and Conventions. Available at: <https://www.canada.ca/en/environment-climate-change/services/wildlife-habitat/international-programs-conventions.html>.

EMPAAC (Eastport Marine Protected Areas Advisory Committee). 2013. Eastport Marine Protected Areas Management Plan. Available at: http://www.icomnl.ca/files/DFO%20Eastport%20Booklet%20-%20English%202013%20PDF_Low%20Res.pdf.

Environment and Natural Resources. 2019. Migratory Bird Sanctuaries Across Canada. Government of Canada. <https://www.canada.ca/en/environment-climate-change/services/migratory-bird-sanctuaries/locations.html#nl>.

FAO (Food and Agriculture Organization). 2019. Vulnerable Marine Ecosystems. Available at: <http://www.fao.org/in-action/vulnerable-marine-ecosystems/en/>.

Government of Canada. 2010. Canada *Wildlife Act*: Act current to 2016-11-09 and last amended on 2010-12-10. Available at: <http://laws-lois.justice.gc.ca/eng/acts/W-9/page-1.html#h-1>.

Government of Canada. 2011. National Framework for Canada's Network of Marine Protected Areas. Fisheries and Oceans Canada, Ottawa, ON. 31 pp.

Government of Canada. 2018. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada [proposed]. Available at: <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery/wolffish-northern-spotted-atlantic-strategy-management-plan.html#toc32>

Government of Newfoundland and Labrador. 2011. Provincial Historic Sites. Available at: <http://www.seethesites.ca/the-sites.aspx?altTemplate=MapView>

Government of Newfoundland and Labrador. 2019. Natural Areas. Department of Fisheries and Land Resources. Available at: https://www.flr.gov.nl.ca/natural_areas/index.html.

IBA Canada (Important Bird Areas Canada). 2019. Important Bird Areas in Canada. Available at: <http://ibacanada.ca>.

Kenchington, E., F.J. Murillo, C. Lirette, M. Sacau, M. Koen-Alonso, A. Kenny, N. Ollerhead, V. Wareham and L. Beazley (2014). Kernel density surface modelling as a means to identify significant concentrations of vulnerable marine ecosystem indicators. *PLoS One*, 9(10), e109365.

NAFO (North Atlantic Fisheries Organization). 2016. NAFO Fishing Closures. Available at: http://awsassets.wwf.ca/downloads/vulnerable_marine_ecosystems.pdf.



BHP CANADA EXPLORATION DRILLING PROJECT (2019-2028)

Existing Biological Environment
February 2020

NAFO (North Atlantic Fisheries Organization). 2018. Northwest Atlantic Fisheries Organization Conservation and Enforcement Measures 2018. Available at: <https://www.nafo.int/Portals/0/PDFs/COM/2018/CEM-2018-web>.

Parks Canada. 2016. Historic Sites. Available at: <https://www.pc.gc.ca/en/lhn-nhs>.

Parks Canada. 2018. National Parks. Available at: <https://www.pc.gc.ca/en/pn-np>.

Parks Canada. 2019. National Marine Conservation Areas. Available at: <https://www.pc.gc.ca/en/amnc-nmca>.

Parsons, J. 2019. The waiting game: After UNESCO evaluation visit, aspiring Geopark waits for possible certification. Northern Pen, July 26, 2019.

Placentia Bay Grand Banks-Large Ocean Management Area Secretariat. 2012. Placentia Bay / Grand Banks Large Ocean Management Area Integrated Management Plan (2012-2017). Available at: <http://www.icomnl.ca/files/PBGB%20LOMA%20IM%20Plan.PDF>. Ramsar Convention 2001

UNCBD (United Nations Convention on Biological Diversity). 2017. Ecologically or Biologically Significant Areas (EBSAs). Available at: <https://chm.cbd.int/>.

UNCBD (United Nations Convention on Biodiversity). 2019. COP 12 Decision XII/22. Marine and coastal biodiversity: ecologically or biologically significant marine areas (EBSAs). Available at: <https://www.cbd.int/decision/cop/default.shtml?id=13385>.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2017. World Heritage List. Available at: <http://whc.unesco.org/en/list>.

WG-EAFM (Working Group on the Ecosystem Approach to Fisheries Management). 2016. Report of the NAFO Joint Fisheries Commission-Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management. 10-12 August 2016. Halifax, NS. NAFO FC-SC Doc., 16/03 Revised. Serial No. N6612.

