5.0 Existing Environment

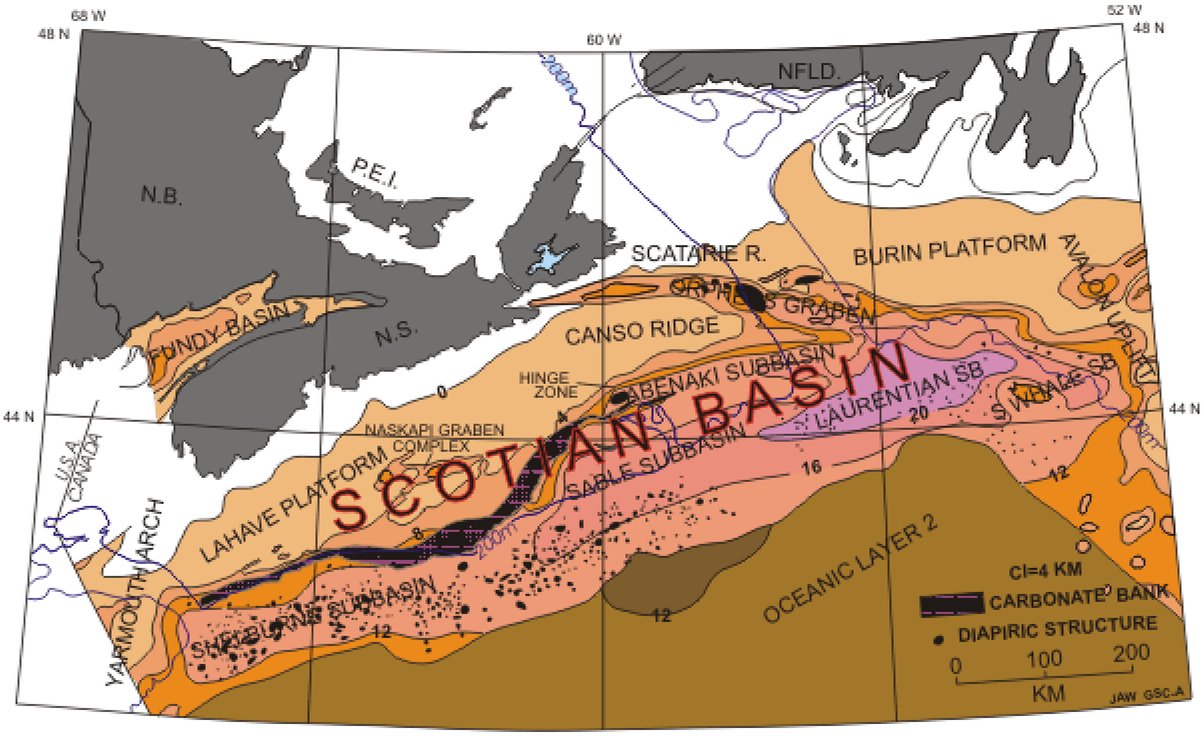
This section provides an overview of the physical, biological and socio-economic environments in which the Project is located and is intended to provide a regional perspective of the existing environment and to help identify key factors that may interact with the Project and require further assessment as Valued Components in Section 7. These environments are described below at different scales and specificity, depending on the information available and/or relevance to the environmental assessment. Where site-specific information may be lacking in the deep waters of the Project Area, general information from the Scotian Shelf and Slope is included. Recent Strategic Environmental Assessments (SEAs) undertaken by the CNSOPB for the Scotian Shelf and Slope have been used extensively to characterize the Project Area and surrounding region. Although no field work is currently planned as part of the environmental assessment process, Shell is undertaking a seabed survey in the Project Area in the spring of 2014. This survey will provide site-specific information regarding the condition and characteristics of the seafloor in relation to the potential wellsites in the Project Area, including geophysical and surficial sediment characteristics, benthic habitat, as well as any potential geohazards.

5.1 MARINE PHYSICAL ENVIRONMENT

5.1.1 Marine Geology and Geomorphology

The Project Area is located within the Scotian Basin geological formation located on the Scotian Slope offshore of Nova Scotia. The basin extends approximately 1200 km from the Yarmouth Arch on the United States and Canadian Border in the southwest to the Avalon Uplift located on the Grand Banks of Newfoundland in the North East (refer to Figure 5.1.1) (CNSOPB 2013). The basin has an average width of 250 km, with a total area of approximately 300 000 km^2. Half of the Scotian Basin is situated on the continental slope in waters ranging in depth from 200 m to over 4000 m, while the other half is situated over the shallow Scotian Shelf in waters less than 200 m (CNSOPB 2013).

The Scotian Basin is a rifted continental margin that formed as a result of the opening of the North Atlantic over 250 million years ago (NRCan 2010). It is a continuous record of sediment from the region's dynamic geological history from the initial opening of the Atlantic Ocean to the recent post-glacial deposition (CNSOPB 2013). The Basin is located on the northeastern flank of the Appalachian Orogen with a maximum sediment thickness of 24 km. The continental-sized drainage system of the paleo-St. Lawrence River provided a continuous supply of sediments which accumulated into a variety of complex and interconnected sub-basins. These sub-basins include the Shelburne, Sable, Abenaki, and Laurentian sub-basins (refer to Figure 5.1.1).

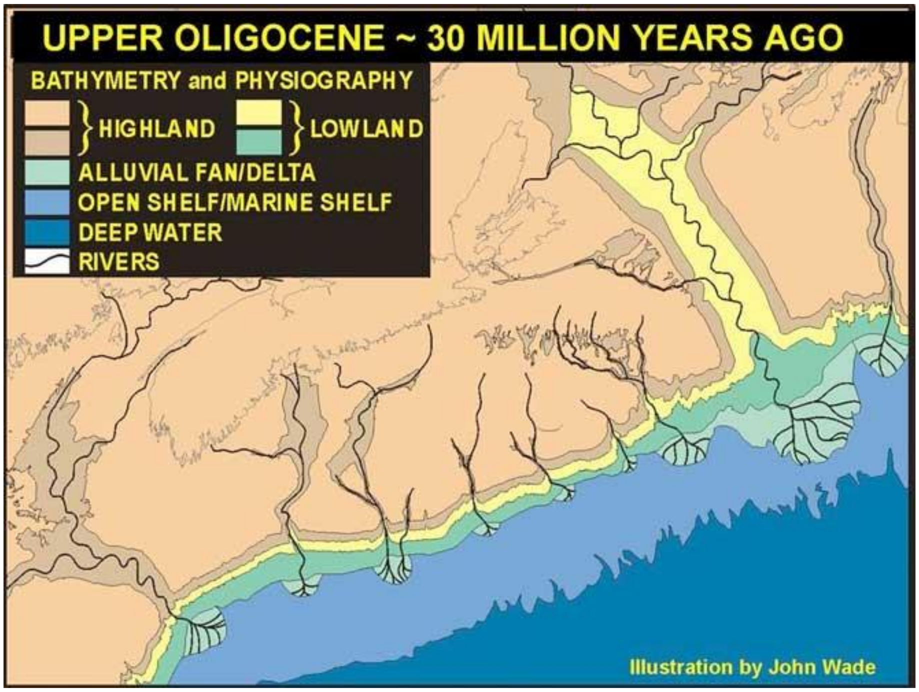


Source: NRCan 2010

Figure 5.1.1 Major Tectonic Features of the Scotian Basin

5.1.1.1 Bedrock Geology

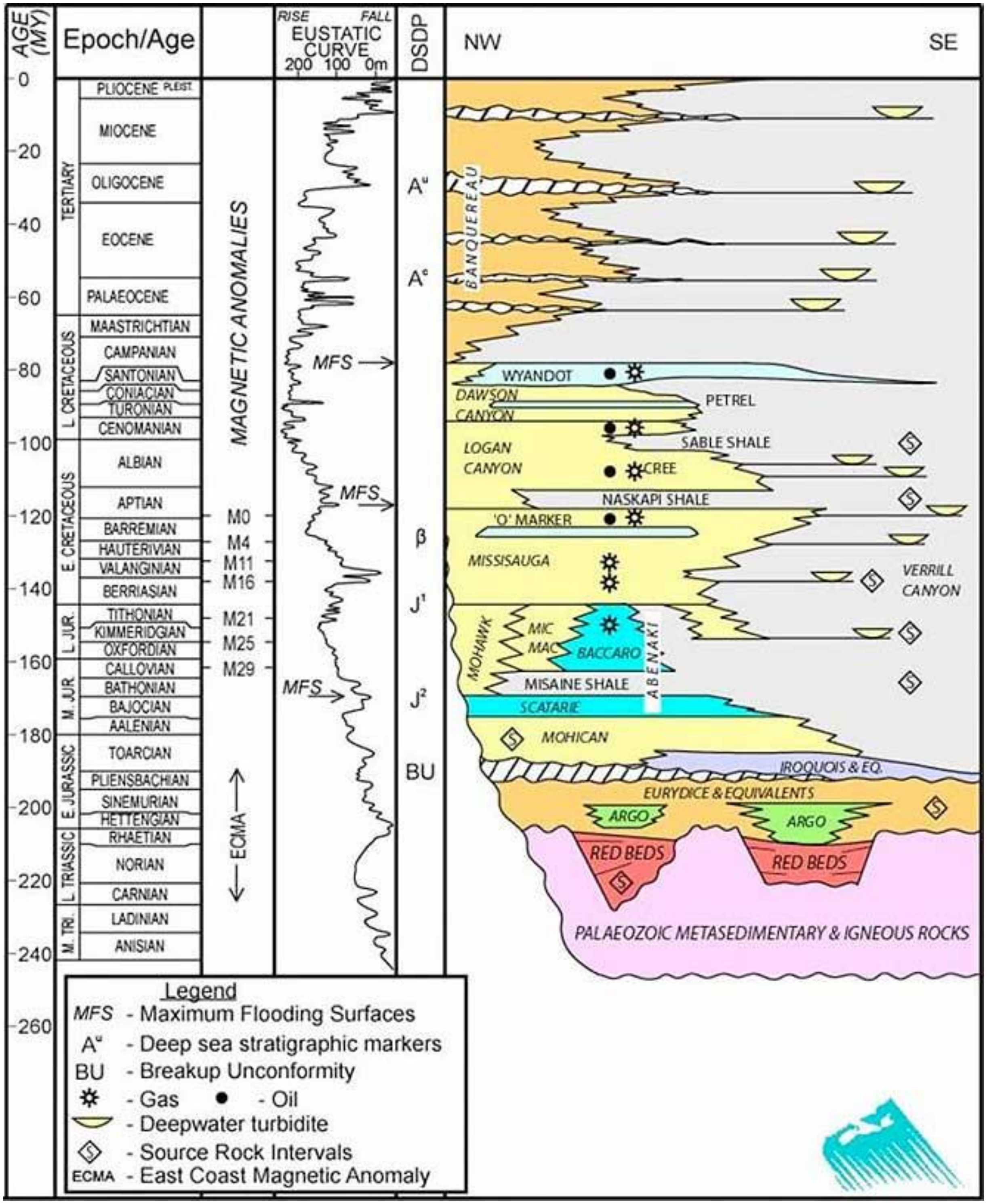
By the end of the Cretaceous period, the Scotian Basin experienced sea level rise and basin subsidence with the deposition of marine marls and chalky mudstones (CNSOer4PB 2013). The ancestral Maritime region was mostly above sea level during the Tertiary period. Sediments eroded from the land and were deposited offshore on the continental shelf. During this period sea levels and temperatures fell, leading to a change in sediment type from the muds and limestone of the Cretaceous period to coarser material, predominantly sand (NRCan 2010). During the Paleocene, Oligocene and Muiocene eras, fluvial and deepwater currents cut into and eroded sediments and transported them further offshore into deeper waters over the Scotian Slope and Abyssal Plain (CNSOPB 2013; Figure 5.1.2). Over the last two million years, this has led to hundreds of metres of glacial and marine sediment deposition on the outer shelf and upper slope offshore Nova Scotia.



Source: CNSOPB 2013

Figure 5.1.2 Simplified Paleogeographic Reconstruction of the Scotian Basin during the Upper Oligocene

From a stratigraphy sequence, the Scotian Basin contains Mesozoic-Cenozoic sedimentary rocks up to 16 km thick, which were deposited during the rifting of Pangaea and the opening of the North Atlantic (NRCan 2010). The earliest fill in the basin occurred during the Triassic rifting and consisted primarily of red continental clastics and evaporates. As the seafloor spread in the early Jurassic, the rift basins were gradually filled by clastics and carbonates. By the mid Jurassic period, fully marine conditions had emerged, leading to an array of alluvial plan, deltaic and carbonate facies. During the early-late Cretaceous period, sedimentation was dominated by transgressive shale, limestone, and chalk units. Sea level fluctuations during the Paleogene and Neogene periods created a mix of marine sandstones and shales interspersed with coarse clastics and marine carbonates. These were overlain by glacial till, glacio-marine silts, and marine sediments during the Quaternary (NRCan 2010). Figure 5.1.3 illustrates a stratigraphic overview of the Scotian Basin.



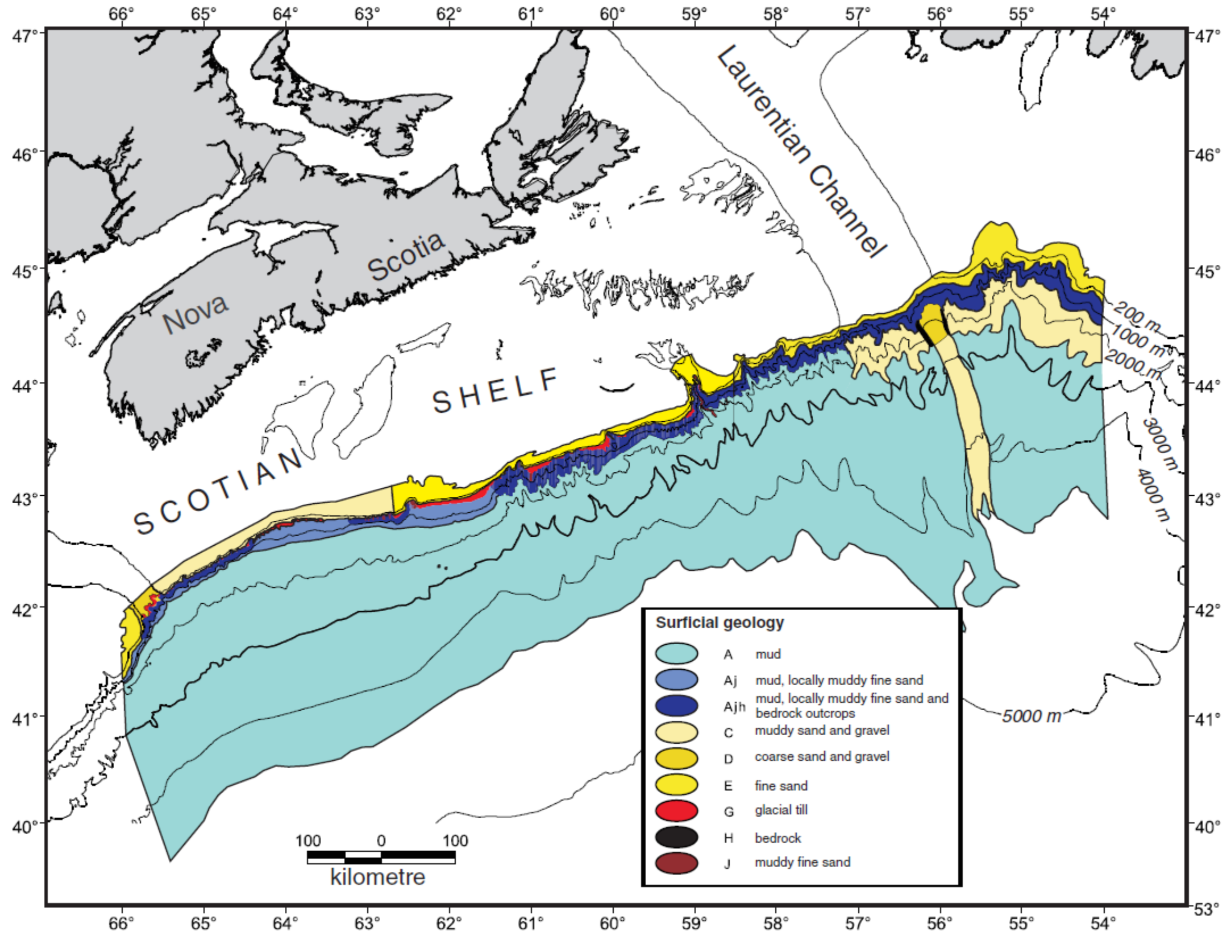
Source: CNSOPB 2013

Figure 5.1.3 Stratigraphic Overview of the Scotian Basin

5.1.1.2 Surface Features and Bedforms

The western Scotian Slope is an area that has a gentle gradient with a relatively smooth seabed surface (WWF 2009). It is characterized by low gentle hills and valleys, which slope towards the deep Scotian Rise and Abyssal Plain. When compared to its counterpart in the east, the western Scotian Slope has a less dynamic seabed with fewer canyons. Within the vicinity of the Project Area, the slope has a few shallow gullies that reach water depths of up to 500 m. As the shelf edge hits the slope west of latitude 62.50 °W, the surficial sediment on the shelf edge and upper slope are comprised mostly of a high concentration of muddy sand and gravel. At the shelf edge off of the Emerald and Western Banks, the seafloor is made up of a mostly fine sand substrate (Piper and Campbell 2002). From the 200 to 1000 m isobaths the seafloor sediments consist mostly of mud with local patches of muddy fine sand. There are also sections of mud with local muddy fine sand and bedrock outcrops, patches of glacial till, and muddy fine sand (Figure 5.1.4). From the 1200 m isobath to 3000 m, the seafloor consists of a smooth mud surface that contains less than 5% sand. On the Continental Rise below the 3000-m water depth profile, the seafloor sediments are primarily composed of muddy foraminifera (single-celled protozoans that produce a shell made of calcium carbonate, mineral grains or other particles glued together).

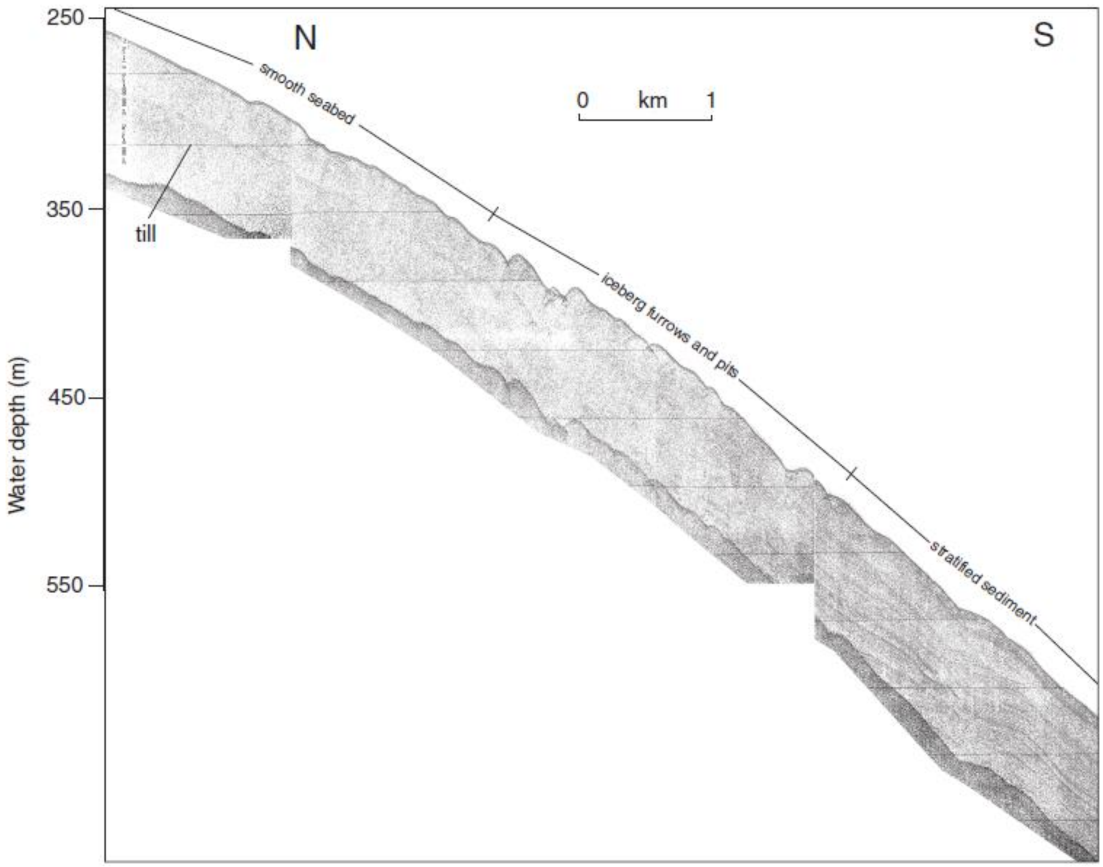
Further to the southwest, Georges Bank is located on the Outer Gulf of Maine Shelf. It is a large oval-shaped bank, underlain by sandstone bedrock (Stantec 2014). The surface of the bank slopes gently towards the southeast and is covered in a sand and gravel-mixed substrate. The northern section of the bank has a coarser substrate containing a coarse gravel and boulder mix. Dynamic bedforms including sand ripples, waves and ridges can be found on the surface of the bank, which have been shaped by the strong currents and large waves found in the area. As Georges Bank transitions from shallow water depths to deeper water towards the open Atlantic, steep slopes and canyons can be found in the area (WWF 2009). The Northeast Channel is the largest and deepest channel which connects the open Atlantic Ocean with the Gulf of Maine (Stantec 2014). It cuts through the outer continental shelf between Georges and Browns Banks at water depths between 200 m and 300 m. Large expanses of the Northeast Channel are covered with glacial till, a mixture of clay, silt, gravel and boulders.



Source: Piper and Campbell 2002

Figure 5.1.4 Seafloor Sediment Types on the Scotian Slope

The seafloor gradient increases at the shelf break at the 80 m to160 m water depth to gradients of 1.1° to 3.3° on the upper slope (Piper and Campbell 2002). Most areas of the shelf break have a smooth seabed up to a water depth of approximately 250 m. From the 250 m to 500 m water depth contours, there are widespread relic formations of iceberg pits and scours (Figure 5.1.5). In shallower water depths, these pits and scours become less obvious as they have been filled in my modern sedimentation, consisting mostly of sand. There are also local areas of sand waves in the 200–250 m water depth range, confirming the abundance of modern sedimentation (Piper and Campbell 2002). West of latitude 62.50 °W, the surficial sediment on the shelf edge and upper slope are comprised mostly of a high concentration of sand and gravel.



Source: Piper and Campbell 2002

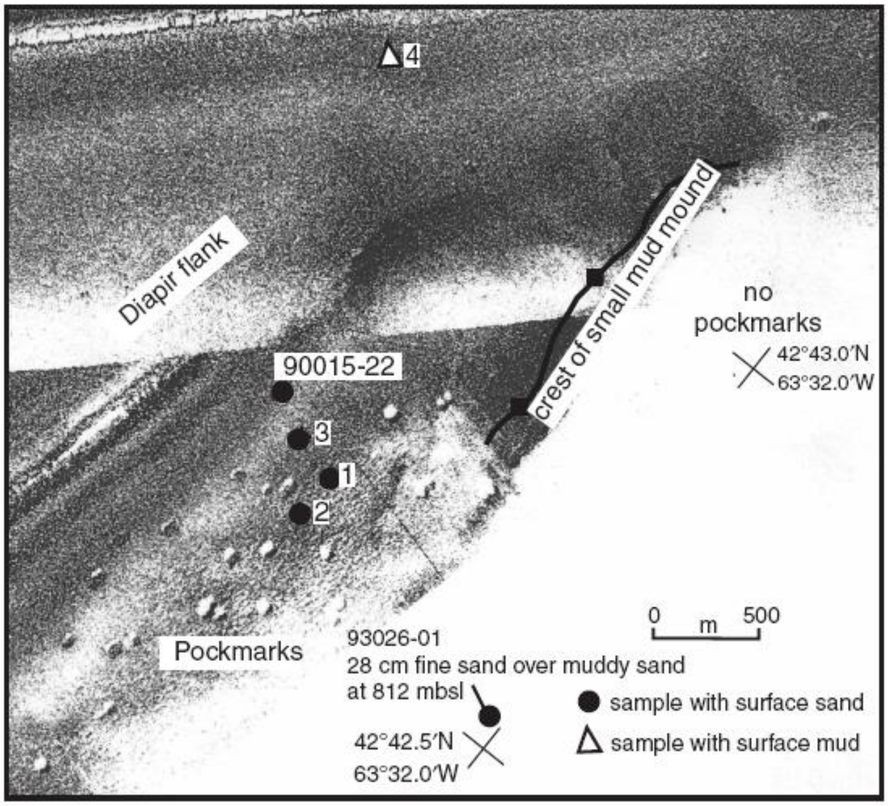
Figure 5.1.5 Typical Cross Section of the Upper Western Scotian Slope, Showing a Smooth Sand Seabed Transitioning to Iceberg Furrows and Pits and to a Stratified Mud Seabed

Further to the east, approximately 180 km east from the Project Area, Sable Island Bank is a large defining bank of the Scotian Shelf. The seafloor of Sable Island Bank is characterized by complex fields of sand ridges that have an average height of 12 m and a width of 6.4 m (Stantec 2014). Sand ridges occur on the lower section of the shore face, extending offshore on either side of Sable Island. The larger and more expansive ridges can be found on the south side of the island and in the deeper waters to the west of the island. At the edge of eastern Scotian Shelf, sand and gravel slump over the edge and onto the upper slope. Dramatic, exposed bedrock cliffs can also be found along the transition from the eastern Scotian Shelf to the Slope (*i.e.*, the shelf break or shelf edge). Along the Scotian Rise, the transition zone from the slope to the Abyssal Plain, glacial erosion, sea level rise and fall, and modern sedimentation have deposited sediments in a wide area seaward of the Scotian Slope. A series of deepwater canyons, including the Gully, Shortland and Haldimand canyons, can be found on the outer edge of the Scotian Shelf and continue down the slope (Stantec 2014).

At the eastern extent of the Scotian Shelf and Slope exists the Laurentian Channel, a deep trough created from an ancient river valley that was eroded by past glaciation. The Laurentian Channel divides the Scotian Shelf and Slope from the Grand Banks (Stantec 2014). The substrate at the mouth of the channel is mostly a sand and mud mixture and the flanks of the channel are covered by old iceberg furrows lined with gravel. At the edge of the Laurentian Channel a large, delta-shaped sediment deposit can be found and which is known as the Laurentian Fan. Two major valleys originate from an area of gullies on the upper slope and terminate at water depths between 4500 m and 5200 m where they open onto a sandy area of the Abyssal Plain (Stantec 2014). To the west of the Laurentian Fan, the debris flow can be found. This is an area occupied by a large mass of muddy debris that has shifted and settled into sheets of sediments. Here, the debris mix with sediment flows down the canyons and slope from the area above, creating a smooth muddy complex material 200 km wide and extending 200 m downslope.

Some features on the seabed can be natural hazards affecting the seafloor and which are referred to as geohazards (*e.g.*, submarine slope failures, pore pressure phenomena, pockmarks). Geohazards are discussed in Section 9 in the context of Effects of the Environment on the Project.

Pore pressure phenomena is described as former or present day activities of fluid flow related to conduits such as faults or sedimentary discontinuities. It is the fluid flow within sediments, exploiting pathways of permeable sediments or faults and resulting in upward migration of gas and water expelled from sediments at depth. The end result of these extrusions is pockmarks and mud volcanoes and diapirisms, which form where entrained sediment erupt at the seafloor. These processes are related to excess pore pressure at depth, which decreases sediment strength and increases slope failure potential. Pore pressure phenomena could include shallow gas accumulations, gas hydrates, shallow water flows, mud diapirism, mud volcanism, fluid vents and pockmarks (Stantec 2014). Figure 5.1.6 illustrates pockmarks and diapir observed in the area by Piper and Campbell (2002).



Source: Piper and Campbell 2002

Figure 5.1.6 SAR High-resolution Sidescan Image of Mud Diapir on the Western Scotian Slope Showing Distribution of Surface Samples. Numbers Refer to Identification of Core Sample.

The morphologic evidence suggests that all these features should be considered as common rather than exceptional on the seafloor (Cochonat *et al.* 2007). Shell is conducting a seabed survey in 2014, during which geohazards such as pore pressure phenomena will be noted.

5.1.2 Atmospheric Environment

5.1.2.1 General Climate

The climate of the Scotian Shelf and Slope varies between Atlantic, boreal, and sub-arctic climates. The warm Gulf Stream and the cold Labrador Current influence the climate in the area, including the Project Area. Air temperatures in the region are measured on Sable Island and have shown an increase of 1°C over the last century (Worcester and Parker 2010). Daily average temperatures on Sable Island range from -1.2 °C in February to 17.9 °C in August, with extreme temperatures ranging from -19.4 °C to 27.8 °C. Precipitation ranges from an average of 100.8 mm in July to 150.7 mm in November (Environment Canada 2013a). Table 5.1.1 presents the average temperature and precipitation profile from 1981 to 2010 on Sable Island.

Table 5.1.1 Temperature and Precipitation Climate Data, 1981–2010, Sable Island, Nova Scotia

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)												
Daily Average	-0.1	-1.2	0.7	4.0	7.5	11.4	15.8	17.9	15.8	11.7	7.3	2.5
Daily Maximum	3.0	1.8	3.3	6.5	10.2	14.2	18.5	20.7	18.6	14.3	9.9	5.5
Daily Minimum	-3.1	-4.2	-2.0	1.5	4.8	8.6	13.0	15.1	13.0	9.1	4.6	-0.5
Extreme Maximum	14.5	12.8	13.7	13.9	17.8	21.7	26.7	27.8	27.0	22.8	18.9	15.6
Extreme Minimum	-19.4	-18.3	-13.6	-8.9	-8.3	0.6	3.0	4.4	0.6	-1.2	-7.8	-16.7
Winds (km/hour)												
Average Wind Speed	31	30	29	26	21	19	17	17	21	25	28	31
Prevailing Wind Direction	W	W	W	W	SW	SW	SW	SW	W	W	W	W
Extreme Hourly Wind Speed	103	117	100	89	77	77	74	98	100	100	130	116
Direction of Extreme Hourly Wind Speed	NNW	N	WSW	ESE	WSW	SSE	ESE	ESE	SW	SSW	W	SW
Extreme Daily Max Gust Speed	141	170	140	122	113	119	100	143	132	158	174	137
Direction of Extreme Daily Max Gust	SSW	NNW	SW	NNE	ENE	W	ESE	SE	NNW	SSW	W	WNW
Precipitation (mm)												
Rainfall	110.42	92.41	107.66	105.86	101.22	115.87	100.8	121.62	129.54	144.83	145.06	123.7
Snowfall (cm)	33.31	19.79	22.14	9.14	0.11	0	0	0	0	0.01	5.18	18.64
Precipitation	144.66	112.51	130.35	114.76	101.33	115.87	100.8	121.62	129.54	144.85	150.73	144.54
Extreme Daily Rainfall	99.3	52.2	87.6	66	99.6	140.7	85.3	155.7	99.2	166.1	84.8	77.5
Extreme Daily Snowfall (cm)	61.0	45.7	45.7	27.4	15.2	0	0	0	0	0.2	25.4	66.0
Days with Precipitation												
≥ 0.2 mm	20.4	16.8	16.7	16.0	14.5	13.9	13.5	12.0	12.4	16.2	19.3	19.8
≥ 5 mm	8.0	5.8	7.3	7.2	5.4	6.4	5.0	5.3	5.6	6.4	8.1	8.5
≥ 10 mm	5.2	3.7	4.4	3.9	3.4	4.1	3.2	3.8	3.6	4.2	4.7	5.2
≥ 25 mm	1.2	0.84	0.74	0.76	0.78	0.88	1.0	1.1	1.2	1.7	1.3	1.1

The North Atlantic Oscillation (NAO) is the dominant atmospheric pattern in the North Atlantic Ocean, which is the significant large-scale abiotic driver of the Scotian Shelf ecozone (Drinkwater *et al.* 1998; Petrie 2007; Worcester and Parker 2010) and likely to impinge on the adjacent Scotian Slope. The NAO is a back and forth pattern between a high pressure cell over the Azores in the south east Atlantic and a low pressure cell over Iceland. The NAO index is a measure in the difference in sea-level pressure between the two locations in winter. A high index brings increased westerly winds, precipitation, and warmer waters to the Scotian region. The opposite forcing occurs with a low NAO index bringing drier conditions, a decrease in storm conditions, and cooler water temperatures as a result of an increase in influence from the Labrador Current.

5.1.2.2 Air Quality

Environment Canada and Nova Scotia Environment (NSE) operate an ambient air quality monitoring station on Sable Island. Ambient concentrations of particulate matter with aerodynamic diameters less than or equal to 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (O_3) are measured at the station. The most recently available ambient air quality concentration data (2011) were obtained from the National Air Pollutant Survey (NAPS) website (Environment Canada 2013c).

A review was conducted of the 2011 ambient air quality data from the Sable Island station and a summary of the 2011 ambient concentrations is provided in Table 5.1.2.

Table 5.1.2 Summary of 2011 Measured Air Contaminant Concentrations on Sable Island, Nova Scotia

Parameter	$PM_{2.5}$ Concentrations (µg/m^3)		SO_2 Concentrations (µg/m^3)		NO_2 Concentrations (µg/m^3)		O_3 Concentrations (µg/m^3)
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour	1-hour
NSE Max Permissible GLC/ CCME CWS	-	30*	900		400	-	160
Maximum	115	13.0	10.5	2.6	13.2	3.8	338
99th Percentile	16.7	10.0	2.6	2.6	7.5	3.8	163
98th Percentile	13.0	10.0	2.6	2.6	5.6	3.8	126
90th Percentile	9.0	7.0	2.6	2.6	3.8	2.3	82.2
Median	4.0	4.0	3	0	1.9	1.9	58.9
Average	4.6	4.3	2.6	0.3	1.7	1.6	64.0
Minimum	0	1.0	2.6	2.6	0	0	27.5
Exceedances	0	0	0	0	0	0	16
Rate of Compliance	100%	100%	100%	100%	100%	100%	98.9%
Hours Available	5029	-	5220	-	2854	-	1502
Percent Available	57.4%	-	59.6%	-	32.6%	-	17.1%

Notes: CCME Canada-wide standard is based on the 98th percentile of annual 24-hour average concentrations averaged over three consecutive years.

In 2011, the measured concentrations of SO_2 and NO_2 were well below the applicable NSE maximum permissible ground-level concentrations for both 1-hour and 24-hour averaging periods. There were some exceedances of the NSE maximum permissible ground-level concentration of 160 µg/m^3 for 1-hour ozone. However, most measured 1-hour ozone concentrations were below the Guideline limit. In 2011 there were a total of 16 exceedances of the NSE ozone Guideline limit out of 1502 hours of available data, thus, the concentrations are below the guideline limit more than 98% of the time, as presented in Table 5.1.2. The 24-hour $PM_{2.5}$ concentrations measured in 2011 were all below the CCME Canada-wide guideline standard of 30 µg/m^3. The annual average concentrations were also well below the NSE maximum permissible ground-level concentrations for both SO_2 and NO_2.

Based on the review of the 2011 ambient air quality data from the Sable Island monitoring station, the ambient air quality in the area is good most of the time, with few exceedances of the applicable limits for ozone. It should be noted that ozone is a secondary pollutant formed from the action of sunlight on nitrogen oxides and hydrocarbons; elevated ozone is often associated with regional scale emissions, for example from the northeastern seaboard of the US and the Canadian mainland.

5.1.2.3 Wind Climate

Data Sources

The MSC50 wind and wave hindcast data were used to characterize the wind and wave climate conditions for the Project Area in addition to other data sources described below. These data sources generally include both wind and wave data, and therefore these sources are identified in this section along with the wind climate results, with the results for the wave climate presented in Section 5.1.3.3. The MSC50 wave hindcast is a comprehensive regional wave modelling study undertaken by Oceanweather Inc. for the Meteorological Service of Canada. Full details on the MSC50 hindcast are presented in Swail *et al.* (2006). This hindcast has been widely used in wave climate and engineering studies for the North Atlantic, particularly for the areas offshore the east coast of Canada. This wave hindcast includes the effects of shallow water physics, sea ice information, large-scale weather patterns, as well as storm track information, and predicts hourly wind and wave conditions at 0.1 degree grid points for the entire northwest Atlantic. For the present investigation, 59 years of hourly wind and wave data from 1954 to 2012 were obtained for the MSC50 Grid Point 2124 (42.2°N, 62.9°W). The water depth at this MSC50 Grid Point is 2516 m. In addition to the hourly wind data, extreme wave conditions data at the Grid Point 2124 were also obtained. The Grid Point 2124 for the MSC50 data is located 15 km northwest from the Project Area and is illustrated on Figure 5.1.7.

Buoy data in the vicinity of Project Area were also obtained and used to compare to the MSC50 data. The details of buoy data are presented in Table 5.1.3 and the buoy locations are shown in Figure 5.1.7. LaHave Bank and East Scotian Shelf buoy data were collected by DFO and Environment Canada. Georges Bank buoy data were collected by the US National Data Buoy Center. The remainder of the data sets in the Table 5.1.3 were collected by drilling rigs and exploration wells, which contain short-term data.

Table 5.1.3 Buoy Data Used in the Metocean Analysis

Name	Station ID	Depth (m)	Location		Period of Record	
			Lat	Long	From	To
LaHave Bank	C 44142	1500	~42.5°N	~64.2°W	9/5/1990	6/1/2006
East Scotian Shelf	C44137	4500	~41.32°N	~61.35°W	11/30/1988	11/4/2013
Georges Bank	44011	86	~41.11°N	~66.6°W	5/23/1984	12/31/2012
Sedco 709 Drilling Rig	MEDS 133	1114	42.89°N	61.51°W	11/19/1982	12/23/1982
Ben Ocean Lancer	MEDS 138	955	42.86°N	61.92°W	5/3/1978	8/3/1978
Sedco 710 Drilling Rig	MEDS 185	1310	42.71°N	63.07°W	1/5/1985	3/25/1985
Balvenie B-79	WEL 441	1804	43.13°N	60.18°W	7/8/2003	9/2/2003
Weymouth A-45	WEL 444	1690	43.07°N	60.6°N	10/28/2003	5/8/2004

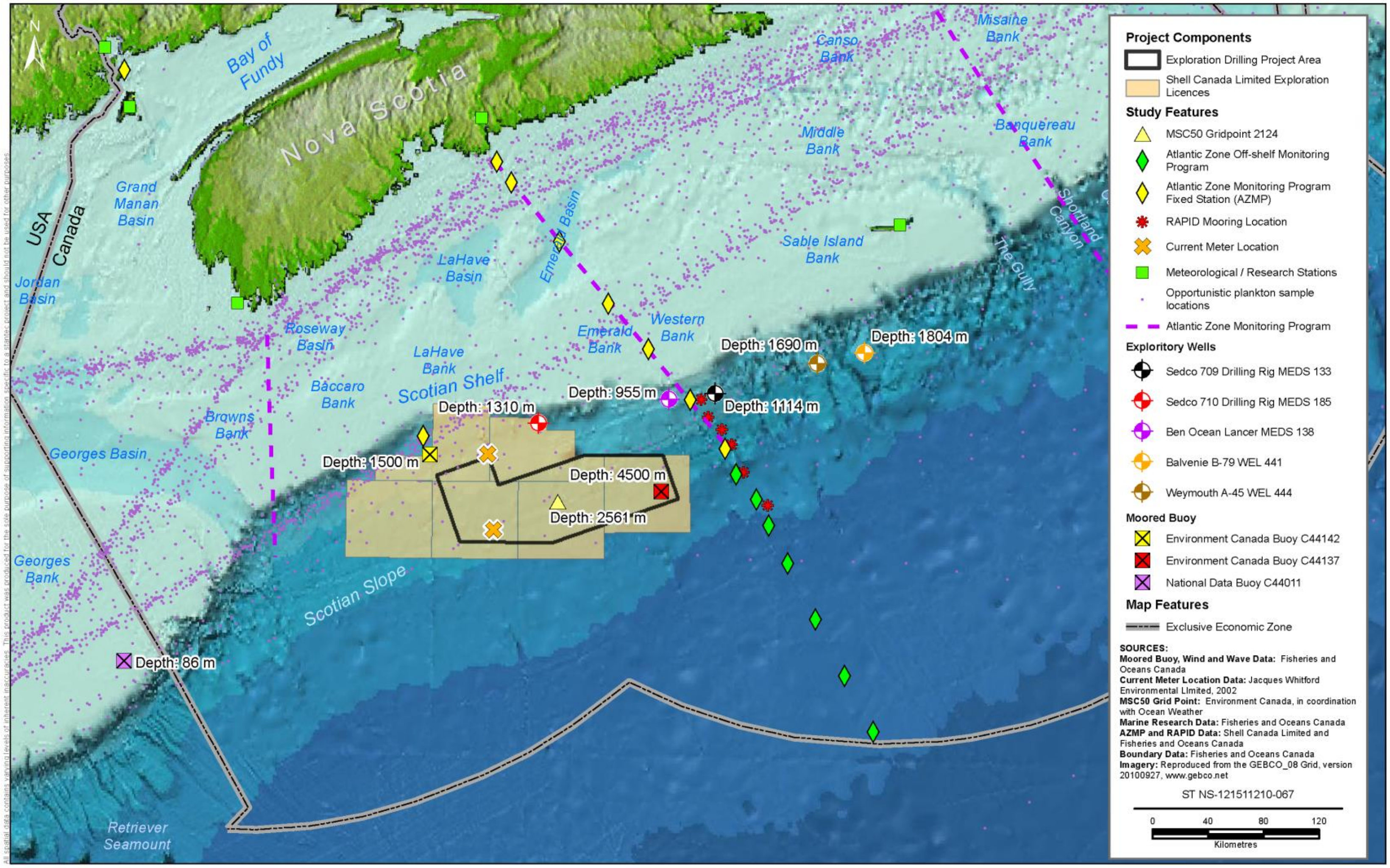


Figure 5.1.7 Locations of MSC50 Gridpoint 2124, Buoys and Other Metocean Data Sources in Relation to the Project Area

Wind Conditions

The MSC50 hourly wind data for the Grid Point 2124 from 1954 to 2012 are the longest records of available data to characterize the wind conditions for the Project Area. Wind speeds from the MSC50 data are 1-hour averages. Figure 5.1.8(a) presents percentage of wind speed occurrence by the wind direction. An annual wind rose for the Grid Point 2124 is provided in Figure 5.1.8(b) and based on 5 years of MSC50 data from 2007 to 2012. Most of the winds are from the northwest, west and southwest directions and 93% of the wind speeds are less than 15 m/s. Figure 5.1.8(c) presents the wind speed duration curve for Grid Point 2124. The wind speed duration curve indicates the percentage of time a given wind speed was equaled or exceeded over a 59-year period from 1954 to 2012.

Figure 5.1.9 illustrates the monthly wind roses for Grid Point 2124. Monthly wind roses indicate that winds are predominantly from the northwest during winter and are predominantly from the southwest during spring and summer. Table 5.1.4 presents the monthly wind conditions. Maximum wind speed ranges from 21.6 m/s in May to 31.6 m/s in September. Table 5.1.5 presents the extreme wind conditions at the MSC50 Grid Point 2124 for return periods ranging from 2 to 100 years.

Table 5.1.4 Monthly Wind Statistics[1]

Month	Mean Wind Speed (m/s)	Most Frequent Direction[2]	Maximum Hourly Wind Speed (m/s)
January	10.7	NW	26.9
February	10.5	NW	27.6
March	9.93	NW	29.3
April	8.34	NW to SW	26.1
May	6.58	SW	21.6
June	5.90	SW	23.2
July	5.43	SW	24.9
August	5.71	SW	28.3
September	6.92	NW to SW	31.6
October	8.54	NW and SW	27.2
November	9.62	NW	26.2
December	10.6	NW	29.1

Notes:
1 Based on 59 years of MSC50 hourly wind data from 1954 to 2012.
2 Direction winds are blowing from.

Table 5.1.5 Extreme Wind Conditions at Grid Point 2124

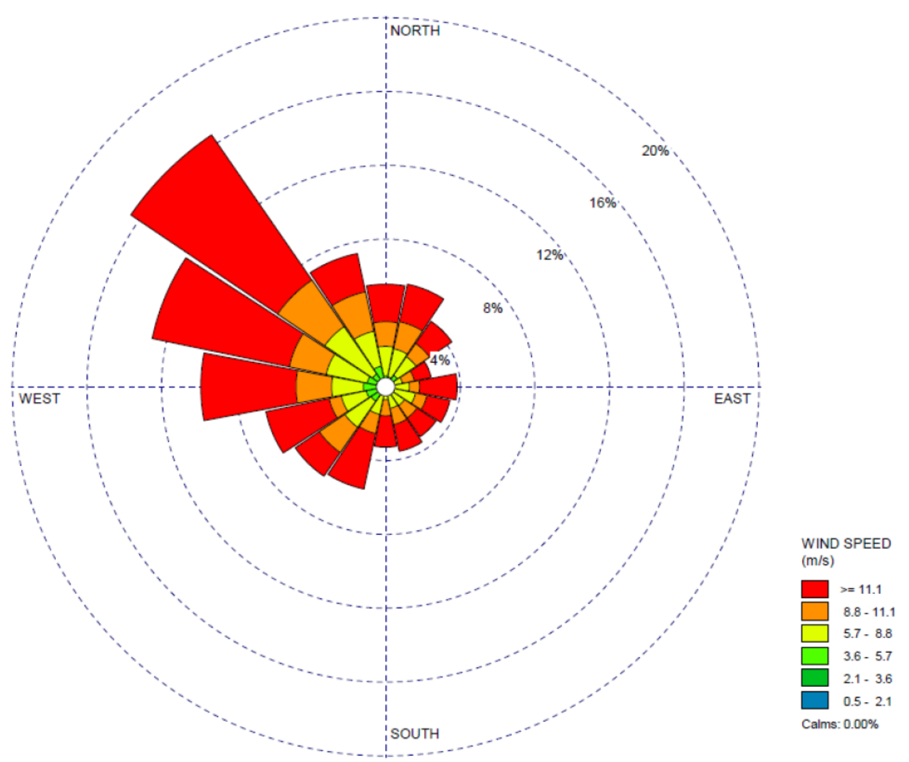
Return Period (Years)	Wind Speed (m/s)[1]							
	N	NE	E	SE	S	SW	W	NW
2	20.9	19.5	20.3	20.4	20.7	21.3	22.4	21.7
5	23.9	22.0	22.4	22.9	23.3	24.2	24.6	23.7
10	25.5	23.5	23.3	24.6	25.1	26.1	26.0	24.8
25	27.3	25.3	24.3	26.9	27.3	28.3	27.8	26.1
50	28.4	26.5	24.8	28.7	29.0	29.9	29.0	26.9
100	29.4	27.7	25.2	30.5	30.7	31.5	30.2	27.7

Notes:
1 Direction winds are blowing from.

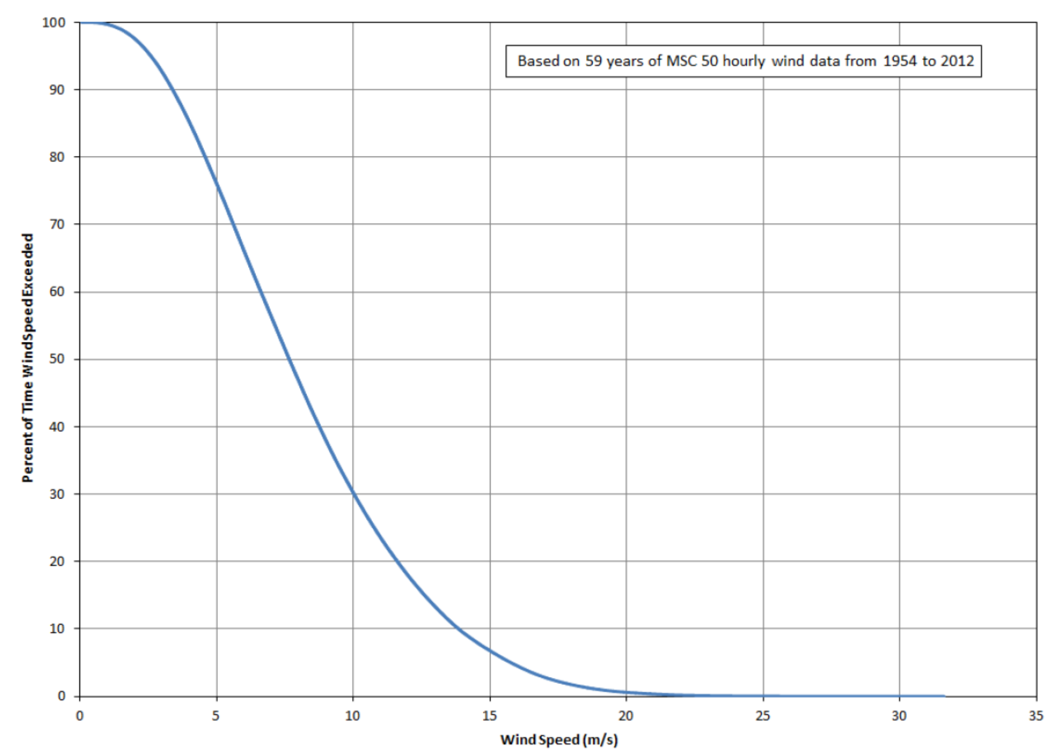
Wind Speed (m/s)	Wind Direction																Total
	N	NNE	NE	NEE	E	SEE	SE	SSE	S	SSW	SW	SWW	W	NWW	NW	NNW	
0-2.5	0.216	0.193	0.218	0.230	0.229	0.213	0.241	0.251	0.311	0.405	0.432	0.413	0.360	0.302	0.263	0.219	**4.50**
2.5-5	0.891	0.814	0.823	0.839	0.835	0.866	0.971	1.137	1.448	1.760	1.993	1.949	1.586	1.297	1.129	1.018	**19.4**
5-7.5	1.198	1.103	0.994	0.923	0.960	0.953	0.885	1.005	1.445	2.062	2.789	2.883	2.198	1.986	1.731	1.438	**24.6**
7.5-10	1.165	1.040	0.911	0.830	0.690	0.633	0.628	0.629	0.919	1.445	2.220	2.388	2.062	2.242	1.976	1.566	**21.3**
10-12.5	0.837	0.696	0.630	0.536	0.392	0.352	0.384	0.373	0.540	0.680	1.070	1.246	1.539	2.227	1.930	1.277	**14.7**
12.5-15	0.446	0.383	0.365	0.291	0.231	0.217	0.205	0.222	0.289	0.332	0.413	0.592	0.995	1.710	1.348	0.701	**8.74**
15-17.5	0.218	0.193	0.178	0.119	0.129	0.111	0.116	0.127	0.146	0.159	0.172	0.277	0.597	1.060	0.668	0.291	**4.56**
17.5-20	0.083	0.070	0.059	0.058	0.043	0.048	0.038	0.040	0.052	0.046	0.046	0.108	0.259	0.373	0.212	0.092	**1.63**
20-22.5	0.025	0.020	0.026	0.030	0.013	0.014	0.012	0.011	0.008	0.009	0.013	0.039	0.084	0.094	0.035	0.039	**0.471**
22.5-25	0.013	0.005	0.004	0.006	0.003	0.003	0.002	0.002	0.003	0.002	0.004	0.011	0.012	0.014	0.012	0.009	**0.105**
25-27.5	0.003	0.004	0.003	0.0004		0.0002	0.0004	0.0002	0.001	0.001	0.002	0.004	0.005	0.002	0.002	0.002	**0.031**
27.5-30	0.0004	0.0002	0.0002	0.0002				0.0002	0.0004	0.0004	0.001	0.0002	0.0004				**0.003**
30-32.5							0.0002	0.0004									**0.001**
Total	**5.10**	**4.52**	**4.21**	**3.86**	**3.52**	**3.41**	**3.48**	**3.80**	**5.16**	**6.90**	**9.16**	**9.91**	**9.70**	**11.3**	**9.31**	**6.65**	**100**

Based on 59 years of MSC 50 hourly wind data from 1954 to 2012.

(a) Percent of Wind Speed by Wind Direction

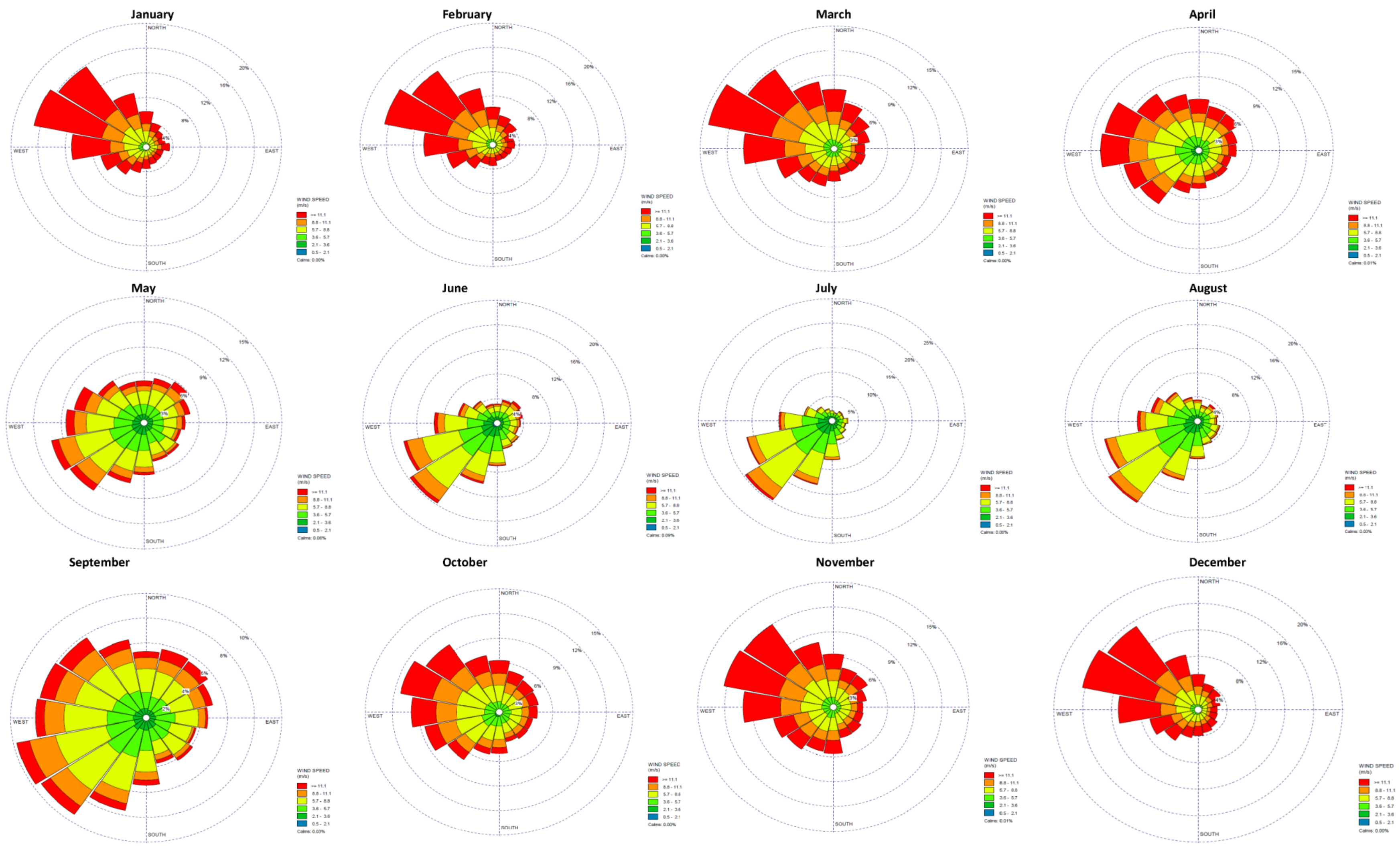


Based on MSC50 hourly wind data from 2007 to 2012
(b) Annual Wind Rose Diagram



(c) Wind Speed Exceedance

Figure 5.1.8 Wind Conditions at Grid Point 2124



Based on MSC50 hourly wind data from 1954 to 2012
Direction Convention: winds are blowing from

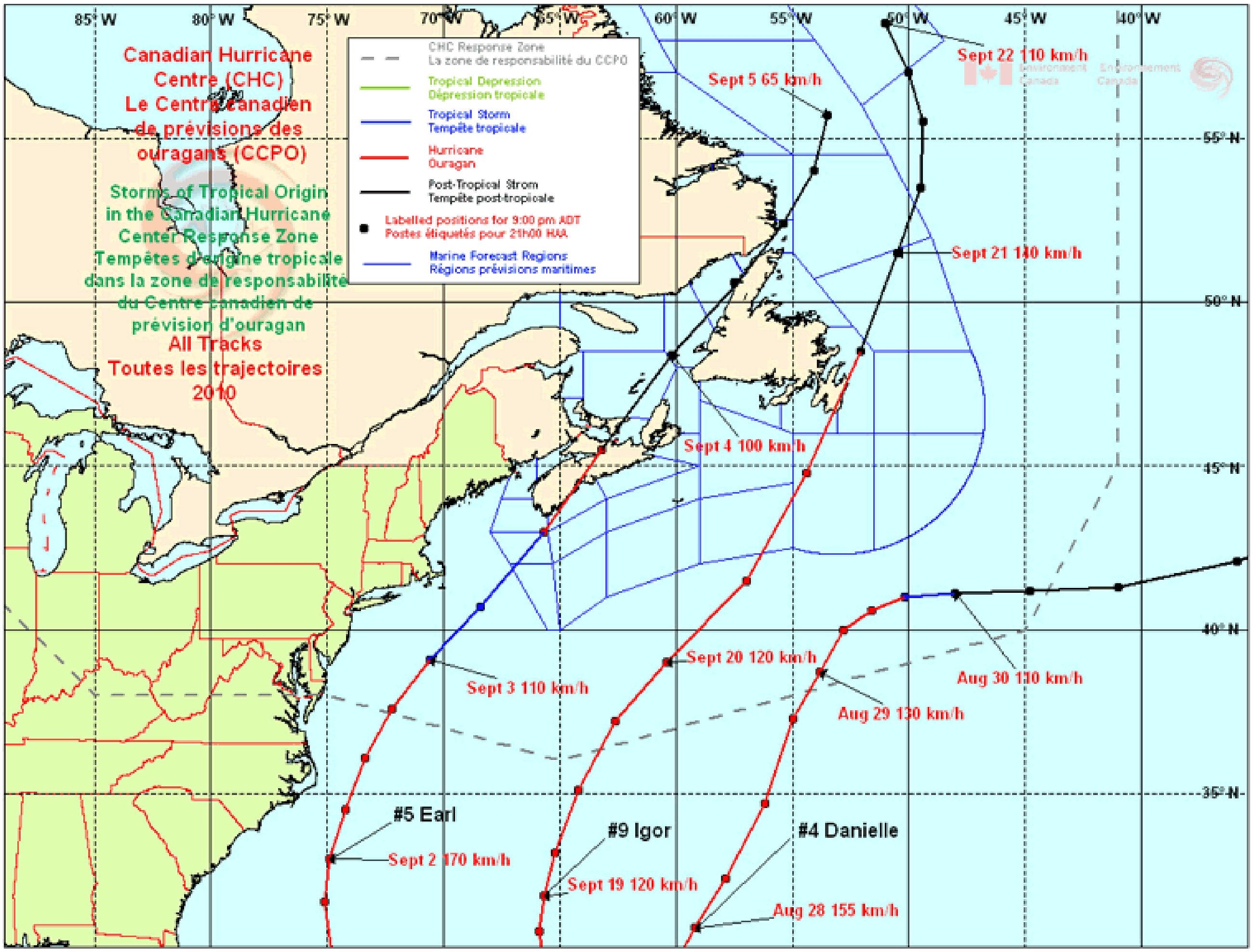
Figure 5.1.9 Monthly Wind Rose at Grid Point 2124

5.1.2.4 Extreme Weather

Storms

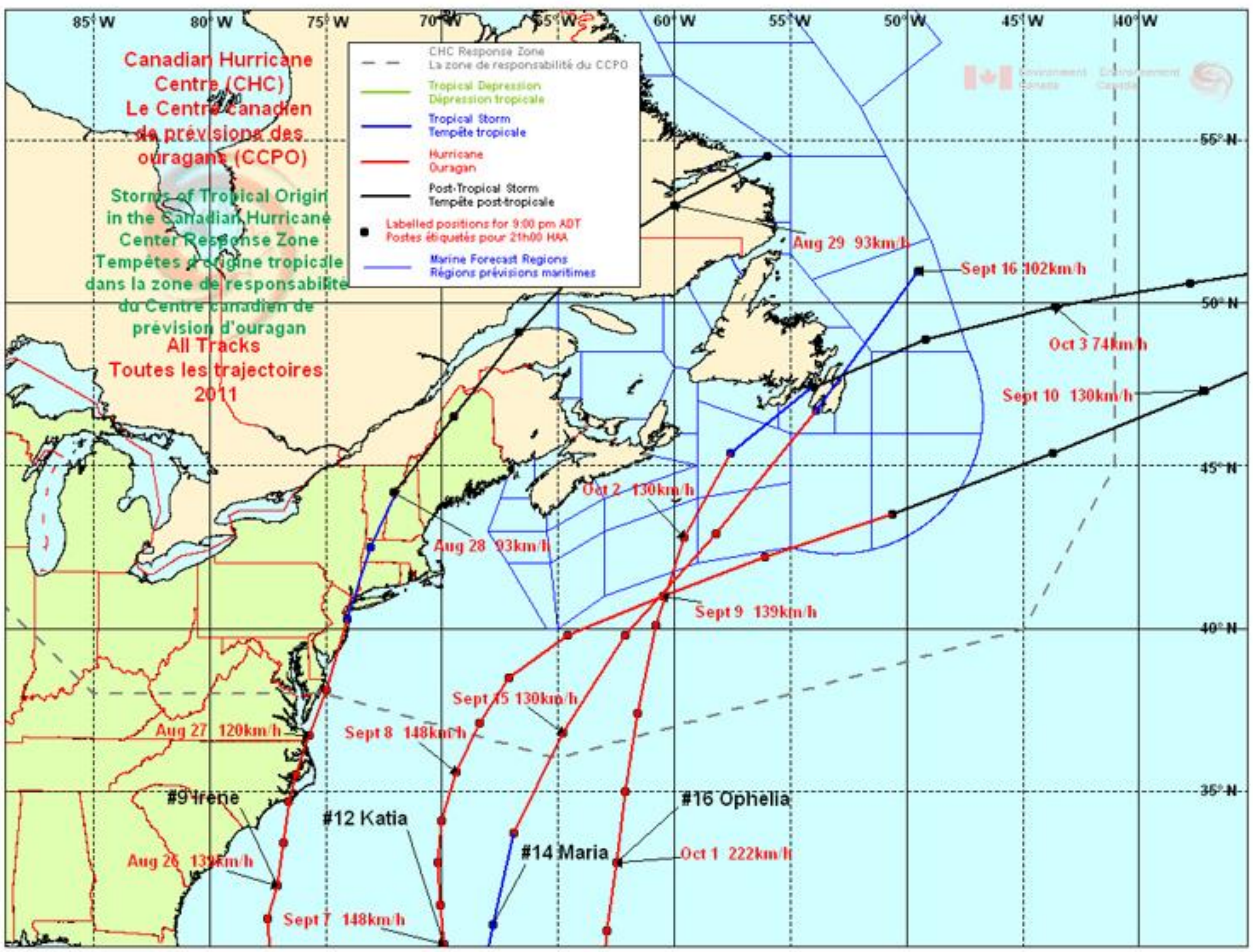
The Scotian Shelf and Slope lie in the path of occasional hurricanes and tropical storms which travel up the eastern coast of North America. Hurricanes can range from category 1 through to category 5 with wind speeds ranging from > 118 km/hour to > 251 km/hour. Hurricanes in the North Atlantic typically form during June to November, bringing intense and damaging winds, rain and storm surges.

Figures 5.1.10 to 5.1.12 illustrate the tracks for storms originating in the tropics which have tracked through Atlantic Canada between 2010 and 2012. Figure 5.1.13 depicts all of the tropical cyclone tracks in the North Atlantic from 1980–2005.



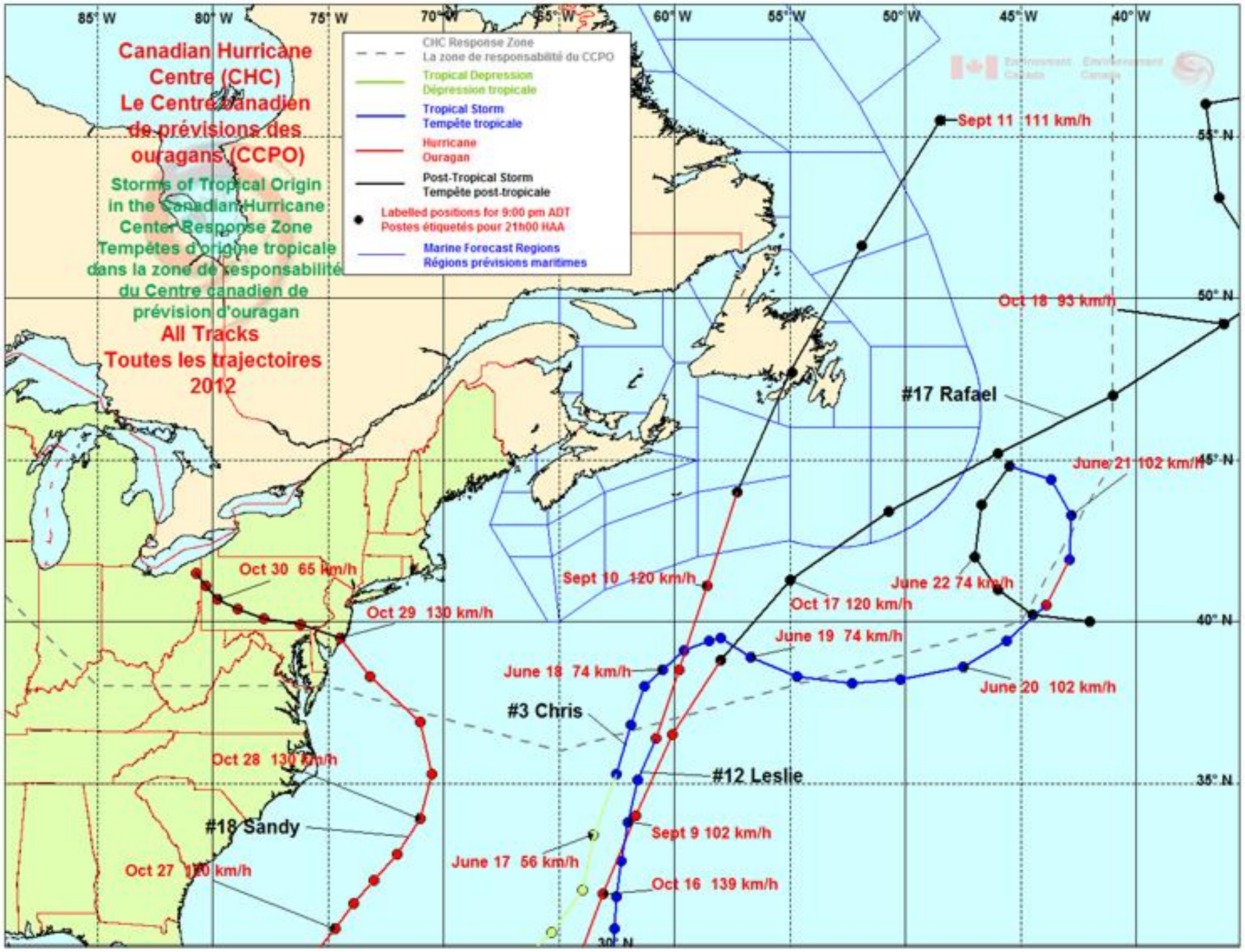
Source: Environment Canada 2012c

Figure 5.1.10 2010 Atlantic Canada Extratropical Storm Tracks



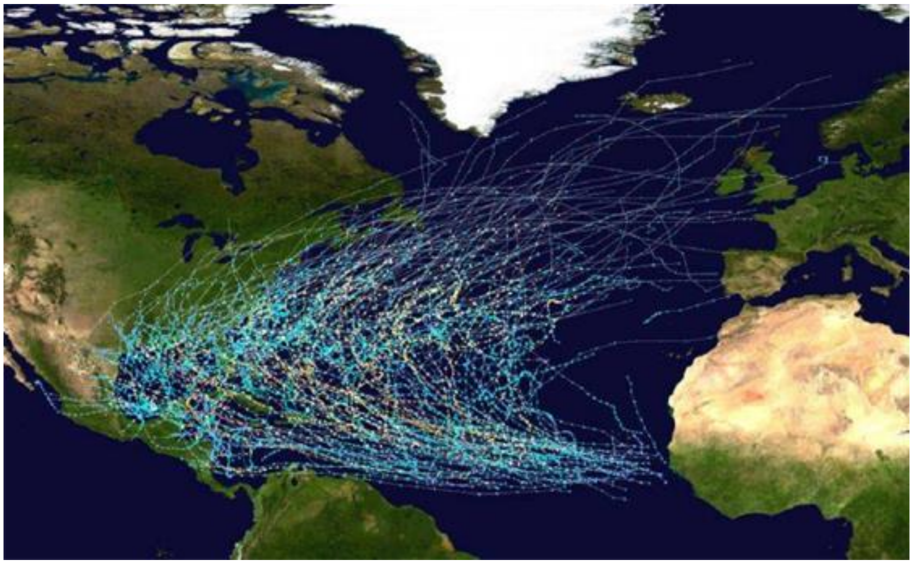
Source: Environment Canada 2012c

Figure 5.1.11 2011 Atlantic Canada Extratropical Storm Tracks



Source: Environment Canada 2012c

Figure 5.1.12 2012 Atlantic Canada Extratropical Storm Tracks



Source: Environment Canada 2013b

Figure 5.1.13 Tropical Cyclone Tracks in the North Atlantic from 1980–2005

Table 5.1.6 below depicts the tropical cyclones that have passed through the Scotian Shelf and Slope and the Project Area in the last ten years. A total of 17 tropical cyclones have passed through the Scotian Shelf and Slope from 2003 to 2013, with four (indicated in table below) passing through or within close proximity to the Project Area. Wind speeds from the storms which impacted the Project Area ranged from 60 km/hour to 170 km/hour (the upper range of 170 km/hour was reported prior to reaching the Project Area and may be different than this value). Tropical cyclones that traveled through the Scotian Shelf and Slope have been most prevalent in September, followed by July, October, August, June and November, respectively.

Table 5.1.6 Tropical Cyclones on the Scotian Shelf and Slope from 2003–2013

Year	Name	Category	Time Frame	Wind Speed (km/hour)
2013	Gabrielle	Tropical Storm	September 10–14	65–85
2012	Leslie	Hurricane	September 4–11	100–120
2011	Maria	Hurricane	September 15–16	100–120
	Ophelia	Hurricane	October 1–3	140–205
2010	Earl*	Tropical Storm	September 2–5	60–70
2009	Bill*	Hurricane	August 23–24	120–150
2008	Cristobal*	Hurricane	July 20–23	80–110
	Kyle	Hurricane	September 28–30	120–130
2007	Chantal	Tropical Storm	July 31–August 1	85**
	Noel	Hurricane	October 28–November 2	130**

Table 5.1.6 Tropical Cyclones on the Scotian Shelf and Slope from 2003–2013

Year	Name	Category	Time Frame	Wind Speed (km/hour)
2006	N/A	Tropical Storm	July 17–18	75**
	Alberto	Tropical Storm	June 10–14	115**
2005	Franklin	Tropical Storm	July 21–29	115**
	Ophelia	Hurricane	September 6–7	140**
	Wilma	Major Hurricane	October 15–25	295**
2004	Gaston	Hurricane	August 27–September 1	120**
2003	Juan*	Hurricane	September 24–29	170**
*Note: These storms passed through the Project Area or within close proximity. **Note: These wind speeds may have occurred outside the Scotian Shelf and Slope region.				

Source: Environment Canada 2013b; NOAA 2013h

Lightning

The Canadian Lightning Detection Network collects lightning measurements throughout Canada and maintains statistics on lightning strikes in Canadian cities and identifies "hot spots" for lightning occurrences. Based on mapping of Canada's lightning hot spots prepared by the Canadian Lightning Detection Network, Nova Scotia and its offshore environs represent an area of very low average flash density (flashes per square kilometre per year) (Environment Canada 2013f). Table 5.1.7 presents statistics on lightning activity in Nova Scotia based on data collected by the Canadian Lightning Detection Network between 1999 and 2008.

Table 5.1.7 Lightning Activity in Nova Scotia

City	Area (km^2)	Total flashes (1999 to 2008)	Total flashes per km^2 per year	Cloud to Ground flashes (1999 to 2008)	Cloud to Ground flashes per km^2 per year
Yarmouth	4.32	21	0.49	19	0.44
New Glasgow	4.94	16	0.32	14	0.28
Truro	5.62	17	0.30	13	0.23
Sydney	102.72	191	0.19	178	0.17
Halifax	43.89	78	0.18	73	0.17

Source: Environment Canada 2013f

5.1.2.5 Visibility and Fog

Fog occurs when moist air passes over a cool surface, usually by advection, cooling the air mass and causing condensation and reducing visibility to less than 1 km (Frost 2004). It is most common at sea when moist warm air encounters cold water and areas of cold-water upwelling. Localized fog can also occur when cold air passes over warm water. Fog is often present on the Scotian Shelf and Slope, especially in the summer months, as warm tropical air moves north and creates large fog banks and stratiform clouds in the area (Hurley 2011).

Historical data for visibility recorded at the Sable Island Weather Station are presented in Table 5.1.8.

Table 5.1.8 Hours of Visibility per Month Recorded at the Sable Island Weather Station, 1971–2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
< 1 km	45.8	52.1	77	107.7	166.6	205.2	215.6	127.3	35.3	28.5	32.5	28.6
1 to 9 km	179.9	147.8	140.3	158.1	158.8	153.2	183.7	175.7	122.1	106.9	132.4	144.1
> 9 km	518.3	477.8	526.7	454.2	418.6	361.6	344.8	441.1	562.6	608.6	555	571.4

Source: Environment Canada 2013a

During the period from 1971 to 2000, the number of hours of visibility less than 1 km ranged from 28.5 hours in October to 215.6 hours in July (Environment Canada 2013a). The number of hours with visibility less than 1 km were greatest during the summer months, particularly in June and July with 65% of the days seeing fog (Hurley 2011). The fall season generally has the least amount of hours of fog due to warmer air and sea temperatures.

5.1.3 Physical Oceanography

5.1.3.1 Bathymetry

The Project Area is located approximately 250 km offshore of Nova Scotia on the southwest Scotian Slope. The Scotian Slope begins at the edge of the Scotian Shelf at a water depth of approximately 200 m, where it then steeply descends to a water depth of 2000 m (Stantec 2014). From water depths of 2000 m to 5000 m, the slope is more gradual in an area known as the Continental Rise. The Project Area is located in depths ranging from 1500 m to 3000 m. Figure 5.1.14 provides a bathymetric overview of the Project Area and the southwest Scotian Slope.

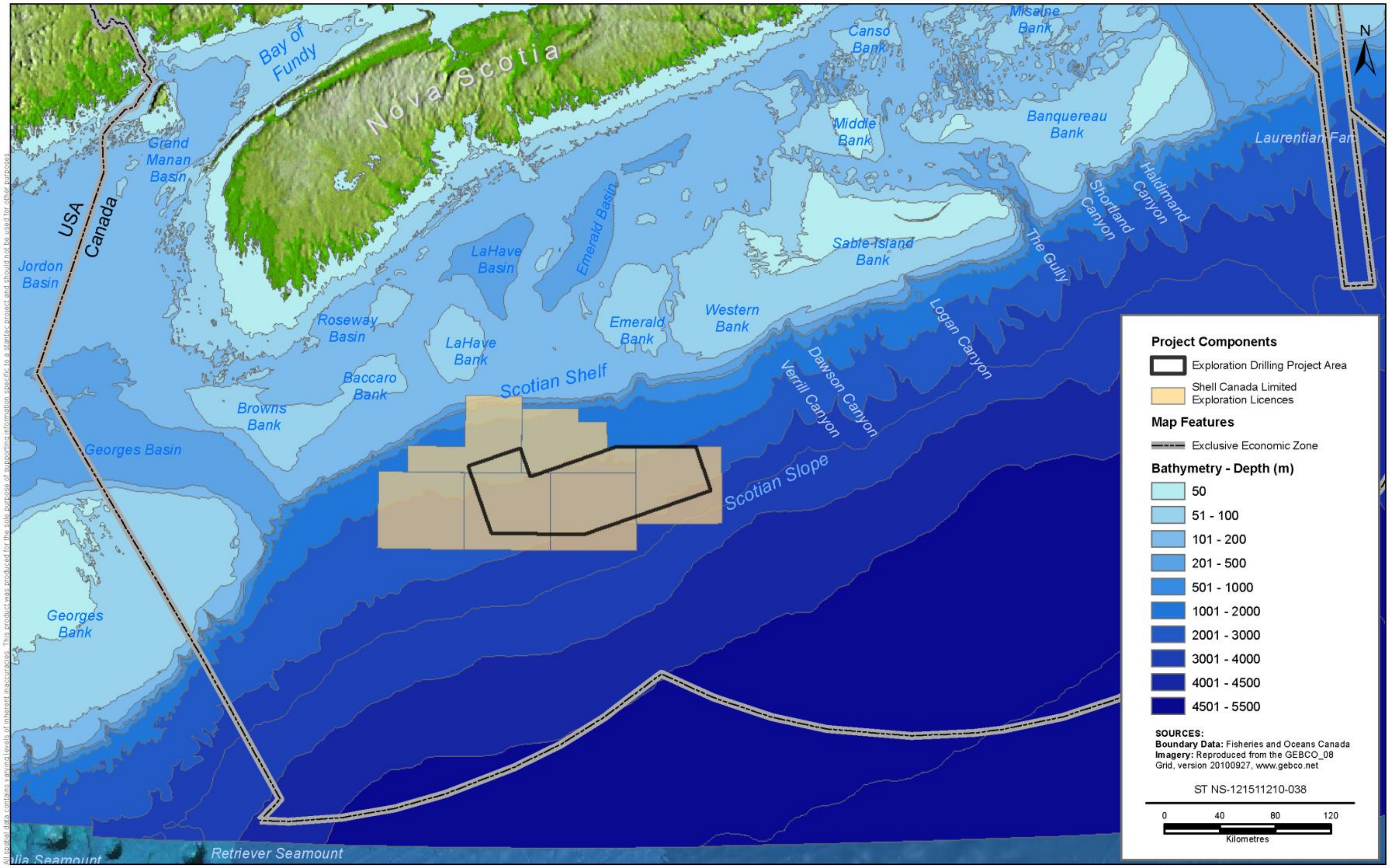


Figure 5.1.14 Bathymetric Overview of the Southwest Scotian Slope

5.1.3.2 Ocean Currents

The physical environment on the Scotian Shelf and Slope is governed by its close proximity to the intersection of major currents of the northwest Atlantic and its complex bathymetry. The three major currents influencing the movement of water on the Scotian Shelf and Slope are the Nova Scotia Current, the Shelf Break Current (an extension of the Labrador Current), and the Gulf Stream (Zwanenburg *et al.* 2006). Relatively cool, fresh waters flow from the Gulf of the St. Lawrence through the Cabot Strait. A portion of this water turns at Cape Breton to flow southwest along Nova Scotia's Atlantic coast, while the rest of the flow continues through the Laurentian Channel to the shelf break. At the shelf break it turns and joins the Shelf Break Current to flow southwest along the shelf edge. The Shelf Break Current is the largest coast transport feeder on the Eastern Scotian Shelf (Han and Loder 2003).

The Gulf Stream flows northeastwards, and its warmer, more saline waters mix with the cool Labrador Current waters over the Scotian Slope, forming a mass of water known as slope water (ACZISC 2011). This slope water periodically leaks onto the Shelf through channels and canyons. The shelf bottom consists of a series of submarine banks and cross-shelf channels along the outer shelf and basins, and troughs along the central shelf which limit and guide the near-bottom flow. The predominant flow of cold, fresh water from the northeast to the southwest results in a general increase in both temperature and salinity as it flows closer to the southwest (Zwanenburg *et al.* 2006).

The eastern end of the Scotian Shelf is primarily comprised of colder, less salty water from the Gulf of St. Lawrence and the Newfoundland Shelf. The water tends to be cold because the Banquereau and Sable Island Banks prevent the mixing of warm saline water from the Gulf Stream. As a result, the water in this area tends to be cold, especially at depth. At the shelf break, the Shelf Break Current produces current speeds ranging from 0.15–0.55 m/s (Han and Loder 2003). Some of the strongest current speeds on the Scotian Shelf and Slope can be found as the water exiting the Laurentian Channel wraps around Banquereau Bank. Here the water makes a sharp southeasterly turn to travel along the shelf edge. Further offshore of the shelf edge, the currents are much weaker and generally travel in a northeasterly direction (Brickmand and Drozdowski 2012).

Further to the south, on the Western Scotian Shelf, the Nova Scotia Current flows in a southwesterly direction close to the coastline. As it reaches the Halifax area it branches in an offshore direction, where it joins the Shelf Break Current and continues to flow southwesterly along the shelf break (Breeze *et al.* 2002.) As the Shelf Break Current flows past the central portions of the Scotian Shelf and to the southwest, current speeds are reduced to a range of 0.05–0.3 m/s (Stantec 2014). On the shelf, the influence of the warm waters from the Gulf Stream is felt primarily within the deep channels and basins. The depression between Emerald and LaHave Banks, known as the Scotian Gulf, is a well-known area of warm water infiltration. Significant differences in circulation patterns exist between the western and central Scotian Shelf. The water masses of the central and western Scotian Shelf are more similar to one another than to those found on the eastern Scotian Shelf (Breeze *et al.* 2002).

An array of 11 current metres was moored at the shelf break south of Halifax, as part of the Shelf Break Experiment conducted by BIO (JWEL 2002a). Two of these moored sites overlap with sections of the Project Area.

Table 5.1.9 summarizes the seasonal current statistics from the two sites. The average current speeds at the different locations were similar in magnitude. Tidal flows in the data sets are considered very small compared to values on the Shelf, which is consistent with the expected decrease in tidal flows over the Slope region (JWEL 2002a). The maximum surface (38–80 m) current speeds were measured during the winter season with a maximum speed of 1.14 m/s. Lower speeds were recorded in the spring and summer, which increased in the fall and ranged from 0.614–0.802 m/s. It should be noted that the mean surface speeds ranged from 0.043–0.128 m/s and were up to ten times smaller in value compared to the maximum recorded speeds at the surface. Average surface current direction flows generally in an easterly direction ranging from northeast to east-southeast. Maximum speeds at mid-depth (1502–1539 m) ranged from 0.174–0.383 m/s and were much lower than the speeds recorded near the surface. Mean current speeds at mid-depth were weak and ranged from 0.012–0.028 m/s. Mid-depth mean currents travel in a westerly direction ranging from southwest to northwest. Maximum speeds at maximum-depth (2532–2537 m) ranged from 0.2–0.291 m/s and were much lower than the speeds recorded near the surface. Mean current speeds at maximum-depth were also weak and ranged from 0.029–0.053 m/s. maximum-depth mean currents travel in a southwesterly to westerly direction.

Table 5.1.9 Seasonal Summary of Current Statistics from Shelf Break Experiment Mooring Sites in Project Area, 1976–1977

Current Speeds (m/s)	Season			
	January-March	April-June	July-September	October-December
Max at Surface (38–80 m)	1.14	0.724	0.614	0.802
Max at Mid-Depth (1502–1539 m)	0.174	0.383	0.205	0.197
Max at Maximum Depth (2532–2537m)	0.291	0.245	N/A	0.2
Mean at Surface (38–80 m)	0.128	0.045	0.043	0.071
Mean Direction at Surface (Deg T)	114	76	46	103
Mean at Mid-Depth (1502–1539 m)	0.022	0.024	0.028	0.012
Mean Direction at Mid Depth (Deg T)	226	316	249	218
Mean at Maximum Depth (2532–2537m)	0.052	0.029	N/A	0.053
Mean Direction at Maximum Depth (Deg T)	206	261	N/A	219

Source: Adapted from JWEL 2002a

At the southwestern limit of the Scotian Shelf and Slope, the movement of water on Georges Bank is driven primarily by tidal currents, wind, and variations in water density. Georges Bank is shallow in depth, and is located at the mouth of the Gulf of Maine and the Bay of Fundy, which gives rise to strong tidal currents found in the area. In the deeper water perimeter areas of the bank, current speeds can reach approximately 0.2 m/s and can reach upwards of 1.0 m/s in the shallow areas on top of the bank (Kennedy *et al.* 2011). The general circulation pattern on Georges Bank is a partial, anticyclonic gyre (water rotates in a clockwise direction). This clockwise circulation is associated primarily with interactions of the tidal currents with the bank's topography. Higher current velocities occur in the summer months, which are associated with horizontal density gradients in the frontal system. This gyre is "leaky" year-round, as storms cause an exchange of water with the nearby waters of Browns Bank, the Gulf of Maine, and the continental slope (Kennedy *et al.* 2011).

At the shelf edge, outer marginal water masses collide to form a frontal zone which shifts in location from year to year. Oceanic fronts occur when there is a sharp boundary between water masses with differing hydrographic properties (Breeze *et al.* 2002). At the boundary, there is an intensification of vertical and horizontal mixing due to differences in physical properties of the water masses. At these frontal zones, cold slope water mixes with the warm water at the edge of the outer banks, supplying nutrients and promoting phytoplankton growth (WWF 2009). Zooplankton, ichthyoplankton, jellyfish and other planktonic organism also congregate in frontal zones which attract sea turtles, whales, pelagic birds and other species that prey on planktonic organism (Breeze *et al.* 2002).

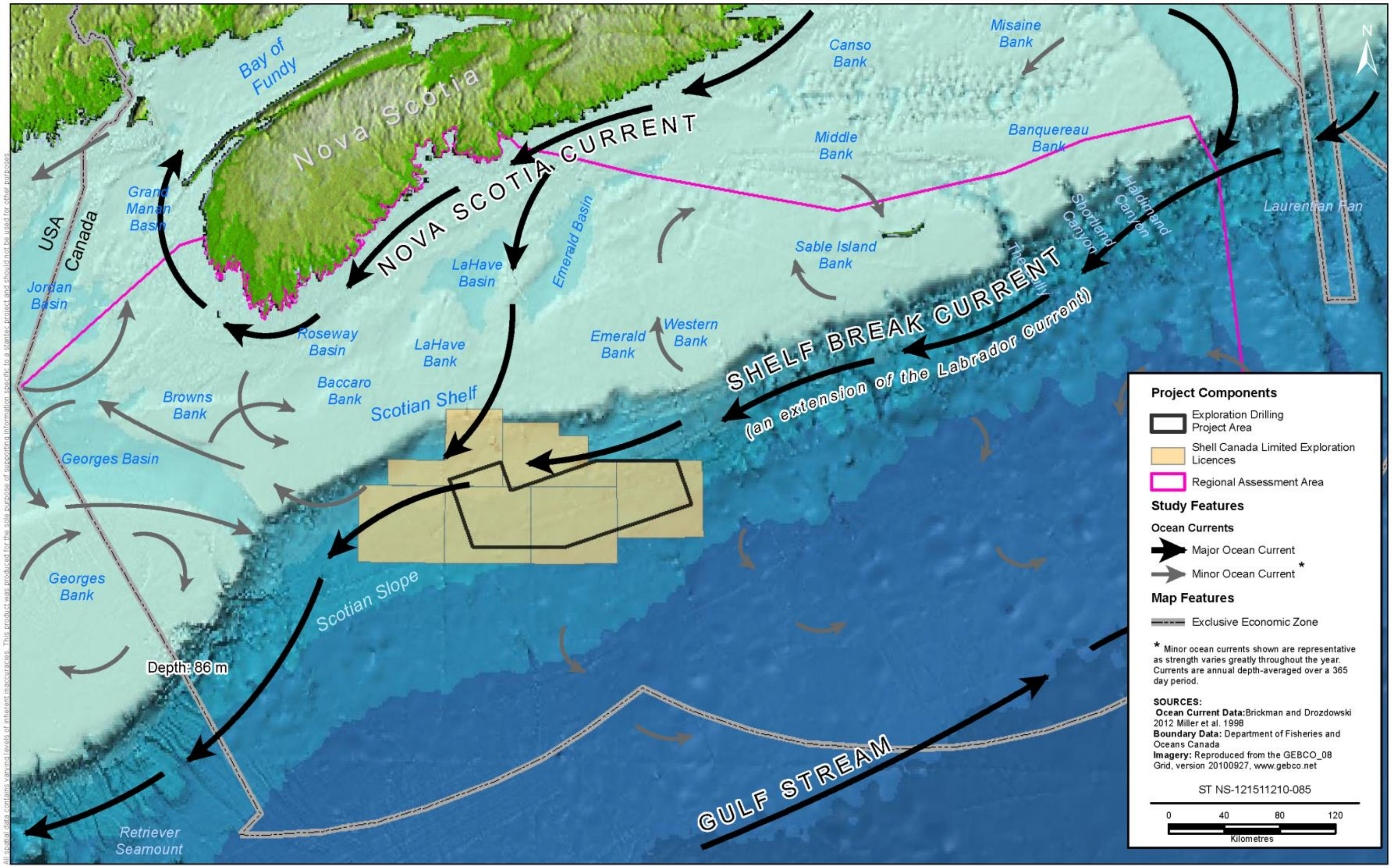


Figure 5.1.15 Overview of Currents

Upwelling occurs when cold, dense water from the benthic zone is forced up to the surface. Winds cause the surface water to move from one area to another, causing deep water to travel upwards and replace the surface water after it has moved. Upwelling frequently occurs in the waters offshore of Nova Scotia during the summer months due to the southwest prevailing winds (Breeze *et al.* 2002). At the shelf break moderate winds lead to regular upwelling from depths of 400 m and greater.

In areas of the shelf edge and slope currents, tidal processes and benthic topography create regular upwelling events and the enhanced mixing of water masses (Breeze *et al.* 2002). Vertical mixing from upwelling and horizontal mixing from Gulf Stream eddy intrusions are important for mixing. However, the generation of internal waves on the shelf edge may be the most important source of mixing on the Scotian Shelf and Slope. Internal waves are formed when water is stratified and tidal forces flow back and forth across the shelf break (Breeze *et al.* 2002). The dissipation of the waves causes layers within the water column to be mixed. Topography enhances the effects of internal waves. The steep slope on the shelf break traps low frequency currents and reflects, refracts, and scatters them. The steep slope on the eastern Scotian Slope is ideal for the creation of internal waves, although the tidal currents on the southwest Slope are much stronger. The internal waves created on the southwest Slope propagate across the shelf and cause widespread mixing. This widespread mixing brings nutrients up into the euphotic zone, propagating high levels of primary production.

5.1.3.3 Wave Climate

The wave climate in the Project Area is necessary to assess the environmental effects for the Project and predict the wave-induced loads on the offshore structures used for drilling. The primary parameters characterizing the wave climate are significant wave height (H_s), the peak spectral period (T_p), and the significant wave period (T_s). The significant wave height is defined as the average height of the highest one-third of all waves for a particular sea state and found to be close to the wave height reported on the basis of observation. The spectral peak period is the period of the waves with the largest energy levels, and the significant wave period is the average period of the highest one-third of all waves for a particular sea state.

Fifty-nine (59) years of hourly MSC50 wave hindcast data from 1954 to 2012 were used to characterize the wave conditions for the Project Area (refer to Section 5.1.2.3 for a description of the MSC50 data set). The MSC50 hourly wave hindcast data include significant wave height, H_s, peak spectral period, T_p (including sea/swell partitions) and dominant wave propagation direction (including sea/swell partitions).

Figure 5.1.16(a) presents data on the significant wave height versus peak period. Approximately 51% of the time the significant wave heights are less than 2 m and 95% of the time the significant waves heights are less than 5.0 m. About 84% of the time wave peak periods are between 3 s and 10 s. Figure 5.1.16(b) presents the percentage of the waves falling within each range of peak wave period. Figure 5.1.16(c) illustrates the annual wave rose of the direction in which which waves are prograting to for Grid Point 2124 and based on 5 years of MSC50 data from

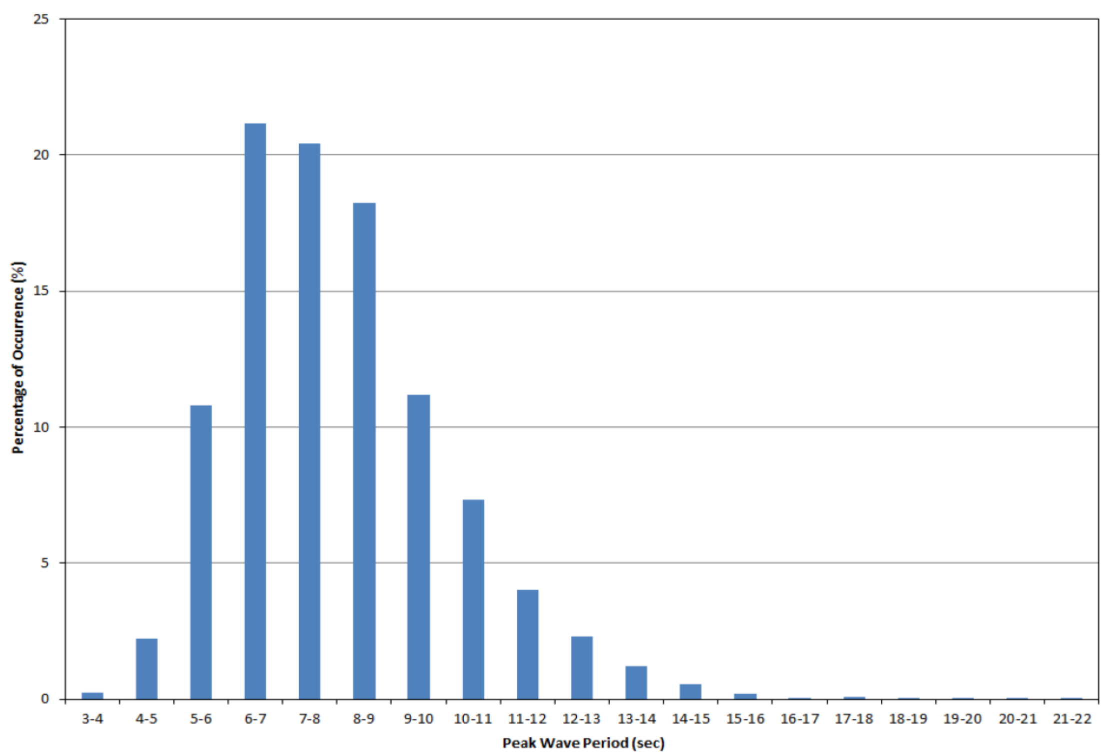
2007 to 2012. The wave rose indicates that most of the wave energy comes from the northwest, west and southwest directions. Figure 5.1.16(d) presents the wave height duration curve for Grid Point 2124. The wave height duration curve indicates the percentage of the time a given wave height was equaled or exceeded over a 59-year period from 1954 to 2012.

Monthly wave height and wave period roses are presented in Figures 5.1.17 and 5.1.18 respectively. Table 5.1.9 provides the mean monthly significant wave height, the maximum monthly significant wave height and the most frequent direction of wave propagation for each month. Significant wave heights are higher during the winter months at Grid Point 2124.

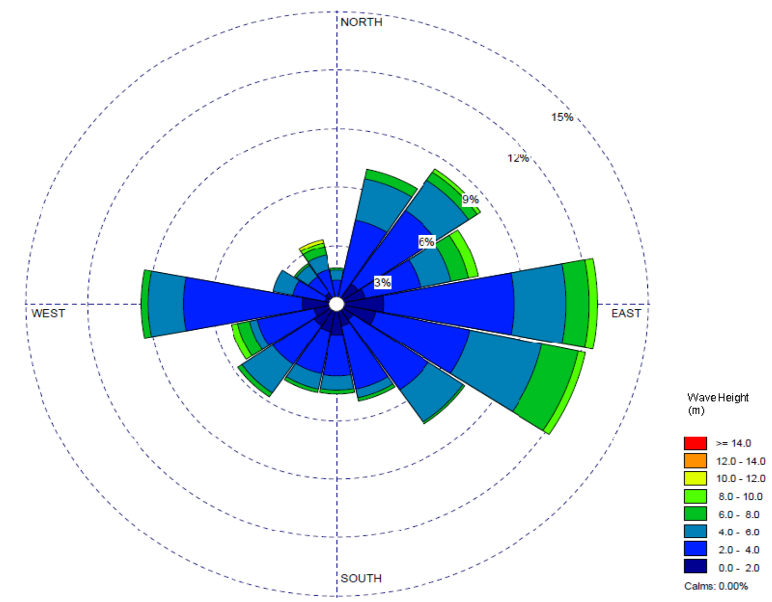
Wave Period (Sec)	Wave Height (m)																Total
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	
3-4	0.089	0.150	0.001														**0.240**
4-5	0.519	1.654	0.068	0.000													**2.24**
5-6	1.630	8.475	0.694	0.006													**10.8**
6-7	2.855	11.767	6.328	0.190	0.002												**21.1**
7-8	1.074	9.129	7.507	2.631	0.054	0.001											**20.4**
8-9	0.685	6.118	4.398	5.299	1.689	0.051	0.001										**18.2**
9-10	0.403	2.589	2.825	1.926	2.492	0.908	0.049	0.002									**11.2**
10-11	0.179	1.088	1.567	1.532	1.142	1.222	0.526	0.077	0.003								**7.34**
11-12	0.155	0.757	0.770	0.619	0.524	0.395	0.438	0.225	0.101	0.017							**4.00**
12-13	0.134	0.731	0.330	0.230	0.232	0.218	0.144	0.113	0.108	0.066	0.007						**2.31**
13-14	0.065	0.426	0.247	0.117	0.085	0.087	0.069	0.032	0.024	0.035	0.032	0.006					**1.22**
14-15	0.022	0.157	0.171	0.070	0.025	0.032	0.025	0.011	0.005	0.002	0.005	0.009	0.003				**0.538**
15-16	0.015	0.109	0.033	0.013	0.007	0.005	0.002	0.001	0.001			0.001	0.004	0.002			**0.193**
16-17	0.018	0.023	0.007	0.001	0.001	0.001	0.001	0.001	0.001				0.0004	0.001	0.001	0.000	**0.055**
17-18	0.018	0.036	0.014												0.0004	0.001	**0.069**
18-19	0.002	0.004	0.000														**0.006**
19-20	0.002	0.002															**0.004**
20-21		0.001															**0.001**
21-22		0.0002															**0.0002**
Total	**7.87**	**43.2**	**25.0**	**12.6**	**6.25**	**2.92**	**1.26**	**0.461**	**0.241**	**0.120**	**0.043**	**0.015**	**0.008**	**0.003**	**0.001**	**0.001**	**100**

Based on 59 years of MSC 50 hourly wave data from 1954 to 2012.

(a) Percent of Peak Spectral Period against Significant Wave Height

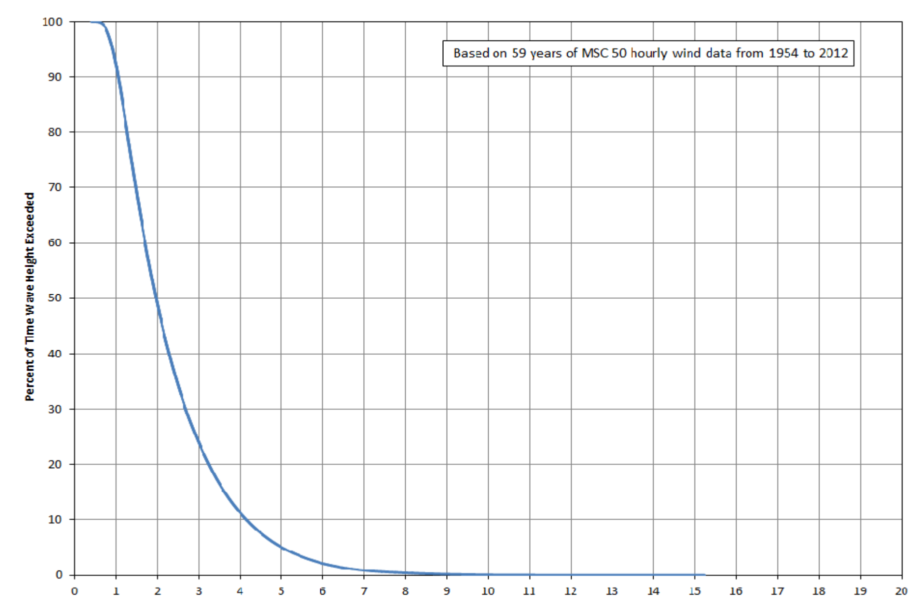


(b) Wave Period Histogram



Based on MSC50 hourly wave data from 2007 to 2012

(c) Annual Wave Rose Diagram



(d) Wave Height Exceedance

Figure 5.1.16 Wave Conditions at Grid Point 2124

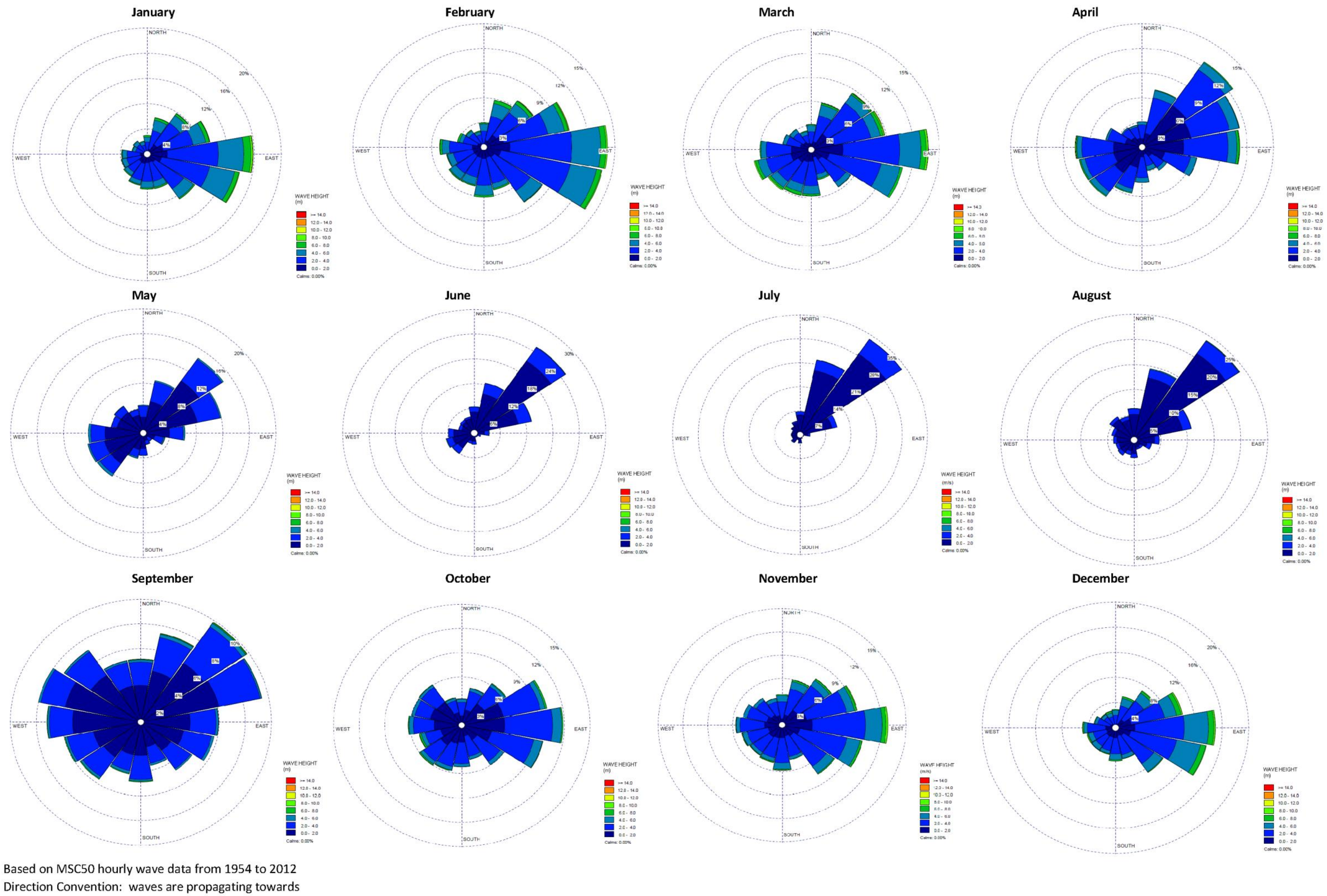
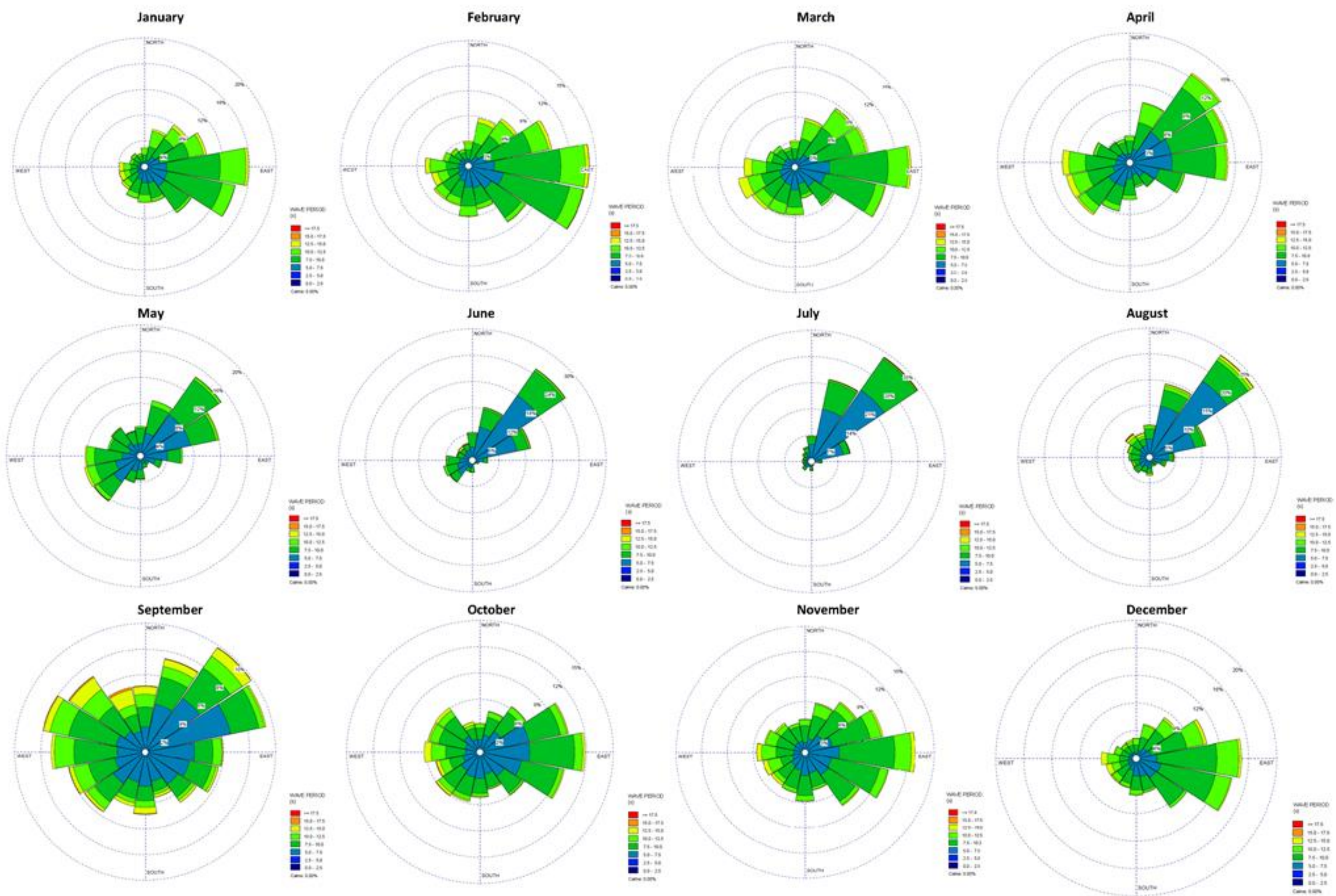


Figure 5.1.17 Monthly Wave (Height) Rose at Grid Point 2124



Based on MSC50 hourly wave data from 1954 to 2012
Direction Convention: waves are propagating towards

Figure 5.1.18 Wave (Period) Rose Diagram at Grid Point 2124

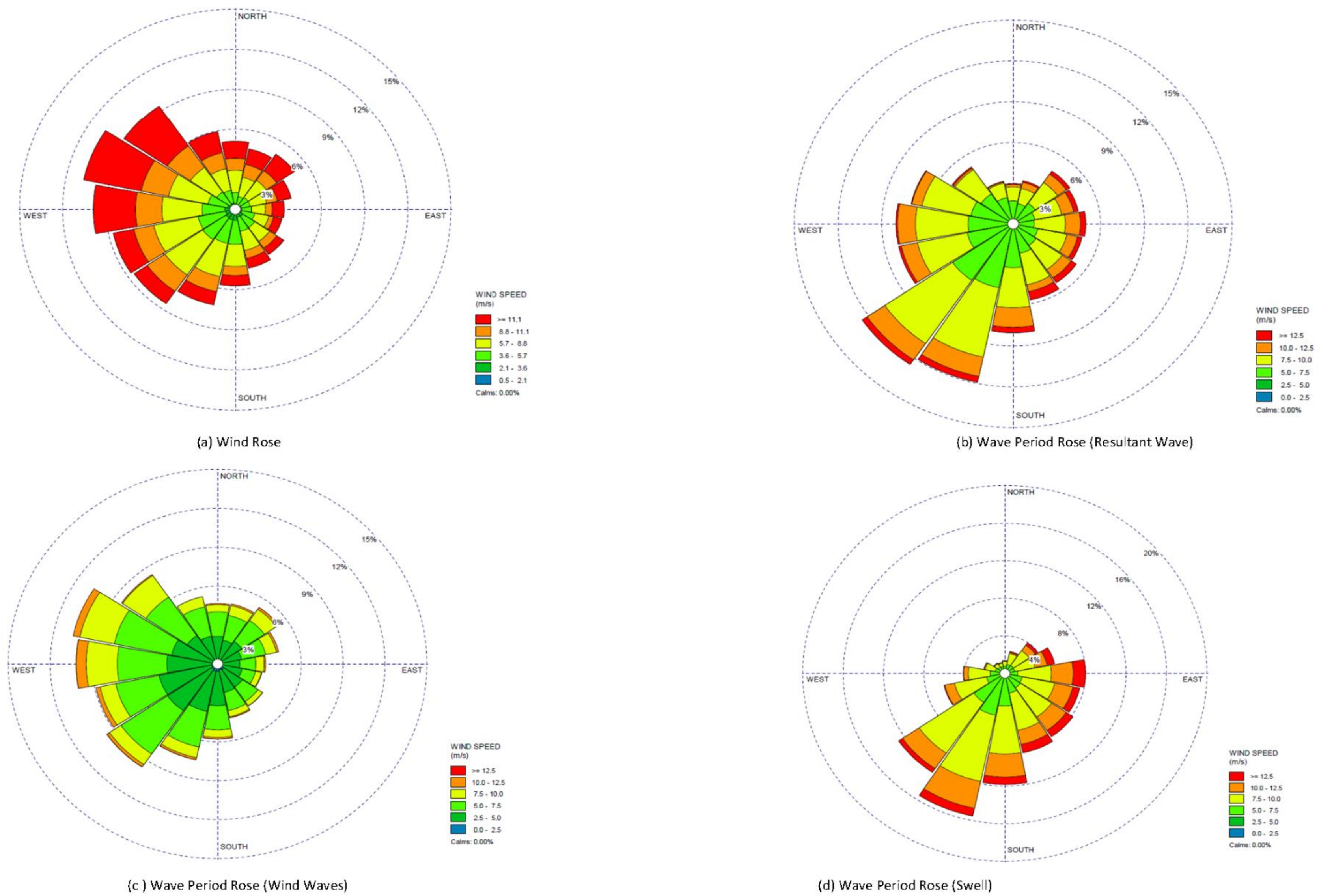
Table 5.1.9 Monthly Wave Conditions at Grid Point 2124[1]

Month	Mean Significant Wave Height (m)	Most Frequent Direction[2]	Maximum Hourly Significant Wave Height (m)
January	3.20	E	12.5
February	3.14	E	11.2
March	2.96	E	15.2
April	2.42	NE, E, SW	11.0
May	1.80	NE	6.76
June	1.56	NE	7.89
July	1.43	NE	8.62
August	1.48	All	13.7
September	1.91	E	13.3
October	2.33	E	13.2
November	2.77	E	13.5
December	3.14	E	12.1

Notes:
[1] Based on 59 years of MSC50 hourly wave data from 1954 to 2012. [2] Direction waves are propagating towards.

The MSC50 wave data were partitioned into sea and swell. Sea corresponds to wind waves generated by local winds. The swell waves are created by wind blowing over an area some distance away for some hours prior to travelling to the area of interest. When the characteristics of both wind and swell waves are combined, the net characteristics are termed the resultant wave. Figure 5.1.19 presents the annual wind and wave roses showing peak period and occurrences of wind, swell and resultant waves. As expected, the direction of wind waves and percentage of occurrences follows that of the wind, and wind and wind-wave period roses have a similar pattern (Figures 5.1.19(a) and 5.1.19(c)). The data in Figure 5.1.19(c) illustrate that the dominant swell directions are from the southwest, south, southeast and east. In summary, the annual wave climate for the Project Area is dominated by:

- wind waves propagating from the west, northwest and north
- wind and swell waves propagating from the southwest and south
- swell from the southeast and east



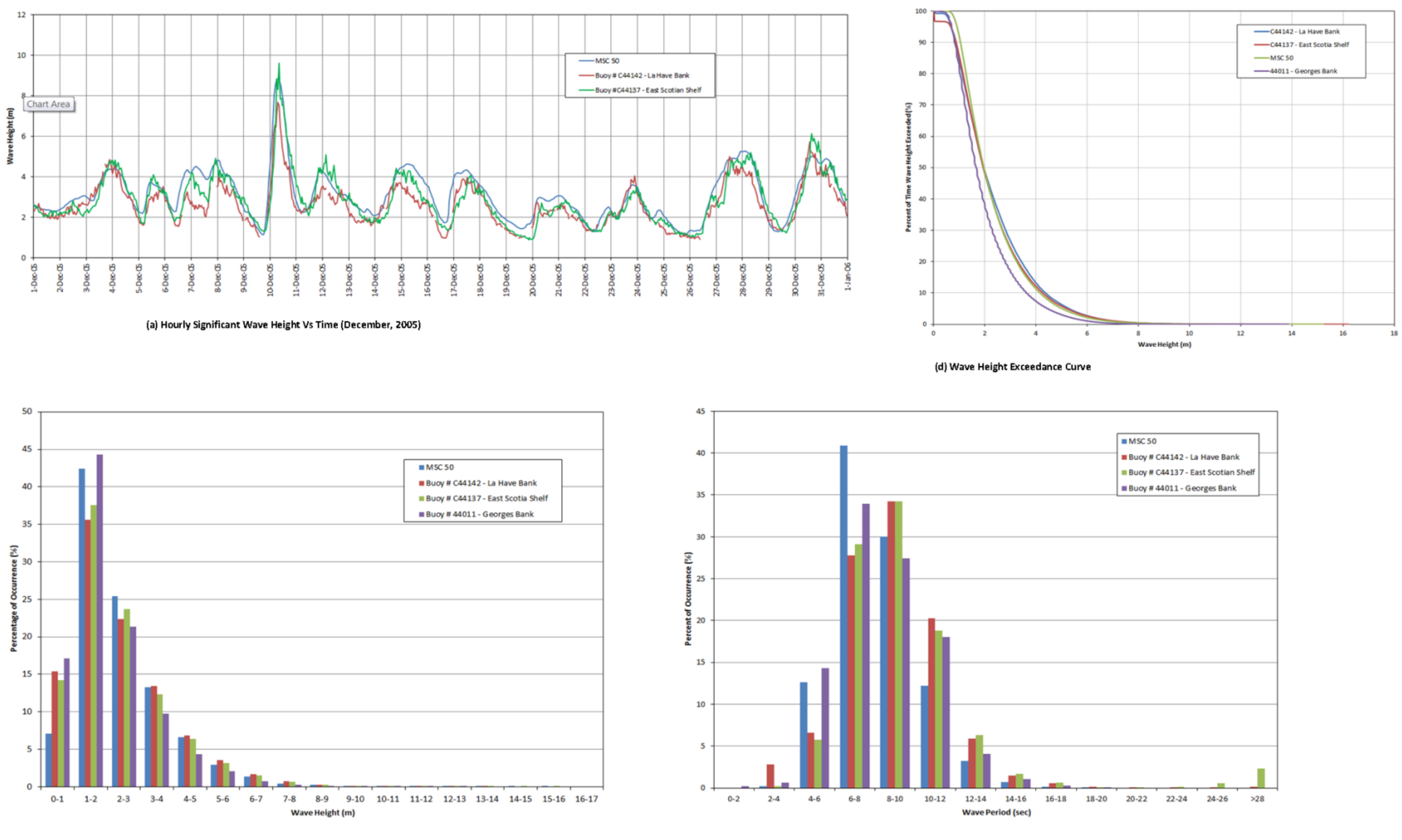
Based on MSC 50 hourly data from 2007 to 2012

Figure 5.1.19 Comparison of Annual Wind Rose and Wave Period Roses for Wind Wave, Swell and Resultant Wave.

Buoy Data

Long-term buoy data at the LaHave Bank station (ID#C44142), East Scotian Shelf (ID#C44137), and Georges Bank (#44011) were used to compare to the MSC50 data. About 48% of the hourly LaHave Bank buoy data, 39% of the hourly East Scotia Shelf buoy data and 20% of the hourly Georges Bank buoy data are not used for the comparison due to the quality of the recorded data and/or malfunction of the buoy. Only data identified as good were used for comparison with the MSC50 data.

Figure 5.1.20(a) compares the hourly significant wave height for December 2005 for the LaHave Bank buoy, East Scotian Shelf Buoy and MSC50 data and indicates that overall agreement is good between the buoys and the MSC50 data. Most of the time the significant wave heights recorded are less than the predicted MSC50 data as illustrated in Figure 5.1.20(a). Figures 5.1.20(b) and 5.1.20(c) compare the percentage of occurrence of wave height and wave period, respectively, among the LaHave Bank buoy, East Scotian Shelf buoy and Georges Bank buoy and MSC50 data. Overall, the percentages of wave height and wave period occurrences are in good agreement between the buoys data and the MSC50 data. Figure 5.1.20(d) shows the wave height exceedance curve for the LaHave Bank buoy, East Scotian Shelf buoy, Georges Bank buoy and MSC 50 data.



(a) Hourly Significant Wave Height Vs Time (December, 2005)

(d) Wave Height Exceedance Curve

(b) Percent of Wave Period Occurrence

(c) Percent of Wave Period Occurrence

Figure 5.1.20 Comparison of Buoy Data and MSC50 Data

The differences between the buoys and the MSC50 data could be attributed to unavailable buoy data and the locations of the buoy and the MSC50 grid point. Mean and maximum monthly wave heights for the LaHave Bank buoy, East Scotian Shelf buoy, Georges buoy and MSC 50 data are presented in Tables 5.1.10 and 5.1.11 respectively.

Table 5.1.10 Comparison of Mean Monthly Significant Wave Height at Buoy Locations

Month	Mean Significant Wave Height (m)			
	MSC50	LaHave Bank (C 44142)	East Scotian Shelf (C 44137)	Georges Bank (44011)
January	3.20	3.15	3.04	2.81
February	3.14	3.14	3.12	2.76
March	2.96	3.01	2.80	2.50
April	2.42	2.39	2.15	2.05
May	1.80	1.72	1.83	1.60
June	1.56	1.55	1.46	1.40
July	1.43	1.36	1.46	1.28
August	1.48	1.36	1.48	1.25
September	1.91	1.76	1.79	1.59
October	2.33	2.46	2.37	2.05
November	2.77	2.78	2.73	2.37
December	3.14	3.19	3.19	2.73

Table 5.1.11 Comparison of Maximum Significant Wave Height at Buoy Locations

Month	Maximum Significant Wave Height (m)			
	MSC50	LaHave Bank (C 44142)	East Scotian Shelf (C 44137)	Georges Bank (44011)
January	12.5	12.6	10.6	9.15
February	11.2	10.4	11.8	9.78
March	15.2	10.7	16.2	8.95
April	11.0	8.65	8.72	8.85
May	6.76	6.33	7.08	7.13
June	7.89	6.94	11.1	7.03
July	8.62	7.13	6.23	5.50
August	13.7	6.90	14.1	10.7
September	13.3	12.1	11.5	11.2
October	13.2	8.82	14.1	12.0
November	13.5	8.67	13.4	13.9
December	12.2	13.6	13.4	10.2

Mean and maximum monthly significant wave heights are presented in Tables 5.1.12 and 5.1.13 for wave data obtained from the offshore platforms and wells (refer to Figure 5.1.7 for the location of platforms and wells). Mean monthly significant wave heights at offshore platforms and wells compare very well with mean monthly wave heights at the MSC50 grid point and buoy locations except for the values derived from partial monthly data for the offshore platforms and wells. Maximum monthly significant wave heights at offshore platforms and wells are much less than the maximum monthly significant wave heights at the MSC50 grid point and buoy locations. This is primarily due to the short-term records for the offshore platforms and wells compared to the long-term record data at the MSC50 grid point and buoy locations.

Table 5.1.12 Mean Monthly Significant Wave Heights at Offshore Platforms and Wells

Month	Mean Significant Wave Height (m)				
	Sedco 709 (MEDS 133)	Ben Ocean Lancer (MEDS 138)	Sedco 710 (MEDS 185)	Balvenie B-79 (WEL 441)	Weymouth A-45 (WEL 444)
January	-	-	4.75[P]	-	3.11
February	-	-	3.20	-	2.99
March	-	-	4.00[P]	-	2.45
April	-	-	-	-	2.17
May	-	1.62[P]	-	-	1.26[P]
June	-	1.49	-	-	-
July	-	1.25	-	1.51[P]	-
August	-	1.03[P]	-	1.30	-
September	-	-	-	1.02[P]	-
October	-	-	-	-	3.35[P]
November	3.50[P]	-	-	-	2.39
December	3.99[P]	-	-	-	3.11

Notes:
[P] based on partial data

Table 5.1.13 Maximum Monthly Significant Wave Heights at Offshore Platforms and Wells

Month	Maximum Significant Wave Height (m)				
	Sedco 709 (MEDS 133)	Ben Ocean Lancer (MEDS 138)	Sedco 710 (MEDS 185)	Balvenie B-79 (WEL 441)	Weymouth A-45 (WEL 444)
January	-	-	8.97[P]	-	5.86
February	-	-	8.23	-	6.05

Table 5.1.13 Maximum Monthly Significant Wave Heights at Offshore Platforms and Wells

Month	Maximum Significant Wave Height (m)				
	Sedco 709 (MEDS 133)	Ben Ocean Lancer (MEDS 138)	Sedco 710 (MEDS 185)	Balvenie B-79 (WEL 441)	Weymouth A-45 (WEL 444)
March	-	-	7.26[P]	-	5.54
April	-	-	-	-	5.22
May	-	5.48[P]	-	-	2.39[P]
June	-	3.57	-	-	-
July	-	4.14	-	3.79[P]	-
August	-	1.50[P]	-	3.11	-
September	-	-	-	1.94[P]	-
October	-	-	-	-	5.50[P]
November	5.54[P]	-	-	-	5.70
December	8.05[P]	-	-	-	6.01

Notes:
[P] based on partial data

Extreme Wave Conditions

Extremal analysis data were obtained for the Grid Point 2124 from the Oceanweather website (http://www.oceanweather.net/MSC50WaveAtlas/Extremes/MSC50_M6_Index.htm). Extremal analysis was carried out using 58 years of hourly wave data from 1954 to 2011 using various probability distributions including Gumbel, Weibull, Generalized Extreme Value and Generalized Pareto. The Generalized Extreme Value distribution was selected based on visual best fit with simulated peak wave heights. Table 5.1.14 provides extreme wave conditions for Grid Point 2124 for various return periods.

The largest extreme waves are propagating towards the north and northeast directions. Significant wave heights are 8.0 m and 15.1 m for the 2- and 100-year return periods, respectively, for the north waves. Significant wave heights are 8.8 m and 14.9 m for the 2- and 100-year return periods, respectively, for the northeast waves. Wave periods ranged from 10.7 s to 16.0 s for extreme wave conditions (Table 5.1.14). The wave rose diagram (Figure 5.1.18) indicates that peak wave periods larger than 12.5 s correspond to swell waves. These observations indicate that the extreme wave conditions for the Project Area are most likely:

- swell propagating towards the north, northeast and east, created by distant storms
- either wind waves or swell propagating towards the southwest, west and northwest
- wind waves propagating towards the south and southeast

Table 5.1.14 Extreme Wave Conditions at Grid Point 2124[1]

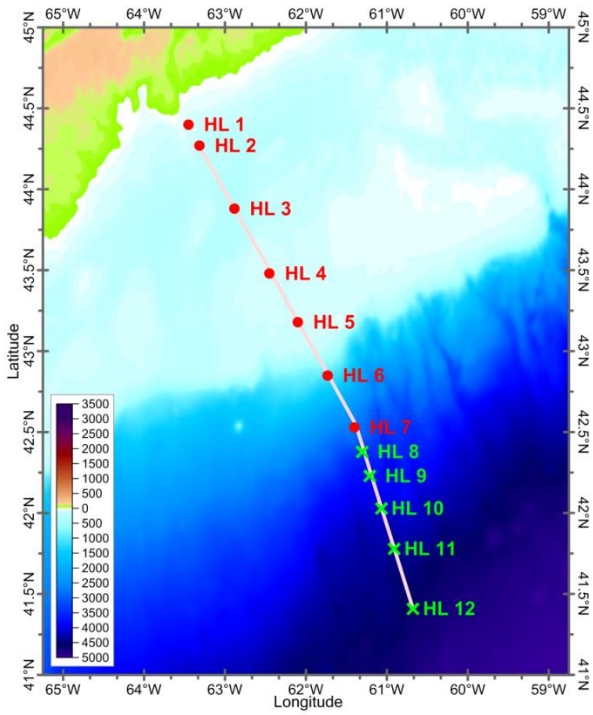
Direction[2]	S			SW			W			NW			N			NE			E			SE		
Return Period	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}	H_s	T_p	H_{max}
Year	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m
2	6.8	10.7	12.5	6.7	11.0	12.5	6.8	11.4	12.7	6.9	11.2	12.5	8.0	12.8	14.4	8.8	12.9	16.1	9.0	12.6	16.5	6.9	10.9	12.9
5	8.1	11.4	14.9	8.4	12.1	15.6	8.5	12.3	15.8	8.1	12.0	14.7	9.5	13.6	17.0	10.6	13.9	19.1	10.3	13.3	18.8	8.1	11.4	14.8
10	8.9	11.8	16.4	9.4	12.8	17.6	9.7	12.9	17.9	8.9	12.5	16.1	10.7	14.1	18.9	11.7	14.5	21.1	11.0	13.6	20.1	8.8	11.8	16.0
25	9.9	12.2	18.3	10.8	13.5	20.0	11.2	13.6	20.6	10.2	13.2	18.1	12.3	14.9	21.5	13.0	15.1	23.3	11.8	13.9	21.5	9.8	12.1	17.6
50	10.6	12.5	19.6	11.8	14.0	21.8	12.3	14.1	22.5	11.1	13.7	19.6	13.6	15.4	23.7	14.0	15.6	24.9	12.2	14.1	22.4	10.4	12.43	18.7
100	11.2	12.7	20.9	12.7	14.5	23.5	13.4	14.5	24.5	12.2	14.2	21.2	15.1	16.0	26.0	14.9	15.9	26.5	12.7	14.3	23.2	11.1	12.7	19.7

Notes:
[1] Based on 58 years of MSC50 hourly wave data from 1954 to 2011. [2] Direction waves are propagating towards.

5.1.3.4 Water Mass Characteristics

The water temperatures on the Scotian Shelf and in the Gulf of Maine are among the most variable in the North Atlantic (Worcester and Parker 2010). The temperatures on the Western Scotian Shelf and Slope are generally warmer than the Eastern Scotian Shelf and Slope. This is due to the infiltration of warm Gulf Stream water entering in between Browns and Western Banks. The normal temperature on the Western Scotian Shelf and Slope are both seasonally and spatially more dynamic than those found on the Eastern Scotian Shelf. This is also due to the impact of warm water from the Gulf Stream and increased vertical mixing (Breeze *et al.* 2002). Surface temperatures typically show a large variation over the Scotian Shelf.

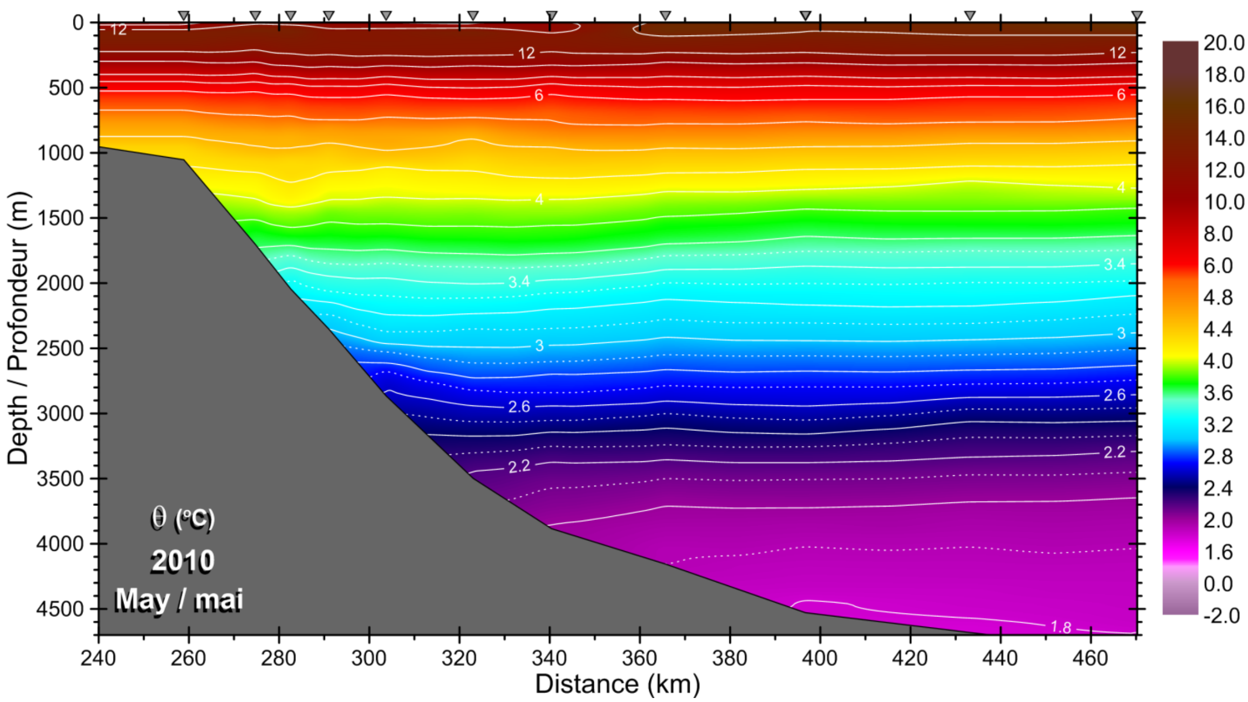
The Atlantic Zone Off-Shelf Monitoring Program (AZOMP) led by the DFO's Bedford Institute of Oceanography, collects and analyzes physical, chemical and biological oceanographic observations from the continental slope and deeper waters of the Northwest Atlantic (DFO 2013g). The Scotian Slope/Rise Monitoring Program collects data over the Scotian Slope and Rise at deepwater stations added to the offshore end of the Halifax Line from the Atlantic Zone Monitoring Program (AZMP) (Refer to Figure 5.1.21). Data on water temperature, salinity, and density profiles collected through AZOMP are provided below.



Source: DFO 2013g

Figure 5.1.21 Stations on the Halifax Line of the Atlantic Zone Monitoring Program (Stations in Red) and the Atlantic Zone Off-Shelf Monitoring Program (Green)

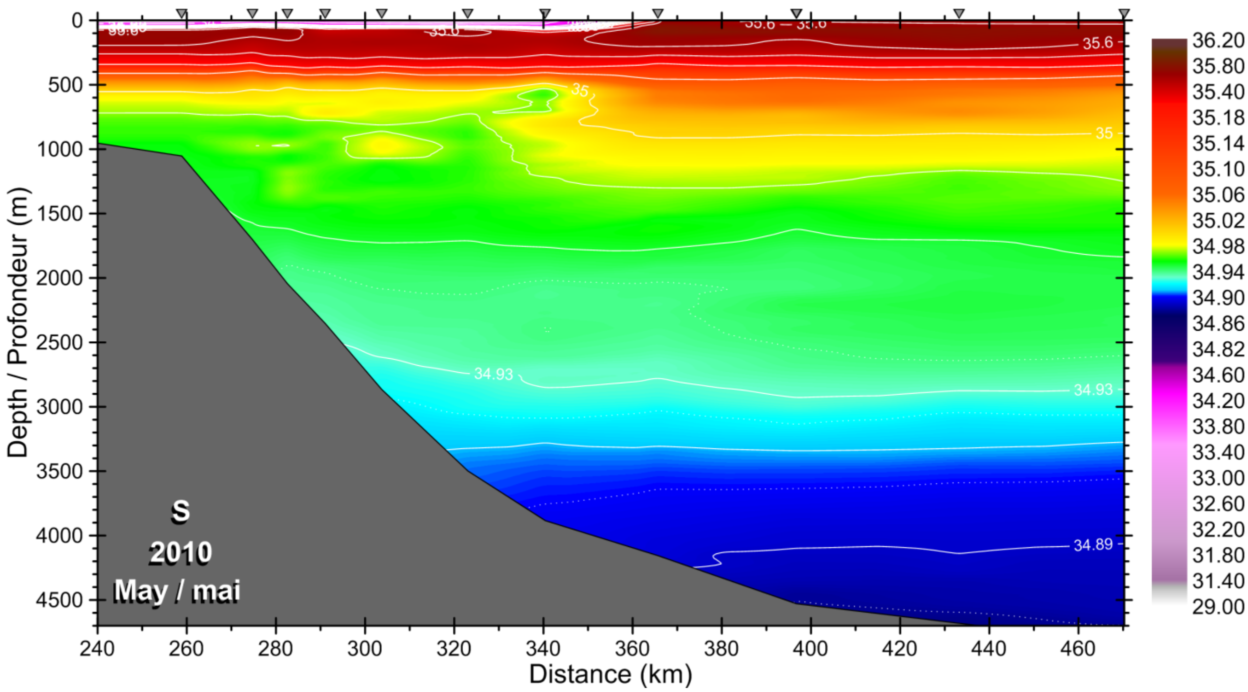
Over the Scotian Slope, water temperatures are the highest in the surface waters, with the coldest waters being found in the deep abyssal depths (DFO 2013g). This temperature profile is provided in Figure 5.1.22.



Source: DFO 2013g

Figure 5.1.22 Temperature Profile along the Extended Halifax Line (AZOMP) on the Scotian Slope (May 2010)

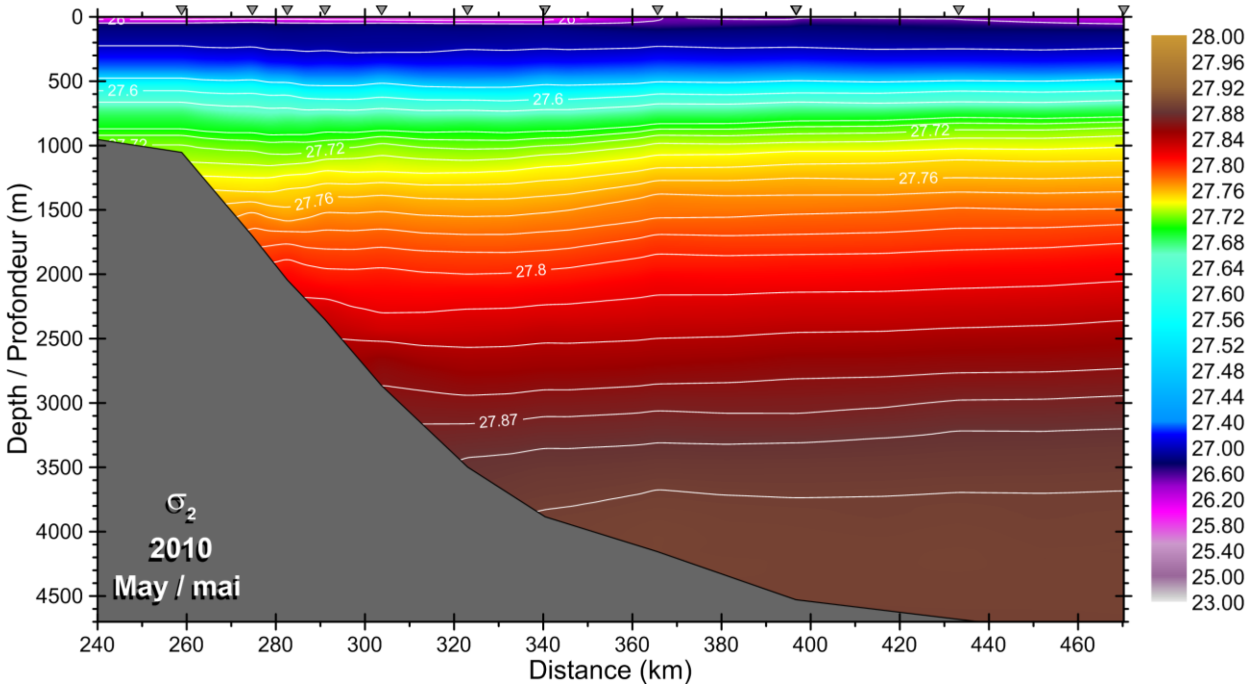
Salinity is an important characteristic of marine waters. It influences the presence of marine life both directly through salinity preferences and needs of differing species and indirectly through its effect on stratification, which affects the growth of phytoplankton and thus primary production (Breeze *et al.* 2002). The Labrador Current and Gulf Stream (34–36 practical salinity unit (psu)) are both more saline than the Shelf Current (31–33 psu). In general, it has been found that salinity does not vary systematically with temperature, although periods of low temperatures are generally associated with lower salinities and higher temperatures with higher salinities (Breeze *et al.* 2002). In the upper ocean over the Scotian Slope the water is relatively fresh (less saline) out to the area where the Gulf Stream and Labrador Current approach from offshore (DFO 2013g). Labrador Sea Water lies beneath the Slope Water at intermediate depths, with Denmark Strait Overflow water lying along the bottom beneath the 3000 m isobath. The Denmark Strait Overflow water is the coldest, densest, and freshest water mass of what is known as North Atlantic Deep Water (NADW). The NADW is a complex of several water masses formed by deep convection and also by the overflow of dense water across the Greenland-Iceland-Scotland Ridge. Labrador Sea Water as well as Denmark Strait Overflow Water comprise components of the NADW. The salinity profile taken during May 2010 can be seen in Figure 5.1.23. The profile depicts the less saline surface water from the Shelf Current closer to shore, with a more saline surface layer below it from the impacts of the Gulf Stream and the Labrador Current further offshore.



Source: DFO 2013g

Figure 5.1.23 Salinity Profile along the Extended Halifax Line (AZOMP) on the Scotian Slope (May 2010)

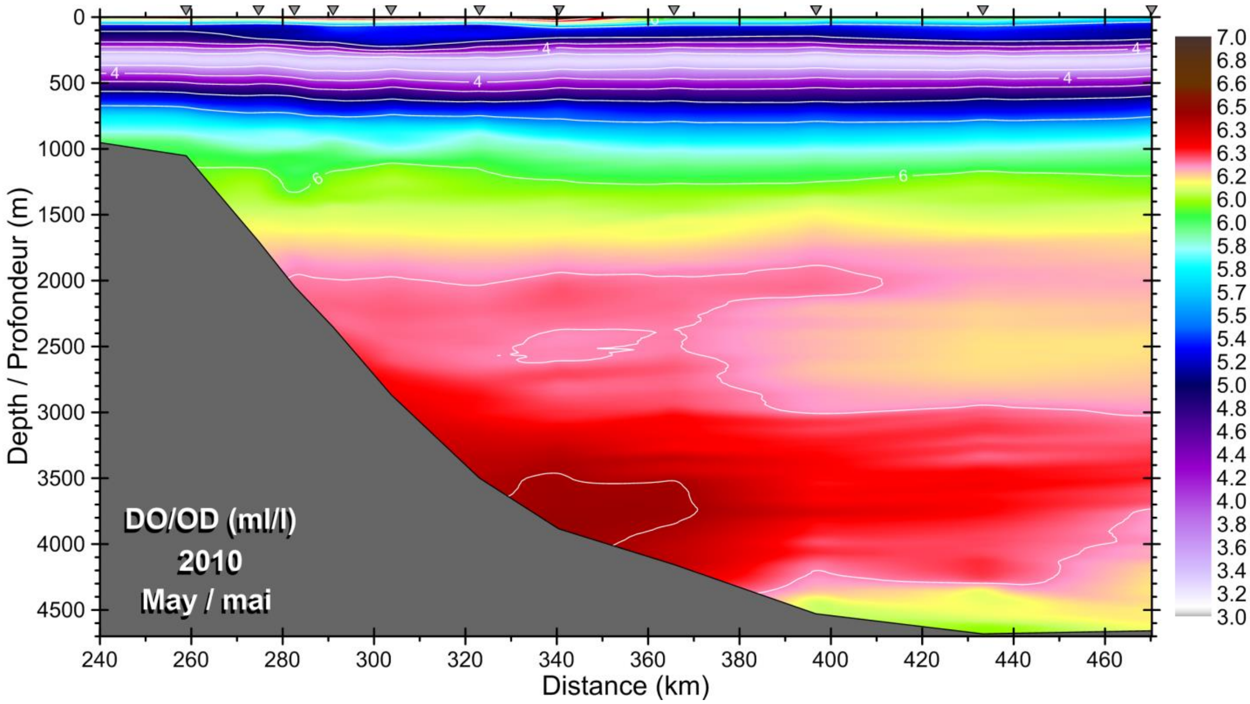
The density of seawater depends on temperature, salinity, and pressure. Density increases with depth in the ocean (Worcester and Parker 2010). The difference in density between water at two depths is known as the density stratification. The stratification divided by the difference in depths is called the stratification index. High levels of stratification inhibit the vertical mixing of water and as a result can decrease nutrient fluxes to the surface waters, and affect the growth of phytoplankton. Increased stratification can also reduce turbulence, concentrating phytoplankton and thus lead to increased primary production in the surface waters (Worcester and Parker 2010). Under increased stratification, there is a tendency for more primary production to be recycled within the upper mixed layer, reducing the amount available for deeper layers (Hebert *et al.* 2012). On the Scotian Shelf, the 0 m to 50 m stratification index increased during the 1990s and from the mid to late 1990s was at its 50 year maximum on record. Changes in stratification have also been noted in the eastern Gulf of Maine and on Georges Bank, with stratification increasing steadily from the mid-1980s. Figure 5.1.24 depicts the density profile along the Halifax Extended Line of the Scotian Slope during May of 2010, clearly depicting increasing density with depth.



Source: DFO 2013g

Figure 5.1.24 Density Profile along the Extended Halifax Line on the Scotian Slope (May 2010)

Strong stratification has the potential to inhibit the vertical mixing of water to a degree to cause dissolved oxygen levels in the deeper layers to become depressed. The waters in the Project Area do stratify, but not to a degree where low dissolved oxygen levels become an issue for the species inhabiting the area. The lowest dissolved oxygen levels can be found within the deepest basins in the area (Worcester and Parker 2010). Figure 5.1.25 depicts the dissolved oxygen profile along the Halifax Extended Line of the Scotian Slope during May of 2010. The profile depicts decreasing dissolved oxygen with water depth up to a depth of 500 m. Below this 500 m layer dissolved oxygen increases to a depth of 4500 m and begins to decrease again after this depth is reached.

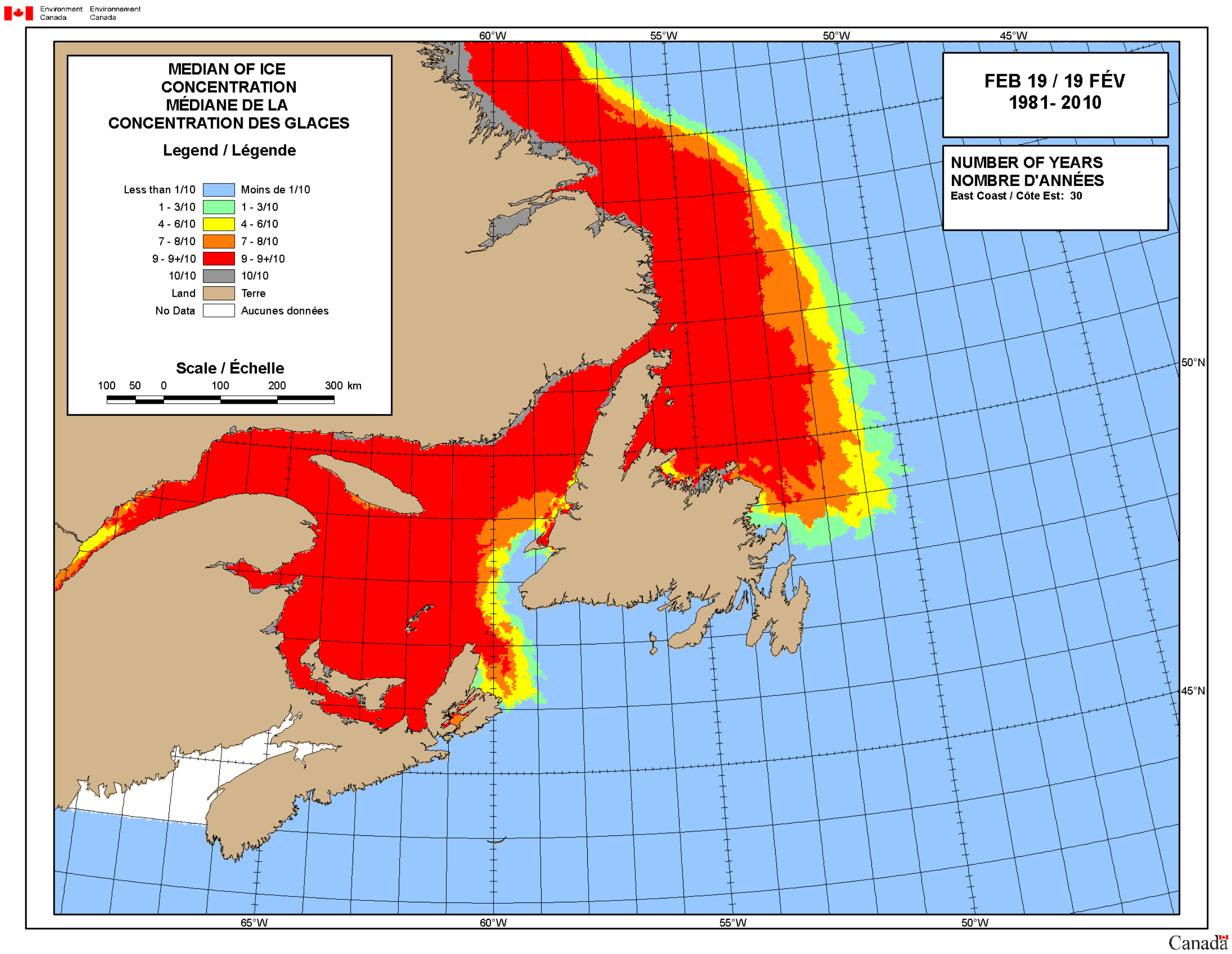


Source: DFO 2013g

Figure 5.1.25 Dissolved Oxygen along the Extended Halifax Line on the Scotian Slope (May 2010)

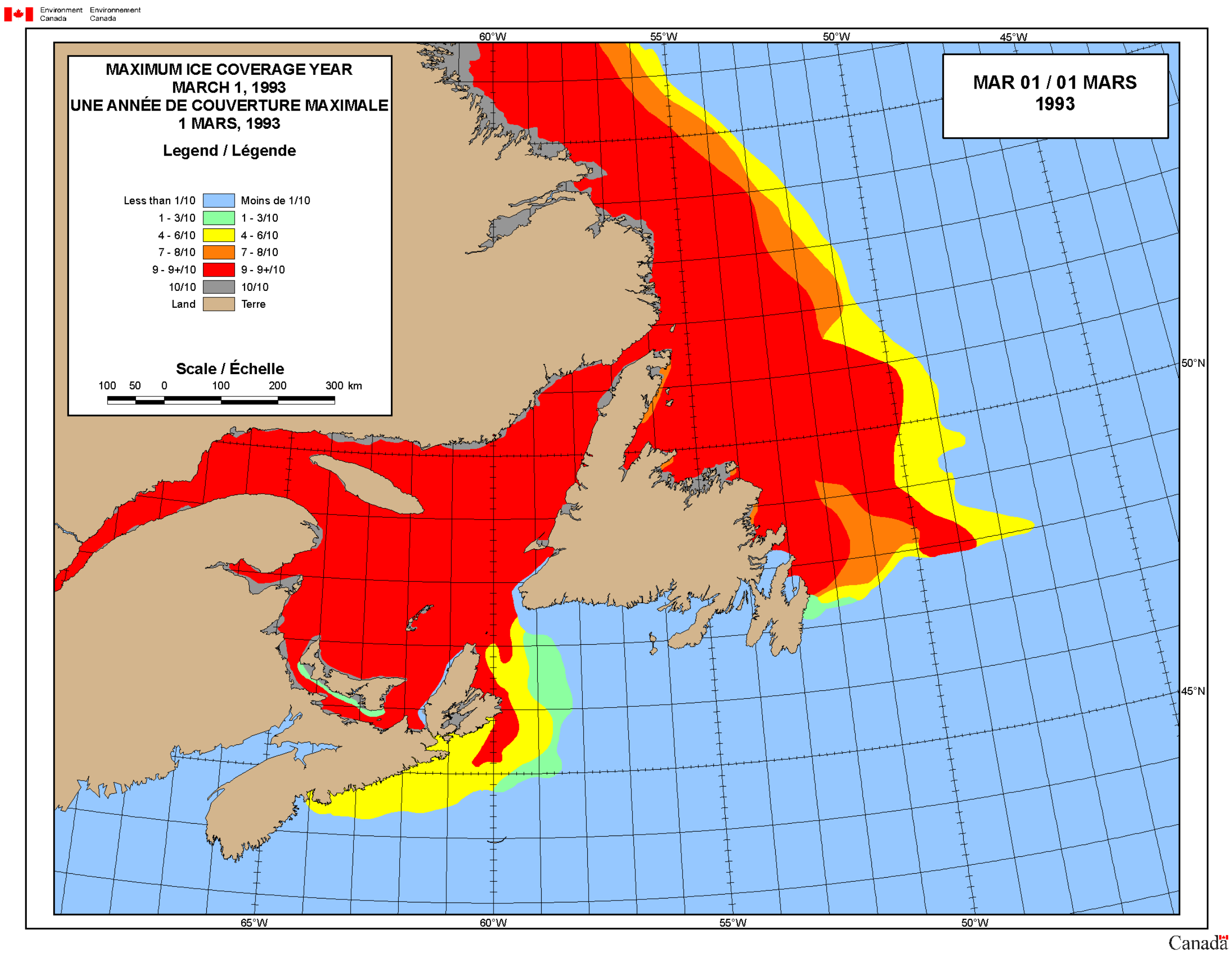
5.1.3.5 Sea Ice and Icebergs

Sea ice and icebergs are very rare in the Nova Scotia offshore environment (Worcester and Parker 2010). Sea ice is generally transported out of the Gulf of St. Lawrence through the Laurentian Channel and pushed out to the Scotian Shelf by northwesterly winds and ocean currents. Generally, sea ice will only make it as far as the Eastern Scotian Shelf and melt before reaching the Central and Western sections of the Shelf. Localized sea ice may also form along the coastline of Nova Scotia, but would melt and dissipate after break-up before it has any chance of entering the Project Area. Figure 5.1.26 illustrates the maximum extent of median sea ice concentration from 1981–2010. Figure 5.1.27 presents the maximum extent of ice coverage that occurred on the east coast from 1981–2010, which occurred on March 1, 1993. On the basis of Figures 5.1.26 and 5.1.27, ice is not observed in the Project Area.



Source: Environment Canada 2012b

Figure 5.1.26 Maximum Extent of Median Sea Ice Concentration 1981–2010



Source: Environment Canada 2012b

Figure 5.1.27 Maximum Ice Coverage – March 3, 1993

5.1.3.6 Ocean Noise

Ambient noise has been defined by the National Research Council as "the overall background noise caused by all sources such that the contribution from a single specific source is not identifiable". It is a representation of the background noise typical of the location and depth where the measurements are taken after identifiable and occasional noise sources have been accounted for.

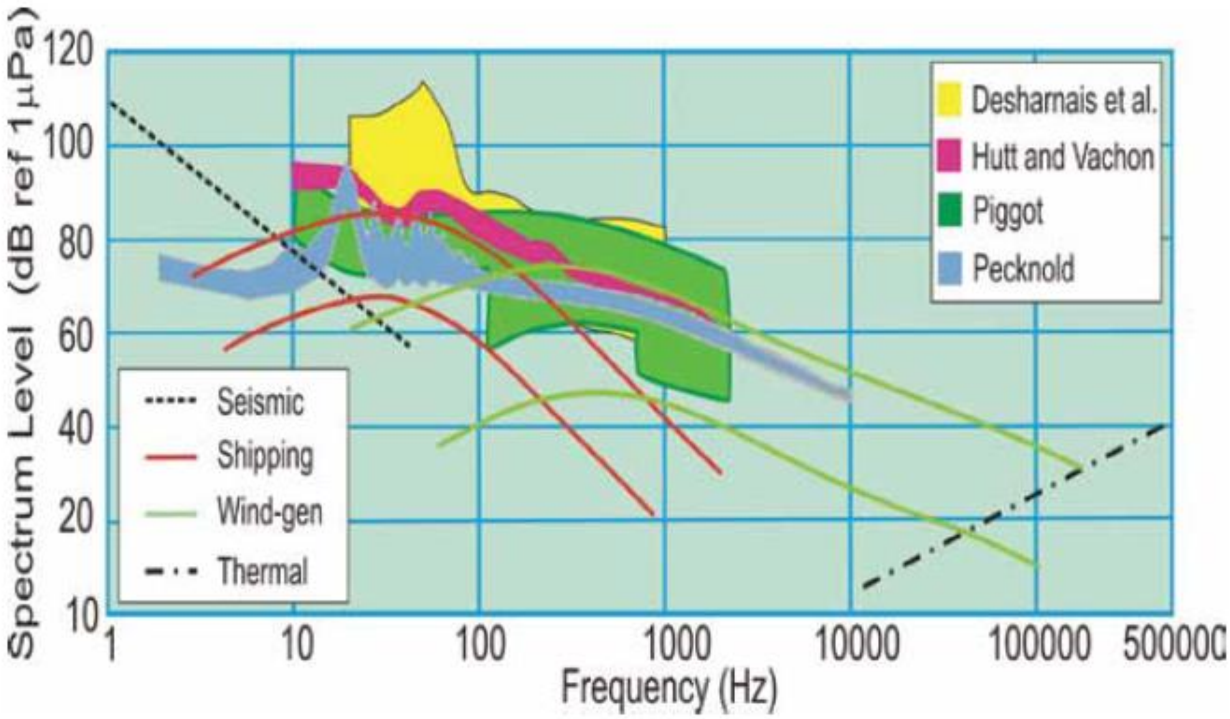
The Scotian Shelf is an active economic area with many influences (shipping, commercial fishing, oil and gas, defence, construction, marine research, and tourism) which all contribute to the ambient noise in the area at a constant and intermittent basis (Walmsley and Theriault 2011). On the Scotian Shelf, shipping is the major and consistent contributor to low-frequency ambient noise. Sound profiles taken in offshore areas of the shelf are representative of high-density shipping. Studies have indicated that at frequencies dominated by shipping noise, background noise levels are up to 40 dB higher than noise levels generated by strong winds. The ocean is a naturally noisy environment with ambient noise escalating as the wind and sea state rise. Noise levels associated with various sea state levels can be seen in Table 5.1.15. In general noise created from surf noise can range from 60 to > 100 dB re 1µ Pa @ 1m at low frequencies (JWEL 2002b).

Table 5.1.15 Sound Levels and Frequencies Associated with Various Marine Related Activities

Source	Dominant Frequency (Hz)	Source Level (dB re 1µ Pa @ 1m)
Sea State* 0	100	60
Sea State 3	100	97
Sea State 5	100	102
Surf Noise	100–700	
650cc Jet Ski	800–50 000	75–125
7 m vessel with outboard engine	630	152
Fishing Boat	250–1000	151
Fishing Trawler	100	158
Tug	1000	170
Tanker	60	180
Container Ship	8	181
Freighter	41	172
Airgun Array	10–100	255
Naval Sonar	2000–8000	225
Depth Sounder	3000	200
Bottom Profiler	1000–10 000	215
Side Scan	60 000–300 000	225
Acoustic Deterrent Devices	1000–25 000	205
Dredging	Broadband	131
Impact Pile Driving	10–120	190
Drilling (including DP system noise)	10–10 000	130–190
TNT (1–100 lbs)	2–1000	272–287
*Sea State 0 = glassy, wind < 1.8 km/hour; Sea State 3 = small white caps, wind 20.4–29.7 km/hour; Sea State 5 = moderate waves, some spray, wind 40.8–60.0 km/h		

Source: Walmsley and Theriault 2011, JWEL 2002b, OSPAR 2009

There is an abundance of noise data collected on the Scotian Shelf over the years, although there has not been a formal long-term monitoring program of ambient noise. There have been, however, several studies over the last 50 years which have characterized the general ambient noise characteristics of the Scotian Shelf (Desharnais and Collison 2001; Hutt and Vachon 2003; Piggott 1964; Pecknold *et al*. 2010; Walmsley and Theriault 2011). These studies show that there is considerable spatial and temporal variation in ambient noise levels. Wind and wave generated noise is generally higher than predicted for average sea states. The studies have also shown that at frequencies dominated by shipping noise (10–100 Hz), ambient noise levels are up to 40 dB higher than noise levels generated by high winds (Walmsley and Theriault 2011). Figure 5.1.28 shows spectrum-frequency profiles for datasets showing ambient noise at sites on the Scotian Shelf.



Source: Walmsley and Theriault 2011

Figure 5.1.28 Spectrum-frequency Profiles for Datasets, from Various Studies, Showing Ambient Noise at Sites on the Scotian Shelf (Studies include: Desharnais and Collison 2001; Hutt and Vachon 2003; Piggott 1964; Pecknold *et al.* 2010)

Ocean floor morphology, ocean depth, temperature, salinity, and proximity to land are important modifying factors in determining the characteristics of noise distribution in the marine environment (Walmsley and Theriault 2011). Noise can be expected to be higher close to fixed developments and sites where there are many forms of mechanization occurring at once (Walmsley and Theriault 2011).

5.2 MARINE BIOLOGICAL ENVIRONMENT

5.2.1 Plankton

5.2.1.1 Bacterial Communities

Bacterial communities consist of prokaryotes (single celled organisms including bacteria and archaea) which make up the smallest free-living cells in any pelagic ecosystem. Bacteria can have a variety of energy sources with some using light as their primary energy source (photoautotrophs), or auxiliary source (photoheterotrophs), with the majority of bacteria using organic material as an energy source (heterotrophs) (DFO 2011a). Since the majority of bacteria are secondary producers (rely on organic material for energy) their abundance can be correlated to the abundance of phytoplankton communities. The majority of bacteria rely on material derived from phytoplankton, including waste exuded from plankton cells, cell autolysis, viral lysis, and organic material released from grazers feeding on phytoplankton (DFO 2011a). Figure 5.2.1 below depicts the concentration of bacteria in the water column along the Halifax AZOMP line over the Scotian Slope.

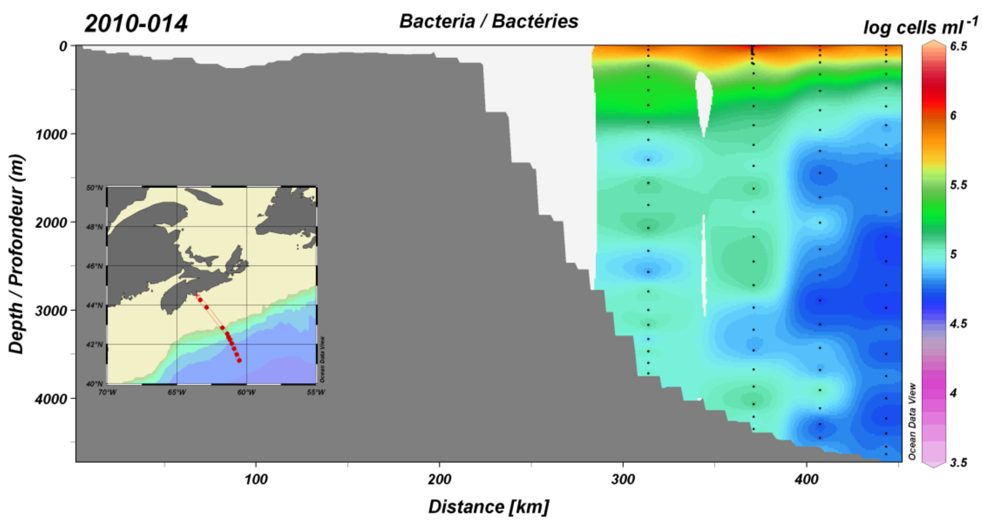


Figure 5.2.1 Concentration of Bacteria in the Water Column of the Halifax AZOMP line, 2010

The highest concentration of bacteria can be found in the upper surface layer of the water column where the highest abundance of phytoplankton is also found. This is likely due to the fact that the majority bacteria rely of dissolved organic matter (DOM) derived from phytoplankton as their primary energy source. It should also be noted that bacteria exist throughout the water column, below the photic zone, relying on DOM for energy.

Bacteria, specifically heterotrophic bacteria, are natural microbial agents which have the ability to remediate hydrocarbon contamination in the marine environment. Crude oil can be found naturally in the marine environment from natural seeps in the ocean floor (ASM 2011). Crude oil, in essence, is a natural product which has been generated by organisms millions of years ago which used photosynthesis to harness the energy of the sun as their principal energy source. The occurrence of petroleum hydrocarbons in offshore Scotian Shelf and Slope sediments is common with background levels ranging from 1.0 to 26 mg/kg on the Scotian Shelf and Grand Banks (JWEL 2003). Certain microbes in the marine environment have evolved to harness the energy contained in hydrocarbons or crude oils. These bacteria contain enzymes which allow them to combust hydrocarbons as an energy source, much in the same manner as an engine, but at lower temperatures (ASM 2011). There are many different compounds contained within crude oil, some of which can be degraded by many types of bacteria, while some can only be degraded by specific bacteria. As a result, a community of bacteria must work together to fully degrade all of the differing compounds contained within hydrocarbons.

5.2.1.2 Phytoplankton

Phytoplankton are microscopic plant-like organisms which, at the base of the marine food web, influence production of all higher trophic levels in an ecosystem (Worcester and Parker 2010). Phytoplankton are distinctive among ocean biota in that they derive their energy from sunlight and structural requirements from nutrients in the surrounding water (DFO 2011a). On the Scotian Shelf diatoms and dinoflagellates are generally the forms with the largest cell size and are the most commonly recognized types of phytoplankton. Their distinctive cycle of abundance is based on the balance between growth and mortality which may be strongly influenced by the shelf's complex physical oceanographic features. Their abundance is characterized by widespread spring and fall blooms related to a high concentration of nutrients and sunlight in the water column.

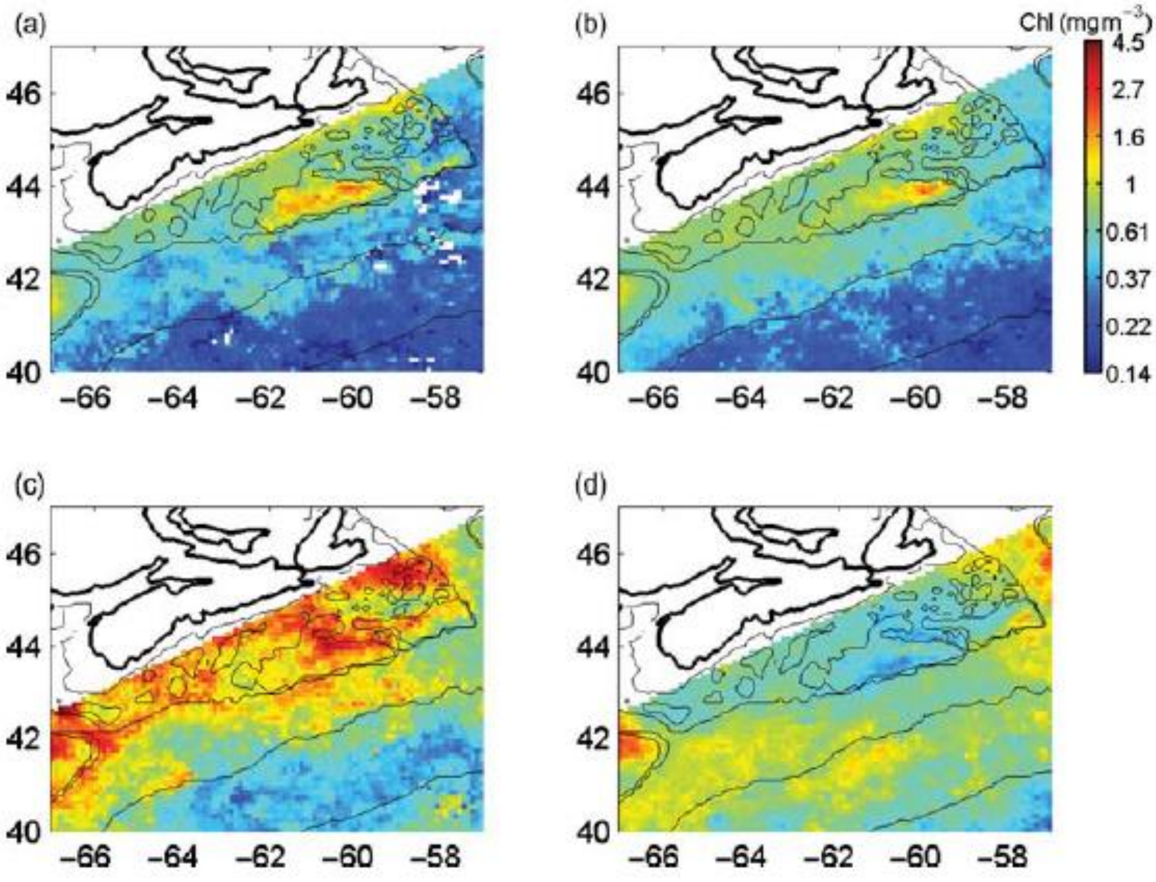
Blooms can vary in spatial and temporal scales. Recent trends in the magnitude and duration of the spring bloom on the Scotian Shelf indicate that blooms are beginning earlier now than they did in the 1960s and 1970s and are more intense and longer in duration (Worcester and Parker 2010). The two dominant groups of phytoplankton are the diatoms (which have silica shells) and the dinoflagellates (which can swim with flagella) (Boudreau 2013). The spring bloom is typically dominated by diatoms, with dinoflagellates contributing significantly to blooms later in the season.

The initiation of the spring bloom on the Scotian Shelf and Slope varies by approximately two months depending on the location within the shelf and slope (Zhai *et al.* 2011). Table 5.2.1 depicts the average day of spring bloom initiation, bloom duration, peak day of the spring bloom and the amplitude of the spring bloom in various areas of the Scotian Shelf and Slope. Figures 5.2.2 and 5.2.3 depict surface chlorophyll concentrations during various times of the year and spring bloom characteristics on the Scotian Shelf and Slope.

Table 5.2.1 Values of Spring Bloom Characteristics on the Scotian Shelf and Slope

Region	Day of Bloom Initiation	Bloom Duration	Day at Peak of Bloom	Bloom Amplitude (mg/m³)
Eastern Scotian Shelf	93	31	109	2.5
Middle Scotian Shelf	69	48	92	1.3
Western Scotian Shelf	88	29	102	1.6
Slope Water	67	99	117	0.6
Gulf Stream	84	72	120	0.5

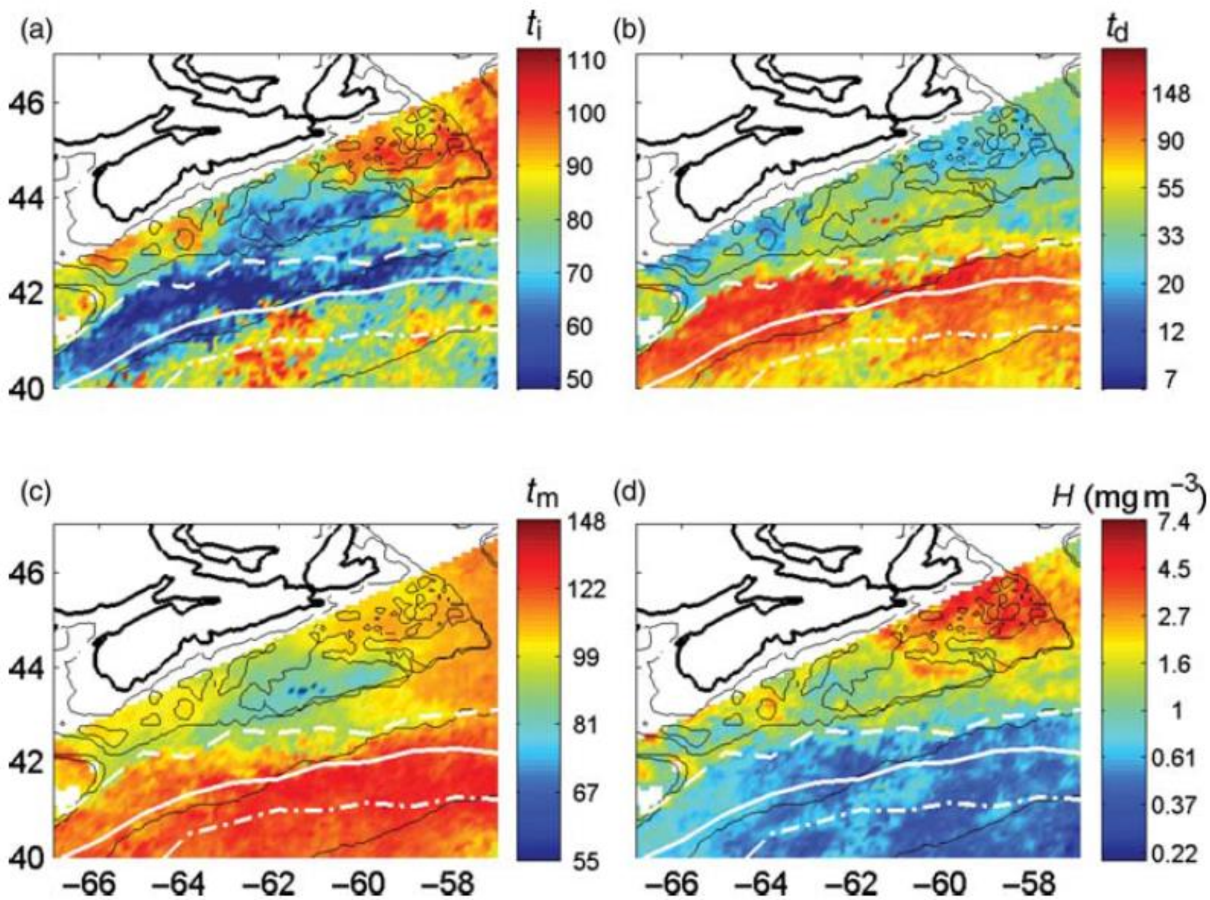
Source: Zhai *et al.* 2011



Source: Zhai *et al*. 2011

Figure 5.2.2 Ten Year Averages (1998–2007) of Eight-day Composite Surface Chlorophyll Concentrations from (a) Days 24–32 (Late January to Early February), (b) Days 56–64 (Late February to Early March), (c) Days 88–96 (Late March to Early April), and (d) Days 120–128 (Late April to Early May)

The duration of the spring bloom generally lasts longer in the slope (99 days) and Gulf Stream areas (72 days), than on the shelf (50 days) (Zhai *et al.* 2011). Even though the bloom on the slope starts before it does on the shelf, it doesn't reach a peak until after the shelf bloom has peaked. The waters of the Scotian Slope and Gulf Stream tend to peak much later than those waters over the Scotian Shelf (Figure 5.2.3). Furthermore, the amplitude of the spring bloom is much less on the slope and Gulf Stream when compared to shelf waters. The amplitude of the spring bloom is the highest over the Eastern Scotian Shelf with a general decline towards the southwest (Figure 5.2.3).



Source: Zhai *et al.* 2011

Figure 5.2.3 Spring Bloom Characteristics for the Scotian Shelf and adjacent regions: (a) time of bloom initiation (ti), (b) duration (td), (c) peak timing (tm), and (d) amplitude

5.2.1.3 Zooplankton

Zooplankton are animals that are unable to maintain their horizontal spatial distribution in the water column against current flow (DFO 2011a). The zooplankton serve as the link between primary producers (phytoplankton) and the larger organisms in the marine environment of the Scotian Shelf and Slope (Breeze *et al.* 2002). Zooplankton are consumed by most marine species at some stage of their life cycle, from large baleen whales to small anemones (Breeze *et al.* 2002). As a result, the availability of zooplankton is a limiting factor for the success of many species on the Scotian Shelf and Slope. Zooplankton can be divided into three main categories based on size:

- Microzooplankton (20–200 µm in length), which includes ciliates, tintinnids, and the eggs and larvae of larger taxa
- Mesozooplankton (0.2–2 mm in length), which includes copepods, larvaceans, pelagic molluscs, and larvae of benthic organisms
- Macrozooplankton (> 2mm), which includes larger and gelatinous taxa

The mesozooplankton community on the Scotian Shelf and Slope is dominated by copepods, with the most abundant species being: *Calanus finmarchicus* and *Pseudocalanus* sp. (winter/spring dominant); *Paracalanus parvus, Centropages typicus,* and *Centropages hamatus* (summer/fall dominant); and *Oithona similis* (abundant year-round) (Kennedy *et al.* 2011; Boudreau 2013).

In general, zooplankton abundance peaks from May to June, with the lowest concentrations from December to January.

Changes in the abundance of long-lived zooplankton species (*e.g. Calanus*) can be influenced by large scale processes such as the changes in circulation. On the Scotian Shelf zooplankton levels observed from 2000 to 2006) have been lower than those levels observed in the 1960s and 1970s, which is the reverse of the recent phytoplankton trend. However they are beginning to recover from the lows observed in the 1990s (ASZISC 2011).

5.2.1.4 Ichthyoplankton

Ichthyoplankton are zooplankton comprised of the planktonic eggs and larvae of fish and shellfish. Ichthyoplankton, as well as other early planktonic life stages of marine animals, are collectively referred to as the meroplankton due to the fact that they are planktonic for only a portion of their life cycle (NOAA 2007).

The Scotian Shelf Ichthyoplankton Program (SSIP), which was conducted from 1976–1982, is one of the major sources of information on zooplankton for the Eastern Scotian Shelf. The outflow of the Gulf of St. Lawrence (Nova Scotia Current) is responsible for maintaining high biomass of ichthyoplankton on the northeast half relative to the southwestern half of the Scotian Shelf during June and October. High biomasses of various ichthyoplankton communities have been found on the Emerald and Western Banks during the spring and summer (Breeze *et al.* 2002).

Horseman and Shackell (2009) analyzed results from the SSIP to characterize areas on the Scotian Shelf and Slope where larvae were found. Some species larvae were found in proximity (less than 100 km) to the Project Area off Browns, Baccaro, and LaHave Banks along the slope. These species include monkfish (*Lophius spp.*), haddock (*Melanogrammus aeglefinus*), red hake (*Urophycis chuss*) and redfish (*Sebates spp.)*. The majority of fish species' larvae were found scattered along the banks of the Shelf from Emerald Bank to Sable Island including Atlantic mackerel (*Scomber scombrus*), silver hake (*Merluccius bilinearis*), cusk (*Brosme brosme*), pollock (*Pollachius virens*) and American plaice (*Hippoglossoides platessoides*). Some species larvae were found even further east towards the Laurentian Channel including witch flounder, and yellowtail founder. Herring larvae were found closer to shore, with larger numbers near southwest Nova Scotia.

Eggs and larvae have the potential to be found in areas of the Scotian Shelf and Slope year-round as a result of some species such as the Atlantic cod (*Gadus morhua*), roundnose grenadier (*Coryphaenoi des rupestris*), and skate species having the potential to spawn during all months of the year. Other fish such as Atlantic mackerel, wolffish species (*Anarchichas spp.*), American plaice and flounder species only spawn for short periods of time over the course of a few months. Based on variability between species, Shackell and Frank (2000) concluded from analyzing the SSIP data that the Scotian Shelf supports an array of species larvae throughout the year, with a seasonal change of species abundances with each season. In general (year-round) the most common genera found in the SSIP survey area include *Merluccius, Sebates, Urophycis, Glyptophalus,* and *Ammodytes.* Table 5.2.2 depicts the most abundant genera found within the survey area by season.

Table 5.2.2 Seasonal Abundance of Fish Larvae

Genus	Common Name(s)	Percentage of Total (%) (per Season)
Winter		
Ammodytes	Sand lance	26.8
Clupea	Atlantic herring	19.0
Pollachius	Pollock	12.8
Gadus	Atlantic cod	10.6
Lumpenus	Shanny, Eelbenny	5.6
Spring-Summer		
Sebates	Redfish	18.6
Ammodytes	Sand lance	16.6
Gadus	Atlantic cod	8.8
Hippoglossoides	American plaice	8.2
Melanogrammus	Haddock	7.6

Table 5.2.2 Seasonal Abundance of Fish Larvae

Genus	Common Name(s)	Percentage of Total (%) (per Season)
Summer-Fall		
Merluccius	Silver hake	21.9
Urophycis	Longfin, Red, White hake	16.1
Glyptocephalus	Whitch flounder	11.3
Enchelyopus	Fourbeard rockling	7
Sebates	Redfish	7

Source: Shackell and Frank 2000

Table 5.2.3 below depicts the respective spawning seasons as well as the time of year when eggs and larvae may be present in the water column on the Scotian Shelf and Slope for species at risk as well as for commercially important pelagic, groundfish, and invertebrate species.

Table 5.2.3 Summary of Spawning and Hatching Periods for Fish Species that May Occur in the Vicinity of the Project Area

Common Name	Scientific Name	Primary Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Species at Risk														
Acadian redifish	Sebates fasciatus	Scattered over entire Scotian Shelf and Slope												
American plaice	*Hippoglossoides platessoides*	Nearshore: Halifax to Liverpool Georges to Banquereau Banks and edge, Roseway Basin												
Atlantic cod	*Gadus morhua*	Nearshore: Halifax to Yarmouth Georges Bank and scattered throughout the Western Scotian Shelf (WSS), with higher concentrations in Eastern Scotian Shelf (ESS)												
Atlantic wolffish	*Anarchichas lupus*	*Nearshore: South of Bridgewater and Southwest NS Roseway and LaHave Basins*												
Blue shark	*Priomace glauca*	*Not on Shelf or Slope*												
Cusk	*Brosme brosme*	*Georges Basin, Roseway Basin, Browns to Western Sable Island Bank and edges*												
Deepwater redfish	*Sebastes mentalla*	Scattered over entire Scotian Shelf and Slope												
Roughhead grenadier	*Macrourus berglax*	*Southern Grand Banks, Potentially Scotian Slope*												
Roundnose grenadier	*Coryphaenoi des rupestris*	*Scotian Slope*												
Smooth skate	*Malacoraja senta*	*Roseway Basin*												
Spiny dogfish	*Squalus acanthias*	*Roseway, LaHave, and Emerald Basins*												
Spotted wolffish	*Anarchias Minor*	*Outside of the RAA*												
Throny skate	*Amblyraja radiate*	*Roseway and LaHave Basins Emerald to Banquereau Banks*												
Winter skate	*Leucoraja ocellata*	*Browns Bank, Western to Banquereau Banks*												
Pelagic Species														
Atlantic herring	*Clupea harengus*	*Nearshore: Halifax to SouthwestNS Browns to Banquereau Banks, with a few along the shelf edge*												

Table 5.2.3 Summary of Spawning and Hatching Periods for Fish Species that May Occur in the Vicinity of the Project Area

Common Name	Scientific Name	Primary Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Atlantic mackerel	*Scomber scombrus*	*Emerald to Banquereau Banks and few along shelf edge*												
Black dogfish	*Centroscyllium fabricii*	*Gives birth to pups in Laurentian Channel*												
Capelin	*Mallotus villosus*	*Nearshore: Halifax* *Eastern Scotian Shelf outside of the RAA*												
Groundfish Species														
Atlantic halibut	*Hippoglossus hippoglossus*	*Browns to Banquereau Banks and Shelf Edge*												
Haddock	*Melanogrammus aeglefinus*	*Nearshore: Halifax to Liverpool* *Georges Bank, Browns Bank to Western Sable Island Bank and Shelf Edge, Roseway Basin*												
Monkfish	Lophius spp.	Georges to Banquereau Banks and Shelf Edge												
Pollock	*Pollachius virens*	*Nearshore: Halifax to Yarmouth* *Georges Bank, Browns to Western Bank*												
Red hake	*Urophycis chuss*	*Browns Bank to Sable Island Bank and Scotian Shelf edge*												
Sand lance	*Ammodytes dubius*	*Banquereau Bank*												
Silver hake	*Merluccius bilinearis*	Brown's Bank and Slope, Emerald to Banquereau Banks and Shelf edge												
Turbot-Greenland flounder	*Reinhardtius hippoglossoides*	*Potentially Scotian Slope*												
White hake	*Urophycis tenuis*	*Georges Bank, Roseway Basin, Baccaro Bank and Edge, Western to Sable Island Bank and edge*												
Witch flounder	*Glyptocephalus cynoglossus*	*Nearshore: Halifax to SW NS* *Georges to Banquereau Banks and the Shelf edge and slope*												
Yellowtail flounder	*Limanda ferruginea*	*Nearshore: south of Halifax* *Georges Bank, Browns Bank, Emerald to Banquereau Banks*												
Invertebrate Species														
Lobster*	*Homarus americanus*	*Nearshore waters*												

Table 5.2.3 Summary of Spawning and Hatching Periods for Fish Species that May Occur in the Vicinity of the Project Area

Common Name	Scientific Name	Primary Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Jonah crab**	*Cancer borealis*	*N/A*												
Scallop	Potential for multiple species	Nearshore Southwest NS Georges Bank, Browns Bank, Western to Banquereau Banks												
Northern shrimp	*Pandalus borealis*	Nearshore waters												
Shortfin squid	*Illex illecebrosus*	Not completely known - Possibly Continental Shelf South of Cape Hatteras and in the Gulf Stream												
Snow crab	*Chinoecetes opilio*	Nearshore Southwest NS and Bridgewater to Halifax Eastern Scotian Shelf Sable Island to Banquereau												

Source: BIO 2013a; Campana *et al.* 2003, 2013; Cargnelli *et al.* 1999a,1999b; COSWEIC 2006a, 2007a, 2008a, 2010b,2012a, 2012b; DFO 2001, 2007b, 2009a, 2009b, 2010b, 2011a, 2013e2013f, 2013h, 2013i, 2013k, 2013l, 2013m, 2013n, 2013o; NOAA 2013b, 2013c; SARA 2013a, 2013b; Horseman and Shackell 2009

*Note: Lobster eggs are extruded by the female from June to September and held until they hatch approximately 9–12 months later.

**Note: Very little biological information exists for Jonah Crab on the Scotian Shelf and Slope.

	Mating period
	Potential Spawning Period
	Anticipated Peak Spawning Period
	Eggs and/or Larvae Present

5.2.2 Benthic Habitat

5.2.2.1 Previous Benthic Habitat Characterizations

Several deep sea benthic surveys were undertaken along the Scotian Slope during 2001 and 2002 in former licence blocks in and around the Shelburne Basin Project Area. The Pembroke and Pinehurst Blocks (ELs 2386 and 2396) leased by Kerr-McGee Offshore Limited (JWEL 2001a), Torbrook Block (EL 2384) leased by Encana Corporation (JWEL 2001b), as well as EL 2382 and EL 2381 leased by Shell Canada Ltd (JWEL 2003) were all surveyed during this time period. The licence blocks which have been previously surveyed fall within the depth range of the Project Area (refer to Figure 5.2.4). The habitat among the adjacent blocks is consistent and provides strong evidence to suggest that similar habitat may occur within the Project Area. This section describes the benthic habitat and communities found within each of the surveyed blocks. As part of Shell's Shelburne Basin Venture Seabed Survey proposed for 2014, Shell intends to collect seabed samples as well as underwater photographs to provide additional information on the seabed sediment characteristics and benthic conditions in proximity to future wellsite locations. Additionally an ROV survey will be conducted in advance of drilling activities to confirm and further identify and characterize any seabed sensitivities or constraints prior to finalizing the chosen drilling location.

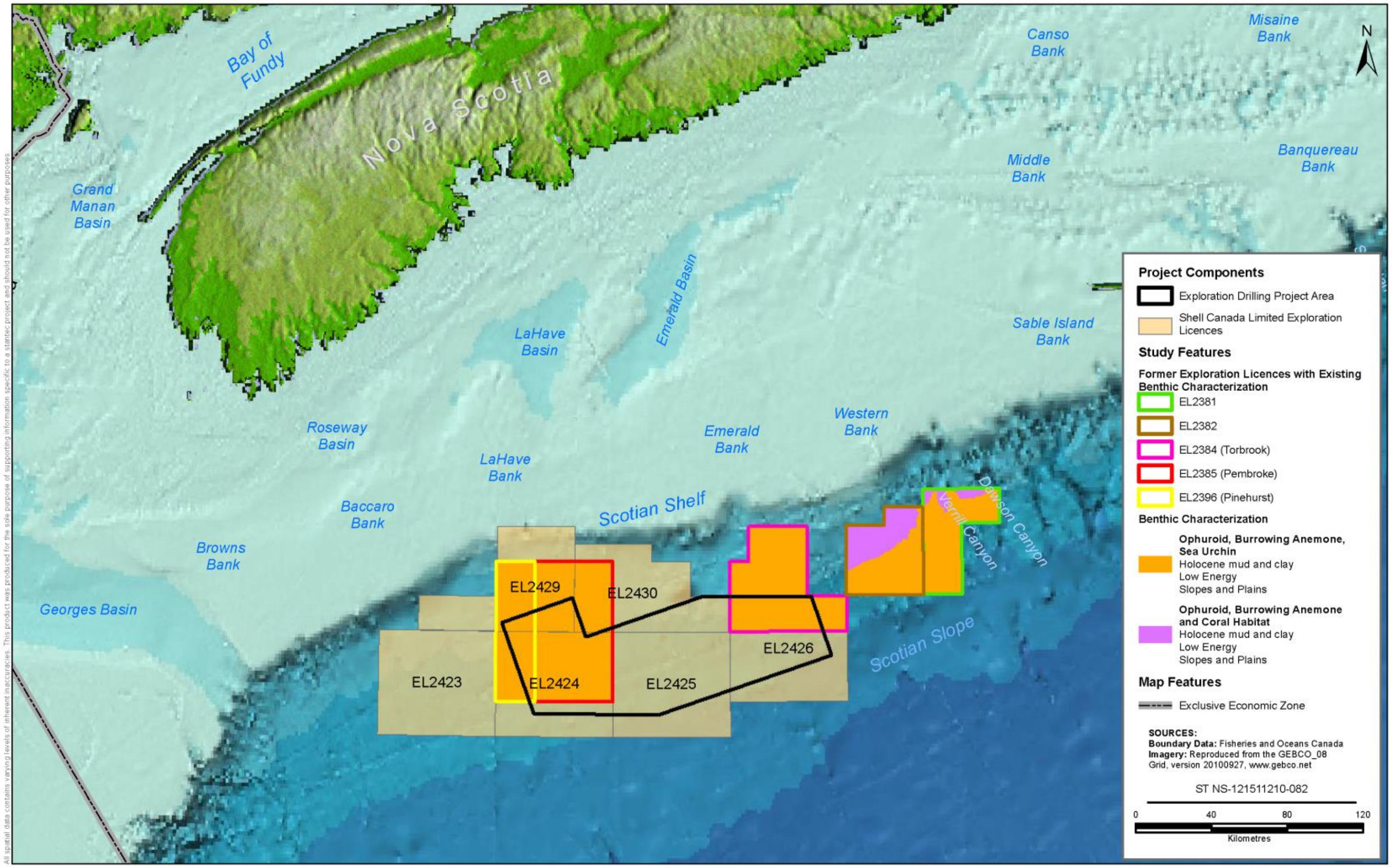
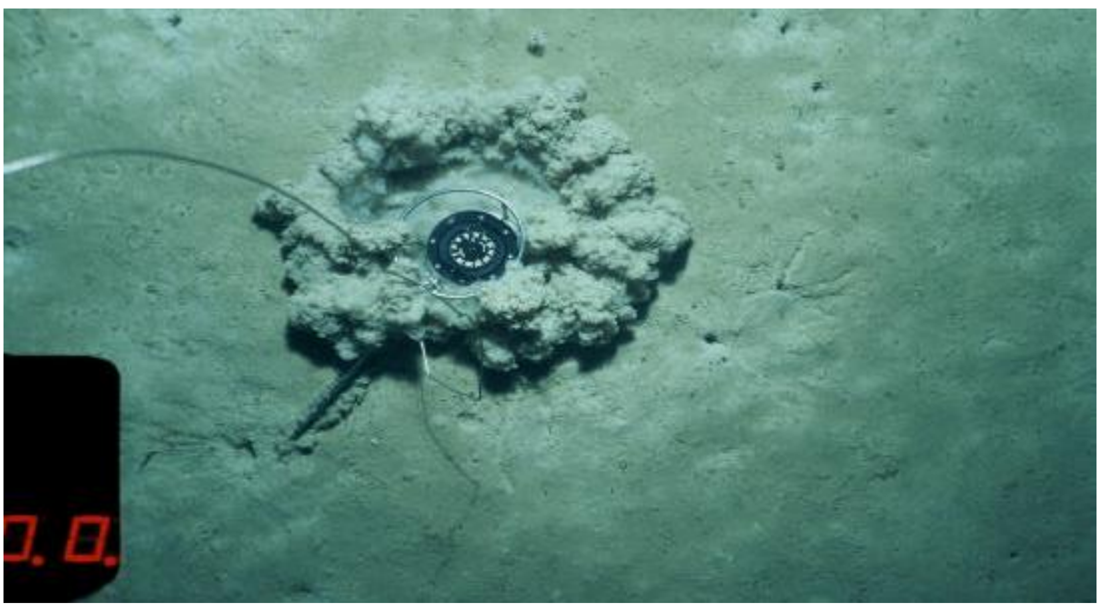


Figure 5.2.4 Areas of Existing Benthic Characterization in Proximity to the Project Area

Pinehurst and Pembroke Blocks – ELs 2396 and 2386

The Pinehurst and Pembroke licences were located on the Scotian Slope, west of the Project Area (BEPCo 2004) (Figure 5.2.4). Water depth ranges from 700 to 2500 m in the Pinehurst Block, and 1050 to 2900 m in the Pembroke Block. The seafloor in this areais characterized by an area of little relief and gentle slopes. From 1159 to 2000 m, the slope is approximately 1.5°, although there are areas of steeper slopes. The seafloor of the Pembroke Block was observed to be without large topographic feature diversity (JWEL 2002a).

A combination of underwater camera transects and grab samples in a 2001 deepwater survey (JWEL 2001a) provided information on both infaunal and epifaunal benthic community assemblages. The data obtained from both camera transects and grab samples suggested that the benthic habitat over the licence area is comprised of Holocene silt and clay. This material blankets the slope, providing an expansive habitat for epibenthic brittlestars and infaunal burrowing anemones. Refer to Figure 5.2.5 for typical benthic habitat that was found within the Pinehurst and Pembroke Blocks in 2001.

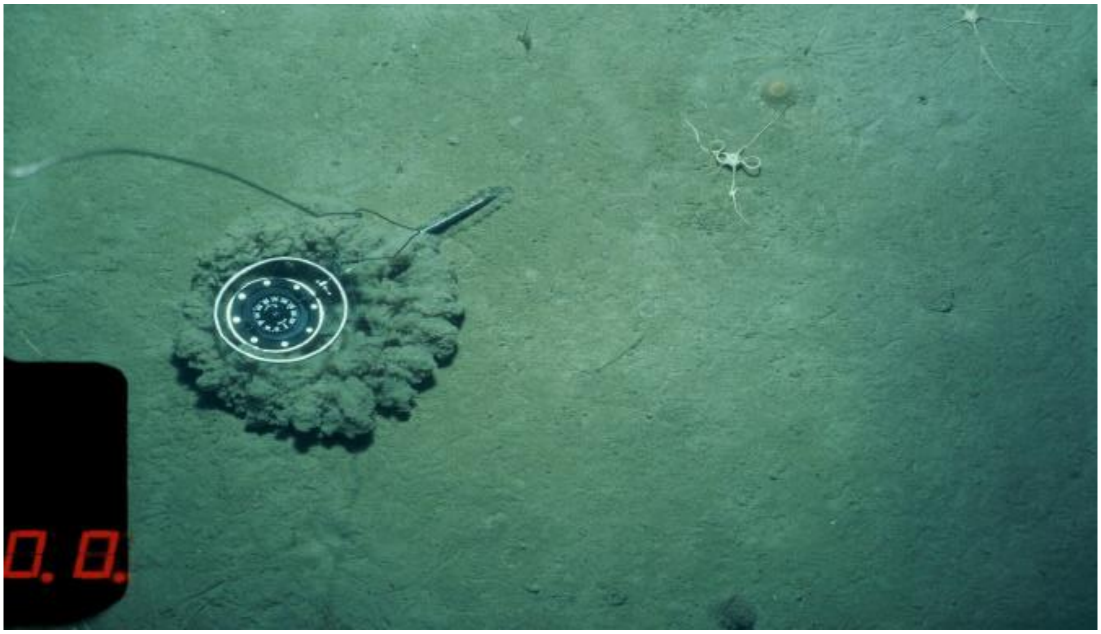


Source: JWEL 2001a

Figure 5.2.5 Typical Seafloor Habitat in the Pembroke and Pinehurst Blocks (image size 1.2 m²)

Approximately 56% of the seafloor images within the survey areas showed barren habitat and lacked visible epifaunal organisms. Brittlestars, polychaete tubes, and burrowing anemones were the most common visible organisms (Figure 5.2.6) (JWEL 2001a). Other species which were rarely observed included sea pens (*Pennatulacea*), sea cucumbers (*Holothuroidea)*, benthic shrimp, starfish (*Asteroidea)*, and sea urchins (*Echinoidea)*. Small mollusks (snails, clams, and scaphopods) as well as crustaceans (amphipods, isopods, and tanaids) were other taxa found in the sediments. Brittle stars ranged in density from 0–4.5 per m^2 and anemones ranged from 0–

2.7 per m^2. Overall densities of observed species were low with an average of 0.8–1.2 per m^2. Corals were not observed in any of the images taken and only one coral, a stony cup coral, was found in a grab sample (JWEL 2001a).



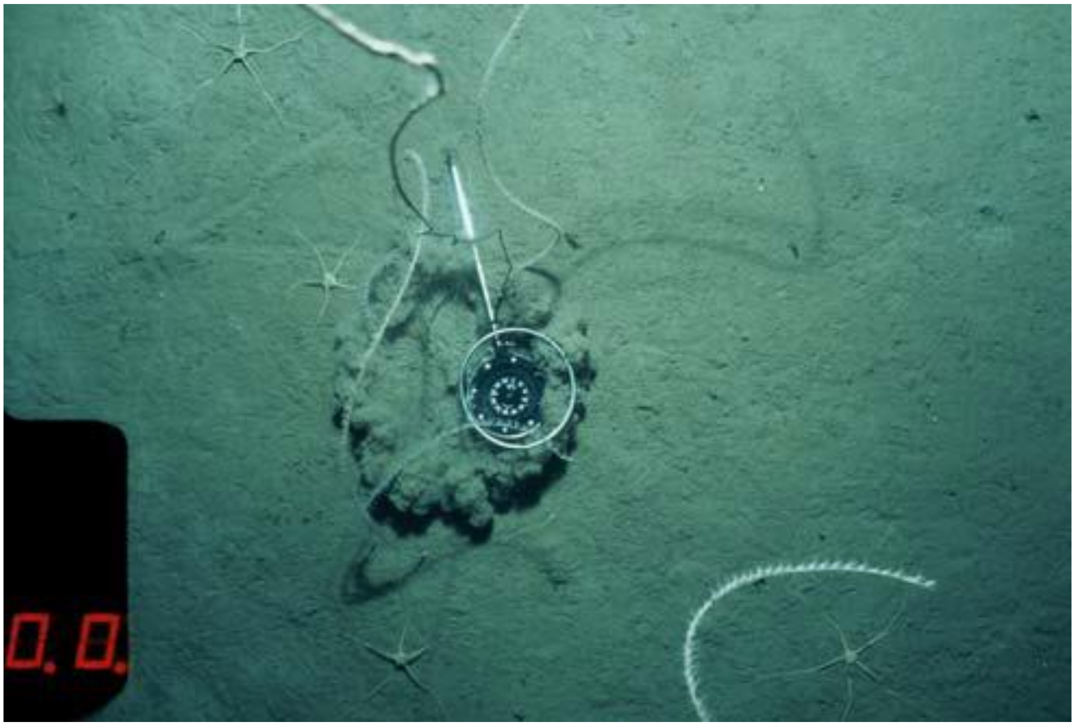
Source: JWEL 2001a

Figure 5.2.6 Brittlestars and Burrowing Anemones (image size 1.1 m^2)

Overall the benthic habitat within the Pinehurst and Pembroke Blocks was identified as Ophuroid and Burrowing Anemone habitat. Benthic fauna across the blocks appeared to be generally low in abundance and diversity (JWEL 2001a). The two blocks have not been found to be an area of significant coral development.

Torbrook Block – EL 2384

The Torbrook Block was a former Exploration Licence located on the Scotian Slope east of the Project Area (Figure 5.2.7). The benthos in that area shows little relief and gentle slope. The Licence area was located in depths ranging from 850 to 3000 m with a seabed consisting of silts and clays of Holocene age (BEPCo 2004). Survey techniques similar to that of the Pinehurst and Pembroke Blocks were employed to characterize the benthic habitat within the Torbrook Block in 2001. Isolated gravel material was observed, but rare. A diverse benthic community was found in the Torbrook Block with ophiuroids (brittle stars) (0–20.4 per m^2) and burrowing anemones (0–1.6 per m^2) were the most common species present, which is typical of soft sediment habitats. Sea urchins (0–2 per m^2) and sea whips (0–6.8 per m^2) were frequently observed at a few stations but not throughout the block (Figure 5.2.7). Brittle stars and anemones were typically found on substrate which had 25% sand content, while the sea urchins and sea whips were found in muddy sediments.



Source: BEPCo 2004

Figure 5.2.7 Sea Whips in Mud Substrate of the Torbrook Block

EL 2381 and 2382

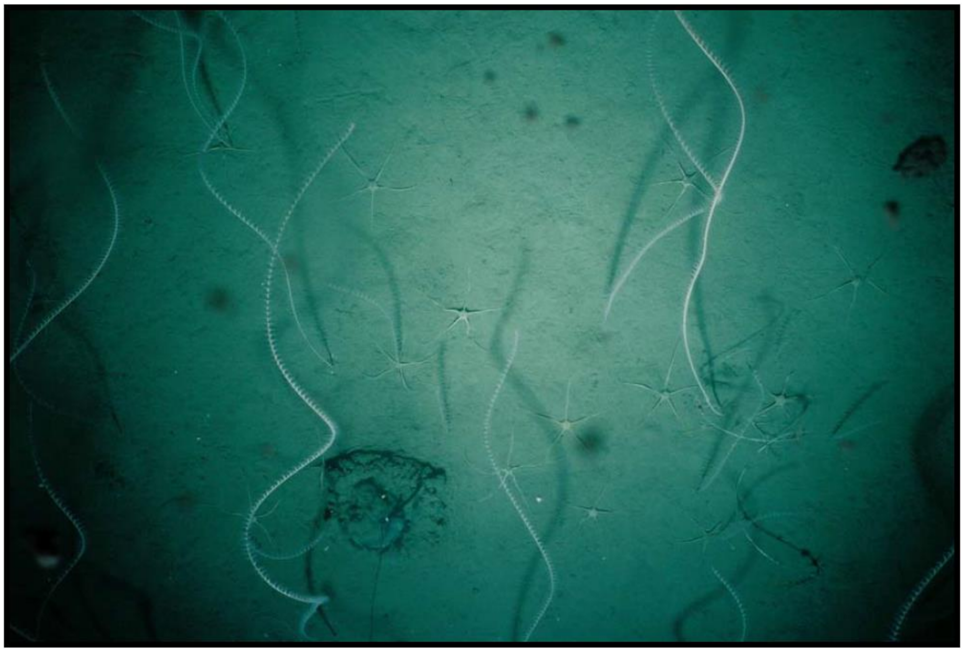
ELs 2381 and 2382 were both former deepwater Exploration Licence blocks located east of the Project Area in water depths ranging from 1500 to 3400 m (JWEL 2003) (Figure 5.2.8). A survey was conducted in September of 2002 during which a combination of grab samples and still camera transects were taken to characterize the benthic community as well as surficial sediments within the licence blocks.

The seabed in EL 2381 is incised by Verrill and Dawson Caynons in the centre of the block with slopes of 1.5–2 degrees. The seabed within EL 2382 is relatively flat with minor escarpments and an overall seabed slope of two degrees (JWEL 2003). The sediments within EL 2381 and 2382 are composed primarily of Holocene silts and clays (JWEL 2003). These silts and clays are slowly deposited in deep water and form a "blanket" over the area. The sediments consist primarily of a clay component, with a secondary silt component, and a lesser fine sand component and vary in thickness from 0.5 to 1 m. Figure 5.2.8 depicts the typical substrate found within ELs 2381 and 2382. There are isolated patches of gravel substrate, although these are rare. Sand sedimentation was observed in Dawson Canyon. Petroleum hydrocarbons were found in 14 of the 16 sampling stations over the two licence blocks with the majority of total petroleum hydrocarbon (TPH) levels measuring < 3 mg/kg. The occurrence of petroleum hydrocarbons in offshore Scotian Shelf and Slope sediments is common with background levels ranging from 1.0 to 26 mg/kg on the Scotian Shelf and Grand Banks (JWEL 2003).

Source: JWEL 2003

Figure 5.2.8 Typical Benthic Habitat in EL 2381 and EL 2382

Brittle stars and burrowing anemones were the most common organisms observed within ELs 2381 and 2382. Polychaetes, sea cucumbers, sea urchins and large nudibranchs were also observed within the licence blocks (JWEL 2003). A few stations contained corals which included sea whips, the soft coral *Anthomastus* spp., and the octocorals *Umbellula*. All of the coral species were observed at depths less than 2000 m. Figures 5.2.9 and 5.2.10 illustrate commonly found species within the blocks. Overall, the benthic fauna across the two blocks was low in abundance and diversity and no regions containing significant coral development were observed (JWEL 2003).



Source: JWEL 2003

Figure 5.2.9 Sea Whip Coral Observed in EL 2381

Source: JWEL 2003

Figure 5.2.10 Large Nudibranch Observed in EL 2381

5.2.2.2 Corals and Sponges

Corals and sponges are marine benthic invertebrates that attach themselves to bottom substrates and filter-feed on suspended particles in the water column. Corals and sponges provide various ecological functions. Dense aggregations of corals and sponges can alter bottom currents and provide a niche space for other organisms, thereby increasing the biodiversity of the area. In particular, corals and sponges provide marine fish and invertebrate protection from strong currents and predators, and can serve as nursery areas for larval and juvenile life stages, feeding areas, breeding and spawning areas, and resting areas (Campbell and Simms 2009). Corals and sponges also contribute to biogeochemical processes, including nutrient cycling between the sea bottom and the water column (Kenchington *et al.* 2012). Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make corals and sponges particularly vulnerable to direct physical impacts and limit recovery (DFO 2013d).

There are two major groups of ahermatypic corals (also referred to as cold water corals) offshore Nova Scotia: hard/stony corals (Scleractinia) and octocorals (also referred to as soft corals). Unlike hermatypic corals that are true reef-building corals and live in warm, shallow waters and contain symbiotic algae, cold water corals can live at depths without the influence of sunlight. Cold water corals can occur in solitary or reef formations. Most corals require a hard substrate to attach to, although some species are able to anchor themselves into soft sediments (ASZISC 2011).

In general, cold water corals are poorly studied, in part due to their inaccessibility since most species are found at water depths greater than 200 m of the continental slopes, canyons, or seamounts (DFO 2011a). DFO has led coral research on the Scotian Shelf and Slope and Gulf of Maine, including various research surveys, since the late 1990s. Figure 5.2.11 displays the known distribution of corals and sponges on the Scotian Shelf (data courtesy of DFO). While it is noted that the extent of the survey did not extend into the Project Area, the data do show the general distribution and diversity of coral and sponge species on the Scotian Shelf and Slope.

Results of deepwater benthic surveys conducted in 2001 and 2002 on the Western Scotian Slope and reported in the BEPCo. Canada Company's *Environmental Assessment Report for Exploratory Drilling on EL 2407* (JWEL 2001a) indicate the presence of stony cup coral (*Flabellum* sp.), sea whips (Order Gorgonacea), and sea pens on soft sediments in water depths ranging from 400 m to 2200 m (refer to Section 5.2.2.1). These corals may therefore be potentially present in the Project Area.

Reef structures are more likely to be encountered on hard substrates which can be observed along the end of channels between fishing banks and in submarine canyons. The largest octocorals reported on the Scotian Shelf are gorgonian corals (*e.g.*, bubblegum and seacorn corals) of which the highest concentration in the Maritimes occurs in the Northeast Channel and is now protected from bottom fishing disturbances in the Northeast Channel Coral Conservation Area. Other designated areas on the Scotian Shelf and Slope offering protection to corals includes the Gully Marine Protected Area (MPA) and the Lophelia Coral Conservation Area on the southeastern slope of Banquereau Bank (refer to Section 5.2.7 for more information on designated protected areas).

At least 34 species of sponge have been identified on the Atlantic coast, including the rare Russian hat glass sponge (*Vazella pourtalesi*) which is known only to occur in specific locations on the Scotian Shelf, the Gulf of Mexico and the Azores. Globally unique sponge grounds for this species on Sambro Bank and Emerald Basin have recently received protection as DFO closed these areas to bottom-contact fishing in 2013 to help protect these sponges from further damage (DFO 2013d).

Shell is planning to conduct a seabed survey in 2014 which will include seabed sampling and underwater photography, which will provide some baseline information on the benthic habitat, including the potential presence of corals and sponges within the Project Area. Additionally an ROV survey will be conducted in advance of drilling to further identify and characterize any seabed sensitivities or constraints prior to finalizing the chosen drilling location.

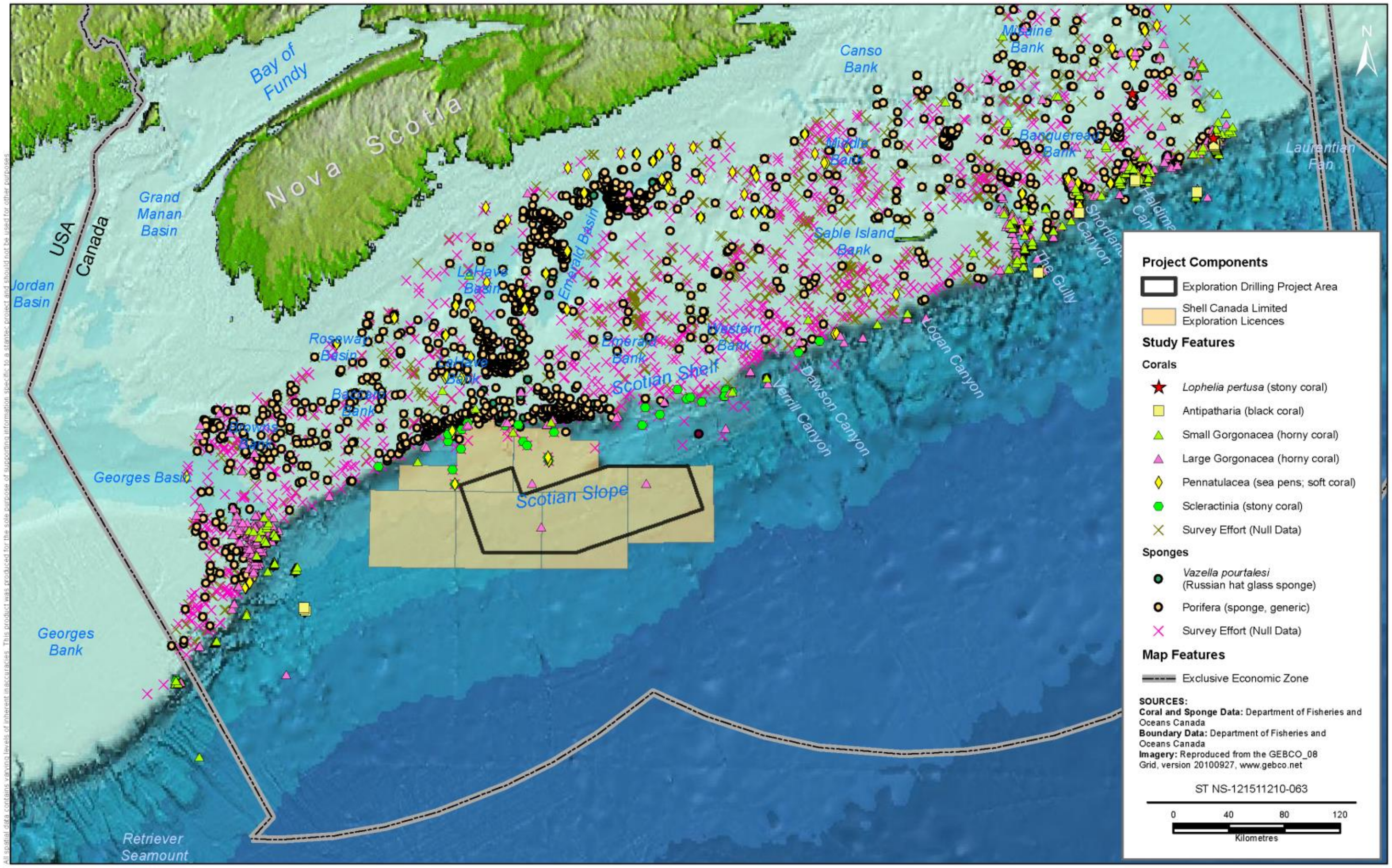


Figure 5.2.11 Coral and Sponge Locations on the Scotian Shelf and Slope

5.2.3 Marine Fish

5.2.3.1 Groundfish

Table 5.2.4 summarizes the characteristics and distribution of groundfish of commercial, recreational, or Aboriginal value likely to occur in the vicinity of the Project Area and on the Scotian Shelf or Slope. Descriptions of groundfish SOCI are provided in Section 5.2.3.4; secure species are described below.

Table 5.2.4 Groundfish of Commercial, Recreational or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area	Timing of Presence
*Acadian redfish	*Sebastes fasciatus*	Low	Year-Round
*American plaice	*Hippoglossoides platessoides*	Low	Year-Round
*Atlantic cod	*Gadus morhua*	Low	Year-Round
Atlantic halibut	*Hippoglossus Hippoglossus*	Low	Year-Round
*Deepwater redfish	*Sebastes mentalla*	Low	Year-Round
Haddock	*Melanogrammus aeglefinus*	Low	Year-Round
Hagfish	*Myxine glutinosa*	Low	Year-Round
Monkfish	*Lophius americanus*	Low	Year-Round
Pollock	*Pollachius virens*	Low	Year-Round
Red hake	*Urophycis chuss*	Low	Year-Round
Sand lance	*Ammodytes dubius*	Low	Year-Round
Silver hake	*Merluccius bilinearis*	Low	Year-Round
Turbot – Greenland flounder	*Reinhardtius hippoglossoides*	Moderate to High	Year-Round
*White hake	Urophycis tenuis	Low	Year-Round
Witch flounder	*Glyptocephalus cynoglossus*	Low	Year-Round
Yellowtail founder	*Limanda ferruginea*	Low	Year-Round
*Note: Species of Conservation Interest (SOCI)			

Source: DFO 2009f, 2009g, 2009h, 2010b, 2013p, 2013q, 2013r, 2013s, Horseman and Shackell 2009, NOAA 2006, 2013h, 2013i, 2013j, 2013k.

Atlantic Halibut (*Hippoglossus hippoglossus*)

Atlantic halibut are distributed from north of Labrador to Virginia. On the Scotian Shelf, halibut are most abundant between 200 and 500 m and can be found on the banks and basins of the Continental Shelf at temperatures ranging from 3 to 5 °C. They prefer sand, gravel or clay substrates. The species can grow to sizes of over 2.5 m in length and reach weights of over 300 kg. The Atlantic halibut is the largest and most commercially-valuable groundfish in the Atlantic Ocean (DFO 2009f). The species preys on benthic organisms which shift from invertebrates to fish as the halibut grows larger in size. Small halibut (< 30cm) feed on hermit crabs, shrimp, crabs, and mysids, while larger fish (> 70 cm) consume various species of flatfish, redfish, and pollock (DFO 2013v).

Females mature at 10 to 14 years with spawning occurring from December to June in deep water depths ranging from 300 m to 700 m. Large females may lay up to as many as several million eggs. The eggs are 3–4 mm in diameter and float freely in the ocean until they hatch 16 days later, giving birth to larvae which are 7 mm in length. Larvae survive on a yolk sac for four to five weeks until they begin feeding on plankton. Atlantic halibut may live for up to 50 years, with a typical lifespan of 25–30 years (DFO 2009f).

Haddock (*Melanogrammus aeglefinus*)

Haddock is a demersal gadoid species which is usually closely associated with the seafloor, preferring broken ground, gravel, pebbles, clay, smooth hard sand, sticky sand of gritty consistency, and shell beds. They are most commonly found at depths from 50 m to 250 m (DFO 2013p). Haddock can be found from Greenland to Cape Hatteras, and are common on the Scotian Shelf on all of the banks and basins. Juveniles are more common in the shallower banks and shoals with adults being found in the deeper basins and shelf edge locations (NOAA 2013h). Haddock feed on a variety of benthic organisms including mollusks, polychaetes, crustaceans, echinoderms, and fish eggs. Adults sometimes prey upon small fish including herring, skates, spiny dogfish, and a variety of groundfish, including haddock themselves (NOAA 2013h).

Haddock are a fast growing species, which generally live from three to seven years and mature from one to four years of age. Spawning occurs from January to July over rock, sand, gravel and mud bottom on areas of Georges Bank and eastward to Sable Island Bank and the shelf edge. Spawning also takes place in nearshore areas from Halifax to Liverpool (Horseman and Shackell 2009). Haddock are highly fecund, producing on average 850 000 eggs, with larger fish producing up to 3 million eggs (NOAA 2013h). Eggs and larvae are pelagic until larvae reach a size of 25 mm and settle into deeper waters.

Hagfish (*Myxine glutinosa*)

Hagfish is a benthic species which can be found in the Northwest Atlantic from the coast of Florida to the Davis Strait and Greenland (DFO 2009g). They can be found in depths up to 1200 m at temperatures less than 14 °C and salinities less than 32 ppt. They prefer soft substrates and areas with low current velocities. They live in burrows which collapse once they emerge, taking approximately 4–11 minutes to rebuild them once they return (DFO 2009g).

Spawning occurs year-round with each female carrying 1–30 horny-shelled large eggs. Females deposit the eggs in burrows (DFO 2009g). Newly hatched hagfish resemble adults and range in size 6–7 cm in length. Hagfish feed on a variety of infaunal and epifaunal invertebrates including nemerteans, polychaetes, and crustaceans. They also scavenge on vertebrate and invertebrate remains which settle down from the pelagic zone.

Monkfish (*Lophius americanus*)

Monkfish can be found from the Northern Gulf of St. Lawrence to Cape Hatteras. They have been found inhabiting areas up to 800 m in water depth, but are most commonly found from 70 to 190 m (DFO 2010b). They prefer water temperatures ranging from 3 °C to 9 °C. Concentrations of monkfish can be found on the banks and basins and the edge of the Scotian Shelf. Monkfish can grow to a size of over 1 m and have a lifespan of up to 12 years. Monkfish live on the ocean floor, typically consisting of sand, mud and shell hash (NOAA 2013i). They are opportunistic feeders preying upon anything that is available. Juveniles prey mostly on small fish, shrimp and squid, while adults prey on fish (including other monkfish), crustaceans, mollusks, seabirds, and diving ducks. They use a modified spine as bait to lure their prey into attacking distance and because of this they are sometimes referred to as angler fish.

Sexual maturity occurs between three and four years, with spawning typically occurring during the summer months from Georges to Banquereau Bank and the shelf edge (Horseman and Shackell 2009). Females lay eggs in a veil, which is a clear, ribbon-like mucous sheet that can contain up to a million tiny pink eggs. Once the female sheds the veil, the sheet floats on the ocean's surface. The veil of eggs can measure 6–12 m in length and be between 0.15 m and 1.5 m wide (NOAA 2013i).

Pollock (*Pollachius virens*)

Pollock is a gadoid species found from southern Labrador to Cape Hatteras, with major concentrations on the Scotian Shelf, including the banks and basins of the shelf. Adults live over a variety of substrate types including sand, mud, rock and various types of vegetation (NOAA 2013j). Pollock swim in schools and travel between the Scotian Shelf and Georges Bank, with some fish veering into the Gulf of Maine.

Adults mature at 4–7 years and spawning occurs from September to March in Canadian waters. Spawning takes place on Georges to Western Banks as well as in nearshore areas from Halifax to Yarmouth (Horseman and Shackell 2009). An average female produces 225 000 eggs which are buoyant and hatch in approximately nine days. Larvae measure 3–4 mm long on hatching and grow rapidly. Larvae feed on copepods. Following the larval stage young pollock move into shallow waters and feed on small crustaceans.

Red Hake (*Urophycis chuss*)

The red hake can be found from the Gulf of St. Lawrence to North Carolina from water depths of 10–500 m at temperatures of 5–12 °C. Red hake prefer a soft sand or muddy substrate (NOAA 2006).Within the RAA red hake can be found in the LaHave and Emerald Basins as well as along the shelf edge. During the spring and summer the species migrates to shallower waters to spawn, returning to the deeper waters of the shelf edge and slope during the winter months (NOAA 2006). They feed on a variety of items including crustaceans, as well as fish including: haddock, silver hake, sand lance, and mackerel.

Spawning occurs in the summer to early fall. Females produce buoyant free floating eggs and hatch larvae which measure 1.8–2.0 mm long. Larvae are pelagic for two to three months until reaching a size of 25–30 mm long when they become demersal.

Sand lance (*Ammodytes dubius*)

In the northwest Atlantic, sand lance can be found from Cape Hatteras to Greenland and are generally found in water depths of less than 90 m (DFO 2013q). They are generally found along coastal zones and on the shallow waters of offshore banks on sand or small gravel benthic substrates. Sand lance do not make extensive migrations, but will travel between resting and feeding grounds. The sand lance will bury itself in the substrate in-between feeding periods, which it does mainly during the day (DFO 2013q). Sand lance feed on a variety of organisms with its main prey consisting of copepods.

Sand lance mature at two years of age and spawn on sand in shallow water depths during the winter months (DFO 2013q). The eggs stick to the substrate and remain there until they hatch. Upon hatching, the larvae become pelagic and remain in the surface waters for a few weeks and are an important food source for predators. Once the larvae reach a few centimetres in length they develop into juveniles and descend to the benthos where they spend the rest of their lives (DFO 2013q).

Silver Hake (*Merluccius bilinearis*)

Silver hake can be found from southern Newfoundland to South Carolina. On the Scotian Shelf and Slope this species can be found in the LaHave and Emerald Basins as well as along the shelf edge. The species can be found most commonly at the depths ranging from 150 m to 200 m at temperatures ranging from 5 °C to 10 °C (DFO 2013r). Silver hake feed mainly on shrimp, krill, and sand lance.

Silver hake have a maximum age of 12 years and mature at an age of 2 years (DFO 2013r). Seasonal migrations occur during the spawning period which takes place from June to September, peaking in July and August on Browns to Sable Island Banks as well as the Shelf edge (Horseman and Shackell 2009). Silver hake move from the deeper waters of the LaHave and Emerald Basins and move to the shallow waters of the Emerald, Western, and Sable Island Banks.

Eggs are buoyant and remain in the water column for a few days before hatching. Larvae measure 2.6–3.5 mm in length and are pelagic for 3–5 months before seeking the bottom.

Turbot – Greenland Flounder (*Reinhardtius hippoglossoides*)

Greenland flounder can be found in water depths ranging from 90–1600 m from western Greenland to the southern edge of the Scotian Slope. This species is most common along the shelf edge and slope and prefer soft mud substrates. Females mature at approximately nine years of age (NOAA 2013k). Spawning is believed to occur during the winter and early spring with females producing 30 000 to 300 000 eggs. After hatching, the young rise to 30 m below the surface where they live until they are 70 mm long. The Greenland flounder feed on various fish species, crustaceans, and squid (NOAA 2013k).

Witch Flounder(*Glyptocephalus cynoglossus*)

Witch flounder is a deepwater boreal flatfish that can commonly be found from Labrador to Georges Bank at depths from 100 m to 400 m, although they are occasionally found up to 1600 m (DFO 2010c). They occur most commonly in deep holes and channels and along the shelf slope on sand and muddy bottoms at temperatures ranging from 2–6 °C (DFO 2013s). On the Scotian Shelf area they can be found in areas of high abundance along the edge of the Laurentian Channel, between Sable Island and Banquereau Bank, in the deep holes of Banquereau, and at the mouth of the Bay of Fundy. Witch flounder are a fairly sedentary species, congregating in water which is suitable for spawning and dispersing to surrounding areas to feed. Their primary prey items include polychaetes, small crustaceans, shrimp, and occasionally small fish (DFO 2013s).

Spawning occurs from May to October with a peak occurring from July to August. Spawning takes place on the Scotian Shelf and shelf edge from Georges Bank to Banquereau Bank, as well as in nearshore areas from Halifax to Southwest Nova Scotia (Horseman and Shackell 2009). Eggs and larvae are pelagic and drift in the currents until settling to the benthos. The pelagic stage of the witch flounder life history is longer than that of any other flatfish and lasts from four months to one year. During this time eggs and larvae drift in the Labrador Current and settle where temperatures are suitable for survival. Eggs and larvae which originate from the southern banks of the Scotian Shelf will not travel great distances as they are trapped in slower circular currents. Occasionally eggs and larvae will drift out over the slope (DFO 2013s).

Yellowtail Flounder (*Limanda ferruginea*)

Yellowtail flounder is a small-mouthed Atlantic flatfish that inhabits relatively shallow waters of the Continental Shelf from southern Labrador to Chesapeake Bay. A major concentration of yellowtail flounder occurs on Georges Bank from the Northeast Peak to the Great South Channel. This species prefers sand or sand-mud sediments and depths ranging from 40 m to 80 m (NOAA 2013l). Adults feed on amphipods, shrimp, polychaetes, crabs, mollusks, and small fish species (DFO 2009h). The species are capable of long distance migrations, taking advantage of midwater tidal currents to efficiently move from one area to another, although migration patterns have yet to be identified.

Both male and female yellowtail flounders mature at two to three years (DFO 2009h). Yellowtail flounder spawn near the substrate on Georges, Browns, and Emerald to Banquereau Banks, as well as in nearshore areas, from May to July in Canadian waters. The number of eggs produced ranges from 350 000 to over 4 million. The eggs are fertilized and rise to the surface waters where they drift during development. The eggs hatch in approximately 5 days rearing 11–16 mm larvae.

5.2.3.2 Pelagic Fish

Table 5.2.5 summarizes the characteristics and distribution of pelagic fish of commercial, recreational, or Aboriginal value likely to occur in the vicinity of the Project Area. Descriptions of pelagic SOCI are provided in Section 5.2.3.4, secure species are described below.

Table 5.2.5 Pelagic Fish Species of Commercial, Recreational, or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area	Timing of Presence
Albacore tuna	*Thunnys alalunga*	Moderate	July to November
Atlantic herring	*Clupea harengus*	Low	Year-round
Atlantic mackerel	*Scomber scombrus*	Low	Winter – deep water on the Shelf Spring/Summer – Migrate to shallower coastal zones
Bigeye tuna	*Thunnus obesis*	Moderate	July to November
Black dogfish	*Centroscyllium fabricii*	Low	Year-round
*Bluefin tuna	*Thunnus thynnus*	Moderate	June to October
*Blue shark	*Prionace glauce*	Moderate	June to October
Capelin	*Mallotus villosus*	Low	Year-round
*Porbeagle shark	*Lamna nasus*	Moderate	Year-round
*Shortfin mako shark	*Leurus oxyringus*	Moderate	July to October
Swordfish	*Xiphias gladuis*	Moderate	July to October
White marlin	*Tetrapturus albidus*	Moderate	July to October
Yellowfin tuna	*Thunnus albacares*	Moderate	July to October
*Note: Species of Conservation Interest			

Source: DFO 1997, GMRI 2014, FLMNH 2013a, 2013b, NOAA 2013a, 2013b, 2013c, 2013d, 2013f, 2013g.

Albacore Tuna (*Thunnys alalunga*)

Albacore tuna can grow up to 140 cm and weigh 60 kg. The species has a life span of 12 years and mature at six years. Spawning occurs from March to July in subtropical areas of the Atlantic and Mediterranean Sea (NOAA 2013a). Albacore tuna enter Canadian waters in July and remain until November feeding on forage species. Females produce between 800 000 and 2.5 million buoyant eggs which hatch in one to two days. After hatching larvae grow quickly and remain in the spawning grounds until the second year when, during the spring, they begin their migration to the North American coast. Albacore tuna are distributed sparsely along the Scotian Shelf edge and slope, with higher numbers further offshore above the abyssal plain.

Atlantic Herring (*Clupea harengus*)

Atlantic herring can be found from Labrador to Cape Hatteras. They are common along the coast of Nova Scotia and offshore banks and known to be present in the Roseway, LaHave, and Emerald Basins (NOAA 2013b).

Atlantic herring form massive schools prior to spawning and migrate to spawning grounds which are located in coastal waters as well as on offshore banks (GMRI 2014). Coastal spawning areas include areas off southwest Nova Scotia as well as in the Bay of Fundy and off of Grand Manan Island. Offshore, spawning occurs on areas of Georges Bank. Spawning begins in August in Nova Scotia and eastern Maine regions and begins in October to November in the southern Gulf of Maine and Georges Bank. Females produce 30 000 to 200 000 eggs that are deposited on rock, gravel, and sand substrate. Schools of herring can produce such a large number of eggs that the ocean floor becomes covered in a dense carpet of eggs several centimetres thick. The eggs hatch within seven to ten days and by late spring the larvae grow into juveniles foraging in large schools in the summer. Larvae are at the mercy of ocean currents for a period which lasts on average for six months (GMRI 2014). The species has a life expectancy of 15 years and matures at four years of age. Atlantic herring primarily feed on zooplankton, krill, and fish larvae (NOAA 2013b)

Atlantic Mackerel (*Scomber scombrus*)

Atlantic mackerel have life expectancies of up to 20 years and mature at the age of two or three years. They are sensitive to water temperatures and make migrations on a seasonal basis to feed and spawn. During the winter they occupy moderately deep water, 70–200 m, along the Continental Shelf from Sable Island Bank to Chesapeake Bay and migrate over Sable Island Bank in the spring and summer months. Atlantic mackerel feed primarily on crustaceans including copepods, krill, and shrimp (NOAA 2013c). They also feed on squid and some small fish.

The species has two major spawning groups with one group spawning in the Mid-Atlantic Bight from April to May, with the second group spawning in June and July in the Gulf of St. Lawrence. Spawning takes place close to shore with females releasing batches of eggs five to seven times during the spawning season. The eggs are buoyant and hatch within four to eight days (NOAA 2013c).

Bigeye Tuna (*Thunnus obesis*)

Bigeye tuna are a tropical tuna that can be found in temperate to tropical waters from Nova Scotia to Brazil. The species has a life expectancy of nine years and mature at about three years of age. Spawning takes place in tropical waters throughout the year with a peak during the summer months (NOAA 2013d). Females spawn at least twice a year and release between 3 to 6 million eggs. The larvae remain in tropical waters and as juveniles grow they move into more temperate waters. Mature bigeye tuna enter Canadian waters including the Scotian Shelf in July and remain until November to feed. Bigeye tuna have a similar distribution as the albacore with a few fish inhabiting waters along the Scotian Shelf edge and slope, with higher numbers further offshore (NOAA 2013d).

Black Dogfish (*Centroscyllium fabricii*)

The black dogfish is a deepwater species found in temperate to boreal waters over the outer continental shelves and slopes of the North Atlantic Ocean. They have been observed at depths up to 1600 m, but are most common at depths of 550–1000 m and temperatures between 3.5 °C and 4.5 °C. The black dogfish preys upon squid, benthic and pelagic crustaceans, shrimp, jellyfish, and fish species including redfish (FLMNH 2013a). Reproduction occurs year-round. Females are ovoviviparous giving birth to 4–40 pups that measure 13–19 cm in length. In Canadian waters they give birth in parts of the Laurentian Channel.

Capelin (*Mallotus villosus)*

Capelin are not normally found in the Scotian Shelf or Bay of Fundy region, although there have been two exceptions observed in recent years. During the mid-1960s capelin were abundant in the Bay of Fundy and have been abundant on the Eastern Scotian Shelf since the 1980s (DFO 1997). Capelin are a pelagic schooling species which can be found in high abundances at depths of 40–150 m and at temperatures of < 4 °C.

Capelin are a very short-lived species and grow rapidly during the first four years of their lives, with growth rates averaging 2–3 cm/year with a maximum size of 20 cm (DFO 1997). Capelin mature at three years of age, with spawning occurring during June and July. Capelin feed on plankton, copepods, euphasiids, and amphipods and they are an important prey item for many species of fish and mammals.

Swordfish (*Xiphias gladuis*)

Swordfish can be found along the Gulf Stream and as far north as the Grand Banks. They have a life expectancy of nine years. Spawning takes place in the Sargasso Sea and in the Caribbean from December to March and off the southeast United States from April to August. Swordfish migrate into Canadian waters in the summer as part of their annual seasonal movement, following spawning in subtropical and tropical areas. Swordfish can be found along the Scotian Shelf edge and slope as well as on the edges of the banks feeding in cooler more productive waters. Swordfish feed on a variety of fish species as well as invertebrates including squid (NOAA 2013f).

White Marlin (*Tetrapturus albidus*)

In western Atlantic waters, marlin can be found in warm temperate waters and tropical waters. During the summer months marlin migrate into Canadian waters off of Nova Scotia. Marlin can be found along the Scotian Shelf edge and slope. They are a pelagic species usually found swimming above the thermocline in waters over 100 m in depth (FLMNH 2013b). They can be found in waters which are greater than 22 °C and are often found in areas with upwelling, and distinct geographic features including shoals, drop-offs, and canyons. White marlin feed on squid, mahi mahi, mackerel, herring, flying fish and bonito.

Spawning occurs once per year northeast of Little Bahama Bank, northwest of Grand Bahama Island. They typically spawn in the early summer months in deep oceanic waters with high surface temperatures ranging from 20–29 °C (FLMNH 2013b).

Yellowfin Tuna (*Thunnus albacares*)

Yellowfin tuna have life expectancies of up to seven years and mature between two and three years of age. Spawning takes place from May to August in the Gulf of Mexico and from July to November in the southeastern Caribbean (NOAA 2013g). Females spawn every three days during spawning season producing one to four million eggs. Yellowfin tuna migrate into Canadian waters, including the Scotian Shelf to feed during the summer months. Yellowfin tuna have similar distributions as the albacore and bigeye tunas, sparsely populating the shelf edge and slope with higher numbers further offshore.

5.2.3.3 Invertebrates

Table 5.2.6 summarizes the characteristics and distribution of invertebrate species of commercial, recreational, or Aboriginal value that are likely to occur in the Study Area.

Table 5.2.6 Invertebrate Species of Commercial, Recreational or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area	Timing of Presence
American lobster	*Homarus americanus*	Low	Year-round
Jonah crab	*Cancer borealis*	Low	Year-round
Atlantic sea scallop	*Placopecten magellanicus*	Low	Year-round
Northern shrimp	*Panadalus borealis*	Low	Fall/Winter – Nearshore Spring/Summer-Offshore

Table 5.2.6 Invertebrate Species of Commercial, Recreational or Aboriginal Value Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	Potential for Occurrence in the Project Area	Timing of Presence
Shortfin squid	*Illex illecebrosus*	High	April – November*
Snow crab	*Chionoecetes opilio*	Low	Year-round
* Note: This is assumed based on theoretical / assumed spawning times.			

Source: Choi *et al.* 2011; DFO 2009g, 2009i, 2013m, 2013n, 2013q, 2013t; NOAA 2004.

Although not in the immediate vicinity of the Project Area, other commercial invertebrates more commonly found on the Eastern Scotian Shelf (*e.g.*, Sable Island, Middle, Canso Banquereau and Misaine Banks) include striped shrimp (*Panadalus montagui*), Stimpson's surf clam (*Mactromeris polynyma*), and sea cucumber (*Class Holothuroidea*) which are prevalent on Sable Island Bank and Middle Bank.

American Lobster (*Homarus americanus*)

Lobster can be found along the Atlantic coastline and on the Continental Shelf from Northern Newfoundland to South Carolina. Lobster can be found in the vicinity of the Project Area within the Northeast Channel and along the edges of the shelf. Inshore population can be found on almost all locations of the nearshore shelf. Lobsters can be found inhabiting waters ranging in temperature from -1.5 °C to 24 °C (DFO 2013m). Adult American lobsters are typically found in waters shallower than 300 m but have been found at depths up to 750 m. They prefer substrate with rock and boulder shelter so that they can shield themselves from predators and daylight as they are nocturnal. They can also be found in areas with sand, gravel or mud substrates. During the summer months, lobsters migrate to shallower water to take advantage of warm water temperatures. During the winter season they migrate to deeper waters to avoid winter storms, ice, and extreme cold water temperatures (DFO 2013m). Lobsters are active hunters feeding on a variety of species including crab, mollusks, polychaetes, gastropods, starfish, sea urchins, and fish. They will also act as scavengers and eat the dead remains of animals if they are available.

Lobster reproduction takes two years. Immediately after molting females mate with males and store sperm in the undersides of their bodies in a sperm plug. During this time females are developing eggs internally for 12 months. The next summer eggs are extruded and fertilized with the stored sperm. Females carry the fertilized eggs for 9–12 months before hatching. Egg bearing females will move inshore to hatch their eggs during the late spring to early summer. American lobsters shed their shells as they grow which is known as moulting. Once the larvae have hatched, they remain planktonic for approximately four moulting periods which last 10–20 days each before settling to the benthos (DFO 2013m).

Jonah Crab (*Cancer borealis*)

Jonah crab are found from Newfoundland to South Carolina and in the Bermuda Islands at water depths ranging from intertidal to 800 m (DFO 2013n). Offshore Nova Scotia they are generally found at water depths of 50–300 m and are present along the shelf break. Little biological information exists for Jonah crab. At 50% maturity, males are approximately 128 mm long and females are approximately 92 mm long. Females can start spawning at sizes as small as 65 mm (DFO 2013n). Jonah crab feed mainly on benthic invertebrates including mussels, snails, barnacles, and will sometimes scavenge on dead fish.

Atlantic Sea Scallop (*Placopecten magellanicus*)

Atlantic sea scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina and are prevalent on Browns and Georges Banks. Atlantic sea scallop can live for up to 20 years (NOAA 2013q). Females can reproduce beginning at the age of two, but do not produce many eggs until the age of four. Spawning occurs in the late summer to early fall with females producing hundreds of millions of eggs per year. Once eggs have hatched the larvae remain in the water column for four to six weeks before settling on the sea floor. Scallops feed by filtering phytoplankton and other small organisms out of the water (NOAA 2013q)

Northern Shrimp (*Panadalus borealis*)

Northern shrimp is the most abundant of all the shrimp species found in the Canadian Atlantic (DFO 2013t). The species can be found from Massachusetts to Greenland at water depths from 10–350 m (DFO 2013t; NOAA 2013m). The species prefers soft mud benthic substrates. Northern shrimp are important in marine food chains as they are an important prey item for many species of fish and marine mammals. Although a benthic species, northern shrimp will migrate vertically through the water column at night (diel vertical migration) to feed on small crustaceans in the pelagic zone (DFO 2013t). They also prey on phytoplankton and zooplankton as well as benthic invertebrates (NOAA 2013m).

The northern shrimp is a hermaphroditic species (possesses the reproductive organs of both sexes). The species first reaches maturity as a male at the age of 2–3 years and by the age of 4–5 years they transform into a female, spending the rest of their lives in this state (DFO 2013t). In the northwest Atlantic, mating occurs during the late summer to fall in offshore waters, with fertilized eggs remaining attached to the females abdominal appendages until the following spring. Females migrate to nearshore waters during the late fall to early winter. After approximately seven to eight months the eggs hatch during April and May. The larvae remain pelagic and drift in the ocean currents feeding on planktonic organisms. After a period of a few months they settle to the benthic zone and start to resemble adults. Juveniles will remain in coastal waters for over a year before migrating to deeper offshore waters and mature as males. Overall northern shrimp migrate with seasonal changes in water temperature spending the fall and winters in nearshore waters when the water is the coolest and migrating offshore during the spring and summer (NOAA 2013m).

Shortfin Squid (*Illex illecebrosus*)

The life cycle of the shortfin squid is approximately one year in length (DFO 2009i). The shortfin squid may reproduce during any part of the year although most reproduction occurs during the winter months over the continental shelf south of Cape Hatteras, North Carolina. Reproduction occurs with males inserting spermataphore packages into the female near the gills. Once males have released their spermataphores they die off (DFO 2009i). The female carries the spermataphores for a few days. Females then expel their eggs through jets in their abdomen while at the same time creating one or multiple jelly masses which contains up to 100 000 eggs and measures up to 1 m in diameter. Once the female has spawned she also dies off. The fertilized mass of eggs is pelagic and travels north in the Gulf Stream (DFO 2009i).

When the squid first hatch after 8–16 days they are known as paralarvae. Paralarvae are abundant in the convergence zone of Gulf Stream water and slope water where there is an area of high productivity. Once reaching a size of 5 cm the paralarvae become juveniles and feed mainly on crustaceans (Euphausiids) at night near the surface waters; they also feed on nematodes and fish (NOAA 2004). At this stage juveniles grow at a rate of 1.5 mm per day. Once reaching a size of 10 cm juveniles are at the adult stage and can reach sizes of up to 35 cm. During the spring juveniles and adults migrate onto the Scotian Shelf area from the slope frontal zone and feed on fish including: cod, mackerel, redfish, sand lance, herring, and capelin. Adults will also cannibalize smaller squid. Juvenile and adult squid have diel vertical migrations in which they rise vertically in the water column to feed at night and migrate to deeper depths during the day. During the fall months the shortfin squid will migrate off the shelf to spawn presumably in the Gulf Stream and south of Cape Hatteras. Spawning is believed to occur from December to March (NOAA 2004).

Snow Crab (*Chionoecetes opilio*)

Snow crab is a decapod crustacean that occurs over a broad depth range (50 to 1300 m) in the Northwest Atlantic. On the Scotian Shelf and Slope area snow crab can be found in nearshore zones off southwest Nova Scotia and from Bridgewater to Halifax. They can also be found in high concentrations on Western, Sable Island, and Banquereau Banks and their respected shelf edges (DFO 2013v). Snow crab have a tendency to be found in water temperatures ranging between -1.0 °C and 11.0 °C, although prolonged periods spent above 7°C have been shown to be detrimental. Snow crab are generally observed on soft mud bottoms, with smaller and moulting crabs also found on substrates comprising boulder and cobble (Choi *et al.* 2011). Snow crab typically feed on shrimp, fish (capelin and lumpfish), starfish, sea urchins, polychaetes, detritus, large zooplankton, other crabs, mollusks and anemones (DFO 2013v). Adult males are defined by their terminal molt and only a portion will recruit into the fishery, which defines a minimum carapace width of 95 mm (DFO 2009g). It takes on average eight years for snow crab to be large enough to be retained by the fishery (DFO 2010g).

Snow crabs are brooded by their mothers for up to two years depending on water temperatures, food availability, and the maturity of the mother. Rapid development of eggs has been known to occur (12–18 months) on the Scotian Shelf with 80% of females following this reproductive cycle. Females spawn approximately 100 000 eggs which hatch between April and June. Upon hatching the larvae are pelagic and feed on plankton for three to five months. Larvae settle to the benthos in the fall and winter. Once larvae have settled to the benthic zone they grow rapidly, moulting twice a year (Choi *et al.* 2011).

5.2.3.4 Species of Conservation Interest

There are various fish SOCI which may be present on the Scotian Shelf or Slope (refer to Table 5.2.7). Marine fish SOCI are defined as those that are listed as endangered, threatened, or special concern by SARA or by COSEWIC. For detailed descriptions of each fish SOCI refer to text found below Table 5.2.7. For details on mating, spawning and potential times and locations of species' larvae and eggs refer to Table 5.2.3.

Table 5.2.7 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area	Timing of Presence
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	Low	Year-round
American eel	*Anguilla rostrata*	Not Listed	Threatened	Transient	Silver eel out migration from NS in November. Larvae and glass eels on the Slope and Shelf March to July
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened	Low	Year-round
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered	High	June to October
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered	Low	Year-round
Atlantic cod (Southern population)	*Gadus morhua*	Not Listed	Endangered	Low	Winter – Deep water of Browns and LaHave Banks Summer- Southern Northwest Channel, shallow waters of Browns and LaHave Banks
Atlantic salmon (Outer Bay of Fundy population)	*Salmo salar*	Not Listed	Endangered	Transient	March to November
Atlantic salmon (Inner Bay of Fundy population)	*Salmo salar*	Not Listed	Endangered	Transient	March to November

Table 5.2.7 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area	Timing of Presence
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered	Transient	March to November
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered	Transient	March to November
Atlantic sturgeon (Maritimes population)	*Ancipenser oxyrinchus*	Not Listed	Threatened	Low	Year-round
Atlantic (striped) wolffish	*Anarhichas lupus*	Special Concern	Special Concern	Low	Year-round
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	Low to Moderate	Year-round
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern	Moderate to High	June to October
Cusk	*Brosme brosme*	Not Listed	Endangered	Low to Moderate	Year-round
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened	Low	Year-round
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened	Low	Year-round
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered	High	Year-round
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern	Moderate	Year-round
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered	Moderate to High	Year-round
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened	Moderate	July to October
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	Moderate	Year-round
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	High	Year-round
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened	Low	Year-round

Table 5.2.7 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area	Timing of Presence
Striped bass (Southern Gulf of St. Lawrence population)	*Morone saxatilis*	Not Listed	Special Concern	Low	June to October
Striped bass (Bay of Fundy population)		Not Listed	Endangered	Low	
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern	Low to Moderate	Year-round
White shark	*Carcharodon Carcharias*	Endangered	Endangered	Low	June to November
White hake	*Urophycis tenuis*	Not Listed	Special	Moderate	Year-round

Source: BIO 2013a; Campana *et al.* 2013; COSWEIC 2006a, 2006b, 2007, 2008, 2009b, 2009c, 2010a, 2010b, 2010c, 2010d, 2011a, 2012a, 2012b, 2012c, 2012d, 2012e, DFO2013b, 2013e, 2013l, 2013j, 2013k; Horseman and Shackell 2009; Maguire and Lester 2012; NOAA2013e; SARA 2013a

Acadian Redfish (*Sebastes fasciatus*)

The Acadian redfish live primarily along the Scotian Shelf edge and slope and in deep channels. The species can be found on the Scotian Shelf and Slope primarily at depths ranging from 150–300 m (DFO 2013 k). Migratory movement information is lacking for the species due to the fact that they cannot be tagged (gas bladder ruptures when brought to the surface). It is believed that once they have settled to the seafloor their dispersal and migration is limited. The species can be found in a wide range of habitats and is known to use rocks and anemones as protection from predators.

The Acadian redfish reaches sexual maturity very late and has highly successful abundance every five to 12 years (COSEWIC 2010c). The Acadian redfish is a slow-growing species that can attain an age of up to 75 years. Females are ovoviviparous, keeping fertilized eggs inside until the larvae have hatched. Breeding occurs between September and December, with larval extrusion occurring in the spring. Larvae may be present in the water column May to August and occupy surface waters feeding on copepods and fish eggs. These larvae can be found over the entire shelf and slope (Horseman and Shackell 2009). At the larval stage, Acadian redfish feed on the eggs of fish and invertebrates. Once they reach juvenile and adult stages, they feed on copepods, euphausiids, and fish (COSEWIC 2010c).

American Eel (*Anguilla rostrata*)

American eels can be found in Canadian freshwater, estuarine, coastal, and marine environments from Niagara Falls to Labrador and have a very complex life history (DFO 2013j). MaturesSilver eels spawn in the Sargasso Sea with hatching occurring from March to October, peaking in August. The larvae are transparent and willow-shaped and are transported to North American coastal waters via the Gulf Stream (COSWEIC 2012c). After approximately 7–12 months, larvae enter the Continental Shelf area and become glass eels taking on an eel shape while remaining transparent. As glass eels migrate towards freshwater coastal streams they are known as elvers. Elvers will run into the freshwater streams with runs peaking from April to June in Nova Scotia. Elvers eventually transform into yellow eels, which is the major growth phase for the species. Yellow eels will spend years maturing in freshwater streams and coastal areas before making a major transformation to return to the Sargasso Sea to spawn. On average, yellow eels will remain in coastal areas or freshwater for 9 to 22 years before metamorphosing both morphologically and physiologically into silver eels (COSEWIC 2012c). Nova Scotian silver eels will begin their outmigration to the Sargasso Sea in November travelling over 2000 km to spawn for the only time during their life.

American Plaice (*Hippoglossus platessoides*)

The American plaice is a benthic marine flatfish with a laterally compressed body. The Maritime Population of American plaice is concentrated in the Gulf of St. Lawrence and on the Scotian Shelf. The species is closely associated with the seafloor and commonly found in water depths of 100 to 300 m where soft / sandy sediments are present (DFO 2013i). Females are batch spawners, spawning batches of eggs for up to one month. Spawning occurs in April / May. Eggs and larvae are pelagic and may be present in the water column between May and June (COSEWIC 2009b). Major spawning areas on the Scotian Shelf are on Banquereau, Western and Browns Banks (Horseman and Shackell 2009).

American plaice prefer water temperatures ranging from 1 °C to 4 °C on the Scotian Shelf. They are opportunistic feeders and consume a variety of prey items including: polychaetes, echinoderms, mollusks, crustaceans, and small fish. Throughout their Canadian range, American plaice do not undergo extensive migrations and are limited to local movements made in response to seasonal changes in temperatures or prey availability (COSEWIC 2009b).

Atlantic Bluefin Tuna (*Thunnus thynnus*)

Atlantic bluefin tuna are highly migratory, with long and varied routes. This species can usually be found in Canadian waters in the summer. Bluefin tuna are distributed throughout the North Atlantic Ocean, occupying waters up to a depth of 200 m from Newfoundland to the Gulf of Mexico (Maguire and Lester 2012). They have as life expectancy of up to 20 years and mature at about eight years of age. Spawning takes place in the Gulf of Mexico and the Mediterranean Sea. Females produce up to 10 million eggs in a year. The eggs are fertilized in the water column by males and hatch after two days.

Important prey items for the species include: herring, mackerel, capelin, silver hake, white hake, and squid. However they are opportunistic and will feed on jellyfish, salps, as well as demersal and sessile fish and invertebrate species (NOAA 2013e).

Adult bluefin tuna enter Canadian waters from June to October. Bluefin tuna can be found distributed in high concentrations along the shelf edge and in the Northeast Channel (Hell Hole) (Maguire and Lester 2012). In addition, they can also be found in the pelagic zone over the Scotian Shelf and Slope. Bluefin tuna are pelagic species which can tolerate a wide range of temperatures due to their ability to regulate their own body temperatures.

Atlantic Cod (*Gadus morhua*)

Atlantic Cod can generally be found in coastal, nearshore and offshore areas from depths of a few metres to 500 m. Atlantic Cod have been observed spawning in both offshore and inshore waters at all times of the year depending on location at depth ranging from a few metres to hundreds of metres (COSEWIC 2010d). Peak spawning has been observed during the spring with spawning occurring in batches. Eggs and larvae are pelagic and float on the surface and drift with the oceanographic conditions at the time of spawning. Each female will produce several million eggs, with usually only one egg surviving to maturity. Eggs and larvae may be present in the upper water column of the Scotian Shelf year-round.

Juvenile cod, up to the age of four, prefer habitats that provide protection and cover such as nearshore waters with eelgrass or areas with rock and coral (COSEWIC 2010d). For the first few weeks of life Atlantic cod reside in the upper 10–50 m of the ocean. The primary factor which determines habitat selection for cod are prey availability and temperature.

Laurentian South Population

Cod from this population overwinter in the waters off eastern Cape Breton and the Continental Shelf south of the Laurentian Channel. They return to the Gulf from May to October, although there may be a resident population which does not return (COSEWIC 2010d).

Southern Population

Atlantic cod from this population inhabit waters from the Bay of Fundy and southern Nova Scotia, including the Scotian Shelf south and west of Halifax, to the southern extent of the Grand Banks. This population spends winters in the deeper waters of Browns and LaHave Banks as well as on inshore waters close to Nantucket. It summers in the southern Northwest Channel and in shallow waters of Browns and LaHave Banks (COSEWIC 2010d).

Atlantic Salmon (*Salmo salar*)

Atlantic salmon are iteroparous, returning to natal rivers to spawn after the completion of ocean scale migrations (COSEWIC 2010a). Collectively as a species, adult salmon return to freshwater rivers after a feeding stage at sea from May to November, with some fish returning as early as March. Female salmon deposit eggs in gravel nests in October and November, usually in gravel riffle sections of streams. Fertilization typically involves multiple males competing aggressively for access to multiple females. This leads to multiple paternities for a given female's offspring. Spawned-out or spent adults (kelts) return to sea immediately after spawning or remain in freshwater until the following spring (COSEWIC 2010a). Fertilized eggs incubate in nests over the winter and begin to hatch in April. Hatchlings (alevins) remain in the gravel riverbed for several weeks while living off a large yolk sac. Once the yolk sac has been absorbed, free swimming parr begin to actively feed. Parr will remain in freshwater for one to eight years before they begin a behavioural and physiological transformation and migrate to sea as smolts, completing the life cycle.

In general, Atlantic salmon make long oceanic migrations from their over wintering at sea locations to their native freshwater streams. This migration occurs from May to November (COSEWIC 2010a). Spawned out adults either return to their overwintering location following spawning or wait until the following spring to return to sea. The majority of Atlantic salmon overwinter in the Labrador Sea and Flemish Cap Area. The major controlling factor for habitat choice of at sea salmon is temperature. Salmon at sea can be found in temperatures ranging from 1 °C to 12.5 °C, with the majority being found at temperatures of 6–8 °C.

Outer Bay of Fundy Population

This population extends from the Saint John River westward to the US border. Migration patterns to the north Atlantic may cause the population to be present in the Project Area; any presence will be transient in nature. It is believed that some of the Outer Bay of Fundy population overwinters in the Bay of Fundy and Gulf of Maine (COSEWIC 2010a).

Inner Bay of Fundy Population

This population extends from Cape Split around the Inner Bay of Fund to a point just east of the Saint John River estuary. It is believed that some of the Inner Bay of Fundy Salmon overwinter in the Bay of Fundy and Gulf of Maine (COSEWIC 2010a).

Eastern Cape Breton Population

This population extends from the northern tip of Cape Breton to northeastern Nova Scotia (mainland). Migration to the North Atlantic is not likely to cross the Project Area (COSEWIC 2010a).

Nova Scotia Southern Upland Population

This population extends from northeastern Nova Scotia (mainland) along the Atlantic and Fundy coasts up to Cape Split. Migration between freshwater rivers and the North Atlantic poses the potential of the population passing through the Project Area with a presence being transient in nature (COSEWIC 2010a).

Atlantic Sturgeon (*Ancipenser oxyrinchus*)

Atlantics sturgeon can be found throughout the coastal waters of the Maritimes and on the Scotian Shelf. They are generally concentrated in water depths less than 50 m and are highly migratory (COSEWIC 2011a). Adults migrate into estuaries and rivers in the autumn (August-October) or in the spring (May-June) prior to reproduction. Adults will often overwinter in deep channels and pools in rivers and estuaries downstream of the spawning sites. Adults and large juveniles move both inwards and seawards in responses to season and salinity. They can be found in the Bay of Fundy, along the coast of Nova Scotia and offshore as far as Banquereau and Sable Island Banks (COSEWIC 2011a).

Atlantic sturgeon use a variety of habitats at various points in their life cycle. These include rivers, estuaries, bays, and the open ocean (COSEWIC 2011a). They prey on benthic organisms including polychaete worms, shrimp, amphipods, isopods, gastropods and small fish (sand lance).

Atlantic Wolffish (*Anarhichas lupus*)

The Atlantic wolffish occurs along the Scotian Shelf with a higher concentration around Browns Bank, along the edge of the Laurentian Channel, and into the Gulf of Maine. They are most commonly found inhabiting the seafloor in water depths of 150 to 350 m and have been found in depths as deep as 918 m (COSEWIC 2012b). Juvenile and adult Atlantic wolffish live on the Scotian Shelf on rocky or sandy substrates; they do not use soft benthic habitats. They rely on boulders and caves for spawning. Atlantic wolffish prey on mostly invertebrates (85%) consisting of whelks, sea urchins, hermit crabs, crabs and scallops. A smaller portion of their diet consists of fish with their main prey being redfish.

Atlantic wolffish make short migrations to spawning grounds in shallow waters during the fall (COSEWIC 2012b). Eggs / larvae may be present on the seafloor in fall to early winter. The eggs are deposited in crevices on rocky substrates and are guarded by males until they hatch. Larvae hatch at approximately 20 mm and live off a yolk sac until it is fully absorbed. Larvae have been found in coastal regions south of Bridgewater and off Southwest Nova Scotia. Larvae have also been observed in the Roseway and LaHave Basins. Juvenile Atlantic wolffish are capable of wide dispersion, while adults are fairly sedentary (COSEWIC 2012b).

Basking Shark (*Cetorhinus maximus*)

Basking sharks are believed to have a life span of 50 years, with males maturing between 12–16 years of age and females maturing between 16–20 years of age (COSEWIC 2009c). Males and females pair up in the summer, presumably to mate. Females have a gestation period of 2.6–3.5 years and give birth to pups with an average length at birth of 1.5–2 m. The species feeds on zooplankton, which congregate in oceanic fronts.

They can be found throughout the North Atlantic with concentrations in coastal waters of Newfoundland and near the mouth of the Bay of Fundy. They have also been observed on Georges Bank, the Northwest Channel, and the LaHave and Emerald Banks. Some sightings have also shown the species on Sable Island Bank and over the slope. During the summer months they can be found in surface waters, particularly the LaHave and Emerald Basins, where they may mate. During the winter they are believed to be found on the Scotian Slope at great depths.

Habitat requirements have not been investigated in Canada, but it is believed that the basking shark lives primarily in oceanic front locations where their main food source, zooplankton, congregates (COSEWIC 2009c). Tagging studies have shown the species occupying surface waters to depths of over 1200 m.

Blue Shark (*Priomace glauca*)

Blue sharks are viviparous (bearing live young) with an average litter size of 26 pups. Blue sharks typically mate in the spring to early summer (COSEWIC 2006a). The female may store sperm for months to years while waiting for ovulation to occur. The gestation period lasts 9–12 months, with birth occurring usually in the spring to fall. The length of newborn pups averages 40–50 cm, taking four to five years to mature to a length of 193–210 cm. Blue sharks are opportunistic predators preying upon bony fish, squid, birds, and marine mammal carrion.

Blue sharks are commonly found in offshore waters in water depths up to 350 m. They are most abundant along the coast of Nova Scotia including the shelf and slope during summer and fall (June to October). Blue sharks can be found in water temperatures between 5.6–28 °C but prefer temperatures of 8–16 °C. Temperature is believed to be a primary factor in migration (COSEWIC 2006a).

Cusk (*Brosme brosme*)

Cusk are commonly found between the Gulf of Maine and southern Scotian Shelf. They are most common along the southwestern Shelf but have been frequently noted as far up the shelf as Sable Island (SARA 2013b). Cusk can be found along the Scotian Slope, as well as within the Gully and the Laurentian Channel. Cusk prefer water depths of 200–600 m. They feed on invertebrates and inhabit benthic area consisting of a hard and rocky seabed. They can seldomly be found over gravel and mud, but have rarely been seen on sand substrates.

Cusk are a slow-growing and later-maturing species with males maturing at five years and females at seven (SARA 2013b). Spawning occurs from May to August with females laying from 100 000 to over a million eggs. The eggs are buoyant and hatch 4 mm larvae that remain buoyant, until settling to the benthos at a size of 50–60 mm. Larvae can be found over Georges and Roseway Basin, as well as from Browns to Sable Island Banks and respective shelf edges (Horseman and Shackell 2009).

Deepwater Redfish (*Sebastes mentalla*)

The deepwater redfish has similar life history characteristics as the Acadian redfish, with the major difference being that they release their larvae 15–25 days earlier (COSEWIC 2010c). They are closely associated with the seafloor and commonly found inhabiting waters deeper than the Acadian redfish. They can be found in a wide range of habitats, using rocks and anemones as protection from predators. Commonly found inhabiting waters of 350–500 m, the species can be found on the edge of the banks and in deep channels from the Labrador Sea to Sable Island. Migratory movement information is lacking for the species due to the fact that they cannot be tagged (gas bladder ruptures when brought to the surface). It is believed that once they have settled to the seafloor dispersal is limited (COSEWIC 2010c).

Northern Wolffish (*Anarhichas denticulatus*)

The Northern wolffish's range is off northeast Newfoundland and across the North Atlantic Ocean with occasional occurrence on the Eastern Scotian Shelf off Cape Breton (DFO 2009b). The species can be found in waters with temperatures of 2–5 °C and depths of 400 to 1500 m. Before the decline of the Northern wolffish, they were caught on substrates of all types. Today they are most often found on sand and shell hash. Temperature is a limiting factor for distribution of this species (COSEWIC 2012d).

During the summer months females lay up to 30 000 large eggs in a nest on the seafloor. Larvae may be present on the seafloor in fall to early winter (COSEWIC 2012d). Due to the occasional nature of this species on the Scotian Shelf, it is very unlikely that larvae would be found in the area.

Porbeagle Shark (*Lamna nasus*)

Porbeagle sharks are a pelagic species commonly inhabiting continental shelves and ocean basins at depths of 1–2800 m. They have also been found closer to shore, although this is more occasional (SARA 2013a).

Male porbeagle sharks mature at eight years, with females maturing at 13, with a life expectancy of 25–46 years. Mating occurs from late September to November. Females are ovoviviparous having a gestation period of eight to nine months. Females leave the Continental Shelf in December and travel at great depths (> 500 m) and swimming up to 2500 km to the Sargasso Sea (DFO 2013e). Females give birth here in March and April inhabiting the deep, cool waters. The young of the year start appearing in Atlantic Canadian waters in June and July. It is believed that the young sharks "hitch a ride north" on the deep cool sections of the Gulf Stream (DFO 2013e).

Immature porbeagle sharks inhabit the Scotian Shelf with mature individuals migrating along the shelf waters to mating grounds located on the Grand Banks, off the mouth of the Gulf of St. Lawrence, and on Georges Bank during September to November. There is a population which undertakes extensive annual migrations. During January to February, this population can be found in the Gulf of Maine, Georges Bank and the Southern Scotian Shelf. By spring they can be found on the edge of the Scotian shelf and in offshore basins and in the summer and fall, they can be found off the southern coast of Newfoundland and in the Gulf of St. Lawrence (Campana *et al.* 2013).

Roughhead Grenadier (*Macrourus berglax*)

The roughhead grenadier is a benthopelagic species that is closely associated with the seafloor and commonly found in water depths of 400 to 2000 m on or near the continental slope of the Newfoundland and Labrador Shelves from the Davis Strait to the southern Grand Banks. They have also been observed on Banquereau, Sable Island, Browns and Georges Banks. The species is an opportunistic predator which feeds on invertebrates, small fish, and squid (COSEWIC 2007).

Roughhead grenadier are a slow-growing and late-maturing fish species with a long life cycle. The species matures on average at 15 years of age. Spawning may occur within the southern Grand Banks during the winter and early spring, although it is possible that the species spawns year-round. Females lay over 25 000 pelagic eggs over a lengthy spawning period (COSEWIC 2007).

Roundnose Grenadier (*Coryphaenoides rupestris*)

The roundnose grenadier is a continental slope species with the deeper part of its geographic range not well surveyed (COSEWIC 2008a). It is more abundant in the northern portion of its Canadian range although some captures have been made along the Scotian Slope. It is closely associated with the seafloor and commonly found inhabiting waters 400 to 1200 m in depth but has been found in water depths of up to 2600 m. The species prefers areas absent of currents and can be found in aggregations in troughs, gorges, and lower parts of the Scotian Slope. Aggregations have been found around the North Atlantic Sea Mounts. Spawning is believed to occur year-round with peaks at different times for different areas. Females will spawn 12 000 to 25 000 pelagic eggs.

Roundnose grenadier have been observed moving up and down continental slopes, moving to deeper water in the winter and shallower water in the summer. They have also been observed to carry out diurnal vertical migrations of 1000 m off the bottom. The species feeds in the water column on a variety of prey items including: copepods, amphipods, squid, and small fish (COSEWIC 2008a).

Shortfin Mako (*Isurus oxyrinchus*)

The shortfin mako is a pelagic species that migrates north following food stocks (*i.e.*, mackerel, herring, and tuna) in the late summer and fall. It has been observed from Georges Bank to the Grand Banks and is rarely found in waters with temperatures less than 16 °C. The species prefers water temperatures ranging from 17 °C to 22 °C and is often associated with Gulf Stream waters over the shelf and slope occurring at depths from the surface to 500 m (COSEWIC 2006f).

The species can reach lengths of over 4 m. Females mature at 2.7–3 m at an average age of 17 years old. Females have litters of 4–25 pups after a 15–18 month gestation period. Pups are born at a length of 70 cm. Shortfin makos have a lifespan ranging 25–45 years (COSEWIC 2006f).

Smooth Skate (Malacoraja senta)

The smooth skate can be found from the Grand Banks to South Carolina. In Canadian waters It is common from the Grand Banks along the Scotian Shelf and into the Gulf of Maine area. The species is commonly found at depths ranging from 70 m to 480 m, up to depths of 1400 m at temperatures ranging from -1.3 °C to 15.7 °C (BIO 2013a). Smooth skates prefer soft mud bottom substrate consisting of silts and clay, but they have also been found on sand, shell hash, gravel and pebble substrates. Smooth skates primarily feed on small crustaceans, and will eat fish once they reach later (largest) stages of their life.

The smooth skate is a slow-growing, late-maturing and long-lived species that are capable of spawning year-round with no known observed peak in spawning rates. Females mature at an average age of 11 years. Females will lay an egg-capsule on the benthic substrate. A young, juvenile is developed in the egg capsule in one to two years before hatching (BIO 2013a).

Spiny Dogfish (*Squalus acanthias*)

Spiny dogfish are commonly found from the intertidal zone to the continental slope in water depths up to 730 m. They are most abundant between Nova Scotia and Cape Hatteras with the highest concentration in Canadian waters being on the Scotian Shelf. They prefer a temperature range of 6–12 °C and show no strong association with substrate type (COSEWIC 2010b). Spiny dogfish follow a general seasonal migration between inshore waters during the summer-fall, and offshore waters during the winter-spring.

Spiny dogfish reach a maximum size of 1.5 m and have a lifespan of 25–30 years. Females mature at 15 years and mating occurs during the spring. After a gestation period of 18– 24 months an average of six pups are born which are approximately 25 cm in length (COSEWIC 2010b). Both mating and pupping is believed to occur along the edge of the Scotian Shelf in the spring.

Spotted Wolffish (*Anarhichas minor*)

The main range of the spotted wolffish is west of Greenland to the Grand Banks with some occurrence on the Eastern Scotian Shelf off Cape Breton. The species is only occasionally seen on the Scotian Shelf and the Gulf of Maine (COSWEIC 2012e). The species is commonly found inhabiting the seafloor in water depths of 50 to 800 m. The species prefers a substrate of coarse sand and a sand and shell mix with rocks to provide shelter. The spotted wolffish grows slower than other wolffish species. Females mature at seven years and spawning occurs in the summer to late fall/ early winter. Approximately 50 000 large eggs are laid on the seafloor and are guarded by the male until they hatch (COSWEIC 2012e).

Striped Bass (*Morone saxatilis*)

The striped bass is anadromous species (spawns in fresh water before moving downstream to brackish and salt water to feed and mature). Young-of-the-year move downstream over the summer where they continue to feed and grow in estuaries and coastal bays. Older fish migrate along the coast in search of prey (*e.g.*, juvenile herring, smelt and tomcod). In the fall, the striped bass move back upstream where they overwinter in brackish or fresh water, likely to avoid low ocean temperatures (COSEWIC 2004).

The natural range of the striped bass extends along the Atlantic coast of North America, from the St. Lawrence Estuary to the St. Johns River in northeast Florida. There is historical evidence of striped bass spawning in five rivers of Eastern Canada: the St. Lawrence Estuary, the Miramichi River in the southern Gulf of St. Lawrence, and the Saint John, Annapolis and Shubenacadie rivers in the Bay of Fundy (COSEWIC 2004). There are two genetically distinct populations in Eastern Canada which could potentially be found in coastal waters in the vicinity of the Project: the Bay of Fundy population and the Southern Gulf of St. Lawrence population. Given the coastal/freshwater nature of this species, interaction with the Project is considered to be highly remote. However, this species has been considered in recognition of its importance to recreational and Aboriginal fisheries.

Thorny Skate (*Amblyraja radiate*)

The thorny skate can be found on the Scotian Shelf with highest concentrations being found on the Eastern Scotian Shelf and the Lower Bay of Fundy (COSEWIC 2012a). The species can be found in depths ranging from 20 m to 1400 m on substrates including sand, shell hash, gravel, pebbles, and soft muds. Thorny skates are a slow growing species with maturity being reached at an age of 11 years. It is believed that peak spawning occurs in the fall and winter months.

White Shark (*Carcharodon Carcharias*)

The white shark is rare in North Atlantic Canadian waters (32 records in 132 years), as it is the northern edge of their range. Recorded sightings range from the Bay of Fundy to the Laurentian Channel, as well as on the Sable Island Bank. They can range in water depth from the surface to 1300 m, are highly mobile and seasonally migrant (COSEWIC 2006b). Males mature at age 8–10 at a length of 3.5–4.1 m, with females maturing at an age of 12–18 with a length of 4–5 m. Females are ovoviviparous with a gestation period of 14 months, giving birth to an average of 7 pups (COSEWIC 2006b).

White Hake *(Urophycis tenuis)*

In general white hake reside on the Scotian Shelf and upper slope and prefer soft bottom substrates in water temperatures ranging from 5 °C to 11°C (DFO 2013l). High concentrations have been found on Georges Bank and the offshore banks of the Scotian Shelf. Juvenile white hake feed on shrimp, polychaetes, and small crustaceans. Adults feed on herring, cod, haddock, other hake species, redfish, mackerel and other species found in the area.

Males reach maturity at 2–4 years with females maturing at 3–5 years. Female white hake can produce several million eggs each during spawning season (DFO 2013l). Once released, the eggs are buoyant and float near the surface until they hatch. Larvae and juveniles are pelagic until they reach a size of 50–60 mm, which can take 2–6 months (DFO 2013l).

5.2.4 Marine Mammals

5.2.4.1 Overview

Three groups of marine mammals can be found on the Scotian Shelf and Slope: the Mysticetes (toothless/baleen whales), Odontocetes (toothed whales), and Pinnipeds (Seals).

There are six species of Mysticetes and ten species of Odontocetes known to occur on the Western Scotian Slope (Stantec 2014) and which could potentially be present in the Project Area (refer to Table 5.2.8). Critical habitat for the endangered North Atlantic right whale has been identified in Roseway Basin on the Scotian Shelf (within the RAA) and the Grand Manan Basin in the Bay of Fundy (outside the RAA) (Brown *et al.* 2009). Critical habitat for the endangered Northern bottlenose whale has been designated in the Gully and in the Shortland and Haldimand Canyons on the east of the Scotian Shelf and Slope, although there have been sightings along the shelf break and within Dawson and Verrill Canyons.

Figures 5.2.12 and 5.2.13 display sightings data of Mysticetes and Odontocetes between 1911 and 2013 as provided by DFO. It should be noted that these data have been collected from various sources over the years, including sightings from fishing and whaling in the 1960s and

1970s and more recently from opportunistic observer programs on fishing vessels and as such survey effort is not consistent across all data collections areas and the data have not been completely error-checked nor undergone comprehensive quality control. The database also includes data from scientific expeditions by DFO, non-government organizations, and Dalhousie University research teams. Much of the data were collected on an opportunistic basis from vessels offshore Nova Scotia, with survey efforts not being consistent or rigorously applied (*e.g.*, lack of sightings does not necessarily represent lack of species presence in a particular area).As shown on Figures 5.2.12 and 5.2.13, cetaceans are sighted more often in areas where there are greater bathymetric changes such as along the shelf edge, in the slopes of basins on the shelf, and in the canyons connecting the deep slope waters up to the shallower waters of the shelf. These figures do not include observational data collected during the Shelburne Basin 3D seismic survey by Shell Canada Limited between June and August 2013. These data were recorded daily and reported on a weekly basis and provide some insight on the types of species observed in the Project Area during the summer months (refer to Figure 5.2.14). As a result of multiple vessels with Marine Mammal Observers (MMO) collecting observational data at the same time the observational data may over-estimate the number of sightings as a result of the same marine mammal having been recorded more than once. Data collected over the 2013 seismic program and shown in Figure 5.2.14 suggest that density of marine mammals in the Project Area increases from spring to summer. The majority of sightings recorded during Shell's 2013 seismic survey were dolphins and pilot whales, with few sightings of SARA-listed species including the fin whale, a species of special concern under SARA.

Tables 5.2.8 and 5.2.9 present information on presence and timing of marine mammals known to occur in the vicinity of the Project Area, based on a review of existing literature incorporated within the SEA for the Western Scotian Slope (Phase 3B) (Stantec 2014).

Table 5.2.8 Marine Mammals Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential for Occurrence in the Project Area	Timing of Presence
Mysticetes (Toothless or Baleen Whales)					
Blue whale (Atlantic population)	*Balaenoptera musculus*	Schedule 1, Endangered	Endangered	Low	Summer to Fall
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Schedule 1, Special Concern	Special Concern	High	Year- round (highest concentrations in Summer)
Humpback whale (Western North Atlantic population)	*Megaptera novaeangliae*	Schedule 3, Special Concern	Not at Risk	Moderate	Summer
Minke whale	*Balaenoptera acutorostrata*	Not Listed	Not at Risk	Moderate	Spring to Summer
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1, Endangered	Endangered	Low	Summer
Sei whale	*Balaenoptera borealis*	Not Listed	Not Listed	High	Summer to early Autumn
Odontocetes (Toothed Whales)					
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Not Listed	Not at Risk	Moderate	June to December
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Schedule 2, Threatened	Special Concern	Low	Summer to Fall
Killer whale	*Orcinus orca*	Not Listed	Special Concern	Low - Moderate	Summer
Long-finned pilot whale	*Globicephala melas*	Not Listed	Not at Risk	High	Year-round
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Schedule 1, Endangered	Endangered	Low	Year-round

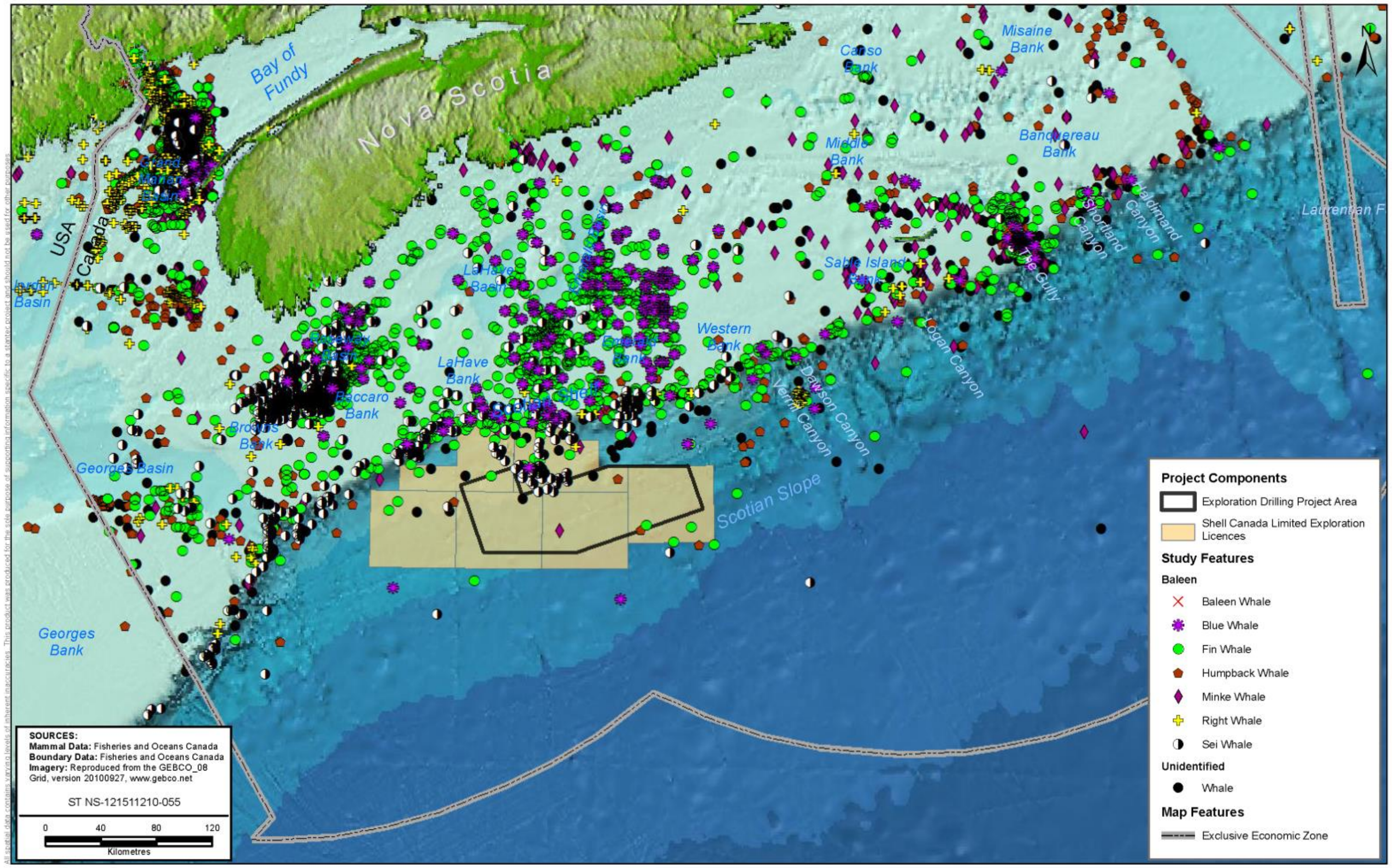
Table 5.2.8 Marine Mammals Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential for Occurrence in the Project Area	Timing of Presence
Sowerby's beaked whale	*Mesoplodon bidens*	Schedule 1, Special Concern	Not Listed	Low - Moderate	Year-round
Short-beaked common dolphin	*Delphinus delphis*	Not Listed	Not at Risk	High	Summer to Fall
Sperm whale	*Physeter macrocephalus*	Not Listed	Not at Risk	High	Summer
Striped dolphin	*Stenella coeruleoalba*	Not Listed	Not at Risk	High	Summer to Fall
White-beaked dolphin	*Lagenorhynchis albiorostris*	Not Listed	Not at Risk	Moderate	Year-round

Source: Adapted from Stantec 2014

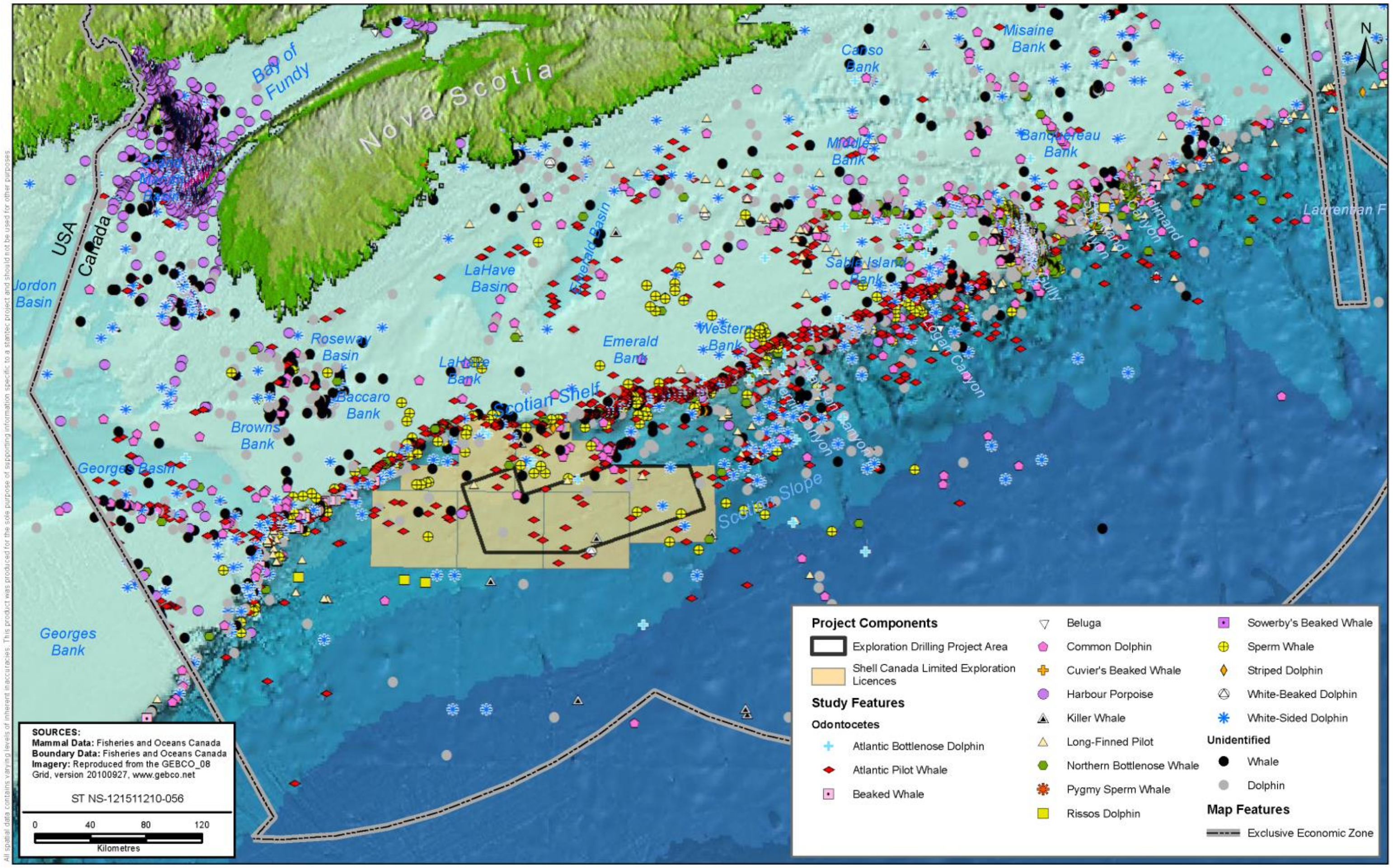
Table 5.2.9 Marine Mammal Presence on the Scotian Shelf and Slope

Common Name	Scientific Name	January	February	March	April	May	June	July	August	September	October	November	December
Mysticetes (Baleen Whales)													
Blue whale	*Balaenoptera musculus*					■	■	■	■	■	■	■	
Fin whale	*Balaenoptera physalus*	■	■	■	■	■	■	■	■	■	■	■	■
Humpback whale	*Megaptera novaeangliae*					■	■	■	■	■			
Minke whale	*Balaenoptera acutorostrata*			■	■	■	■	■	■	■			
North Atlantic right whale	*Eubalaena glacialis*					■	■	■	■	■			
Sei whale	*Balaenoptera borealis*					■	■	■	■	■	■		
Odontocetes (Toothed Whales)													
Atlantic white-sided dolphin	*Lagenorhynchus acutus*						■	■	■	■	■	■	■
Harbour porpoise	*Phocoena phocoena*					■	■	■	■	■	■	■	
Killer whale	*Orcinus orca*					■	■	■	■	■			
Long-finned pilot whale	*Globicephala melas*	■	■	■	■	■	■	■	■	■	■	■	■
Northern bottlenose whale	*Hyperoodon ampullatus*	■	■	■	■	■	■	■	■	■	■	■	■
Sowerby's beaked whale	*Mesoplodon bidens*	■	■	■	■	■	■	■	■	■	■	■	■
Short-beaked common dolphin	*Delphinus delphis*					■	■	■	■	■	■	■	
Sperm whale	*Physeter macrocephalus*					■	■	■	■	■			
Striped dolphin	*Stenella coeruleoalba*					■	■	■	■	■	■	■	
White-beaked dolphin	*Lagenorhynchis albiorostris*	■	■	■	■	■	■	■	■	■	■	■	■
■	Timing of Presence on the Scotian Shelf and Slope												



Source: DFO Marine Mammals Sightings Database

Figure 5.2.12 Mysticetes Sightings (1911–2013) on the Scotian Shelf and Slope



Source: DFO Marine MammalsSightings Database

Figure 5.2.13 Odontocete Sightings (1911–2013) on the Scotian Shelf and Slope

Stantec

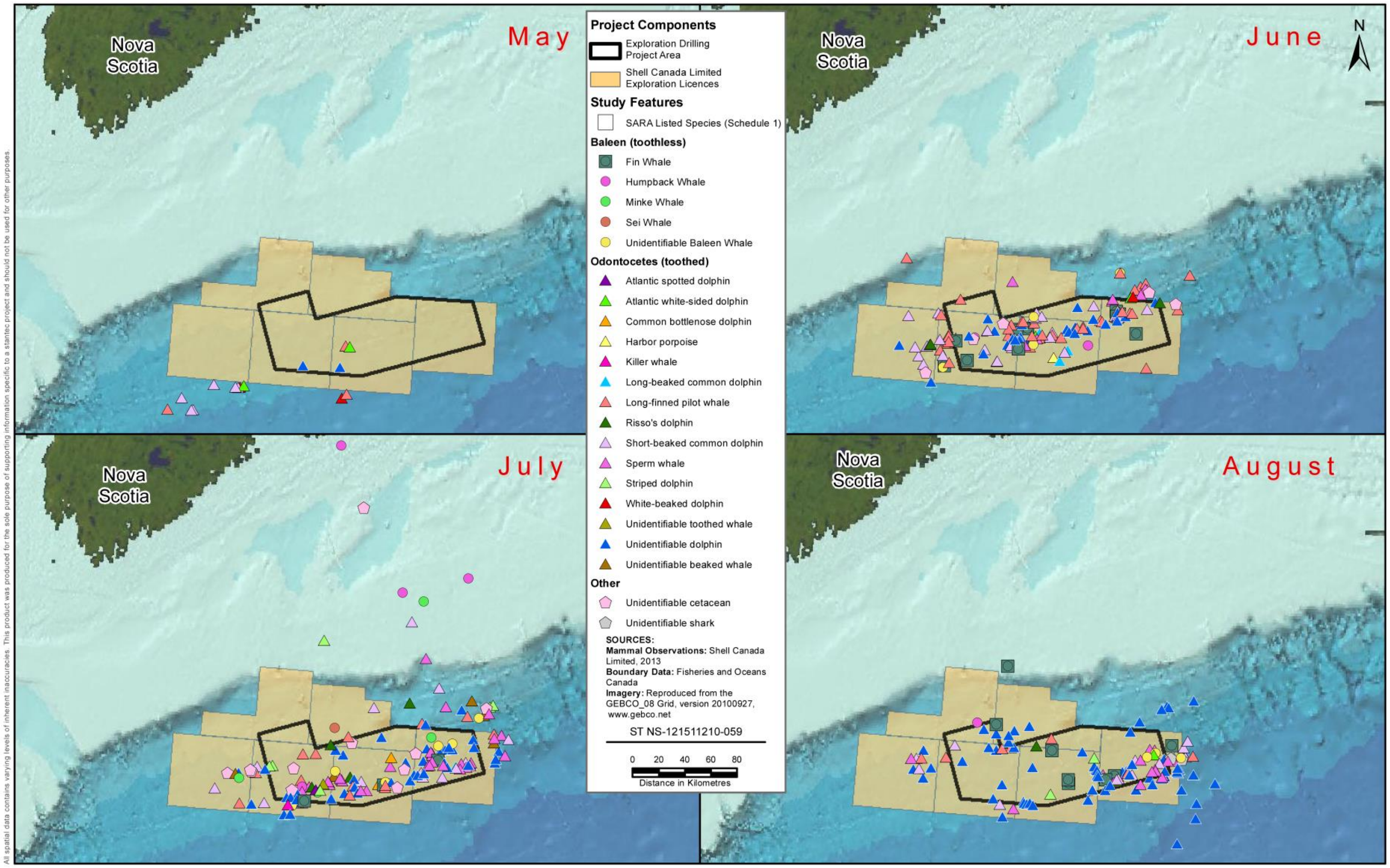


Figure 5.2.14 Marine Mammal Observations Collected during the 2013 Shelburne Seismic Survey

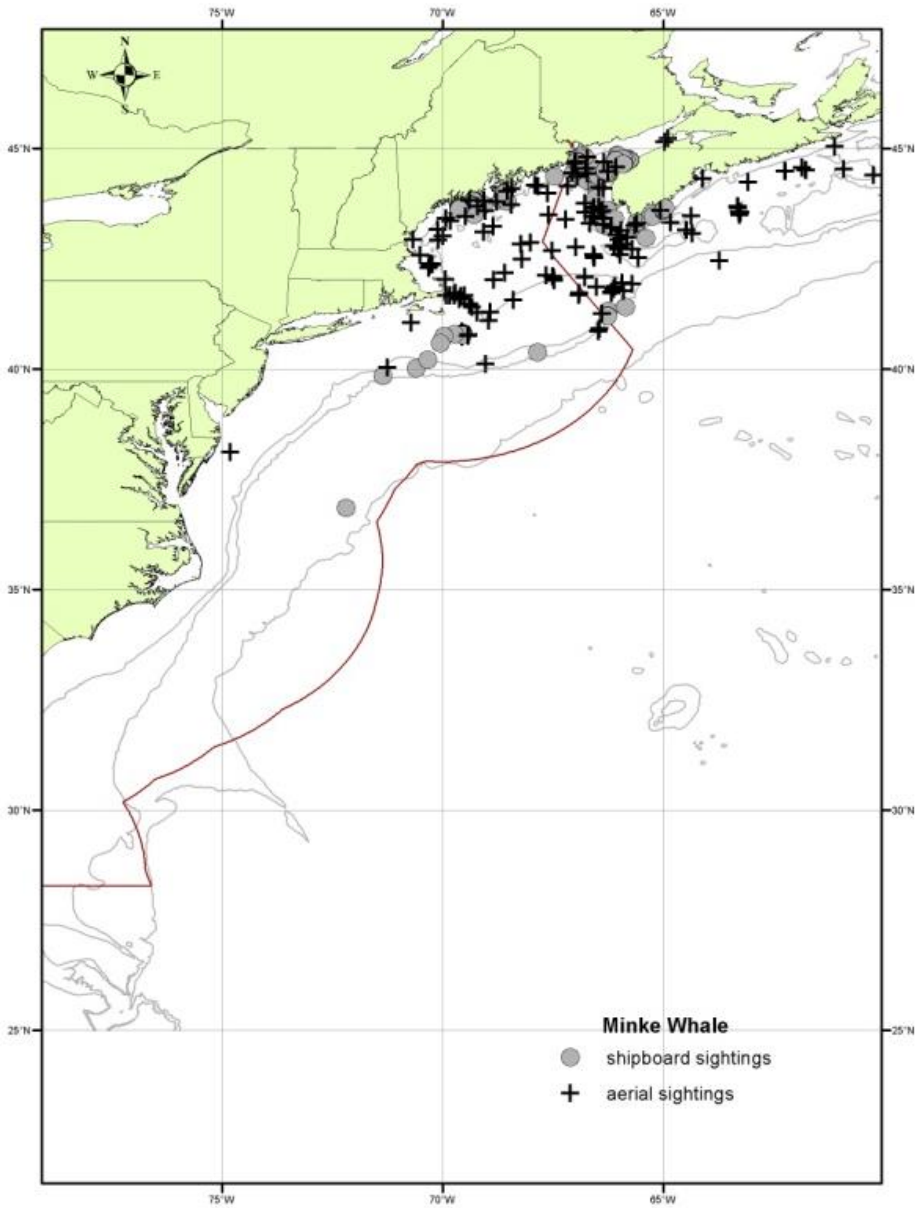
5.2.4.2 Mysticetes (Baleen Whales)

The following section describes mysticetes which may be found in vicinity of the Project Area or on the Scotian Shelf or Slope. Descriptions of SOCI mysticetes can be found in Section 5.2.4.4.

Minke Whale (*Balaenoptera acutorostrata)*

Minke whales can be found in all of the oceans of the world. Mike whales found in Canadian waters belong to the Canadian East Stock and inhabit areas from the Gulf of Mexico in the south to Davis Strait in the north (DFO 2011a). Minke whales generally occur along the Continental Shelf feeding on plankton, krill, and small schooling fish including capelin, cod, eels, herring, mackerel, salmon, sand lance, and wolffish. Minke whales can generally be found in Canadian waters during the spring and summer.

Minke whales have a lifespan of 50 years and reach maturity at approximately six years of age for males and seven years of age for females (DFO 2011a). Mating is thought to occur during the winter in tropical and subtropical waters, followed by a gestation period of 10–11 months. Females give birth to a single calf. Figure 5.2.15 represents both shipboard and aerial sightings of minke whales between 1995 and 2011.



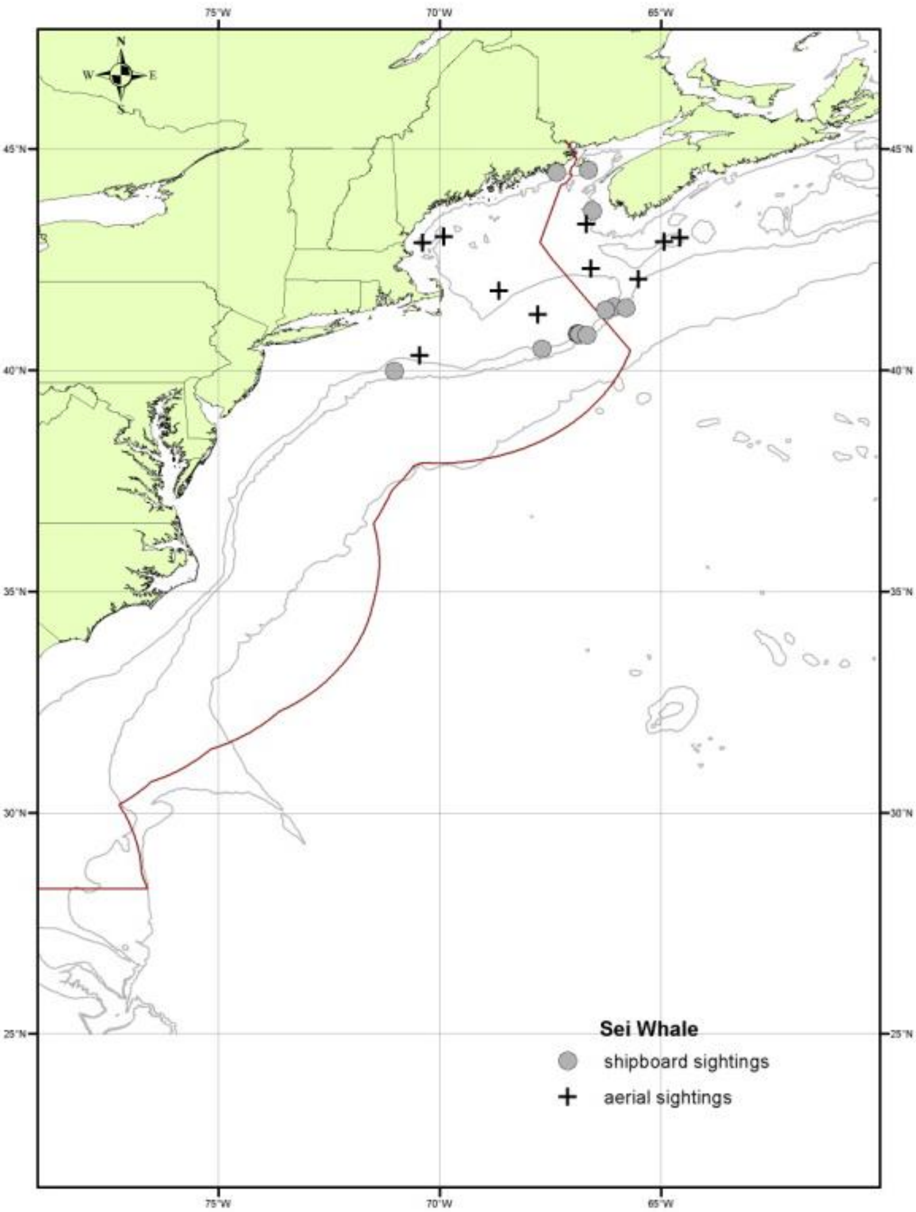
Source: NOAA 2013n

Figure 5.2.15 Distribution of minke whale sightings from Northeast Fisheries Science Centre (NEFSC) and Southeast Fisheries Science Centre (SEFSC) shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

Sei Whale (*Balaenoptera borealis*)

In Atlantic Canadian waters sei whales can be found from Georges Bank in the south to Labrador in the north. During the summer and early autumn months, a large portion of the population can be found on the Scotian Shelf. The southern portion of their range during the spring and summer is the Gulf of Maine and Georges Bank, with an abundance of sightings concentrated on eastern Georges Bank and along the southwest edge of the Bank (DFO 2011a). In general sei whales use pelagic habitats over deeper water up to the 2000 m depth contour. Along the Scotian Shelf they are most associated with the shelf edge, as well as the upper slope waters. Sei whales feed mainly on copepods and plankton floating in the upper layers of the water column.

Sei whales reach maturity between 5 and 15 years of age, with a lifespan ranging from 50–70 years. Mating and calving occurs at lower latitudes during the winter months, which is followed by a gestation period of 10–12 months (DFO 2011a). Calves are weaned from their mothers for a period of six months on the summer feeding grounds. Figure 5.2.16 depicts shipboard and aerial sightings of sei whales between 1995 and 2011.



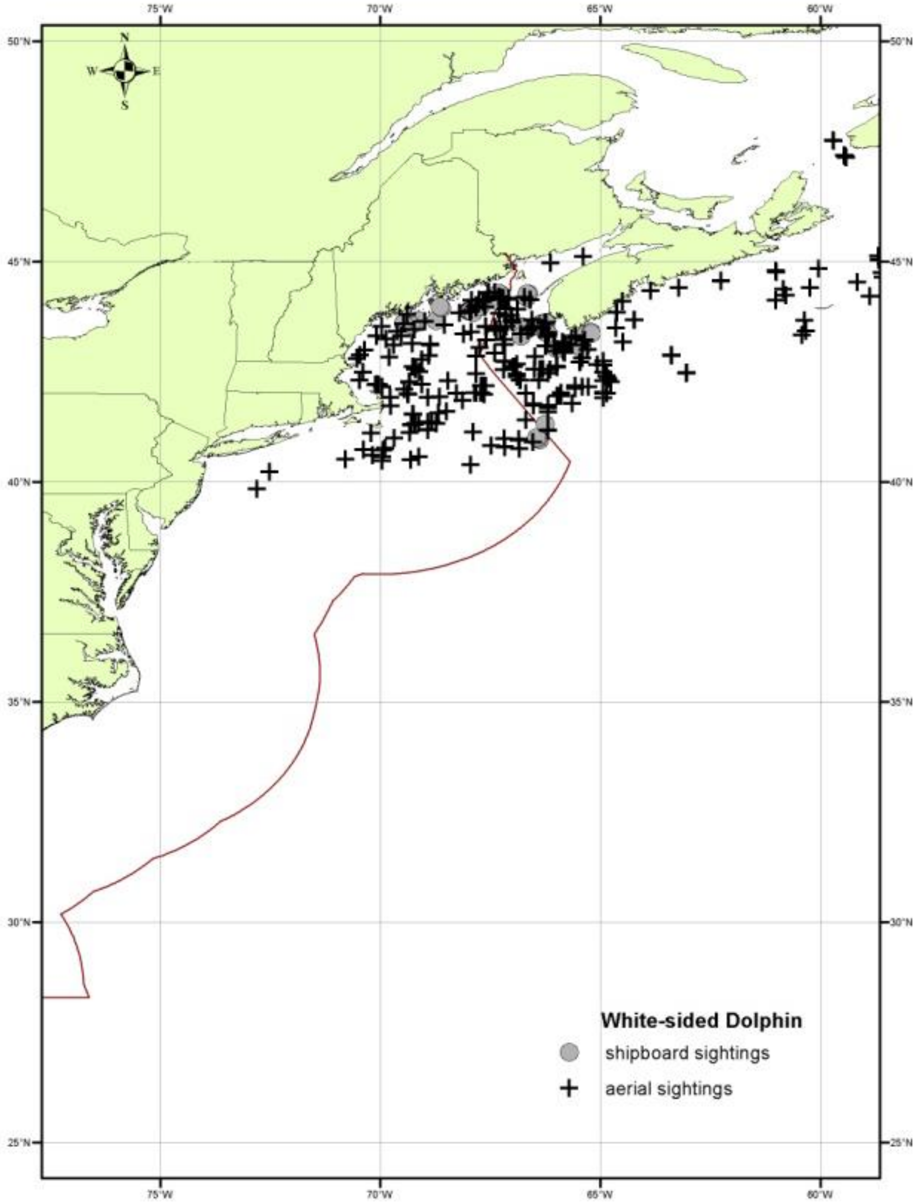
Source: NOAA 2013n

Figure 5.2.16 Distribution of sei whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

5.2.4.3 Odontocetes (Toothed Whales)

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

Atlantic white-sided dolphins are distributed throughout the Continental Shelf and Slope areas of the North Atlantic. They are primarily found over the Continental Shelf in waters up to 100 m in depth and can be found from western Greenland to North Carolina (NOAA 2013n). There are believed to be three stocks of the species which include a Gulf of Maine stock, a Gulf of St. Lawrence stock, and a Labrador Sea stock. The Gulf of Maine stock is most common in continental shelf waters from the Hudson Canyon to Georges Bank and in the Gulf of Maine to the lower Bay of Fundy. The Atlantic white-sided dolphin has been observed to carry out seasonal distribution shifts. From January to May few Atlantic white-sided dolphins can be found from Georges Bank to New Hampshire, with even fewer being found further south to North Carolina. From June to September larger numbers can be found on Georges Bank and in the lower Bay of Fundy. From October to December intermediate densities can be found on southern Georges Bank to the southern Gulf of Maine (NOAA 2013n). Figure 5.2.17 depicts shipboard and aerial sightings of Atlantic white-sided dolphins between 1995 and 2011.



Source: NOAA 2013n

Figure 5.2.17 Distribution of Atlantic white-sided dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011.

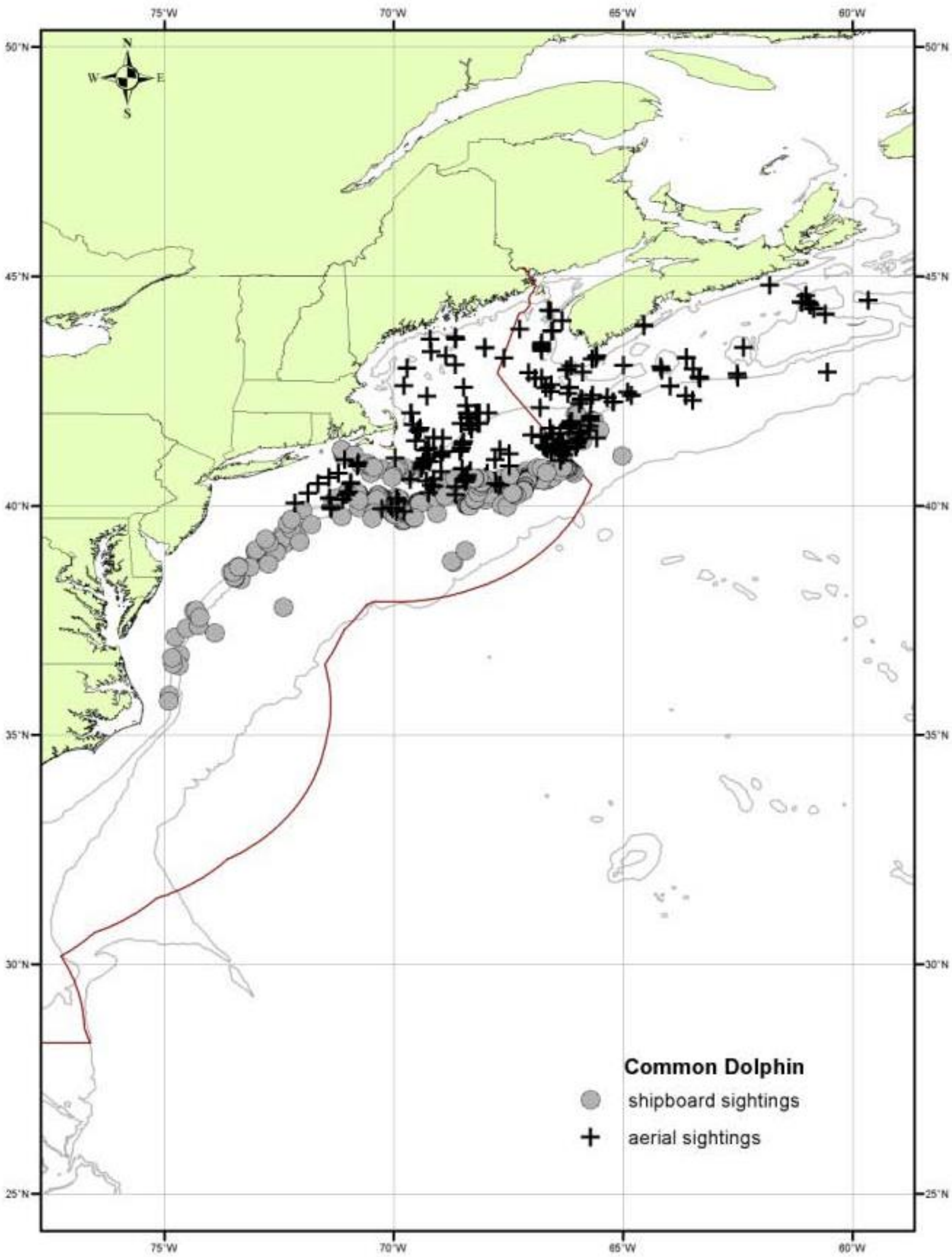
Long-finned Pilot Whale (*Globicephala melas*)

Long-finned pilot whales can be found from the waters off North Carolina to the Davis Strait and Greenland (Reeves *et al.* 2002) and can be found on the Scotian Shelf and Slope year-round. The species can be found frequenting coastal waters of Cape Breton during the summer months, and moving further offshore during the winter. The species tends to inhabit areas of high relief and submerged banks. They can also be found associated with the Gulf Stream and thermal fronts along the Continental Shelf (NOAA 2013n).

Long-finned pilot whales in the North Atlantic mate and calve between April and September following a gestation period of up to two years (Reeves *et al.* 2002). The reproductive cycle for this species lasts between three and five years as females are not pregnant and lactating at the same time. The species feeds primarily on squid and mackerel.

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin may be one of the most widely distributed cetacean species, inhabiting tropical, sub-tropical, and temperate areas. In the Northwest Atlantic it can be found from Newfoundland to Florida (Reeves *et al.* 2002) The species can be found on the Scotian Shelf and Slope during the summer and autumn months once water temperatures increase above 11°C (NOAA 2013n). The species calves during the late spring to early summer and gestation lasts 10–11 months. Females remain in lower latitudes during calving and lactation periods (Reeves *et al.* 2002). Short-beaked common dolphins feed primarily on schooling fish and squid. Figure 5.2.18 displays shipboard and aerial sightings of short-beaked common dolphins between1998 and 2011.



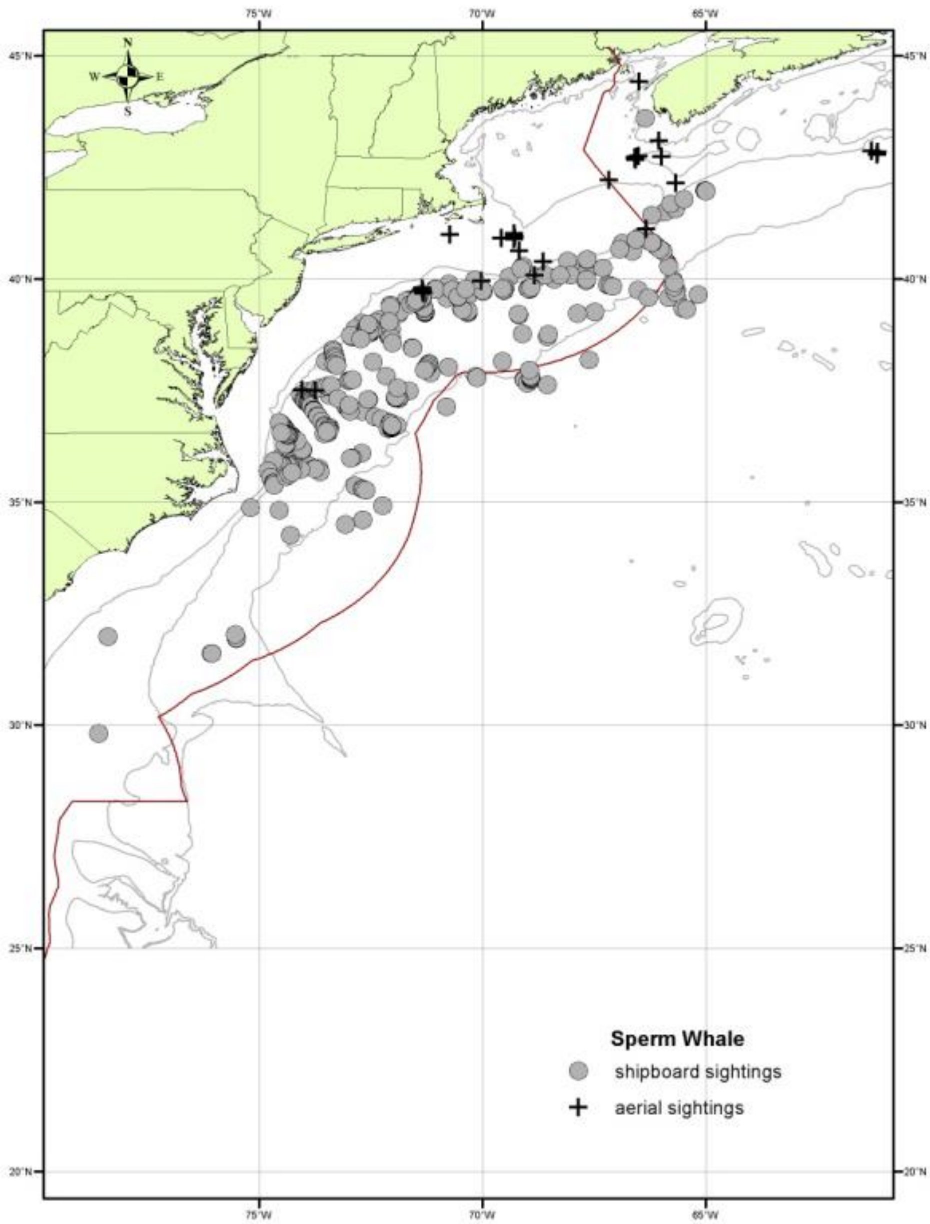
Source: NOAA 2013n

Figure 5.2.18 Distribution of short-beaked common dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

Sperm Whale (*Physeter macrocephalus*)

The sperm whale can be found along the Scotian Shelf edge and may be more common in the submarine canyons of the shelf, as it is regularly seen in the Gully. Sperm whales can also be found along the edge of the Laurentian and Northeast Channels and can be commonly found in areas where water mixes to produce areas of high primary productivity. The sperm whale has been sighted more regularly on the eastern end of the Scotian Shelf and Slope at water depths of 200 m–1500 m. Only adult male sperm whales travel to northern waters to feed, while all age classes and sexes can be found in tropical and temperate waters further south (Reeves *et al.* 2002).

Sperm whale breeding grounds are located in tropical and sub-topical waters where the majority of mating occurs during the spring. The gestation period for sperm whales can last up to 18 months (Reeves *et al.* 2002). Nursing of calves lasts for at least two years with some calves nursing for longer periods. Sperm whales feed on or near the bottom of the ocean where their primary prey items include squid, octopus, skates, sharks, and various benthic fish species. Figure 5.2.19 represents both shipboard and aerial sightings of sperm whales between 1998 and 2011.



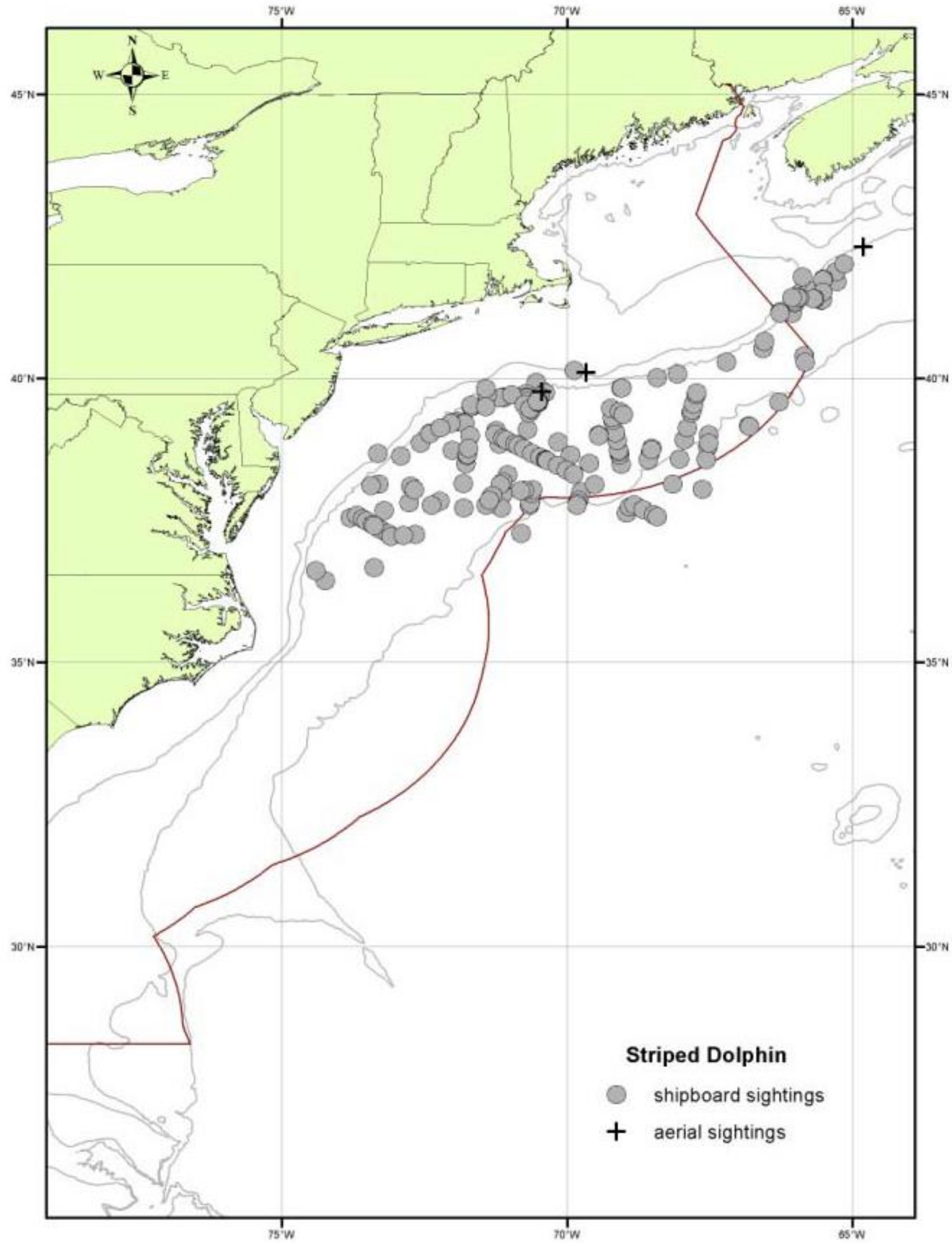
Source: NOAA 2013n

Figure 5.2.19 Distribution of sperm whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin can be found from Cape Hatteras to the southern margin of Georges Bank and also offshore over the continental slope and rise in the mid-Atlantic regions. They prefer the warm waters found on the shelf edge and are often seen in the Gully. In general striped dolphins prefer continental slope waters offshore to the Gulf Stream (NOAA 2013n). Few striped dolphins have been sighted on the Scotian Shelf over the winter months. Striped dolphins prey upon small schooling fish species such as herring, capelin, and mackerel, as well as squid (Reeves *et al.* 2002).

Striped dolphins are born in the late summer or early fall after a gestation of period of a year Calving takes place in large schools of 30 or more individuals comprised of adults, calves and juveniles. The calving period usually lasts four years (Reeves *et al.* 2002). Figure 5.2.20 below represents both shipboard and aerial sightings of striped dolphins between 1998 and 2011.



Source: NOAA 2013n

Figure 5.2.20 Distribution of striped dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006, 2007, 2010 and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

White-beaked Dolphin (*Lagenorhynchis albiorostris*)

This species is a year-round resident of the area inhabiting waters from Cape Cod to Greenland. Little information is known about the reproductive cycle of the white-beaked dolphin. It is believed that the species calves from May to September. White-beaked dolphins prey on small schooling fish species such as herring and capelin, squid, cod, haddock, octopus, as well as crustaceans (Reeves *et al.* 2002).

5.2.4.4 Species of Conservation Interest

There are various marine mammal SOCI which may be present on the Scotian Shelf or Slope (refer to Table 5.2.8). Marine mammal SOCI are defined as those that are listed as endangered, threatened, or special concern by SARA or by COSEWIC. For detailed descriptions of each marine mammal SOCI refer to text found below. For details on the presence of various marine mammal species in the vicinity of the Project Area and on the Scotian Shelf and Slope refer to Table 5.2.9.

Mysticetes (Baleen Whales)

Blue Whale (*Balaenoptera musculus*)

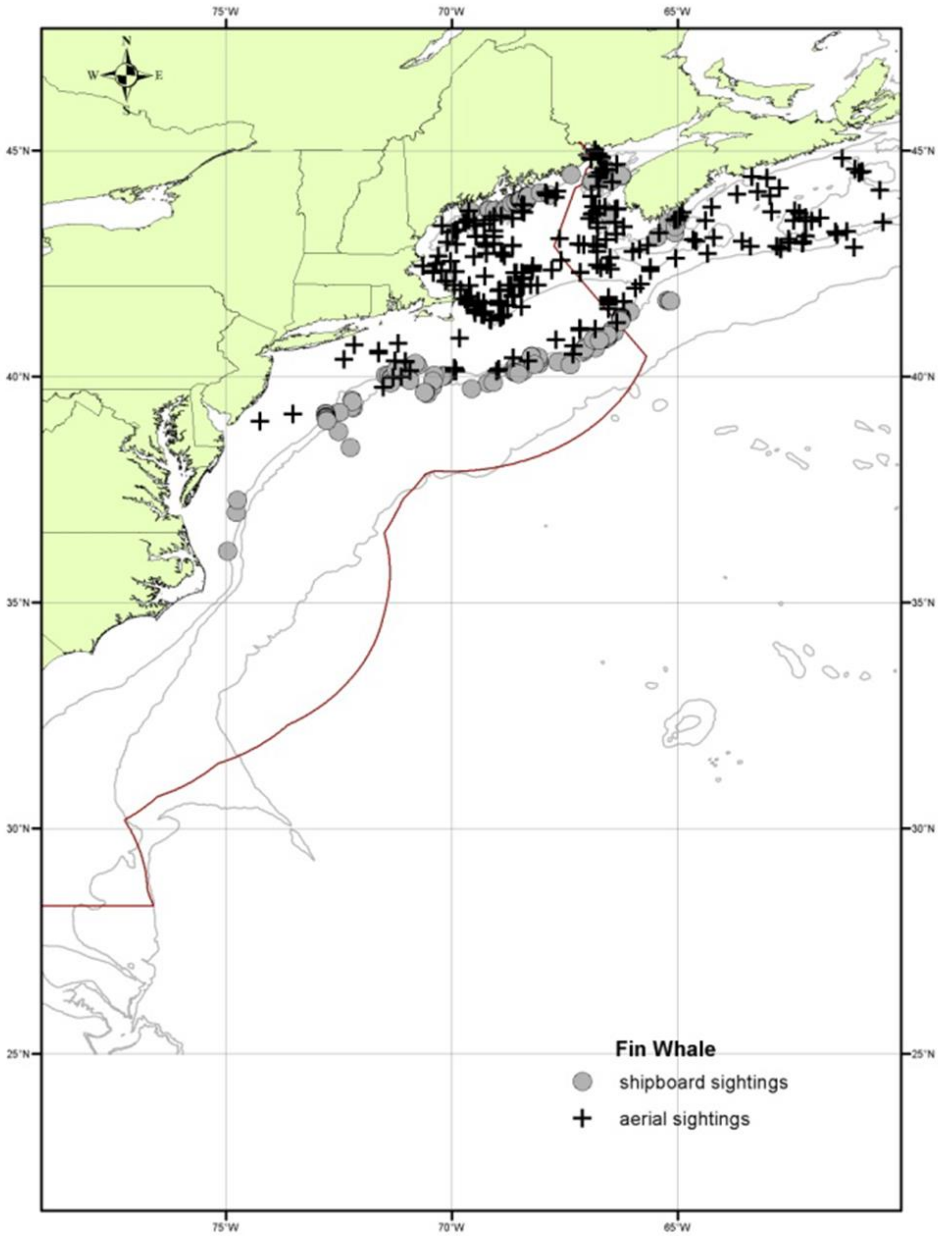
The blue whale mates and calves from late fall to mid-winter in the Northern Hemisphere (COSEWIC 2002b). Male and female blue whales reach sexual maturity from 5–15 years. Females give birth to a single calf every two to three years after a gestation period of 10–11 months. The life expectancy of blue whales is believed to be approximately 70–80 years and possibly longer. Blue whales feed almost exclusively off krill in both coastal and offshore waters, especially in areas of upwelling where productivity is high (DFO 2011a).

The blue whale has a large range, including along the Scotian Shelf, but a low population density. They can be found in small migrant herds, surfacing every 5 to 15 minutes for breathing. The Atlantic population is observed mainly in the St. Lawrence Estuary and shallow coastal zones where mixing and upwelling produces high numbers of krill (Beauchamp *et al.* 2009). Blue whales feed in these cold upwelling zones in temperate and polar waters from spring to early winter. On the Scotian Shelf, they can be found from May to October in areas of high primary productivity. The species has been more commonly sighted on Sambro, Emerald, Western, and LaHave Banks. They have also been sighted along the slope and between Roseway Bank and Basin. Blue whales were sighted regularly by whalers on the Scotian Shelf from 1966–1969, although they have been rarely sighted since this time period (COSEWIC 2002b).

Fin Whale (*Balaenoptera physalus*)

Fin whales are the most commonly sighted whale species along the Scotian Shelf. Concentrated in the northwest Atlantic region during summer months for feeding, (but seen year-round) they have been sighted throughout the Scotian Shelf between Western and LaHave Banks and on the Scotian Slope and shelf edge. The estimated population size for the western North Atlantic fin whale stock is 3985 individuals based on surveys conducted in 2006 and 2007 (DFO2011a).

Fin whales reach sexual maturity at 5–15 years of age. There is little known information on where they spend their winter months or the location of calving and breeding areas (DFO 2011a). It is believed that mating and calving occur in temperate waters at low latitudes during the winter months. Mating is followed by a gestation period of 11–12 months. The calf will wean from its mother for six to seven months until reaching a winter feeding ground. Females give birth every two to three years. The fin whale is a filter feeder, feeding on small schooling fish such as herring and capelin, squid, and crustaceans including mysids and krill. Figure 5.2.21 plots shipboard and aerial sightings of fin whales between 1995 and 2011.



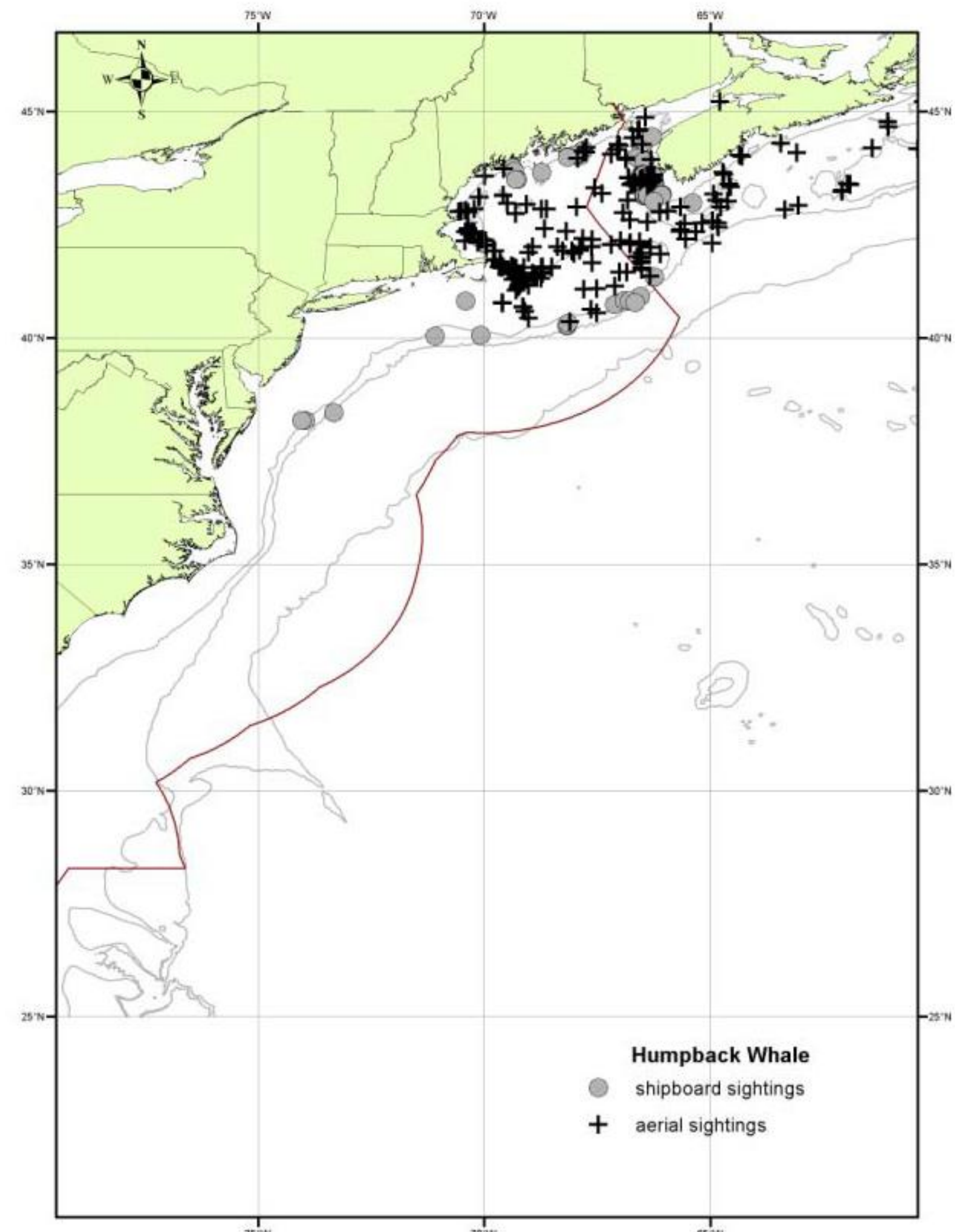
Source: NOAA 2013n

Figure 5.2.21 Distribution of fin whale sightings from NEFSC (Northeast Fisheries Science Center) and SEFSC (Southeast Fisheries Science Center) shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

Humpback Whale (*Megaptera novaeangliae*)

Humpback whales can be found throughout oceans all over the world (DFO 2011a). In Atlantic Canadian waters humpback whales are common in the summer and can be sighted from the Gulf of Mexico to southeastern Labrador (DFO 2011a). Most sightings occur in coastal waters. Humpback whales undergo extensive seasonal migrations and have a number of distinct feeding aggregations. Newfoundland and Gulf of Maine subpopulations migrate to the Scotian Shelf and Slope during the summer months to forage. In the fall humpbacks migrate to southern waters to overwinter and breed in tropical waters. During the spring they migrate back to northern waters to feed in the summer (DFO 2011a). The estimated North Atlantic population (including Gulf of Maine and Scotian Shelf stocks) is 7698 based on genetic tagging data. Humpback whales are seasonal filter feeders, feeding on crustaceans including krill and copepods, plankton, and small fish including herring, mackerel, capelin and sand lance.

Humpback whales reach sexual maturity after approximately nine years of age. Mating occurs in tropical waters during the winter months with a gestation period of approximately one year. Birthing usually occurs between January and April in tropical waters, with females giving birth usually every two years (DFO 2011a). Figure 5.2.22 plots shipboard and aerial sightings of humpback whales between 1995 and 2011.



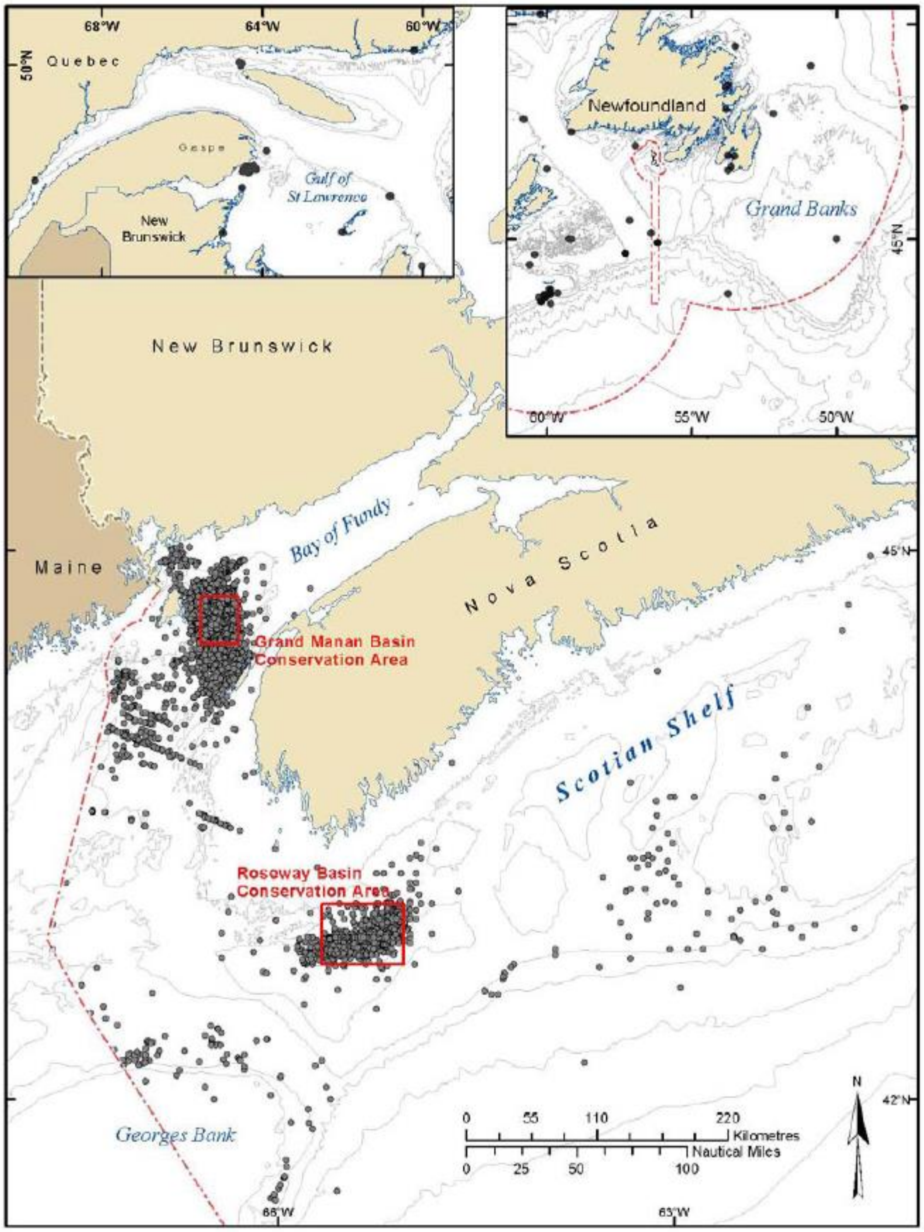
Source: NOAA 2013n

Figure 5.2.22 Distribution of humpback whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale can be found from the coastal waters of the United States to Newfoundland and the Gulf of St. Lawrence (DFO 2011a). Adult females give birth in the warm waters of the coastal southern US, whereas males and non-calving females are rarely seen in this area, with their winter locations largely unknown (DFO 2011a). There are over-wintering aggregations which are known to reside in Cape Cod Bay and the central Gulf of Maine. A northern migration occurs in the late winter and early spring from calving grounds with mother and calf pairs moving along the shore. During the spring, right whales can be seen feeding and socializing in the Great South Channel, Cape Cod Bay, and Massachusetts Bay. By July, right whales can be found in their critical habitats, which include the Grand Manan Basin in the lower Bay of Fundy, and the Roseway Basin on the southwestern Scotian Shelf. From October into the winter a southern migration can be observed with whales returning to the warmer waters of the southern US coast (DFO 2011a).

Right whales migrate to Canadian waters to feed. Their main prey items include large and oil-rich copepods as well as other small zooplankton and barnacle larvae. The population of right whales in the Northwest Atlantic is estimated to be approximately 450 (DFO 2011a). Female right whales give birth to a single calf in the coastal waters of the Southern US between Georgia and Florida. Figure 5.2.23 depicts the Canadian range of North Atlantic right whale sightings between 1951and 2005.



Source: Brown *et al.* 2009

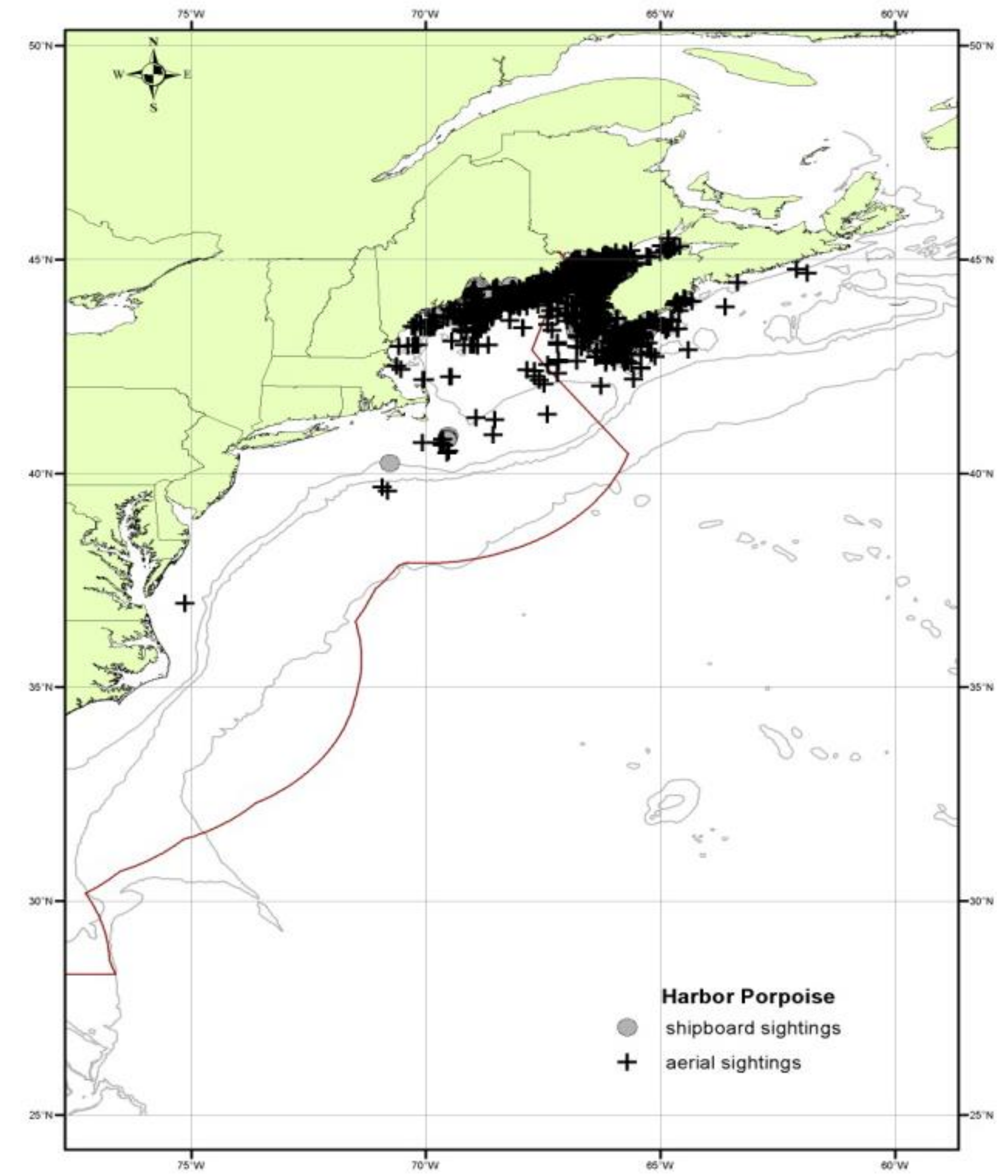
Figure 5.2.23 The Canadian range of the North Atlantic right whale 1951–2005. Data is based on individual sightings from the North Atlantic Right Whale Consortium 1951–2005, the St. Andrews Biological Station whale sightings database 1992–2005, and the DFO Newfoundland Region whale sighting database 1975–2003.

Odontocetes (Toothed Whales)

Harbour Porpoise (*Phocoena phocoena*)

In the Northwest Atlantic, harbour porpoises can be found from the Bay of Fundy to Baffin Island. Distributional information for the species is limited to the summer months, when visual surveys are possible (COSEWIC 2006c). Harbour porpoises are widely distributed over the continental shelves and are generally found within 250 km of shore. They are an occasional visitor to the shallow banks of the Scotian Shelf, although they are rarely sighted. The estimated population size of harbour porpoises in the Gulf of Maine/Bay of Fundy region is 89 054 based on 2006 surveys conducted in the region. During the summer months they can be found in waters less than 150 m deep. During the winter months they migrate south to the US eastern coast as far south as North Carolina, with some individuals overwintering in the Bay of Fundy (COSEWIC 2006c).

Compared to other cetaceans the harbour porpoise has a relatively early age of sexual maturity and is highly fecund (COSEWIC 2006c). Sexual maturity is reached by approximately three years. Mating occurs during late spring to early summer followed by a gestation period of 10–11 months. The gestation period is followed by a lactation period of six months. Most females mate each year and thus spend their entire adult lives both lactating and pregnant. Figure 5.2.24 depicts shipboard and aerial sightings of harbour porpoise between 1995 and 2011.



Source: NOAA 2013n

Figure 5.2.24 Distribution of harbour porpoise sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

Killer Whale (*Orcinus orca*)

Killer whales in the Northwest Atlantic and eastern Canadian Arctic can be found from Baffin and Hudson Bay to US coastal waters (COSEWIC 2008b). Killer whales were once common in the Gulf of St. Lawrence and the St. Lawrence estuary but are now only occasionally sighted in these waters. Declining arctic summer sea ice is allowing killer whales to expand their range into the arctic.

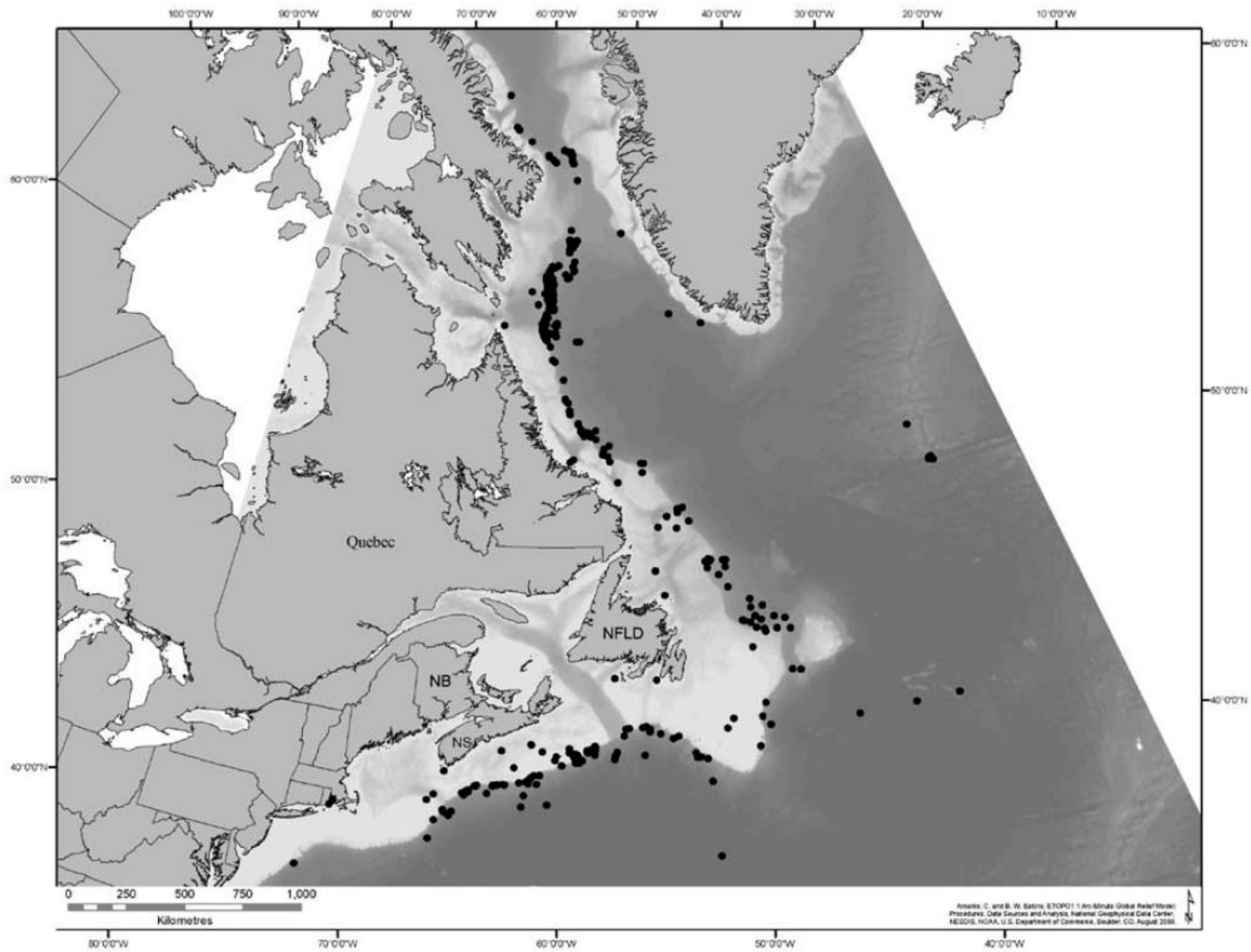
Male killer whales reach sexual maturity at an average of 12.8 years with females reaching maturity at an average of 14.1 years (COSEWIC 2008b).

In the northwest Atlantic, killer whales have been observed preying on harp seals, white-beaked dolphins, minke whales, beluga whales, humpback whales, auks, Bluefin tuna, and herring. They have been sighted most in the summer months, although this may be due to an increased observation effort during this time period (COSWEIC 2008b). There is no evidence of long range north-south migrations.

Northern Bottlenose Whale (*Hyperoodon ampullatus*)

The northern bottlenose whale can be found inhabiting waters off the east coast of Canada that are deeper than 500 m (COSWEIC 2011b). They can be found concentrated along the continental slope at depths of 800–1500 m, with a major concentration off the eastern Scotian Shelf. The Scotian Shelf population is concentrated around the Gully, and Shortland and Haldimand Canyons (all designated Critical Habitat under SARA), east of the Project Area. There have been sightings primarily along the shelf break, including at Dawson and Verrill Canyons and into deeper waters off the slope. The species is non-migratory and can be found year-round in the area. Figure 5.2.25 illustrates sightings of Northern bottlenose whales in Canadian waters from 1976 to 2010.

Females reach sexual maturity at 8–13 years of age, with males reaching maturity earlier on at an age of 7–9 years (COSEWIC 2011b). Females give birth to a single calf every two years after a gestation period of 12 months. They feed primarily on deepwater fishes and squid, and as a result fit into a very narrow ecological niche. Whitehead and Wimmer have estimated the Scotian Shelf population to contain 164 adult and immature whales (COSEWIC 2011b).

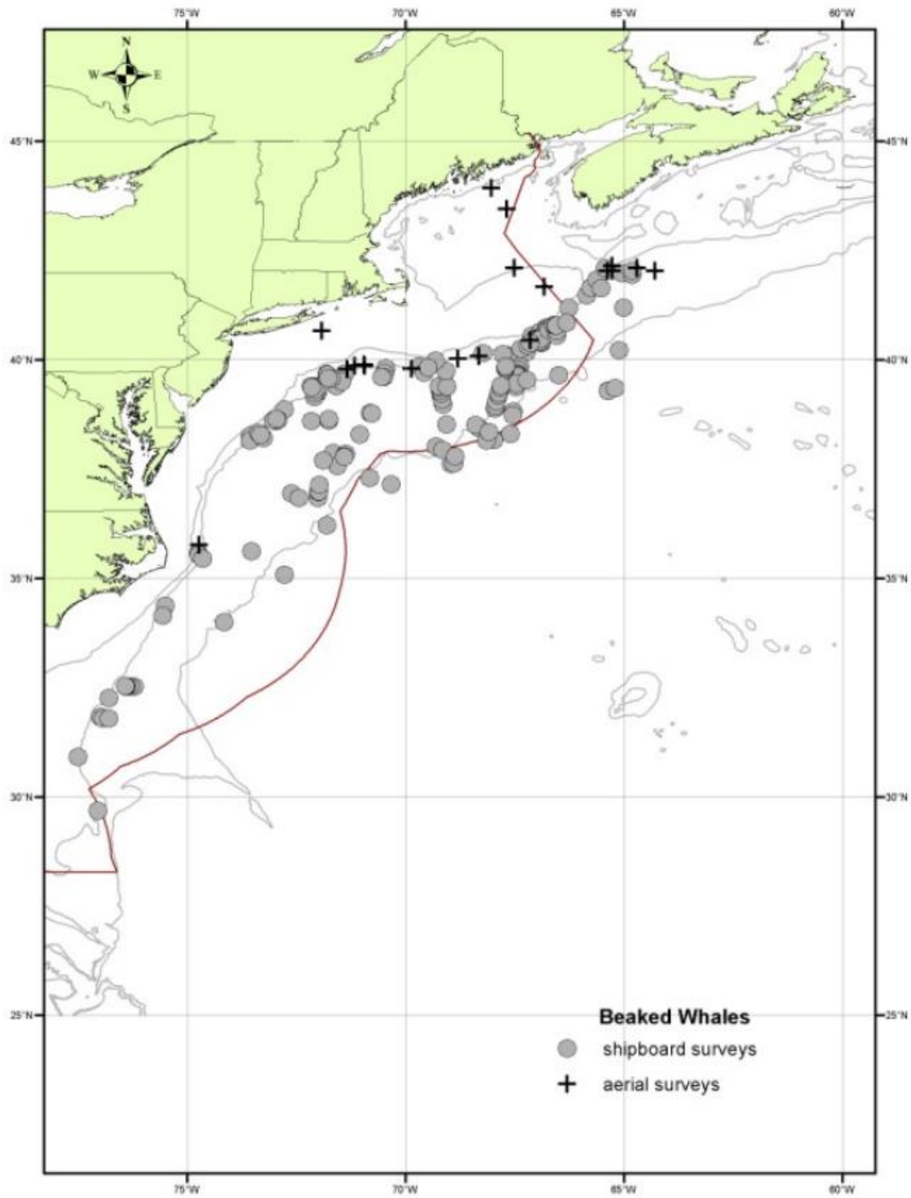


Source: COSEWIC 2011b

Figure 5.2.25 Sightings of Northern Bottlenose Whales off Canada and Adjacent Waters (n= 16 808) Between 1867 and 2010

Sowerby's Beaked Whale (*Mesoplodon bidens*)

Sowerby's beaked whale is only found in the North Atlantic with some known occurrence along the Scotian Shelf. Although sightings are rare, the specieshas been observed in the Gully MPA. In recent years, sightings have significantly increased in the Gully, Shortland, and Haldimand Canyons, in the eastern areas of the shelf and slope. On the Western Scotian Shelf, they can be found on the edges of Browns and Baccaro Banks as well as the entrance to the Northeast Channel (NOAA 2013n). Habitat tends to concentrate around shelf edges and slopes and has been found in waters deeper than 1500 m (COSEWIC 2006d). The timing and age at which breeding occurs for Sowerby's beaked whale is largely unknown. The species feeds mainly on mid-depth to deepwater fish as well as squid (COSEWIC 2006d). Figure 5.2.26 depicts shipboard and aerial sightings of beaked whales between 1995 and 2011.

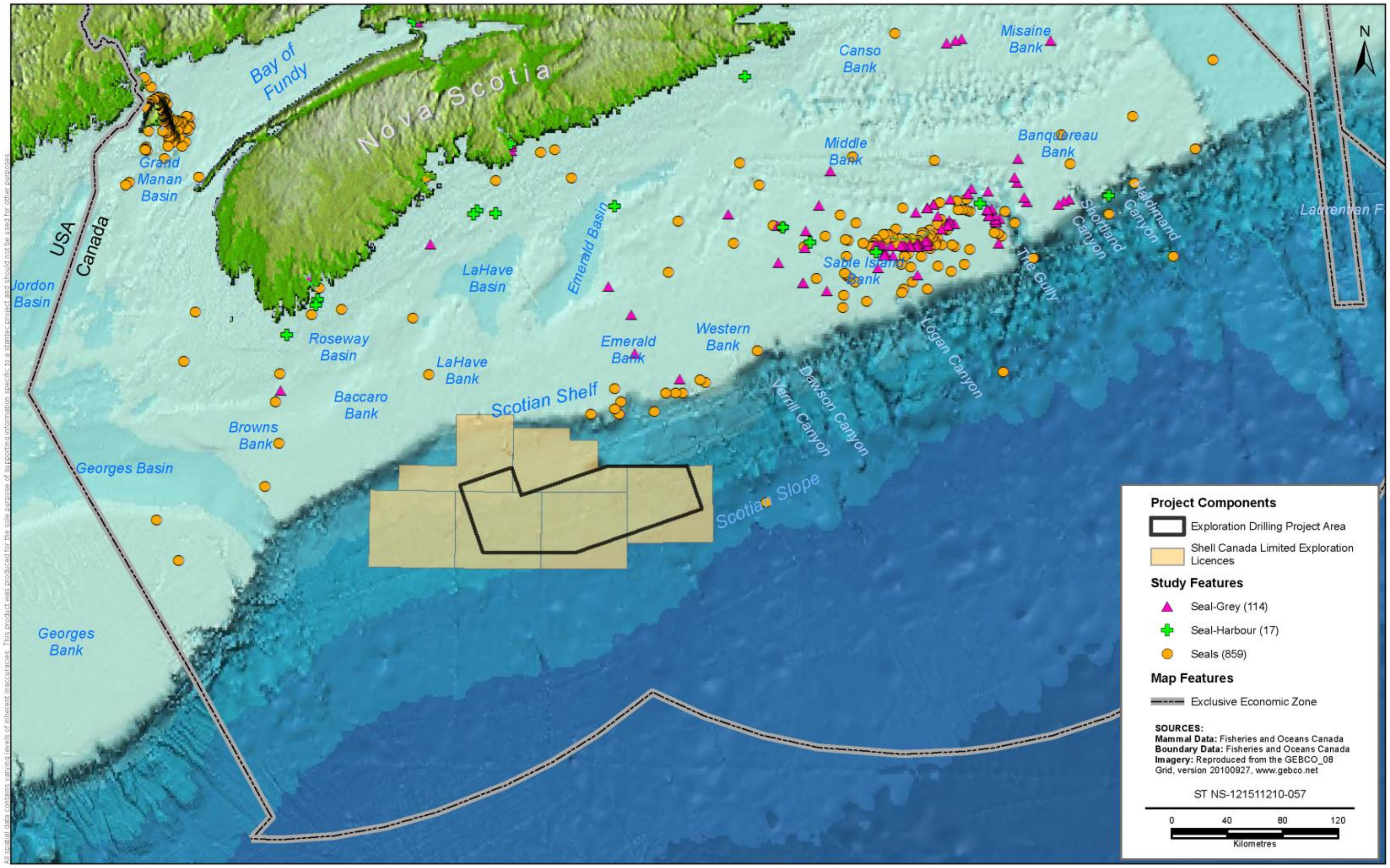


Source: NOAA 2013n

Figure 5.2.26 Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. Isobaths represent the 100, 1000, and 4000 m depth contours.

5.2.4.5 Pinnipeds

There are five species of pinnipeds (seals) that can be found foraging year-round in the waters over the Scotian Shelf and Slope, although only the grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are known to breed offshore Nova Scotia (Stantec 2014). Sable Island is a significant area for seals as it hosts the world's largest breeding colony of grey seals, as well as a smaller population of harbour seals (DFO 2011a). Smaller breeding colonies have also been found on coastal islands along Southwestern Nova Scotia at Flat, Mud, Noddy, and Round Islands (Bowen *et al.* 2011). Grey seals pup from mid-December to late January, while harbour seals pup from mid-May to mid-June. Harp seal (*Pagophilus groendlandica*), hooded seal (*Cystophora cristata*), and ringed seal (*Phoca hipsida*) are considered to be infrequent visitors and have occasionally been observed foraging offshore Nova Scotia (DFO 2011a). None of the seal populations present offshore Nova Scotia are designated under SARA or by COSEWIC. Figure 5.2.27 shows where seal observations have been recorded on the Scotian Shelf and Slope between 1911 and 2013.



Source: DFO Marine Mammals Sightings Database

Figure 5.2.27 Seal Sightings on the Scotian Shelf and Slope (1911–2013)

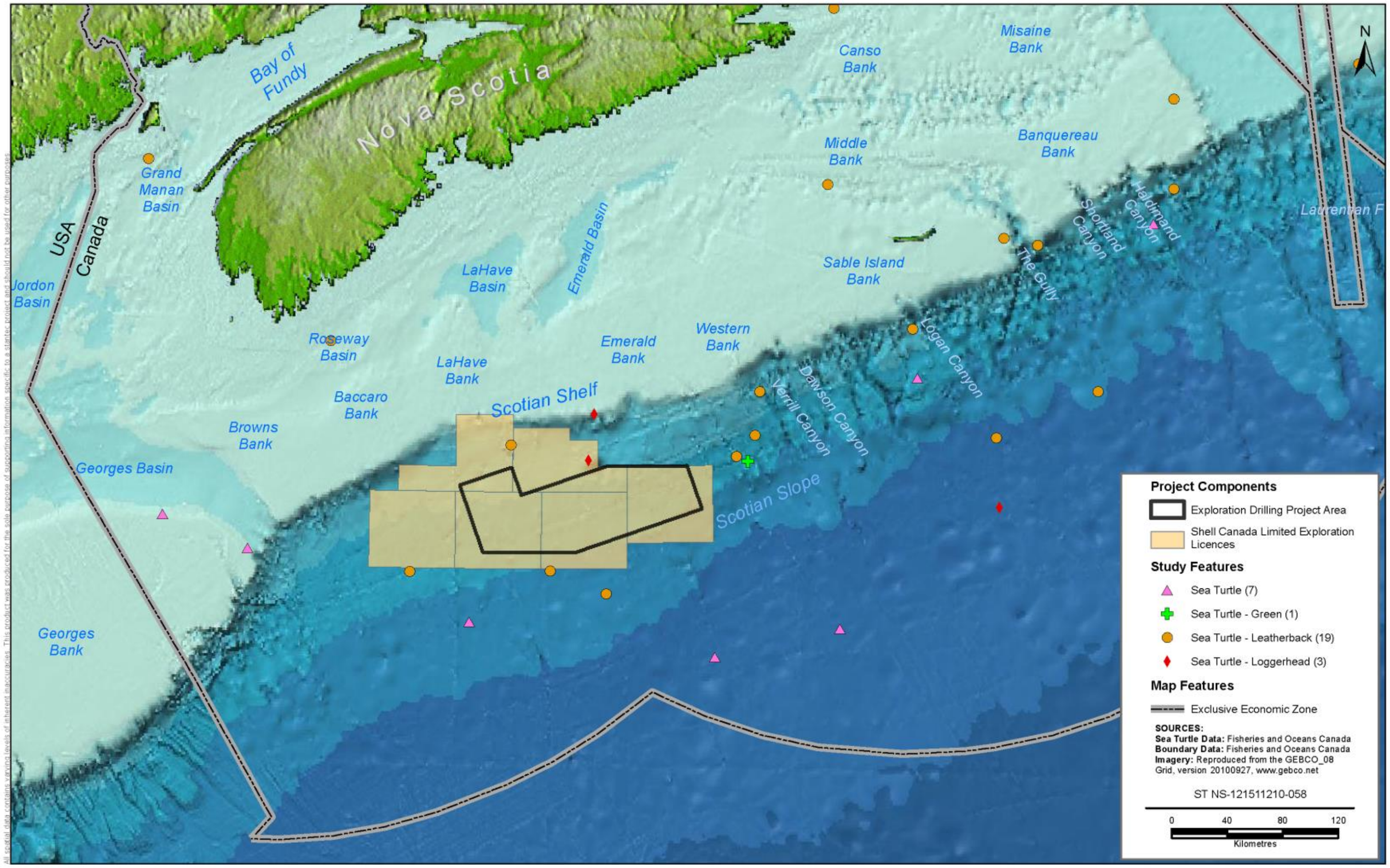
5.2.5 Sea Turtles

There are four species of sea turtles that can be found migrating and foraging on the Scotian Shelf and Slope (Table 5.2.10), although only the endangered leatherback turtle and the loggerhead turtle are known to regularly forage in Atlantic Canada waters. As indicated in the SEA for the Western Scotian Slope (Stantec 2014), DFO is currently in the process of using satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada. The information generated by this exercise will be used to propose critical habitat for designation under SARA (DFO 2011c). Figure 5.2.28 depicts sea turtle sightings recorded from 1911 to 2013, according to the DFO Marine Mammals Sightings Database. Figure 5.2.29 shows the locations where sea turtles were observed during Shell's 2013 Shelburne Basin 3D seismic survey.

Table 5.2.10 Sea Turtle Species Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area	Timing of Presence
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1, Endangered	Endangered	High	April to December
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered	High	April to December
Kemp's ridley turtle	*Lepidochelys kempii*	Not Listed	Not Listed	Low	Summer
Green sea turtle	*Chelonia mydas*	Not Listed	Not Listed	Low	Summer

Source: Stantec 2014



Source: DFO Marine Mammals Sightings Database

Figure 5.2.28 Sea Turtle Sightings on the Scotian Shelf and Slope (1911–2013)

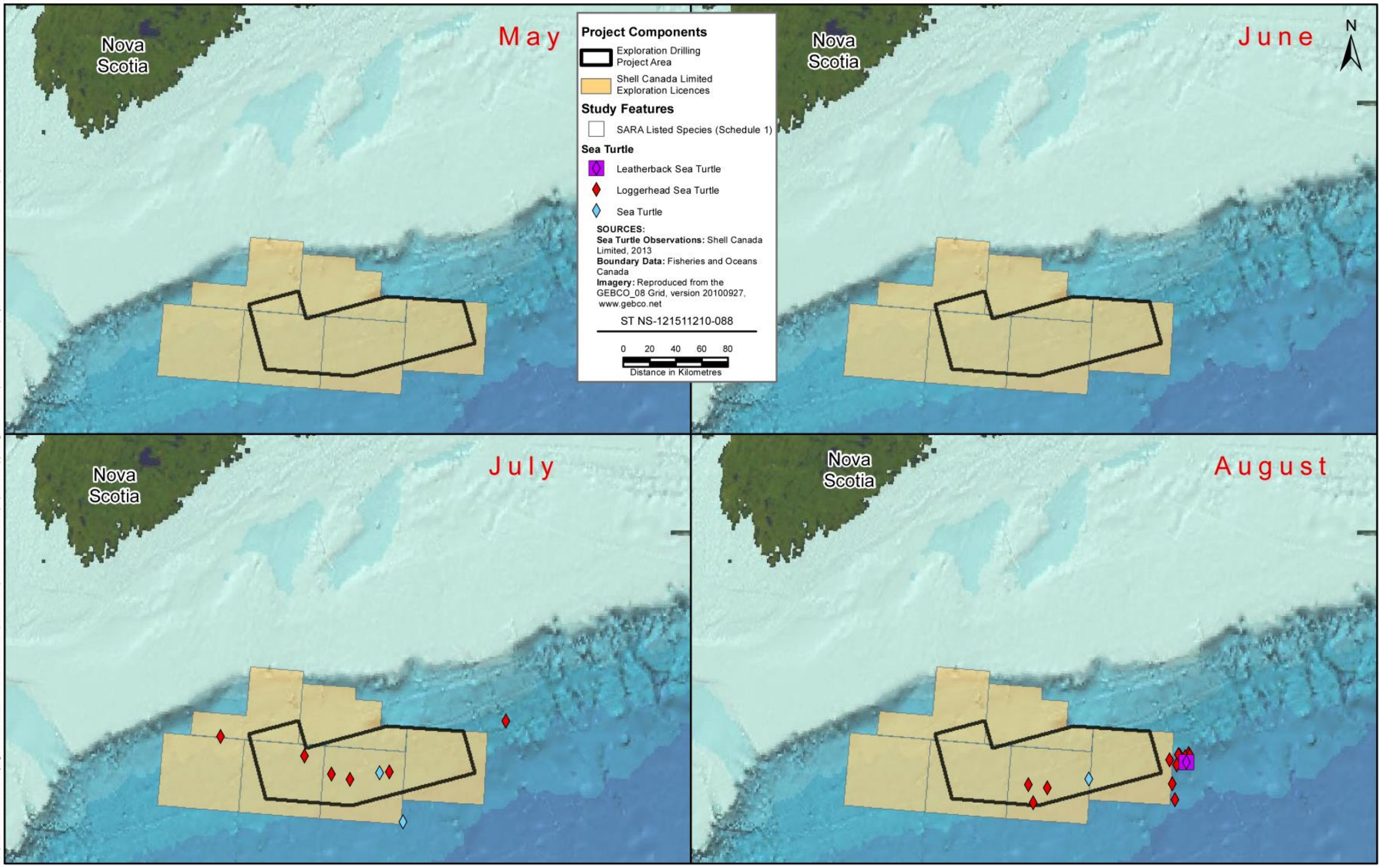


Figure 5.2.29 Sea Turtle Observations Collected during the 2013 Shelburne Seismic Survey

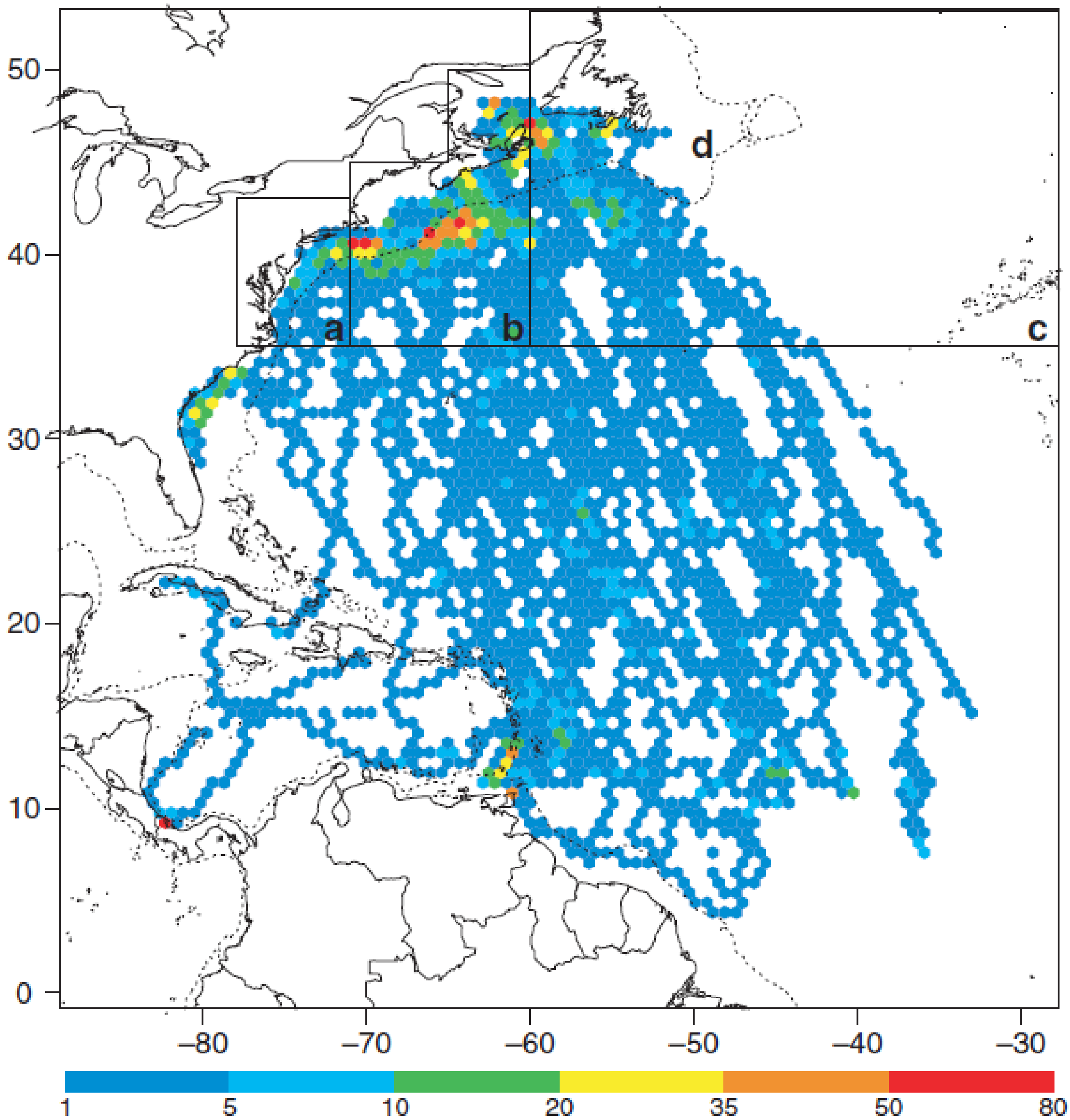
Leatherback Sea Turtle (*Dermochelys coriacea*)

The leatherback sea turtle is the most widely distributed and largest of all marine turtles. In the Northwest Atlantic, they can be found in both the shelf and offshore slope waters as well as in the Gulf of St. Lawrence (COSEWIC 2012f). Data comprised of satellite tracking studies as well as sighting information indicate that the species can be found in Atlantic Canadian waters from April to December. The highest densities of leatherbacks can be found from July to September. The species distribution generally shifts from the southwest to the northeast, as the foraging period progresses in the area (COSEWIC 2012f). Slope waters off the Northeast Channel are also thought to provide habitat throughout the entire summer and fall. The species can be found in high densities in the shelf waters off Cape Breton Island, off the south coast of Newfoundland, the southern Gulf of St. Lawrence, as well as in offshore slope waters including the Northeast Channel.

Their distribution in Canadian waters is believed to be primarily based on maximizing foraging habits. The species forages on gelatinous zooplankton (primarily jellyfish consuming on average 330 kg/day) in the waters of the Scotian Shelf during the summer and fall months. The species follows a predictable migratory cycle which includes annual return trips between southern feeding and breeding areas and northern foraging habitat (COSEWIC 2012f). The leatherback may swim more than 10 000 km between nesting locations in the tropics and foraging areas in the north. Leatherbacks found in Atlantic Canada originate from nesting beaches in the wider Caribbean, South and Central America, and Florida. James *et al.* (2005) tagged 38 leatherback turtles from 1999 to 2003 with satellite tags and tracked their migration patterns. Figure 5.2.30 depicts the number of days that each turtle spends in a particular area. It should be noted that the Western Scotian Slope is a high area of use for foraging by the species. Although critical habitat for this species has not yet been defined under SARA, it is expected that this will occur in 2014 and may encompass a large area of the Scotian Shelf and Slope in the RAA (DFO, pers. comm. 2014).

There are five life-history stages in the leatherback sea turtle's life cycle which include: egg and hatching, post-hatchling, juvenile, sub-adult, and adult. The age of maturity for the species is largely uncertain but is estimated to range from 6.8 to 29 years (COSEWIC 2012f). Mating observations have been rare and occur in the southern latitudes of their nesting sites. Males will travel with nesting colonies in advance of the nesting season and remain until peak nesting has finished. Females generally nest on sandy, tropical beaches at 2–4 year intervals. Both the time and duration of nesting varies with geographic location and lasts between three and six months in a nesting year. Females generally lay on average 80 eggs several times over a nesting season, typically at 8–12 day intervals. Nesting is generally nocturnal, with daytime nesting occasionally occurring.

One leatherback sea turtle was recorded during the marine mammal observation program for the Shelburne Basin 3D seismic survey on the Scotian Slope between June and August 2013 (refer to Figure 5.2.29).



Source: James *et al.* 2005

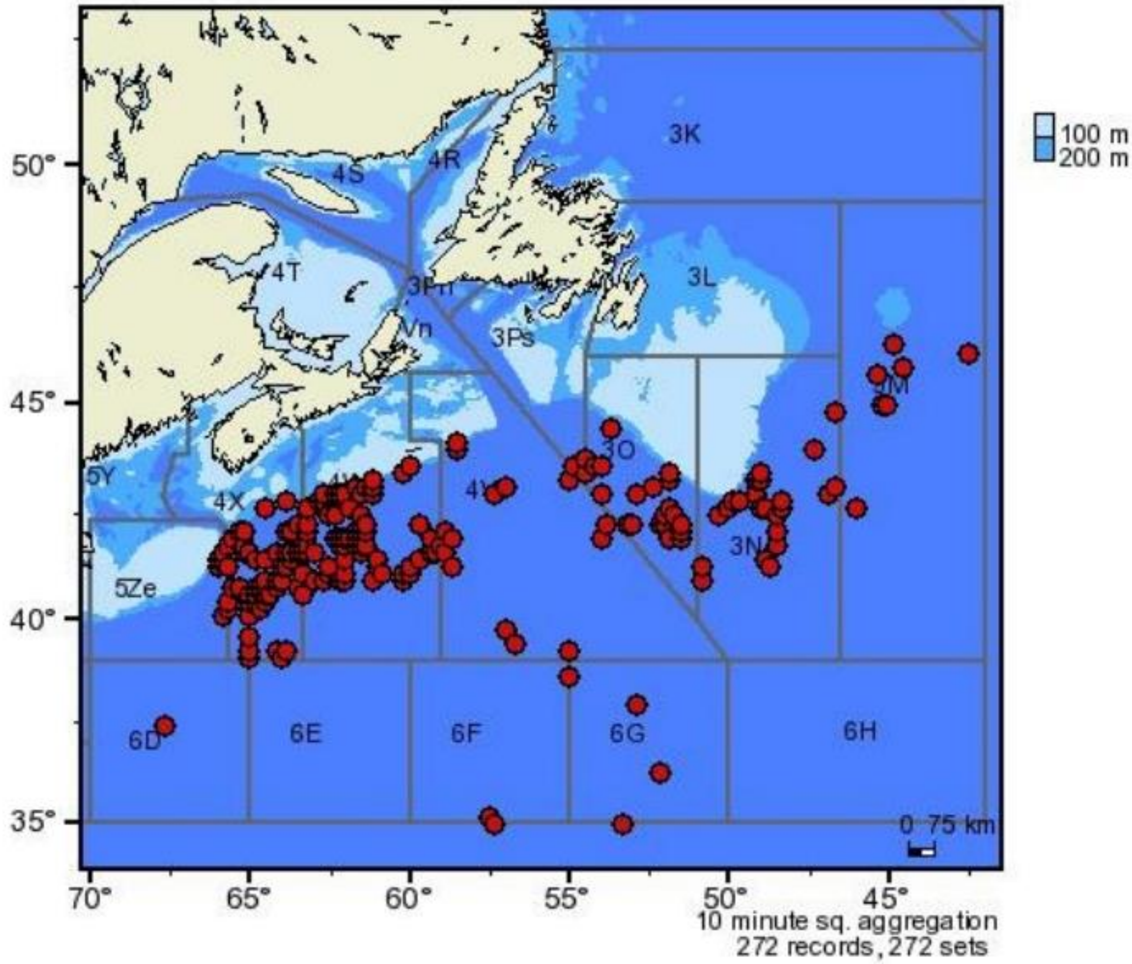
Figure 5.2.30 The spatial use of 38 leatherback turtles equipped with satellite tags in the waters off Nova Scotia. Leatherback Turtles were tagged from 1999–2003 with an average observation period of 218 days. Colour denotes the number of day(s) each turtle was tracked in a particular polygon.

Loggerhead Sea Turtle (*Caretta caretta*)

Immature loggerhead sea turtles occur regularly at the edge of the Scotian Shelf and on the Slope and are routinely found foraging on the Scotian Shelf and Slope and Georges Bank. They migrate to Atlantic Canada waters during the spring months and return south for the winter, breeding as far north as Virginia with the largest breeding colony in North America in Florida (COSEWIC 2010e). Recent findings have determined that not all loggerheads leave the area during the winter months. Telemetry data has shown that some turtles move east and northeast during the winter. From observations it seems that loggerhead sea turtles are found mostly within the 20–25 °C water temperature contours. Loggerheads were absent when temperatures were below 15 °C. In general they are associated with the warm waters of the Gulf Stream in Atlantic Canadian waters. The species can occasionally be found closer to shore when warm core rings break off and intrude over the Scotian Shelf.

In general, loggerhead sea turtles make predictable migrations from southern breeding grounds in the Southern US, Caribbean, Gulf of Mexico, and South America to temperate foraging grounds in the Northern Atlantic (COSEWIC 2010e). Nesting occurs on beaches and occasionally estuarine shorelines at night. Females tend to return to the site of their birth to nest. Females nest on a 2–3 year interval and lay three to four clutches of on average 112 eggs with 14 days in-between events. Eggs hatch approximately 7–13 weeks.

Sixteen loggerhead turtles were observed during the Shelburne Basin 3D seismic survey on the Scotian Slope between June and August 2013. Figure 5.2.31 depicts the location of Loggerhead turtle captures recorded by at-sea observers on Canadian pelagic longline fishing trips between 1999 and 2008.



Source: COSEWIC 2010e

Figure 5.2.31 The location of loggerhead sea turtle captures recorded by at-sea observers on Canadian pelagic longline fishing trips 1999–2008. Each point represents a location where one or more loggerhead turtles were caught.

Kemp's Ridley Turtle (*Lepidochelys kempii*)

Kemp's ridley turtle is the smallest of sea turtles. The species can be found throughout the Gulf of Mexico and along the US eastern seaboard and can occasionally be seen in the waters of Nova Scotia (NOAA 2013o). Adult Kemp's ridleys can be found in depths of less than 50 m over sand or muddy substrates, feeding on crabs, fish, jellyfish, and mollusks. Nesting occurs almost exclusively on three main beaches in Mexico.

Green Sea Turtle (*Chelonia mydas*)

The green sea turtle is unique among sea turtles in that it is herbivorous, feeding on plants (NOAA 2013p). Green sea turtles are widely distributed in tropical and sub-tropical waters between 30° North and 30° South. In the Western Atlantic they are found from the Gulf of Mexico to Massachusetts. The nesting season of the green sea turtle varies from location to location but females usually nest in the summer months from June to July on beaches throughout their southern range (NOAA 2013p).

A green turtle and green turtle-loggerhead hybrid documented in nearshore waters off Nova Scotia by James *et al.* (2004) represent the most northerly confirmed records of green turtle in the Northwest Atlantic. There is some evidence that the green turtle occurs regularly on the Scotian Shelf seasonally, although their observed numbers are much lower than the leatherback and loggerhead.

5.2.6 Marine Birds

5.2.6.1 Overview

Waters off the Scotian Shelf are known to be nutrient rich and highly productive due to the complex oceanographic conditions of the area (Fifield *et al.* 2009). It has been estimated that over 30 million seabirds use eastern Canadian waters each year (Fifield *et al.* 2009). Large numbers of breeding marine birds as well as millions of migrating birds from the southern hemisphere and northeastern Atlantic can be found using the area throughout the year (Gjerdrum *et al.* 2008, 2012). The combination of northern hemisphere birds and southern hemisphere migrating birds results in a diversity peak during spring months (Fifield *et al.* 2009). During the fall and winter significant numbers of overwintering alcids, gulls, and Northern Fulmars (*Fulmarus glacialis*) can be found in Atlantic Canadian waters (Brown 1986), whereas in the summer, species assemblages are dominated by shearwaters, storm-petrels, Northern Fulmars, and gulls (Fifield *et al.* 2009).

Marine related birds can be divided into four groups:

- pelagic seabirds
- neritic seabirds
- waterfowl and divers
- shore birds

Pelagic seabirds are truly a marine species, feeding and resting at sea, only coming to land to breed, usually on rocky cliffs and islands. Non-breeding seabirds can be found on the Scotian Shelf and Slope during all times of the year (Lock *et al.* 1994). During the summer months, large numbers of Great and Sooty Shearwaters (*Puffinus gravis* and P. *griseus*) migrate from the sub-Antarctic through the North Atlantic, first appearing in April and reaching a peak during July. Wilson's Storm Petrels (*Oceanites oceanicus*) also migrate from the same regions and are abundant during the summer months, with the highest concentrations over Georges Bank and the southern Scotian Shelf (Lock *et al.* 1994). The winter seabird fauna is quite different, consisting mainly of Arctic breeding birds. Dovekies (*Alle alle*) can be found wintering in ice-free waters throughout the Atlantic. Northern fulmars, auks, and Black-legged Kittiwakes (*Rissa tridactyla*) can also be found in the area throughout the winter months. In total, at least 19 species of pelagic seabirds regularly occur on the Scotian Shelf and Slope throughout the year (Table 5.2.11).

Neritic seabirds typically feed in shallow coastal waters and return to land to rest at night. Neritic species which have the potential to be found over the Scotian Shelf and Slope include terns, gulls, and cormorants. Approximately 14 species of neritic seabirds occur on the Scotian Shelf and Slope throughout the year, including the endangered Ivory Gull and Roseate Tern (Table 5.2.11).

Waterfowl can be broadly divided into seaducks, dabbling ducks, swans and geese. All of the waterfowl species found in association with the Scotian Shelf (with the exception of eiders) nest near fresh water. Eiders typically nest on coastal islands where fresh water is available and raise their broods in coastal waters. Outside of the breeding season, seaducks are generally found on coastal waters, over reefs and banks where benthic prey are accessible. Many dabbling ducks forage in freshwater or sheltered coastal waters such as bays, salt marshes and estuaries during the non-breeding season. In addition, Canada Goose (*Branta canadensis*) are attracted to deltaic areas, where they rely on shallow, open, fast-flowing water for foraging when they arrive in early spring. For nesting, this species prefers peatlands and fluvial sites in boreal regions.

During the winter months, waterfowl are distributed fairly evenly along the coast of Nova Scotia. The lowest densities of waterfowl are associated with exposed coastal portions of Cape Breton's Northern peninsula (Lock *et al.* 1994). Eiders are the only abundant waterfowl in the coastal area during the summer months. In July and August as many as 30 000 moulting eiders can be found nearshore between Shelburne and Port Mouton (Lock *et al.* 1994). During the fall months, the number of coastal waterfowl is variable as birds move through the area on migration routes to the south (Lock *et al.* 1994). Approximately 18 species of waterfowl regularly occur in association with coastal waters of the Scotian Shelf and Slope, including the endangered Harlequin Duck and Barrows Goldeneye, a species of Special Concern (Table 5.2.11).

Many shorebirds nest in wetland or upland habitats and utilize coastal stopover sites for feeding and resting during migration. Although many shorebirds nest in inland habitats, some species such as Willet (*Tringa semipalmata*) and Piping Plover (*Charadrius melodus*) will raise their young in coastal environments. Most shorebirds (with the exception of Purple Sandpipers (*Calidris maritima*) which primarily use rocky shorelines during migration and overwintering), forage along coastal beaches, exposed mud flats or salt marshes during migration, with high concentrations of birds often being found in associated with sites that provide an abundant food source. Such stopover sites can be crucial to the survival of shorebird species because they provide important energy reserves that are necessary for undertaking long, uninterrupted flights (COSEWIC 2007). Of exception to these coastal associations, phalaropes (*Phalaropus spp*.) typically forage on the surface of the sea in areas where upwelling brings plankton to the surface, and are thus often found offshore. Approximately 23 species of shorebird regularly occur in association with the Scotian Shelf and Slope, including the endangered Red Knot and Piping Plover (Table 5.2.11).

Table 5.2.11 Marine Birds[1] of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Pelagic Seabirds					
Atlantic Puffin	*Fratercula arctica*				Likely
Black-legged Kittiwake	*Rissa tridactyla*				Likely
Common Murre	*Uria aalge*				Likely
Cory's Shearwater	*Calonectris diomedea borealis*				Likely
Dovekie	*Alle alle*				Likely
Great Shearwater	*Puffinus gravis*				Likely
Great Skua	*Stercorarius skua*				Likely
Leach's Storm-Petrel	*Oceanodroma leucorhoa*				Likely
Long-tailed Jaeger	*Stercorarius longicaudus*				Likely
Manx Shearwater	*Puffinus puffinus*				Likely
Northern Fulmar	*Fulmarus glacialis*				Likely
Northern Gannet	*Morus bassanus*				Likely
Parasitic Jaeger	*Stercorarius parasiticus*				Likely
Pomarine Jaeger	*Stercorarius pomarinus*				Likely
Razorbill	*Alca torda*				Likely
Sooty Shearwater	*Puffinus griseus*				Likely
South Polar Skua	*Stercorarius maccormicki*				Likely
Thick-Billed Murre	*Uria lomvia*				Likely
Wilson's Storm-Petrel	*Oceanites oceanicus*				Likely
Neritic Seabirds					
Arctic Tern	*Sterna paradisaea*				Likely
Black Guillemot	*Cepphus grille*				Unlikely
Black-headed Gull	*Larus ridibundus*				Unlikely
Bonaparte's Gull	*Larus philadelphia*				Unlikely
Common Tern	*Sterna hirundo*				Likely
Double-Crested Cormorant	*Phalacrocorax auritus*				Unlikely

Table 5.2.11 Marine Birds[1] of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Glaucous Gull	*Larus hyperboreus*				Likely
Great Black-backed Gull	*Larus marinus*				Likely
Great Cormorant	*Phalacrocorax carbo*				Unlikely
Herring Gull	*Larus argentatus*				Likely
Iceland Gull	*Larus glaucoides*				Likely
Ivory Gull	*Pagophila eburnea*	Endangered	Endangered		Likely
Ring-billed Gull	*Larus delawarensis*				Likely
Roseate Tern	*Sterna dougallii*	Endangered	Endangered	Endangered	Likely
Waterfowl					
American Black Duck	*Anas rubripes*				Unlikely
American Green-winged Teal	Anas crecca				Unlikely
Barrows Goldeneye	*Bucephala islandica*	Special Concern	Special Concern		Unlikely
Black Scoter	Melanitta nigra				Unlikely
Bufflehead	*Bucephala albeola*				Unlikely
Canada Goose	*Branta Canadensis*				Unlikely
Common Eider	*Somateria mollissima*				Unlikely
Common Goldeneye	*Bucephala clangula*				Unlikely
Common Loon	*Gavia immer*				Unlikely
Greater Scaup	*Aythya marila*				Unlikely
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern	Endangered	Unlikely
Lesser Scaup	Aythya affinis				Unlikely
Long-tailed Duck	*Clangula hyemalis*				Unlikely
Mallard	Anas platyrhynchos				Unlikely
Red-breasted Merganser	*Mergus serrator*				Unlikely
Red-throated Loon	*Gavia stellata*				Unlikely
Surf Scoter	Melanitta perspicillata				Unlikely
White-winged Scoter	Melanitta fusca				Unlikely

Table 5.2.11 Marine Birds[1] of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Shorebirds					
American Golden-Plover	*Pluvialis dominica*				Unlikely
Black-bellied Plover	*Pluvialis squatarola*				Unlikely
Dunlin	*Calidris alpina*				Unlikely
Greater Yellowlegs	*Tringa melanoleuca*				Unlikely
Killdeer	*Charadrius vociferus*				Unlikely
Least Sandpiper	*Calidris minutilla*				Unlikely
Lesser Yellowlegs	*Tringa flavipes*				Unlikely
Pectoral Sandpiper	*Calidris melanotos*				Unlikely
Piping Plover (melodus subspecies)	*Charadrius melodus melodus*	Endangered	Endangered	Endangered	Unlikely
Purple Sandpiper	*Calidris maritima*				Unlikely
Red Knot rufa ssp	*Calidris canutus rufa*	Endangered	Endangered	Endangered	Unlikely
Red Phalarope	*Phalaropus fulicaria*				Likely
Red-necked Phalarope	*Phalaropus lobatus*				Likely
Ruddy Turnstone	*Arenaria interpres*				Unlikely
Sanderling	*Calidris alba*				Unlikely
Semipalmated Plover	*Charadrius semipalmatus*				Unlikely
Semipalmated Sandpiper	*Calidris pusilla*				Unlikely
Short-billed Dowitcher	*Limnodromus griseus*				Unlikely
Spotted Sandpiper	*Actitis macularius*				Unlikely
Whimbrel	*Numenius phaeopus*				Unlikely
White-rumped Sandpiper	*Calidris fuscicollis*				Unlikely
Willet	*Tringa semipalmata*				Unlikely

[1] Exluding rare transients / vagrants, except for Species at Risk which are known to occasionally occur (*e.g.*, Ivory Gull)

[2] Spatial boundaries of the Project Area are shown in Figure 5.2.32; potential occurrence considers known spatial and temporal use of the waters near the Project Area; Unlikely: generally restricted to coastline and nearshore waters; Likely: regular occurrence in offshore waters and may be expected to occur within the Project Area during the breeding season (*i.e.*, for feeding), migration, and/or overwintering.

5.2.6.2 Seasonal Distribution of Marine Birds in Association with the Scotian Shelf and Slope

Information on the distribution and abundance of marine birds in association with the Scotian Shelf and Slope was primarily obtained from the PIROP (Programme Intégré de Recherches sur les Oiseaux Pélagiques) and Eastern Canadian Seabirds at Sea (ECSAS) databases. Seabird observations within these databases are from ship-based surveys and were mapped according to season (Figure 5.2.33 to Figure 5.2.48), including spring (March, April, and May), summer (June, July, and August), fall (September, October, and November), and winter (December, January, and February). Despite some differences in the survey methods between ECSAS and PIROP, data were integrated into common maps to convey information on the relative distribution and abundance of seabirds. Species were either mapped individually or combined into guilds / or taxonomic groups depending on their abundance and distribution on the Scotian Shelf and along the Slope. Those which were mapped individually were Black Guillemot (*Cepphus grille*), Dovekie, Northern Fulmar, Northern Gannet (*Morus bassanus*), and Black-legged Kittiwake. Guilds and/or taxonomic groups were used to convey patterns for other species and included large alcids, cormorants, gulls, jaegers, phalaropes, shearwaters, skuas, storm-petrels, terns, and waterfowl. The distribution and abundance of seabird observations made during ship-based surveys were considered with respect to the locations of large seabird colonies, but more detailed information on the location of colonies and the types and abundances of species they support are provided in Section 5.2.6.3.

Additional information on the densities of seabirds in association with the Scotian Shelf was obtained from Fifield *et al.* (2009), which presented results from a 3.5 year offshore seabird monitoring program (Table 5.2.12). This program was intended to assess seabird abundance and distribution in areas of eastern Canada with oil industry activity. Data from Fifield *et al.* (2009) were collected as part of the larger ECSAS initiative, which used distance sampling methods to account for varying seabird detectability. The majority of surveys were conducted from either oil industry supply ships or DFO research/fishery patrol vessels. A small number of other surveys were conducted from ferries, cargo vessels, seismic ships or sailboats (Fifield *et al.* 2009). Although the data from this study is encompassed in the larger ECSAS database, it has been referenced here because it provides a comparison between the Scotian Shelf (and nearby Gulf of Maine) to other waters of the Northeast (particularly the Gulf of St. Lawrence, and the Newfoundland and Labrador Shelves).

Information on the spatial distribution and timing of PIROP and ECSAS survey effort is provided in Figure 5.2.32. Data on the distribution of seabird observations (all data) indicate that survey effort varies with season and that more effort has been directed at certain locations along the Scotian Shelf and Slope than others. In general, ECSAS and PIROP survey effort has been relatively low in winter compared to summer, spring, and fall (Figure 5.2.32). Surveys have been more abundant on than off the Scotian Shelf, and more frequent along certain shipping lanes than others (Figure 5.2.32).

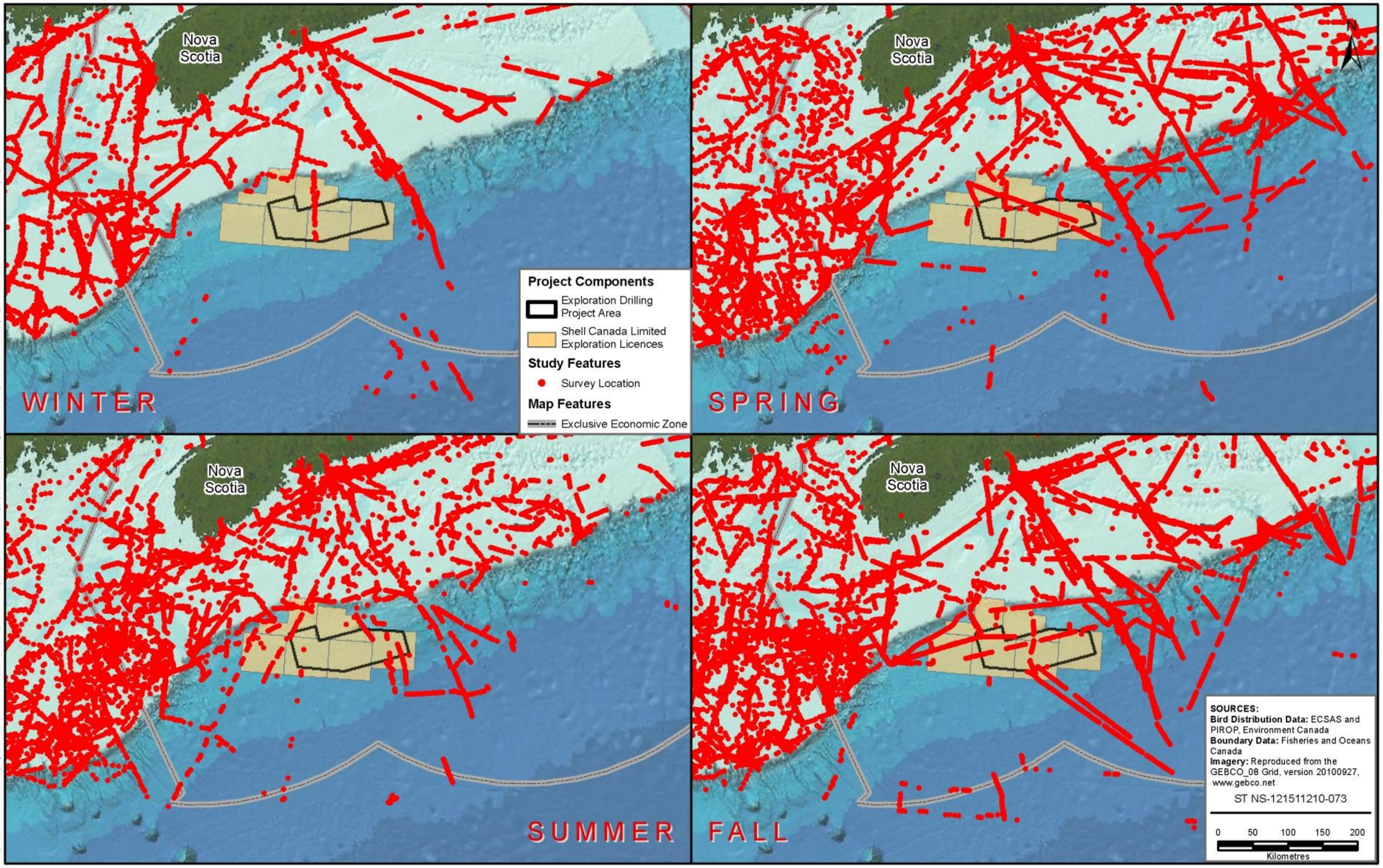


Figure 5.2.32 Seasonal ECSAS and PIROP Survey Effort on the Scotian Shelf and Slope

Marine birds are present throughout the Scotian Shelf and Slope during the summer months and are often encountered in relatively high abundance (Figure 5.2.33). Data from Fifield *et al.* (2009) suggest that the abundance of seabirds on the Scotian Shelf and Slope (and nearby Gulf of Maine) are highest during summer months compared to other seasons (Table 5.2.12). Additionally, the abundance of waterbirds on the Scotian Shelf at this time of year are estimated to be greater than those associated with the Gulf of St. Lawrence, but less than with the Newfoundland and Labrador Shelves (Fifield *et al.* 2009). According to the PIROP and ECSAS datasets obtained for this Project, the most abundant species observed on the western Scotian Shelf and Slope during summer are Red Phalarope (*Phalaropus lobatus*), Great Shearwater (*Puffinus gravis*), and Wilson's Storm Petrel (*Oceanites oceanicus*). In addition, Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Herring Gull (*Larus argentatus*), Great Black-backed Gull (*Larus marinus*), and Sooty Shearwater (*Puffinus griseus*) are also abundant at this time of year. The richness and abundance of seabirds on the Scotian Shelf and Slope during summer months strongly reflects the presence of migrating birds. At this time of year, species that breed mostly in the high Arctic are starting to migrate through the area on the way to their winter grounds (*e.g.*, Red Phalarope), and those that breed in the South Atlantic migrate to the North Atlantic during the austral winter (*e.g.,* Great Shearwater and Wilson’s Storm-Petrel). Marine birds that breed in nearby areas (*e.g.*, Leach's Storm-Petrel) have arrived in the area and begun nesting by June. The offshore distribution of breeding birds during this period (June-August), however, is restricted, as they become central-place foragers while attending nests and chicks. As such, at-sea observations in the Project Area are not necessarily indicative of species’ abundance within the broader region at this time.

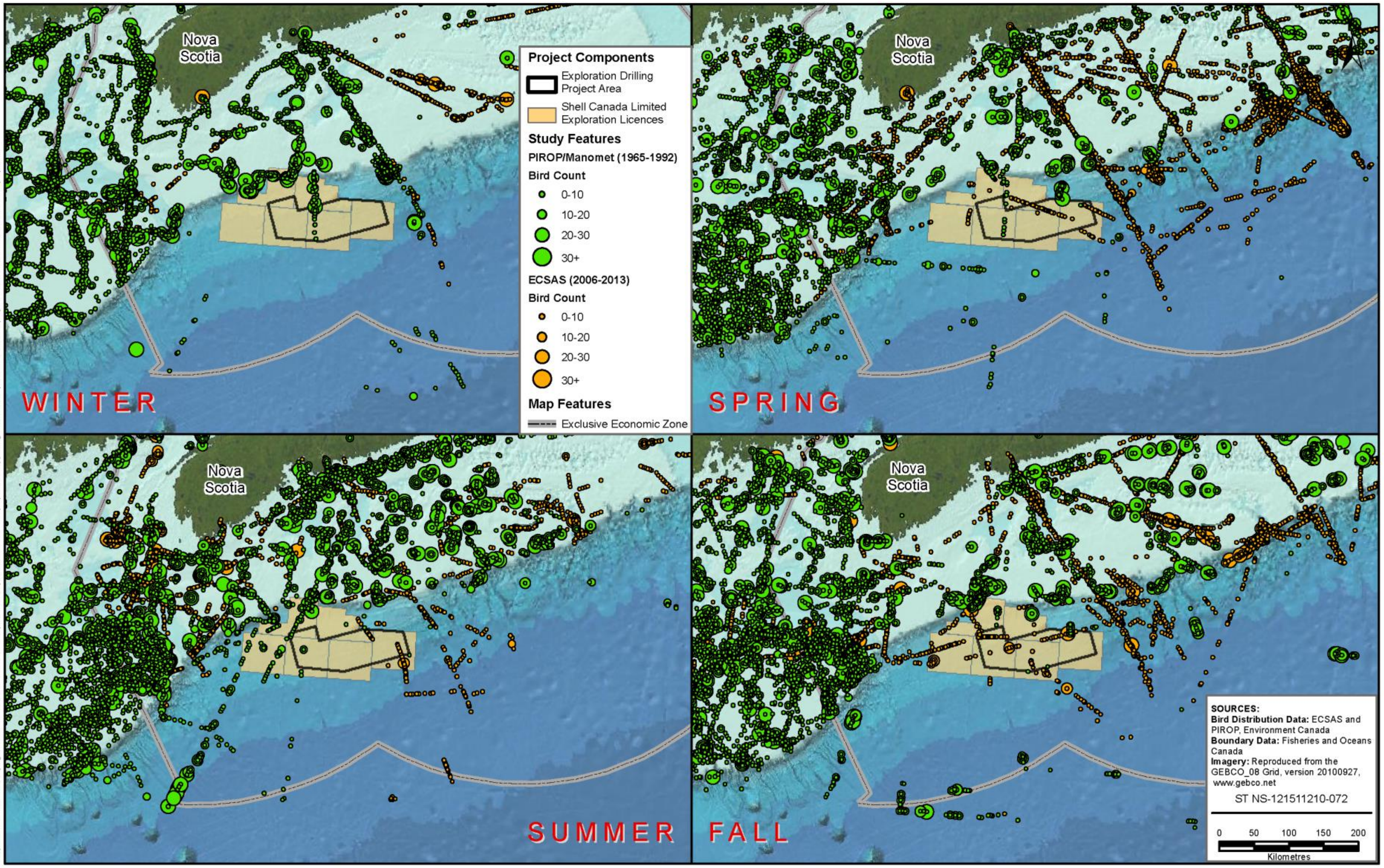


Figure 5.2.33 Seasonal Distribution of all Marine Birds on the Scotian Shelf and Slope

Marine birds may be encountered throughout the Scotian Shelf and Slope during the fall (Figure 5.2.33) but data suggest that their concentrations at this time of year are lower than other seasons (Fifield *et al.* 2009). For example, the seasonal weighted mean of seabirds on the Scotian Shelf during fall (4.23 birds/km^2) was estimated to be approximately half of that calculated for the summer months (8.30 birds/km^2) (Table 5.2.12). Furthermore, the weighted mean of seabirds on the Scotian Shelf (and nearby Gulf of Maine) during fall has been estimated to be less than half than that associated with the Gulf of St. Lawrence and Labrador Shelves (Fifield *et al.* 2009). The species and abundances observed on the Scotian Shelf and Slope during fall would reflect migrating species, the departure of adults and newly fledged young from local seabird colony sites, as well as an influx of wintering species. ECSAS and PIROP data indicate that the most abundant species along the western Scotian Shelf during the fall is Great Shearwater, which would be migrating to the North Atlantic. Additionally, relatively large amounts of Herring Gull, Black-legged Kittiwake, Great Black-backed Gull, and Northern Fulmar were encountered during PIROP and ECSAS in the fall.

Available data indicate that high concentrations of seabirds have been encountered in association with the western Scotian Shelf and Slope during winter (Figure 5.2.33). PIROP and ECSAS data indicate that relatively high concentrations of Black-legged Kittiwake are present at this time, as well as Northern Fulmar, Dovekie, Herring Gull, Great Black-backed Gull, and Thick-billed Murre (*Uria lomvia*). The diversity and abundance of species found on the western Scotian Shelf and Slope between December and February primarily reflects the overwintering presence of birds that migrate to the region from more northern latitudes and the year-round residents.

Marine birds are found throughout the western Scotian Shelf and Slope during spring (Figure 5.2.33). Data indicate that particularly high concentrations of Dovekie, Thick-billed Murre, and Herring Gull are observed along the western Scotian Shelf at this time of year, with Northern Fulmar, Great Black-backed Gull, Great Shearwater, and Leach's Storm-Petrel also being relatively abundant. The diversity and abundance of species observed at this time of year reflects the lingering presence of species that overwinter along the Scotian Shelf and Slope but breed in more northern areas (*e.g.*, Dovekie, Thick-billed Murre), the passage migration of species that breed in the South Atlantic but migrate to the North Atlantic during the austral winter (*e.g.*, Great Shearwater), and the return of those that breed in the area (*e.g.*, Leach's Storm-Petrel). Data from Fifield *et al.* (2009) suggest that seabird concentrations on the Scotian Shelf and Slope (and nearby Gulf of Maine) during spring months are higher than the in the Gulf of St. Lawrence, but lower than that found in association with the Newfoundland and Labrador Shelf ocean regions (Table 5.2.12).

Table 5.2.12 Seasonal Weighted Median (and range) of Seabird Densities (birds/km²) in each of the Marine Ecoregions of Atlantic Canada (from Fifield *et al.* 2009)

Species	Season	Scotian Shelf - Gulf of Maine	Gulf of St. Lawrence	Newfoundland and Labrador Shelves
All Seabirds	Spring	7.92 (0.68 to 25.37)	3.10 (0.37 to 4.52)	14.30 (1.89 to 31.77)
	Summer	8.30 (1.73 to 148.56)	5.27 (2.21 to 14.31)	11.51 (0.34 to 48.78)
	Fall	4.23 (0.97 to 21.18)	11.57 (7.41 to 12.11)	9.24 (0 to 46.73)
	Winter	7.67 (4.39 to 29.44)	-	9.53 (2.31 to 45.12)
Northern Fulmars	Spring	0.75 (0 to 4.24)	1.19 (0 to 1.61)	1.00 (0 to 22.44)
	Summer	0.15 (0 to 1.64)	0.64 (0 to 4.19)	0.48 (0 to 24.17)
	Fall	0.30 (0 to 3.31)	0.27 (0.17 to 0.39)	0.65 (0 to 7.59)
	Winter	1.08 (0 to 12.37)	-	1.91 (0 to 36.77)
Shearwaters	Spring	0 (0 to 0.46)	0 (0 to 0)	0 (0 to 6.30)
	Summer	1.78 (0.29 to 84.02)	0.24 (0 to 0.87)	0.12 (0 to 16.39)
	Fall	2.20 (0 to 18.40)	5.06 (0.20 to 8.27)	0.80 (0 to 31.57)
	Winter	0 (0 to 3.74)	-	0 (0 to 7.20)
Storm-Petrels	Spring	0 (0 to 1.36)	0.12 (0 to 0.12)	0.08 (0 to 6.66)
	Summer	0.78 (0 to 12.74)	0 (0 to 0.21)	0.17 (0 to 8.46)
	Fall	0.02 (0 to 1.47)	0 (0 to 0)	0.26 (0 to 4.41)
	Winter	0 (0 to 0)	-	0 (0 to 0.04)
Northern Gannets	Spring	0.40 (0 to 1.03)	0.94 (0 to - 0.94)	0 (0 to 2.75)
	Summer	0 (0 to 1.69)	0.42 (0 to 1.37)	0 (0 to 3.31)
	Fall	0.19 (0 to 2.83)	2.42 (0.88 to 2.42)	0 (0 to 0.83)
	Winter	0.04 (0 to 0.22)	-	0 (0 to 0)
Large Gulls	Spring	1.22 (0 to 21.33)	0.34 (0 to 0.64)	0.74 (0 to 23.43)
	Summer	0.08 (0 to 8.39)	0.40 (0.16 to 1.70)	0.16 (0 to 9.38)
	Fall	0.58 (0 to 2.86)	0.93 (0.28 to 0.93)	0.13 (0 to 4.51)
	Winter	0.62 (0 to 2.31)	-	0.95 (0 to 20.83)
Black-legged Kittiwakes	Spring	0.06 (0 to 3.74)	0.50 (0 to 0.50)	0.72 (0 to 7.06)
	Summer	0 (0 to 0.76)	0.14 (0 to 2.34)	0.38 (0 to 7.87)
	Fall	0.11 (0 to 1.39)	0.79 (0.15 to 5.81)	0.05 (0 to 14.81)
	Winter	1.96 (0 to 21.31)	-	2.45 (0 to 19.93)
Dovekies	Spring	0.71 (0 to 36.98)	0 (0 to 0)	0.59 (0 to 32.10)
	Summer	0 (0 to 2.68)	0 (0 to 0.25)	0.18 (0 to 47.62)
	Fall	0 (0 to 0.25)	0.10 (0.10 to 4.37)	0.20 (0 to 35.76)
	Winter	2.13 (0 to 10.93)	-	0.93 (0 to 11.20)
Murres	Spring	0.88 (0 to 4.37)	0.74 (0 to 2.33)	3.73 (0 to 12.49)
	Summer	0.06 (0 to 2.60)	0.65 (0 to 4.62)	1.79 (0 to 46.57)
	Fall	0 (0 to 0.14)	0 (0 to 0.11)	0.07 (0 to 11.59)
	Winter	0.61 (0 to 7.71)	-	3.05 (0 to 15.21)
Other Alcids	Spring	0.14 (0 to 1.53)	0.20 (0 to 0.20)	0.25 (0 to 9.36)
	Summer	0.04 (0 to 0.91)	0.11 (0 to 4.03)	0.13 (0 to 13.06)
	Fall	0.05 (0 to 0.65)	0.04 (0.04 to 1.12)	0 (0 to 3.16)
	Winter	0.37 (0 to 4.69)	-	0.36 (0 to 3.45)

5.2.6.2.1 Large Alcids

Large alcids (including Common Murre (*Uria aalge*), Thick-billed Murre, Razorbill (*Alca torda*), and Atlantic Puffin (*Fratercula arctica*)) are common occurrences within the waters off the western Scotian Shelf and Slope and may be present in the vicinity of the Project Area during all times of the year. As a group, they are distributed throughout the western Scotian Shelf and Slope in association with both coastal features and more offshore waters (Figure 5.2.34). Thick-billed Murres accounted for the majority of PIROP and ECSAS alcid observations on the western Scotian Shelf and Slope, with particularly high occurrences being recorded in spring and winter. Thick-billed Murres, Common Murres, Razorbills, and Atlantic Puffins all overwinter on the Scotian Shelf and Slope but only Atlantic Puffin and Razorbill are known to breed along the southwestern coast of Nova Scotia (Sibley 2000; Tufts 1986; Environment Canada 2013d). Although Common and Thick-billed Murres primarily nest in more northern latitudes, Grand Manan and Machias Seal Island in New Brunswick are known to support nesting Common Murres (Ronconi and Wong 2003; Diamond 2013).

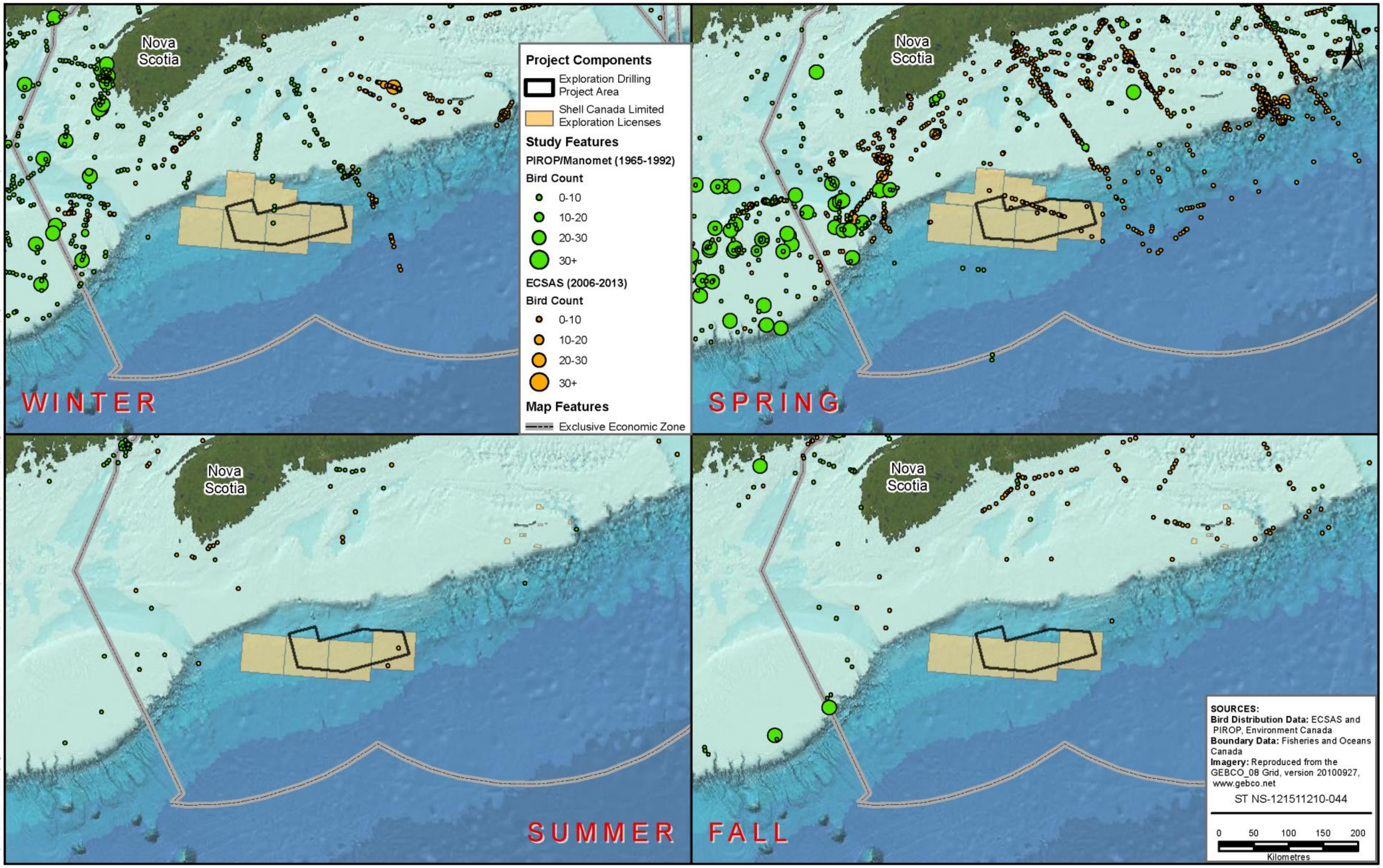


Figure 5.2.34 Seasonal Distribution of Large Alcids on the Scotian Shelf and Slope

5.2.6.2.2 Dovekie

Dovekies nest in the high Arctic and do not breed in Canada in significant numbers. However, they occur on the Scotian Shelf and Slope during most months of the year, with highest numbers during winter and spring (Figure 5.2.35), when they are amongst the most abundant pelagic seabird species on the Scotian Shelf and Slope. Data from Fifield *et al.* (2009) suggest that Dovekies are more abundant in association with the Scotian Shelf (and Gulf of Maine) during winter and spring than the Newfoundland and Labrador Shelves, but have considerably lower concentrations than this region in summer and fall (Table 5.2.12).

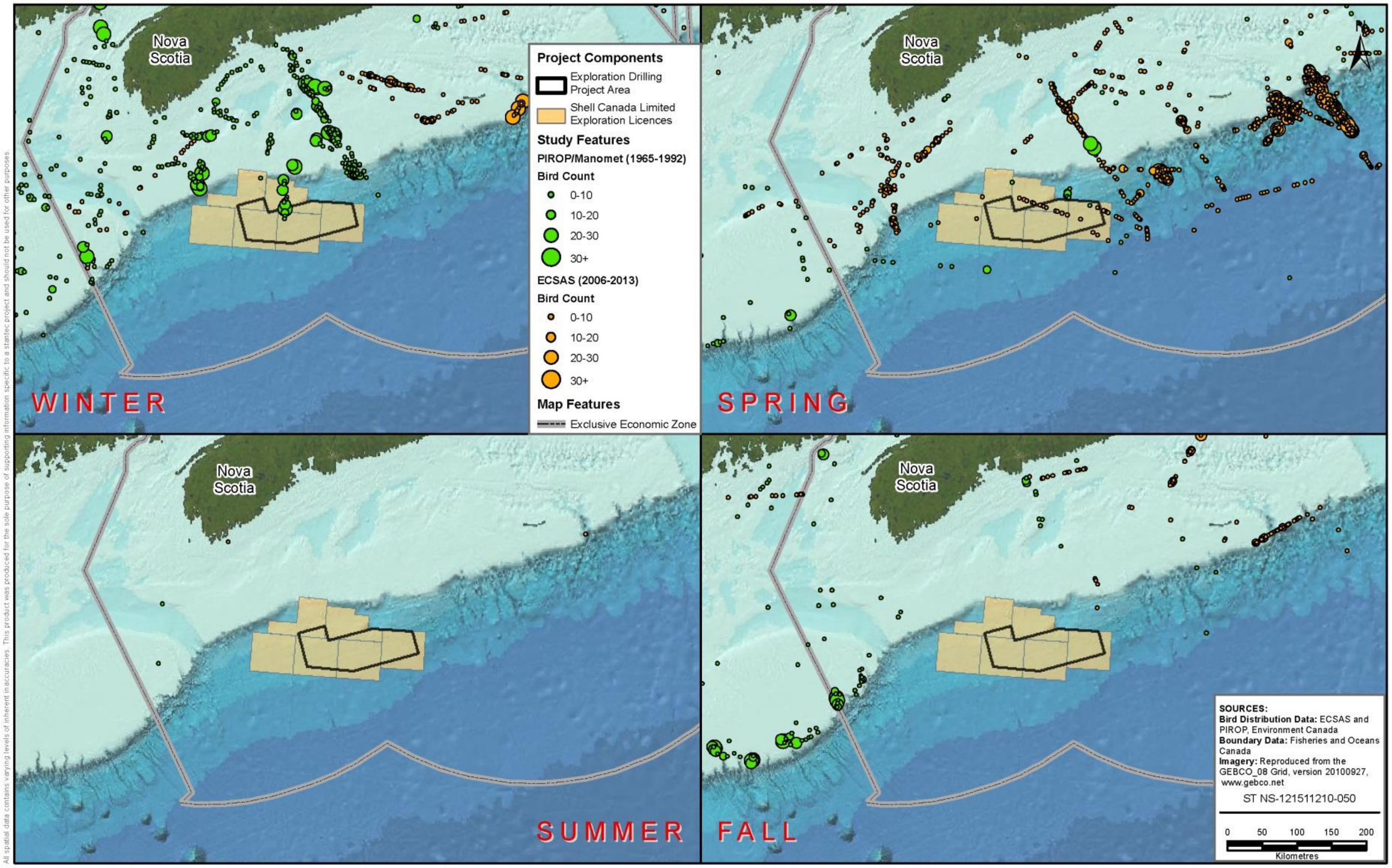


Figure 5.2.35 Seasonal Distribution of Dovekie on the Scotian Shelf and Slope

5.2.6.2.3 Black Guillemot

Black Guillemots are present in on the Scotian Shelf year-round but are largely restricted to coastal areas (Figure 5.2.36). Black Guillemots breed in Nova Scotia and during summer they are only commonly encountered in close proximity to their widely distributed nesting colonies (Tufts 1986). Black Guillemots are also common in inshore waters during late fall and winter, with relatively high occurrences along the eastern and southwestern shores of the province (Tufts 1986).

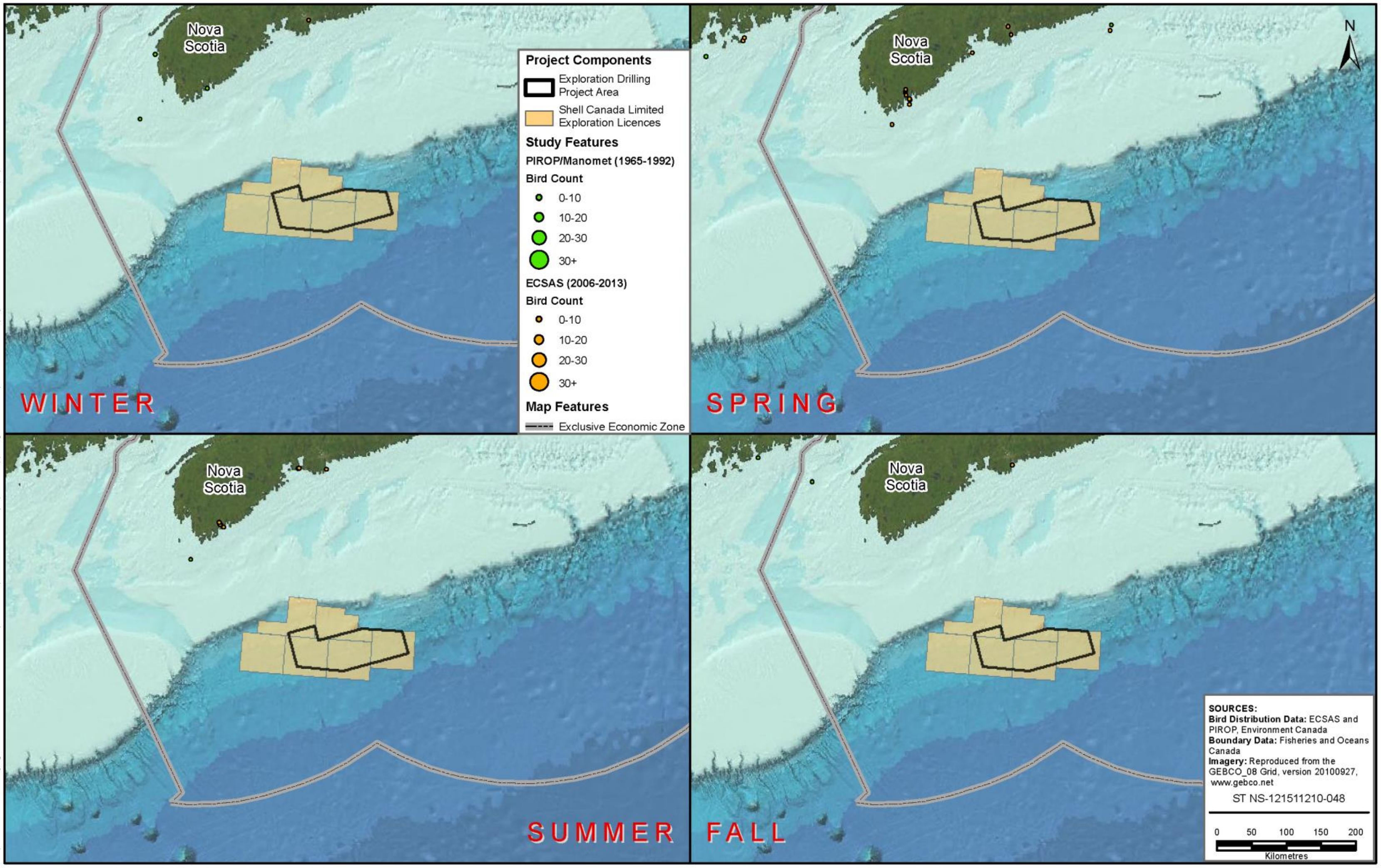


Figure 5.2.36 Seasonal Distribution of Black Guillemot on the Scotian Shelf and Slope

5.2.6.2.4 Cormorants

Data on the distribution and abundance of cormorants indicate that they may be encountered in the waters off Nova Scotia throughout the year, are typically restricted to coastal environments, with only infrequent offshore observations of few individuals (Figure 5.2.37). The majority of the ECSAS and PIROP observations are of Double-crested Cormorants (*Phalacrocorax auritus*) but several observations of Great Cormorants in the area exist. Cormorants are most abundant during the summer months, and breed along much of Nova Scotia's coastline, including southwestern parts of the province (NSDNR 2011a). Although some individuals overwinter in the region, the majority of cormorants migrate to more southern locations (Sibley 2000; Tufts 1986). Cormorants are not expected to regularly occur in or adjacent to the Project Area because of its distance from the coastline.

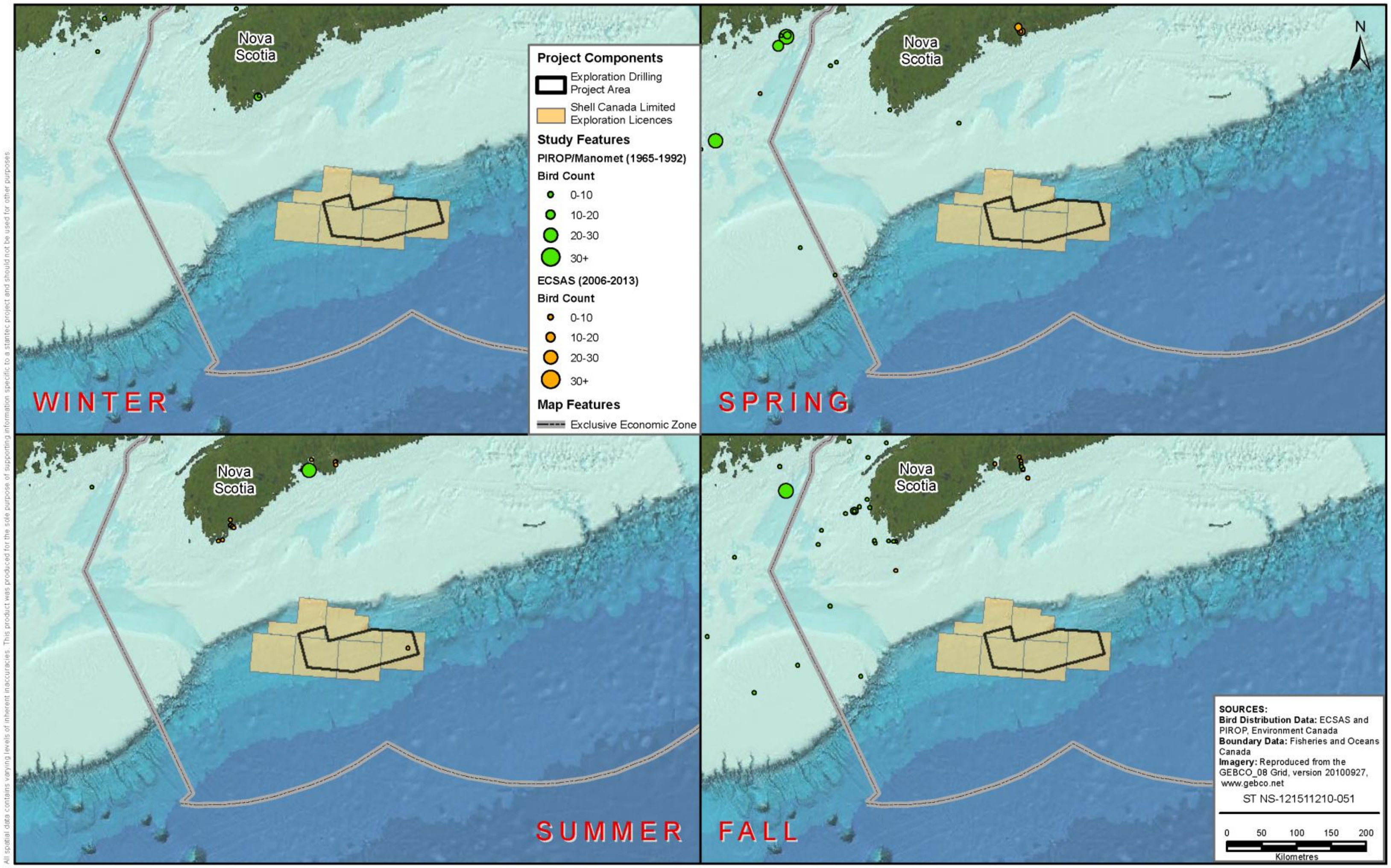


Figure 5.2.37 Seasonal Distribution of Cormorants on the Scotian Shelf and Slope

5.2.6.2.5 Black-legged Kittiwake

Black-legged Kittiwakes are pelagic gulls that spend the majority of their time in offshore waters, except during the breeding season when they come onshore to nest. High numbers of Black-legged Kittiwakes overwinter on the Scotian Shelf and Slope, and ECSAS and PIROP data obtained for the Project indicate that they are the most abundant species recorded in the area during winter. However, compared to more northern ecoregions (Table 5.2.12), such as the Newfoundland and Labrador Shelves (Fifield *et al.* 2009), their abundances at this time of year are less. Black-legged Kittiwakes are also common on the Scotian Shelf and Slope during fall, and to a lesser extent spring (Figure 5.2.38). They are relatively uncommon during summer months when the majority of the population is congregated at colony sites at more northern latitudes. However, Black-legged Kittiwakes are known to nest along the southwestern coast of Nova Scotia at Pearl Island, near Lunenburg (Environment Canada 2013d) and may be encountered foraging in the vicinity of colonies or far offshore during this time.

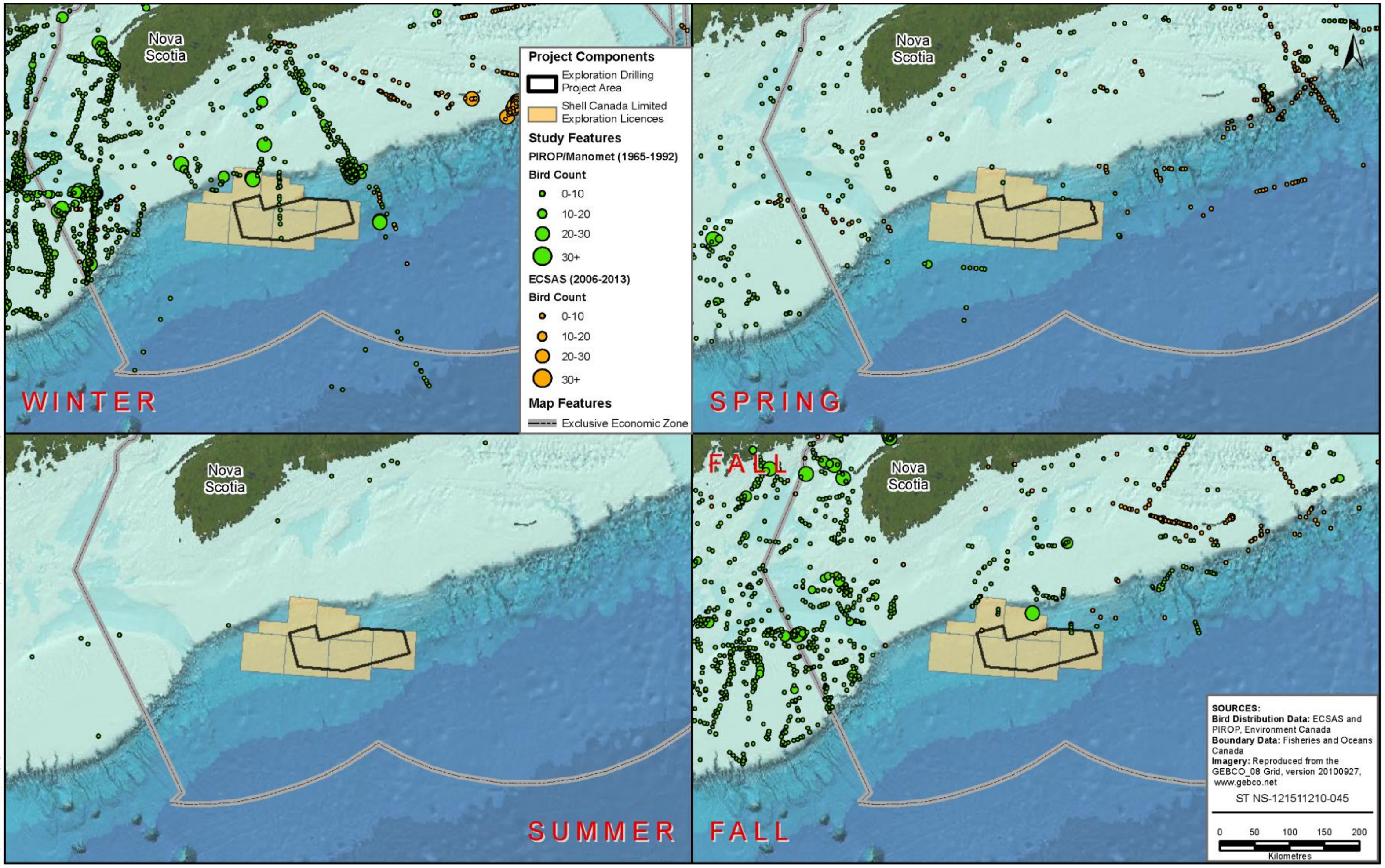


Figure 5.2.38 Seasonal Distribution of Black-legged Kittiwake on the Scotian Shelf and Slope

5.2.6.2.6 Gulls

As a guild, gulls are amongst the most abundant marine related birds present on the Scotian Shelf and Slope, and data indicate that they are present throughout the region at all times of the year (Figure 5.2.39). Both large and small gulls are included in this group, with the exception of Black-legged Kittiwakes which have been examined separately. The most abundant species recorded during ECSAS and PIROP surveys were Herring Gull and Great Black-backed Gull, both of which breed along the coast of Nova Scotia . Other gull species recorded include (in order of decreasing abundance) Ring-billed Gull (*Larus delawarensis*), Iceland Gull (*L. glaucoides*), and Glaucous Gull (*L. hyperboreus*), along with several vagrant species. Although seasonal patterns vary depending on the particular species, gulls (in general) may be expected to occur in the vicinity of the Project Area during all seasons. Data from Fifield *et al.* (2009) suggest that large gulls are most common during spring with higher concentration on the Scotian Shelf (and Gulf of Maine) as compared to northerly regions of the Gulf of St. Lawrence or the Newfoundland and Labrador Shelves (Table 5.2.12). The reverse is true in summer (Fifield *et al.* 2009).

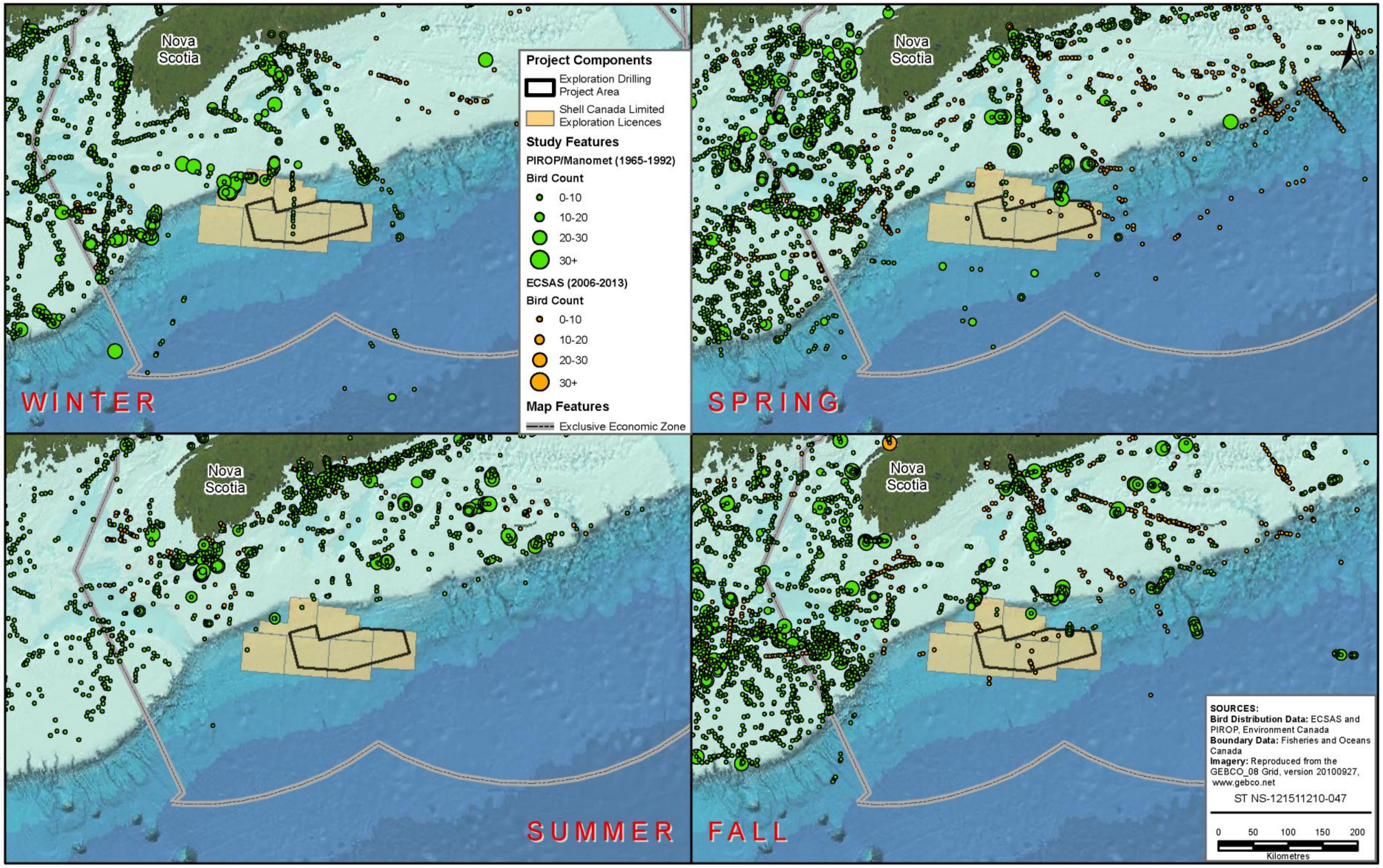


Figure 5.2.39 Seasonal Distribution of Gulls on the Scotian Shelf and Slope

5.2.6.2.7 Jaegars

Jaegers do not breed in Atlantic Canada but are present in offshore waters of the region mostly during their spring and fall migration to and from their Arctic nesting sites (Figure 5.2.40). The majority of PIROP and ECSAS records on the western Scotian Shelf are of Pomarine Jaegars (*Stercorarius pomarinus*), with lesser amounts of Parasitic (*S. parasiticus*) and Long-tailed Jaegers (*S. longicaudus*) also being present.

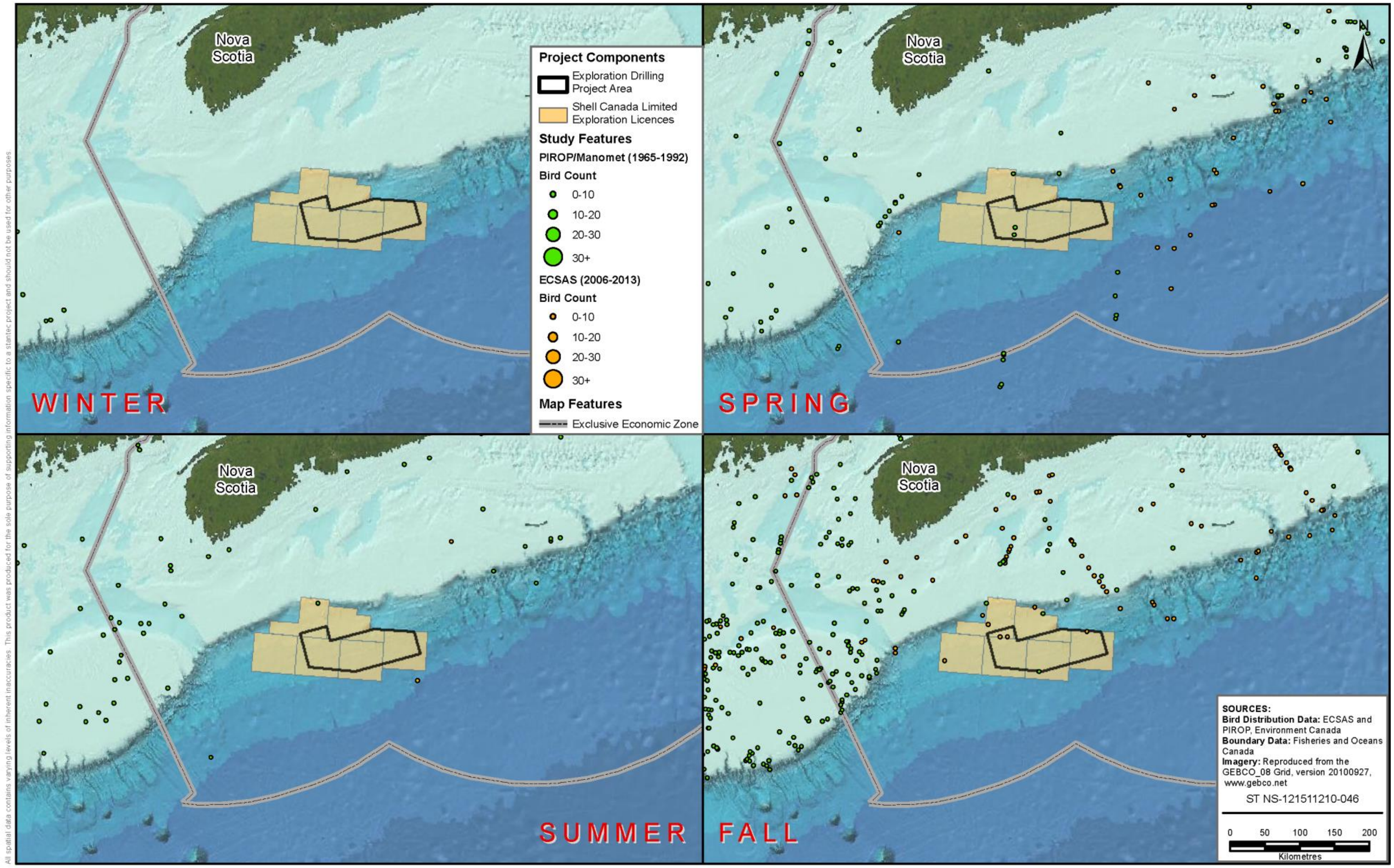


Figure 5.2.40 Seasonal Distribution of Jaegers on the Scotian Shelf and Slope

5.2.6.2.8 Northern Fulmar

Large colonies of Northern Fulmar are located in the Arctic and although they do not breed in the vicinity of the Scotian Shelf and Slope in significant numbers, they are present in offshore waters year-round (Figure 5.2.41). ECSAS and PIROP data indicate that they are amongst the most abundant species encountered throughout the year, with particular high numbers being encountered in winter. During these times, they are distributed throughout the Scotian Shelf and Slope, with concentrations being particularly high at the southwestern end near Georges Bank. They are likely present in and around the Project Area all times of the year. Although relatively common in the waters on the Scotian Shelf, data from Fifield *et al.* (2009) indicate their abundance throughout the year is less than that for the Newfoundland and Labrador Shelves (Table 5.2.12).

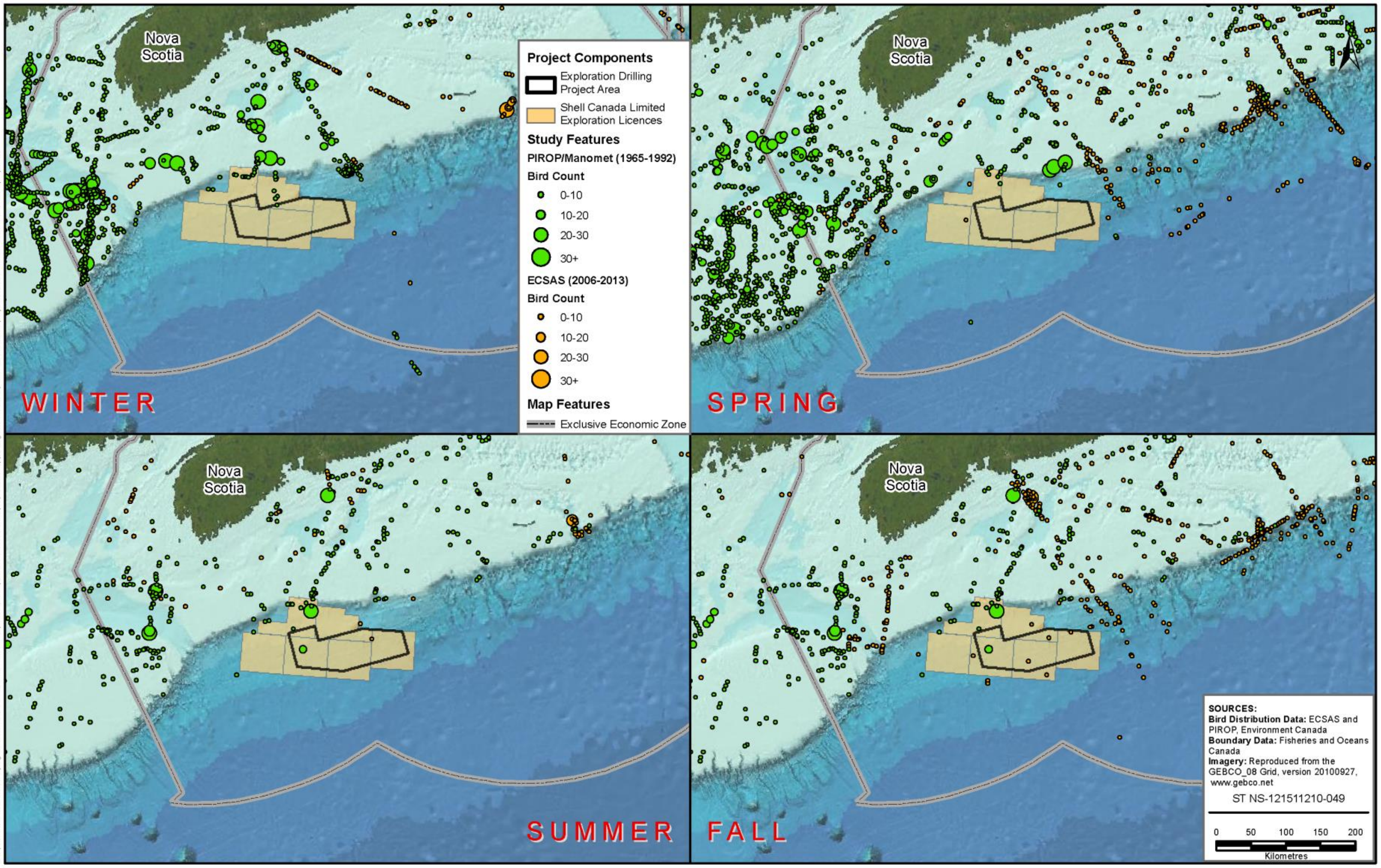


Figure 5.2.41 Seasonal Distribution of Northern Fulmar on the Scotian Shelf and Slope

5.2.6.2.9 Northern Gannet

Northern Gannets may be encountered on the Scotian Shelf and Slope throughout the year but are most common during the spring and fall (Figure 5.2.42). In summer, the regional population is concentrated at colony sites in Newfoundland and the Gulf of St. Lawrence. Although they do not breed along the Scotian Shelf coastline, a small summer population of immature Northern Gannets regularly occurs around Nova Scotia (Tufts 1986). In Nova Scotia, their southward migration is typically observed to begin in early September and to peak during mid-October (Tufts 1986), with some individuals remaining there in winter (Sibley 2000). Birds migrating north during spring are typically first observed in March, with peak migration in Nova Scotia extending from mid-April to mid-May (Tufts 1986).

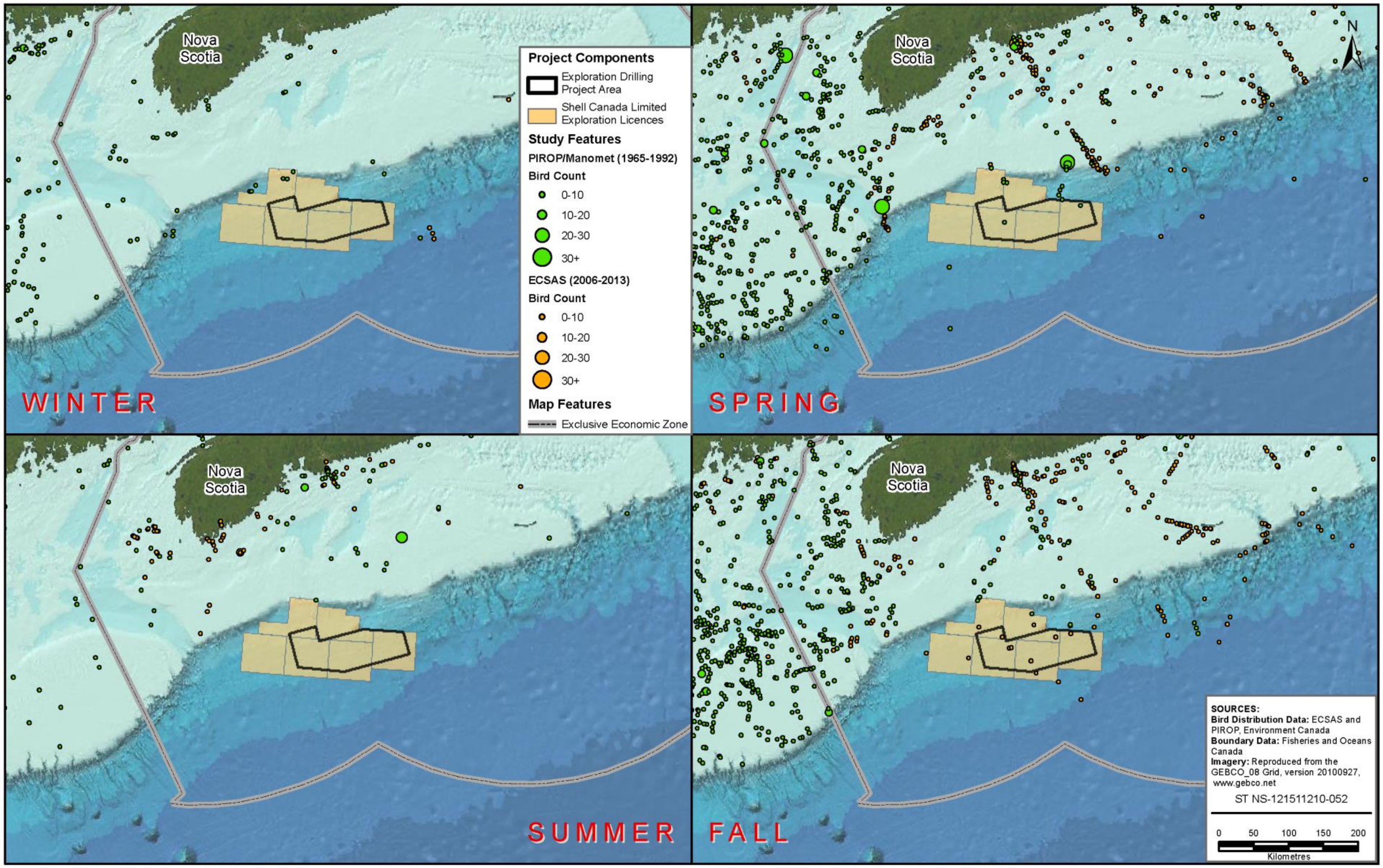


Figure 5.2.42 Seasonal Distribution of Northern Gannet on the Scotian Shelf and Slope

5.2.6.2.10 Phalaropes

Phalaropes are surface plankton feeders and are mostly concentrated in upwelling areas. Phalaropes use the Scotian Shelf and Slope area during migration between their arctic nesting grounds and more southerly wintering areas. PIROP and ECSAS data indicate that phalaropes have been recorded on the Scotian Shelf and Slope throughout the year, but are most common during spring and fall (Figure 5.2.43). During these times, they have been encountered in greatest abundance in the waters off southwestern Nova Scotia, near Georges Basin / the Northeast Channel (Figure 5.2.43). The majority of phalaropes recorded are Red Phalaropes, although small numbers of Red-necked Phalarope (*P. lobatus*) have also been encountered during spring, summer, and fall.

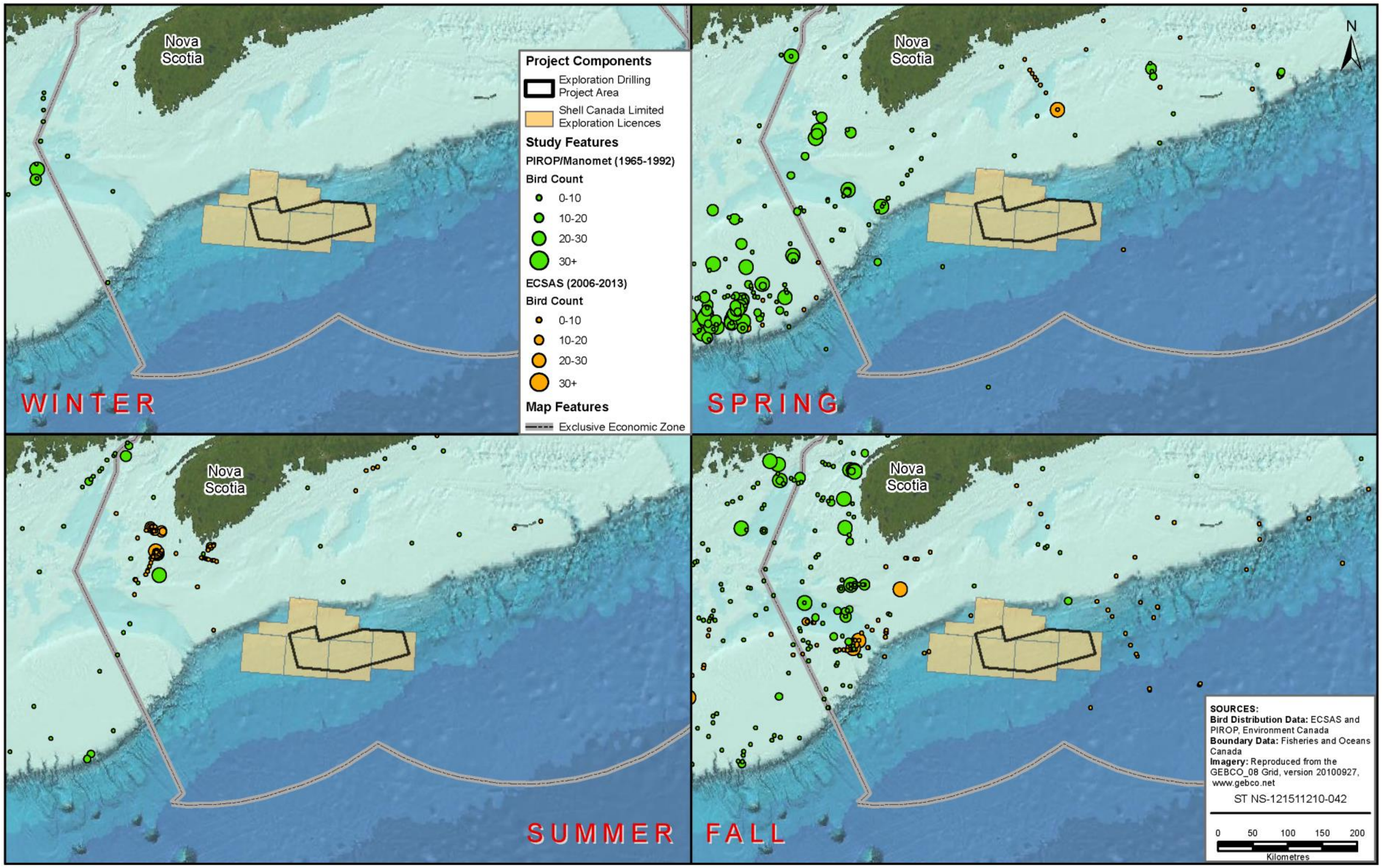


Figure 5.2.43 Seasonal Distribution of Phalaropes on the Scotian Shelf and Slope

5.2.6.2.11 Shearwaters

Shearwaters are common summer visitors on the Scotian Shelf and Slope but spend the winter months in the southern hemisphere, where they breed. PIROP and ECSAS data indicate that they are particularly abundant in offshore waters in summer and fall and may be encountered throughout the extent of the western Scotian Shelf and Slope at this time (Figure 5.2.44). Although encountered less frequently during spring, they may occur throughout much of the area at this time of year, with larger concentrations often occurring near the edge of the shelf (Figure 5.2.44). Shearwaters are generally absent from the area during winter months but have been recorded near the Project Area in December. Great Shearwater account for the majority of shearwater observations in the PIROP and ECSAS databases, although Sooty Shearwaters are also relatively abundant. Other species of shearwater that have been observed on the western Scotian Shelf and Slope include Cory's Shearwater (*Calonectris diomedea*), Manx Shearwater (*Puffinus puffinus*), Audubon's Shearwater (*P. lherminieri*), and Yelkouan Shearwater (*P. yelkouan*).

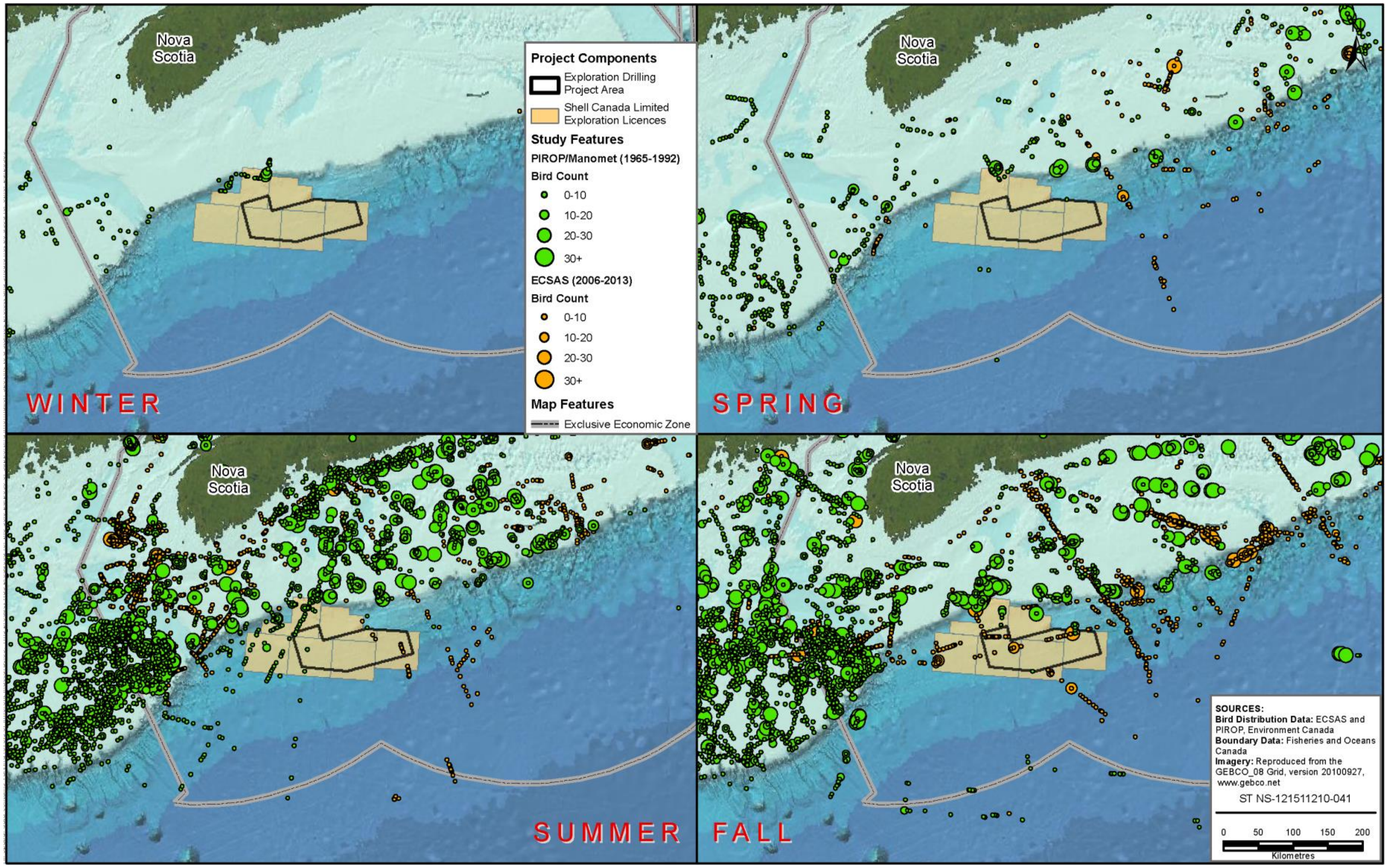


Figure 5.2.44 Seasonal Distribution of Shearwaters on the Scotian Shelf and Slope

5.2.6.2.12 Skuas

Skuas may be encountered on the Scotian Shelf and Slope throughout the year (Figure 5.2.45). The majority of records in the area are of Great Skua (*Stercorarius skua*) but South Polar Skua (*S. maccormicki*) also frequent the waters off Nova Scotia during migration. Great Skua nest on islands in the northeast Atlantic but are known to overwinter in waters of the northwest Atlantic (Sibley 2000), and occur on the Scotian Shelf and Slope during that time. The majority of PIROP and ECSAS records for this species on the western Scotian Shelf and Slope are during the fall. ECSAS / PIROP data indicate that most records for this species in the area are during fall, but that South Polar Skua have also been infrequently encountered on the western Scotian Shelf and Slope during spring and summer months.

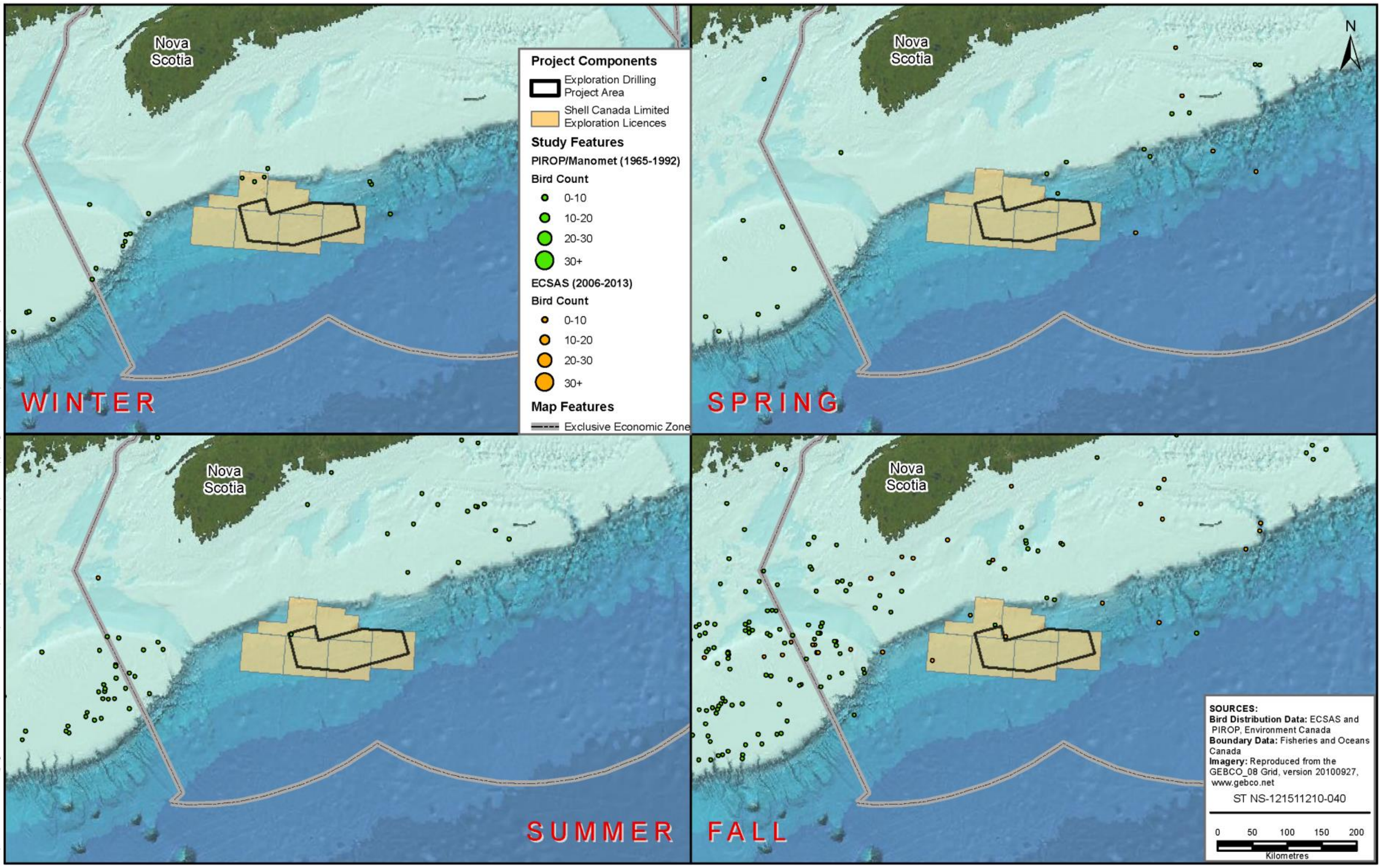


Figure 5.2.45 Seasonal Distribution of Skuas on the Scotian Shelf and Slope

5.2.6.2.13 Storm Petrels

Storm-petrels arrive in the Scotian Shelf and Slope in spring and stay until late fall. Peak densities are reached in summer as a result of the return of Leach's Storm-Petrels to their breeding colonies and an influx of Wilson's Storm-Petrels from their breeding grounds in the southern hemisphere to the North Atlantic. The majority of ECSAS and PIROP storm-petrel observations on the western Scotian Shelf and Slope were in summer (Figure 5.2.46) and during this time Wilson's Storm-Petrels were observed to be almost four times as abundant as Leach's Storm-petrel. Although the breeding range of the Leach's Storm-Petrel in the western North Atlantic is centered on Newfoundland, a number of Leach's Storm-Petrel breeding colonies have been recorded in Nova Scotia. The largest of the colonies is on Bon Portage Island near Cape Sable Island and is estimated to be comprised of over 48 000 pairs (Environment Canada 2013d). Smaller colonies up to a couple hundred pairs are found elsewhere in the area, including on Sable Island, Bald Tusket Island, Half Bald Island, Inner Bald Tusket Island, and Pearl Island (Environment Canada 2013d).

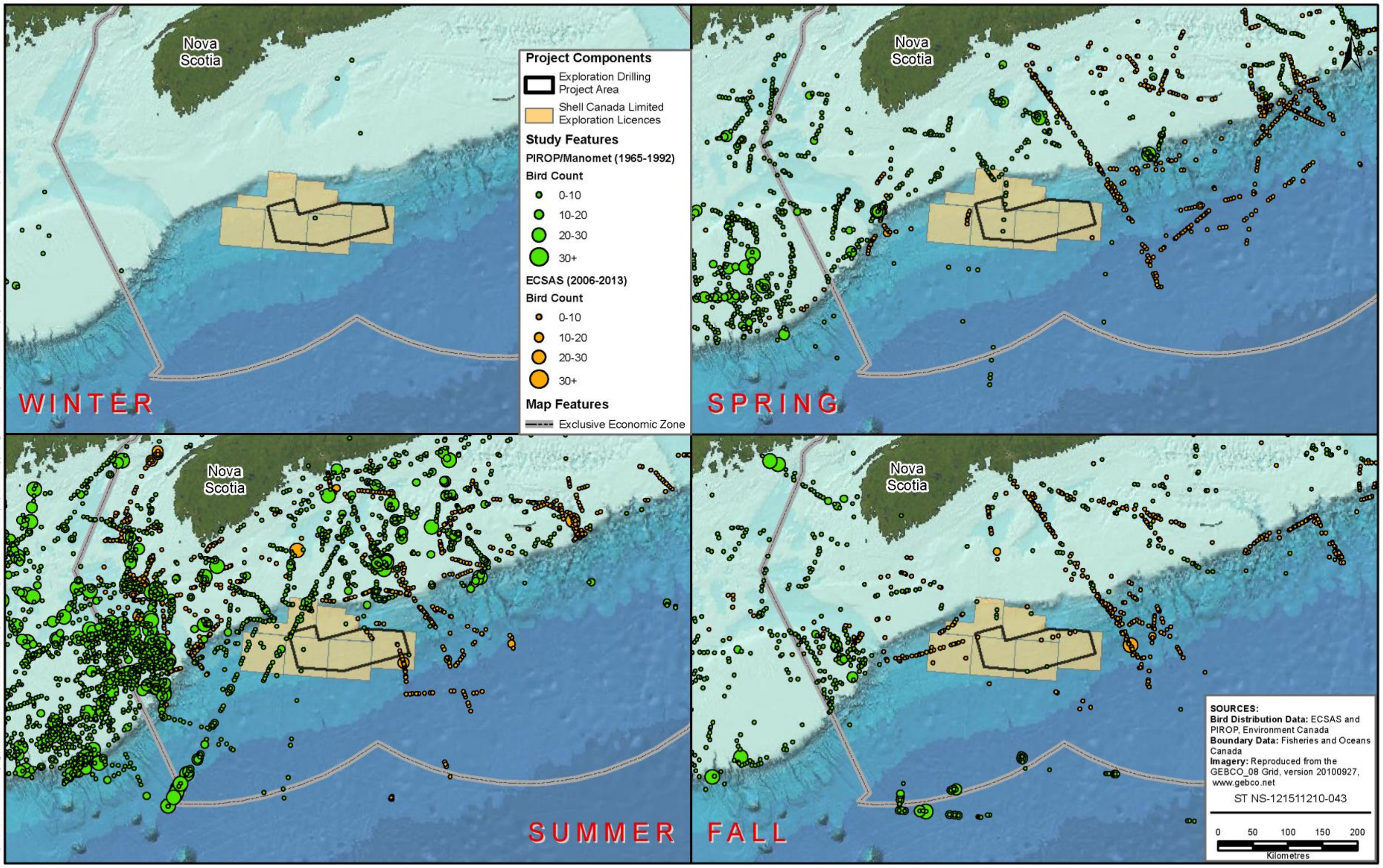


Figure 5.2.46 Seasonal Distribution of Storm Petrels on the Scotian Shelf and Slope

5.2.6.2.14 Terns

Most terns arrive on the Scotian Shelf and Slope during May from their more southern wintering grounds and they are of greatest abundance in the summer months (Tufts 1986). Common Tern (*Sterna hirundo*) was the most abundant species of tern encountered during PIROP and ECSAS surveys but Arctic Terns (*Sterna paradisaea*) are also common. Data indicate that terns are present throughout the region, but were most frequently encountered in proximity to coastal features and in vicinity of their breeding colonies (Figure 5.2.47). Southward winter migration for Common Terns occurs during August and September (Tufts 1986) and for Arctic Terns it begins in mid-July and is largely completed by mid-September (Tufts 1986). Arctic Terns are the most likely tern species to occur in the immediate vicinity of the Project Area as they forage offshore, unlike Common Terns which are largely restricted to coastal areas (Erskine 1992). In addition, Roseate Terns (*Sterna dougallii*) breed at select sites on mainland Nova Scotia, as well as Sable Island, and have potential to forage in the vicinity of the Project Area. Although PIROP and ECSAS data indicate that Least Tern (*Sternula antillarum*), some unidentified noddies (*Anous sp.*) and skimmers (*Phychops sp*.) have also been recorded in the Scotian Shelf and Slope, none of these species would regularly frequent the waters in and around the Project Area.

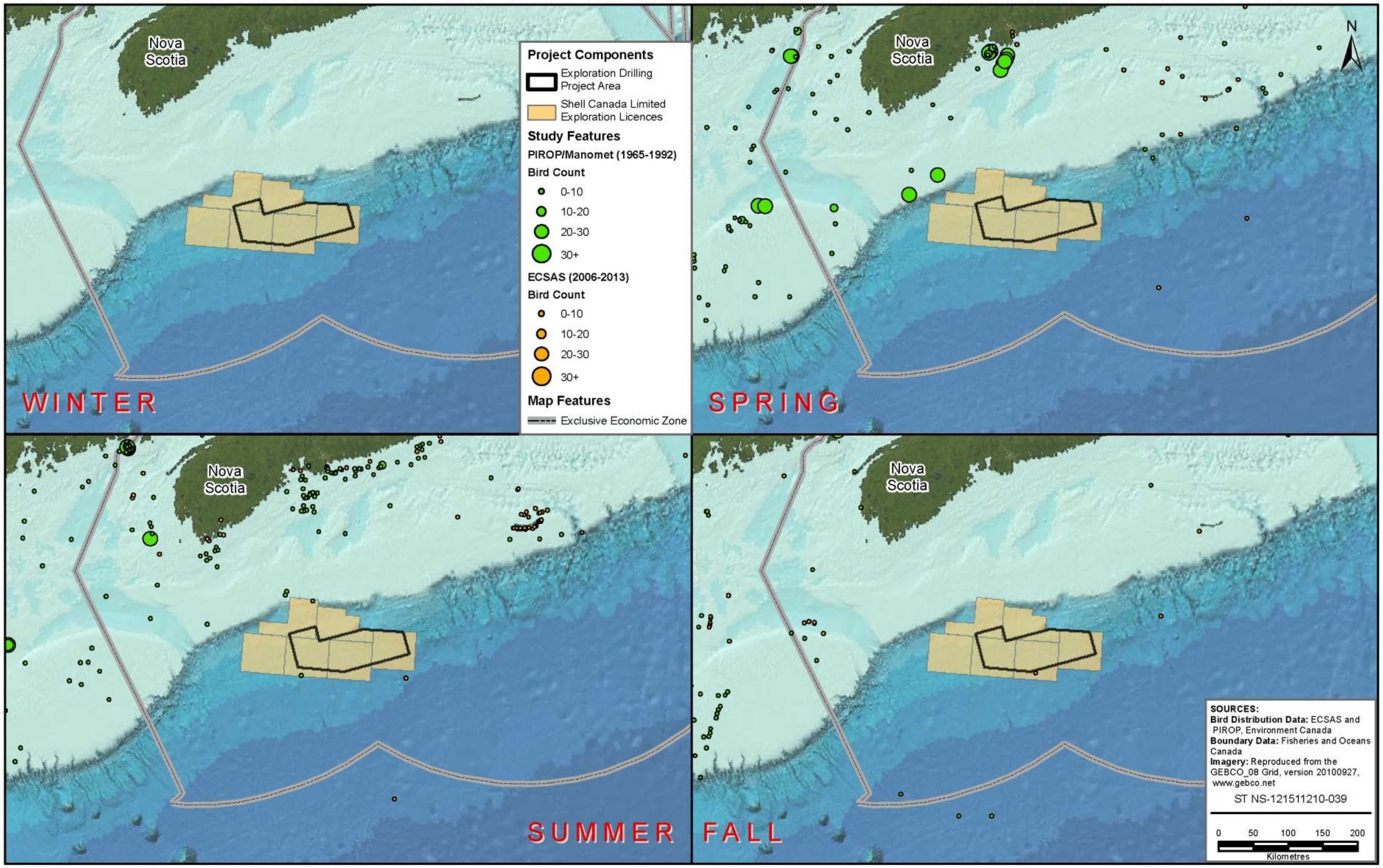


Figure 5.2.47 Seasonal Distribution of Terns on the Scotian Shelf and Slope

5.2.6.2.15 Waterfowl

A variety of waterfowl are present in the waters of the western Scotian Shelf throughout the year. Although waterfowl may occur within the vicinity of the Project Area at all times of the year, they are infrequently observed in offshore waters and are more closely associated with the coastline (Figure 5.2.48). Common Eiders are one of the most abundant waterfowl species in coastal waters of the Scotian Shelf during the breeding season. They nest on islands scattered along the mainland Nova Scotia portion of the RAA, with relatively dense aggregations of nesting islands present between Yarmouth and Cape Sable Island, and in Mahone Bay (NSDNR 2013). In addition to Common Eiders, ECSAS and PIROP data indicate that White-winged Scoter (*Melanitta fusca*), Canada Goose, Black Scoter (*Melanitta nigra*), Long-tailed Duck (*Clangula hyemalis*), and Common Loon (*Gavia immer*) were also encountered in relative abundance in the waters of the western Scotian Shelf and Slope.

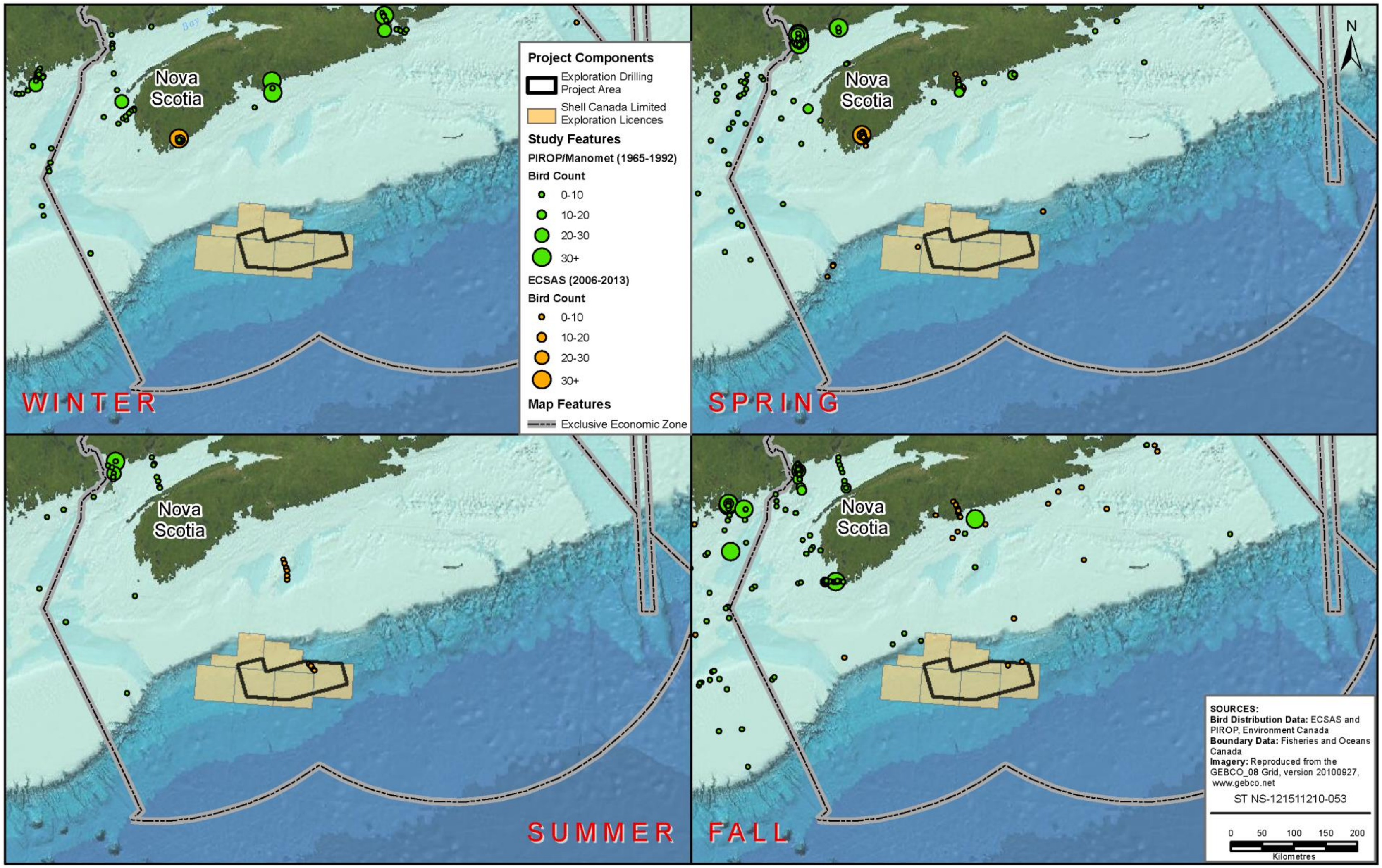


Figure 5.2.48 Seasonal Distribution of Waterfowl on the Scotian Shelf and Slope

5.2.6.3 Marine Bird Colonies

The coastline of the Scotian Shelf within the RAA for the Project supports over a hundred colonies of nesting marine birds (Table 5.2.13, Table 5.2.14 and Figure 5.2.49), ranging in size from a few individuals to thousands of breeding pairs (Table 5.2.14). In general, marine bird nesting colonies are distributed all along the mainland of Nova Scotia, with a particularly dense aggregation in the area between Cape Sable Island and Yarmouth. This area has a large number of small islands which provide a high density of potential nesting sites.

Leach's Storm-Petrel is the most numerous breeding seabird in the RAA with an estimated 48 783 breeding pairs across five colonies (Table 5.2.13). The vast majority (98%) of Leach's Storm-Petrels are found on Bon Portage Island near Cape Sable Island, with other relatively large colonies being found on Inner Bald Tusket Island and Half Bald Tusket Island (Figure 5.2.49 and Table 5.2.14).

Table 5.2.13 Summary of Marine Bird Nesting Data in the RAA

Species	Unit of Measure	Number of Nesting Colonies		Abundance	
		Mainland Nova Scotia	Sable Island	Mainland Nova Scotia	Sable Island
Atlantic Puffin[1]	Pairs	4	0	262	0
Black-legged Kittiwake[1]	Pairs	1	0	5	0
Common Eider[2]	None	29	0	No Data	No Data
Cormorant[3]	Nests	34	0	1871+	0
Leach's Storm-Petrel[1]	Pairs	5	3	48683	100
Great Black-back Gull[4,6]	Pairs	64	Not Reported	2349	398
Herring Gull[4,6]	Pairs	40	45	2241	843[7]
Razorbill[1]	Pairs	1	0	5	0
Terns[5,6]	Individuals	27	3	1770	8484[8]

[1]Environment Canada 2013d
[2]NSDNR 2013
[3]NSDNR 2011a, primarily Double-crested Cormorant
[4]Environment Canada 2013e
[5]CWS 2013a, includes Common Tern, Arctic tern, and Roseate Tern
[6]Ronconi 2013
[7]Based on an average of the two values provided by Ronconi (2013)
[8]Number of individuals estimated by multiplying the number of pairs identified by Ronconi (2013) by two

Nova Scotia is near the southern limit for nesting Atlantic Puffins, Razorbills and Black-Legged Kittiwakes. The few breeding colonies for these species are patchily distributed along the coastline of the western Scotian Shelf. The largest Atlantic Puffin colony is located on Pearl Island at the mouth of Mahone Bay, which is also the only site known to support Razorbills and Black-Legged Kittiwakes within the RAA (Table 5.2.14).

Great Black-Backed Gulls and Herring Gulls are the second and third most abundant breeding seabirds in the RAA (Table 5.2.13). The largest concentrations of nesting gulls are found on Sable Island which supports 14% of all nesting great Black-Backed Gulls and 27% of all nesting Herring Gulls in the RAA. Devils Island at the mouth of Halifax Harbour also supports a very large gull colony composed of 691 Herring Gulls and 119 Great Black-Back Gulls (Figure 5.2.49 and Table 5.2.14).

Tern colonies (species are not differentiated for the majority of survey data) are scattered throughout the RAA, with several large colonies present at various locations. Sable Island supports the largest tern colonies. The three colonies present on Sable Island in 2013 support an estimated 8484, representing approximately 83% of all of the nesting terns in the RAA (Table 5.2.13). Other large tern colonies are found on The Brothers islands (450 terns) and the bar at Dung Cove (520 terns) (Figure 5.2.49 and Table 5.2.14). All other tern colonies contain fewer than 100 nesting terns. Colonies in association with The Brothers Islands and Sable Island are particularly important because they support the endangered Roseate Tern.

Cormorant colonies (Double-Crested Cormorants and Great Cormorants are not differentiated in the survey data) are scattered throughout the mainland Nova Scotia portion of the RAA, and are not present on Sable Island (Figure 5.2.49 and Table 5.2.14). No abundance data are available for 13 of the 34 known colony sites, and numbers associated with others are not necessarily accurate (NSDNR, pers. comm. 2014.). Within the subset of cormorant colonies for which abundance data is available, the largest colonies are found on Little Duck Island in Mahone Bay and Blanche Island at the mouth of Port LaTour (Figure 5.2.49 and Table 5.2.14). Together these two colonies account for 43% of the cormorant nests found in the 21 colonies for which abundance data is available. Because Great Cormorants breed mostly in northern Nova Scotia, most of the cormorants nesting in the RAA are likely to be Double-Crested Cormorants.

Common Eider nesting sites are found on islands scattered along the mainland Nova Scotia portion of the RAA with relatively dense aggregations of nesting islands present in the area between Yarmouth and Cape Sable Island and in Mahone Bay (Figure 5.2.49 and Table 5.2.14). No abundance data are available for these nesting sites. No common eider nesting occurs on Sable Island.

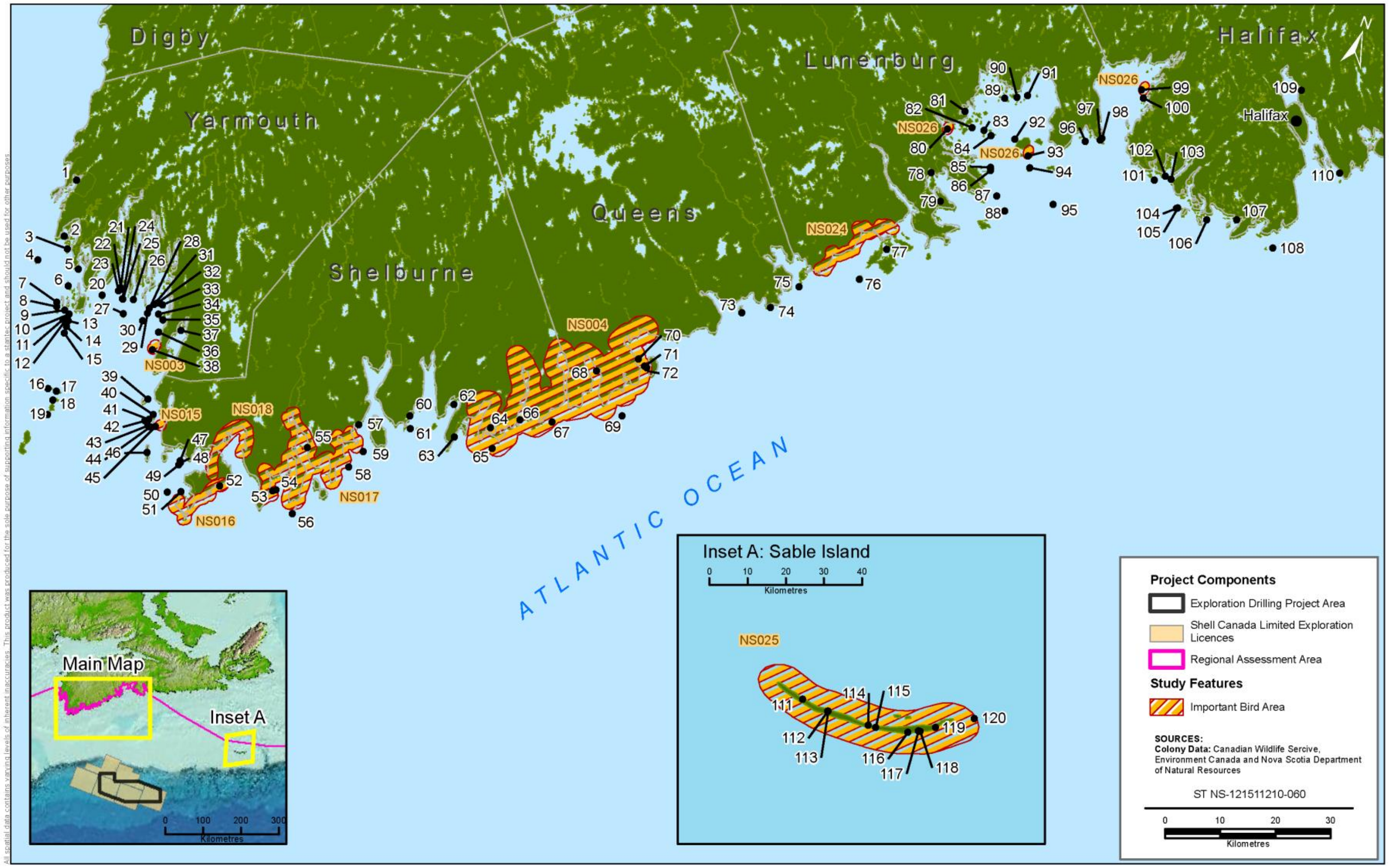


Figure 5.2.49 Distribution of Seabird Colonies and Important Bird Areas within the RAA

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]
Mainland Nova Scotia										
1	Doctors Island				na					
2	Very small gravel island, near Crawleys Island								2	
3	Reef Island					28	65			
4	Green Island			na	50	36	36			
5	Ram Island, Little River Harbour					27	12			
6	Murder Island spit								65	
7	Holmes Island					2				
8	Northen Head Spectacle Islands								3	
9	Marks Island					3	25			
10	Peases Island					21	84			
11	Half Bald Tusket Island							180		
12	Little Half Bald Tusket Island					13				
13	Little Bald Tusket Island					14				
14	Inner Bald Tusket Island				30			200		
15	Bald Tusket Island							50		
16	Flat Island, (S of Tusket I)			na		2				
17	Round Island	7		na		5	15			
18	Mud Island	75		na		11				
19	Noddy Island	80		na		9				
20	Western Bar Island			na		5	45			

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]
21	Fish Island, Inner					61				
22	Inner Fish Island			na	na					
23	Little Fish Island			na	na	17	11			
24	Eastern Bar Island (Gooseberry)			na	140					
25	Gooseberry Island, Lobster Bay					72				
26	East Money Island				143					
27	Gull Island			na		39			50	
28	The Thrum						25			
29	Pumpkin Island (LB)			na		22	22			
30	Whitehead Island				17	29	43			
31	Lears Island					104	56			
32	Little Gooseberry Island				12	176	44			
33	Big Gooseberry Island					39				
34	Ram Island (LB)					50				
35	Canoe Island					9	35			
36	Abbotts Harbour Island					57	14			
37	Chesapeake Island								60	
38	The Brothers			na			4		450	
39	John's Island			na		111	37			
40	Vigneau Island			na		39				
41	Ram Island (GoM)					2				
42	Whale Island				na	7				

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]
43	Goodwin Island			na		7				
44	Raspberry Island			na						
45	Solomans Island					4				
46	Bon Portage Island			na		81	150	48 244		
47	Double Island				70					
48	Round Island				6					
49	Good Landing Island				na					
50	Green Island					116	116		26	
51	Fish Island, Cape Sable								33	
52	Little Stoney Island				50	30	3			
53	Brooks Island					2				
54	Page Island					28				
55	small unnamed island, Negro Harbour								2	
56	Blanche Island				410	106	26			
57	small unnamed island, near Cranes Point, Shelb Hrb								27	
58	Gull Rock				60	12	6			
59	Grey Island			na	na	39	55		85	
60	south end of The Bar, Dung Cove								520	
61	Jordon Bay Gull Rock				140	12	27			
62	N tip of Egg Beach								31	
63	Potato Island					30	20			

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]
64	small unmed island, Little Harbour Lake								15	
65	Ram Island			na	75	21	7			
66	Hughes Island, off Louis Head								33	
67	Green Rock				70	63	42			
68	Bijou Rocks, Port Joli (Furthest East)								36	
69	Little Hope Island				60					
70	Massacre Island				na	2	7			
71	Thrum Cap, near Jackie's Island				5					
72	Jackies Island					4	4			
73	Coffin Island					20				
74	Puddingpan Island					2				
75	Toby Island				na	58	19			
76	Indian Island			na	na	56	37			
77	small unnamed island, near Round Island								24	
78	unamed island beside Corkum Island causeway								32	
79	Gully Island, Lower South Cove								46	
80	Westhaver Island, Mahone Harbour								29	
81	Crow Island								80	

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]
82	Spectacle Island								24	
83	Andrew Island								3	
84	Rafuse Island			na						
85	Chockle Cap Island				30	66	99			
86	Indian Island			na						
87	Little Duck Island			na	400	73	31			
88	Big Duck Island			na						
89	Quaker Island								26	
90	tip of Woody Island								2	
91	Saddle Island			na						
92	Star Island				na		94			
93	Grassy Island, Mahone Bay								38	
94	Flat Island			na		21				
95	Pearl Island	100	5	na		84	125	9		5
96	Gravel Island			na						
97	Southwest Island					39	42			
98	north of Southwest Island				na					
99	Wedge Island				20	35	53			
100	Franks George Island, North			na						
101	Dover Castle					18				
102	High Island					31				
103	Gull Island, Inner				na	28				

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]
104	Hopson Island					17				
105	Duck Island (PB)					4				
106	Woody Island				na	74	8			
107	Thrumcap Island				13	4				
108	Sambro Island				70	33	6			
109	Island off of Dartmouth Yacht Club								28	
110	Devil's Island					119	691			
Sable Island										
Colony #	**Name**	**ATPU (pairs)[1]**	**BLKI (pairs)[1]**	**COEI[2]**	**Cormorants (nests)[3]**	**GBBG (individuals)[6]**	**HEGU (individuals)[6]**	**LSPE (pairs)[1]**	**Terns (nests)[6]**	**RAZO (pairs)[1]**
111	Sable Island-6-eastern Spit					81	82			
112	Sable Island-5					131	183			
113	Main Station								2211	
114	Sable Island (general)							100		
115	Sable Island-4					134	163			
116	Sable Island-3					236	349			
117	Old East Light								13	
118	East Light								2018	
119	Sable Island-2					225	436			
120	Sable Island-1					171	208			

Table 5.2.14 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	ATPU (pairs)[1]	BLKI (pairs)[1]	COEI[2]	Cormorants (nests)[3]	GBBG (pairs)[4]	HEGU (pairs)[4]	LSPE (pairs)[1]	Terns (individuals)[5]	RAZO (pairs)[1]

Species codes: ATPU - Atlantic Puffin; BLKI - Black-legged Kittiwake, GBBG - Great Black-backed Gull; HEGU - Herring Gull; LSPE - Leach's Storm-Petrel; RAZO - Razorbill
[1]Environment Canada 2013d
[2]NSDNR 2013
[3]NSDNR 2011a
[4]Environment Canada 2013e
[5]CWS 2013a
[6]Ronconi 2013, HEGU and GBBG counts on Sable Island are for sectors and do not represent individuals colonies

5.2.6.4 Important Bird Areas

Important Bird Areas (IBAs) are discrete areas that support nationally or globally important groups of birds. These may include birds of conservation concern, areas where particularly large concentrations of birds congregate, or areas that support birds whose distribution is restricted by range or specific habitat requirements. IBAs are not legally protected but are often found within areas that have been designated as protected areas by federal or provincial authorities.

Nine coastal IBAs are present within the RAA (Figure 5.2.49), the attributes of which are described in Table 5.2.15. The nine IBAs are scattered throughout the RAA but many are located southern Nova Scotia, between Liverpool and Yarmouth. These areas have been designated as IBAs for a variety of reasons including the presence of breeding habitat for species at risk, important shorebird migration habitat, important coastal waterfowl habitat, and/or the occurrence of regionally significant colonial water bird colonies.

Species at risk that are known to be regularly associated with the IBAs in the RAA include Piping Plover (in IBAs NS004, NS016, NS017, NS018, and NS024), Roseate Tern (in IBAs NS003, NS025 and NS026), Harlequin Duck (in IBAs NS004 and NS024), and Red Knot (in IBA NS016) (Figure 5.2.49, Table 5.2.15).

Important shorebird migration habitat is present in IBAs NS004, NS016, NS018, and NS024. These areas contain beaches, mud flats and salt marshes that attract large numbers of shorebirds during fall migration.

IBAs NS004, NS016, NS017, and NS018 contain regionally significant waterfowl habitat. These areas provide important staging and wintering habitat for sea ducks, American black ducks and geese. Regionally significant colonial water bird nesting areas are present in IBAs NS003, NS015 and NS025.

Five of the nine IBAs present in the RAA are considered to be globally significant sites (NS003, NS015, NS016, NS024, and NS025) (Table 5.2.15). NS003 (The Brothers) supports 50% of the breeding population of Roseate Terns in Canada. NS015 (Bon Portage) is the site of the largest Leach's Storm-Petrel colony in the Maritime provinces which represents greater than 1% of the western Atlantic population of this species. NS016 (East Cape Sable Island) supports 4% of the Atlantic Canada Piping Plover population. During fall, up to 7% of the global population of Semi-palmated Sandpipers (*Calidris pusilla*) and five percent of the global population of Short-billed Dowitchers (*Limnodromus griseus*) have been recorded at this IBA site. NS024 (South Shore (East Queens County Sector)) provides breeding habitat for up to 3% of the Atlantic Canada Piping Plover population and up to 1% of the global population of Semi-palmated Plovers (*Charadrius semipalmatus*) have been recorded at this location during fall migration. NS025 (Sable Island) provides breeding habitat for up to 5% of the North American population of Common Terns and 1% of the North American populations of Herring Gull and Great Black-Backed Gull. Sable Island also supports almost the entire population of the large Ipswich subspecies of the Savannah Sparrow (*Passerculus sandwichensis princeps*).

The nearest IBAs to the Project Area are located approximately 170 km to the north. These include IBAs NS016, NS017 and NS018 (Table 5.2.15). NS016 (Eastern Cape Sable Island) provides breeding habitat for Piping Plover and is a migration stop over for Red Knot (*Calidris canutus rufa*). It also provides important habitat for other species of migrating shorebirds and migrating and wintering waterfowl. NS017 (South Shore (Roseway to Baccaro)) provides breeding habitat for Piping Plover as well as important staging and wintering areas for waterfowl. NS018 (South Shore (Barrington Bay Sector)) provides breeding habitat for Piping Plover as well as regionally important shorebird migration habitat and waterfowl staging and wintering habitat.

Table 5.2.15 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID*	Location	Size (km^2)	Status	Bird Species	Description	Conservation Status
The Brothers	NS003	Lower West Pubnico, NS	4.51	Globally Significant: Congregatory Species; Nationally Significant: Threatened Species	Roseate Tern, Arctic Tern, Common Tern	Supports approximately half of the Canadian Roseate Tern population.	IBA Conservation Plan written/being written
Bon Portage Island	NS015	Shag Harbour, NS	3.00	Globally Significant: Congregatory Species, Colonial Waterbirds/Seabird Concentrations	Leach's Storm-Petrel, Great Blue Heron, Black-crowned Night Heron, Snowy Egret	Supports the largest known Leach's Storm-Petrel colony in the Maritimes and a mixed species heronry. A monitoring station for migrating birds is also established on the island.	Research Station (privately owned)
South Shore (Barrington Bay Sector)	NS018	Barrington Passage, NS	42.06	Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, sea ducks and shorebirds	Supports an important number of Piping Plovers and important migratory habitat	na
Eastern Cape Sable Island	NS016	Clark's Harbour, NS	33.62	Globally Significant: Congregatory Species, Shorebird Concentrations; Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, Semi-palmated Sandpipers, Short-billed Dowitchers, Black-bellied Plovers, Sanderlings, Ruddy Turnstones, Least Sandpipers, White-rumped Sandpipers, Greater Yellowlegs, Willets, Black-bellied Plover, Sanderling, Red Knot, American Oystercatcher, Brant, Short-billed Dowitcher, Short-eared Owl, as well	Nesting Piping Plover and important migratory habitat for a diversity of avifauna.	IBA Conservation Plan written/being written

Table 5.2.15 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID*	Location	Size (km^2)	Status	Bird Species	Description	Conservation Status
					as loons, herons, egrets, cormorants, seaducks, bay ducks, alcids, pelagic species, warblers, vireos, tanagers and sparrows.		
South Shore (Roseway to Baccaro)	NS017	Shelburne, NS	156.55	Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, scoters, eiders, American Black Duck.	Includes four Piping Plover beaches and provides important habitat for migrating waterfowl.	na
South Shore (Port Joli Sector)	NS004	Liverpool, NS	435.61	Continentally Significant: Congregatory Species, Nationally Significant: Threatened Species	Piping Plover, Harlequin Duck, Canada Goose, American Black Duck, Common Goldeneye, Common Loon, Common Eider, Black-bellied Plover, Semi-palmated Sandpiper, Willet, Least Sandpiper, Pectoral Sandpiper.	Supports nesting Piping Plovers, important shorebird migration habitat, overwintering grounds for Harlequin Ducks and other waterfowl.	Migratory Bird Sanctuary (federal), National Park, Provincial Park (including Marine)
South Shore - East Queens Co. Sector	NS024	Bridgewater, NS	49.01	Globally Significant: Congregatory Species, Nationally Significant: Threatened Species, Congregatory Species	Piping Plover, Semi-palmated Plover and other shorebirds, Harlequin Duck.	Supports nesting Piping Plovers, important shorebird migration habitat, occasional overwintering grounds for Harlequin Ducks.	Provincial Park (including Marine)

Table 5.2.15 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID*	Location	Size (km^2)	Status	Bird Species	Description	Conservation Status
Grassy Island Complex	NS026	Mahone Bay and Margaret's Bay, NS	9.96	Nationally Significant: Threatened Species, Congregatory Species	Roseate Tern.	Complex of three islands regularly support Roseate Terns.	IBA Conservation Plan written/being written
Sable Island	NS025	Sable Island, NS	461.89	Globally Significant; Nationally Significant: Threatened Species, Restricted Range Species	Ispwich Savannah Sparrow (ssp. princeps), Herring Gulls, Great Black-backed Gulls, Common Terns, Roseate Tern, Common Tern, Arctic Tern, Leach's Storm-Petrel, Least Sandpiper.	Supports the population of Ispwich Savannah Sparrow (ssp. princeps), Roseate Terns, and large numbers of nesting colonial waterbirds.	Migratory Bird Sanctuary (federal)
* Refer to Figure 5.2.46 for location.							

Source: http://www.ibacanada.com

5.2.6.5 Species of Conservation Interest

Species of Conservation Interest (SOCI) include all species listed under Schedule 1 of the federal SARA as endangered, threatened, or of special concern; listed under the Nova Scotia *Endangered Species Act* (NS ESA) as endangered, threatened, or vulnerable; and those that are listed as endangered, threatened, or of special concern by COSEWIC, but not yet listed in Schedule 1 of SARA.

There are six marine bird SOCI whose distribution records overlap with the Project RAA: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, and Barrow's Goldeneye. There are six marine bird SOCI whose distribution records overlap with the Project RAA: Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, and Barrow's Goldeneye. A variety of reference material was used to obtain information on the distribution of these species within the region, including data from PIROP and ECSAS, as well as data from the Atlantic Canada Conservation Data Centre (ACCDC) for the area within an approximate 6-km radius of Halifax Harbour, which is where the supply base will be located (refer to Section 5.3.1). Information on the regional importance, abundance, and distribution of marine bird SOCI is provided in the following sections, along with other key information on habitat requirements, general life history, and recovery strategies.Information on the regional importance, abundance, and distribution of marine bird SOCI is provided in the following sections, along with other key information on habitat requirements, general life history, and recovery strategies.

Ivory Gull

The Ivory Gull is listed as endangered on Schedule 1 of SARA and is a rarely encountered vagrant in Nova Scotia, being assigned a status of "accidental" (NSDNR 2011b) and "SNA" (*i.e.*, a conservation status is not applicable) (ACCDC 2011). During May and early June Ivory Gulls nest on flat terrain or on sheer cliffs in the high-Arctic. Outside their breeding season, they live near the edges of pack ice of the North Atlantic Ocean, particularly in the north Gulf, Davis Strait, the Labrador Sea, and the Strait of Belle Isle (COSEWIC 2006e). Vagrant Ivory Gulls are occasionally observed in coastal areas of Nova Scotia during winter months. For example, there are multiple records of this species from the Halifax area, and they have also been observed during winter near Lunenburg, Cape Sable, and Sambro (Cornell Lab of Ornithology 2014; Tufts 1986). Although rare, vagrant Ivory Gulls may also occur at other times of the year – for example, one was observed on Sable Island in June of 1969 (Tufts 1986). No Ivory Gulls were recorded within the ECSAS, PIROP, or ACCDC datasets obtained for the Project.

Until recently, the Canadian Arctic was thought to support 20–30% of the entire global breeding population of Ivory Gull and to contain colonies of global importance. However, aerial surveys conducted during 2002–2005 suggest that the Canadian breeding population has declined and is now comprised of 500–600 individuals, representing an approximate 80% decline over the last 18 years (COSEWIC 2006e). The percentage Ivory Gulls that winter in Canadian waters is largely unknown. Approximately 35 000 individuals were observed among the pack ice of the Labrador Sea in 1978 (Orr and Parsons 1982), representing the bulk of the world population. However, a

2004 survey conducted off the coast of Newfoundland and Labrador showed a decrease in Ivory Gull numbers, with sightings of 0.69 individuals sighted per 10 minutes observed in 1978 to 0.02 individuals sighted per 10 minutes in 2004 (COSEWIC 2006e). Confirmed threats to Ivory Gulls (in Canada and/or globally) include illegal shooting of adults for food, climate change that is altering ice conditions in the circumpolar Arctic, oiling at sea, and escalating diamond exploration and drilling activities at key breeding locations (COSEWIC 2006e).

As outlined in the management plan for Ivory Gull (Stenhouse 2004), the recovery goal is to return the breeding population to historic levels (approximately 1000 breeding pairs) and the breeding range to historic areas (in at least four regional breeding areas within the historic range) by 2014. The recovery objectives are to prevent further loss to the population; understand the life history and potential threats to Ivory Gull; protect known habitat; and to reach out to the public and cooperate internationally in recovery efforts (Stenhouse 2004). Although there have been advances in increased awareness and understanding of the Ivory Gull since the last status assessment (COSEWIC 2006e), breeding populations appear to be remaining at low levels within Canada (Government of Canada 2012).

Piping Plover

The Piping Plover (*melodus* subspecies is a migratory shorebird listed as endangered on Schedule 1 of SARA and by the NS ESA. It nests in sand, gravel, or cobble, in open elevated areas of coastal beaches, barrier island sandspits, or peninsulas in marine coastal areas (Haig and Elliot-Smith 2004). Within Canada, the *melodus* subspecies occurs in New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Québec (Environment Canada 2012a). In Nova Scotia, Piping Plovers breed on less than 30 beaches, along the South Shore (Shelburne to Halifax Co.), North Shore (Pictou and Antigonish Co.), and in Cape Breton (Victoria, Inverness and Cape Breton Co.). They typically arrive at their nesting grounds between the end of March and early May and young hatch between late May and June onwards, depending on when nesting was initiated. Nest initiation may occur any time after the birds arrive until mid-July. Nests are only occasionally initiated after this time. Migration back to the wintering grounds begins in early to mid-July and by early September the bulk of the population has left Canada (Environment Canada 2012a). Although important Piping Plover habitat is found along much of southern Nova Scotia, they are unlikely to occur within the Project Area as a result of their coastal affinity. ACCDC data obtained for the Project do not include records of Piping Plover in the vicinity of Halifax Harbour, but they do have potential to pass through the area during migration.

The latest North American population estimate for the *melodus* subspecies obtained in 2006 was 3323 adults, of which 460 (14%) were located in Canada (Goossen and Amirault-Langlais 2009). In 2008, the Nova Scotian population was estimated to include 44 pairs (Environment Canada 2012a). Although a banding research program conducted from 1998 to 2003 suggested that the Nova Scotian subpopulation was predicted to remain stable or to increase slowly (Calvert 2004), data collected since the end of the banding program suggests that the population in southern Nova Scotia is declining (Environment Canada 2012a).

Noted threats to this species are human disturbance, predation (egg, chick and adult), habitat loss and degradation, and livestock disturbances. Additional threats that may directly affect the plovers include driving vehicles on beaches, pets, boats, oil spills, mosquito control, and hurricanes (Stucker and Cuthbert 2006). In addition to these stressors, the population found along the southern shore of Nova Scotia appears to be reproductively isolated from the rest of the eastern population (Environment Canada 2012a).

The 2012 recovery strategy for Piping Plover (Environment Canada 2012a) identifies critical habitat for this species as "any site with suitable habitat occupied by at least one nesting pair of Piping Plovers (*melodus* subspecies) in at least one year since 1991 (the first year of complete survey coverage)". "Suitable habitat" is outlined as those areas with the following key habitat features, as identified by Boyne and Amirault (1999): a gently sloping foredune; wide stretches of beach that afford protection from flooding at normal high tide; a substrate combined of sand, gravel, or cobble, or some combination of these; and a foredune that is sparsely vegetated or relatively free of vegetation. Sites identified as critical habitat for Piping Plover correspond with its currently known nesting distribution in eastern Canada, and along the coastline of Nova Scotia (Environment Canada 2012a). Approximately 30 sites have been identified as critical habitat along the southern coastline of Nova Scotia (Figure 5.2.50). In addition to these breeding sites, Piping Plovers may be observed in association with beaches along much of Nova Scotia's coastline during fall migration.

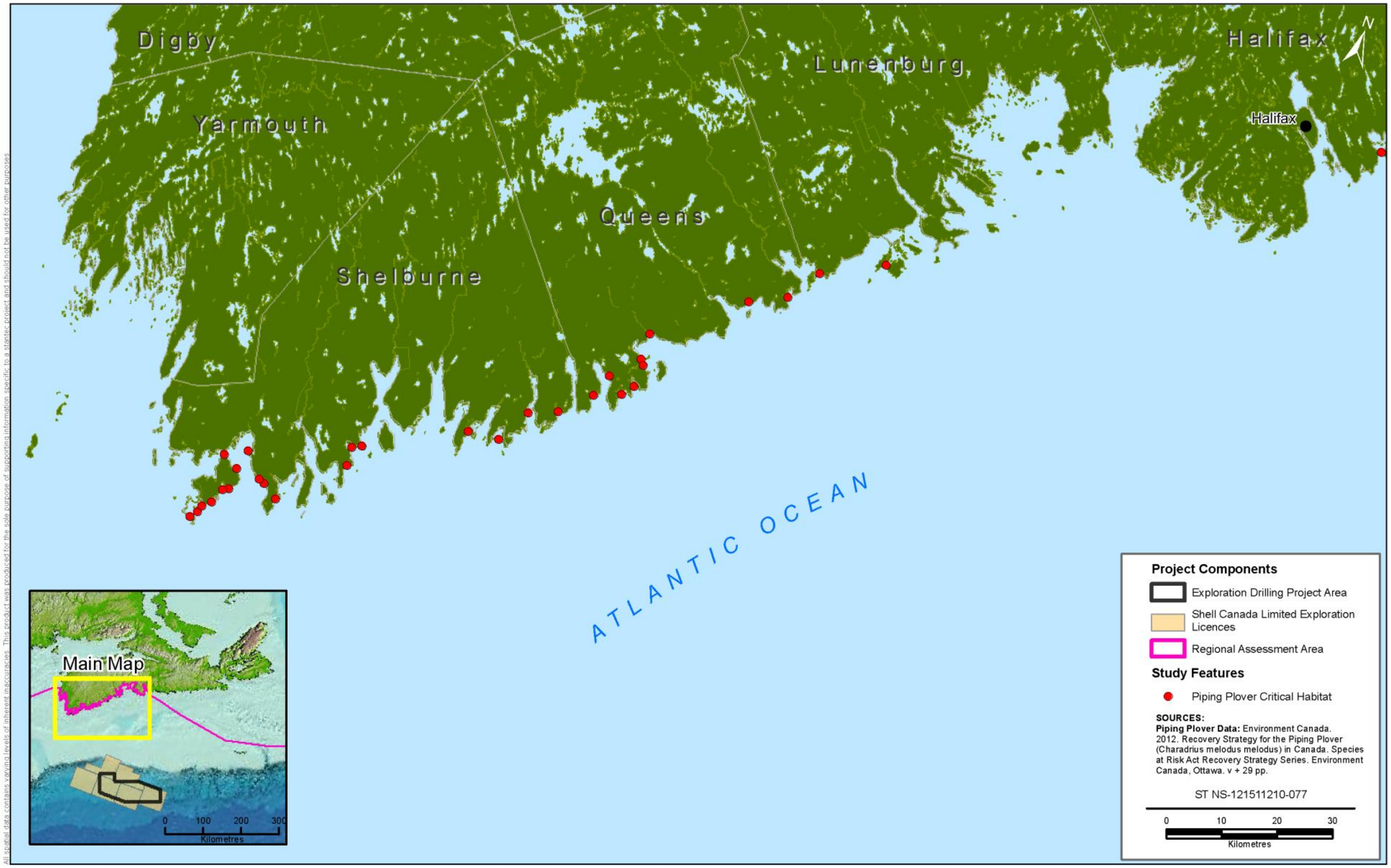


Figure 5.2.50 Critical Habitat for Piping Plover within the RAA

The short-term population objectives outlined in the recovery plan for Piping Plover *melodus* subspecies are to "achieve and maintain a regional population of 255 pairs and an annual productivity of 1.65 chicks fledged per territorial pair" (Environment Canada 2012). The long-term objectives are to increase the population to 310 pairs across eastern Canada and to 60 within Nova Scotia. The success of the recovery strategy implementation will be measured annually against whether a) the population is maintained at 255 pairs and b) regional productivity target of 1.65 chicks fledged per territorial pair is achieved. Over three consecutive international censuses (which will occur every five years) success of the recovery strategy implementation will be measured against whether a) the population is increased to 310 pairs and b) the population distribution is unchanged from the 1991 International Census (Environment Canada 2012). The strategy that is recommended in the recovery plan to address threats to this species is to "ensure enough suitable habitat to meet population objectives, reduce predation, reduce human disturbance, minimize impacts of adverse weather conditions, minimize impacts of poorly understood mortality factors, address key knowledge gaps to recovery, and monitor the population" (Environment Canada 2012).

Roseate Tern

The Roseate Tern is listed as endangered on Schedule 1 of SARA and under the NS ESA. Within Canada this species breeds almost exclusively on coastal islands in Nova Scotia, although small numbers of birds also breed in Quebec and New Brunswick. Roseate Tern nesting sites are populated with beach grass and herbaceous plants and always in association with Common or Arctic Terns (in northeastern North America) to provide protection from diurnal predators (Nisbet and Spendelow 1999, in COSEWIC 2009d).

There are approximately 120 to 150 pairs of Roseate Terns in Atlantic Canada, with another 4000 estimated to occur in the northeastern United States (Environment Canada 2010). The majority of those found in Nova Scotia are associated with Country Island (> 40 pairs) and the Brothers Islands (> 80 pairs) of Nova Scotia, with small amounts also nesting on Sable Island and the Magdalen Islands (COSEWIC 2009d). ACCDC data obtained for the Project did not indicate any records of Roseate Terns within the vicinity of Halifax but PIROP and ECSAs data indicate that they are occasionally observed in the waters off Nova Scotia during ship-based surveys, with potential to occur within the Project Area.

Threats to the Roseate Tern include predation from gulls and animals such as foxes, high post-fledging mortality and a shortage of males (*i.e.*, at least in some United States colonies) (Environment Canada 2010). The population's restricted distribution makes it vulnerable to localized threats such as human development, catastrophic weather events such as hurricanes (Nisbet and Spendelow 1999; Lebreton *et al.* 2003), pollution and disease (Environment Canada 2010). In addition, the reproductive rate of Roseate Tern is limited by delayed maturity to age of first reproduction, small clutch size, low annual adult survival for a seabird and relatively low survival to first breeding (Environment Canada 2010).

The Canadian Recovery Plan aims to maintain and enhance breeding productivity, and to restore the population's range across broadly distributed colonies (Environment Canada 2010). The long-term goal (*i.e.*, 10 years, currently to 2015) is to have at least 150 pairs of Roseate Terns nesting in at least three colonies in Canada. Specific objectives of the recovery plan are to maintain high numbers of breeding pairs at Country Island, Nova Scotia (> 40 pairs) and The Brothers, Nova Scotia (> 80 pairs), enhance productivity at managed colonies to high levels, restore a broader distribution by establishing at least one more managed colony, remove or reduce threats to Roseate Terns and their habitat, and maintain small peripheral nesting colonies on Sable Island and the Magdalen Islands (Environment Canada 2010). These objectives are to be achieved through monitoring population size, distribution, movement, and productivity; enhancing nesting habitat; managing additional colonies; identifying critical habitat; protecting habitat; identifying limiting factors at managed colonies; monitoring threats; and improving decision making and planning (Environment Canada 2010).

Although there is a national recovery plan in place for the Roseate Tern (Environment Canada 2010), its population recovery relies heavily on the 95% of the population nesting in the United States. Critical habitat has been identified for this species and includes Sable Island, specific coastal islands of Nova Scotia, and the Magdalen Islands (Environment Canada 2010). Areas of critical habitat for this species that are closest to the Project include the Brothers Islands in Yarmouth County and Sable Island (Figure 5.2.51).

Figure 5.2.51 Critical Habitat for Roseate Tern within the RAA

Red Knot

The Red Knot *rufus* subspecies is a medium-sized shorebird and is listed as endangered on Schedule 1 of SARA and under the NS ESA. Its breeding range falls entirely within the central parts of the Canadian Arctic and it overwinters in South America (COSEWIC 2007b). The Red Knot uses coastal areas with extensive sand flats during migration and is considered a fairly common transient along the coastline of Nova Scotia during fall migration, and rarely encountered in winter and during spring migration (Tufts 1986). Of the ten areas in eastern Canada identified in the status assessment for this species as being important sites for Red Knot migration, two are in Nova Scotia: southern Cape Breton Island and Cape Sable (COSEWIC 2007b). Other locations where Red Knot have been observed in Nova Scotia include coastal areas of Sable Island, Yarmouth, Shelburne, Lunenburg, and Dartmouth (Cornell Lab of Ornithology 2014, Tufts 1986). Although ACCDC records do not include Red Knot observations within the vicinity of the Halifax Harbour, this species is known to occasional stop at beaches in the area during migration. Because of its coastal affinity, Red Knot is unlikely to occur within the Project Area itself.

The estimated Red Knot *rufus* subspecies population in 2006 was 18 000 to 20 000 birds based on surveys conducted in the wintering range in South America; a decrease of 73.4% since 1982. The principal threats to the Red Knot include deterioration of food resources during spring migration, and habitat loss and degradation. The dwindling supply of horseshoe crab eggs in Delaware Bay, the most important food used during the final spring stopover, is the single most important threat to the Red Knot. Various factors leading to decreased habitat availability during migration in eastern North America are also contributing threats to the population (COSEWIC 2007b).

Harlequin Duck

The eastern population of Harlequin Duck is listed in Schedule 1 of SARA as a Species of Special Concern and as endangered under the NS ESA. Harlequin Ducks winter along rocky coastlines at traditional sites where they form pair bonds, and in spring they fly inland to breed in fast-flowing rivers and streams. Four distinct breeding populations are present within the low arctic: Pacific, Icelandic, Greenlandic, and eastern North American. In eastern Canada, the breeding range extends throughout a large portion of northern Quebec and Labrador, with isolated breeding ranges on the Northern Peninsula of Newfoundland, the northeast Gaspé Peninsula, and northern New Brunswick (Robertson and Goudie 1999). Although pairs of Harlequin Duck have been observed on the Margaree and Tusket Rivers during the breeding season (CWS pers. comm. 2012), they have not been confirmed to be breeding in Nova Scotia. However, they are known to forage in areas of rocky high energy shoreline around the coast of Nova Scotia during spring and fall migration, and during the winter. Areas within the RAA where Harlequin Ducks are known to regularly overwinter include near Prospect and Little Port L'Hebert (Figure 5.2.52). An aerial survey along the Atlantic Coast of Nova Scotia on March 6, 2013, identified approximately 192 birds near Prospect and 224 in the area of Little Port L'Hebert, with additional concentrations within the province being associated with Digby Neck and the Bay of Fundy, the Eastern Shore Islands, and Louisbourg (CWS, unpublished data, 2013). ACCDC data obtained for the Project did not indicate any records of Harlequin Duck within the vicinity of Halifax, although this species is sometimes observed at the mouth of the harbour (Cornell Lab of Ornithology 2014).

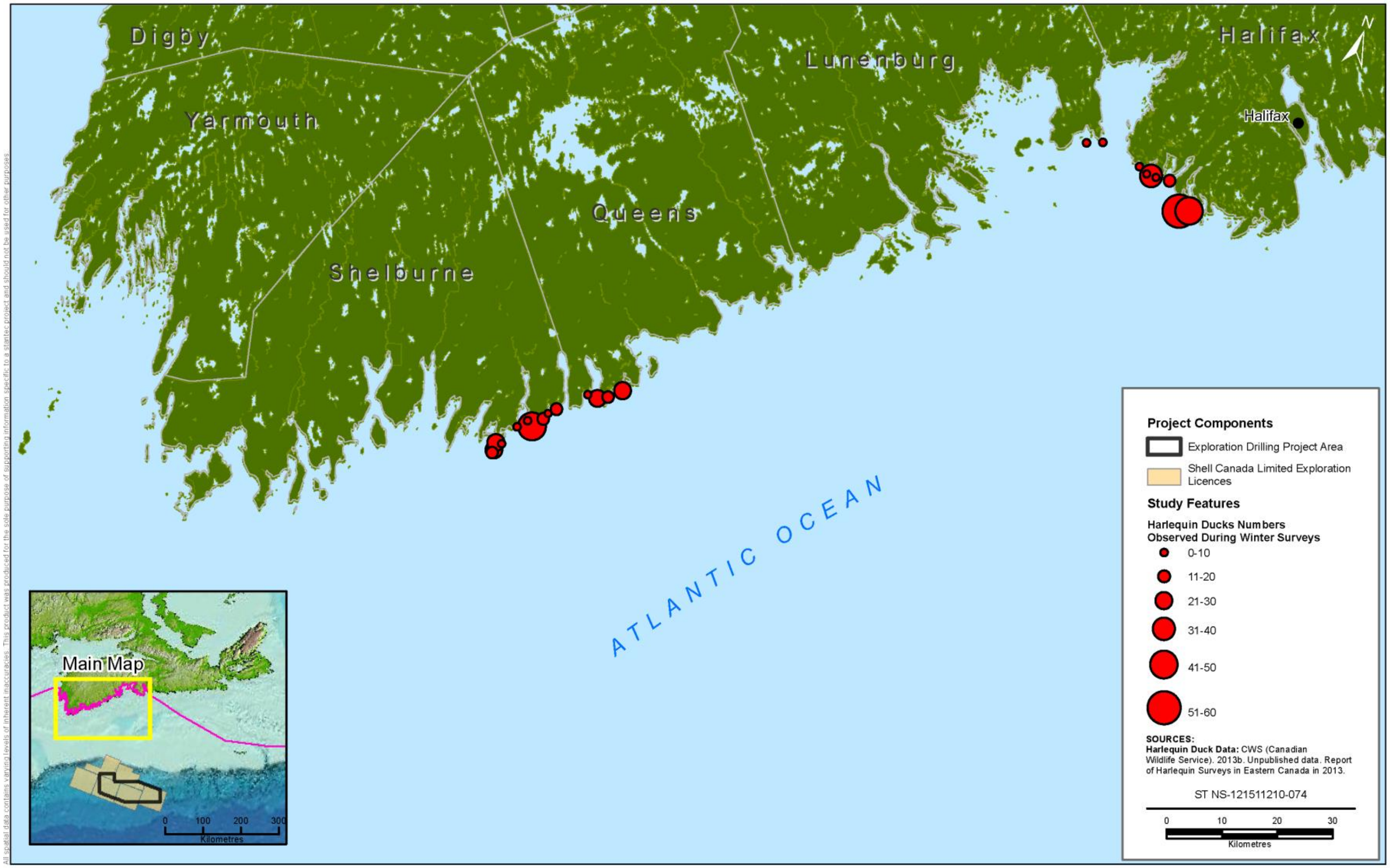


Figure 5.2.52 Known Harlequin Duck Overwintering Sites within the RAA

In 1990, COSEWIC designated the eastern North American population of Harlequin Duck as endangered due to declines during the 20th century. However, the eastern population of the species is currently rebounding and the COSEWIC designation was downgraded to Special Concern in 2001 to reflect this population increase. A census of the breeding population has been considered impractical because Harlequin Ducks are dispersed over a wide area on fast-flowing rivers of northern Newfoundland, Labrador, and Quebec. However, estimates of wintering populations are known because they tend to concentrate in traditional areas during this time. Based on the best available information, a conservative winter population estimate for eastern North America is 2925 individuals, with primary Canadian wintering locations being in the southern and eastern coasts of Nova Scotia (approximately 600 Harlequin Ducks), the Bay of Fundy (approximately 300), and southern Newfoundland (approximately 450) (Thomas 2010). In winter, they are typically found close to shore where the surf breaks along exposed rocky headlands, reefs, and offshore islands. In such habitats, they dive to feed on small shellfish and shrimp-like animals among these churning waters.

The types and importance of threats to the eastern population of Harlequin Duck vary across its range but they are generally considered to be susceptible to disturbance on their wintering, moulting, and breeding grounds (Environment Canada 2007), including those from interactions with fishing nets, aquaculture development, hunting activities, boats, and oil spills (Robertson and Goudie 1999; Thomas and Robert 2001). Hunting is considered a major factor that led to the low population estimate in the 1980s (Goudie 1990) but the legal hunt for this species has been closed in the Atlantic Flyway since 1990. While the abundance of Harlequin Ducks is increasing at key wintering locations, loss due to hunting remains a concern. Logging and hydroelectric development are considered to pose threats to some breeding populations (Robertson and Goudie 1999).

A Harlequin Duck federal management plan was completed in 2007, with an initial goal of sustaining a population of 2000 wintering individuals within eastern North America for at least three of five consecutive years (Environment Canada 2007). The long-term goal of the plan was to achieve at least 3000 wintering individuals (with at least 1000 adult females) for at least three of five consecutive years by 2010. Although population levels are increasing at the four key wintering locations in eastern North America (Thomas and Robert 2001), the eastern North American wintering population has still not met the initial goal outlined in the recovery plan. However, survey effort from 2005–2006 suggests that the 2000 individual mark was met for these two years (CWS, pers. comm. 2012.). The specific objectives of the plan are to work with interested parties to clearly identify possible threats to the population and identify ways to reduce or eliminate these threats; accurately assess the population; identify habitats and areas that are important for breeding, moulting, wintering, and staging, and protect and manage these areas; further understand knowledge gaps; and, collaborate with Greenland in Harlequin Duck conservation efforts (Environment Canada 2007).

5.2.6.5.1 Barrow's Goldeneye

Barrow's Goldeneye is a medium-sized diving duck that primarily breeds and winters in Canada, with the majority of wintering occurring in the inner Gulf and the North Shore of Québec. The wintering range of the Barrow's Goldeneye extends along the shores of the Atlantic provinces and Maine but the large majority of the population (*i.e.*, > 95%) winter in the St. Lawrence Estuary and Gulf (Environment Canada 2011). In the Atlantic provinces, they occur most commonly in winter in open water areas associated with flow constrictions or in thermal effluent discharge zones (Environment Canada, Canadian Wildlife Service – Atlantic Region, unpublished data; cites in Environment Canada 2011). Their winter diet consists of marine molluscs and crustaceans.

The world distribution of Barrow's Goldeneye consists of three separate populations. The eastern population of Barrow's Goldeneye is listed as a Species of Special Concern under Schedule 1 of SARA. Although the range of the eastern population is unknown, data indicate that breeding is exclusive to Canada, with the only confirmed breeding records being from Québec. Barrow's Goldeneye prefer to breed at high elevations on alkaline wetlands around freshwater lakes. Wintering populations in Quebec are on small fishless lakes above 500 m elevation, nesting in tree holes or cavities within 2 to 3 km of a water body (Todd 1963; Robert *et al.* 1999a, 1999b). The eastern North American population is approximately 6800 individuals, the equivalent of 2100 pairs (Robert *et al.* 2010). Fewer than 1000 Barrow's Goldeneye winters in the Atlantic provinces (New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador) and in Maine (Daury and Bateman 1996; cited in Environment Canada 2011). Although ACCDC, PIROP, and ECSAS datasets obtained for the Project do not include records for Barrow's Goldeneye, this species is occasionally observed along the southern coast of Nova Scotia, including in association with Halifax Harbour and near Lunenburg and Liverpool (Tufts 1986, Cornell Lab of Ornithology 2014).

Population trends for this species are unknown, but the Eastern population is considered to have declined in the 20th century and have potential to still be in decline (Environment Canada 2011). Threats to this species include logging in its breeding grounds, fish stocking, oil spills (particularly in the St. Lawrence Estuary and the Gulf of St. Lawrence)), hunting, and sediment contamination in areas where they congregate (Environment Canada 2011).

The objective of the management plan for the eastern population of Barrow's Goldeneye (Environment Canada 2011) is to maintain and, if possible, increase its current population size and range. In order to achieve this objective, the size of the population is to be maintained for the next ten years at not less than 6800 individuals across the species' range (Environment Canada 2011).

5.2.7 Summary of Species of Conservation Interest

Marine fish, mammals, turtles, and bird SOCI can be found on the Scotian Shelf or Slope during various times of the year. Table 5.2.16 summarizes a complete list of SOCI that have the potential to be found within the Scotian Shelf and Slope area.

Table 5.2.16 Species of Conservation Interest with Potential to Occur on the Scotian Shelf or Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation
Marine Fish Species of Conservation Interest			
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened
American eel	*Anguilla rostrata*	Not Listed	Threatened
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened
Atlantic bluefin Tuna	*Thunnus thynnus*	Not Listed	Endangered
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered
Atlantic cod (Southern population)		Not Listed	Endangered
Atlantic salmon (Outer Bay of Fundy)	*Salmo salar*	Not Listed	Endangered
Atlantic salmon (Inner Bay of Fundy)		Not Listed	Endangered
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered
Atlantic sturgeon (Maritimes populations)	*Ancipenser oxyrinchus*	Not Listed	Threatened
Atlantic (striped) wolffish	*Anarhichas lupus*	Special Concern	Special Concern
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern
Blue shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern
Cusk	*Brosme brosme*	Not Listed	Endangered
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered
Roughhead grenadier	*Macrourus berglax*	Not Listed	Special Concern
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered

Table 5.2.16 Species of Conservation Interest with Potential to Occur on the Scotian Shelf or Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Threatened
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened
Striped bass (Southern Bulf of St. Lawrence population and Bay of Fundy population)	*Morone Saxatilis*	Not Listed	Special Concern Endangered
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern
White shark	*Carcharodon Carcharias*	Endangered	Endangered
White hake	*Urophycis tenuis*	Not Listed	Special
Marine Mammal Species of Conservation Interest			
Blue whale (Atlantic population)	*Balaenoptera musculus*	Schedule 1, Endangered	Endangered
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Schedule 1, Special Concern	Special Concern
Humpback whale (Western North Atlantic population)	*Megaptera novaeangliae*	Schedule 3, Special Concern	Not at Risk
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1, Endangered	Endangered
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Schedule 2, Threatened	Special Concern
Killer whale	*Orcinus orca*	Not Listed	Special Concern
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Schedule 1, Endangered	Endangered
Sowerby's beaked whale	*Mesoplodon bidens*	Schedule 1, Special Concern	Not Listed
Sea Turtle Species of Conservation Interest			
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1, Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered

Table 5.2.16 Species of Conservation Interest with Potential to Occur on the Scotian Shelf or Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation
Marine Bird Species of Conservation Interest			
Ivory Gull	*Pagophila eburnea*	Endangered	Endangered
Roseate Tern	*Sterna dougallii*	Endangered	Endangered
Barrows Goldeneye	*Bucephala islandica*	Special Concern	Special Concern
Harlequin Duck	*Histrionicus histrionicus*	Special Concern	Special Concern
Piping Plover (melodus subspecies)	*Charadrius melodus melodus*	Endangered	Endangered
Red Knot rufa ssp	*Calidris canutus rufa*	Endangered	Endangered

5.2.8 Special Areas

Special Areas include areas on the Scotian Shelf and Slope which have been recognized as being ecologically unique or sensitive and may also be protected or managed through federal or provincial legislation. There are several protected Special Areas located on the Scotian Slope and Shelf, although as shown in Table 5.2.17, most of them are more than 100 km from the Project Area. These Special Areas include an oil and gas moratorium, SARA critical habitat, coral conservation areas, a marine protected areas (MPA), national park reserve, and various fisheries closures (to protect fish stocks and benthic habitats). Fisheries closures may not have direct significance to oil and gas activities, but they do indicate areas of importance for fish spawning and/or protection of juveniles, and therefore have been included for consideration as relevant Special Areas (Stantec 2014). These Special Areas are shown on Figure 5.2.53 and are described in Table 5.2.18.

Table 5.2.17 Proximity of Protected Special Areas to the Project Area

Special Area	Distance from Project Area
Browns Bank (Haddock Spawning Closure)	56 km
Haddock Nursery Closure, Emerald/Western Bank (Haddock Box)	60 km
Redfish Nursery Closure Area (Bowtie)	92 km
Lobster Fishing Area 40 (Georges Bank)	105 km
Georges Bank Oil and Gas Moratorium Area	120 km
Northeast Channel Coral Conservation Area	130 km
Hell Hole (Northeast Channel)	135 km
Georges Bank Fishery Closure (5Z)	158 km
Sambro Bank and Emerald Basin Sponge Conservation Areas	152 km, 182 km
Sable Island National Park Reserve	220 km
The Gully Marine Protected Area (MPA)	262 km
Northern Bottlenose Whale Critical Habitat (Sanctuaries): The Gully, Shortland Canyon, Haldimand Canyon	273 km, 330 km, 366km
Lophelia Conservation Area (LCA)	442 km

In addition to protected areas, there are several ecologically and biologically sensitive areas (EBSAs), many of which are incorporated in the protected areas noted above. EBSAs have been identified based on a compilation of scientific expert opinion and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf (Doherty and Horsman 2007). Of particular relevance to the Project Area are the EBSAs highlighted in the SEA for the Western Scotian Slope (Stantec 2014) including the Scotian Slope/Shelf Break, which runs through the Project Area. This EBSA is recognized as being ecologically unique (includes areas of unique geology and provides habitat heterogeneity), and providing important feeding and overwintering habitat and/or migratory routes for leatherback sea turtles, shellfish, finfish, and seabirds (Doherty and Horsman 2007).

Figure 5.2.53 depicts designated Special Areas including protected areas and fisheries conservation areas. Table 5.2.18 includes an overview of relevant Special Areas as drawn from various SEAs that have been prepared for the Scotian Shelf and Slope between 2012 and 2014 (Stantec 2012a, Stantec 2013a, Stantec 2014).

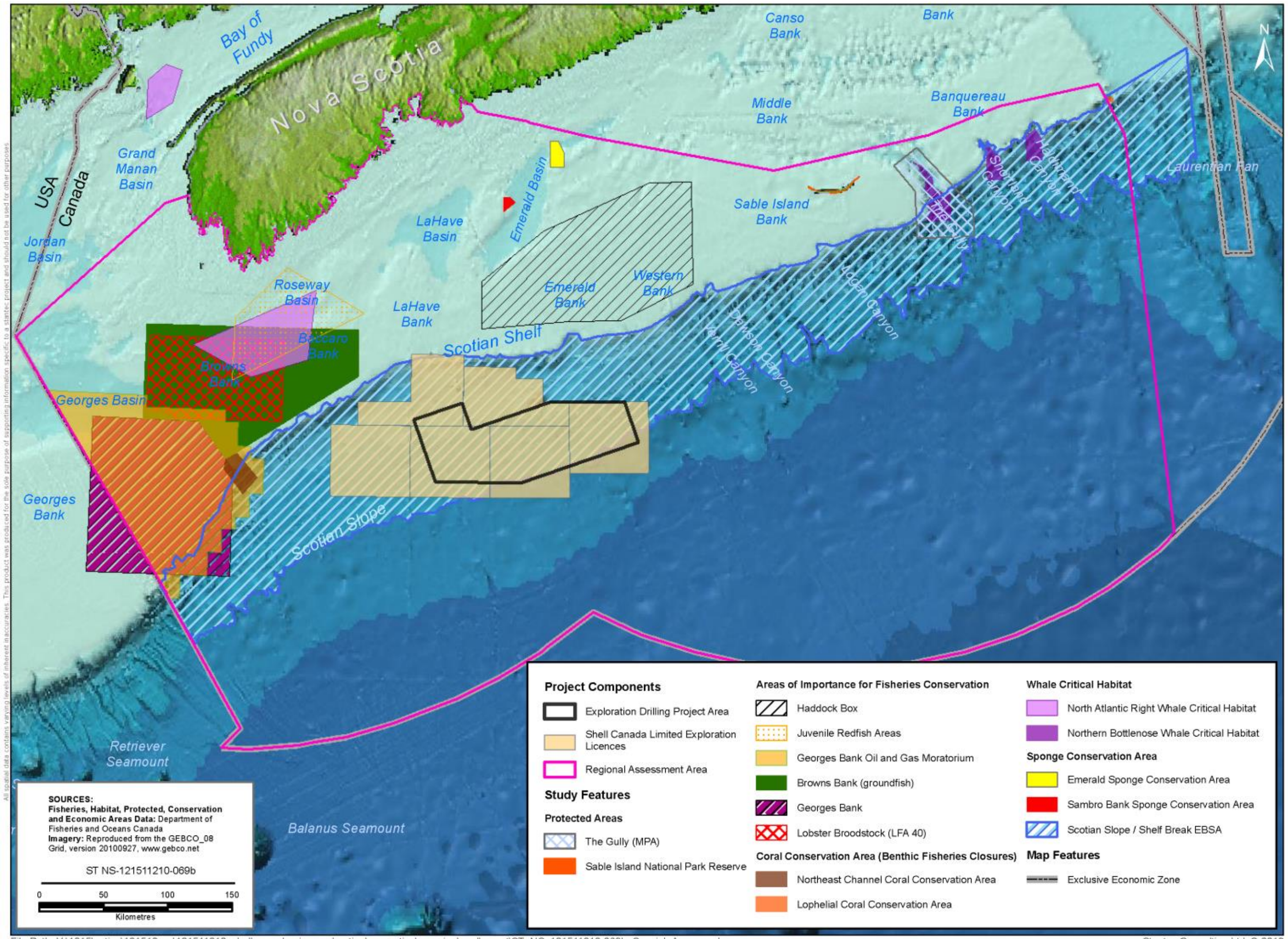


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Figure 5.2.53 Special Areas

Table 5.2.18 Special Areas in the RAA

Roseway Basin North Atlantic Right Whale Area to be Avoided/Critical Habitat (SARA)	
Location and Proximity to Project Area	• Approximately 3318 km^2 located in Roseway Basin between Baccaro and Browns Banks. • Approximately 95 km from the Project Area.
Designation and Administration	• In 1993, Roseway Basin was designated as a conservation area for right whales (Brown *et al.* 2009). • In 2007 Transport Canada submitted a proposal to the International Maritime Organization (IMO) for the designation of a recommend seasonal Area to be Avoided (ATBA) by ships 300 gross tonnage and upwards in transit during the period of 1 June through 31 December in order to significantly reduce the risk of ship strikes of the highly endangered North Atlantic right whale. This was adopted by IMO in 2007 and implemented in May 2008 (IMO 2007; Brown *et al.* 2009). • The North Atlantic right whale is listed as an endangered species on Schedule 1 of SARA. The Recovery Strategy for the North Atlantic right whale (*Eubalaena glacialis*) in Atlantic Canadian Waters (Brown *et al.* 2009) adopts the designated ATBA as provisional boundaries for a critical habitat designation under SARA.
Ecological Significance	• Right whales have shown an affinity for edges of banks and basins, upwellings and thermal fronts, and appear to be highly dependent on a narrow range of prey (*e.g.*, Calanoid copepods) (Brown *et al.* 2009). • Roseway Basin is an important area of right whale aggregation where right whales have been observed feeding and socializing in the summer and autumn months. Right whale abundance and stage C5 *Calanus finmarchicus* concentrations peak during this time (Brown *et al.* 2009). • Research is ongoing to evaluate prey distribution in Roseway Basin to refine critical habitat boundaries (Brown *et al.* 2009). • On average 17 whales (range 0–117) are sighted in the Roseway Basin habitat annually and these remain in the habitat for an average of 136.4 (±70.9) days in any given year (Vanderlaan *et al.* 2009).
Georges Bank Oil and Gas Moratorium Area	
Location and Proximity to Project Area	• Georges Bank is an offshore bank located on the outer continental shelf straddling the Canada-United States maritime boundary, with the northeast portion of the Bank in Canadian waters. • The moratorium area covers approximately 15 000 km^2 and includes the Canadian portion of Georges Bank and much of the Northeast Channel to the southwest edge of Browns Bank (DFO 2011a). • Approximately 120 km from the Project Area.
Designation and Administration	• In 1988, the Governments of Canada and Nova Scotia placed a moratorium on all petroleum activities on the Canadian portion of Georges Bank and adjacent areas. The moratorium was extended until 2012 following an independent panel review in 1999. • Schedule IV of the Accord Acts delineates the Canadian portion of the moratorium area. • In early 2010, the moratorium was extended by both governments to 2015 and in December 2010, the Province of Nova Scotia passed the *Offshore Licensing Policy Act* which prohibits the exploration or drilling for or the

Table 5.2.18 Special Areas in the RAA

	production, conservation, processing or transportation of petroleum on George Bank indefinitely. A public review, no earlier than December 31, 2022, may be ordered at the discretion of the Minister of Energy to re-examine the moratorium. There is currently no mirror legislation for the federal government. • Exploration rights issued to leaseholders on the Canadian portion prior to the moratorium are suspended while the moratorium remains in effect. • The Government of the United States established a moratorium on the United States portion of Georges Bank in 1990; this moratorium has been extended to 2017.
Ecological Significance	• Georges Bank is recognized internationally as a unique ecosystem that exhibits high levels of biological productivity and biodiversity. • Georges Bank is at the northern edge of southern assemblages of plankton and fish and at the southern edge of northern assemblages, therefore biodiversity is very high in this area (of both subpolar and subtropical assemblages); with the Northeast Peak being the most productive part of Georges Bank (NRCan and NSPD 1999). • Georges Bank supports a highly productive, diverse, and economically valuable fishing industry with landings of scallops, lobster, groundfish and large and small pelagics. Fish productivity has been reported to be two to two and half times that in other comparable areas such as the Gulf of Maine or the Scotian Shelf (NRCan and NSPD 1999). • The high and persistent productivity of phytoplankton and fish and the co-occurrence of spawning and nursery areas on the Northeast Peak are biological features that contribute to Georges Bank uniqueness and ecological significance (NRCan and NSPD 1999). • Strong and persistent tidal currents (dominant physical factor on the Bank) result in high mixing rates, nutrient supply and overall dispersion (Boudreau *et al.* 1999). • Georges Bank serves as a feeding ground, nursery, and migration corridor for more than two dozen whale (including SARA-listed species) and four seal species (NRCan and NSPD 1999). • Georges Bank serves as an important feeding area for birds owing to high mixing rates and nutrient supply.
Northeast Channel Coral Conservation Area	
Location and Proximity to Project Area	• Approximately 424 km^2 in the Northeast Channel, east of Georges Bank. • Approximately 130 km from the Project Area.
Designation and Administration	• In June 2002 DFO established a Coral Conservation Area in accordance with the *Fisheries Act* and the *Oceans Act* with the objective of protecting high densities of intact octocorals (*Paragoria arborea*, bubblegum coral and *Primnoa resedaeformis*, seacorn coral). This is one of three areas of significance for cold-water corals offshore Nova Scotia (the Gully and Lophelia Coral Conservation Area in Laurentian Channel being the other two) (DFO 2006). • The Northeast Channel Coral Conservation Area is divided into two zones: 1. Restricted bottom fisheries zone - ~ 90% of the area is closed to all bottom fishing gear used for groundfish or invertebrate fisheries (*e.g.*, longline, otter trawl, gillnet, trap). The highest density of corals, as

Table 5.2.18 Special Areas in the RAA

	observed in scientific surveys, is found in this zone. 2. Limited bottom fisheries zone - about 10% of the area is open to authorized fishing activities. At the present time, the area is open only to longline gear for groundfish (with an At-sea Observer) and is closed to all other bottom fishing gear. • In 2006 DFO developed a coral conservation plan (DFO 2006) for the Maritimes Region which provides an objective and strategy to protecting and understanding important benthic habitats.
Ecological Significance	• The conservation area was primarily selected on basis of having the highest density of large branching octocorals (gorgonian), *Paragorgia arborea* and *Primnoa resdaeformis* in the Maritimes and visual evidence indicated vulnerability to bottom fishing damage (Cogswell *et al.* 2009). • The conservation area contains 12 taxa of coral (amalgamating the genus *Primnoa* and *Paragorgia*), including gorgonian corals, sea pens, and stony corals and is optimally positioned to protect the highest density and least impacted branching gorgonians in the area (Cogswell *et al.* 2009). • Corals provide various ecosystem functions and coral biomass has been shown to be closely correlated to fish biodiversity (Campbell and Simms 2009).
Sambro Bank and Emerald Basin *Vazella* Closure Areas	
Location	• Sambro Bank *Vazella* Closure area is 62 km^2 on Sambro Bank, between LaHave Basin and Emerald Basin on the Scotian Shelf. • Emerald Basin *Vazella* Closure area is 197 km^2 in Emerald Basin on the Scotian Shelf.
Designation and Administration	• In 2013, in accordance with DFO's *Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas* (DFO 2009c), DFO closed two areas on the eastern Scotian Shelf known to contain the highest density of *Vazella pourtalesi* to bottom-contact fishing. • DFO's Sensitive Benthic Areas Policy is guided by the legal and policy framework designed to manage Canada's fisheries and ocean resources including the *Fisheries Act*, the *Oceans Act* and SARA as well as Canada's commitments under several international agreements including Canada's commitment under the United Nations Resolution 61/105 to protect vulnerable marine ecosystems in domestic waters (DFO 2009c).
Ecological Significance	• The glass sponge *Vazella pourtalesi* is known to exist in only three locations worldwide – the Gulf of Mexico, the Azores, and in Canada. • The locations on the eastern Scotian Shelf are the only instances where large aggregations have been found and thus are regarded as being globally-unique aggregations; the Gulf of Mexico and the Azores populations exist as individuals or in small aggregations (DFO 2013c). • Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make the sponges particularly vulnerable to physical impacts and limit recovery (DFO 2013c).
Sable Island National Park Reserve	
Location and Proximity to Project Area	• Located 290 km offshore from Halifax, Sable Island is a windswept crescent-shaped sandbar 42 km long by 1.5 km wide that emerges from the Atlantic

Table 5.2.18 Special Areas in the RAA

	Ocean near the edge of the Continental Shelf (Parks Canada 2010). • Approximately 220 km from the Project Area.
Designation and Administration	• Sable Island is protected under the *Canada National Parks Act* which prohibits drilling from the surface of Sable Island and one nautical mile seaward of the low water mark of Sable Island as defined by the Canadian Hydrographic Service (Parks Canada 2011). • To comply with the *National Parks Act*, an *Amending Agreement of Significant Discovery Licence 2255E* was executed on December 21, 2011 (CNSOPB 2011). • As of April 1, 2012, Parks Canada is responsible for managing access to the island by coordinating registrations, schedules, logistics, and written authorizations from the Canadian Coast Guard pursuant to the *Canada Shipping Act*, as is required in the current legislative context until the Canada *National Parks Act* is amended to include Sable Island National Park Reserve. (J. Sheppard, Parks Canada, pers. comm., 2012). • Sable Island was designated as a Migratory Bird Sanctuary (MBS) in 1977 and is administered by the Canadian Wildlife Service (CWS) and is also an Important Bird Area (IBA) (Environment Canada 2012b). • Sable Island is protected under the *Special Places Protection Act* for its rich archaeological and heritage resources. • The Meteorological Service of Canada, a branch of Environment Canada, maintains a continuous presence on the island. They also continue to provide operational services by agreement with Parks Canada, including all services related to landing on and visiting the island (J. Sheppard, Parks Canada, pers. comm. 2012). • There are seasonally occupied facilities belonging to Department of Fisheries and Oceans, and Coast Guard including a number of buildings, two lighthouses, two helicopter landing pads and a navigation beacon (Canadian Coast Guard 2006).
Ecological Significance	• Over 190 species of plants and 350 species of birds recorded. The Ipswich (Savannah) Sparrow and the Roseate Tern both breed on the island and are protected under SARA. • The Ipswich Sparrow nests almost exclusively on Sable Island and is the dominant terrestrial bird on the island. The birds breed on virtually all vegetated areas on Sable Island, including healthy terrain and areas dominated by Marram Grass. In winter, they occur in coastal dunes, especially in areas with dense beach grass (COSEWIC 2009d). The species' localized distribution makes it particularly vulnerable to potential threats such as chance events (*e.g.*, harsh weather and disease during breeding season), predation, human activity, and habitat loss. • The 2006 proposed Recovery Strategy for the Roseate Tern (Environment Canada 2006) was the first recovery strategy for a migratory bird posted on the SARA Public Registry to identify "critical habitat" as defined in the Act (200 m buffer zone around tern colonies). The Amended Recovery Strategy for the Roseate Tern (Environment Canada 2010) has the objective to continue to maintain the small peripheral colonies of Roseate Terns nesting on Sable Island. A former recommended focus on restoration of Roseate Terns to Sable Island was not attempted on Sable Island (primarily due to financial constraints) and since then, only one or two pairs of Roseate Terns have nested there each year (Environment Canada 2010).

Table 5.2.18 Special Areas in the RAA

	• Home to the world's largest breeding colony of grey seals, which pup on the island between late December and early February. Harbour Seals also breed on the island and are year-round residents. • Hundreds of harp and hooded seals and one or two ringed seals come ashore for a few hours or days during the winter and early spring (DFO 2011a). • Over 400 wild horses, believed to have been introduced sometime in the mid-1700s, inhabit the island (Parks Canada 2011).
The Gully Marine Protected Area (MPA)	
Location and Proximity to Project Area	• The Gully is located approximately 200 km south-east of Nova Scotia, east of Sable Island, on the edge of the Scotian Shelf (DFO 2008a). • In the Gully the seafloor drops away over 2.5 km extending approximately 65 km long and 15 km wide making it one of the most prominent undersea features on the east coast of Canada (DFO 2008a). • Approximately 262 km from the Project Area.
Designation and Administration	• In 1994, DFO identified part of the Gully as a Whale Sanctuary to reduce noise disturbance and ship collisions with whales (DFO 2008a). • In May 2004, the Gully was designated an MPA under the *Oceans Act* (DFO 2011c). • The *Gully Marine Protected Area Regulations* prohibit any activity within or in the vicinity of the MPA that disturbs, damages, destroys or removes any living marine organism or any part of its habitat within the MPA and in the vicinity of the MPA. These regulations apply to the entire water column and the seabed to a depth of 15 m (DFO 2011c). • The *Gully Marine Protected Area Management Plan* was developed to support the *Gully Marine Protected Area Regulations* and provide guidance to DFO, other regulators, marine users, and the public on protecting and managing this important ecosystem (DFO 2008a, DFO 2011c). • The MPA contains three management zones, each providing varying levels of protection based on conservation objectives and ecological sensitivities (DFO 2008a): Zone 1 consists of the deepest sections of the canyon and is preserved in a near-natural state with full ecosystem protection - this zone is highly restricted with few activities permitted (research and limited vessel transit); Zone 2 provides strict protection for the canyon sides and outer area of the Gully – some fisheries are allowed in this region; and Zone 3 includes the shallow water and sandy banks that are prone to regular natural disturbance and allows some fishing. • Fishing for halibut, tuna, shark and swordfish have been allowed in Zones 2 and 3 provided the activities are conducted under a federal fishing licence and approved management plan (DFO 2008a). Scientific research and monitoring may be approved in all three zones provided a plan is submitted and the research meets all regulatory requirements. Other activities may be permitted in Zone 3 provided they do not cause disturbance beyond the natural variability of the ecosystem and are subject to plan submission and Ministerial approval. • The CNSOPB has not allowed petroleum activities in the Gully since 1998 (CNSOPB 2012c).

Table 5.2.18 Special Areas in the RAA

Ecological Significance	• The Gully has significant coral communities, a diversity of both shallow and deepwater fishes, and a variety of whales and dolphins including blue whales, sperm whales, Sowerby's beaked whales, and aggregations of prey of whale species. A resident population of endangered Northern bottlenose whales is found in the deep canyon area. These whales are among the world's deepest divers and make regular trips to the canyon depths for food (DFO 2008a).
Northern Bottlenose Whale Critical Habitat (Sanctuaries): The Gully, Shortland Canyon, Haldimand Canyon	
Location and Proximity to Project Area	• Approximately 273 km, 330 km and 366 km respectively from the Project Area on the Eastern Scotian Slope.
Designation and Administration	• In 1994, Fisheries and Oceans Canada (DFO) designated a Whale Sanctuary in the Gully for the Northern bottlenose whales. Using an annual Notice to Mariners, vessel operators are asked to avoid the Gully or transit it cautiously. • The Recovery Strategy for Northern bottlenose whale identifies the entirety of Zone 1 of the Gully Marine Protected Area and areas with water depths of more than 500 m in Haldimand Canyon and Shortland Canyon as Critical Habitat under SARA for the Scotian Shelf population. Since Northern bottlenose whales use the full depth range in these areas, breathing and socializing at the surface and diving to feed at or near the bottom, critical habitat for this species should be considered to include the entire water column and the seafloor (DFO 2011d). • Pursuant to section 58(5) of SARA, Critical Habitat for the Northern bottlenose whale was identified in the Final Recovery Strategy for this species, and posted on the SARA Public Registry in May 2010. Note the portion of the Northern bottlenose whale critical habitat located in the Gully MPA Zone 1 was described in the Canada Gazette 1 on August 14, 2010. The prohibition in section 58(1) of SARA came into force within the Gully MPA Zone 1 area on November 11, 2010 (DFO 2010d). Critical habitat is protected under SARA through provisions set out section 32 of the Act.

Table 5.2.18 Special Areas in the RAA

Ecological Significance	• Northern bottlenose whales are sighted consistently, throughout the year, at the entrance of the Gully (COSEWIC 2002a). • The Scotian Shelf population of Northern bottlenose whales live at the southern extreme of the species' range and appear to be largely or totally distinct from the populations further north, seem to be non-migratory, and spend an average of 57% of their time in a small core area at the entrance of the Gully, which has seafloor relief that is unique in the western North Atlantic. These characteristics make the population particularly sensitive to human activities (COSEWIC 2002a). Recent acoustic monitoring studies indicate that Northern bottlenose whales feed year-round in the Gully, Shortland, and Haldimand Canyons, as well as in between these canyons (Moors 2012). • Northern bottlenose whale habitat is characterized by waters of more than 500 m in bottom depth, particularly around steep-sided features (*e.g.,* underwater canyons and continental slope edge), and access to sufficient accumulations of prey (*Gonatus* squid) (DFO 2011d). • Distribution of this species extends west of the Gully and it is believed that other canyons along the Scotian Slope (*e.g.*, Logan Canyon) may also provide important habitat for this species (DFO 2011d).
***Lophelia* Conservation Area (LCA)**	
Location and Proximity to Project Area	• The *Lophelia* Conservation Area (LCA) is 15 km^2 area located at the mouth of the Laurentian Channel on southeast Banquereau Bank, about 260 km southeast of Louisbourg. • Approximately 442 km from the Project Area.
Designation and Administration	• Created in 2004 to include the reef area and a one-nautical mile buffer closed to all bottom fisheries, based on consultation with active fisheries representatives (Cogswell *et al.* 2009). • The larger area surrounding the conservation area is regionally known to fishermen as the Stone Fence. • The *Lophelia* Conservation Area is closed to fishing under the *Fisheries Act*.
Ecological Significance	• Nine coral species, including the reef-building *Lophelia pertusa*, have been identified from the area (Cogswell *et al*. 2009). • The LCA contains the only known living *Lophelia pertusa* reef in Atlantic Canada (DFO 2011a). • Evidence of coral rubble, overturned rocks, and lost fishing gear indicate areas have been impacted by bottom fishing (Cogswell *et al*. 2009). • Predicted to contain high marine mammal diversity in entrances of channels, particularly dolphins and deep diving whales (Doherty and Horsman 2007).
Scotian Slope/Shelf Break ESBA	
Location and Proximity to Project Area	• The Scotian Slope/Shelf Break EBSA (approximately 68 603 km^2) is located on the Scotian Slope from Georges Bank to the Laurentian Channel and runs through the Project Area.

Table 5.2.18 Special Areas in the RAA

Designation and Administration	• EBSAs have been identified based on a compilation of scientific expert opinion and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf. • Using the criteria of uniqueness, aggregation, fitness consequences, naturalness, and resilience, DFO experts identified EBSAs for consideration in a marine protected area (MPA) network analysis exercise to address conservation objectives in accordance with the *Oceans Act*.
Ecological Significance	• Includes areas of unique geology (iceberg, furrows, pits, complex/irregular bottom). • High finfish diversity due to habitat heterogeneity provided by depth. • Primary residence for mesopelagic fishes. • Inhabited by corals, whales, sharks, tuna, swordfish. • Migratory route and foraging area for endangered leatherback turtles – the area supports concentrations of salps which are a source of food for turtles. • High diversity of squid. • Overwintering area for number of shellfish species. • Halibut overwintering, lobster overwintering. • Seabird feeding/overwintering area. • Greenland sharks.
Select Fisheries Closure Areas for Fisheries Conservation	
Browns Bank (Haddock Spawning Closure)	• Seasonal fishery closure area to protect 4X cod and haddock during spawning season and reduce exploitation rates in Southwest Nova Scotia. Closure terms and area has evolved since the 1970s but currently prohibits fishing gear capable of catching demersal species (*e.g.*, hook gear, scallop dredges) during March–May (O'Boyle 2011). • Approximately 56 km from the Project Area.
Haddock Nursery Closure, Emerald/Western Bank (Haddock Box)	• The Haddock Box is an important nursery area for the protection of juvenile haddock, and is closed year-round by DFO, pursuant to the *Fisheries Act*, to the commercial groundfish fishery. Scallop fishing continues to occur on the easternmost part of the closed area (O'Boyle 2011) • Established to protect juvenile haddock in Northwest Atlantic Fisheries Organization (NAFO) Division 4VW (no considerations for biodiversity or habitat protection) (O'Boyle 2011). • Adult haddock aggregate to spawn within the Haddock Box, including Emerald Bank, from March to June, with peak spawning in March/April (BEPCo. 2004). • Closed area may be playing role in increasing haddock stock and abundance of other non-target species (*e.g.*, winter flounder, plaice, silver hake) (O'Boyle 2011). • Approximately 60 km from the Project Area.
Redfish Nursery Closure Area (Bowtie)	• Located on Browns Bank, extending into Roseway Basin, this special management area (known informally as the "Bowtie") is closed January to June to fishing using small mesh gear (mesh < 130 mm) to protect small redfish (DFO 2005a; LGL 2013).

Table 5.2.18 Special Areas in the RAA

	• Approximately 92 km from the Project Area.
Lobster Fishing Area 40 (Georges Bank)	• A closure of LFA 40 area on Browns Bank to all lobster fishing has been in place since 1979 as a measure to protect lobster broodstock. • It has been surmised that the LFA 40 closure may also be beneficial to the protection of North Atlantic right whales and leatherback turtles given the proximity of the Roseway Basin (critical habitat for North Atlantic right whales) and decreased risk of entanglement in fishing gear (O'Boyle 2011). • Approximately 103 km from the Project Area.
Hell Hole (Northeast Channel)	• The Hell Hole is an important area for bluefin tuna. Longline fisheries are not permitted to fish within the Hell Hole from July to November to reduce bluefin tuna bycatch (DFO 2005). • Approximately 135 km from the Project Area.
Georges Bank (5Z)	• Since 2005, a scallop fishery area/time closure (February–March) has been implemented to reduce bycatch and minimize disturbance to spawning aggregations of cod by the offshore scallop fishery on Georges Bank. The time restrictions (February–March) coincides with cod spawning season and the area corresponds with density of cod abundance and overlap with scallop catches on Georges Bank (DFO 2012a). • Approximately 149 km from the Project Area.

5.3 SOCIO-ECONOMIC ENVIRONMENT

5.3.1 Land and Nearshore Ocean Use

OSVs will travel between the MODU and an onshore supply base located at Woodside Atlantic Wharf, on the Dartmouth side of Halifax Harbour. The supply base is not included in the approved scope of the Project to be assessed. Halifax Harbour is a major inlet of the North Atlantic Ocean, approximately midway along the south-eastern coast of Nova Scotia. It is surrounded by the Halifax Regional Municipality in Halifax County and is bordered by the communities of Halifax to the west, Bedford to the north, and Dartmouth to the east. The Port of Halifax accommodates cargo vessels and cruise ships on a year-round basis. In addition to marine container and cruise terminals, the port includes bulk handling facilities, a high volume roll-on/roll-off terminal, oil wharves, rail facilities, and ferry terminals.

Halifax Harbour is currently subject to high levels of marine-related industrial activity (*e.g.*, ship loading and unloading, container handling, storage and laydown, rail and truck traffic, ship repair and rebuilding, servicing offshore oil rigs, and/or vessel layup), including associated noise, light, and other sensory disturbance. The supply base location has no natural intertidal zone, as the existing shoreline was previously infilled to accommodate present operations. The potential for previously undisturbed heritage, historic, or archaeological resources to be present on-site is therefore assumed to be low.

Commercial fisheries in the Harbour include a small commercial finfish fishery seaward of McNabs Island which consists of groundfish (cod, haddock, pollock and halibut) and pelagic (herring and mackerel) species (Rozee 2000). Bedford Basin and other areas throughout the Harbour support a bait fishery (pollock, herring, mackerel and smelt) for both commercial and recreational bait (Rozee 2000). The fishing season for salmon runs from July through October, and the fishing season for mackerel runs from June through October. Both of these species migrate along the edges of the Narrows during passage to and from Sackville River (Stantec 2010). Commercial and recreational fisheries for clams and mussels are closed due to fecal coliform levels in the Harbour. Some recreational groundfishing occurs just outside of the Harbour, but this type of fishing is not common within the Harbour itself.

Lobster is the primary commercial species harvested within Halifax Harbour. The Harbour is included within the boundaries of Lobster Fishing Area (LFA) 33, which extends from Cow Bay, Halifax County to Port La Tour, Shelburne County. The majority of fishers in the Halifax area fish with 250 traps. Fishers licensed to fish in LFA 33 are not restricted to stay within a particular zone. Therefore, certain users fish in the Harbour as one of several fishing grounds that they frequent (Stantec 2010).

The area around McNabs Island supports the majority of lobster fishing activity. Approximately one or two traps are situated around Georges Island. Light lobster fishing also occurs in the Bedford Basin, with most traps placed intermittently along the shoreline, as well as in Tufts Cove. Most Harbour fishers also fish outside of the Harbour; Eastern Passage and Herring Cove are the home ports for the majority of lobster fishers that use the Harbour. Only approximately 15 to 20 lobster fishers use the Harbour, including those that fish there exclusively and those that also fish in other areas.

LFA 34 extends from the southwest boundary of LFA 33 (Port La Tour, Shelburne County) off southwestern Nova Scotia and into the Bay of Fundy. LFA 34 has the highest landings and most participants of any LFA in Canada (DFO 2013x). Both LFA 33 and LFA 34 share the same fishing season (end of November to May 31).

Inshore recreational fisheries target many of the same species that are fished commercially in the nearshore and offshore, including American eel, mackerel, herring, and scallop. In addition to nearshore fisheries, there are several finfish (*e.g.,* salmon, cod, trout) and shellfish (*e.g.,* oyster, mussel, scallop, sea urchin, clam) aquaculture operations in the harbours and bays along the Nova Scotia coastline in the RAA (NSDFA 2013).

Additional information offshore fisheries is provided in Sections 5.3.3 and 5.3.4.

5.3.2 Offshore Ocean Uses and Infrastructure

The following additional ocean uses and infrastructure occur on the Scotian Shelf and Slope in the vicinity of the Project Area:

- oil and gas exploration and production
- military operations
- marine traffic

- tourism and recreational activities
- marine research
- seabed hazards associated with human activities

5.3.2.1 Oil and Gas Exploration and Production

A number of offshore oil and gas development activities take place on the Scotian Shelf. Development of the offshore petroleum industry can be broadly assigned to three major work categories: exploration; production; and decommissioning. There is no current offshore oil and gas activity in the Project Area. Several exploratory wells have been drilled in the general vicinity of the Project Area, all of which have been plugged and abandoned. Figure 5.3.1 presents the locations of existing and proposed offshore oil and gas activities and infrastructure off the coast of Nova Scotia, as well as areas associated with ELs, SDLs, and production licences.

In addition to the ELs awarded to Shell in March 2012 and January 2013, further Calls for Bids have been conducted and are planned for the Nova Scotia Offshore Area. In November 2012, it was announced that British Petroleum Exploration Operating Company Limited (BP) was the successful bidder on four offshore parcels (ELs 2431, 2432, 2433 and 2434) immediately adjacent to Shell's ELs. BP recently submitted an EA to the CNSOPB in association with a proposed 3D seismic program to be conducted in 2014. Depending on the results of the seismic survey, BP could potentially begin drilling as early as 2017 (Mellor 2014). In March 2013, a Call for Bids (NS 13-1) consisting of six parcels on the central and eastern Scotian Shelf was initiated; it closed October 24, 2013 with no bids received. Figure 5.3.1 outlines the current status of the Nova Scotia Offshore land parcels as well as the location of the NS 13-1 Call for Bids parcels.

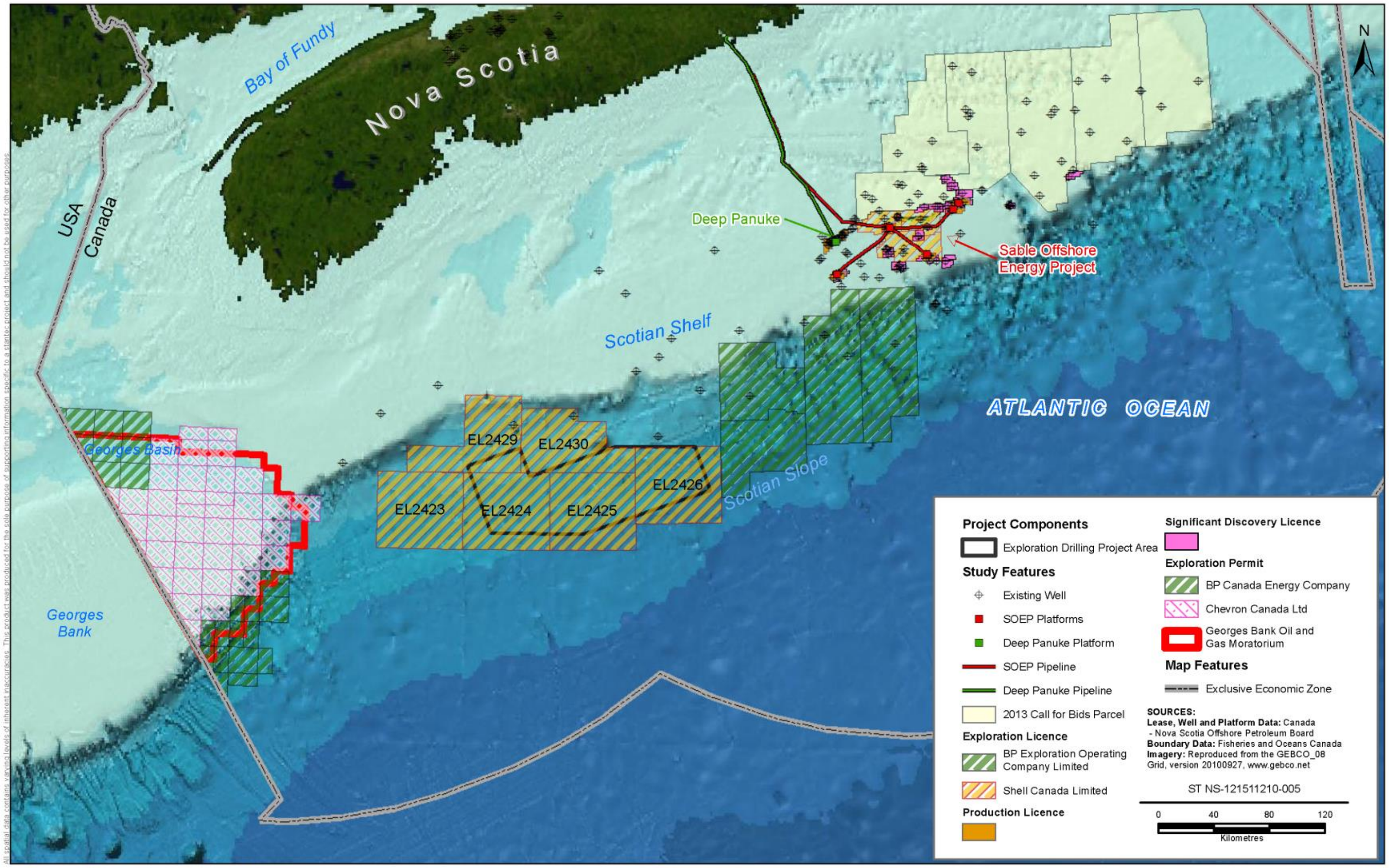

Figure 5.3.1 Offshore Nova Scotia Licensed Areas and Infrastructure

In addition to the currently delineated ELs and Call for Bid parcels, the CNSOPB has outlined much of the remaining shelf and slope region of the Nova Scotia Offshore Area as Bid Forecast Areas for the period 2014 to 2016. As such, it is anticipated that exploration activities and tenures in proximity to the Project Area will increase.

Active and decommissioned offshore oil and gas production projects on the Scotian Shelf consist of:

- the now-decommissioned Cohasset-Panuke Project, which was operated by Pan-Canadian (now Encana) and LASMO Nova Scotia Limited during the period of 1992–1999
- the active Sable Offshore Energy Project (SOEP), which is operated by ExxonMobil Canada Limited (ExxonMobil) and partners and has been producing natural gas since 1999
- the Deep Panuke Offshore Gas Development Project (Deep Panuke), which is operated by Encana Corporation (Encana) and commenced natural gas production in 2013

Related infrastructure on the Scotian Shelf includes two existing subsea natural gas pipelines for SOEP and Deep Panuke. The Maritimes & Northeast Pipeline (M&NP) – owned by Spectra Energy (77.53%), Emera Inc. (12.92%), and ExxonMobil (9.55%) (NSDOE 2009a) – connects the Sable gas field to Goldboro, Nova Scotia, where it ties in to an underground pipeline that transports the gas to markets in Nova Scotia, New Brunswick, and the United States (M&NP 2009). Natural gas from Deep Panuke is processed offshore and similarly transported via subsea pipeline to Goldboro, Nova Scotia where it joins with M&NP for further transport to market (Encana 2013).

5.3.2.2 Military Operations

The Department of National Defence and the Canadian Armed Forces (DND) conducts training and other activities off the coast of Nova Scotia, including sovereignty patrols, maritime surveillance, naval training and combat readiness, search and rescue, humanitarian relief and aid to civil authorities, and operational support to other government departments. Canada's east coast naval presence is provided through the Royal Canadian Navy's Maritime Forces Atlantic (MARLANT), which is headquartered in Halifax, Nova Scotia. To carry out its missions, MARLANT uses a range of platforms, including patrol frigates, coastal defence vessels, destroyers, submarines, ship-borne helicopters and long-range patrol aircraft (DFO 2005a).

In addition to the various types of missions and patrols carried out by DND, it also conducts naval training activities in designated nearshore and offshore exercise areas. Maps, coordinates and descriptions of military activities permitted in these exercise areas are provided in the Canadian Coast Guard's Annual Notice to Mariners. Figure 5.3.2 shows the locations of DND exercise areas off the coast of Nova Scotia and indicates the activities for which they are zoned. Military training may also be occasionally conducted in these areas by foreign vessels or aircraft under certain circumstances. The most common military activity in the region is training involving aircraft, surface vessels, and submarines. Live fire training is not usually conducted (DFO 2005a). As illustrated on Figure 5.3.2, the Project Area overlaps with exercise areas M1, M2, N1 and N2. These areas are employed for sub-surface operations but are not used for firing exercises.

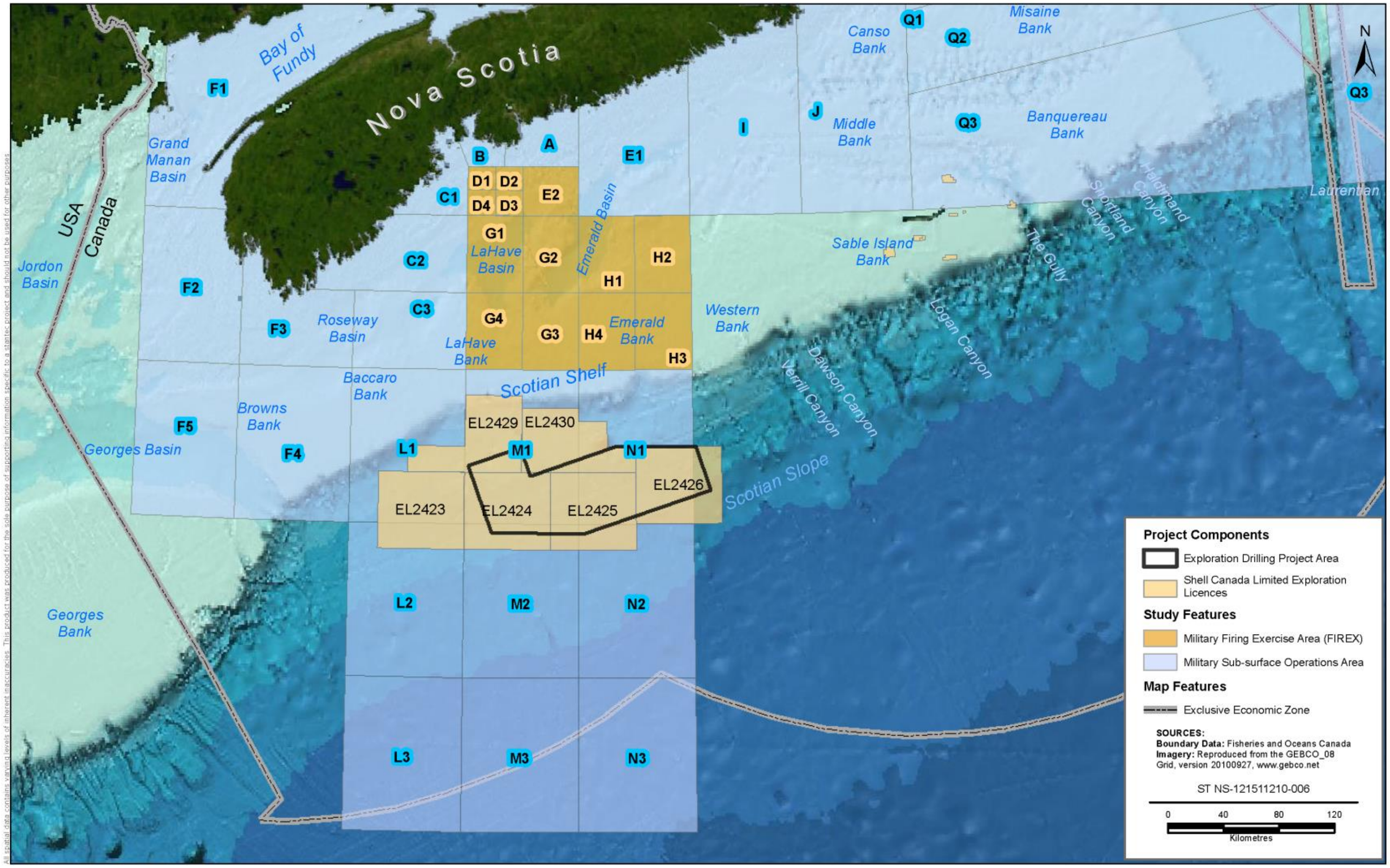

Figure 5.3.2 Department of National Defence Operations Areas

Stantec

5.3.2.3 Marine Traffic

Several established routes are commonly used for international and domestic commercial shipping within Canadian waters. There are four distinct regional traffic patterns off the coast of Nova Scotia (Stantec 2014):

- international shipping over the Scotian Shelf as part of the "great circle route" (*i.e.*, shortest distance over the earth's surface) between Europe and the eastern seaboard of the United States and Canada
- international and domestic shipping along the coast of Nova Scotia bound to and from the United States, Bay of Fundy, Gulf of St. Lawrence and Newfoundland
- shipping through the Cabot Strait, a major sea route linking trans-Atlantic shipping lanes to the St. Lawrence Seaway and the Great Lakes
- traffic associated with the major ports of Halifax, Saint John, Port Hawkesbury (Strait of Canso) and Sydney (smaller ports along Nova Scotia's coastline include Liverpool, Lunenburg, Shelburne and Sheet Harbour)

Although there is no designated shipping corridor through the Project Area and much of the shipping traffic travels along the Scotian Shelf, adjacent to the Project Area, the Southwest Scotian Slope is host to a variety of ocean vessel traffic (refer to Figure 5.3.3). Outside of the main shipping corridors it is left to the vessel captain's discretion to select a preferred routing (Hurley 2011).

Commercial shipping in the region is generally in the form of tankers and general, bulk and containerized cargo carriers. The area is also transited by a range of cruise ships, government vessels, and fishing vessels (DFO 2005a), the latter of which accounts for over 70% of marine traffic volume southeast of Nova Scotia (*i.e.*, between Cape Breton and Yarmouth out to the EEZ) (Stantec 2014). Shipping traffic volumes offshore Nova Scotia is in the range of 44 263 vessels a year, with highest volumes between May and September when fishing vessels are most active (Pelot and Wootton 2004).

A designated ballast water exchange zone extending from the Scotian Slope to the EEZ provides ships the opportunity to exchange ballast waters mid-ocean to reduce the risk of alien species introduction and transfer.

The Atlantic Pilotage Authority has designated Halifax Harbour as a compulsory pilotage area under the *Pilotage Act*. The area subject to mandatory pilotage includes two designated anchoring areas (Anchorage Areas A and B) located in the approaches to Halifax Harbour.

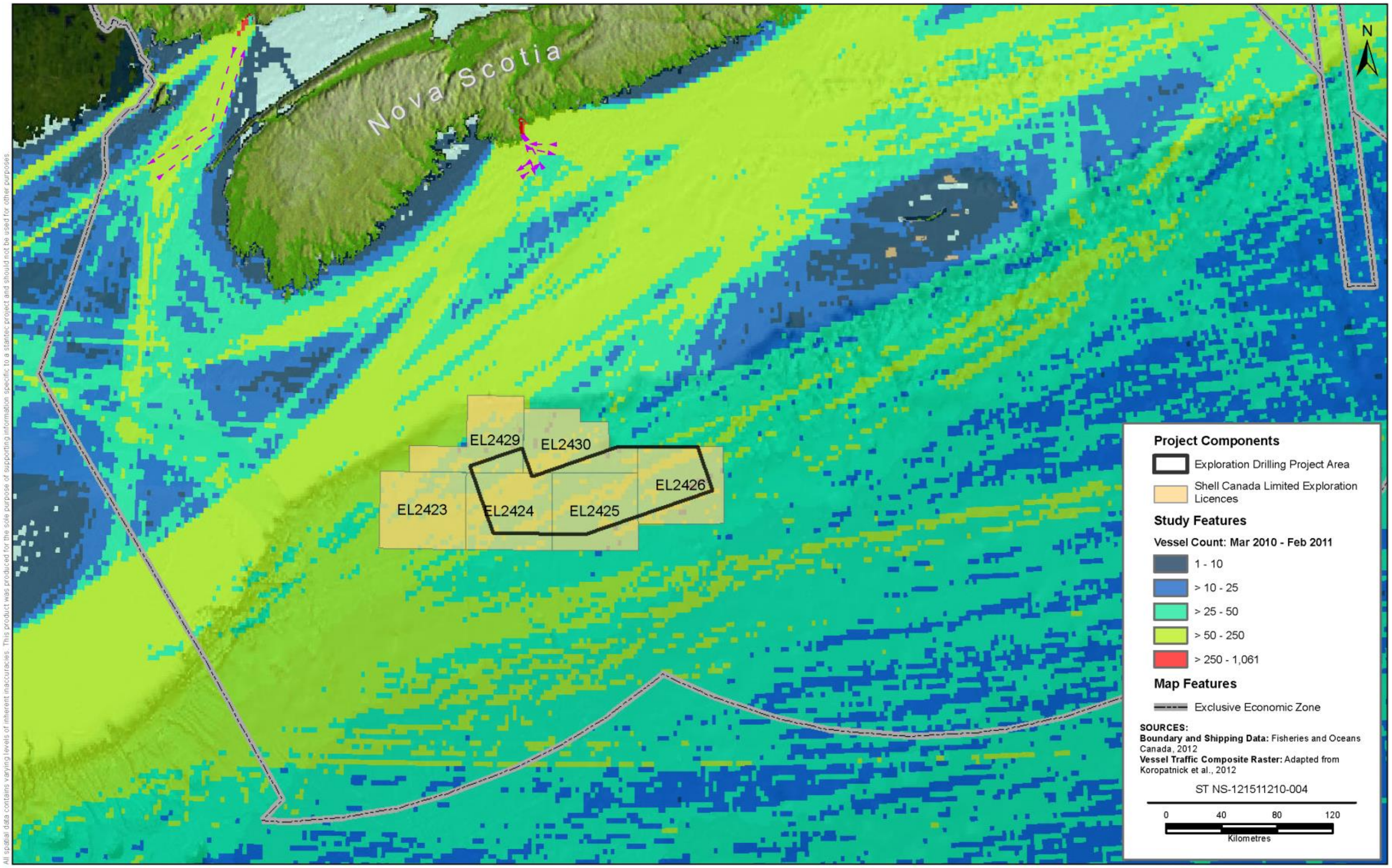

Figure 5.3.3 Shipping Traffic

5.3.2.4 Tourism and Recreational Activities

Recreational activities off the coast of Nova Scotia may include swimming, sailing/yachting, kayaking, scuba diving, and other watersports; recreational fishing; whale and seabird watching; and the transiting of cruise ships.

There were at least 174 marine tourism operators throughout the province of Nova Scotia in 2003, the majority of which were associated with whale and seabird watching tours. Sport-fishing and boat tours also represented a large proportion of marine tourism operators in Nova Scotia. In 2000, approximately 5% of all visitors to the province took part in a whale or seabird watching tour, while 7% participated in a sport-fishing or sightseeing cruise (DFO 2005a).

Whale watching activities tend to be concentrated around areas of whale congregation, particularly around the mouth of the Bay of Fundy and off northern Cape Breton. Although other marine tourism activities are more geographically dispersed, most marine tourism activities occur in coastal rather than offshore areas. The vast majority of tourism activities off the coast of Nova Scotia occur between May and October (DFO 2005a).

As indicated in the SEA for the Western Scotian Slope (Stantec 2014), recreational fisheries in the vinicity of the Project Area are limited though may include fishing charters and tournaments for large pelagics (*e.g.*, sharks, tuna). According to DFO, there are no recreational licences that would fish in the offshore proximal to the Project Area. Recreational tuna and shark derby licence holders often hire commercial vessels for derby fishing, however, they typically fish inshore of Sable Island in eastern Nova Scotia and/or venture to the Hell Hole in southern Nova Scotia. They do not typically venture offshore beyond the Shelf Break (DFO, pers. comm. 2014).

5.3.2.5 Marine Research

There are several ongoing scientific research programs on the Scotian Shelf, some of which occur in proximity to the Project Area. Figure 5.3.4 presents locations of known ongoing programs, but may not capture short-term research initiatives.

A number of buoys are moored on the Scotian Shelf and Slope for marine research purposes (Figure 5.3.4), including those operated by the Gulf of Maine Ocean Observing System, the United States National Data Buoy Center, and Environment Canada. During the Shelburne Basin 3D seismic survey conducted in 2013, an Environment Canada weather buoy was identified within the Project Area.

In 2008, the National Oceanography Research Centre and the Bedford Institute of Oceanography deployed an array of current profilers, temperature/salinity sensors and bottom pressure recorders in the area of the Scotian Slope as a contribution to the international RAPID Climate Change Program. The purpose of these moorings, called the RAPID-Scotia Line, is to measure the variability of the Atlantic meridional overturning circulation (DFO 2013v). The locations of the RAPID moorings for 2013 are indicated on Figure 5.3.4.

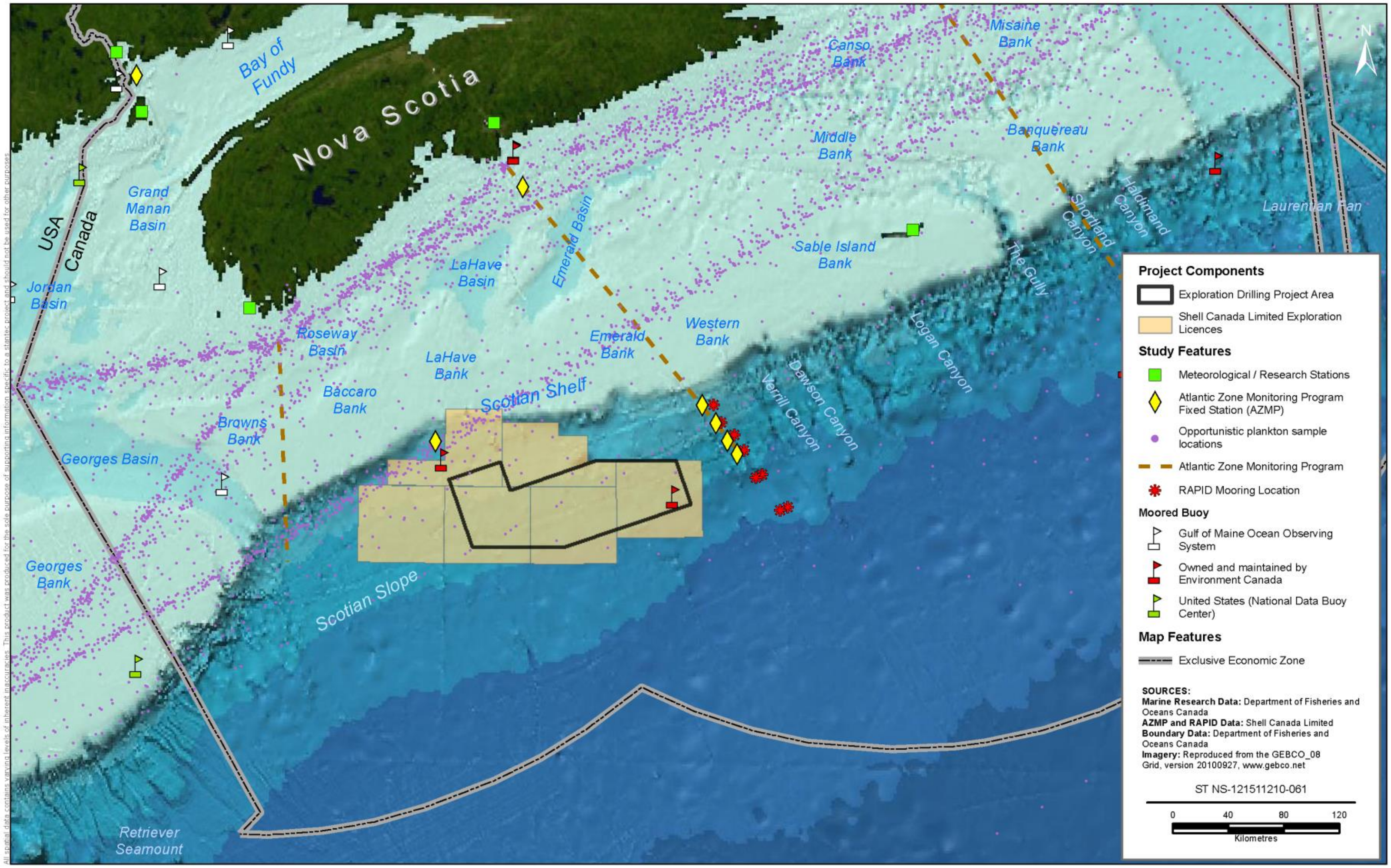

Figure 5.3.4 Marine Research Locations

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The Scotian Shelf and Slope also contain research transects associated with the Atlantic Zone Monitoring Program (AZMP) study. AZMP is a comprehensive environmental monitoring program designed and implemented by DFO in 1999. The program was introduced to increase DFO's capacity to understand, describe, and forecast the state of the ocean environment and to relate these changes to the predator/prey relationships of marine resources. The Halifax Line and the Browns Bank Line of the AZMP run to the west and east of the Project Area, respectively. There is also a fixed station (Halifax Station 2) on the Halifax Line. AZMP transects and stations are sampled by DFO on a bi-weekly or monthly schedule during the ice-free season. Through the related Scotian Slope and Rise Monitoring Program, DFO collects and analyzes physical, chemical and biological observations at deepwater stations added to the offshore end of AZMP's Halifax Line (Stantec 2014). These deepwater stations, referred to as the Extended Halifax Line, are located over the continental rise and complement the AZMP stations over the continental slope and shelf (BIO 2013b). The locations of AZMP transects and moorings for 2013 are shown on Figure 5.3.4. The Ocean Tracking Network (based at Dalhousie University) and DFO jointly operate a fixed and semi-permanent series of almost 200 acoustic receivers along the ocean bottom along the Halifax Line.

Biological data for the Scotian Shelf and Slope is collected through various means. Scientists at DFO monitor fish populations of the Scotian Shelf, Bay of Fundy, and Gulf of Maine on an ongoing basis. Some of the most important sources of information on the state of marine fish populations are bottom trawl surveys, which are generally conducted in March and July within the Scotian Shelf and Slope area.

In addition, scientists from Dalhousie University (Whitehead Lab) conduct cetacean studies in the region every 3–4 years, and the Continuous Plankton Recorder Survey, run by the Sir Alister Hardy Foundation for Ocean Science, has been using vessels of opportunity to collect plankton samples on the Scotian Shelf and Slope since 1931 (Stantec 2014), including in the Project Area.

At present, Shell is not aware of any research studies occurring or planned for within the Project Area; however, the final locations and scheduling for marine research initiatives are generally determined on an annual basis.

5.3.2.6 Seabed Hazards Associated with Human Activities

Seabed hazards associated with human activities on the Scotian Shelf and Slope include cables, explosives, shipwrecks, and disposal sites. Drill sites will be selected within the Project Area to avoid Project interaction with any such hazards. Shell's Shelburne Basin Venture Seabed Survey to be conducted in 2014, prior to drilling, will provide information on any previously unidentified hazards or debris relative to the proposed drilling sites.

The submarine cable industry has been active for approximately 150 years. Many cables have been laid on the seafloor during this time, including copper telegraph cables, telephone cables, and fibre optic cables. As shown on Figure 5.3.5, there are several active and inactive cables that cross through the Project Area. The location of subsea cables are charted and as such will be avoided during the selection of drill sites. Shell will consult with applicable cable owners prior to drilling to discuss proposed Project activities and components. Drilling activities will not interfere with active cable operation.

A number of publicly known explosives disposal sites are located off the coast of Nova Scotia. As illustrated on Figure 5.3.6, all of these sites are located well outside of the Project Area. However, given that Halifax Harbour has been used as a military port for centuries, lost or discarded unexploded ordnances (UXOs) could potentially present at various locations on the Scotian Shelf, including in association with shipwrecks. Through the UXO Legacy Sites Program, Defence Construction Canada (DCC) and DND identify sites that may pose UXO risk as a result of past DND activities. These locations are shown on Figure 5.3.6, along with recorded shipwrecks and non-explosive ocean disposal sites in the vicinity of the Project Area.

In order to effectively identify any potential seabed hazards (*i.e.* subsea cables, explosive disposal sites, UXOs, historical shipwrecks), additional surveys (*e.g.*, side scan sonar, multi-beam sonar, sub-bottom profile, magnetometer, gravity and bathymetric surveys) will be conducted in advance of the exploratory drilling program. As well as part of the exploratory drilling program, an ROVsurvey will be conducted in advance of drilling activities.

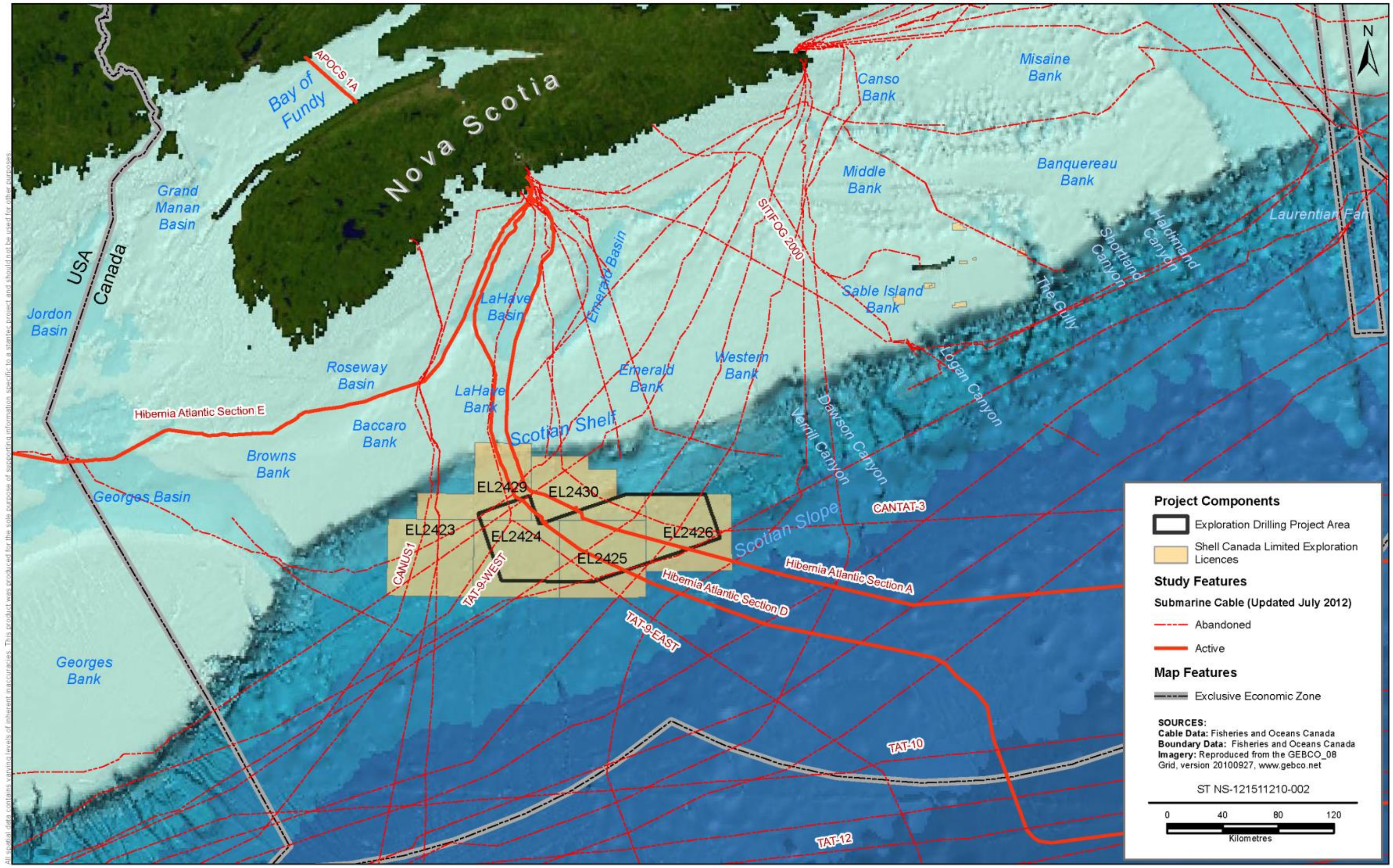

Figure 5.3.5 Subsea Cables

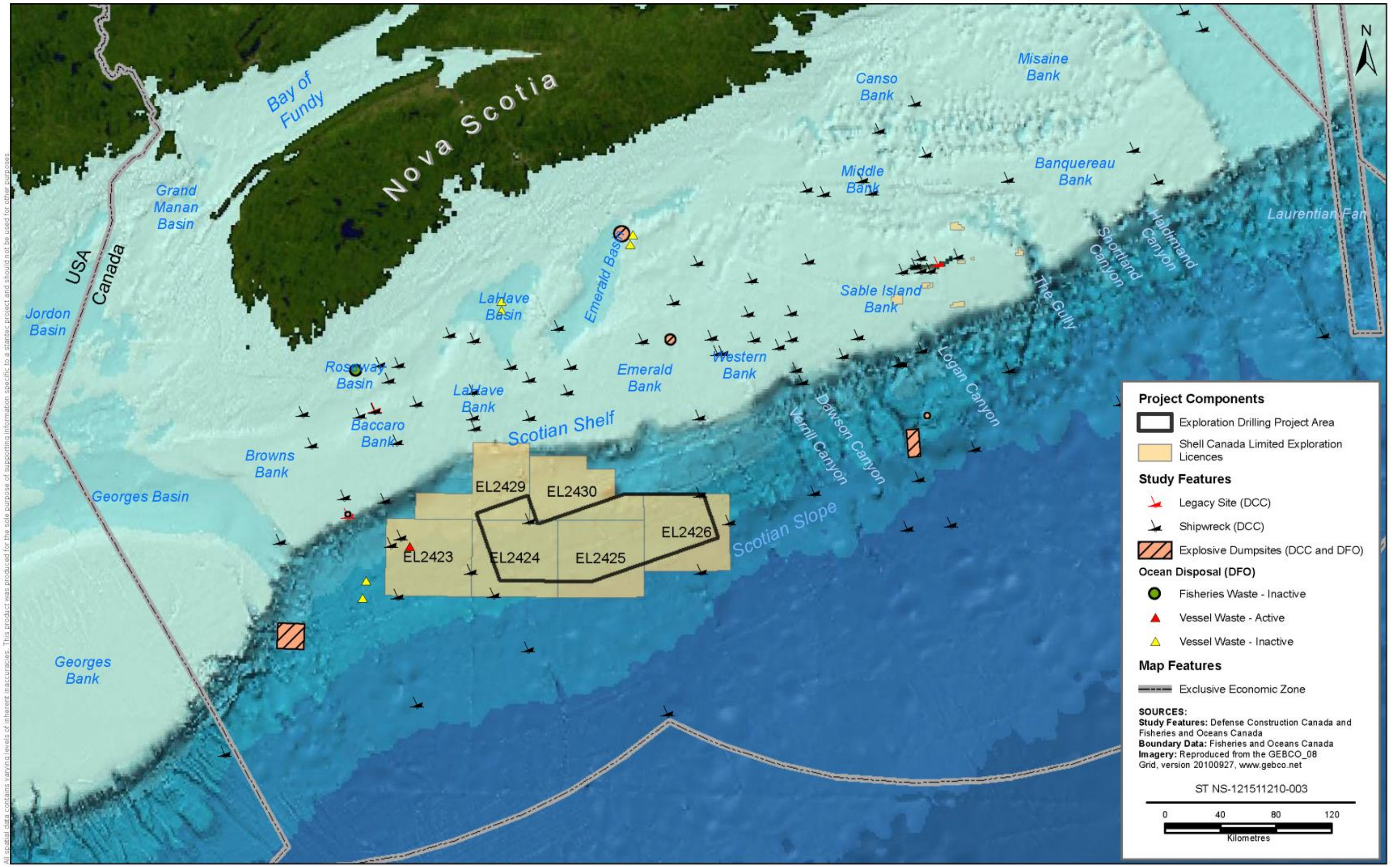

Figure 5.3.6 Shipwrecks and Ocean Disposal Sites

5.3.3 Offshore Commercial Fisheries

5.3.3.1 Historical Fisheries

Aboriginal peoples began harvesting fish and shellfish on the Scotian Slope several thousand years ago whereas commercial fishing started in the mid-1500s. By 1700, Nova Scotia was a large exporter of cod, mackerel and herring. Catches continued to increase until 1973 when total landings of fish on the Scotian Shelf peaked, with catches exceeding 750 000 000 kg (750 000 t) (Worcester and Parker 2010). Throughout this period of commercial fishing groundfish landings dominated (mainly gadoids) with 450 000 t landed in 1973, these landings would decrease to less than 15 000 t in 1997. This drastic decrease in landings helped impose the moratorium on fishing, especially for cod, in 1993; this moratorium remains in effect in NAFO Division 4W, though a small fishery is present in 4X (Worcester and Parker 2010; Best 2009).

5.3.3.2 Commercial Fisheries

The Scotian Slope is commercially fished by fleets from all four Atlantic provinces; there has been no active foreign fleet since they were excluded after the first cod collapse in the 1970s (DFO 2005b). Management of the commercial fishing activity on the Scotian Shelf by DFO is conducted through the Maritimes Regional offices. Many of the major species are fished according to quota systems (*i.e.*, groundfish), while others are fished according to availability (*i.e.*, herring, mackerel and tunas) or specific season lengths (*i.e.*, lobster and crab). Licences and quotas are set by DFO for individual species management areas, NAFO Divisions and Unit Areas. A Summary of the fishery licence and landing information is presented in Table 5.3.1 for the Southwest Scotian Slope and Shelf Region. This data is representative of 2012 licencing and preliminary landings data as of August 16, 2013 and offers a snapshot of fishing activity in the area. Changes in licencing and landings for these fisheries may vary between years. Aggregated landings maps incuded in Appendix E provide an overall picture of fishing activity in the area over a much longer time period.

Table 5.3.1 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2012P[1])	Number of Communal Commercial Licences (2012P[1])	Total Number of Licences with Landings (2012P[1])	Number of Communal Commercial Licences with Landings (2012P[1])	Landings for all Licences in tonnes (t, 2012P[1])	Landings for Communal Commercial Licences in tonnes (t, 2012P[1])
Crab CFA 24 NAFO 4X	 CFA 24 – 53 4X – 9	 CFA 24 – 24 4X – 3	 CFA 24 – 47 4X – 6	 CFA 24 – 12 4X – 2	Total landings for all licences –5581 t	Total landings for all Communal Commercial licences – 1477 t
Groundfish (All Gear) (Includes cusk, dogfish, flatfish, red hake, white hake, silver hake, halibut, redfish, wolfish) NAFO 4W NAFO 4X	Total licences for all areas (some licences may fish multiple areas) = 2329 4W – 921 4X – 2063	Total Communal Commercial licences for all areas (some licences may fish multiple areas) = 26 4W – 12 4X – 25	Total Licences with landings for all areas (some licences may have landings from multiple areas) = 439 4W – 119 4X – 355	Total Communal Commercial Licences with landings for all areas (some licences may have landings from multiple areas) = 5 4W – 1 4X – 5	Total landings for all areas = 38 947 t 4W-10 994 4X- 20 640	Total Communal Commercial landings for all areas = * t[2] 4W - * 4X- 833
Hagfish NAFO 4W NAFO 4X	Total licences for all areas (some licences may fish multiple areas) = 7 4W – 6 4X – 4	Total Communal Commercial licences for all areas = 1 4W – 1 4X – 0	Total Licences with landings for all areas (some licences may have landings from multiple areas) = 7 4W – 6 4X – 4	Total Communal Commercial licences with landings for all areas = 1 4W – 1 4X – N/A	Total landings for all areas = 2359 t 4W- 1996 4X – *	Total Communal Commercial landings for all areas = * t 4W- * t 4X – N/A
Large Pelagics (Vessel-based licences that are valid to fish all of DFO Maritimes Region.	Shark – 3 Swordfish (harpoon + longline) – 901	Shark – 0 Swordfish – 14	Shark – 0 Swordfish (harpoon & longline) – 68 4W – 24	Shark – N/A Swordfish(harpoon & longline) – 4	Shark – N/A Swordfish Total – 642 t 4W – 345 t	Shark – N/A Swordfish Total – * t 4W – * t 4X – * t

Table 5.3.1 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2012P[1])	Number of Communal Commercial Licences (2012P[1])	Total Number of Licences with Landings (2012P[1])	Number of Communal Commercial Licences with Landings (2012P[1])	Landings for all Licences in tonnes (t, 2012P[1])	Landings for Communal Commercial Licences in tonnes (t, 2012P[1])
Some licences are issued out of DFO Gulf Region). NAFO 4W NAFO 4X	Tuna (Bluefin) – 54	Tuna (Bluefin) – 4	4X – 59 Tuna (Bluefin) – 58 4W – 31 4X – 33	4W – 2 4X – 4 Tuna (Bluefin) – 4 t 4W – 1 4X – 2	4X – 193 t Tuna (Bluefin) – 159 t 4W – 42 t 4X – 98 t	Tuna (Bluefin) – * t 4W – * t 4X – * t
Lobster (Inshore and Offshore) *LFA 31b-34* *LFA 41*	LFA 31B – 71 LFA 32 – 159 LFA 33 – 700 LFA 34 – 979 LFA 41 – 1	LFA 31B – 0 LFA 32 – 6 LFA 33 – 15 LFA 34 – 29 LFA 41 – 0	LFA 31B – 71 LFA 32 – 144 LFA 33 – 604 LFA 34 – 931 LFA 41 – 1	LFA 31B – N/A LFA 32 – 3 LFA 33 – 10 LFA 34 – 21 LFA 41 – N/A	31B – 1080 t 32 – 922 t 33 – 5293 t 34 –23 985 41 – * t	31B – N/A 32 – * t 33 – 72 t 34 – 401 t 41 – N/A
Mackerel (Vessel-based licences that are valid to fish all of DFO Maritimes Region) NAFO 4W NAFO 4X	1844	12	63 4W – 10 4X – 54	0	423 t 4W – 174 t 4X – 249 t	N/A
Scallop (Vessel-based licences that are valid to fish all of DFO Maritimes Region)	6 (Offshore)	0	6	N/A	N/A	N/A

Table 5.3.1 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (*i.e.* Commercial and Communal Commercial) (2012P[1])	Number of Communal Commercial Licences (2012P[1])	Total Number of Licences with Landings (2012P[1])	Number of Communal Commercial Licences with Landings (2012P[1])	Landings for all Licences in tonnes (t, 2012P[1])	Landings for Communal Commercial Licences in tonnes (t, 2012P[1])
SFA 25 *SFA 26*			SFA25 – 3 SFA26 – 6			
Notes: [1] Data for reporting 2012 is preliminary (denoted by 2012P) and as such, may be incomplete and/or subject to change without notice. [2] To protect confidentiality, landings totals are denoted by an asterisk (*) in instances where less than five separate licence holders have been active.						

Source: Modified from Stantec 2014; data courtesy of DFO.

The Project Area is located within Commercial Fisheries Management Areas for fish, lobster, scallop and crab (Figure 5.3.7). Data on commercial fisheries are generally obtained from DFO based on the interaction with NAFO Unit Areas. The Project Area is located mostly in NAFO Unit Area 4Wm, but overlaps with 4Xn and 4Xl, as illustrated in Figure 5.3.8.

Landings data for NAFO Divisions 4W and 4X for 2007 to 2012 were acquired from DFO from the Maritimes region. These data represent the most up-to-date verified data at the time of writing (December 2013). These data from NAFO Divisions 4W and 4X are presented in Table 5.3.2 and characterize the commercial fisheries within a broader region within which the Project Area is located. Landings data from NAFO Unit Areas 4Wm, 4Xn and 4Xl as presented in Table 5.3.3 represent more specific data surrounding the Project Area.

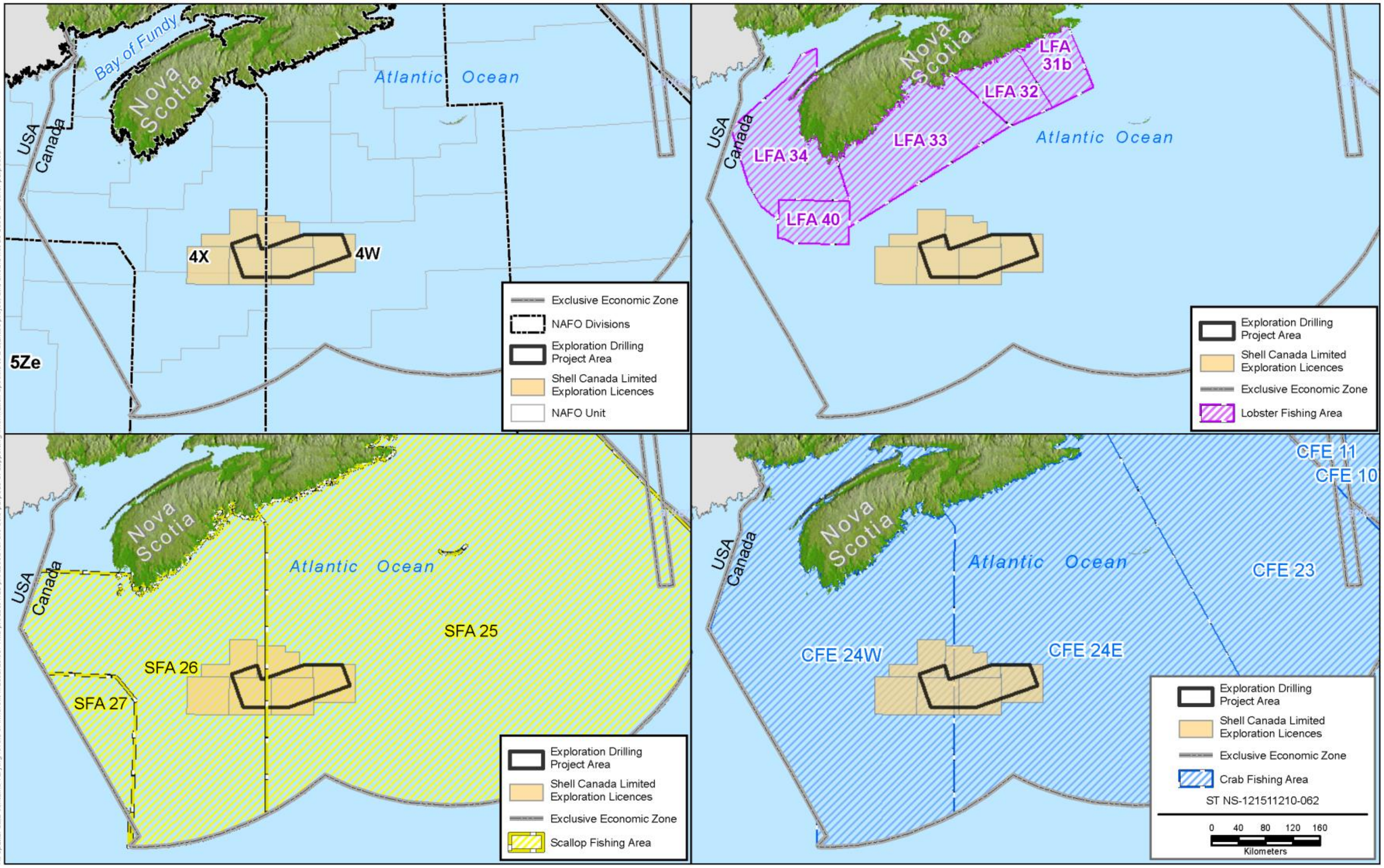

Figure 5.3.7 Commercial Fisheries Management Areas

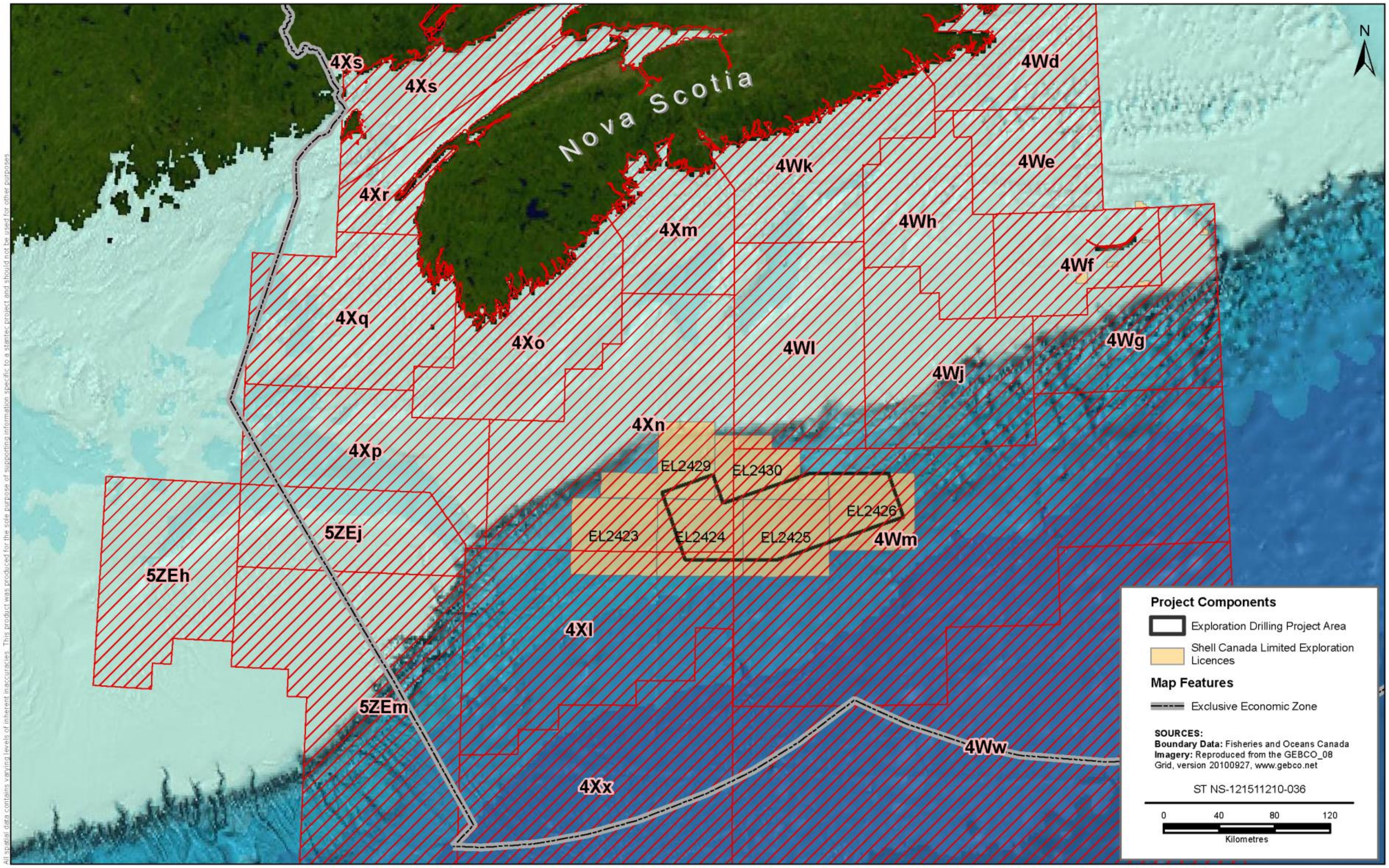

Figure 5.3.8 NAFO Unit Areas

Table 5.3.2 Landed Value of Fisheries Harvest within NAFO Divisions 4W, 4X, and 5ZE (2007–2012)

	2007		2008		2009		2010		2011		2012	
	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)
Groundfish												
4W	12 792	12 789	13 667	13 649	11 059	10 678	10 597	10 747	11 204	13 024	13 280	14 354
4X	26 431	35 692	23 965	32 192	24 239	33 865	22 281	31 695	21 023	32 177	21 034	33 976
5ZE	13 884	20 517	16 803	22 749	19 322	30 605	19 160	24 902	14 276	22 544	7468	14 917
Total Groundfish	**53 107**	**68 998**	**54 435**	**68 590**	**54 619**	**75 148**	**52 039**	**67 345**	**46 504**	**67 746**	**41 782**	**63 248**
Pelagics												
4W	9642	9465	3944	6285	15 412	7968	10 865	9346	12 293	9739	2731	10 773
4X	80 424	21 956	58 889	18 439	55 136	21 928	58 181	22 786	52 803	22 938	52 731	22 409
5ZE	302	2626	472	3572	455	3300	529	4381	307	2427	313	2642
Total Pelagics	**90 368**	**34 047**	**63 305**	**28 296**	**71 003**	**33 197**	**69 575**	**36 512**	**65 402**	**35 105**	**51 150**	**55 002**
Shellfish												
4W	9642	65 064	11 224	67 265	13 164	58 989	14 182	62 106	13 476	77 517	13 269	74 222
4X	48 316	305 369	47 062	21 148	40 817	281 650	49 642	329 402	58 559	361 654	58 038	360 782
5ZE	36 779	49 977	48 807	65 453	48 189	64 466	44 801	60 891	37 879	59 910	33 926	73 488
Total Shellfish	**94 737**	**420 410**	**107 093**	**453 866**	**102 170**	**405 104**	**108 625**	**452 398**	**109 915**	**499 080**	**105 232**	**508 492**
Other Species												
4W	1	8	1	19	0	6	0	1	0	0	-	-
4X	15 900	1703	16 572	2228	43 292	1408	41 123	3367	16 989	1355	11 812	799
5ZE	43	467	15	163	16	177	6	66	22	-	-	-
Total Other Species	**15 943**	**2178**	**16 588**	**2410**	**43 309**	**1590**	**41 129**	**3 433**	**17 012**	**1356**	**11 812**	**799**
Grand Total	**254 156**	**525 634**	**241 421**	**553 161**	**271 102**	**515 040**	**271 367**	**559 689**	**238 833**	**603286**	**209 976**	**627 541**

Source: Data courtesy of DFO

Table 5.3.3 Landed Value of Fisheries Harvest within the Project Area (NAFO Unit Areas 4Wm, 4XI, and 4Xn), 2007–2012

	2007		2008		2009		2010		2011		2012	
	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)
Groundfish												
4Wm	40	$67	13	$31	22	$15	18	$32	52	$78	24	$61
4XI	6	$35	8	$14	15	$27	10	$23	5	$9	-	-
4Xn	3387	$5610	3474	$5600	4648	$6219	4264	$6223	5192	$6996	5014	$8545
Total Groundfish	**3433**	**$5712**	**3495**	**$5645**	**4685**	**$6261**	**4292**	**$6278**	**5249**	**$7083**	**5038**	**$8606**
Pelagics												
4Wm	114	$936	101	$715	69	$716	28	$213	40	$281	31	$258
4XI	93	$747	78	$521	68	$495	59	$428	124	$553	119	$1281
4Xn	222	$892	263	$1554	387	$1845	308	$1265	340	$2094	459	$3253
Total Pelagics	**429**	**$2575**	**443**	**$2790**	**524**	**$3056**	**395**	**$1906**	**504**	**$2928**	**609**	**$4792**
Shellfish												
4Wm	0	-	0	-	0	-	0	-	0	-	0	-
4XI	No Data	-	No Data	-	No Data	-	No Data	-	No Data	-	No Data	-
4Xn	171	$1261	197	$1440	96	$622	133	$1016	99	$860	97	$786
Total Shellfish	**171**	**$1261**	**197**	**$1440**	**96**	**$622**	**133**	**$1016**	**99**	**$860**	**97**	**$786**
Other Species												
4W	0.5	$8	1	$19	0.4	$6	0.1	$1	0.1	$1	-	-
4X	15 899	$1703	16 571	$2228	43 292	$1408	41 123	$3367	16 989	$1355	11 812	$798
Total Other Species	**15 900**	**$1711**	**16 572**	**$2247**	**43 292**	**$1414**	**41 123**	**3368**	**16 989**	**$1356**	**11 812**	**$798**
GRAND TOTAL	**19 936**	**$11 259**	**20 710**	**$12 122**	**48 598**	**$11 351**	**45 945**	**$12 569**	**22 845**	**$12 227**	**17 556**	**$14 982**

Source; Data courtesy of DFO

From 2007 to 2012 in NAFO Divisions 4X and 4W (Table 5.3.2) shellfish dominated the landing values with between 79 and 81% of the total catch in that period, though it represented a proportionally smaller amount of the landing weight (37–50%). The shellfish fishery value and landing weights decrease within the Project Area. From 2007 to 2012 within NAFO Unit Areas 4Xn, 4Wm and 4Xl (Table 5.3.3) the value of the shellfish fishery represented between 5 and 12% of the total landed values. The value of groundfish landings represented the highest commercial value from 2006 to 2012 with between 47 and 57% of the total landed values.

The majority of the harvest for NAFO Unit Areas 4Xn, 4Wm and 4Xl was landed in Nova Scotia. For the entire NAFO Unit Area 4Xn from 2007 to 2012, the landings were dominated by groundfish. Species-specific landing data could not be obtained from DFO for the years of 2007 to 2012 due to confidentiality issues and updated policies for releasing fisheries data. However, the EA for the Shelburne Basin 3D Seismic Exploration Survey (LGL 2013) provides species-specific information allowing the identification of primary commercial species fished in the vicinity of the Project Area.

The EA for the Shelburne Basin 3D Seismic Exploration Survey (LGL 2013) reported landings for NAFO Unit Areas 4Xn, 4Wm and 4Xl, as well as 4Wi and 4Wj. Within this expanded area, the primary commercial pelagic species include: swordfish, bigeye tuna and yellowfin tuna, with landings averaging 41, 12 and 9 metric tonnes, respectively from 2005 to 2010. The primary commercial groundfish species fished in the same NAFO Unit Areas include: redfish, monkfish, and haddock representing landings of 11, 10, and 6 metric tonnes, respectively, from 2005 to 2010. Although Atlantic lobster and other species of crab have been harvested within 4Xn and 4Wl along the edge of the Scotian Shelf, landings were only provided for red crab (4 metric tonnes from 2005 to 2010).

The fishing effort in NAFO Unit Areas 4Xn, 4Wm and 4Xl for the years of 2006–2010 are presented in Figures 5.3.9 to 5.3.11 by group, the landing data is geo-referenced by latitude and longitude for all groups in which data was provided. Note that not all of the catch data summarized in Tables 5.3.8 and 5.3.9 include harvest locations coordinates and as such, the commercial fishery figures may not illustrate the same information as portrayed in the tables. Species specific fisheries data for the years of 2006–2010, are presented in Figures 1 to 22 of Appendix E.

As evident in Figures 5.3.9 to 5.3.11, there is minimal fishing effort within and surrounding the Project Area. Harvesting in the Project Area appears to be limited to localized fishing of Atlantic halibut, Atlantic cod, Atlantic hagfish, cusk, monkfish, redfish, red hake, silver hake, swordfish, white hake, shark species such as porbeagle, and bluefin and other species of tuna

Based on Figure 5.3.9 a productive harvest location is situated approximately 50 km northwest of the Project Area between Baccaro and LaHave Banks. This region represents productive fishing grounds for Atlantic halibut, cod, haddock, pollock, cusk, flatfish, redfish, white hake, wolfish and monkfish with limited fishing for crab and lobster.

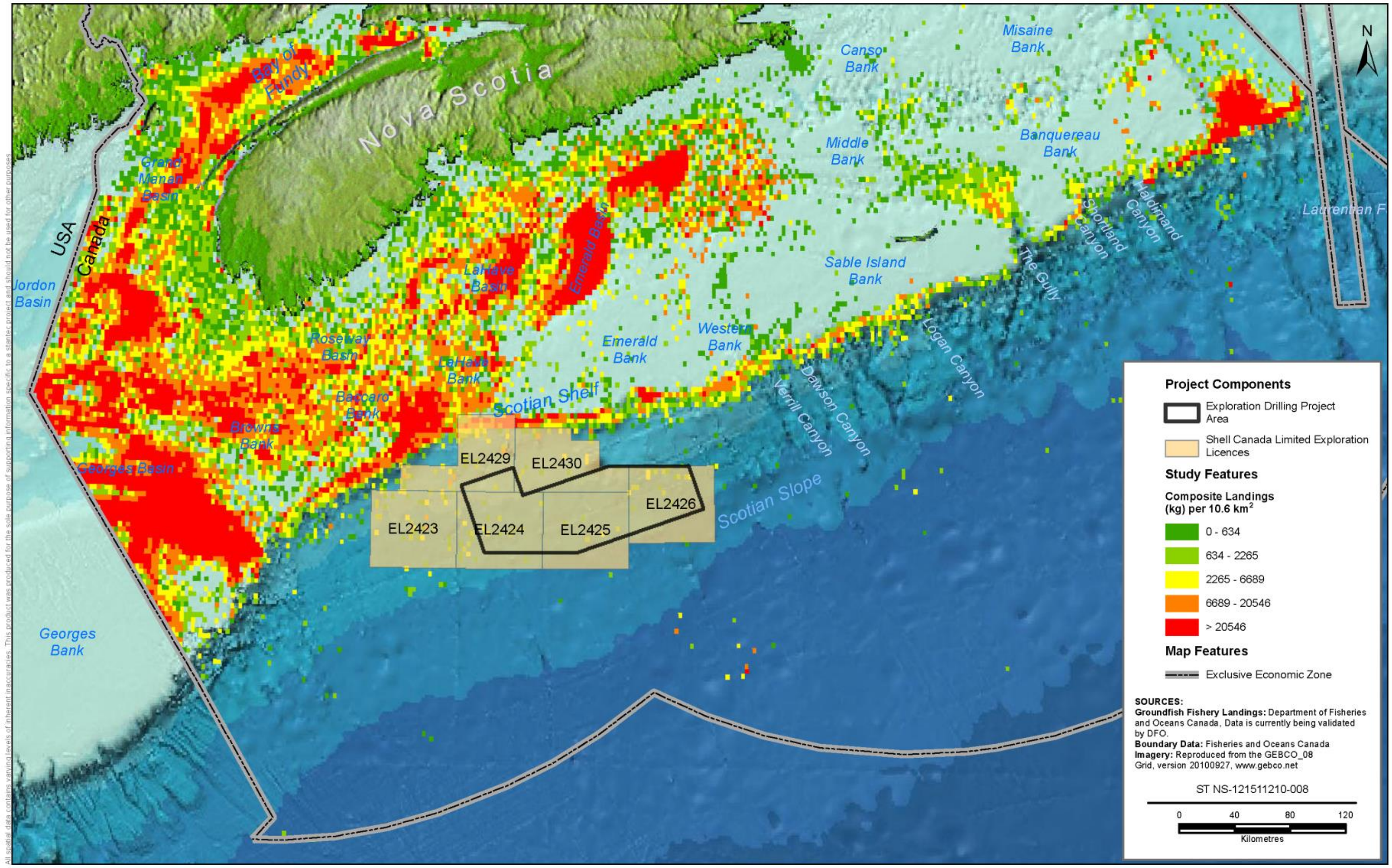

Figure 5.3.9 Groundfish Landings, All Gear Types, 2006–2010

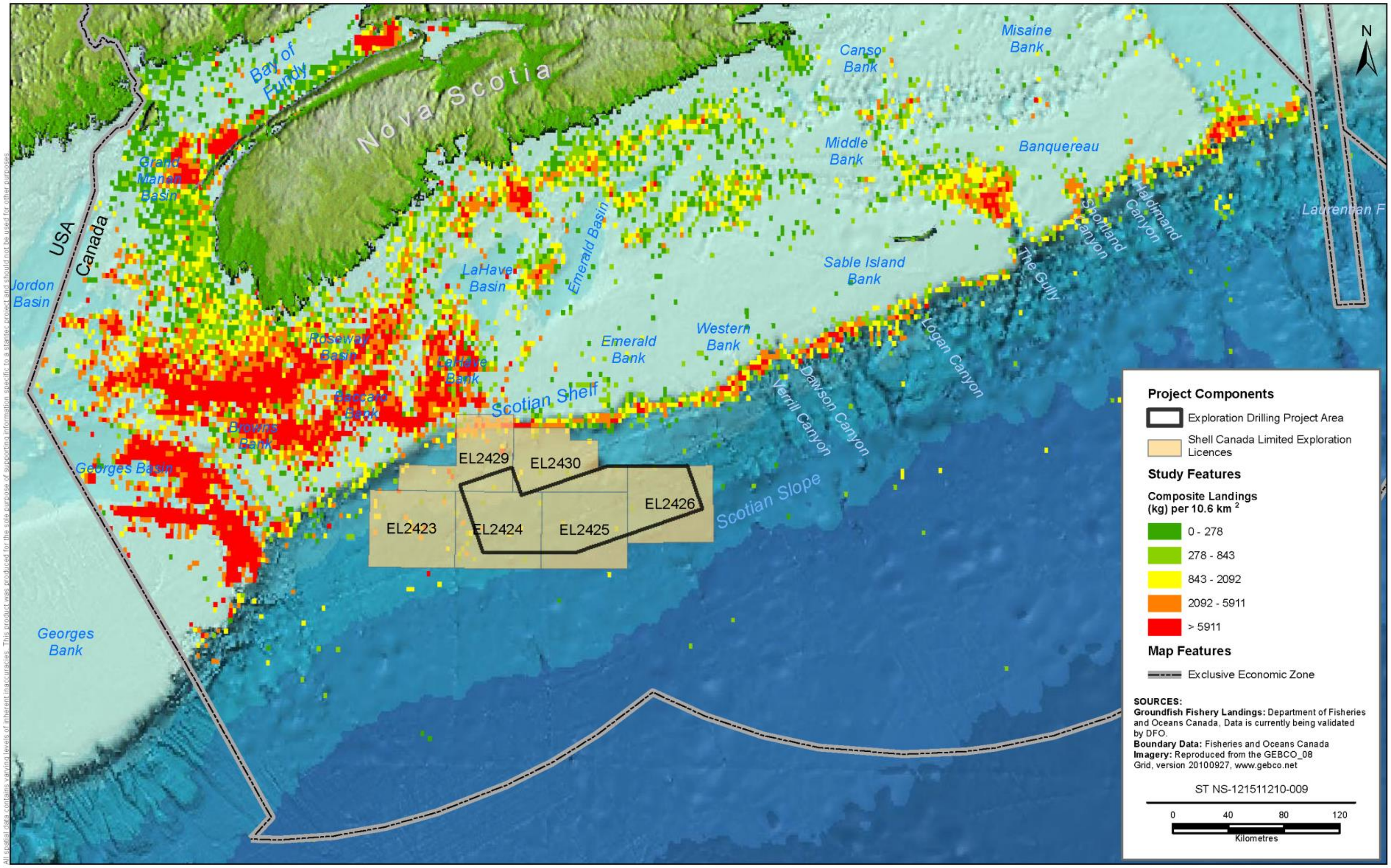

Figure 5.3.10 Groundfish Landings, Longline, 2006–2010

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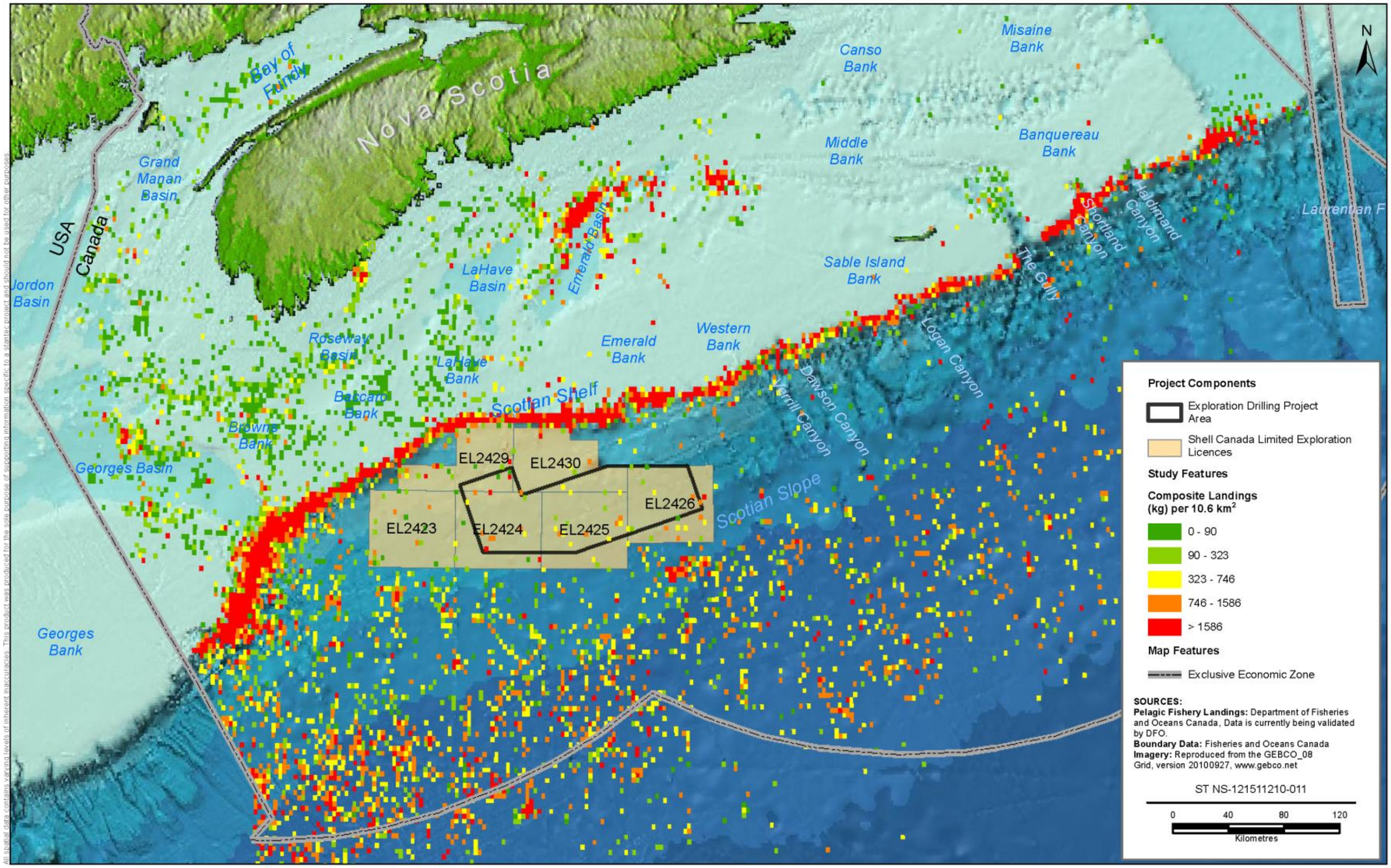

Figure 5.3.11 Large Pelagic Landings, 2006–2010

5.3.3.3 Key Commercial Fish and Shellfish Species

As indicated in Section 5.3.3.2, georeferenced species-specific landings data could not be obtained from DFO for the years of 2007 to 2012. However, based on previous data (*e.g.*, as presented in LGL 2013) it can be surmised that the primary commercial species likely harvested in the Project Area include: swordfish, bigeye tuna and yellowfin tuna, redfish, monkfish, haddock, and red crab. Species descriptions are provided in Section 5.2.3.

Table 5.3.4 lists key commercial fish species and the fishing seasons in which they are typically fished.

Table 5.3.4 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within Study Area

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species													
Albacore tuna	*Thunnys alalunga*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Bigeye tuna	*Thunnus obesus*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Bluefin tuna	*Thunnus thynnus*	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Yellow
Mackerel	*Scomber scombrus*	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Green	Green	Green
Porbeagle shark	*Lamna nasus*	Green	Yellow	Red	Red	Red	Red	Green	Green	Green	Yellow	Yellow	Yellow
Swordfish	*Xiphias gladuis*	Green	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Red	Yellow
White marlin	*Tetrapturus albidus*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Yellowfin tuna	*Thunnus albacares*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Groundfish Species													
American plaice	*Hippoglossoides platessoides*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic cod	*Gadus morhua*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic halibut	*Hippoglossus hippoglossus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Cusk	*Brosme brosme*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Greysole-Witch flounder	*Glyptocephalus cynoglossus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Haddock	*Melanogrammus aeglefinus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Monkfish	*Lophius spp.*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Pollock	*Pollachius virens*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Redfish (deepwater and Acadian)	*Sebastes mentella / Sebastes fasciatus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Red hake	*Urophycis chuss*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow

Table 5.3.4 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within Study Area

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Silver hake	*Merluccius bilinearis*	Low	Low	Low	Low	Low	Open	High	High	High	Open	Low	Low
Stripped catfish (wolfish)	*Anarchichas lupus*	Low	Low	Low	Low	Low	Open	High	High	High	Open	Low	Low
Turbot – Greenland flounder	Reinhardtius hippoglossoides	Low	Low	Low	Low	Low	Open	High	High	High	Open	Low	Low
White hake	*Urophycis tenuis*	Low	Low	Low	Low	Low	Open	High	High	High	Open	Low	Low
Invertebrate Species													
Lobster*	*Homarus americanus*	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open
Scallop	potential for multiple species	Low	Low	Low	Low	Open	Open	Open	Open	Open	Open	Low	Low
Snow crab	*Chionoecetes opilio*	Closed	Closed	Closed	Open	Open	Open	Open	Open	Open	Closed	Closed	Closed
Red crab	*Chaceon quinquedens*	Closed	Closed	Closed	Open	Open	Open	Open	Open	Open	Closed	Closed	Closed

*Note: The Study Area falls within multiple Lobster Fishing Areas (33, 34, 40, and 41) with different fishing seasons. See below for the various lobster fishing seasons:
LFA 33: Last Monday in November–May 31
LFA 34: Last Monday in November–May 31
LFA 40: Closed year-round.
LFA 41: Open year-round.

- [Green] Open Fishing Season * Note all large pelagic fisheries are open year-round.
- [White] Closed Fishing Season
- [Red] High Fishing Activity within the Season
- [Yellow] Low Fishing Activity within the Season

Data sources: Stantec 2014

5.3.3.3.1 Groundfish Fisheries

Landings of Western Scotian Shelf/Bay of Fundy cod averaged 20 000 t annually over several decades, but declined after 1990 to a range of 3000 to 5000 t since 2000 (O'Boyle 2012). Atlantic cod as well as witch flounder stocks on the Western Scotian Shelf are considered to be at a critical state. Haddock, halibut, winter flounder, and sculpin are considered to have healthy stock status (O'Boyle).

Within Unit Areas 4W and 4X the ground fishery is open year-round with specific months providing better fishing based on the seasonal movement of fish species. The most intensive fishing occurs from July to September, though the central shelf basins and provides high yields year-round. Most fishing vessels utilize trawls and longlines, with longlines used predominantly on the shelf edge and deepwater channels (Stantec 2014).

Groundfish stocks in the vicinity of the Project Area are fished along the Scotian Slope break and the LaHave and Baccaro Banks. The following describes current conditions of the three principal groundfish species fished within the Project Area.

Redfish fished within the Project Area and along the Scotian Shelf are part of stock Unit 3. The unit 3 Total Allowable Catch (TAC) is 10 000 t. (DFO 2012a) Annual redfish landings from Unit 3 gradually increased from the 1970s to the mid 1980s before a decline in the early 1990s (DFO 1999). Recent reports on the Unit 3 stock indicates the current population is a healthy stock which shows large inter-annual fluctuations though a general stock increase was observed from 2000 to 2012 (DFO 2012a).

Monkfish are generally caught as scallop bycatch, though a more directed fishery developed as a result of the cod collapse (O'Boyle 2012). These vessels operate with an unrestricted bycatch (DFO 2002a). The latest Stock Assessment Report from DFO on the Scotian Shelf 4VWX5Ze Stock was published in 2002 and indicates that continuation of the cautious (1000 t) approach to harvesting is appropriate.

There are five haddock stock fisheries though directed fisheries are only permitted in NAFO Unit Area 4X5Y on the Scotian Shelf and NAFO Unit Area 5Zjm on George's Bank. The Project Area is located within fishing grounds for the 4X5Y stock. Between 2006 and 2010 the TAC for this stock ranged from 6000 to 7000 t. (DFO 2013b). From 2006 to 2009 the TAC was 7000 t though this was lowered in 2010 to 6000 t (DFO 2012a).

Figures 5.3.9 and 5.3.10 depict locations of groundfish species catches within and around the Project Area.

5.3.3.3.2 Pelagic Fisheries

During the period from 1980 to 2000 pelagic species have shown fluctuations in catch and have ranged from 8% to 15% of the total landed value on the Scotian Shelf (Stantec 2014). On the Scotian Shelf, bigeye tuna, yellowfin tuna, swordfish and blue shark stocks are considered to be in a healthy state, while bluefin tuna, albacore tuna, shortfin mako, porbeagle, blue marlin, and white marlin stocks are in a critical state as determined by DFO (Stantec 2014).

Within Unit Areas 4W and 4X the pelagic fishery is open year-round with specific months providing better fishing based on the seasonal movement of fish species. The most intensive fishing occurs during the summer and fall, though the main swordfish fishery is from June to November (Stantec 2014). Most fishing vessels use pelagic (floating) longline though bluefin tuna and swordfish are also angled or fished with electric harpoon (Stantec 2014).

The following describes current conditions of the three principle pelagic species fished within the Project Area, though based on the large habitat areas covered by each of these large demersal species, stock assessments are generally based on large regions.

Atlantic Canadian catches of swordfish were 1489 t in 2012, which was one of the highest annual landings since 1988 (ICCAT 2012a). The swordfish population is separated by the International Commission for the Conservation of Atlantic Tunas (ICCAT) into North and South Atlantic stocks with independent TACs. The worldwide TAC for the North Atlantic swordfish fishery is 13 700 this has decreased from 2007–2009 where the TAC was 14 000 t. Minimum size limits are in place for the North Atlantic swordfish fishery a 125 cm lower jaw fork length (LJFL) with a 15% tolerance or a 119 cm LJFL with zero tolerance and evaluation of the discards (ICCAT 2012a).

Data provided by ICCAT from the 1988–2012 shows Atlantic Canadian landings of bigeye tuna were highest in 2000 (327 t) and have decreased to a low of 103 t in 2010 (ICCAT 2012b). In 2012 Atlantic Canadian catches of bigeye tuna totaled 166 t. Total worldwide catches of bigeye tuna in 2012 were below the TAC of 85 000t with a harvest of 70 536 t. The historical TAC was reduced in 2009 from 90 000 t to 85 000t (ICCAT 2012b).

Atlantic Canadian catches of yellowfin tuna were 93 t in 2012 down from 304 t in 2004 (ICCAT 2012c). Total worldwide catches of yellowfin tuna have declined to 100 000 t in 2007 from 193 000 t in 1990 (ICCAT 2012c.) From 2007 to 2011 catches have increased through only by 10–20%. Beginning in 2013 ICCAT proposed a worldwide TAC of 110 000 and time area closures for fishery aggregating devices such as floating longlines. Estimates of fishable biomass trends indicate a recent decline though a slow continued rebuilding tendency (ICCAT 2012c).

Figure 5.3.11 demonstrates that pelagic fisheries around the Project Area are concentrated primarily along the shelf break (*e.g.*, swordfish) or in deeper waters off the Scotian Slope (*e.g.*, tuna/shark).

5.3.3.3.3 Shellfish Fisheries

Commercial fishing for lobster and crab in and around the Project Area is concentrated on Georges Bank outer shelf, Georges Basin and the upper Scotian slope (DFO 2013b). The scallop fishery, concentrated on Georges Bank and Browns Bank to the west of the Project Area, accounts for approximately 70–80% of the annual scallops landed in Canada (Stantec 2014).

Figures 1 to 4 in Appendix E depict locations of shellfish landings within and around the Project Area. The fishery is predominantly based along the Scotian Shelf break and Georges Basin for lobster with scallop fished along Georges and Browns Banks. Red crab is the primary crab species harvested in the area (LGL 2013), although Jonah crab, rock crab, stone crab, porcupine crab and spider/toad crab are also caught (Stantec 2014). These species are harvested using conical or rectangular crab traps (Stantec 2014). Experimental red crab fisheries occurred on the Scotian Slope in the 1960s and 1980s, which ended due to poor economic performance. The current fishery began in the early 1990s with a TAC of 1300t (DFO 2005; DFO 1997).

Within the Project Area the offshore lobster fishery in LFA 41 is open year-round though has been subject to a TAC of 720 t per year since 2009 (DFO 2013c). If the TAC weight is not harvested the year previous, the unused allocation can be then harvested in the subsequent year. Landings for Lobster in 2010 and 2011 were 869 and 752 t, there were overruns in these two years therefore the allocated TAC in 2012 will be 646 t (Intertek 2012). Lobster are harvested offshore using rectangular wire coated traps (Marine Stewardship Council 2009).

5.3.4 Aboriginal Fisheries

In 1990, the Supreme Court of Canada issued the Sparrow Decision which found the Musqueam First Nation had an Aboriginal right to fish for FSC purposes. The Court found this FSC right takes priority, after conservation, over other uses of the resource. The decision indicated the importance of consulting with Aboriginal groups when their fishing right may be affected (DFO 2008b). In response to this decision DFO developed an Aboriginal Fishing Strategy (AFS). The AFS assists DFO in managing the fishery in a manner consistent with the Supreme Court of Canada's decisions.

The Minister of Fisheries and Oceans issues communal fishing licences to Aboriginal groups, which allows fishing for FSC purposes. In the DFO Maritimes Region, communal FSC licences are held by 16 First Nations and the Native Council of Nova Scotia. Eleven of these communal licences are held by groups in Nova Scotia while the remaining five are held by groups in New Brunswick. These communal licences are for inland and inshore areas, however, as DFO does not provide access for FSC purposes in offshore areas (DFO, pers. comm. 2012 as cited in Stantec 2014).

In response to the Supreme Court of Canada's 1999 Marshall Decision, which affirmed a Treaty right to hunt, fish, and gather in pursuit of a moderate livelihood, DFO implemented the Marshall Response Initiative (MRI), to provide increased First Nations access to the commercial fishery through issuance of communal commercial licences. Communal commercial licences are held under the name of the First Nations community and not under the name of a specific individual.

There are 144 communal commercial licences for commercial fishing within the Western Scotian Shelf and Slope region. These licences are for crab, groundfish, hagfish, swordfish, bluefin tuna, and lobster (DFO 2013) (refer to Table 5.3.1). The communal commercial licences are held by Aboriginal groups in the DFO Maritimes Region, and do not include those communal commercial licences held by the Pictou Landing First Nation and Paq'tnkek First Nation. These two First Nations are located in Nova Scotia, but fall under the jurisdictional authority of the DFO Gulf Region.

Shell has commissioned MGS and UINR to undertake a TUS to obtain information from the on Aboriginal fisheries occurring in and around the Project Area.

This scope of work included conducting a background review of commercial licences, and FSC agreements, as well as interviews with elders, fishers and fisheries managers from a representative subset of First Nations in Nova Scotia and New Brunswick, as well as the NCNS. Based on these interviews, the TUS includes information on target species, general fishing areas, and fishing seasons, along with any additional information pertaining to fish or sensitive areas.

Commercial harvesting by the Mi'kmaq of Nova Scotia and Mi'kmaq and Maliseet in New Brunswick in the RAA targets many of the same species fished by non-Aboriginal commercial fishers, including albacore tuna, bigeye tuna, bluefin tuna, cod, cusk, flounder, haddock, hagfish, hake, halibut, herring, Jonah crab, lobster, pollock, redfish, scallop, shark, shrimp, snow crab, swordfish and yellowfin tuna. Based on interviews conducted as of April 2014, 37 fish species, one mammal (seal), and nine invertebrate groups were identified as species harvested for FSC purposes. The TUS states that there is currently no FSC fishing reported as occurring in the Project Area. However, the TUS also acknowledges that this does not imply that FSC fisheries are not occurring in the Project Area or that the Project Area may not be accessed for future FSC fisheries needs. Lobster and herring were identified as currently being harvested within the LAA and several species (cod, herring, halibut, cusk, gaspereau, haddock, monkfish, pollock, red hake, silver hake, white hake, lobster, scallop, Jonah crab, and marine worms) were identified as being harvested for FSC purposes within the RAA (MGS and UINR 2014). A precautionary approach is therefore taken, assuming that FSC fisheries could potentially occur in the Project Area and LAA, as well as the RAA. It is also acknowledged that species fished for FSC purposes could be harvested outside the RAA but could potentially temporarily interact with the Project during migration activities through the Project Area or LAA.

5.3.5 Physical and Cultural Heritage

Given the offshore location of the Project Area and deepwater depths, a consideration of physical and cultural heritage is limited to shipwrecks that may be present. Figure 5.3.6 presents locations of known shipwrecks in the vicinity of the Project Area. A seabed survey conducted in advance of the exploratory drilling program, as well as a ROVsurvey to be conducted in advance of drilling activities will confirm the absence of historical shipwrecks in the Project Area.