5.0 EXISTING ENVIRONMENT

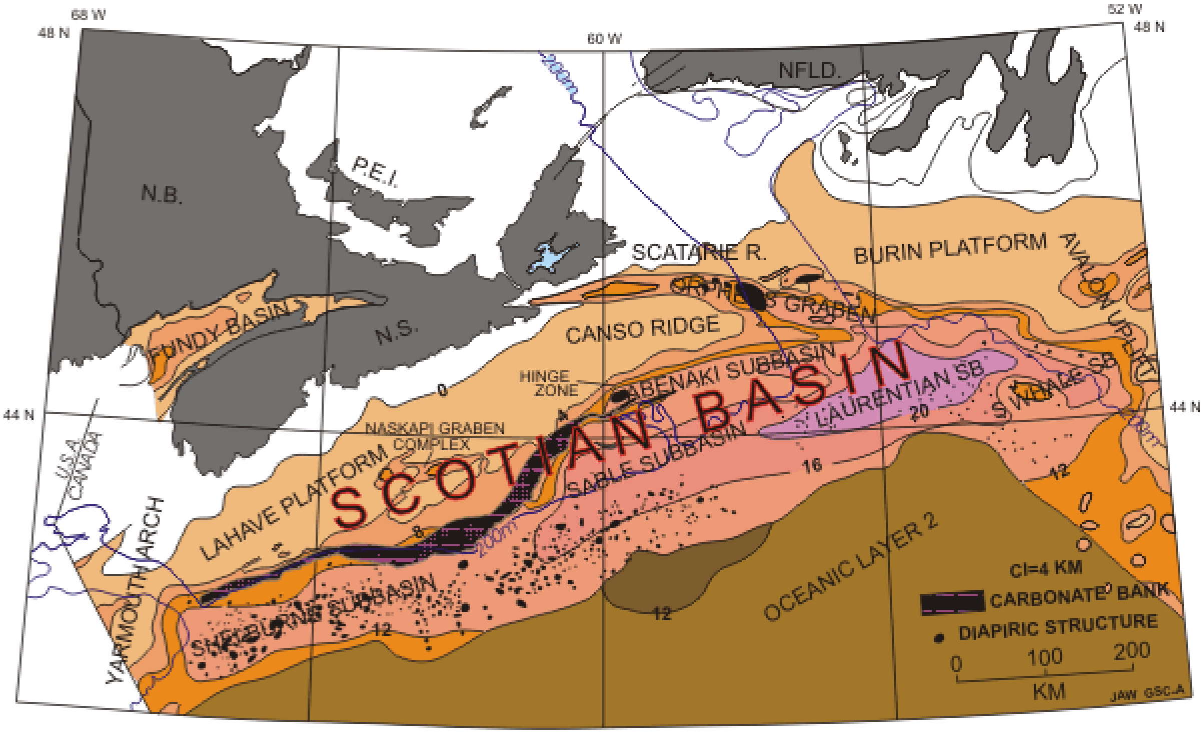
This section provides an overview of the physical, biological and socio-economic environments in which the Project is located and is intended to provide a regional perspective of the existing environment and to help identify key factors that may interact with the Project and require further assessment 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 EA. 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 as well as the Environmental Assessment of BP Exploration (Canada) Limited's Tangier 3D Seismic Survey (LGL 2014) and Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) have been used to characterize the Project Area and surrounding region.

5.1 MARINE PHYSICAL ENVIRONMENT

5.1.1 Marine Geophysical Environment

The Project Area is located within the Scotian Basin geological formation located on the Scotian Slope offshore of Nova Scotia. As described by the CNSOPB (2013) the basin extends approximately 1,200 km from the Yarmouth Arch on the United States (US) 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). 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 4,000 m, while the other half is situated over the shallow Scotian Shelf in waters less than 200 m (CNSOPB 2013).

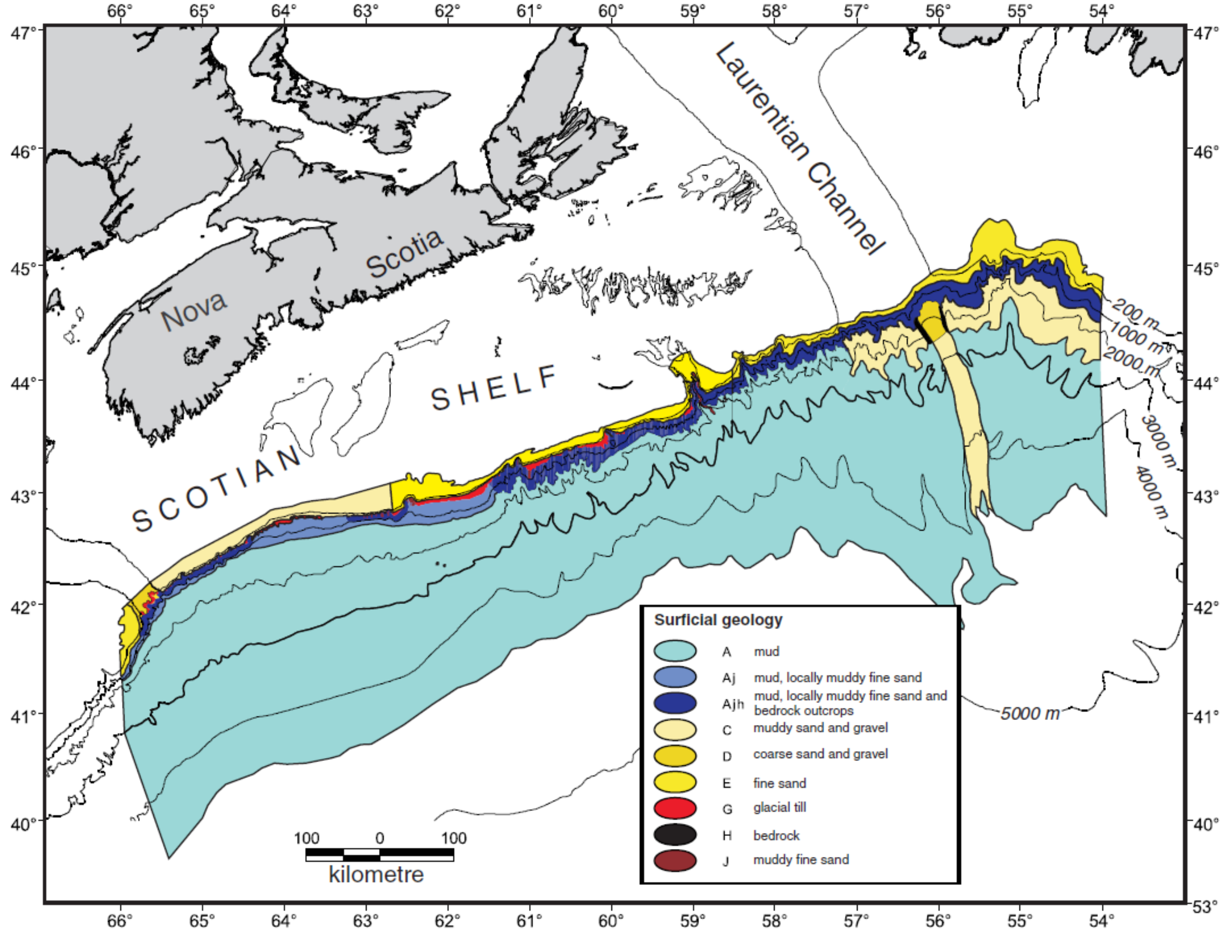
The Scotian Basin is a rifted continental margin located on the northeastern flank of the Appalachian Orogen with a maximum sediment thickness of 24 km. The continental-sized drainage system of the paleo-St. Lawrence River provided a continuous supply of sediments which accumulated into a variety of complex and interconnected sub-basins.



Source: NRCan 2010

Figure 5.1.1 Major Tectonic Features of the Scotian Basin

The Project Area is located on the Scotian Slope which is characterized by a gentle gradient with low gentle hills and valleys, sloping towards the deep Scotian Rise and Abyssal Plain (WWF 2009). 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 1,000 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 5.1.2). From the 1,200 m isobath to 3,000 m, the seafloor consists of a smooth mud surface that contains less than 5% sand. On the Continental Rise below the 3,000-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)(Piper and Campbell 2002).



Source: Piper and Campbell 2002

Figure 5.1.2 Seafloor Sediment Types on the Scotian Slope

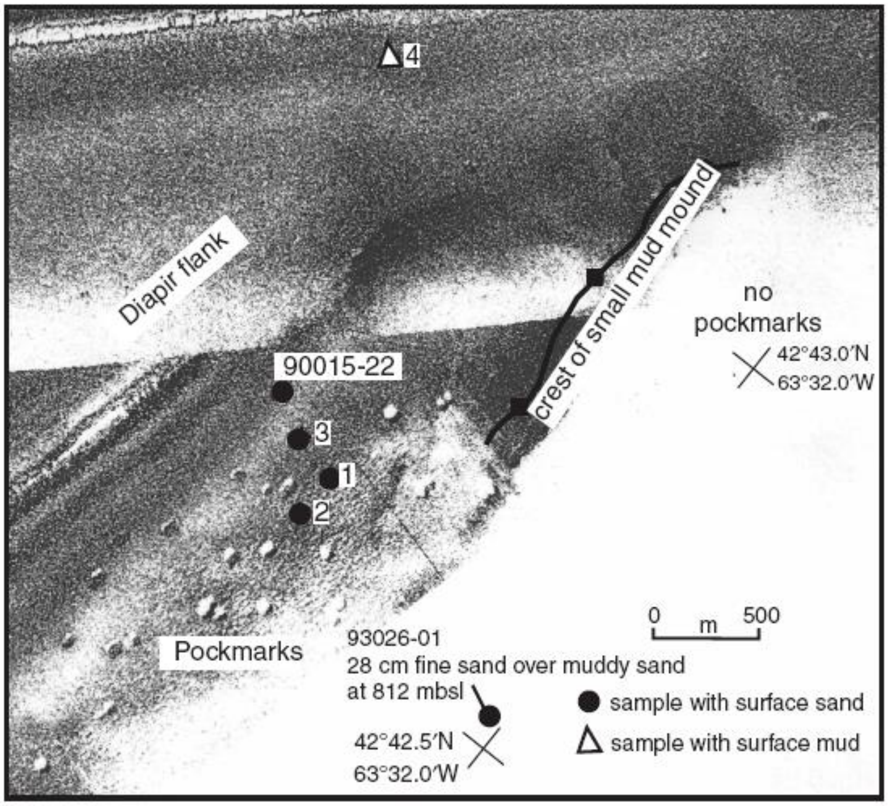
The seafloor gradient increases at the shelf break at the 80 to160 m water depth to gradients of 1.1° to 3.3° on the upper slope (Piper and Campbell 2002). Most areas of the shelf break have a smooth seabed up to a water depth of approximately 250 m. From the 250 to 500 m water depth contours, there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

Sable Island Bank, approximately 48 km northeast from the Project Area, 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 2014b). 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) (WWF 2009). 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.

The Laurentian Channel, which divides the Scotian Shelf and Slope from the Grand Banks at the eastern end of the RAA, is a deep trough created from an ancient river valley that was eroded by past glaciation. 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. The Laurentian Fan is a large delta-shaped sediment deposit at the edge of the Laurentian Channel. Two major valleys originate from an area of gullies on the upper slope and terminate at water depths between 4,500 and 5,200 m where they open onto a sandy area of the Abyssal Plain (WWF 2009). 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.

The mobility of bottom sediments (*e.g.*, susceptibility of sediment transport, slope failure) is an important consideration in assessing natural geological hazards (geohazards) which can affect the selection of wellsites. Other geohazards include pore pressure phenomena and 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 2014a). Figure 5.1.3 illustrates pockmarks and diapir observed on the Western Scotian Slope by Piper and Campbell (2002).



Source: Piper and Campbell 2002

Figure 5.1.3 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). Prior to drilling, BP will conduct a comprehensive regional geohazard baseline review (GBR) followed by detailed geohazard assessments for each wellsite to identify potential geohazards that could impact drilling operations. Section 5.2.2 has additional information on BP's GBR process and how it is being used to help characterize the benthic environment and identify geohazards. Section 9.5.5 has additional information on how geohazards will be identified and managed for the Project.

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, influenced by the warm Gulf Stream and the cold Labrador Current. Air temperatures in the region, as measured on Sable Island, have shown an increase of 1°C over the last century (Worcester and Parker 2010). Daily average temperatures on Sable Island range from below freezing in February, with mean daily minimum being about -5°C, to 18°C in August, with mean daily maximum of 21°C (Freedman 2014). Although precipitation is somewhat less in the summer, the total monthly precipitation does not vary much over the year, ranging from an average of 100.8 mm in July to 150.7 mm in November (Freedman 2014; Environment Canada 2015b). 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

Source: Environment Canada 2015b

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 index quantifies the dominant winter atmospheric function of the North Atlantic Ocean. It affects winds, air temperature, precipitation, and hydrological properties on the eastern Canadian seaboard (DFO 2015b). The NAO is a back and forth pattern between a high-pressure cell over the Azores in the southeast 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 positive index brings increased northwesterly winds, cold air and sea temperatures, and heavy ice in the Labrador Sea (DFO 2015b). During a high positive index the Scotian Shelf experiences increased precipitation, westerly winds and warmer waters. 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. In 2014, the winter NAO was above normal bringing colder winter air temperatures and the highest volume of sea ice seen since 1994 on the Newfoundland and Labrador shelf (outside the RAA)(DFO 2015b).

5.1.2.2 Air Quality

Environment Canada and Nova Scotia Environment (NSE) operated an ambient air quality monitoring station on Sable Island. NSE closed the station in October 2014. 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) were measured at this station. The most recently available ambient air quality data (2012 and 2013) were obtained from the National Air Pollutant Survey (NAPS) website (Environment Canada 2012a and 2013a). Although areas near Sable Island have been used for the exploration and extraction of fossil fuels since 1992, with these industrial activities releasing emissions to the atmosphere, the results from the Sable Island monitoring station do not appear to indicate adverse effects on air quality.

Table 5.1.2 summarizes the most recent (2012-2013) ambient air quality data from the Sable Island station.

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

Parameter	$PM_{2.5}$ Concentrations (µg/m³)*		SO_2 Concentrations (µg/m³)		NO_2 Concentrations (µg/m³)*		O_3 Concentrations (µg/m³)
	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	163	38	7.9	2.6	43.3	7.5	122
99th Percentile	30	22	2.6	0	5.6	3.8	100
98th Percentile	24	20	0	0	3.8	3.8	96

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

Parameter	$PM_{2.5}$ Concentrations (μg/m³)*		SO_2 Concentrations (μg/m³)		NO_2 Concentrations (μg/m³)*		O_3 Concentrations (μg/m³)
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour	1-hour
90th Percentile	16	15	0	0	1.9	1.9	86
Average	-	-	-	-	0	0	68
Minimum	0	1	0	0	0	0	10
Exceedances	0	0	0	0	0	0	0
Rate of Compliance	100%	100%	100%	100%	100%	100%	100%
Hours Available	8497	8410	6307	6307	7884	7971	8672
Percent Available	97%	96%	72%	72%	90%	91%	99%

Note:
CCME Canada-wide standard is based on the 98th percentile of annual 24-hour average concentrations averaged over three consecutive years.
* All data are from 2013 except for $PM_{2.5}$ concentrations, which are from 2014, and NO_2, which are from 2012.

Sources: Environment Canada 2012a, 2013a, 2015f

NO_2 data from 2013 is unavailable; as a result, data from 2012 was used. In 2012, the measured concentrations of NO_2 were well below the applicable NSE maximum permissible ground-level concentrations for both 1-hour and 24-hour averaging periods. In 2013, all the measured concentrations of $PM_{2.5}$, SO_2, and O_3 were also below the NSE maximum permissible ground-level concentrations for both 1-hour and 24-hour averaging periods. O_3 had the highest concentrations of all the parameters with 122 μg/m³ for a 1-hour average period.

Based on the review of the 2012 and 2013 ambient air quality data from the Sable Island monitoring station, the ambient air quality in the area is good most of the time, with no regulatory exceedances. Ozone, a secondary pollutant formed from the action of sunlight on nitrogen oxides and hydrocarbons, is often associated with regional scale emissions, for example from the northeastern seaboard of the US and the Canadian mainland. On Sable Island the median O_3 value for 2013 was 33 ppb, which is essentially unchanged from 2003 to 2006 data that ranged from 27 to 34 ppb (Environment Canada 2010a in Freedman 2014), and well below the Canada-Wide Standards (CWS) of 65 ppb (for 8 hours).

5.1.2.3 Wind Climate

Data Sources

The Meteorological Service of Canada 50-year hindcast (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 (MSC). 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, 60 years of hourly wind and wave data from 1954 to 2013 were obtained for the MSC50 Grid Point 3551 (42.9°N, 60.6°W). The water depth at this MSC50 Grid Point is 2,326 m. In addition to the hourly wind data, extreme wave conditions data at the Grid Point 3551 were also obtained. The Grid Point 3551 for the MSC50 data is located within the Project Area and is illustrated on Figure 5.1.4.

Metocean data collected at buoys located 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 5.1.4. LaHave Bank, East Scotia Slope, Banquereau Bank, and Laurentian Fan buoy data were collected by DFO and Environment Canada. The remainder of the data sets in Table 5.1.3 were collected by drilling rigs and exploration wells, which contain short-term data, and where their locations are also illustrated in Figure 5.1.4.

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	42.49 °N	64.2 °W	9/5/1990	3/21/1995
		1500	42.44 °N	64.10 °W	6/30/1995	1/7/1998
		1300	42.50 °N	64.02 °W	6/25/1998	6/1/2006
	C44150	1300	42.51 °N	64.02 °W	3/1/2006	9/24/2015
East Scotia Slope	C44137	4500	41.32˚N	61.35˚W	11/30/1988	12/8/1988
			41.19 °N	61.13 °W	9/8/1989	6/22/1993
			41.23 °N	61.42 °W	7/3/1993	6/28/1995
			41.60 °N	60.03 °W	6/30/1995	11/2/1995
			41.65 °N	59.95 °W	9/22/1996	3/17/1997
			41.80 °N	59.92 °W	7/22/1997	7/7/1998
			41.83 °N	60.94 °W	7/8/1998	6/8/2003
		4000	42.28 °N	62.00 °W	6/9/2003	9/1/2015
Banguereau Bank	C44139	1500	44.20 °N	57.50 °W	9/5/1997	6/24/1999
			44.26 °N	57.36 °W	6/25/1999	6/8/2003
			44.27 °N	57.08 °W	6/9/2003	9/24/2015

Table 5.1.3 Buoy Data Used in the Metocean Analysis

Name	Station ID	Depth (m)	Location		Period of Record	
			Lat	Long	From	To
Laurentian Fan	C44141	4500	42.12 °N	56.13 °W	9/5/1990	7/2/1999
			42.09 °N	56.31 °W	7/3/1999	6/8/2003
		3000	43.00 °N	58.00 °W	6/10/2003	9/24/2015
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

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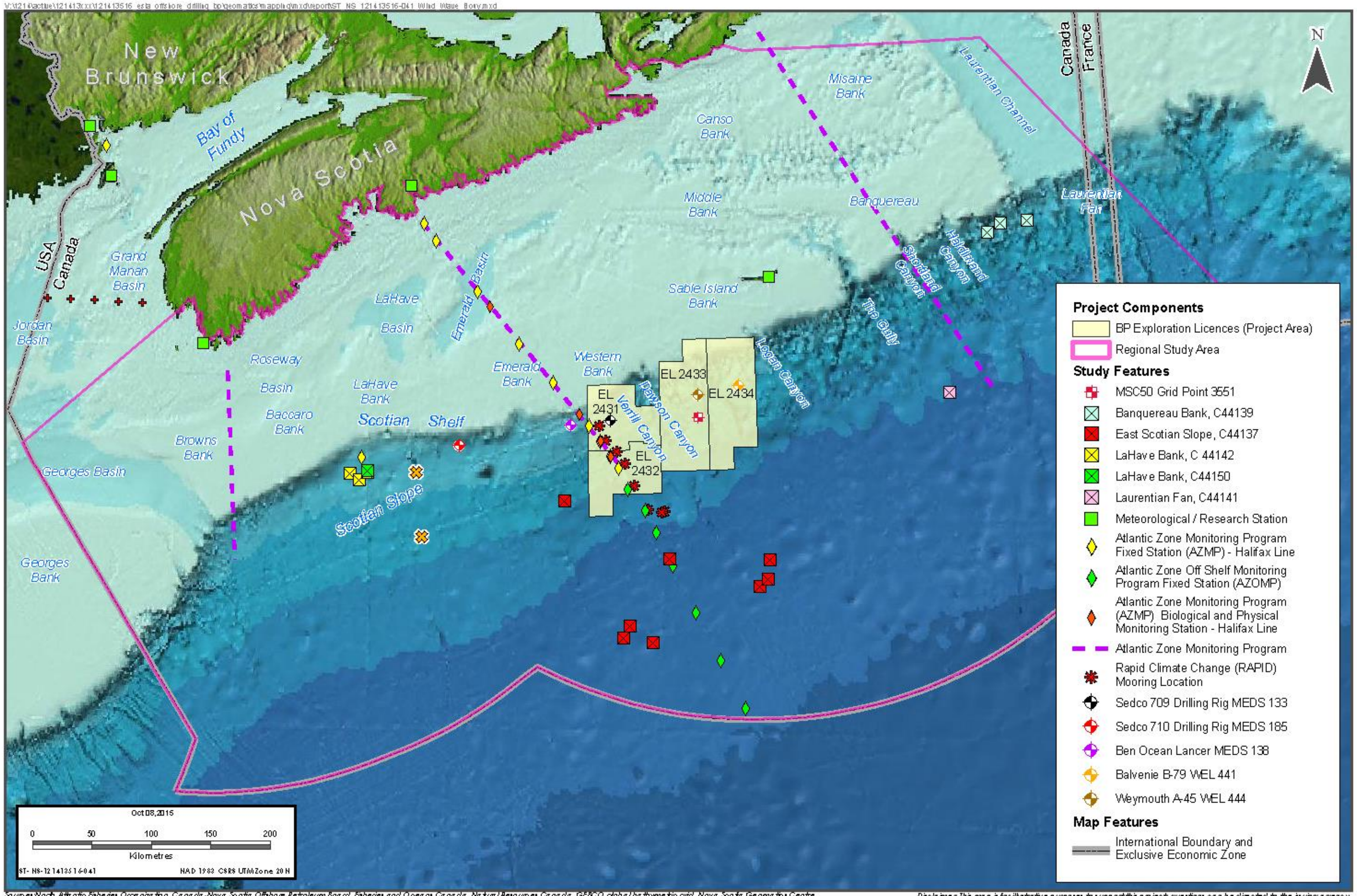


Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre. Jacques Whitford Environmental Ltd.. Environment Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.1.4 Locations of MSC50 Grid Point 3551, Buoys and Other Metocean Data Sources in Relation to the Project Area

Wind Conditions

The MSC50 hourly wind data for the Grid Point 3551 from 1954 to 2013 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 5.1.5(a) presents percentage of wind speed occurrence by the wind direction. An annual wind rose for the Grid Point 3551 is provided in Figure 5.1.5(b) and based on six years of MSC50 data from 2008 to 2013. Most of the winds are from the northwest, west and southwest directions and 92% of the wind speeds are less than 15 m/s. Figure 5.1.5(c) presents the wind speed duration curve for Grid Point 3551. The wind speed duration curve indicates the percentage of time a given wind speed was equaled or exceeded over a 60-year period from 1954 to 2013.

Figure 5.1.6 illustrates the monthly wind roses for Grid Point 3551. 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 and annual wind conditions. Maximum wind speed ranges from 20.4 m/s in May to 29.8 m/s in December. Mean and maximum monthly wind speeds for the LaHave Bank buoy, East Scotia Slope buoy, Banquereau Bank buoy, Laurentian Fan buoy and MSC50 data are presented in Tables 5.1.5 and 5.1.6. Anemometer height is 5 m for La Have Bank buoy, East Scotia Slope buoy, Banquereau Bank buoy, and Laurentian Fan buoy. Winds speed from the MSC50 data set are 1-hour averages while buoy data sets are 10-minute average winds. Buoy wind speeds were adjusted to a reference level of 10 m using the log profile method (Thomas *et al.* 2005).

Extremal wind analysis was carried out using 60 years of hourly wind data from 1954 to 2013 using Gumbel, Weibull, Generalized Extreme Value and Generalized Pareto probability distributions. The Generalized Extreme Value distribution was selected based on visual best fit with simulated wind speeds. Table 5.1.7 presents the extreme wind conditions at the MSC50 Grid Point 3551 for return periods ranging from 2 to 100 years. The predicted range of extreme wind conditions are presented in Table 5.1.8 for various distributions. Tables 5.1.9 to 5.1.13 provide extreme wind speeds for various shorter wind averaging times.

Table 5.1.4 Monthly and Annual Wind Statistics[1] (I-hour Average)

Month	Mean Wind Speed (m/s)	Most Frequent Direction[2]	Maximum Hourly Wind Speed (m/s)
January	11.0	NW	28.4
February	10.8	NW	27.2
March	10.1	NW	28.1
April	8.5	NW to SW	24.2
May	6.8	SW	20.4
June	6.1	SW	24.1
July	5.6	SW	23.5
August	6.1	SW	29.4
September	7.3	NW to SW	28.7

Table 5.1.4 Monthly and Annual Wind Statistics[1] (I-hour Average)

Month	Mean Wind Speed (m/s)	Most Frequent Direction[2]	Maximum Hourly Wind Speed (m/s)
October	8.9	NW and SW	28.3
November	9.9	NW	26.7
December	10.9	NW	29.8
Annual	**8.5**	**NW to SW**	**29.8**

Note:

[1] Based on 60 years of MSC50 hourly wind data from 1954 to 2013.

[2] Direction winds are blowing from.

Table 5.1.5 Comparison of Mean Monthly MSC50 and Buoy Wind Speeds (10-Minute Average)

Month	Mean Monthly Wind Speed (m/s)				
	MSC50	LaHave Bank (C44142 & C44150)	East Scotian Slope (C44137)	Banquereau Bank (C44139)	Laurentian Fan (C44141)
January	11.3	9.1	9.6	7.8	9.1
February	11.1	8.9	9.9	7.6	9.0
March	10.4	8.3	9.8	7.0	8.2
April	8.7	7.4	7.9	5.9	6.3
May	7.1	5.8	7.0	5.4	5.7
June	6.3	5.4	6.2	5.6	6.0
July	5.8	4.9	5.7	5.3	5.5
August	6.2	5.3	5.9	5.7	6.0
September	7.5	6.4	6.8	6.9	6.9
October	9.1	8.2	8.4	8.3	8.2
November	10.2	8.5	9.3	8.5	8.6
December	11.2	9.6	10.2	8.2	9.2
Annual	**8.8**	**7.3**	**8.1**	**6.9**	**7.4**

Table 5.1.6 Comparison of Maximum Monthly MSC50 and Buoy Wind Speeds (10-Minute Average)

Month	Maximum Monthly Wind Speed (m/s)				
	MSC50	LaHave Bank (C44142 & C44150)	East Scotian Slope (C44137)	Banquereau Bank (C44139)	Laurentian Fan (C44141)
January	29.3	27.9	28.0	31.7	32.6
February	28.0	25.3	27.6	34.4	28.1
March	28.9	26.6	25.4	30.3	26.6
April	24.9	21.4	26.0	23.5	21.4
May	21.0	19.7	21.5	20.7	18.0
June	24.8	20.0	25.7	26.8	21.2
July	24.2	20.4	21.9	21.5	17.2
August	30.3	32.4	25.5	22.0	23.2
September	29.6	30.5	26.0	29.3	30.6
October	29.1	26.4	25.5	28.9	25.3
November	27.5	22.6	30.6	25.8	24.0
December	30.7	27.6	31.9	28.9	30.1
Annual	**30.7**	**32.4**	**31.9**	**34.4**	**32.6**

Table 5.1.7 Extreme Wind Conditions at Grid Point 3551 (1-Hour Average)

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	24.9	21.3	20.4	21.2	20.8	20.7	22.0	22.7	22.6
5	26.9	23.9	22.9	23.4	23.1	22.6	24.6	24.7	24.2
10	28.1	25.3	24.4	24.4	24.5	23.9	26.1	25.8	25.1
25	29.4	26.7	26.1	25.3	26.2	25.4	27.8	26.9	25.9
50	30.2	27.6	27.1	25.8	27.4	26.6	29.0	27.7	26.3
100	31.0	28.2	28.1	26.2	28.6	27.6	30.0	28.4	26.7

Note:
[1] Direction winds are blowing from.

Table 5.1.8 Comparison of Extreme Wind Conditions at Grid Point 3551 for Various Probability Distributions – All Directions

Return Period (Year)	Wind Speed (m/s) -1-Hour Average				
	Generalized Extreme Value	Gumbel	Weibull	Generalized Pareto	Predicted Range
2	24.9	25.4	25.3	25.8	24.9-25.8
5	26.9	26.9	26.8	27.0	26.8-27.0
10	28.1	27.9	27.7	27.7	27.7-28.1
25	29.4	29.2	28.9	28.5	28.5-29.4
50	30.2	30.2	29.7	29.0	29.0-30.2
100	31.0	31.1	30.5	29.4	29.4-31.1

Table 5.1.9 Extreme Wind Conditions at Grid Point 3551 – 10-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	25.6	21.9	21.0	21.8	21.4	21.3	22.7	23.4	23.3
5	27.7	24.6	23.6	24.1	23.8	23.3	25.3	25.4	24.9
10	28.9	26.1	25.1	25.1	25.2	24.6	26.9	26.6	25.9
25	30.3	27.5	26.1	26.1	27.0	26.2	28.6	27.7	26.7
50	31.1	28.4	26.6	26.6	28.2	27.4	29.9	28.5	27.1
100	31.9	29.0	27.0	27.0	29.5	28.4	30.9	29.3	27.5

Note:

[1] Direction winds are blowing from.

Table 5.1.10 Extreme Wind Conditions at Grid Point 3551 – 3-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	26.4	22.6	21.6	22.5	22.0	21.9	23.3	24.1	24.0
5	28.5	25.3	24.3	24.8	24.5	24.0	26.1	26.2	25.7
10	29.8	26.8	25.9	25.9	26.0	25.3	27.7	27.3	26.6
25	31.2	28.3	26.8	26.8	27.8	26.9	29.5	28.5	27.5
50	32.0	29.3	27.3	27.3	29.0	28.2	30.7	29.4	27.9
100	32.9	29.9	27.8	27.8	30.3	29.3	31.8	30.1	28.3

Note:

[1] Direction winds are blowing from.

Table 5.1.11 Extreme Wind Conditions at Grid Point 3551 – 2-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	26.6	22.8	21.8	22.7	22.3	22.1	23.5	24.3	24.2
5	28.8	25.6	24.5	25.0	24.7	24.2	26.3	26.4	25.9
10	30.1	27.1	26.1	26.1	26.2	25.6	27.9	27.6	26.9
25	31.5	28.6	27.1	27.1	28.0	27.2	29.7	28.8	27.7
50	32.3	29.5	27.6	27.6	29.3	28.5	31.0	29.6	28.1
100	33.2	30.2	28.0	28.0	30.6	29.5	32.1	30.4	28.6

Note:
[1] Direction winds are blowing from.

Table 5.1.12 Extreme Wind Conditions at Grid Point 3551 – 1-Minute Average

Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	27.6	23.6	22.6	23.5	23.1	23.0	24.4	25.2	25.1
5	29.9	26.5	25.4	26.0	25.6	25.1	27.3	27.4	26.9
10	31.2	28.1	27.1	27.1	27.2	26.5	29.0	28.6	27.9
25	32.6	29.6	28.1	28.1	29.1	28.2	30.9	29.9	28.7
50	33.5	30.6	28.6	28.6	30.4	29.5	32.2	30.7	29.2
100	34.4	31.3	29.1	29.1	31.7	30.6	33.3	31.5	29.6

Note:
[1] Direction winds are blowing from.

Table 5.1.13 Extreme Wind Conditions at Grid Point 3551 – 3-Second Average

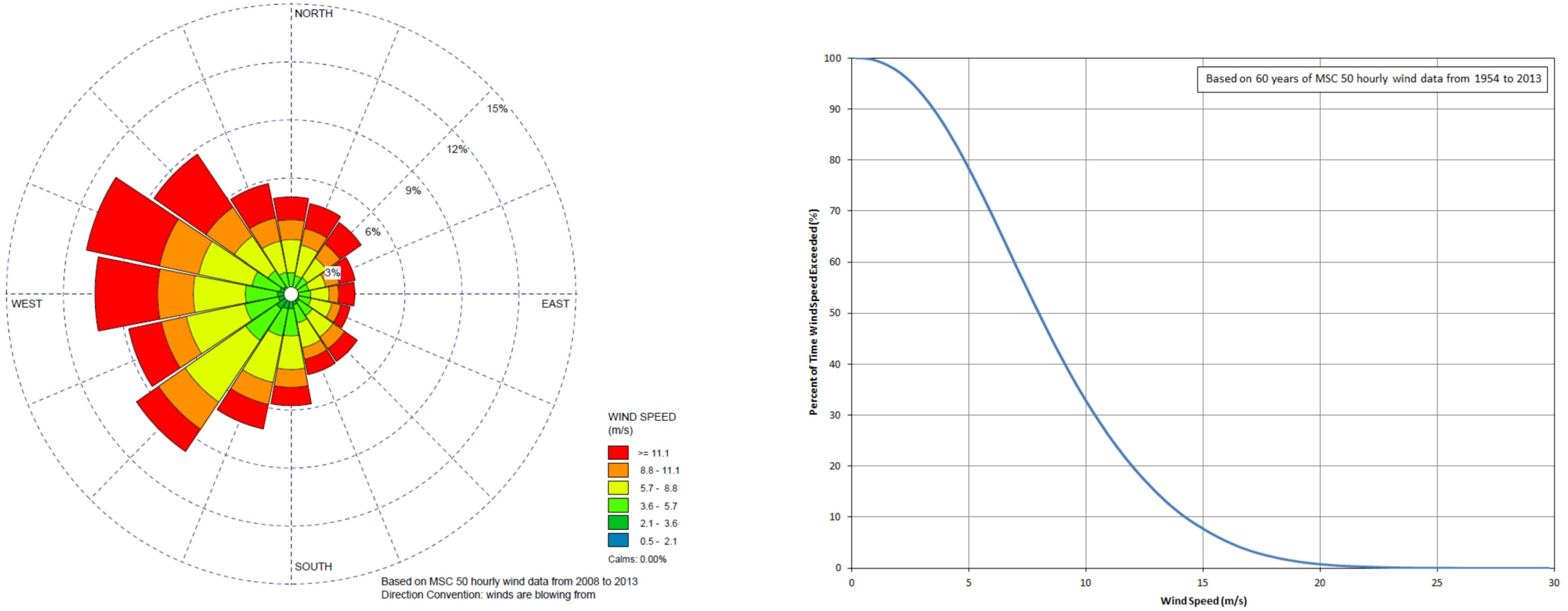
Return Period (Years)	Wind Speed (m/s)[1]								
	All Directions	N	NE	E	SE	S	SW	W	NW
2	32.4	27.7	26.5	27.6	27.0	26.9	28.6	29.5	29.4
5	35.0	31.1	29.8	30.4	30.0	29.4	32.0	32.1	31.5
10	36.5	32.9	31.7	31.7	31.9	31.1	33.9	33.5	32.6
25	38.2	34.7	32.9	32.9	34.1	33.0	36.1	35.0	33.7
50	39.3	35.9	33.5	33.5	35.6	34.6	37.7	36.0	34.2
100	40.3	36.7	34.1	34.1	37.2	35.9	39.0	36.9	34.7

Note:
[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	0.215	0.171	0.169	0.169	0.182	0.198	0.239	0.327	0.399	0.441	0.459	0.434	0.372	0.316	0.256	0.246	**4.59**
2.5-5	0.747	0.742	0.719	0.712	0.704	0.774	0.893	0.949	1.28	1.46	1.78	1.73	1.45	1.24	1.01	0.877	**17.1**
5-7.5	1.17	1.10	0.984	0.885	0.827	0.926	0.928	0.954	1.45	1.96	2.66	2.82	2.09	1.92	1.61	1.39	**23.7**
7.5-10	1.18	1.02	0.873	0.818	0.650	0.705	0.695	0.705	1.10	1.52	2.36	2.51	2.06	2.28	1.87	1.49	**21.8**
10-12.5	0.844	0.678	0.597	0.492	0.425	0.431	0.472	0.450	0.638	0.805	1.19	1.49	1.61	2.25	1.89	1.28	**15.6**
12.5-15	0.495	0.395	0.365	0.310	0.278	0.237	0.259	0.264	0.384	0.393	0.489	0.658	1.10	1.83	1.32	0.774	**9.55**
15-17.5	0.218	0.187	0.168	0.176	0.139	0.151	0.143	0.148	0.172	0.195	0.190	0.313	0.669	1.17	0.649	0.311	**5.00**
17.5-20	0.097	0.088	0.070	0.078	0.056	0.059	0.062	0.060	0.070	0.058	0.060	0.141	0.325	0.422	0.225	0.102	**1.97**
20-22.5	0.025	0.032	0.029	0.031	0.018	0.018	0.016	0.013	0.015	0.012	0.020	0.046	0.090	0.125	0.063	0.037	**0.590**
22.5-25	0.009	0.011	0.005	0.010	0.011	0.005	0.002	0.001	0.002	0.003	0.005	0.015	0.021	0.016	0.015	0.019	**0.150**
25-27.5	0.006	0.002	0.003	0.0004	0.0002	0.0004	0.001	0.001	0.0002	0.0002	0.003	0.004	0.002	0.0004	0.004	0.003	**0.029**
27.5-30	0.001	0.0002	0.002	0.001				0.0002	0.0002	0.0002	0.0002	0.001	0.0002			0.0004	**0.005**
Total	**5.01**	**4.42**	**3.98**	**3.68**	**3.29**	**3.51**	**3.71**	**3.87**	**5.50**	**6.84**	**9.21**	**10.2**	**9.80**	**11.6**	**8.91**	**6.54**	**100**

Based on 60 years of MSC 50 wind data from 1954 to 2013

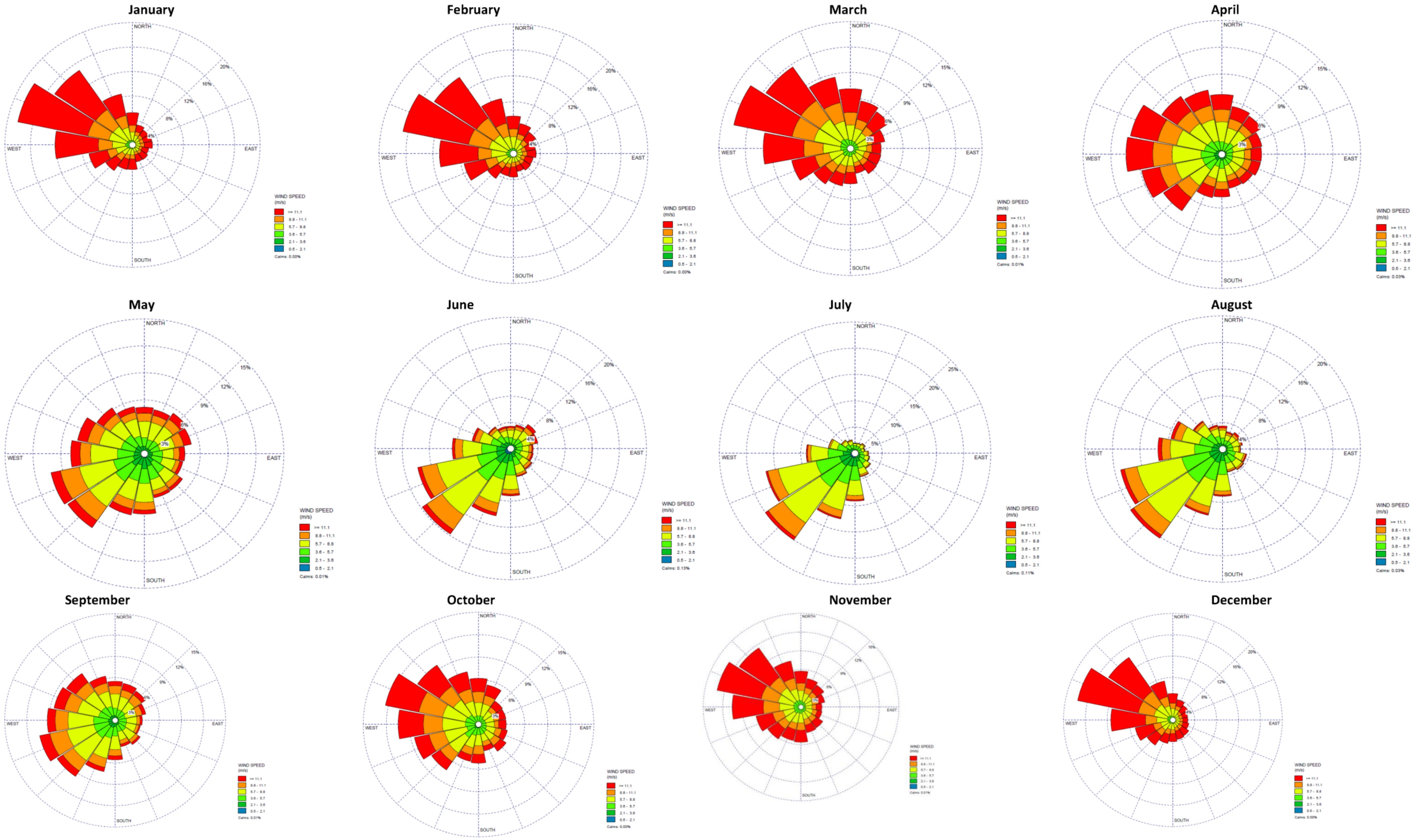
(a) Percent of Wind Speed by Wind Direction



(b) Annual Wind Rose Diagram

(c) Wind Speed Exceedance

Figure 5.1.5 Wind Conditions at Grid Point 3551


January
February
March
April
May
June
July
August
September
October
November
December

Based on MSC50 hourly wind data from 1954 to 2013

Direction Convention: winds are blowing from

Figure 5.1.6 Monthly Wind Rose at Grid Point 3551

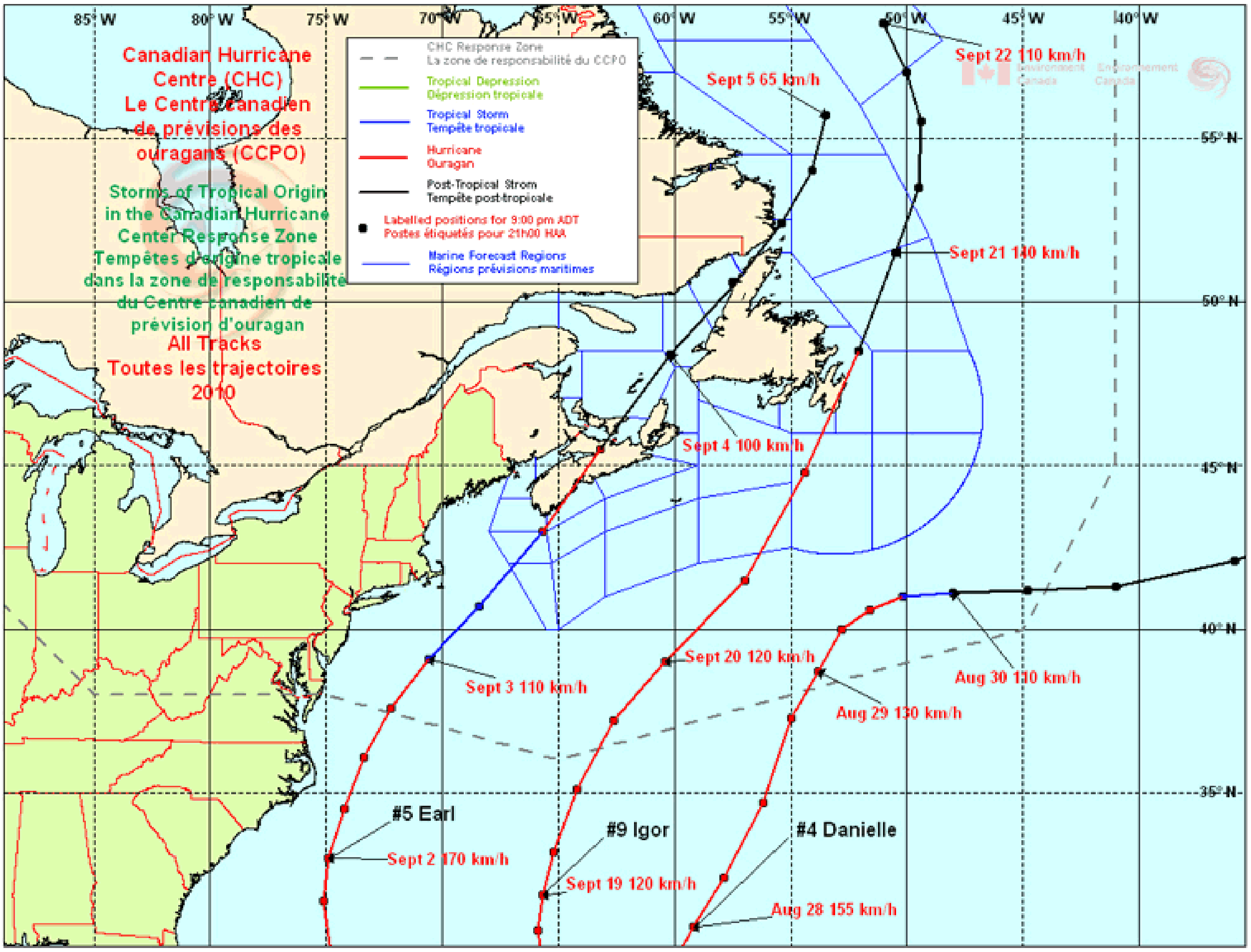
5.1.2.4 Extreme Weather

Extreme weather that could potentially occur in the Project Area and require consideration for Project planning include tropical and extra-tropical cyclones, and lightning.

Tropical and Extra-Tropical Cyclones

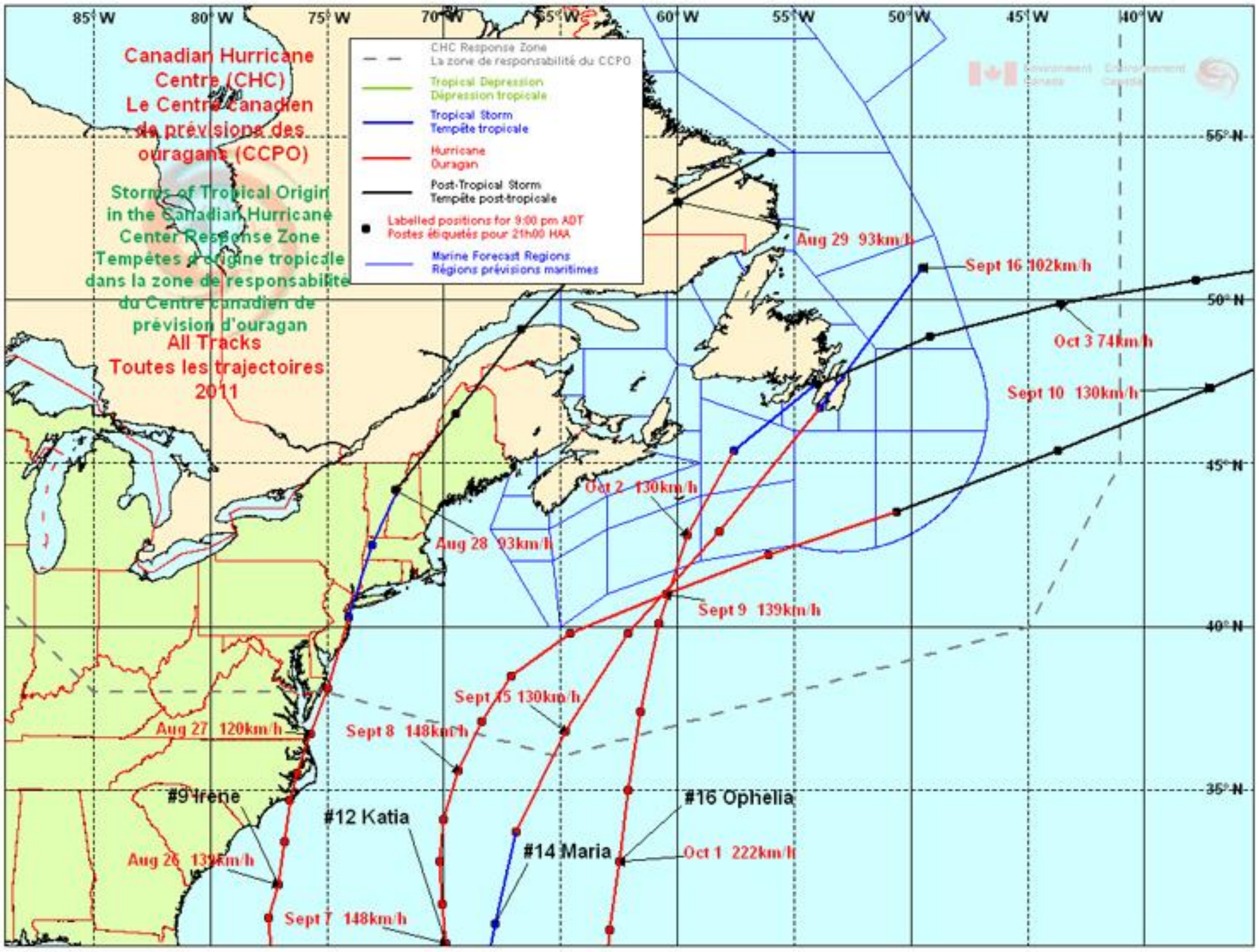
Tropical cyclones (*e.g.*, a hurricane originating over tropic or subtropical waters) typically form during June to November, bringing intense and damaging winds, rain and storm surges. They can range from Category 1 to Category 5 with wind speeds ranging from >118 km/hour to >251 km/hour. Extra-tropical cyclones are cyclones that have lost their "tropical" characteristics as they move north from very warm ocean areas to land or cold water of the North Atlantic. Tropical cyclones can transition to extra-tropical cyclones as they move north and can occur year-round, bringing the high winds and precipitation as well as freezing spray in the winter season.

Figures 5.1.7 to 5.1.11 illustrate the tracks for storms (cyclones) originating in the tropics which have tracked through Atlantic Canada between 2010 and 2014. Figure 5.1.12 depicts all of the tropical and extra-tropical cyclone tracks on the Scotian Shelf and Slope from 1980 to 2012.



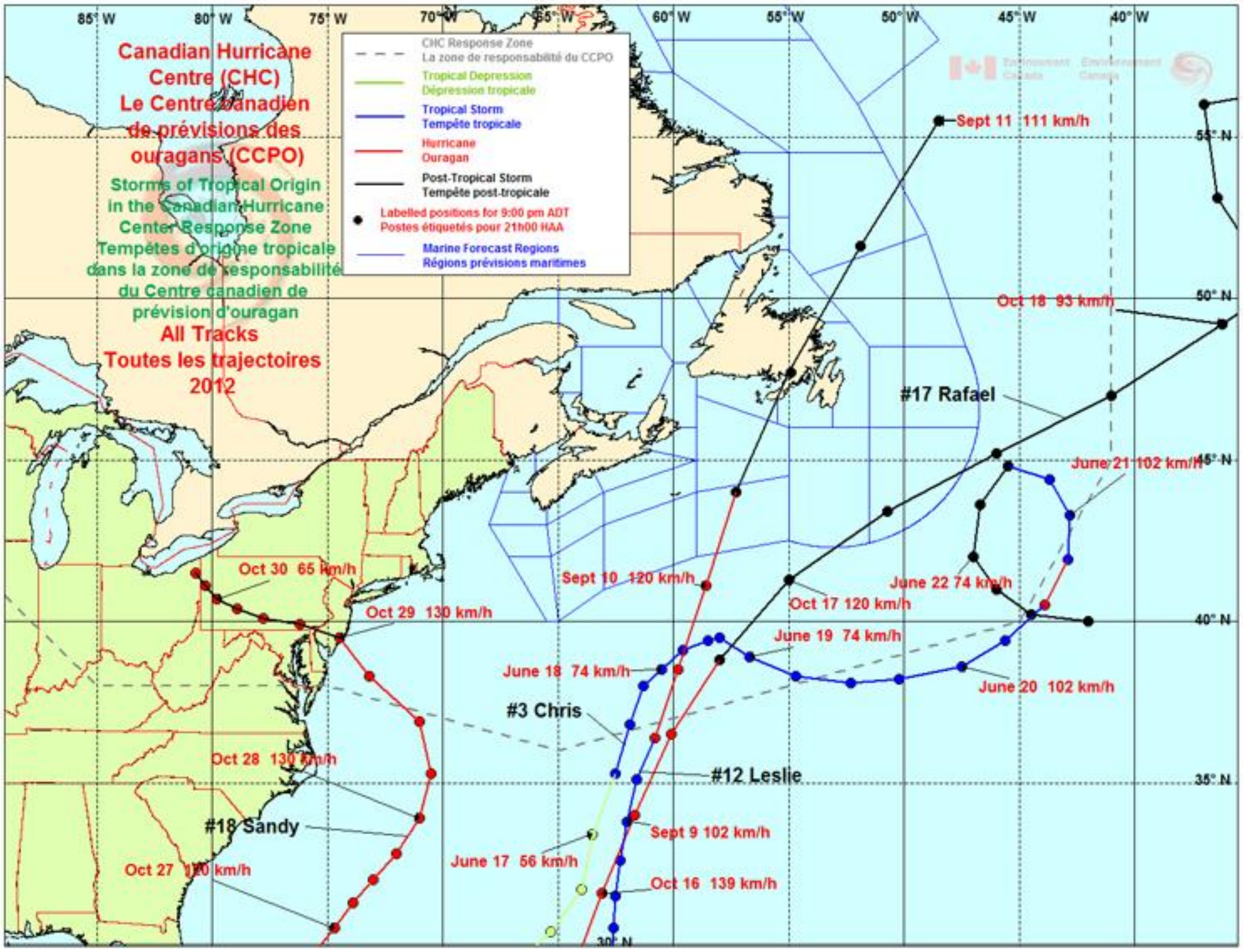
Source: Environment Canada 2015d

Figure 5.1.7 2010 Atlantic Canada Tropical and Extratropical Storm Tracks



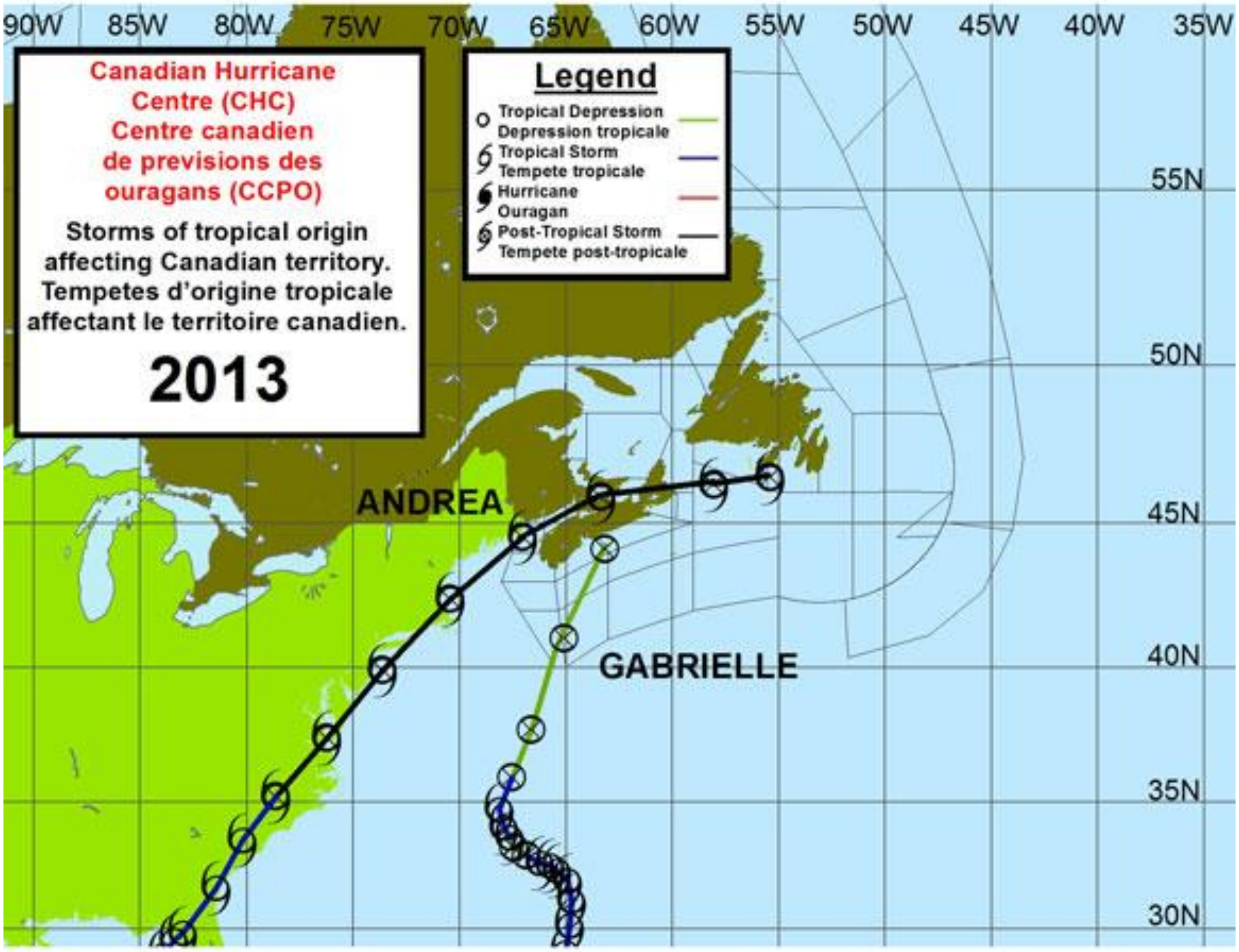
Source: Environment Canada 2015d

Figure 5.1.8 2011 Atlantic Canada Tropical and Extratropical Storm Tracks



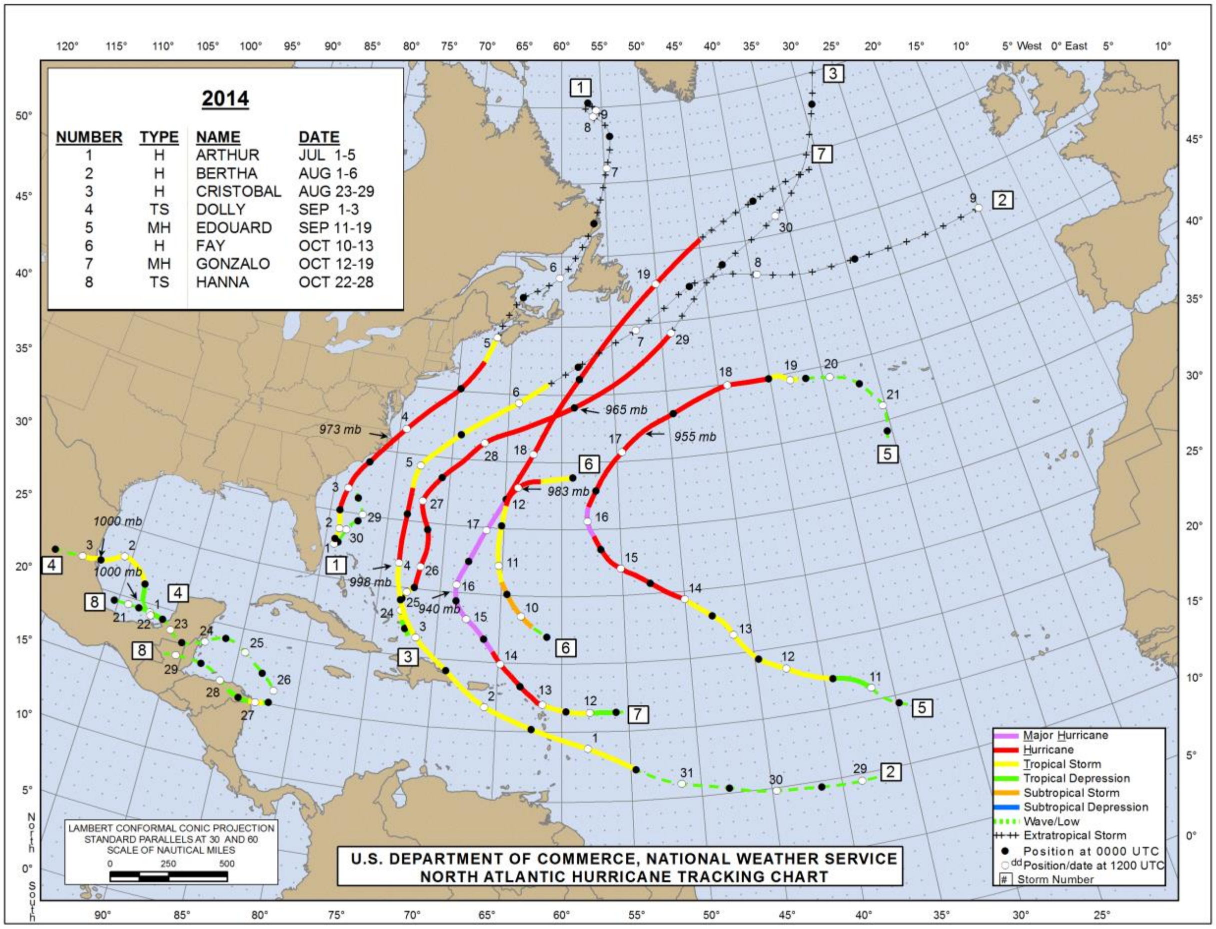
Source: Environment Canada 2015d

Figure 5.1.9 2012 Atlantic Canada Tropical and Extratropical Storm Tracks



Source: Environment Canada 2015d

Figure 5.1.10 2013 Atlantic Canada Tropical and Extratropical Storm Tracks



2014

NUMBER	TYPE	NAME	DATE
1	H	ARTHUR	JUL 1-5
2	H	BERTHA	AUG 1-6
3	H	CRISTOBAL	AUG 23-29
4	TS	DOLLY	SEP 1-3
5	MH	EDOUARD	SEP 11-19
6	H	FAY	OCT 10-13
7	MH	GONZALO	OCT 12-19
8	TS	HANNA	OCT 22-28

Source: NOAA 2015

Figure 5.1.11 2014 Tropical and Extratropical Storm Tracks

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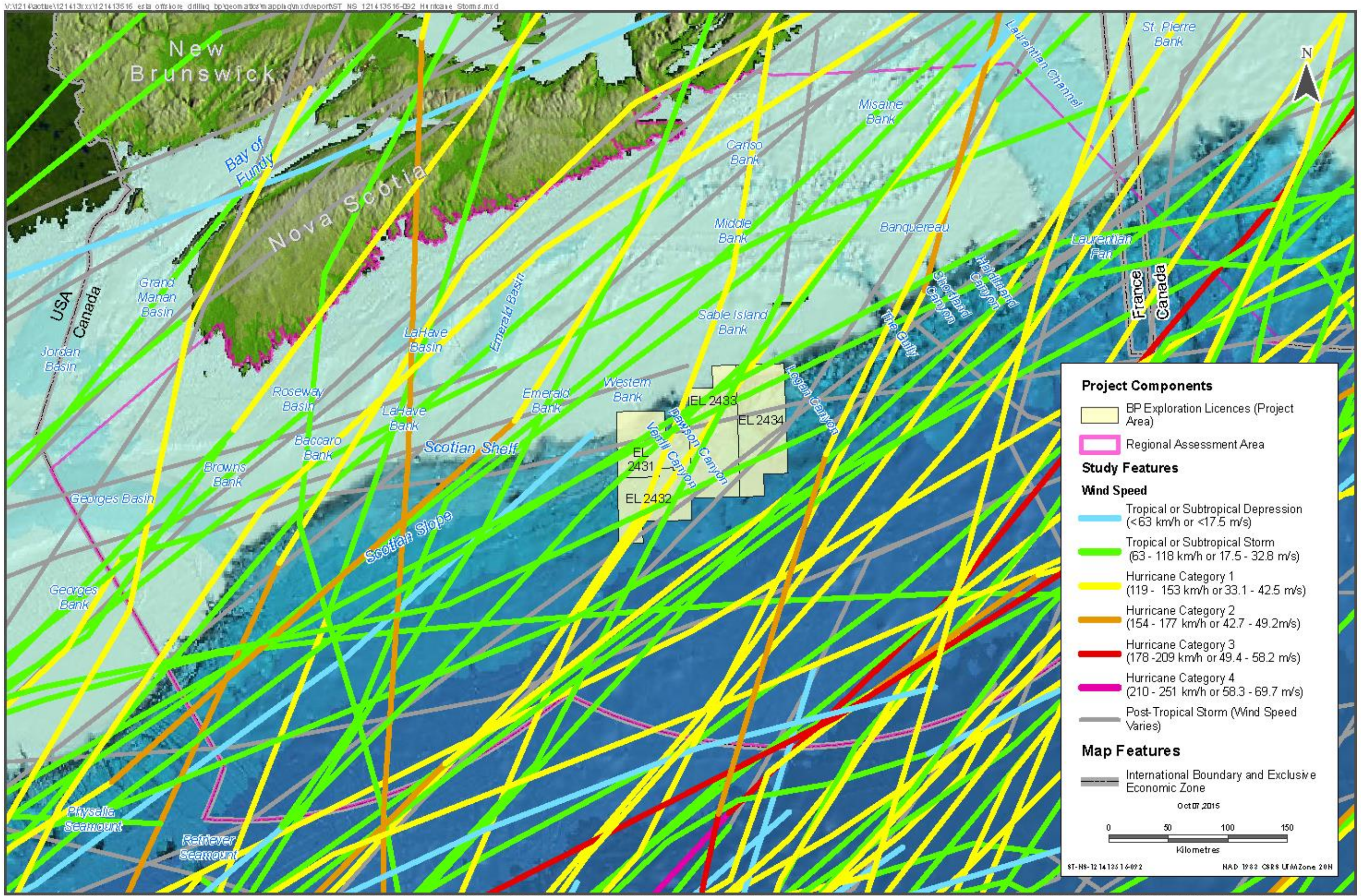


Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Natural Resources Canada. GEBCO global bathymetric grid. NCDC International Best Track Archive for Climate Stewardship (IBTrACS) Project Version 3. [Basin Data]. National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Sources: Environment Canada (2013c), NOAA (2012a, 2014)

Figure 5.1.12 Cyclones in the North Atlantic (1980–2012)

Table 5.1.14 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 22 tropical cyclones have passed through the Scotian Shelf and Slope from 2003 to 2014, with 12 (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 45 to 295 km/hour (the upper range of 295 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, in decreasing monthly frequency respectively. As tropical cyclones pass through the North Atlantic they typically lose strength as they travel over areas of cold water. As a result, wind speeds shown below in Table 5.1.14 may be significantly lower as storms pass through the Scotian Slope and Shelf.

Table 5.1.14 Tropical Cyclones on the Scotian Shelf and Slope from 2003–2014

Year	Name	Category	Time Frame	Wind Speed (km/hour)
2014	Arthur	Hurricane	July 1–5	37–157**
	Bertha*	Hurricane	August 1–6	46–130**
	Cristobal	Hurricane	August 23–29	56–139**
	Gonzalo	Hurricane	October 12–19	46–232**
2013	Gabrielle*	Tropical Storm	September 10–14	65–85
	Andrea	Tropical Storm	June 6–9	65–74
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**
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**

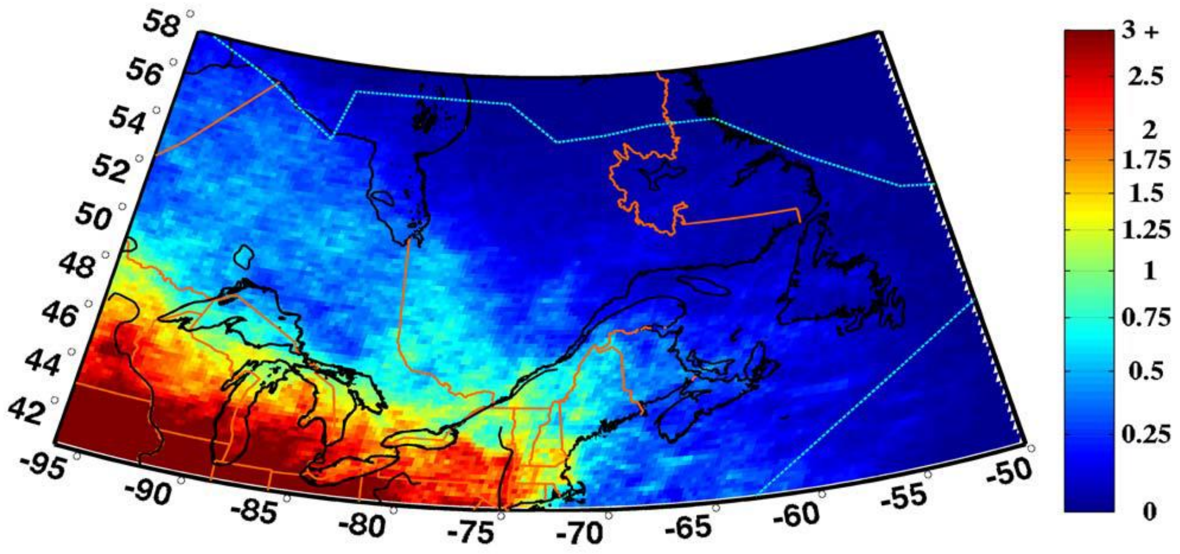
Note:
*These storms passed through the Project Area or within close proximity.
**These wind speeds may have occurred outside the Scotian Shelf and Slope region.

Sources: Environment Canada 2013c; NOAA 2014a; Berg 2015; Blake 2015; Brown 2015a, 2015b; Pasch 2015

Lightning

Lightning occurs virtually year-round over southern Nova Scotia and offshore (Burrows and Kochtubajda 2010). Winter lightning is common in this area as Arctic air masses pass over much warmer water (Lewis 2000, cited in Burrows and Kochtubajda 2010).

As shown in Figure 5.1.13, (Figure 3.b from Burrows and Kochtubajda (2010), both the Nova Scotia landmass and its offshore environs experience low average flash density although there is a subtle increase in flash density in some parts of the offshore.



Note: light blue irregular lines around the periphery are the approximate 70% detection efficiency as of 1 November 2008

Source: Burrows and Kochtubajda 2010

Figure 5.1.13 1999–2008 Average Flash Density (flash km-2 yr-1) for Eastern Canada

There are no specific statistics provided for the Project Area but it is assumed there could be increased lightning activity than that reported for land-based monitoring locations in the province as reported by the Canadian Lightning Detection Network and shown in Table 5.1.15.

Table 5.1.15 Lightning Activity in Nova Scotia as Reported by the Canadian Lightning Detection Network (1999-2013)

City	Area (km^2)	Total Lighting Strikes (1999 to 2013)	Average Number of Days with Lightning (within 25 km^2)
Yarmouth	4.32	11,015	14.3
New Glasgow	4.94	7,850	11.8
Truro	5.62	8,085	12.6
Sydney	102.72	4,610	8.9
Halifax	43.89	7,340	12.1

Source: Environment Canada 2015c

Overall, Nova Scotia and its offshore environs represent an area of very low average flash density (flashes per square kilometre per year) (Environment Canada 2015c).

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 5.1.16. Fog is most prominent from May through July and during this period, fog occurs about one-third of the time and may persist for a week without clearing (Freedman 2014).

Table 5.1.16 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 2013b

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 2013b). The number of hours with visibility less than 1 km was 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 both warmer air and sea temperatures.

5.1.3 Physical Oceanography

5.1.3.1 Bathymetry

The Project Area is located offshore of Nova Scotia on the Scotian Slope, approximately 230 to 370 km southeast of Halifax and 48 km from Sable Island. Water depths in the Project Area range from approximately 100 m to over 3,000 m. Generally speaking, 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 2,000 m (Stantec 2014b). From water depths of 2,000 to 5,000 m, the slope is more gradual in an area known as the Continental Rise. Figure 5.1.14 provides a bathymetric overview of the Project Area and the Scotian Slope. The western Scotian Shelf (west of the Project Area) has a less dynamic bathymetry and seabed with fewer canyons. Verrill Canyon extends into the Project Area whereas Dawson and Logan Canyons are immediately adjacent to the Project Area (Figure 5.1.14). The eastern Scotian Shelf (east of the Project Area) hosts a series of deepwater canyons, including the Gully and Shortland and Haldimand canyons, which originate on the outer edge of the Scotian Shelf and continue down the slope (Figure 5.1.14).

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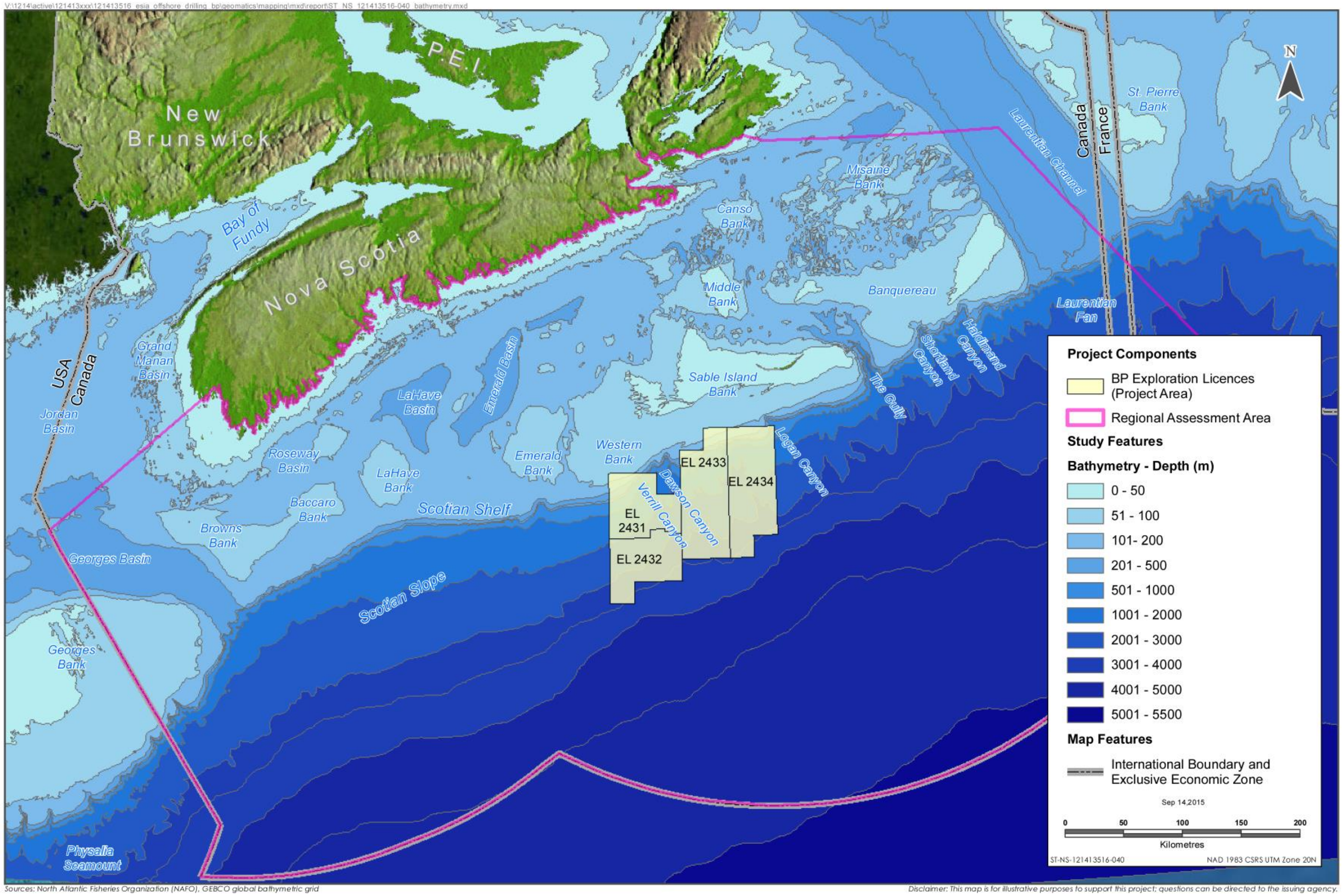

Sources: North Atlantic Fisheries Organization (NAFO), GEBCO global bathymetric grid

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.1.14 Bathymetric Overview of the Scotian Shelf and Slope

5.1.3.2 Ocean Currents

The description of ocean currents for the RAA has been adapted from the Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) which provided a general characterization of ocean currents on the Scotian Shelf and Slope.

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). Figure 5.1.15 provides an overview of currents on the Scotian Shelf and Slope.

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 to 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).

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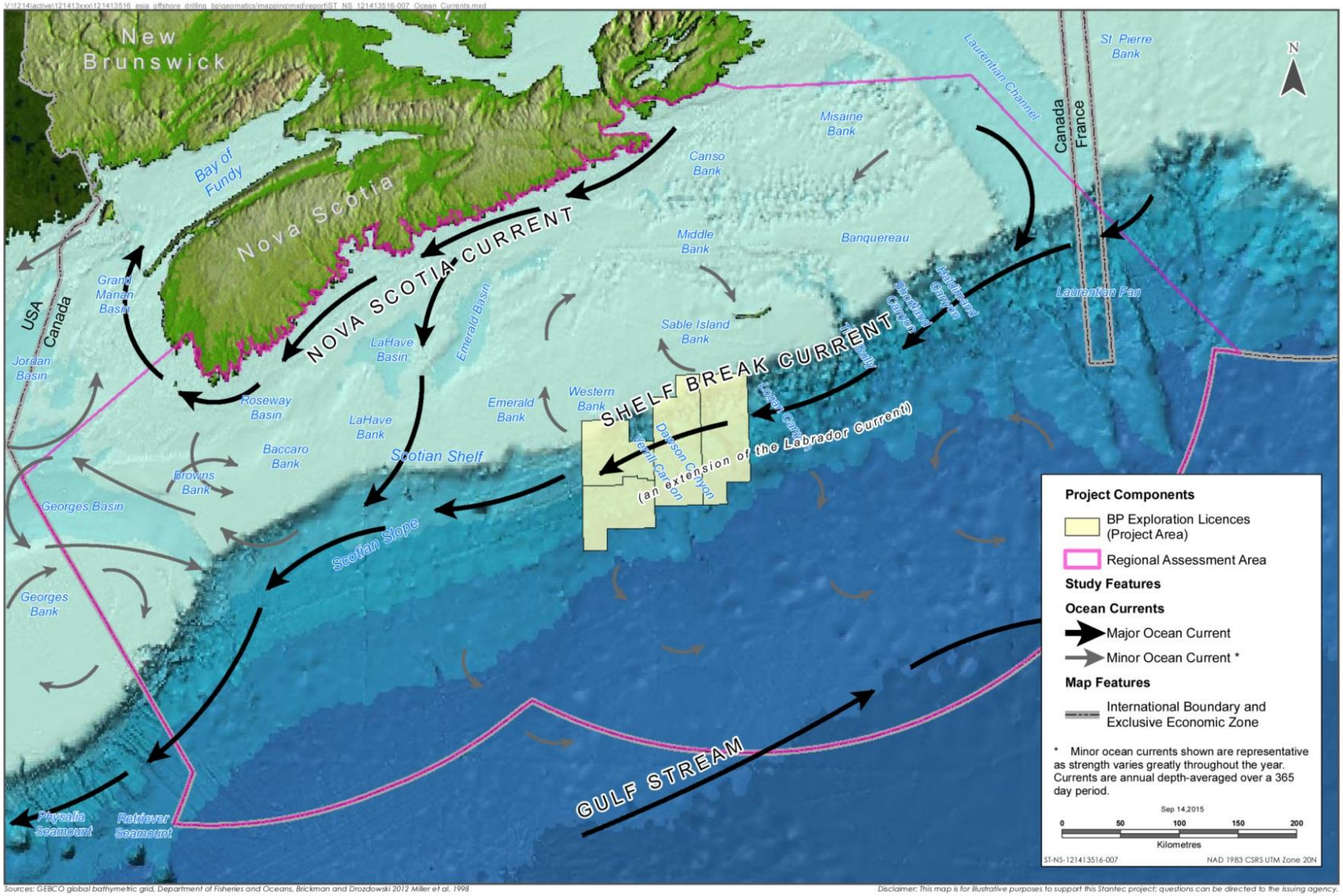


Sources: GEBCO global bathymetric grid, Department of Fisheries and Oceans, Brickman and Drozdowski 2012 Miller et al. 1998

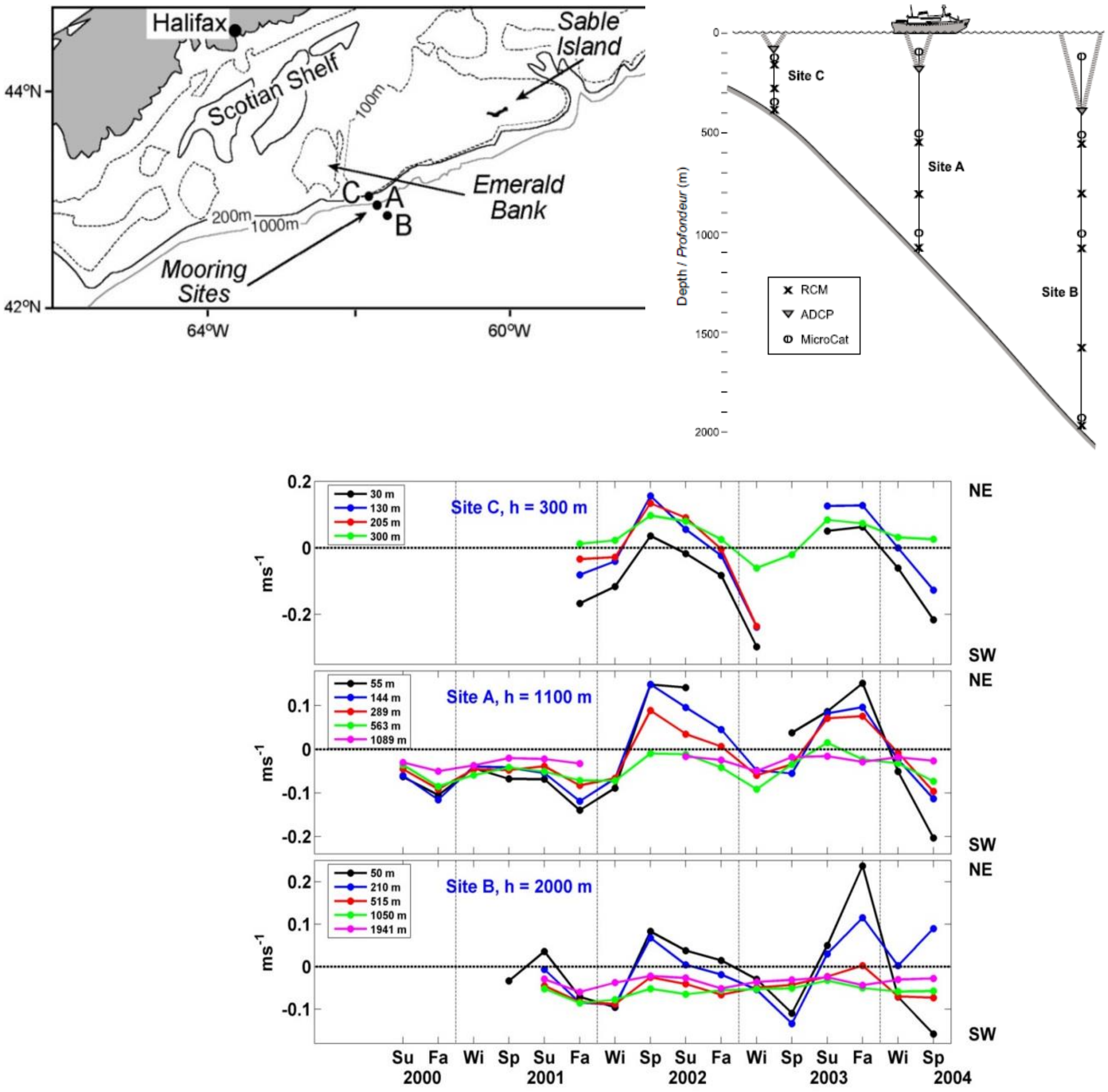
Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Figure 5.1.15 Overview of Currents

On the Western Scotian Shelf, the Nova Scotia Current flows in a southwesterly direction close to the coastline (see Figure 5.1.15). 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 to 0.3 m/s (Stantec 2014b). 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, although 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).

Bedford Institute of Oceanography (BIO) has carried out a multi-year program of moored current and hydrological measurements on the outer Halifax Line of the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) (refer to Figures 5.1.4 and 5.1.16) (Loder and Geshelin 2009). Prior to 2000, there had been limited moored measurements on the section of the Shelf edge and continental slope where the Labrador Current exists.

Figure 5.1.16 illustrates the location and depth of the mooring sites, which are situated within the western section of the Project Area and on the Halifax Line of the AZMP, and current speeds (m/s) at each mooring measured between 2000 and 2004. Overall, the current speeds throughout the water column are relatively low and in the range of 0.05 to 0.2 m/s. The predominate flow measured was towards the southwest, however, in some years the surface layer to a water depth of about 200 to 300 m flowed seasonally towards the northeast. The deeper currents below 500 m at the deeper offshore mooring sites A and B (station depths greater than 1,000 m) are generally weak and less than 0.1 m/s. In contrast to the surface layer, these deeper currents consistently flowed towards the southwest when measured between 2000 and 2004.



Source: Loder and Geshelin (2009)

Figure 5.1.16 Moored Current Measurements on the Scotian Slope (2000-2004)

From the spring of 2002 to 2004, two major events lasted longer than one season (Loder and Geshelin 2009). These long-lasting events were associated with the presence of anomalous warm slope water on the Halifax Line related to mesoscale vulnerability in the Gulf Stream. In the spring of 2002 this warm water extended to depths of 1,000 m at the offshore site B and to 300 m at all three sites. In areas of this intrusion, flow was in the northeasterly direction as compared to typical southwest flow in areas not impacted by warmer waters (Figure 5.1.16; Loder and Geshelin 2009). These findings indicate that it is clear that variability in the Gulf Stream can have large influences on equatorial transport of water on the Scotian Slope. Variability from warm water intrusions from the Gulf Stream can oppose the conventional southwest directional flow of water from the subpolar regions (Labrador Current). In such cases (*e.g.*, spring of 2002 and summer/fall of 2003) there is a net northeast transport of water (Loder and Geshelin 2009).

At the southwestern limit of the Scotian Shelf and Slope (and the RAA), 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 that 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).

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.

Submarine canyons (located along the eastern Scotian Shelf Break) produce various effects on the circulation of water in and surrounding the canyon (Moors-Murphy 2014). Upwelling and downwelling zones are known to occur in submarine canyons. There is generally a downwelling zone at the rim of the canyon on the upstream side of the canyon where water near the floor of the continental shelf flows over the canyon rim and down into the canyon. The water flowing into the canyon typically turns towards the head of the canyon until it reaches the downstream rim and is forced back up onto the shelf, creating a zone of upwelling, and sometimes an eddy (Moors-Murphy 2014). In addition to these upwelling and downwelling zones, the steep topography of the canyons has the potential to enhance internal tides or generate or amplify internal waves. These internal waves and tides can break within the canyon and create turbulence and increasing the vertical mixing of the water column (Moors-Murphy 2014).

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.

Sixty (60) years of hourly MSC50 wave hindcast data from 1954 to 2013 for Grid Point 3551 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).

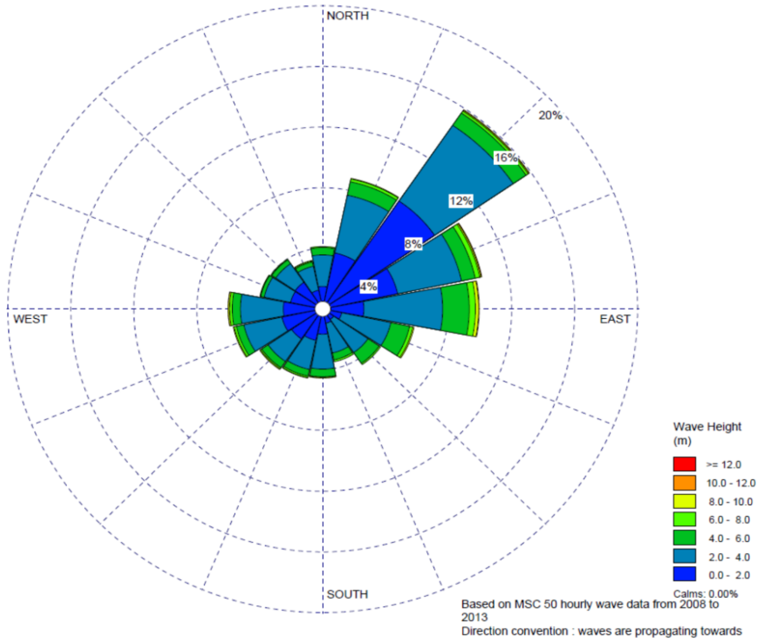
Figure 5.1.17(a) presents data on the significant wave height versus peak period. Approximately 47% of the time the significant wave heights are less than 2 m and 94% of the time the significant waves heights are less than 5.0 m. About 82% of the time wave peak periods are between 3 s and 10 s. Figure 5.1.17(b) presents the percentage of the waves falling within each range of peak wave period. Figure 5.1.17(c) illustrates the annual wave rose of the direction in which waves are prograting to for Grid Point 3551 and based on 6 years of MSC50 data from 2008 to 2013. The wave rose indicates that most of the wave energy comes from the west and southwest directions with waves propagating to the east and northeast directions. Figure 5.1.17(d) presents the wave height duration curve for Grid Point 3551. The wave height duration curve indicates the percentage of the time a given wave height was equaled or exceeded over a 60-year period from 1954 to 2013.

Monthly wave height and wave period roses are presented in Figures 5.1.18 and 5.1.19 respectively. Table 5.1.17 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 3551.

Wave Period (Sec)	Wave Height (m)																
	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	Total
3-4	0.079	0.129	0.001														0.210
4-5	0.407	1.56	0.074														2.04
5-6	1.15	8.00	0.750	0.009													9.91
6-7	2.32	10.3	6.54	0.243	0.002												19.4
7-8	0.882	8.70	7.87	2.79	0.067	0.0004											20.3
8-9	0.426	6.26	4.44	5.60	1.78	0.064	0.002	0.0002									18.6
9-10	0.343	2.40	3.27	1.98	2.54	1.09	0.084	0.004	0.0002								11.7
10-11	0.140	0.971	1.67	1.95	1.53	1.42	0.709	0.089	0.008								8.48
11-12	0.113	0.679	0.703	0.611	0.490	0.372	0.448	0.303	0.128	0.024	0.001						3.87
12-13	0.111	0.791	0.412	0.313	0.415	0.367	0.257	0.187	0.146	0.099	0.012						3.11
13-14	0.054	0.421	0.275	0.141	0.095	0.123	0.110	0.057	0.040	0.056	0.035	0.007	0.001				1.42
14-15	0.031	0.221	0.171	0.090	0.023	0.017	0.015	0.014	0.003	0.004	0.009	0.017	0.007	0.001			0.624
15-16	0.015	0.086	0.026	0.011	0.004	0.006	0.004	0.001	0.001			0.001	0.004	0.001			0.160
16-17	0.009	0.027	0.004	0.002	0.002	0.001	0.002	0.0002	0.001			0.0002		0.0004	0.0004		0.049
17-18	0.016	0.045	0.016	0.0002										0.0002	0.001	0.001	0.077
18-19	0.001	0.005															0.005
19-20	0.002	0.001															0.003
20-21	0.002	0.001															0.004
21-22		0.001															0.001
Total	**6.10**	**40.6**	**26.2**	**13.7**	**6.96**	**3.46**	**1.63**	**0.657**	**0.328**	**0.184**	**0.056**	**0.025**	**0.012**	**0.002**	**0.001**	**0.001**	**100**

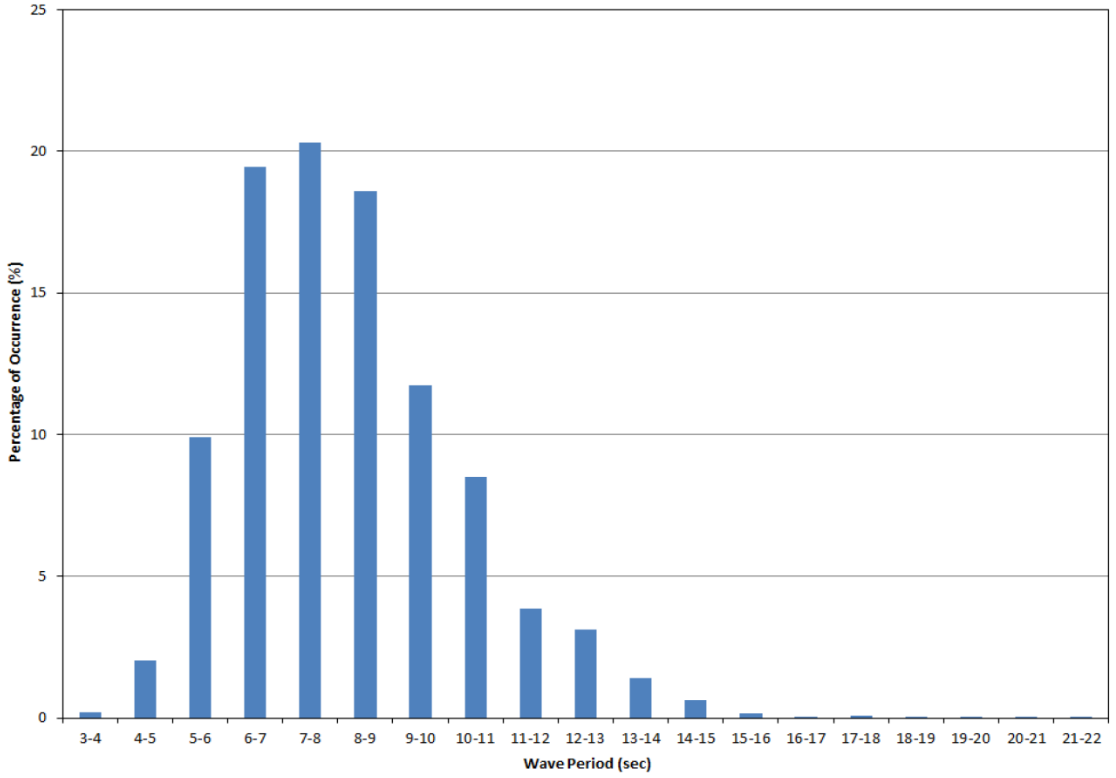
Based on 60 years of MSC 50 hourly wave data from 1954 to 2013

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

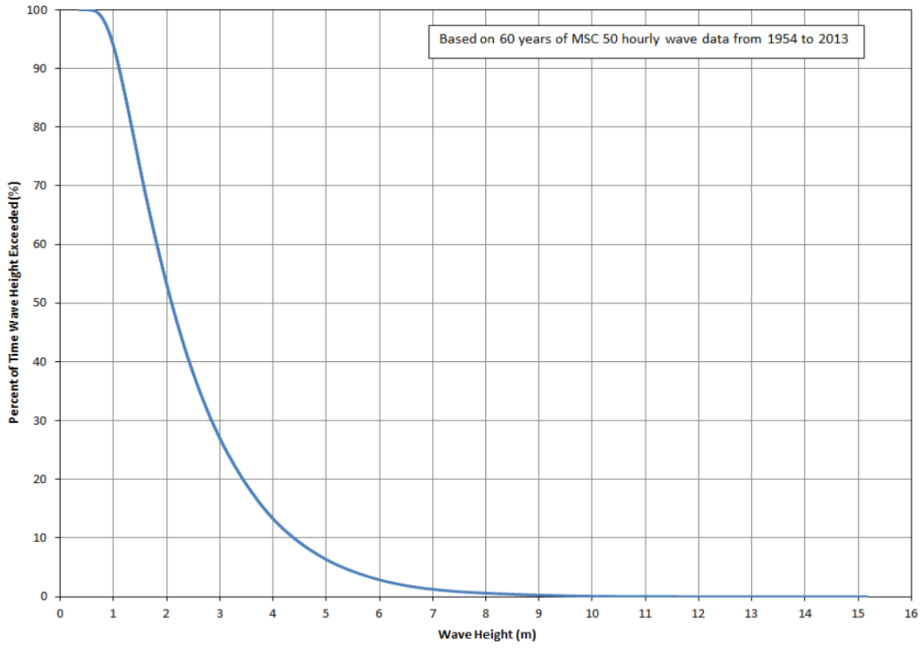


Based on MSC 50 hourly wave data from 2008 to 2013
Direction convention : waves are propagating towards

(c) Annual Wave Rose Diagram



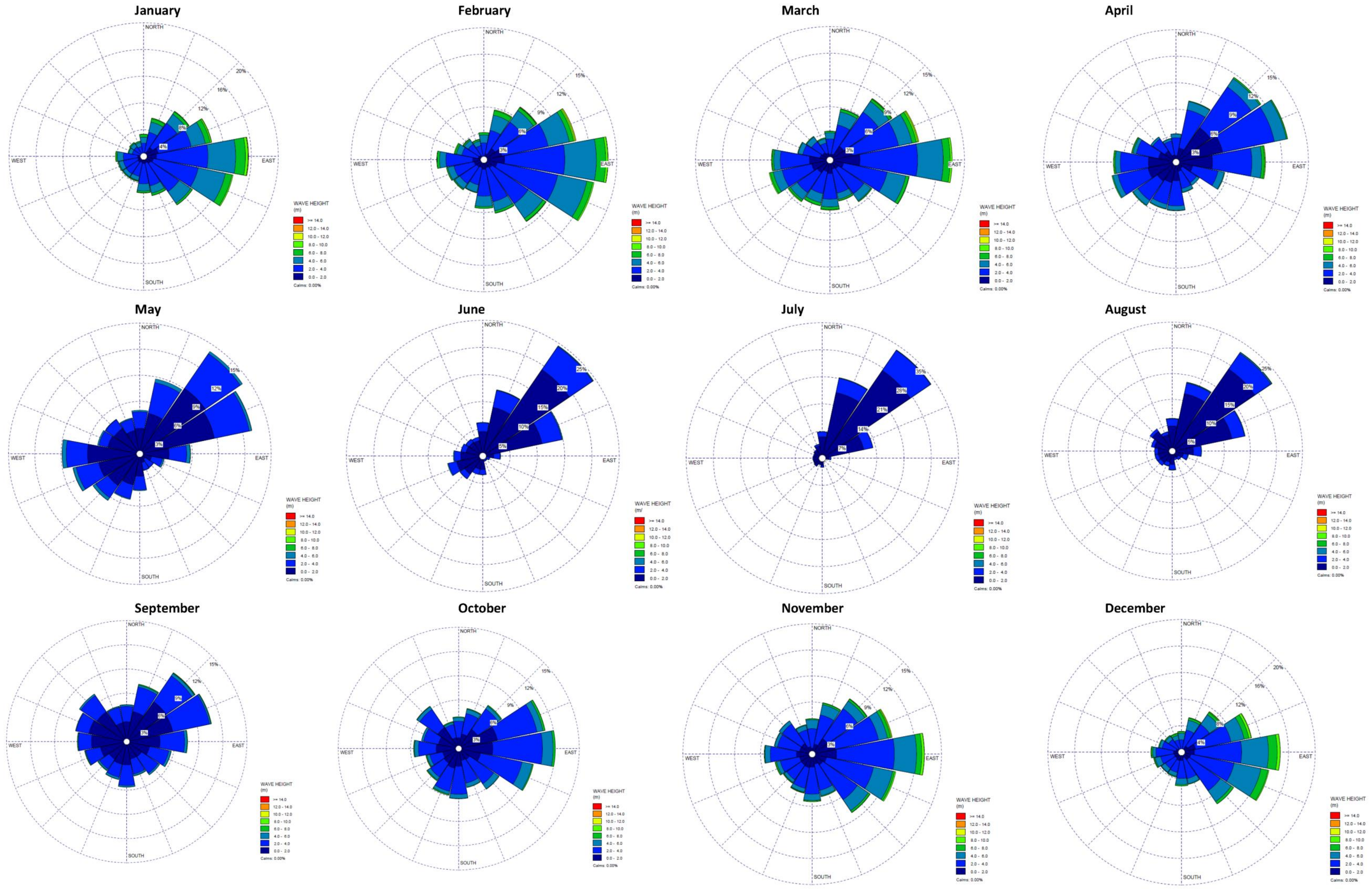
(b) Wave Period Histogram



Based on 60 years of MSC 50 hourly wave data from 1954 to 2013

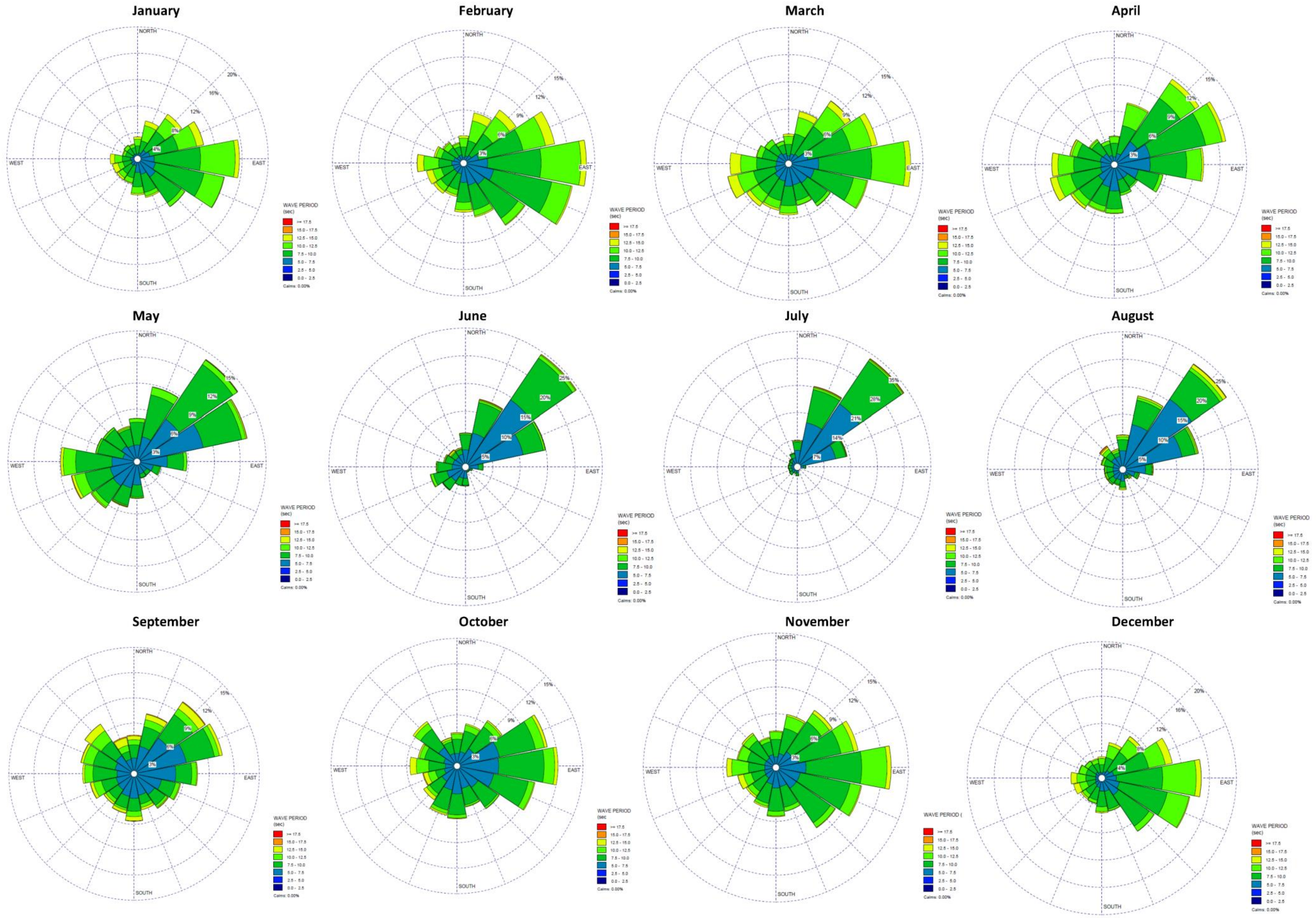
(d) Wave Height Exceedance

Figure 5.1.17 Wave Conditions at Grid Point 3551



Based on MSC50 hourly wave data from 1954 to 2013
Direction Convention: waves are propagating towards

Figure 5.1.18 Monthly Wave (Height) Rose at Grid Point 3551



Based on MSC50 hourly wave data from 1954 to 2013
Direction Convention: waves are propagating towards

Figure 5.1.19 Wave (Period) Rose Diagram at Grid Point 3551

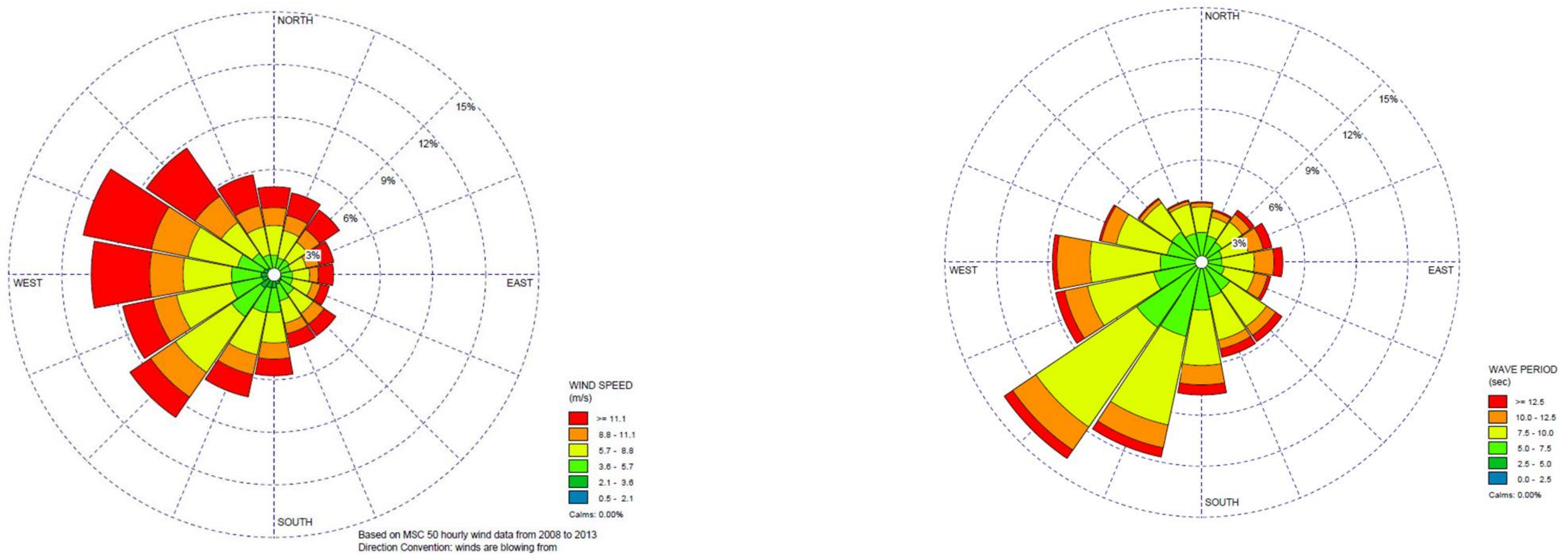
Table 5.1.17 Monthly Wave Conditions at Grid Point 3551[1]

Month	Mean Significant Wave Height (m)	Most Frequent Direction[2]	Maximum Hourly Significant Wave Height (m)
January	3.44	E	13.6
February	3.35	E	12.7
March	3.10	E	15.2
April	2.52	NE, E, SW	11.3
May	1.89	NE	6.84
June	1.64	NE	9.51
July	1.50	NE	9.0
August	1.57	NE	12.2
September	2.01	All	11.3
October	2.47	E	13.0
November	2.94	E	11.9
December	3.39	E	12.7

Note:
[1] Based on 60 years of MSC50 hourly wave data from 1954 to 2013. [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 5.1.20 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 5.1.20(a) and 5.1.20(c)). The data in Figure 5.1.19(d) 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:

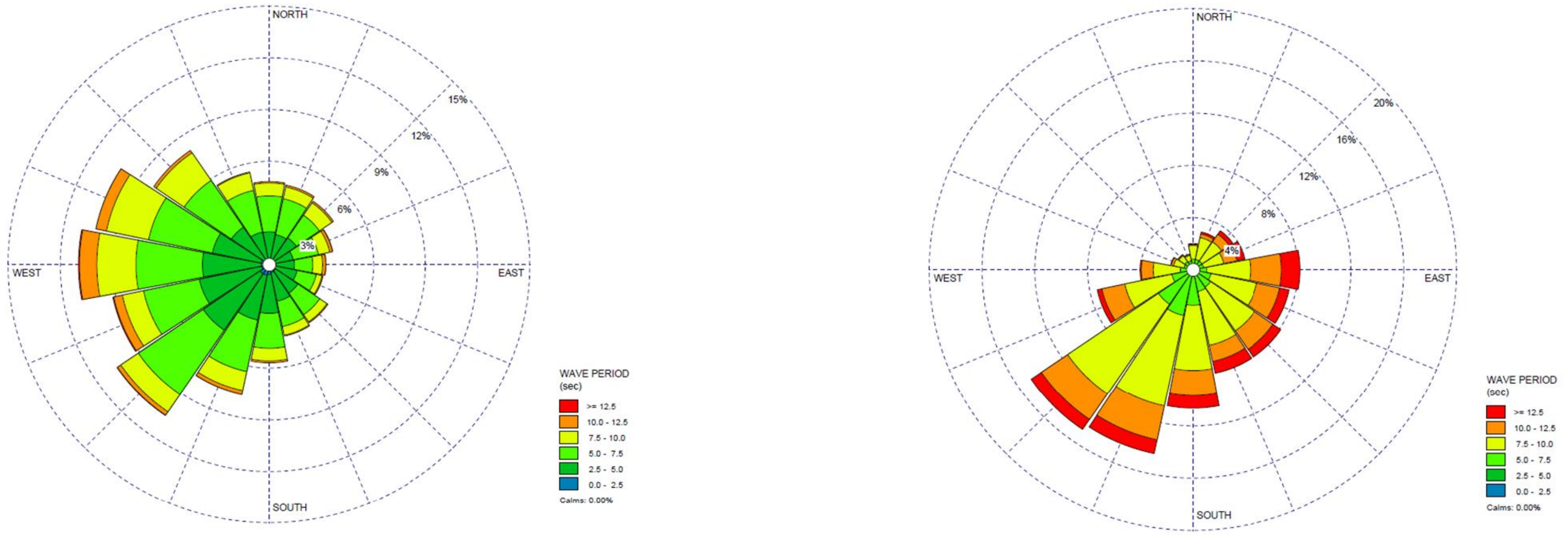
- wind waves propagating from the west, northwest and north;
- wind waves and swell waves propagating from the southwest and south; and
- swell from the southeast and east.



Based on MSC 50 hourly wind data from 2008 to 2013
Direction Convention: winds are blowing from

(a) Wind Rose

(b) Wave Period Rose (Resultant Wave)



(c) Wave Period Rose (Wind Waves)

(d) Wave Period Rose (Swell)

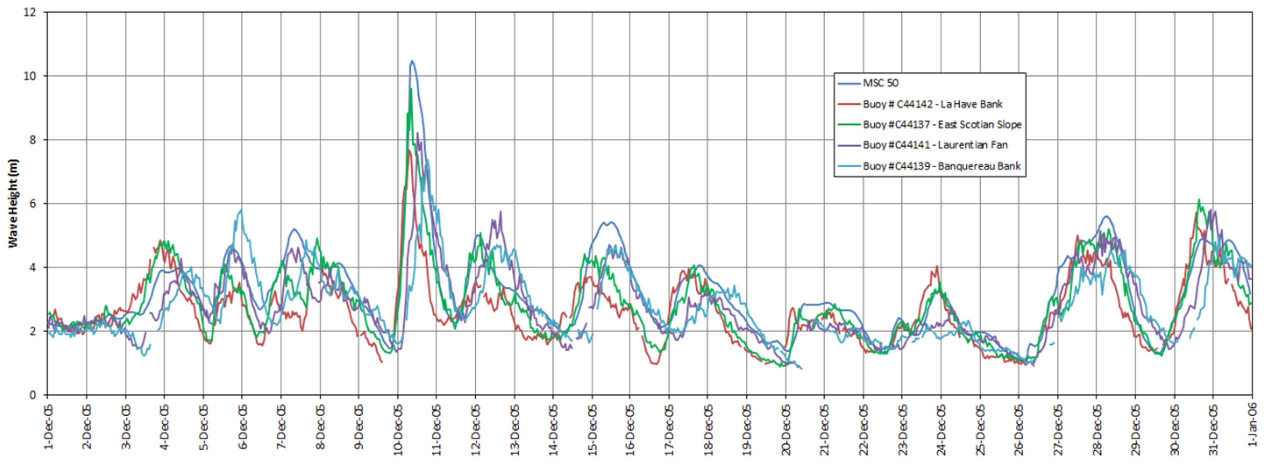
Based on MSC 50 hourly data from 2008 to 2013. Direction Convention: winds are blowing from, and waves are propagating from.

Figure 5.1.20 Comparison of Annual Wind Rose and Wave Period Roses for Wind Wave, Swell and Resultant Wave.

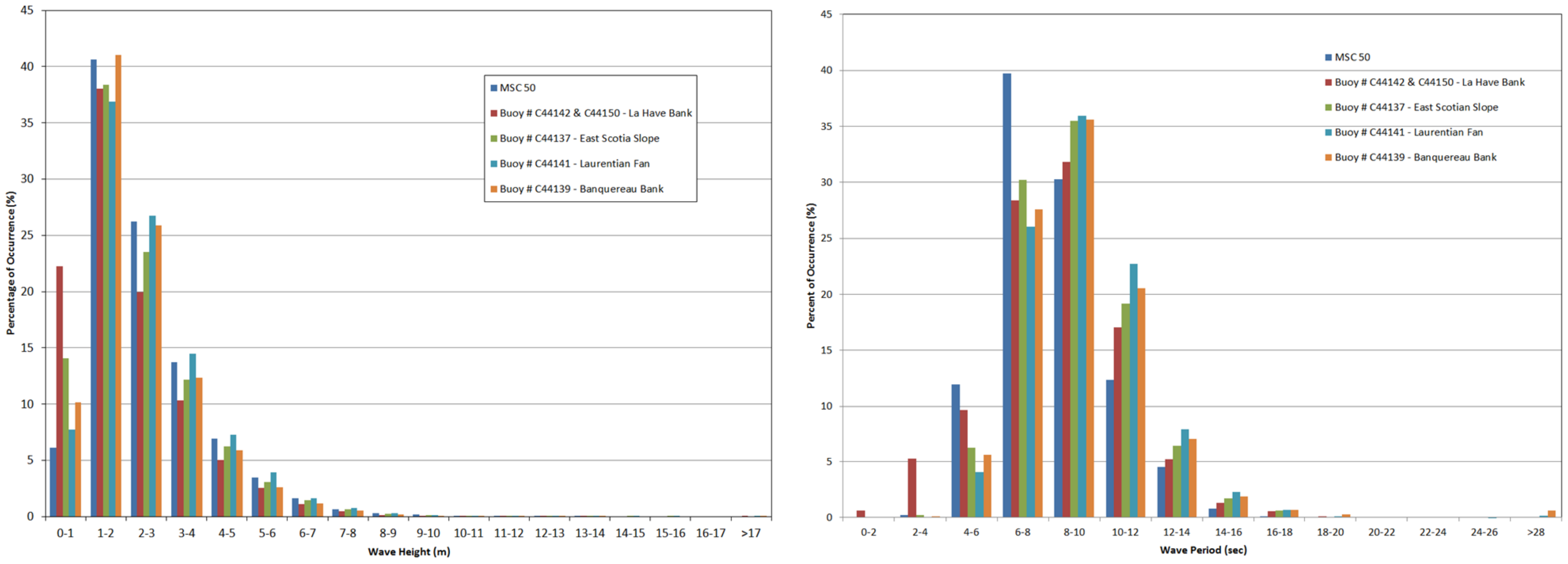
Buoy Data

Long-term buoy data at the LaHave Bank station (ID#C44142 and ID#C44150), East Scotia Slope (ID#C44137), Banquereau Bank (ID# C44139) and Laurentian Fan (ID# C44141) were used to compare to the MSC50 data. About 22% of the hourly LaHave Bank buoy data, 17% of the hourly East Scotia Slope buoy data, 8% of the hourly Banquereau Bank buoy data, and 11% of the hourly Laurentian Fan 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 5.1.21(a) compares the hourly significant wave height for December 2005 for the LaHave Bank buoy, East Scotia Slope Buoy, Banquereau Bank buoy, Laurentian Fan buoy, and MSC50 data and indicates that overall agreement is good between the buoys and the MSC50 data. Figures 5.1.21(b) and 5.1.21(c) compare the percentage of occurrence of wave height and wave period, respectively, among the buoys data and the MSC50 data. Overall, the percentages of wave height and wave period occurrences are in good agreement between the buoys data and the MSC50 data.



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



(b) Percent of Wave Height Occurrence

(c) Percent of Wave Period Occurrence

Figure 5.1.21 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 Scotia Shelf buoy, Banquereau Bank buoy, Laurentian Fan buoy and MSC 50 data are presented in Tables 5.1.18 and 5.1.19, respectively.

Table 5.1.18 Comparison of Mean Monthly Significant Wave Height at Buoy Locations

Month	Mean Significant Wave Height (m)				
	MSC50	**LaHave Bank (C 44142 & C44150)**	**East Scotian Slope (C 44137)**	**Banquereau Bank (C 44139)**	**Laurentian Fan (C44141)**
January	3.44	2.89	3.20	3.18	3.48
February	3.35	2.96	3.27	3.23	3.43
March	3.10	2.63	2.95	2.80	3.07
April	2.52	2.19	2.30	2.23	2.56
May	1.89	1.57	1.89	1.77	1.95
June	1.64	1.33	1.54	1.55	1.68
July	1.50	1.19	1.46	1.40	1.55
August	1.57	1.18	1.47	1.53	1.58
September	2.01	1.50	1.78	1.83	1.94
October	2.47	2.06	2.37	2.42	2.54
November	2.94	2.35	2.76	2.64	2.95
December	3.39	2.83	3.31	3.03	3.52
Annual	**2.48**	**2.03**	**2.35**	**2.31**	**2.52**

Table 5.1.19 Comparison of Maximum Significant Wave Height at Buoy Locations

Month	Maximum Significant Wave Height (m)				
	MSC50	**LaHave Bank (C 44142 & C44150)**	**East Scotian Slope (C 44137)**	**Banqureau Bank (C 44139)**	**Laurentian Fan (C44141)**
January	13.6	12.6	10.6	10.1	12.7
February	12.7	10.4	11.8	11.0	12.7
March	15.2	10.7	16.2	14.0	15.9
April	11.3	8.6	8.7	7.56	13.9
May	6.8	7.2	7.1	6.6	8.0
June	9.5	6.9	11.1	9.8	11.0
July	9.0	9.0	6.2	4.5	6.2
August	12.2	13.4	14.1	10.4	9.4
September	11.3	13.0	11.5	9.9	13.6

Table 5.1.19 Comparison of Maximum Significant Wave Height at Buoy Locations

Month	Maximum Significant Wave Height (m)				
	MSC50	LaHave Bank (C 44142 & C44150)	East Scotian Slope (C 44137)	Banqureau Bank (C 44139)	Laurentian Fan (C44141)
October	13.0	8.8	14.1	11.8	15.0
November	11.9	9.8	13.4	9.4	11.0
December	12.7	13.6	13.4	12.8	12.8
Annual	**15.2**	**13.6**	**16.2**	**14.0**	**15.9**

Mean and maximum monthly significant wave heights for wave data obtained from the offshore platforms and wells (refer to Figure 5.1.4 for the location of platforms and wells) are presented in Tables 5.1.20 and 5.1.21. 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 5.1.20 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

Note:
^{P} based on partial data.

Table 5.1.21 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
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

Note:
^{P} based on partial data.

Extreme Wave Conditions

Extremal analysis data were obtained for the Grid Point 3551 from the Oceanweather website (http://www.oceanweather.net/MSC50WaveAtlas/Extremes/MSC50_M6_Index.htm). Extremal analysis was carried out using 59 years of hourly wave data from 1954 to 2012 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 5.1.22 provides extreme wave conditions for Grid Point 3551 for various return periods. Predicted range of extreme wave conditions are presented in Table 5.1.23 for various probability distributions.

The largest extreme waves are propagating towards the east and northeast directions. Significant wave heights are 9.8 m and 13.0 m for the 2- and 100-year return periods, respectively, for the east waves. Significant wave heights are 9.6 m and 14.5 m for the 2- and 100-year return periods, respectively, for the northeast waves. Wave periods ranged from 10.5 s to 15.5 s for extreme wave conditions (Table 5.1.22).

Table 5.1.22 Extreme Wave Conditions at Grid Point 3551[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	10.5	12.6	6.8	11.3	12.7	7.1	11.3	13.2	7.3	11.8	13.2	8.4	12.9	15.1	9.6	13.3	17.4	9.8	12.9	17.8	7.6	11.2	14.0
5	8.2	11.3	15.1	8.5	12.3	16.0	8.8	12.3	16.2	8.6	12.6	15.6	9.6	13.5	17.1	11.1	14.1	20.2	10.9	13.6	19.9	8.6	11.6	15.8
10	8.9	11.7	16.5	9.6	12.9	18.0	9.7	12.9	18.0	9.5	13.0	17.2	10.3	13.4	18.5	12.1	14.5	21.9	11.6	14.0	21.1	9.2	11.8	16.8
25	9.7	12.1	18.0	10.8	13.5	20.3	10.8	13.5	20.0	10.5	13.6	19.1	11.3	14.3	20.1	13.3	15.0	23.8	12.2	14.4	22.3	9.8	11.9	17.9
50	10.2	12.4	19.0	11.7	13.9	21.8	11.5	13.9	21.3	11.3	14.0	20.6	12.0	14.5	21.3	14.0	15.3	25.1	12.6	14.6	23.0	10.2	12.1	18.6
100	10.6	12.6	19.9	12.5	14.3	23.3	12.2	14.3	22.5	12.1	14.4	22.1	12.6	14.8	22.4	14.5	15.5	26.1	13.0	14.8	23.6	10.6	12.2	19.2

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

Table 5.1.23 Comparison of Extreme Wave Conditions at Grid Point 3351 for Various Probability Distributions – All Directions

Probability Distribution	Generalized Extreme Value			Gumbel			Weibull			Generalized Pareto			Range of Predicted Extreme Wave Conditions		
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}
Year	m	sec	m	m	sec	m	m	sec	m	m	sec	m	m	sec	m
2	10.5	13.5	19.0	10.8	13.6	19.6	10.7	13.5	19.6	10.9	13.7	20.2	10.5-10.9	13.5-13.7	19.0-20.2
5	11.8	14.3	21.2	11.9	14.4	21.4	11.7	14.3	21.3	11.9	14.2	21.9	11.7-11.9	14.2-14.4	21.2-21.9
10	12.6	14.8	22.6	12.5	14.9	22.6	12.4	14.8	22.4	12.5	14.4	22.9	12.4-12.6	14.4-14.9	22.4-22.9
25	13.4	15.3	24.1	13.4	15.5	24.1	13.2	15.4	23.7	13.3	14.8	24.1	13.2-13.4	14.8-15.5	23.7-24.1
50	14.0	15.7	25.1	14.0	15.9	25.2	13.8	15.8	24.7	13.7	15.0	24.8	13.7-14.0	15.0-15.9	24.7-25.2
100	14.5	16.0	26.1	14.7	16.4	26.4	14.4	16.2	25.6	14.2	15.1	25.4	14.2-14.7	15.1-16.4	25.4-26.4

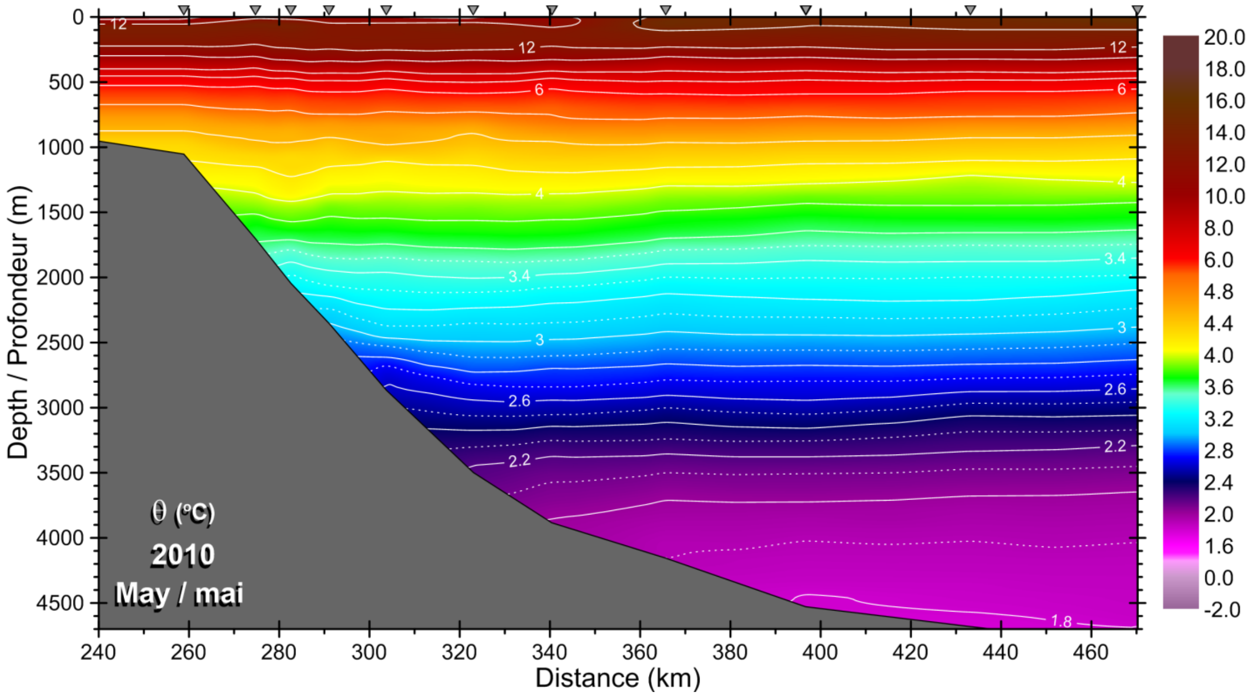
5.1.3.4 Water Mass Characteristics

Physical, chemical and biological oceanographic conditions of the continental slope and deeper waters of the Northwest Atlantic are characterized using data collected by the AZOMP (DFO 2013a). 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 AZMP which run through the Project Area (refer to Figure 5.1.4). Data on water temperature, salinity, and density profiles collected through AZOMP are provided below. Information on other water quality parameters such as pH and turbidity are drawn from the Deep Panuke Comprehensive Study Report (Encana 2002) as these parameters are not monitored through AZOMP.

Temperature

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.

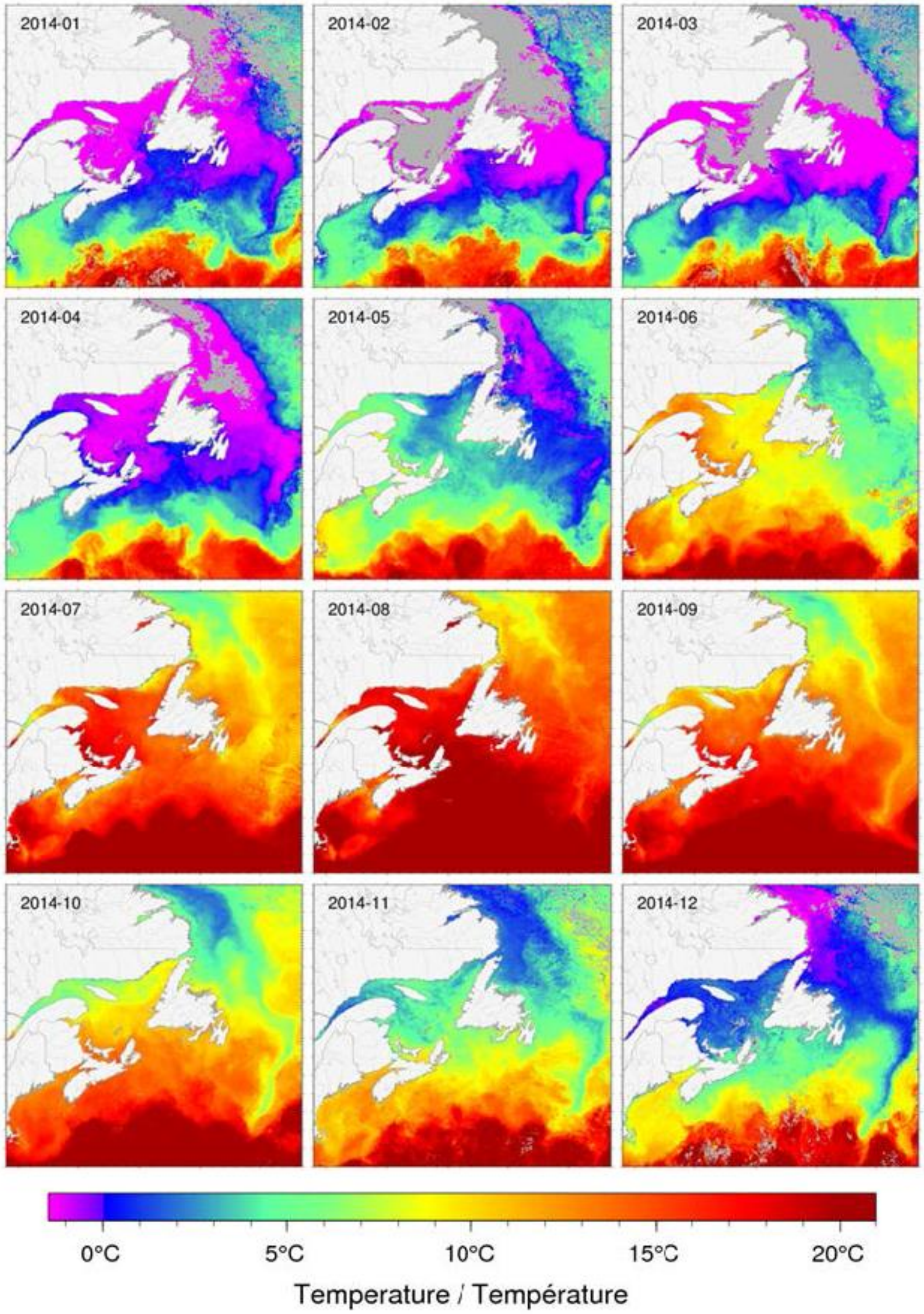
Over the Scotian Slope, water temperatures are the highest in the surface waters, with the coldest waters being found in the deep abyssal depths (DFO 2013a). This temperature profile is provided in Figure 5.1.22.



Source: DFO 2013a

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

In 2014, the annual average temperatures for the water depths 0 to 50 m measured at the high frequency sampling sites of the AZMP were above normal. The past decade has seen a further increase in water temperatures, with record sea surface temperatures seen in 2012, and have generally remained above normal in 2014 (DFO 2015b). Refer to Figure 5.1.23 below for average monthly sea surface temperatures on the Scotian Shelf and Slope in 2014.

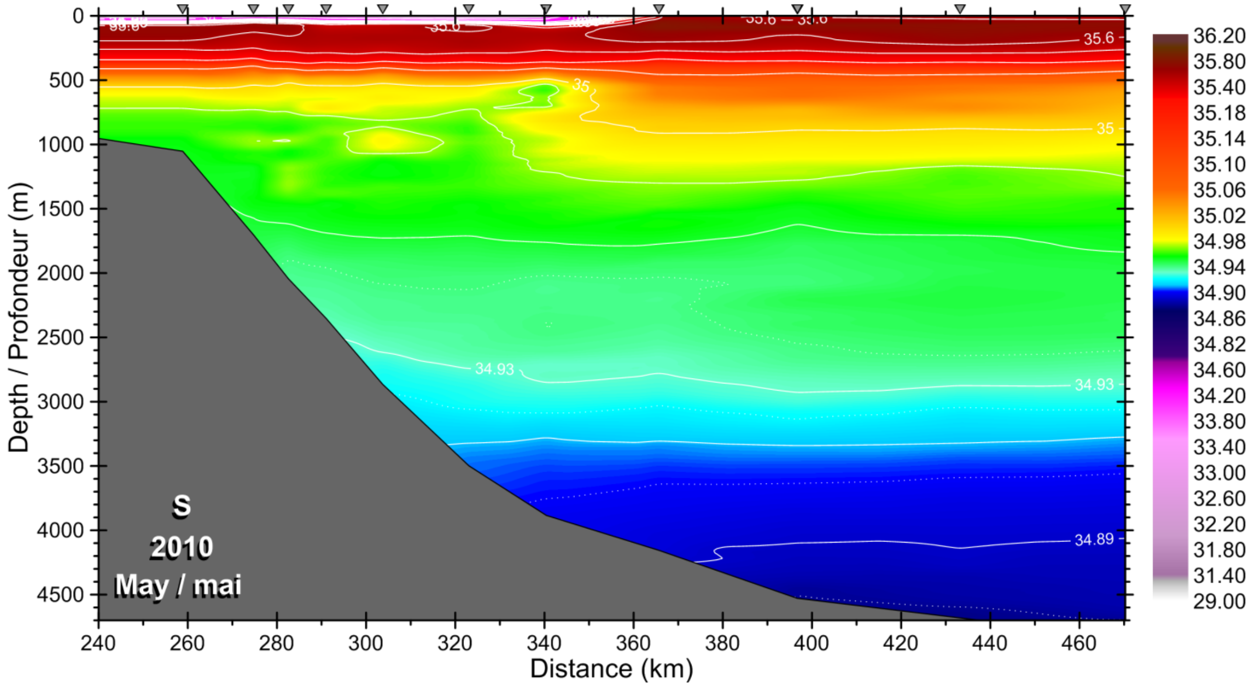


Source: DFO 2015b

Figure 5.1.23 Sea-Surface Temperature Monthly Average for 2014 in the Atlantic Zone

Salinity

Salinity influences the presence of marine life both directly through salinity preferences and needs of differing species and indirectly through its effect on density and stratification, which affects the growth of phytoplankton and thus primary production (Breeze *et al.* 2002). The Labrador Current and Gulf Stream are both more saline (34 to 36 practical salinity unit (psu)) than the Shelf Current (31 to 33 psu) (refer to Figure 5.1.15 for location of currents). The surface waters of the Scotian Slope are relatively fresh out to the area where the Gulf Stream and Labrador Current approach from offshore (DFO 2013a). Labrador Sea Water lies beneath the Slope Water at intermediate depths, with Denmark Strait Overflow water lying along the bottom beneath the 3,000 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). Labrador Sea Water as well as Denmark Strait Overflow Water comprise components of the NADW. The salinity profile collected by DFO during May 2010 can be seen in Figure 5.1.24. The profile to the left of Figure 5.1.24 depicts the less saline surface water layer (0 to 100 m depth) 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.

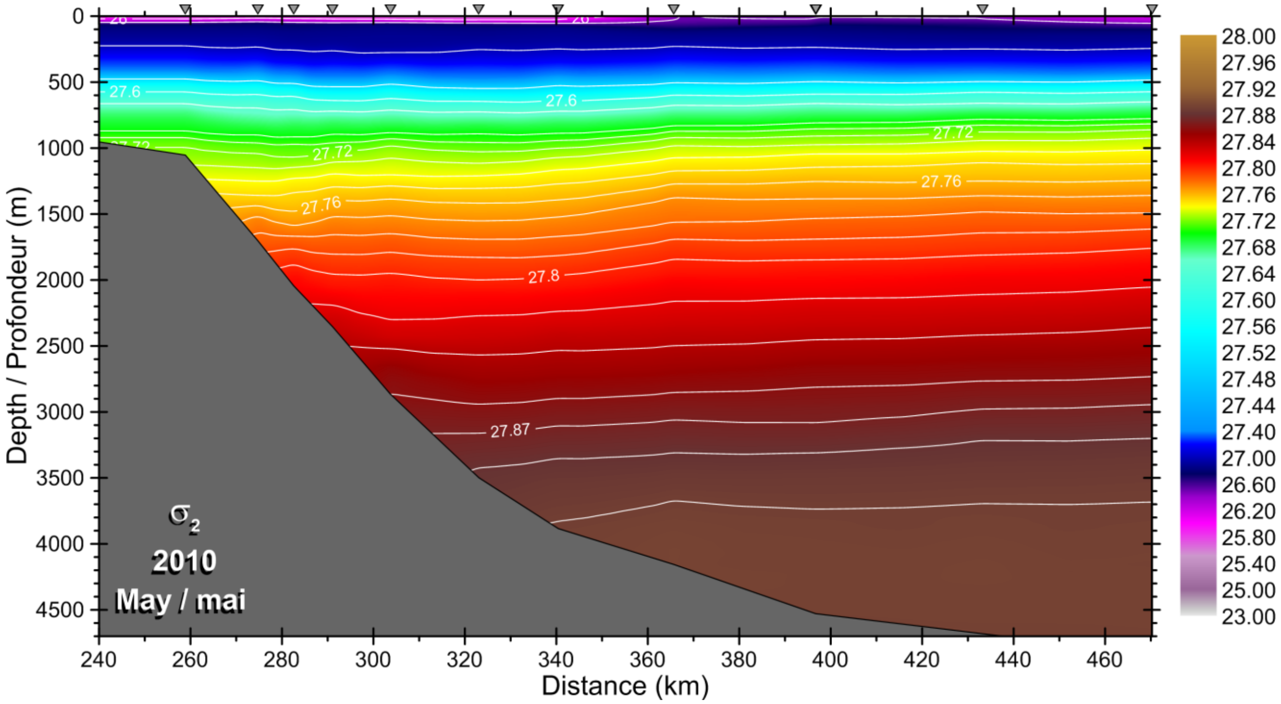


Source: DFO 2013a

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

Density

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 to 50 m stratification index increased during the 1990s and from the mid to late 1990s was at its 50-year maximum on record. Since 1948, there has been a consistent increase in the mean stratification on the Scotian Shelf. This has resulted in a change in the 0 to 50 m density difference of 0.37 kg/m^3 over 50 years (DFO 2015b). 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 5.1.25 depicts the density profile along the Halifax Extended Line of the Scotian Slope during May of 2010, clearly depicting increasing density with depth.

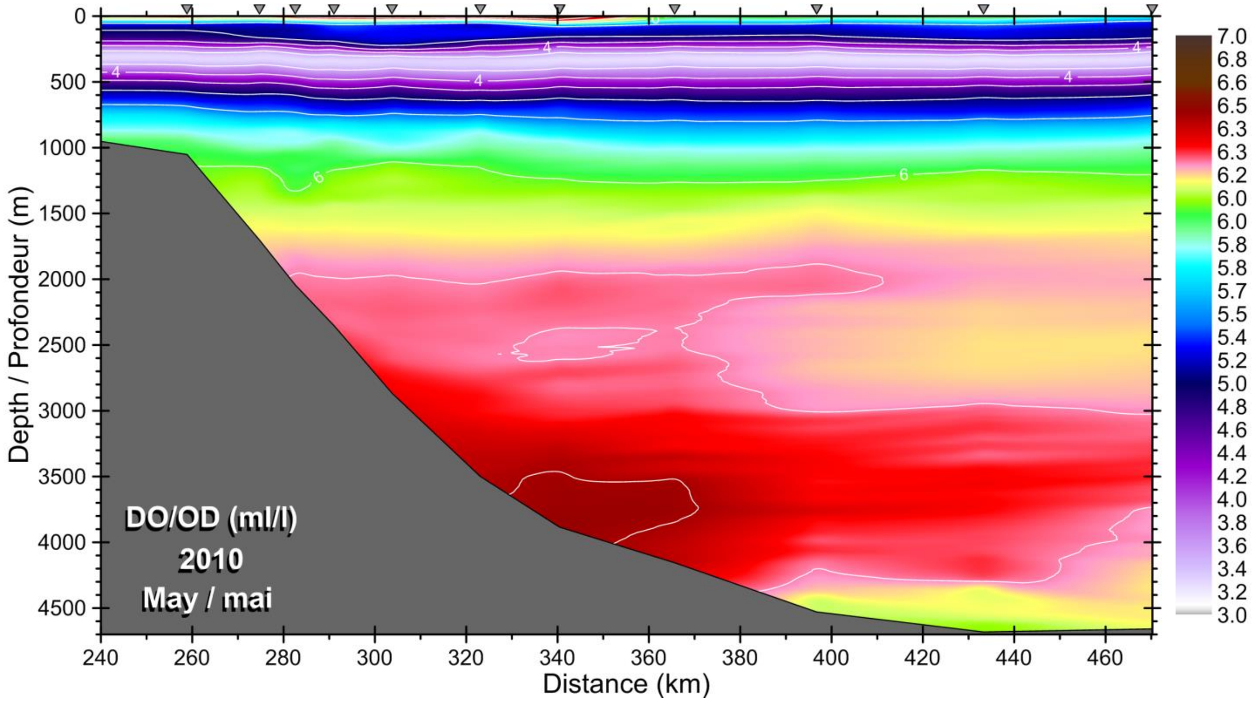


Source: DFO 2013a

Figure 5.1.25 Density Profile along the Extended Halifax Line on the Scotian Slope (May 2010)

Dissolved Oxygen

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 5.1.26 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 4,500 m and begins to decrease again after this depth is reached.



Source: DFO 2013a

Figure 5.1.26 Dissolved Oxygen along the Extended Halifax Line on the Scotian Slope (May 2010)

pH

Data on the pH of waters measured from several areas on the Scotian Shelf and over several decades since the 1930s indicate a declining trend in the pH (*i.e.*, increase in acidity) by about 0.1 to 0.2 units (DFO 2009a). This declining trend is slightly steeper than the average global ocean decrease observed for pH over the same time period (DFO 2009a; Curran and Azetsu-Scott 2013), indicating the occurrence of ocean acidification. Thomas (2015) conducted measurements using seasonal shipboard sampling and from a moored instrument on the Scotian Shelf. He noted that the regional mean surface water pH for the Scotian Shelf is roughly 7.8 in

April and increases to greater than 8.0 in September, with subsurface pH approximately 7.6 throughout the region and which indicated a seasonal decrease due to the respiration of organic matter at depth. Based on data reported in the Deep Panuke Comprehensive Study Report (CSR) (Encana 2002), measured pH values in surface waters on the Scotian Shelf ranged from 8.05 to 8.11, with intermediate and bottom waters ranging from 7.89 to 8.03. It is reasonable to assume that pH values in the Project Area would be similar.

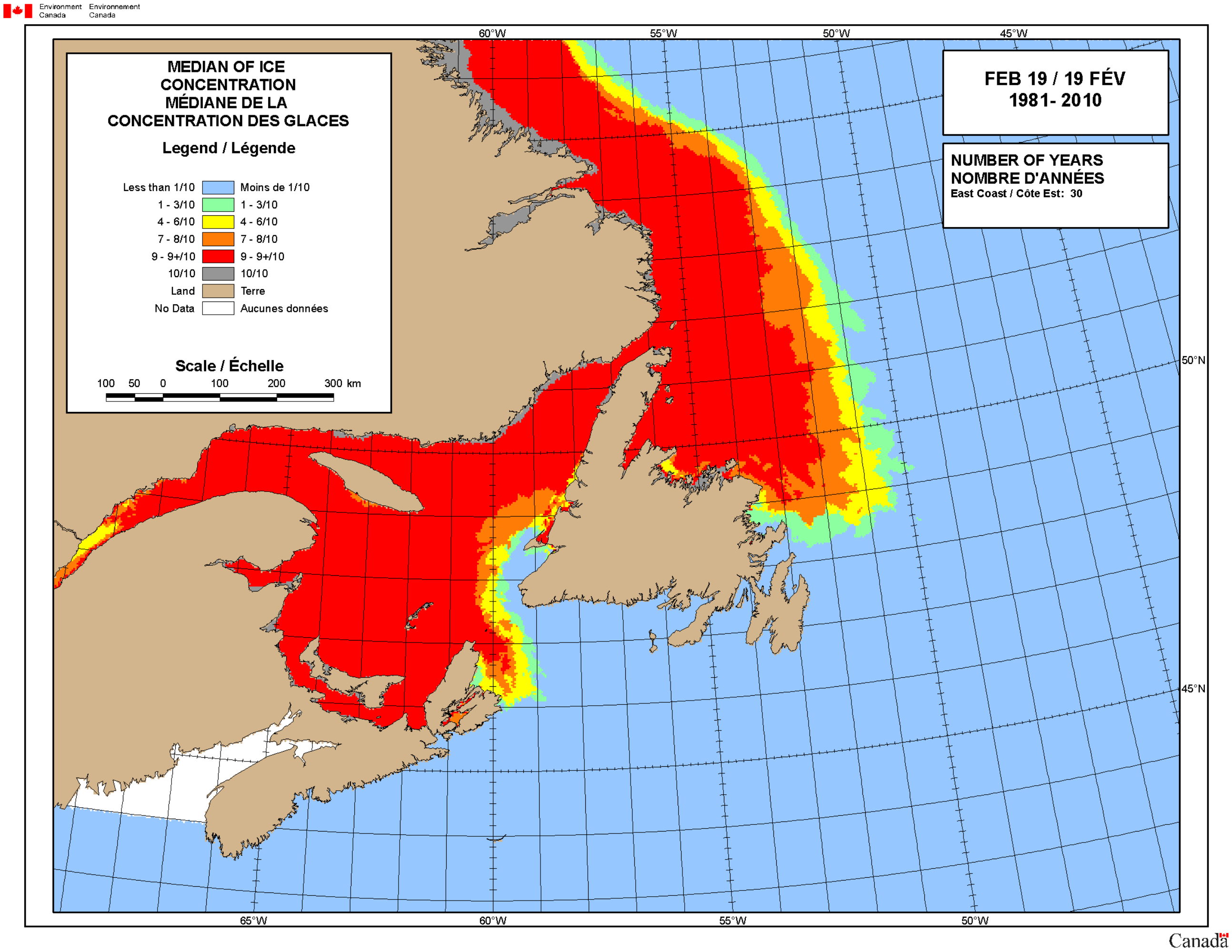
Turbidity

The Deep Panuke CSR recognized a paucity of data on suspended particulate matter (SPM) in the region, referencing data collected in 1970 on Emerald Bank. These data indicated a variation of 5.5 mgl/L at the surface, increasing to 10.1 mg/L at 20 m and then decreasing to 4.0 mg/L below this depth (Encana 2002). It is expected that SPM values in the Project Area would be comparable but lower than those measured in the shallow waters on the Bank. However, it is likely that SPM may be higher over canyons because of the higher fluxes of resuspended sediment than on adjacent shelf or slope (Walcoff and Associates 1989).

5.1.3.5 Sea Ice and Icebergs

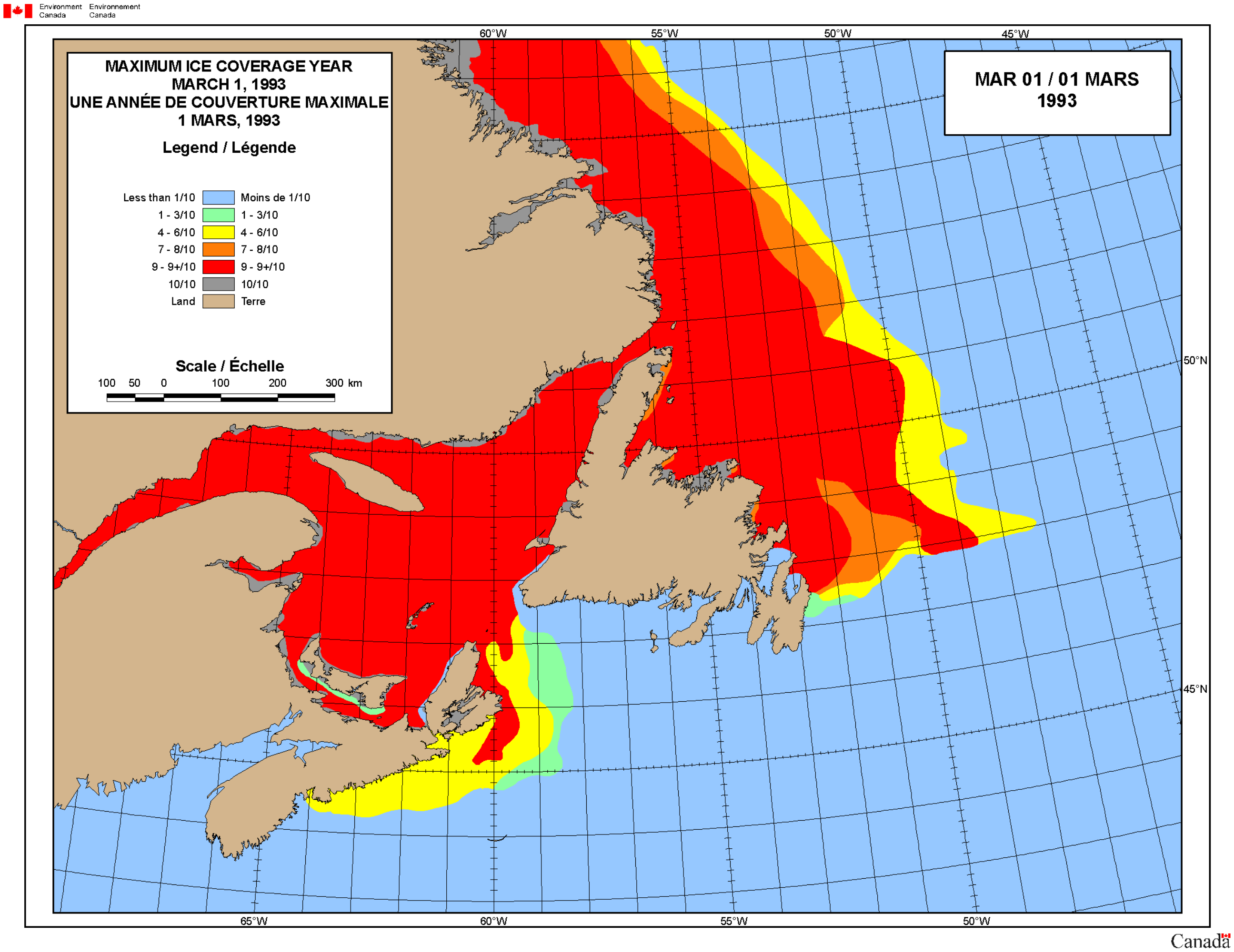
Sea ice and icebergs are very rare in the Nova Scotia offshore environment (Worcester and Parker 2010). Sea ice is generally transported out of the Gulf of St. Lawrence through the Laurentian Channel and pushed out to the Scotian Shelf by northwesterly winds and ocean currents. Generally, sea ice will 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 5.1.27 illustrates the maximum extent of median sea ice concentration from 1981 to 2010. The maximum extent of ice coverage that occurred on the east coast from 1981 to 2010 was observed on March 1, 1993 and which is shown in Figure 5.1.28.

For the past few decades ice volumes on the Scotian Shelf, as well as the Newfoundland and Labrador Shelf, and the Gulf of St. Lawrence, have generally been lower than normal levels. As shown in Figures 5.1.27 taken from the Sea Ice Climatic Atlas for the East Coast (1981-2010), sea ice is rarely observed on the Scotian Shelf. In the winter 2014 to 2015, sea ice was exported to the Scotian Shelf for the first time since 2009 (DFO 2015b) and which is presented in Figure 5.1.29.



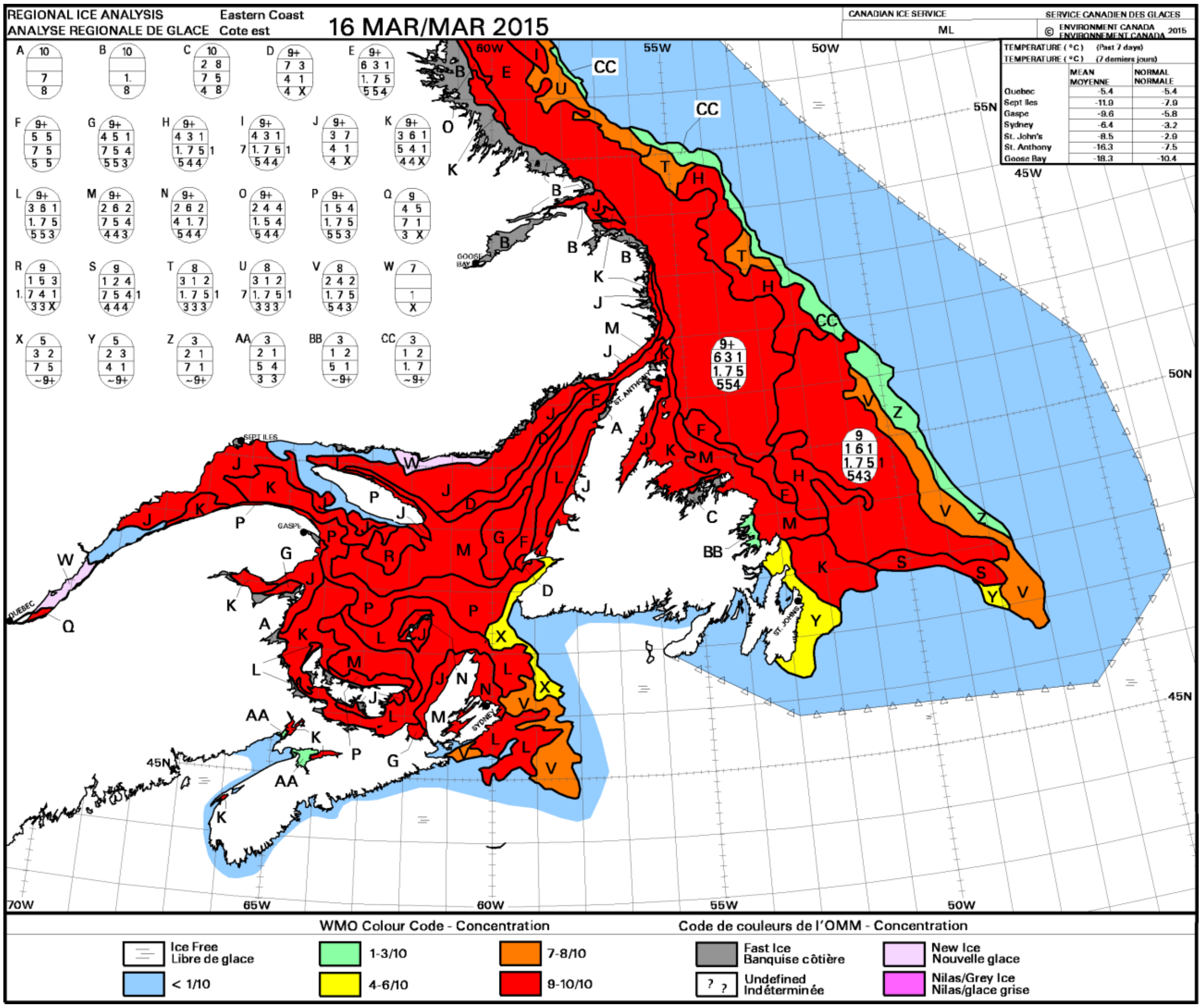
Source: Environment Canada 2012b

Figure 5.1.27 Maximum Extent of Median Sea Ice Concentration 1981–2010



Source: Environment Canada 2012b

Figure 5.1.28 Maximum Ice Coverage Observed on March 3, 1993 for the Period1981–2010.



Source: Environment Canada 2015e

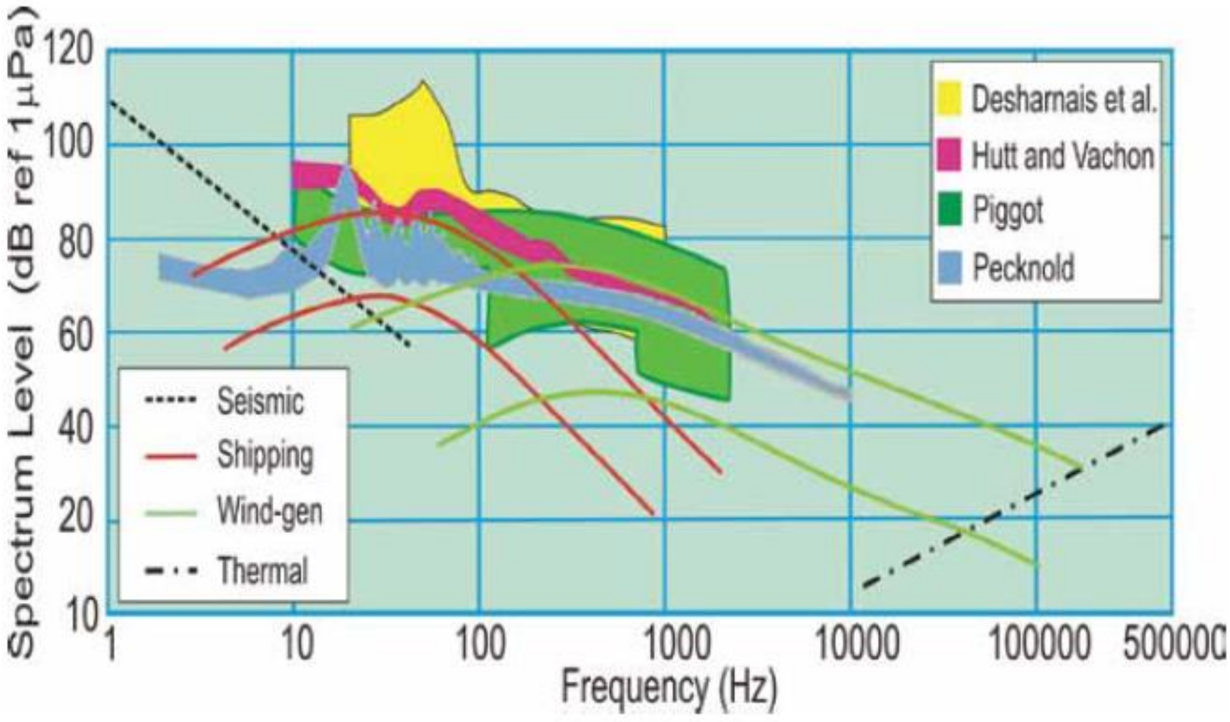
Figure 5.1.29 Sea Ice on the Eastern Scotian Shelf in March 2015

5.1.3.6 Ocean Sound

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" (NRC 2003). Ambient noise 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) contributing to the ambient noise in the area on a constant and intermittent basis depending on the sound source (Walmsley and Theriault 2011). On the Scotian Shelf, shipping is the major and consistent contributor to low-frequency ambient noise. The ocean is a naturally noisy environment with ambient noise escalating as the wind and sea state rise.

Although there has not been a formal long-term monitoring program of ambient noise on the Scotian Shelf, several studies over the last 50 years 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 indicate considerable spatial and temporal variation in ambient noise levels. Wind and wave generated sound is generally higher than predicted for average sea states. The studies have also shown that at frequencies dominated by shipping sound (10 to 100 Hz), ambient noise levels are up to 40 dB re 1 µPa higher than sound levels generated by high winds (Walmsley and Theriault 2011). Figure 5.1.30 presents spectrum-frequency profiles for datasets showing ambient noise on the Scotian Shelf.



Source: Walmsley and Theriault 2011

Figure 5.1.30 Spectrum-frequency Profiles for Datasets, from Various Studies, Showing Ambient Noise 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). Sound levels 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

This section of the EIS describes the existing biological environment in the RAA, as required by the EIS Guidelines, including plankton, benthic communities, marine fish, marine mammals, sea turtles, migratory birds, and Special Areas. Species at Risk (SAR) and Species of Conservation Concern (SOCC) are discussed within each biological group, but are also summarized in a stand-alone section (Section 5.2.9).

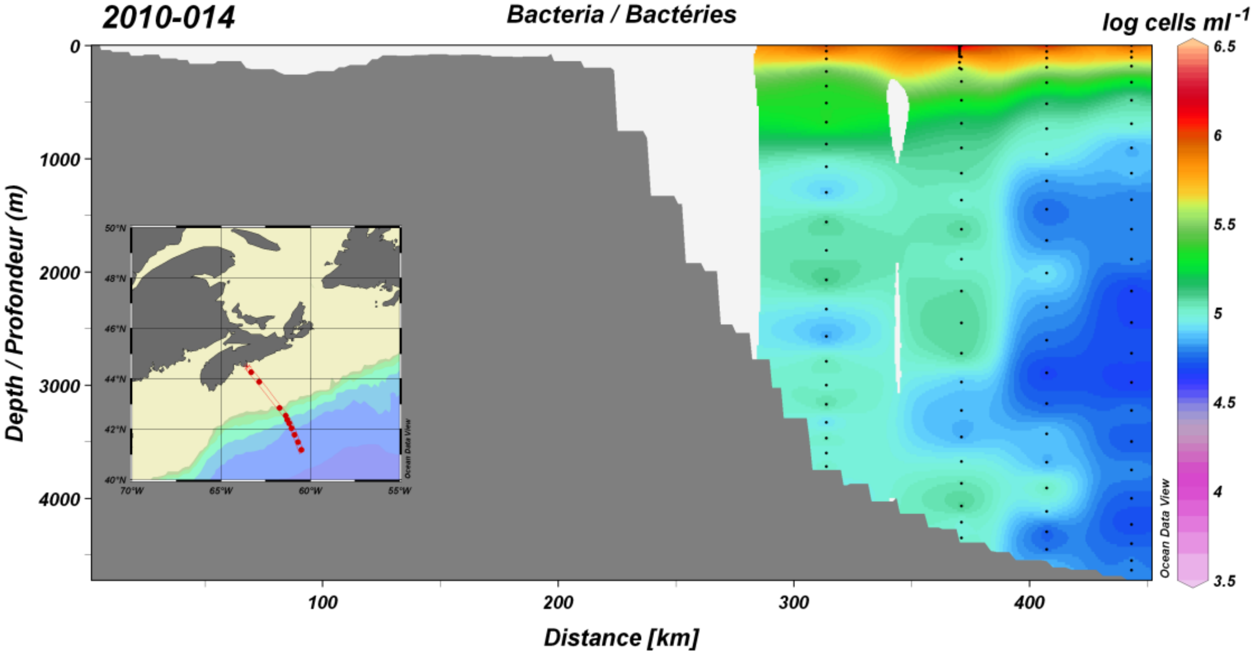
SAR include all species listed under Schedule 1 of the federal SARA as endangered, threatened, or of special concern; listed under the Nova Scotia *Endangered Species Act* (NS ESA) as endangered, threatened, or vulnerable. SOCC include those species that are listed as endangered, threatened, or of special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

This description of the biological environment relies substantially on previous research; no field work was conducted as part of this EIS. In particular, descriptions of species life histories and ranges are drawn primarily from the Shelburne Basin Venture Exploration Project EIS (Stantec 2014a), applicable SEAs conducted by the CNSOPB on the Scotian Shelf and Slope, BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA, as well as marine mammal observer (MMO) records from the recent BP Exploration (Canada) Limited's Tangier and Shell Canada's Shelburne Basin seismic surveys. Information is included in this Section (specifically in 5.2.2) about the process that BP has, and will continue to use, during project planning to increase their understanding of the surrounding 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, relying on organic material for energy, their abundance can be correlated to the abundance of phytoplankton communities (see Section 5.2.1.2 for a discussion on phytoplankton). 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 and where this line overlaps with the western part of the Project Area.



Source: DFO 2011a

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

The highest concentration of bacteria is found in the upper surface layer of the water column (refer to Figure 5.2.1) where the highest abundance of phytoplankton is also found. It should also be noted that bacteria exist throughout the water column, below the photic zone, relying on dissolved organic matter (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 is, in essence, a natural product which has been generated by organisms millions of years ago that 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 use energy contained in hydrocarbons or crude oils, using enzymes to allow them to combust hydrocarbons as an energy source, much in the same manner as an engine, but at lower temperatures (ASM 2011).

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).

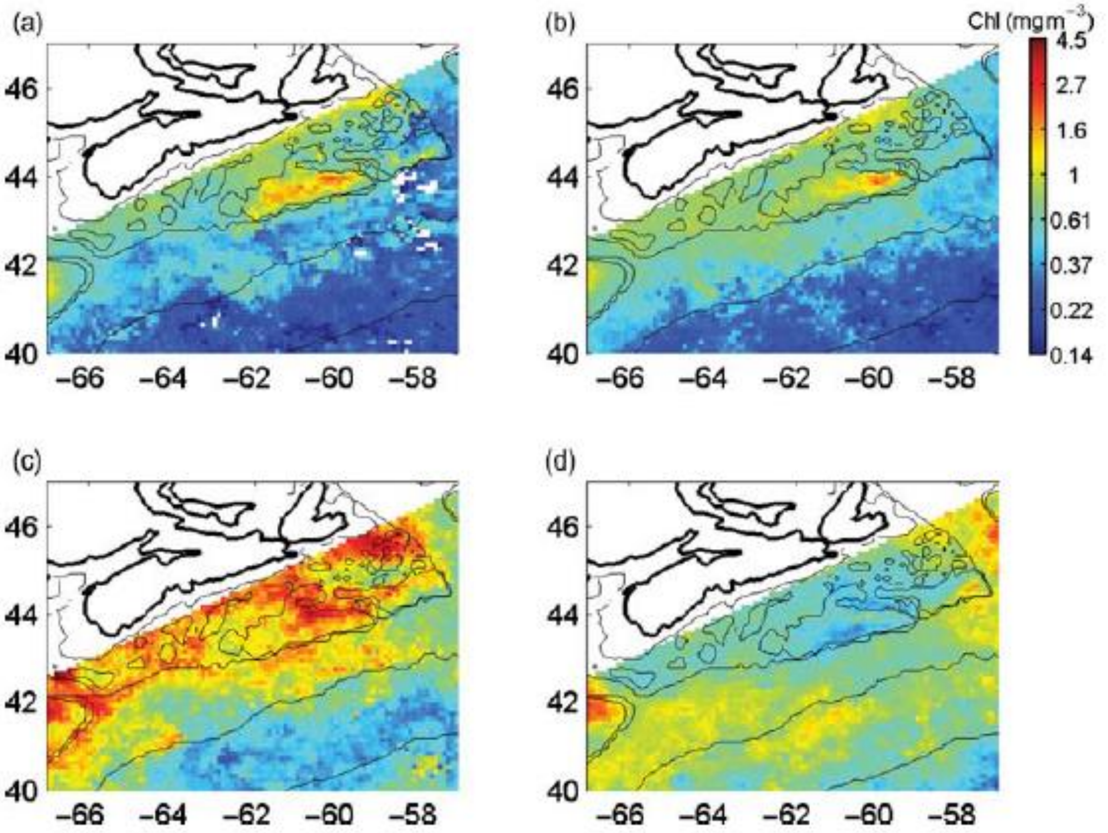
A strong increase in phytoplankton abundance, or bloom, can vary in spatial and temporal scales. Recent trends in the magnitude and duration of the spring bloom on the Scotian Shelf indicate that blooms are beginning earlier now than they did in the 1960s and 1970s and are more intense and longer in duration (Worcester and Parker 2010). The two dominant groups of phytoplankton on the shelf 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 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/m^3)
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

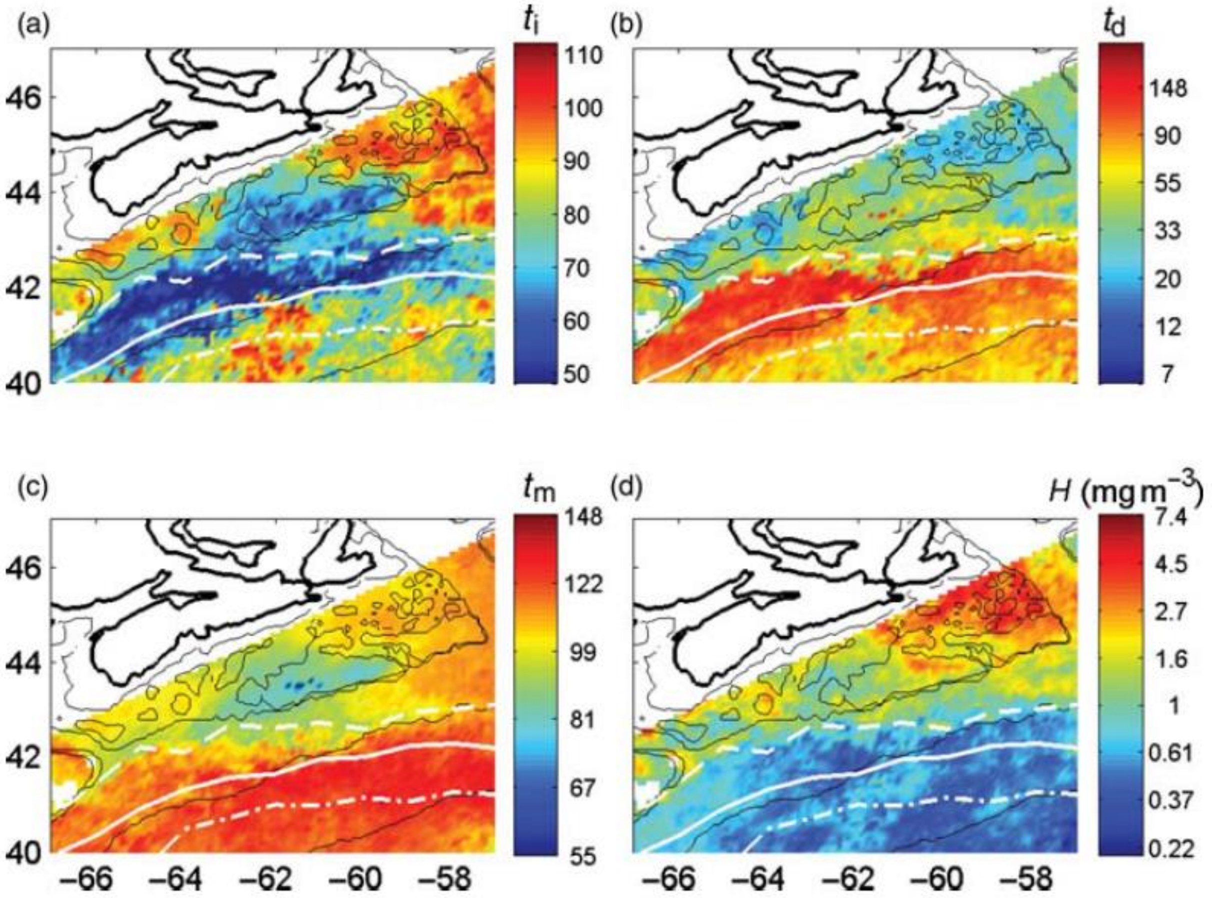
Source: Zhai *et al.* 2011



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 later than those waters over the Scotian Shelf (Figure 5.2.3). Furthermore, the amplitude of the spring bloom is 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 small animals that are suspended and drift in the water column. They serve as the link between primary producers (phytoplankton) and the larger organisms in the marine environment (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). 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; and
- macrozooplankton (> 2mm), which includes larger and gelatinous taxa such as euphausids (krill), tunicates and salps.

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 changes in ocean 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 include 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 to 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 of larvae were found off Browns, Baccaro, and LaHave Banks along the slope. These species include monkfish (*Lophius spp.*), haddock (*Melanogrammus aeglefinus*), red hake (*Urophycis chuss*) and redfish (*Sebastes 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. Species including the Atlantic cod (*Gadus morhua*), roundnose grenadier (*Coryphaenoides rupestris*), and skate have the potential to spawn year-round. Other fish such as Atlantic mackerel, wolffish (*Anarchichas spp.*), American plaice, and flounder species 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 (December – March)		
Ammodytes	Sand lance	26.8
Clupea	Atlantic herring	19.0
Pollachius	pollock	12.8
Gadus	Atlantic cod	10.6
Lumpenus	shanny, eelblenny	5.6
Spring-Summer (April – July)		
Sebastes	redfish	18.6
Ammodytes	sand lance	16.6
Gadus	Atlantic cod	8.8
Hippoglossoides	American plaice	8.2
Melanogrammus	haddock	7.6
Summer-Fall (August – November)		
Merluccius	silver hake	21.9

Table 5.2.2 Seasonal Abundance of Fish Larvae

Genus	Common Name(s)	Percentage of Total (%) (per Season)
Urophycis	longfin, red, white hake	16.1
Glyptocephalus	witch flounder	11.3
Enchelyopus	fourbeard rockling	7
Sebastes	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 redfish	*Sebastes 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 Scotian Shelf or slope*				🟩	🟩	🟩	🟦	🟦	🟦	🟦	🟦	
Cusk	*Brosme brosme*	*Georges Basin, Roseway Basin, Browns to Western Sable Island Bank and edges*					🟦	🟦	🟦	🟦				
							🟥	🟥	🟥	🟥	🟥			
Deepwater redfish	*Sebastes mentella*	Scattered over entire Scotian Shelf and Slope				🟦	🟦	🟦			🟩	🟩	🟩	🟩
						🟥	🟥	🟥	🟥	🟥				
Roughhead grenadier	*Macrourus berglax*	*Southern Grand Banks, potentially Scotian Slope*	🟦	🟦	🟦								🟦	🟦
			🟥	🟥	🟥	🟥							🟥	🟥
Roundnose grenadier	*Coryphaenoides rupestris*	*Scotian Slope*	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
			🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
Smooth skate	*Malacoraja senta*	*Roseway Basin*	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
			🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
Spiny dogfish	*Squalus acanthias*	*Roseway, LaHave, and Emerald Basins*										🟩	🟩	🟩
Spotted wolffish	*Anarhichas minor*	*Outside of the RAA*						🟦	🟦	🟦	🟦	🟦	🟦	🟦
			🟥					🟥	🟥	🟥	🟥	🟥	🟥	🟥
Thorny skate	*Amblyraja radiata*	*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 Southwest NS* *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*						🟦	🟦					
								🟥	🟥	🟥	🟥			
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 halibut	*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[1]	*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[2]	*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	*Chionoecetes opilio*	Nearshore southwest NS and Bridgewater to Halifax Eastern Scotian Shelf; Sable Island to Banquereau	🟩	🟩		🟦	🟦	🟦				🟩	🟩	🟩
						🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	

Note:
[1]Lobster eggs are extruded by the female from June to September and held until they hatch approximately 9–12 months later.
[2]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**

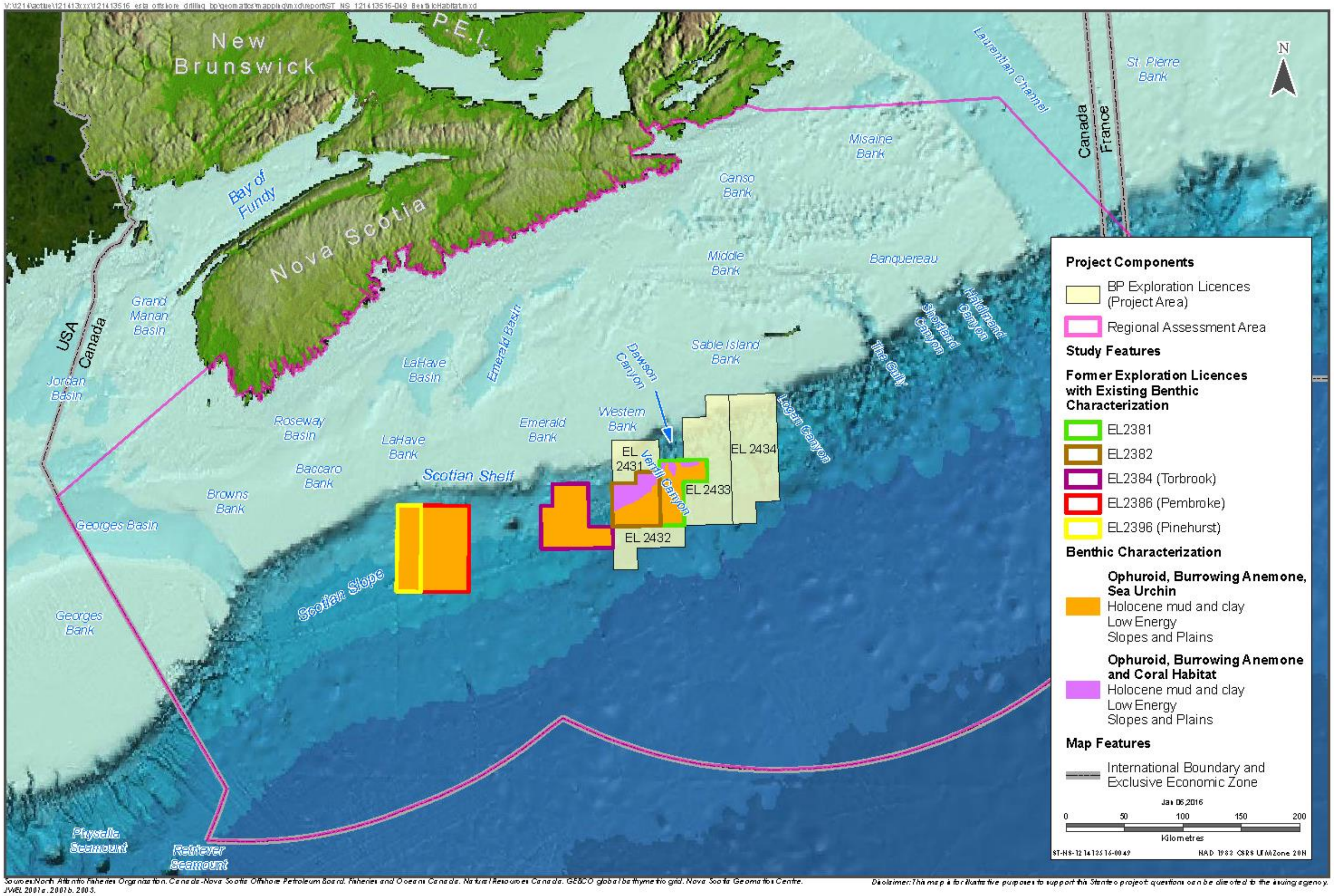
Sources: BIO 2013a; Campana *et al.* 2003, 2013; Cargnelli *et al.* 1999a,1999b; COSWEIC 2006a, 2007a, 2008a, 2010b,2012a, 2012b; DFO 2001, 2007a, 2009b, 2009c, 2010b, 2011a, 2013e2013f, 2013h, 2013i, 2013k, 2013l, 2013m, 2013n, 2013o; NOAA 2013b, 2013c; SARA 2013a, 2013b; Horseman and Shackell 2009

5.2.2 Benthic Habitat

The existing benthic habitat characterization is primarily based on deep-sea benthic surveys previously undertaken in former ELs along the Scotian Slope. Additional information has been sourced and will continue to be refined during Project planning as part of BP's regional Geohazard Baseline Review (GBR) and associated assessments including a site specific shallow hazards assessment and an ROV survey.

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 near and overlapping the Scotian Basin Project Area. The former EL 2382 and EL 2381 leased by Shell Canada Ltd (JWEL 2003), Torbrook Block (EL 2384) leased by Encana Corporation (JWEL 2001b), and Pembroke and Pinehurst Blocks (ELs 2386 and 2396) leased by Kerr-McGee Offshore Limited (JWEL 2001a) were all surveyed during this time period. The areas previously surveyed fall within the depth range of the Project (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.



Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre. JWEL 2001a. 2001b. 2003.

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Sources: JWEL 2001a, 2001b, 2003.

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

Former EL 2381 and 2382

ELs 2381 and 2382 were both former deepwater ELs which overlap the current Project Area and have water depths ranging from 1,500 to 3,400 m (JWEL 2003) (Figure 5.2.4). A survey was conducted in September 2002 to characterize the benthic community and surficial sediments within the licence blocks using grab samples and still camera transects.

The seabed in EL 2381 is incised by Verrill and Dawson Canyons in the centre of the block with slopes of 1.5 to 2 degrees. The seabed in EL 2382 is relatively flat with minor escarpments and an overall seabed slope of two degrees (JWEL 2003). The sediments in 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 of primarily clay, with a secondary silt component and a lesser amount of fine sand, and vary in thickness from 0.5 to 1 m. Figure 5.2.5 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. Refer to Table 5.2.4 for a summary of grain size and carbon content of the surficial sediments in ELs 2381 and 2382. Petroleum hydrocarbons were found in 14 of the 16 sampling stations over the two ELs, with the majority of total petroleum hydrocarbon (TPH) levels measuring less than 3 mg/kg. The occurrence of petroleum hydrocarbons in offshore Scotian Shelf and Slope sediments is common with background levels ranging from 1 to 26 mg/kg on the Scotian Shelf and Grand Banks (JWEL 2003).

Source: JWEL 2003

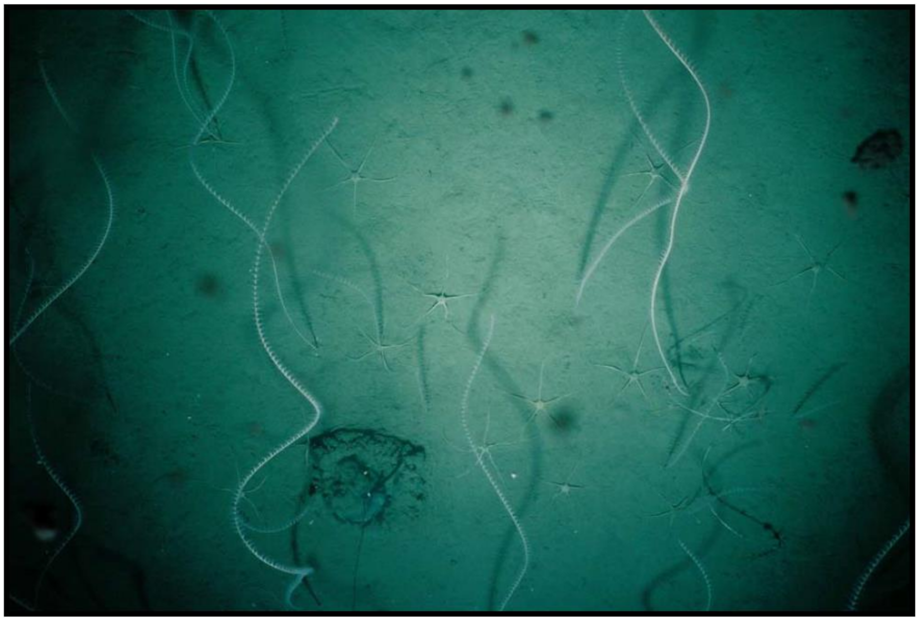
Figure 5.2.5 Typical Benthic Habitat in Former EL 2381 and EL 2382

Table 5.2.4 Summary of Grain Size and Carbon Content of Surficial Sediments from EL 2381 and EL 2382

Parameter	Unit	Range (based on 16 samples)	Mean (St. Dev.)
Gravel (>2 mm)	%	<1.0 - 0.5	0 (0.1)
Sand (0.06-2.0 mm)	%	2.7 - 60.9	10.5 (13.7)
Silt (0.015-0.06 mm)	%	20.5 - 45.4	36.8 (5.6)
Clay (<0.015 mm)	%	18.2 - 63.5	52.7 (10.7)
<12.5 mm	%	100	100 (0)
<9.5 mm	%	100	100 (0)
<4.75 mm	%	100	100 (0)
<PHI -1 (2 mm)	%	99.5 - 100.0	100 (0.1)
<PHI 0 (1 mm)	%	99.2 - 100.0	99.9 (0.2)
<PHI +1 (0.5 mm)	%	97.9 - 100.0	99.8 (0.5)
<PHI +2 (0.25 mm)	%	88.5 - 99.8	98.9 (2.6)
<PHI +3 (0.125 mm)	%	73.1 - 99.4	97.1 (6.0)
<PHI +4 (0.063 mm)	%	38.6 - 97.3	89.5 (13.9)
<PHI +5 (0.031 mm)	%	27.7 - 93.0	81.0 (15.3)
<PHI +6 (0.016 mm)	%	23.4 -86.2	72.6 (15.0)
<PHI +7 (0.008 mm)	%	19.5 - 74.1	60.6 (12.6)
<PHI +8 (0.004 mm)	%	18.2 - 63.5	52.7 (10.7)
<PHI +9 (0.002 mm)	%	10.6 - 45.9	28.3 (10.2)
Benzene	mg/kg	<0.025 - 0.2	0 (0.1)
Toluene	mg/kg	<0.025	<0.025
Ethylbenzene	mg/kg	<0.025	<0.025
Xylenes	mg/kg	<0.05	<0.05
Total C6-C10 (incl BTEX)	mg/kg	<2.5	<2.5
>C10-C21 (fuel range)	mg/kg	0.26 - 0.82	0.4(0.1)
>C21-C32 (lube range)	mg/kg	0.3 - 3.1	1.1(0.7)
Total Carbon	g/kg	12.0 - 33.0	26.5 (4.6)
Total Organic Carbon	g/kg	3.5 - 20.0	15.3 (3.6)
Total Inorganic Carbon	g/kg	8.0 - 14.0	11.1 (1.5)

Source: JWEL 2003

Brittle stars and burrowing anemones were the most common fauna observed in ELs 2381 and 2382. Polychaetes, sea cucumbers, sea urchins and large nudibranchs were also observed (JWEL 2003). A few stations contained corals which included sea whips, the soft coral *Anthomastus* spp., and the octocorals *Umbellula, a sea pen*. All of the coral species were observed at depths less than 2,000 m. Figures 5.2.6 and 5.2.7 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 substantial coral development were observed (JWEL 2003).



Source: JWEL 2003

Figure 5.2.6 Sea Whip Coral Observed in EL 2381

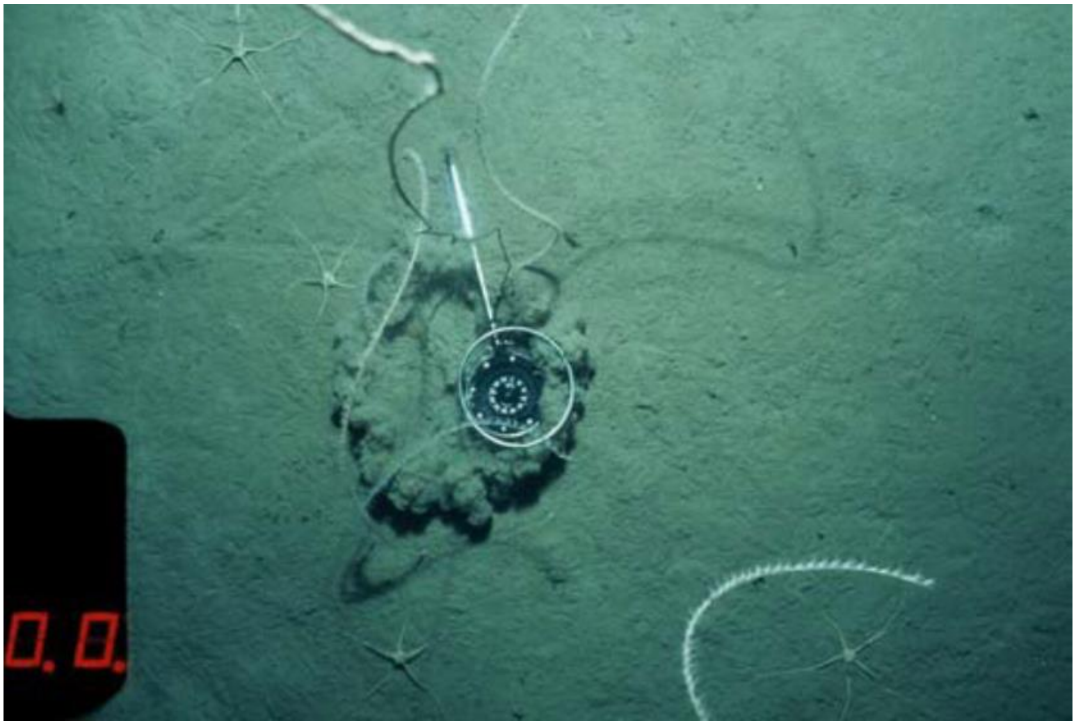
Source: JWEL 2003

Figure 5.2.7 Large Nudibranch Observed in EL 2381

Torbrook Block – EL 2384

EL 2384, known as the Torbrook Block, is a former EL located on the Scotian Slope, immediately west of the Project Area (Figure 5.2.6). The benthos shows little relief and gentle slope. The EL was located in depths ranging from 850 to 3,000 m with a seabed consisting of silts and clays of Holocene age (BEPCo 2004).

The Torbrook Block was surveyed in 2001. Isolated gravel material was observed, but rare. A diverse benthic community was found with brittle stars (0 to 20.4 per m^2) and burrowing anemones (0 to 1.6 per m^2) being the most commonly observed species, which is typical of soft sediment habitats. Sea urchins (0 to 2 per m^2) and sea whips (0 to 6.8 per m^2) were frequently observed at a few stations but not throughout the block (Figure 5.2.8). The silt and clay substrate in deep waters support sparse benthic community assemblage primarily consisting of brittlestars, borrowing anemones and sea urchins.



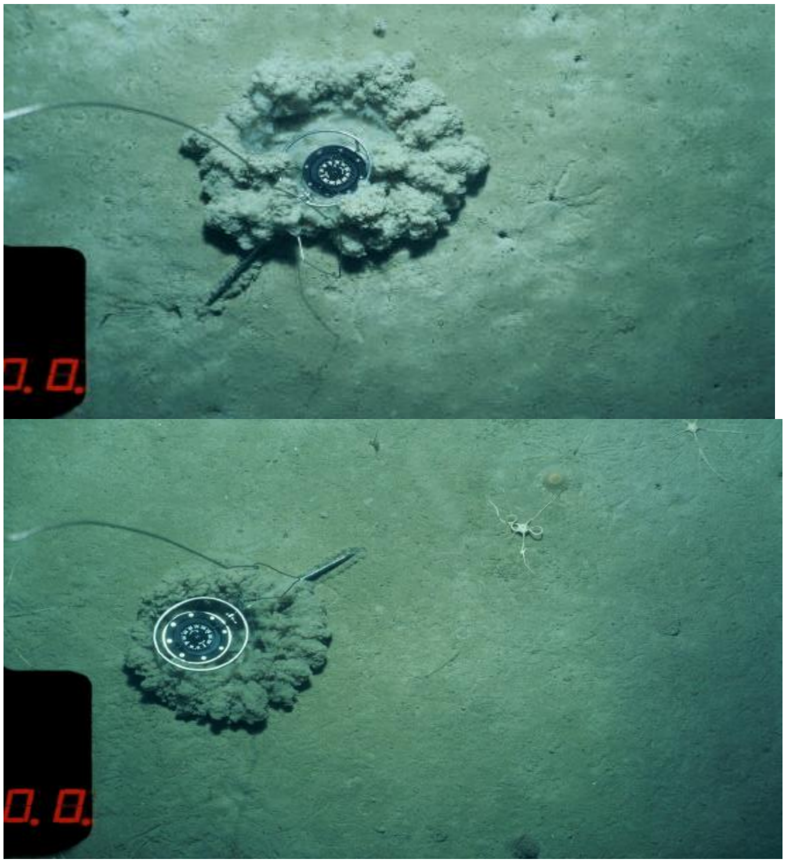
Source: BEPCo 2004

Figure 5.2.8 Sea Whips in Mud Substrate of the Torbrook Block

Pinehurst and Pembroke Blocks – ELs 2396 and 2386

The Pinehurst and Pembroke ELs were located on the Scotian Slope, west of the Project Area (BEPCo 2004) (Figure 5.2.4). Water depth ranges from 700 to 2,500 m in the Pinehurst Block, and 1,050 to 2,900 m in the Pembroke Block. The seafloor is characterized by an area of little relief and gentle slopes. From 1,159 to 2,000 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 ELs is comprised of Holocene silt and clay. This material blankets the slope, providing habitat for epibenthic brittle stars and infaunal burrowing anemones. The uppermost image in Figure 5.2.9 shows the typical benthic habitat observed within the Pinehurst and Pembroke Blocks in 2001.



Source: JWEL 2001a

Figure 5.2.9 Typical Seafloor Habitat in the Pembroke and Pinehurst Blocks (top: image size 1.2 m²) showing Brittle Stars and Burrowing Anemones (bottom: image size 1.1 m²)

Approximately 56% of the seafloor images (41 of 74 images) within the survey areas showed barren habitat and lacked visible epifaunal organisms. Brittle stars, polychaete tubes, and burrowing anemones were the most common visible organisms (lower image in Figure 5.2.9) (JWEL 2001a). Other species which were rarely observed included sea pens (*Pennatulacea*), sea cucumbers (*Holothuroidea*), benthic shrimp, sea stars (*Asteroidea*), and sea urchins (*Echinoidea*). Small mollusks (snails, clams, and scaphopods) as well as crustaceans (amphipods, isopods, and tanaids) were other taxa observed in the sediments. Brittle stars ranged in density from 0 to 4.5 per m^2 and anemones ranged from 0 to 2.7 per m^2. Overall densities of observed species were low with an average of 0.8 to 1.2 individuals 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).

Overall the benthic habitat within the Pinehurst and Pembroke Blocks was identified as ophuroid (brittle star) and burrowing anemone habitat (JWEL 2001a). Benthic fauna across the blocks appeared to be generally low in abundance and diversity. The two blocks were not found to be an area of substantial coral development.

5.2.2.2 Geohazard Baseline Review

BP has carried out a regional GBR of the seabed and shallow geological conditions for potential shallow hazards within the ELs. The GBR was based primarily on 3D WATS exploration seismic data, and supplemented with existing regional data, such as geotechnical cores and offset wells where available. The area assessed as part of the GBR (*i.e.*, the GBR Study Area) overlaps with the sections of the ELs which were included in the WATS seismic survey, which covers approximately 8,500 km^2. Water depths included in the GBR Study Area range between 1,573 m and 3,730 m.

Geohazards are features or geological conditions which could pose a potential hazard to drilling activity. These features may include, but are not limited to, seabed and buried faults, erosion, scour and truncation surfaces, shallow gas charged sediments and hydrates, shallow water flow zones or abnormal pressure zones, variable seabed topography and seabed sediment conditions, and slope failures including slumps and debris flows. Some of these features could be indicative of cold water corals and other benthic communities.

The original 3D WATS data were acquired and processed to support exploration, not site investigation activities, but are considered to have sufficient resolution and bandwidth to define the preliminary spatial variability of marine geohazard risks on drilling and developability across the study area. The data have been processed to a 25 m x 25 m bin size with a 4ms sample rate using a Kirchhoff Prestack Depth Migration and a Sediment Flood velocity model, with a record length of approximately 14,000 m.

In order to assist with a broad, regional understanding of seabed sediments across the ELs, BP developed an extensive geodatabase from sources such as Geological Survey Canada (GSC) expeditions, CNSOPB, Nova Scotia Offshore, Project Offshore Deep Slope (PODS) and BP's own exploration data. This depository houses a significant amount of both marine and terrestrial geotechnical, geophysical, and geological data. The geodatabase was developed by C-CORE and contains specific core sampling information such as grain size distribution, radiocarbon dates, shelf and slope surficial geology and sediment type maps that in most cases cover the entire BP ELs. Moreover, the database provides insight into seabed erosion pattern, canyon formation, local slumps and debris flows, sediment zonation on the outer shelf and upper slope that all complement BP's geophysical exploration data and help to develop a better understanding of the seabed conditions at the well sites. As such, BP considers there to be sufficient existing data and information with regard to surficial seabed conditions for the purpose of drilling exploration wells.

The 3D WATS exploration seismic data was also used to gain a better understanding of potential seabed fluid expulsion features, hardgrounds and variable seabed topography across the area. The expulsion features may be derived from non-hydrocarbon and hydrocarbon based fluids. Fluid expulsion features related to shallow gas often are associated with carbonate hardgrounds and benthic communities. In addition, hardgrounds not related to fluid expulsion such as corals, may also be identified if laterally extensive. BP will take account of such features during well planning, specifically to avoid them when identifying potential wellsite locations to minimize the possibility of encountering shallow hazards and benthic communities.

The GBR has shown that the main concerns for drilling hazards within the GBR Study Area are related to variable seabed sediment properties, slope stability, possible drilling fluid losses within buried coarse-grained channel deposits and faults, regional seismicity, localized shallow gas, possible localized massive gas hydrate accumulations in coarse grained proglacial sediments, and steep angle at the top of salt. BP is currently reprocessing the 3D WATS seismic data to further increase the sampling rate and frequency requirements for detailed shallow hazard assessments for potential wellsite locations. As noted previously, the GBR may be used to assist in scoping areas for preliminary wellsites, to avoid areas of potential geohazards. The reprocessed 3D WATS seismic data will be used to refine well locations and generate site specific shallow hazards assessments to support detailed well design.

Some maps from the GBR have been presented in Figure 5.2.10 to illustrate the type of data that will be used to inform wellsite selection. The representative maps from the GBR included here show surficial geology (top image) and seafloor geomorphology and infrastructures (bottom image).

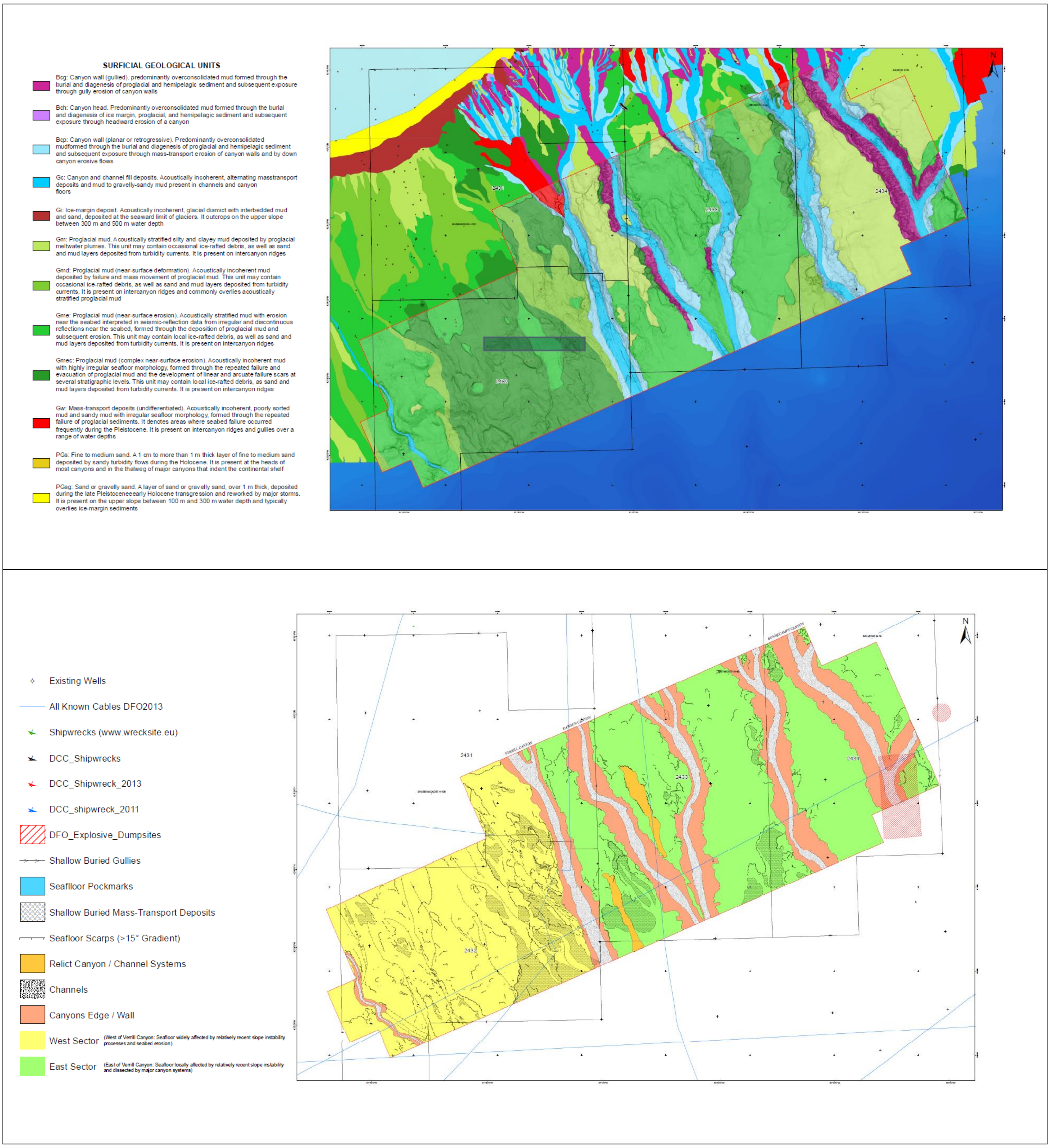


Figure 5.2.10 Extracted Maps from the Geohazard Baseline Review showing Surficial Geology and Seafloor Geomorphology and Infrastructures

Site Specific Shallow Hazards

Site specific shallow hazards assessments will be conducted once potential well locations have been identified, taking account of hazards identified in the GBR. BP will execute the shallow hazard assessment to complete a more detailed description of subsurface geological conditions which could pose a potential hazard to drilling activity and a more detailed explanation of seafloor conditions and evaluation criteria for each individual location. The site specific shallow hazards assessment will be submitted to the CNSOPB for consideration as part of the ADW process.

To provide an indication of the type of information that would be provided as part of the site specific shallow hazards assessment, a preliminary summary of seafloor site conditions at two potential well locations within the ELs has been provided. The two potential well locations that have been assessed are the same locations used as part of the spill modelling assessment (refer to Figure 8.4.1 in Section 8.4). The data that has been provided at this stage in the EIS is for illustrative purposes only and is not intended to serve as a full shallow hazards assessment.

Site 1

Site 1 is located in a generally flat area adjacent to the Bonnecamps Canyon on the Scotian continental slope in EL 2434 with a water depth of approximately 2104 m (refer to Table 8.4.1 and Figure 8.4.1 for additional information about the site location). This preliminary assessment investigates site conditions in a 2500 m radius around the proposed wellsite. Seafloor conditions are interpreted to be generally favourable in the vicinity of the proposed wellsite.

- The seabed appears smooth and stable at the proposed location and slopes approximately 1.8˚ to the southeast.
- The potential for large scale mass transport events impacting the proposed location over the course of exploration drilling activities is negligible. Small scale debris flows related to channel levee and overbank deposition associated with the Bonnecamps Canyon are possible, but unlikely and if present are not expected to negatively impact exploration drilling operations.
- The seafloor in the vicinity of the proposed wellsite is free of amplitude anomalies and topographic features indicative of hard grounds.
- Seafloor amplitude anomalies associated with the channel thalweg are likely indicative of shallow buried channel sands.
- Seafloor sediments are composed of a surficial layer of fine-grained, hemipelagic drape, underlain by proglacial muds. These muds are acoustically stratified, silty and clayey mud deposited by proglacial meltwater plumes. This unit may contain occasional ice-rafted debris, as well as sand and mud layers deposited from turbidity currents.
- There is no indication of faults that offset the seafloor. Faults are observed in the subsurface with some that come close to the seafloor, but are eroded and covered by proglacial muds and hemipelagic drape.
- Evidence of seafloor fluid expulsion mounds or pockmarks is not found within the study area.

- There are no amplitude anomalies or topographic features observed with the current dataset at Site 1 that would suggest the presence of benthic communities however this will be confirmed by an imagery based seabed survey prior to spud.
- Seafloor debris and man-made obstructions have not been identified on the 3D seismic data. There are no reported anthropogenic features such as shipwrecks or debris within the Site 1 study area however this will be confirmed by an imagery based seabed survey prior to spud.

Figure 5.2.11 displays the results of the GBR analysis for Site 1.

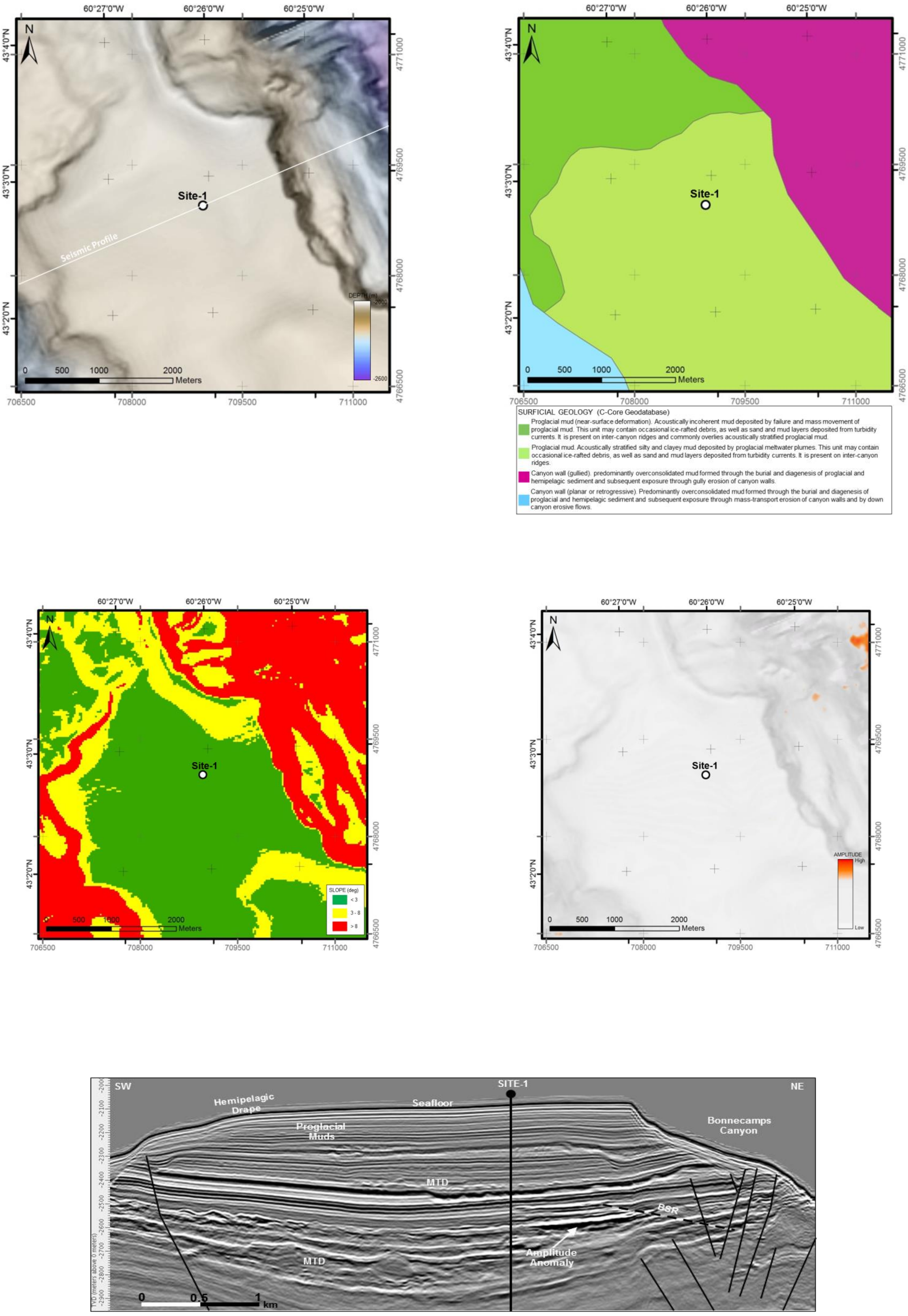


Figure 5.2.11 Characterization of Site 1 Using GBR Data, showing Water Depth, Surficial Geology, Seafloor Gradient, Seafloor Amplitude and Shallow Amplitude Anomaly Assessment.

Site 2

Site 2 is located in EL 2432 at a water depth of approximately 2652 m. Site 2 is located in an area of heavy seafloor erosion on the Scotian slope. This preliminary assessment investigates site conditions in a 2500 m radius around the proposed wellsite. Seafloor conditions are interpreted to be generally favourable in the vicinity of the proposed wellsite. These are summarized as follows:

- The seabed slopes approximately 3.4˚ to the southeast in an area heavily impacted by past seafloor erosion.
- Seafloor sediments are composed of a surficial layer of fine-grained, hemipelagic drape, underlain by proglacial muds. These muds are acoustically incoherent sediments deposited by failure and mass movement. This unit may contain occasional ice-rafted debris, as well as sand and mud layers deposited from turbidity currents.
- The seafloor morphology is characterized by retrogressive failures as well as mounds (erosional remnants) and pits related to past erosional events.
- The potential for large scale mass transport events impacting the proposed location over the course of exploration drilling activities is negligible. Past events are related to sealevel lowstands and progradation of glaciers onto the continental shelf.
- Small scale debris flows are possible, but unlikely and if present are not expected to negatively affect exploration drilling operations.
- There is no indication of faults that offset the seafloor. Faults are observed in the subsurface with some that come close to the seafloor, but are eroded and covered by proglacial muds and hemipelagic drape.
- Evidence of seafloor fluid expulsion mounds or pockmarks is not found within the Site 2 study area.
- Seafloor amplitudes in the vicinity of the proposed well location are generally high, related to past erosion of shallow sediments and presence of coarse-grain and/or overconsolidated sediments near the seafloor. Coarse-grained and/or overconsolidated sediments may cause operational difficulties related to conductor installation operations.
- While the generally rugose seafloor character and presence of amplitude anomalies related to the underlying sediments makes identification of aggregated benthic communities somewhat less certain, there are no interpreted amplitude anomalies or topographic features observed with the current dataset that would suggest the presence of aggregated benthic communities. This will be confirmed by an imagery based seabed survey prior to spud.
- Seafloor debris and man-made obstructions have not been identified on the 3D seismic data. There are no reported anthropogenic features such as shipwrecks or debris within the Site 2 study area however this will be confirmed by an imagery based seabed survey prior to spud.

Figure 5.2.12 displays the results of the GBR analysis for Site 2.

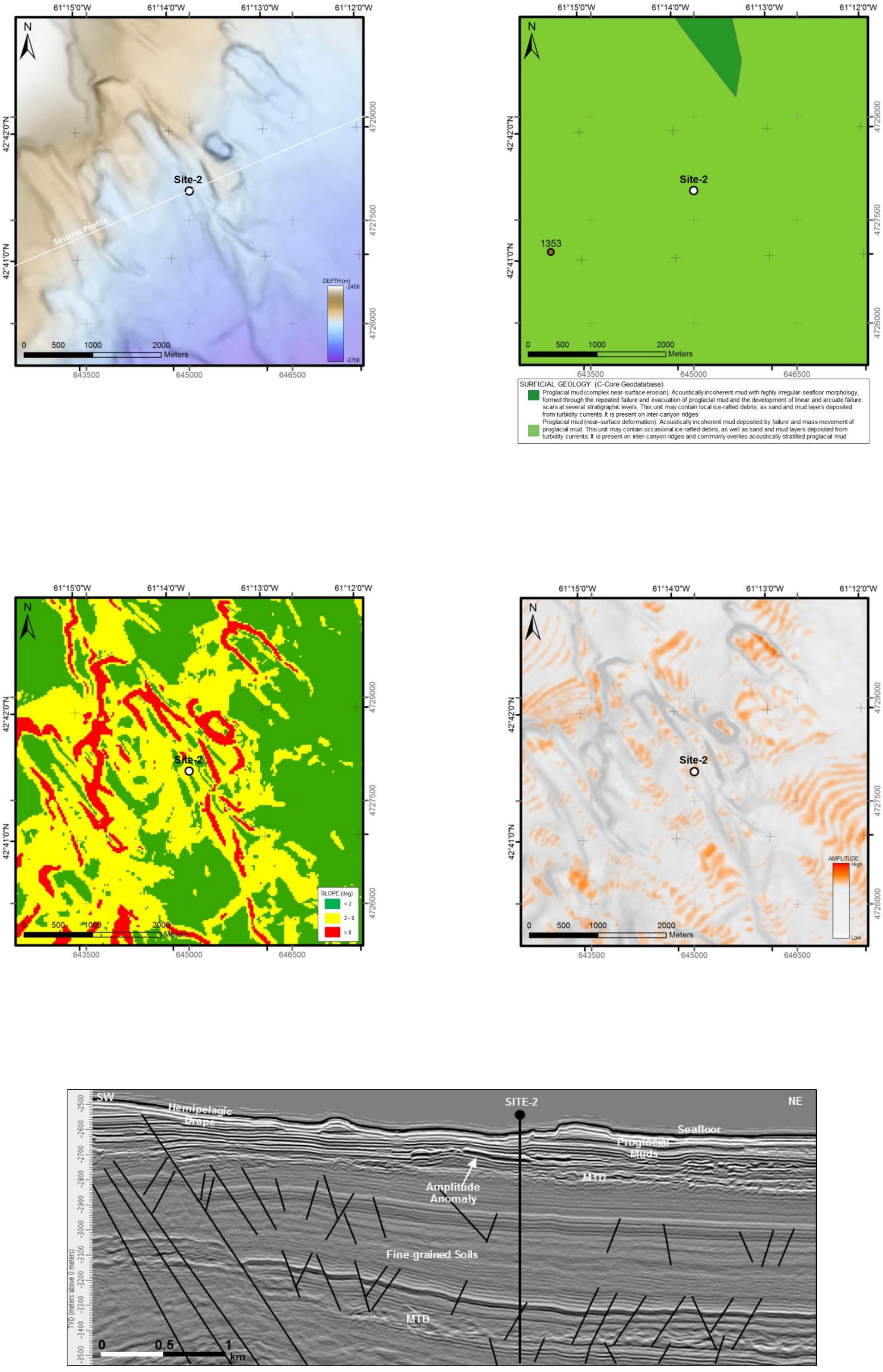


Figure 5.2.12 Characterization of Site 2 Using GBR Data, showing water depth, surficial geology, seafloor gradient, seafloor amplitude and shallow amplitude anomaly assessment

Seabed Survey

BP will confirm information gathered as part of the GBR and site specific shallow hazards assessment through a seabed survey. Features such as shipwrecks, debris on the seafloor, unexploded ordnance and sensitive environmental features, such as habitat-forming corals or species at risk will be identified, if present, through the use of an imagery based seabed survey.

The survey will be carried out once the drilling rig is in place at a proposed wellsite, prior to drilling. The survey will be carried out using a remote operated vehicle (ROV) which will be deployed from a boat or the drilling rig. Footage will be captured over an area with a 500 metre radius in an eight leg pattern in 45 degree increments.

If any environmental or anthropogenic sensitivities are identified during the survey, BP will move the wellsite to avoid affecting them if it is feasible to do so. If it is not feasible, BP will consult with the CNSOPB to determine an appropriate course of action.

5.2.3 Corals and Sponges

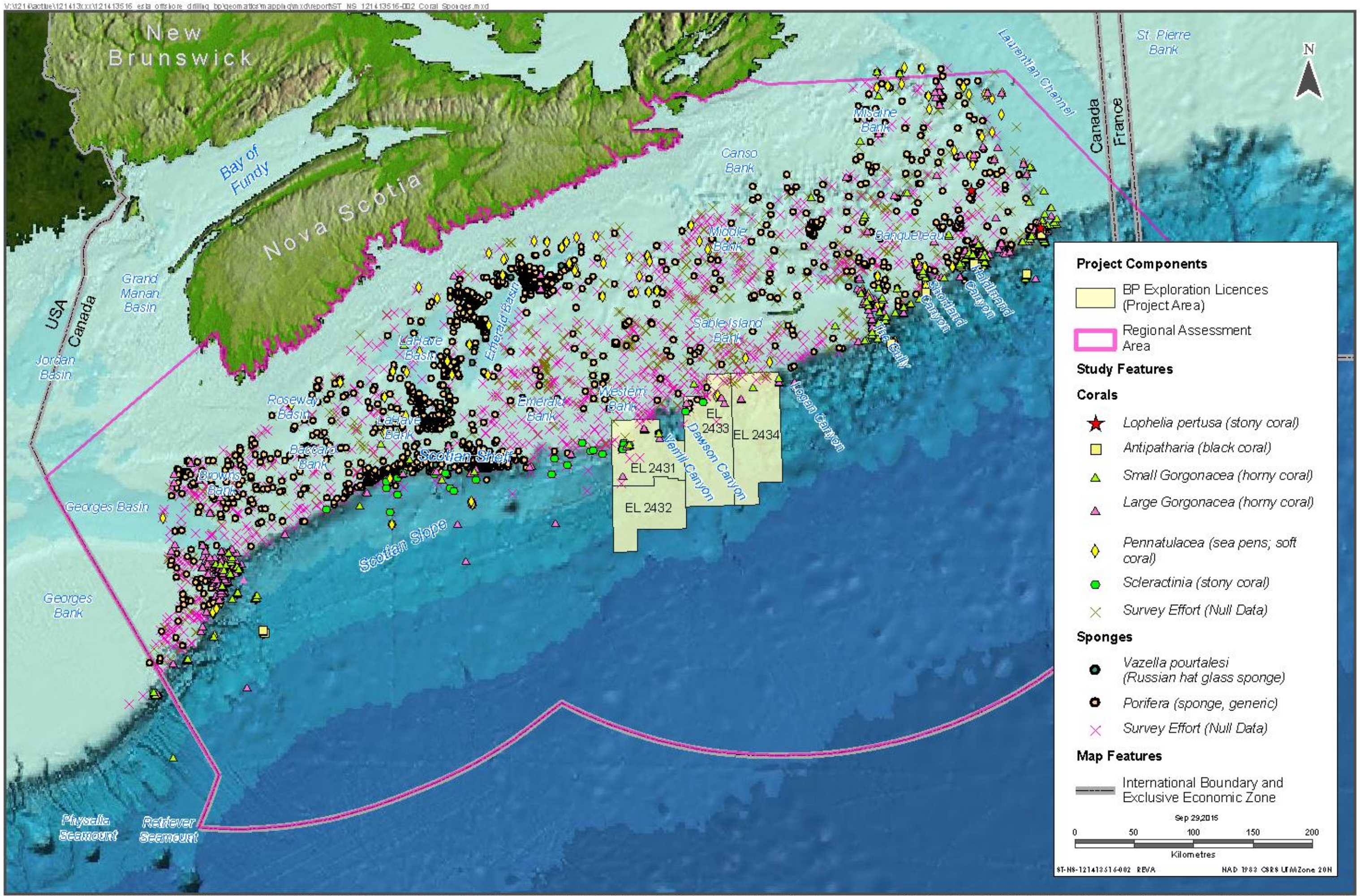
Corals and sponges are marine benthic invertebrates that attach themselves to bottom substrates and filter-feed on suspended particles in the water column. Corals and sponges provide various ecological functions. Dense aggregations of corals and sponges can alter bottom currents and provide a niche space for other organisms, 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 cold-water corals offshore Nova Scotia: hard/stony corals (*Scleractinia*) and octocorals or soft corals. Unlike hermatypic corals that are true reef-building corals and live in warm, shallow waters and contain symbiotic algae, ahermatypic corals are cold-water corals that can live at depths without the influence of sunlight, and 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 as most species are found at water depths greater than 200 m on continental slopes, canyons, or seamounts (DFO 2011a). DFO has led coral research on the Scotian Shelf, Slope, and in the Gulf of Maine, including various research surveys, since the late 1990s. The Gully has the highest known diversity of corals in Atlantic Canada (Moors-Murphy 2014). Figure 5.2.13 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 over the full ELs, the data do show the general distribution and diversity of coral and sponge species on the Scotian Shelf and Slope, including the rare *Lophelia* (reef-building) coral species that is present approximately 200 km to the northeast of the ELs, at a water depth of approximately 300 m.

A few benthic stations sampled in the former EL 2381 and EL 2382 that overlap with the Project Area contained corals, which included sea whips, the soft coral *Anthomastus* spp., and the octocorals *Umbellula* (refer to Section 5.2.2.1). All of the coral species were observed at depths less than 2,000 m (JWEL 2003). Therefore, there is potential for these corals to occur in the Project Area. However, no regions containing substantial coral development were observed in the former two ELs (JWEL 2003). 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 5.2.10 for more information on designated protected areas).

At least 34 species of sponge have been identified on the Atlantic coast, including the 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 (see Figure 5.2.13) 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).



Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.13 Known Coral and Sponge Locations on the Scotian Shelf and Slope

5.2.4 Marine Plants

Marine plants can include macrophytic marine algae (also referred to as seaweeds), flowering plants (*e.g.,* seagrasses), and phytoplankton (refer to Section 5.2.1.2 for a discussion on phytoplankton). Seaweeds found along rocky shores of Nova Scotia include species of green algae, red algae and brown algae. Green algae require a large amount of light and are generally found closer to the surface in intertidal or shallow subtidal areas. Red algae (*e.g*., Irish moss) are able to grow at greater depths and are generally found in the intertidal zone, below the low water mark. Brown algae (*e.g.,* kelp, rockweeds) are the dominant seaweeds and are found in subtidal and intertidal zones (DFO 2013b). Irish moss (*Chondrus crispus*) and rockweed (*Ascophyllum nodosum*) are harvested commercially in Nova Scotia.

Seagrass is a general term for flowering plants that live in low intertidal and subtidal marine environments (DFO 2013b). Seagrass beds (particularly eelgrass beds) are recognized as being among the most highly productive ecosystems in the world (DFO 2013b). Eelgrass (*Zostera marina*), the dominant seagrass found in coastal and estuarine areas around Nova Scotia, provides food and shelter for many species of fish and waterfowl and plays an important role in stabilizing sediments (DFO 2013b; Hastings *et al*. 2014; Allard *et al.* 2014). Eelgrass is very sensitive to environmental changes and has declined considerably along the Nova Scotia coastline in recent decades (DFO 2009c; DFO 2013b; Hastings *et al*. 2014).

5.2.5 Marine Fish

5.2.5.1 Groundfish

Table 5.2.5 and the following text summarize the characteristics and distribution of groundfish of commercial, recreational, or Aboriginal (CRA) value likely to occur in the vicinity of the Project and on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a), as well as the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of groundfish SAR and SOCC (which have the potential to be caught in a CRA fishery) are provided in Section 5.2.5.4.

Atlantic Halibut

Atlantic halibut are distributed from north of Labrador to Virginia. On the Scotian Shelf, halibut are most abundant between 200 and 500 m, in deep-water channels between banks and along the edge of the Continental Shelf. They prefer temperatures from 3 to 5°C, and larger individuals move to deeper water in winter (DFO 2015c). 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). This species preys on benthic organisms and shift from invertebrates to fish as the halibut grows larger in size. Small halibut (<30 cm) feed on hermit crabs, shrimp, crabs, and mysids, while larger fish (>70 cm) consume various species of flatfish, redfish, and pollock (DFO 2013u).

Females mature at 10 to 14 years with spawning occurring from December to June in deep water depths ranging from 300 to 700 m. Large females may lay up to several million eggs. The eggs are 3 to 4 mm in diameter and float freely in the ocean until they hatch 16 days later. Larvae are approximately 7 mm in length and 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 to 30 years (DFO 2009f).

Table 5.2.5 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[1]	Timing of Presence
Acadian redfish[2]	*Sebastes fasciatus*	Low	Year-Round
American plaice[2]	*Hippoglossoides platessoides*	Low	Year-Round
Atlantic cod[2]	*Gadus morhua*	Low	Year-Round
Atlantic halibut	*Hippoglossus Hippoglossus*	Moderate	Year-Round
Atlantic wolffish[2]	*Anarchichas lupus*	Low	Year-Round
Deepwater redfish[2]	*Sebastes mentella*	Low	Year-Round
Haddock	*Melanogrammus aeglefinus*	Low	Year-Round
Hagfish	*Myxine glutinosa*	Moderate	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 halibut	*Reinhardtius hippoglossoides*	Moderate to High	Year-Round
White hake[2]	Urophycis tenuis	Moderate	Year-Round
Witch flounder	*Glyptocephalus cynoglossus*	Low	Year-Round
Yellowtail founder	*Limanda ferruginea*	Low	Year-Round

Note:
[1] This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2] SAR or SOCC.

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

Haddock

Haddock is a member of the cod family found on both sides of the North Atlantic and are generally associated with broken ground, gravel, pebbles, clay, smooth hard sand, sticky sand of gritty consistency, and shell beds. They are most commonly found in water depths from 50 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 other haddock (NOAA 2013h).

Haddock is a fast-growing species, maturing from one to four years of age and generally living from three to seven years. 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

Hagfish is a benthic species that 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 water depths up to 1,200 m. They prefer soft substrates and areas with low current velocities. They live in burrows which collapse once they emerge; taking approximately 4 to 11 minutes to rebuild them once they return (DFO 2009g).

Spawning occurs year-round with each female carrying 1 to 30 large, horny-shelled eggs that are deposited into the burrows (DFO 2009g). Newly hatched hagfish resemble adults and range in size 6 to 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 that settle down from the pelagic zone.

Monkfish

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 2010a). They prefer water temperatures ranging from 3 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 with sand, mud, and shell substrates (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.

Sexual maturity occurs between three and four years, with spawning typically occurring during the summer months from Georges to Banquereau Banks 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 to12 m in length and be between 0.15 m and 1.5 m wide (NOAA 2013i).

Pollock

Pollock is a member of the cod family. This fish is 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 to 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 to 4 mm long upon 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

The red hake can be found from the Gulf of St. Lawrence to North Carolina from water depths of 10 to 500 m at temperatures of 5 to 12°C. Red hake prefer a soft sand or muddy substrate (NOAA 2006).On the Scotian Shelf, they are generally 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 measuring 1.8 to 2.0 mm long. Larvae are pelagic for two to three months, until reaching a size of 25 to 30 mm long when they become demersal.

Sand Lance

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 2015d). They are generally found along coastal zones and on the shallow waters of offshore banks on sand or small gravel 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 2015d). Sand lance feed on a variety of organisms with its main prey consisting of copepods, and are themselves an important prey species for red and silver hake, shortfin squid, Atlantic sturgeon, and minke and humpback whales, as well as commercially important species such as cod and yellowtail flounder (DFO 2015d).

Sand lance mature at two years of age and spawn on sand in shallow water depths during the winter months (DFO 2015d). 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 seabed (DFO 2015d).

Silver Hake

Silver hake is a member of the cod family and 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 water depths ranging from 150 to 200 m and in temperatures ranging from 5 to 10°C (DFO 2013r). Silver hake feed mainly on shrimp, krill, and sand lance, and are prey for monkfish, pollock, Atlantic halibut, cod, and seals (DFO 2013r).

Silver hake have a lifespan of 12 years and mature at 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 to 3.5 mm in length and are pelagic for 3 to 5 months before migrating to the seabed.

Turbot – Greenland Halibut

Greenland halibut can be found in water depths ranging from 90 to1,600 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, and feeds on various finfish and shellfish species and squid (NOAA 2013k).

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 when they migrate to the seabed.

Witch Flounder

Witch flounder is a deep-water flatfish that can commonly be found from Labrador to Georges Bank in water depths from 185 to 400 m, although they have been found at depths of over 1,500 m off southern Nova Scotia (DFO 2015e). They occur most commonly in deep holes and channels and along the shelf slope on sand and muddy bottoms at temperatures ranging from 2 to 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 include polychaetes, small crustaceans, shrimp, and occasionally small fish (DFO 2015e).

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; DFO 2015e). 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 other flatfish, lasting from four months to one year. During this time eggs and larvae drift in the water column 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 slow circular currents. Occasionally eggs and larvae will drift out over the slope (DFO 2015e).

Yellowtail Flounder

Yellowtail flounder is a flatfish found in relatively shallow waters of the Continental Shelf from southern Labrador to Chesapeake Bay. It prefers sandy habitats and is generally found in water depths of approximately 40 to 91 m (NOAA 2012b; DFO 2015f). A major concentration of yellowtail flounder occurs on Georges Bank, from the Northeast Peak to the Great South Channel. Adults feed on amphipods, shrimp, polychaetes, crabs, mollusks, and small fish species (DFO 2015f). Tagging studies have indicated yellowtail flounder are capable of long distance migrations, although migration patterns have yet to be identified (DFO 2015f).

Both male and female yellowtail flounders mature at two to three years. Spawning takes place near the substrate on Georges, Browns, and Emerald to Banquereau Banks, as well as in nearshore areas, from May to July. 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 to 16 mm larvae. The larvae remain in the top water layers for a short amount of time before settling to the seabed (DFO 2015f).

5.2.5.2 Pelagic Fish

Table 5.2.6 summarizes the characteristics and distribution of pelagic fish of CRA value likely to occur in the vicinity of the Project Area. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited’s Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of pelagic SAR and SOCC (which have the potential to be caught in a CRA fishery) are provided in Section 5.2.5.4.

Table 5.2.6 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[1]	Timing of Presence
Albacore tuna	*Thunnus alalunga*	Low	July to November
Alewife	*Alosa pseudolarengus and A. aestivalis*	Low	July to February
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
American eel[2]	*Anguilla rostrata*	Low	March to November
Bigeye tuna	*Thunnus obesus*	Low	July to November
Black dogfish	*Centroscyllium fabricii*	Low	Year-round
Bluefin tuna[2]	*Thunnus thynnus*	Low	June to October
Blue shark[2]	*Prionace glauca*	Moderate	June to October
Capelin	*Mallotus villosus*	Low	Year-round
Cusk[2]	*Brosme brosme*	Moderate	Year-round
Porbeagle shark[2]	*Lamna nasus*	Moderate	Year-round
Shortfin mako shark[2]	*Isurus oxyrinchus*	Moderate	July to October
Swordfish	*Xiphias gladuis*	Moderate	July to October
White marlin	*Kajikia albida*	Moderate	July to October
Yellowfin tuna	*Thunnus albacares*	Low	July to October

Note:
[1] This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2] SAR or SOCC.

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

Albacore Tuna

Albacore tuna are sparsely distributed along the Scotian Shelf edge and slope, with higher numbers further offshore above the abyssal plain, but there is potential for them to occur sporadically in the vicinity of the Project. They enter Canadian waters in July and remain until November feeding on forage species. Spawning occurs from March to July in subtropical areas of the Atlantic and Mediterranean Sea. Females produce between 800,000 and 2.5 million buoyant eggs that hatch in one to two days. After hatching, the 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 (NOAA 2013a).

Alewife

Alewives range along the Atlantic coast from Newfoundland to South Carolina. A preferentially anadromous species, alewives will survive as a landlocked population. Anadromous alewives utilize freshwater streams for spawning and abundant in large rivers during migration between March and June (DFO 2015g). The timing of the spawning migration is related to water temperature and begins earlier in southern habitats.

Adults return to sea shortly after spawning, with juvenilles spending the summer and fall in the freshwater environment. At sea, juvenilles typically school and remain in the nearshore. Adult alewives may remain in inshore waters for the majority of the year but have been found during summer in the offshore such as George's and Emerald Banks (DFO 2015g). Alewives are opportunistic feeders, foraging on zooplankton at the surface though may also forage on benthic invertebrates.

Atlantic Herring

Atlantic herring are found on both sides of the North Atlantic. In the northwest Atlantic, they are found from Labrador to Cape Hatteras (DFO 2015g). They are common along the coast of Nova Scotia and offshore banks and known to be present in the Roseway, LaHave, and Emerald Basins. 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 herring form massive schools prior to spawning and migrate to spawning grounds in both coastal waters and offshore banks (GMRI 2014). Once profuse along the Atlantic Coast, active herring spawning areas are now relatively scarce (Hastings *et al*. 2014). Coastal spawning areas include areas off southwest Nova Scotia as well as in the Bay of Fundy and off Grand Manan Island. Offshore, spawning occurs in areas of Georges Bank. Spawning begins in August in Nova Scotia and eastern Maine regions and begins later (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 carried by ocean currents for approximately six months before becoming active swimmers (GMRI 2014).

Atlantic Mackerel

Atlantic mackerel are pelagic schooling fish which occupy moderately deep water (70 to 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. They are sensitive to water temperatures and make migrations on a seasonal basis to feed and spawn. Mackerel mainly feed on crustaceans including copepods, krill, and shrimp, and opportunistically on squid and small fish (NOAA 2013c).

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

Bigeye tuna are a tropical species that can be found in temperate to tropical waters from Nova Scotia to Brazil. They have a life expectancy of nine years and mature at about three years of age. 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).

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.

Black Dogfish

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 1,600 m, but are most common at depths of 550 to 1,000 m and temperatures between 3.5 and 4.5°C. The black dogfish preys on squid, benthic and pelagic crustaceans, shrimp, jellyfish, and fish species including redfish (FLMNH 2013a).

Black dogfish reproduce year-round. Females are ovoviviparous giving birth to 4 to 40 pups that measure 13 to 19 cm in length. In Canadian waters they give birth in parts of the Laurentian Channel.

Capelin

Capelin are a cold-water pelagic schooling fish, generally occurring in waters with temperatures between -1.5 and 14.0°C (Carscadden *et al.* 1989, Stergiou 1989, Brown 2002 in Bruneau and Gregoire 2011) and at depths between 40 and 150 m. Migration associated with spawning is influenced by water temperature (Carscadden *et al.* 1997, Carscadden *et al.* 2002, Mowbray 2002 in Bruneau and Gregoire 2011).

Capelin are not normally found in the Scotian Shelf or Bay of Fundy region and are unlikely to occur in the vicinity of the Project. However, there have been 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 very short-lived species and grow rapidly during the first four years of their lives, with growth rates averaging 2 to 3 cm/year and reaching 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, euphausiids, and amphipods, and they are an important prey item for many species of fish and marine mammals.

Swordfish

Swordfish can be found along the Gulf Stream and as far north as the Grand Banks. They 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). 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.

White Marlin

In western Atlantic waters, white marlin can be found in warm temperate waters and tropical waters. During the summer months, marlin migrate into Canadian waters off Nova Scotia and 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 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 in the Caribbean Sea, northwest of Grand Bahama Island (FLMNH 2013b).

Yellowfin Tuna

Yellowfin tuna migrate into Canadian waters, including the Scotian Shelf to feed during the summer months. Yellowfin have similar distributions as the albacore and bigeye tunas, sparsely populating the shelf edge and slope with higher numbers further offshore.

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.

5.2.5.3 Invertebrates

Table 5.2.7 summarizes the characteristics and distribution of invertebrate species of commercial, recreational, or Aboriginal value that are likely to occur in the Project Area. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history.

Table 5.2.7 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[1]	Timing of Presence
American lobster	*Homarus americanus*	Low	Year-round
Clams (Atlantic Surf, Soft-shelled, quahaugs)	*Spisula solidissima, Mya areniaria, Mercenaria mercenaria.*	Low	Year-round
Green sea urchin	*Strongylocentrotus droebachiensis*	Low	Year-round
Jonah crab	*Cancer borealis*	Low	Year-round
Atlantic sea scallop	*Placopecten magellanicus*	Low	Year-round
Northern shrimp	*Pandalus borealis*	Low	October to April – Nearshore May to September-Offshore
Shortfin squid	*Illex illecebrosus*	High	April to November[2]
Snow crab	*Chionoecetes opilio*	Low	Year-round

Note:
[1] This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.
[2] This is based on theoretical / assumed spawning times.

Sources: Choi *et al.* 2012; 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 (*Pandalus montagui*), Stimpson's surf clam (*Mactromeris polynyma*), and sea cucumber (Class *Holothuroidea*) which are prevalent on Sable Island Bank and Middle Bank.

American Lobster

Lobster can be found along the Atlantic coastline and on the Continental Shelf from Northern Newfoundland to South Carolina. Adult American lobsters are typically found in waters shallower than 300 m, and fished in waters less than 40 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 animals. They can also be found in areas with sand, gravel or mud substrates (DFO 2015h). Lobster can be found along the edges of the shelf; however, they are not fished offshore in the vicinity of the Project (Pezzack *et al.* 2009). Inshore populations can be found on almost all locations of the nearshore shelf. Lobsters can be found inhabiting waters ranging in temperature from -1.5 to 24°C (DFO 2015h).

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 2015h). Lobsters are active hunters feeding on a variety of species including crab, mollusks, polychaetes, gastropods, sea stars, sea urchins, and fish. They also act as scavengers and eat the dead remains of animals if they are available (Carter and Steele 1982, Elner and Campbell 1987, Gendron *et al.* 2001, Jones and Shulman 2008 in Pezzack *et al.* 2009).

Egg-bearing females will move inshore to hatch their eggs during the late spring to early summer. Once the larvae have hatched, they remain planktonic for approximately four moulting periods that last 10 to 20 days each before settling to the seabed (DFO 2015h).

Clams

Atlantic surf clams, soft-shelled clam, and northern quahog generally inhabit the inshore waters though individuals have been found at depths of 75 m (Duggan 1996). Spawning for all three species generally occurs in the summer months of June through August (Gibson 2003). The larvae remain planktonic for approximately two weeks before beginning settling into benthic habitats. Juvenilles are motile covering short distances, whereas adults are predominantly sessile. Inhabiting burrows in the silty to sandy substrates. Quahogs and Atlantic surf clams generally grow to marketable size in four to five years with soft-shelled clams growing at a slower rate (Gibson 2003).

Green Sea Urchin

Green sea urchins have a circumpolar distribution, ranging into the Arctic regions of both the Atlantic and Pacific Oceans. Urchins live mostly in shallow waters, with a preference for rocky bottom in areas that are not subject to extreme wave action, but they have been found occasionally at depths of more than 1,000 m (Miller 2000). Spawning occurs in early spring and the larvae are planktonic for 8 to 12 weeks before settling to the seafloor. Sea urchins predominantly graze on algae but will consume mussels, echinoderms, barnacles, whelks, sponges and fish carcases (Miller 2000).

Jonah Crab

Jonah crab are found from Newfoundland to South Carolina and Bermuda. Offshore Nova Scotia they are generally found at depths of 50 to 300 m. In coastal areas they prefer rocky substrates, and silt and clay substrates on the continental slope. They mainly feed on benthic invertebrates and will opportunistically scavenge on dead fish (DFO 2015 g).

Research on Jonah crab in Canadian waters has been limited. Studies along the eastern seaboard of the United States has shown inshore movement from spring through fall, followed by winter migration to deeper, warmer waters. Size and sexual segregation were also reported, with small females identified in waters less than 150 m depth, and males most abundant at depths greater than 150 m (Carpenter 1978, in Pezzack *et al.* 2011).

Although not commercially fished in the Project Area, ovigerous (egg-carrying) females have been reported on the Scotian Shelf (DFO 2015i).

Atlantic Sea Scallop

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. They live in discrete, and sometimes large, aggregates (beds) on the seabed. They feed by filtering planktonic organisms from the water column and can live up to 20 years (DFO 2015j; NOAA 2013q).

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 drift in the water column for four to six weeks before settling on the sea floor, generally in the vicinity of existing scallop aggregates (beds) (DFO 2015j; NOAA 2013q).

Northern Shrimp

Northern shrimp is the most abundant shrimp species in the northwest Atlantic (DFO 2013t). They can be found from Massachusetts to Greenland at water depths from 10 to 350 m (DFO 2015k; NOAA 2013m). On the Eastern Scotian Shelf, northern shrimp concentrate in “holes” at depths of more than 180 m, and nearshore concentrations have also been identified. They prefer water temperatures of 2 to 6°C and soft muddy substrates with high organic content (DFO 2015l).

Northern shrimp are important in marine food webs as they are an important prey item for many species of fish and marine mammals. Although a benthic species, northern shrimp migrate vertically through the water column at night (diel vertical migration) to feed on plankton in the pelagic zone (DFO 2015k). They also prey on benthic invertebrates (NOAA 2013m).

The northern shrimp is a hermaphroditic species (possesses the reproductive organs of both sexes). On the Scotian Shelf, they first reach maturity as a male at age of 2, and change gender by age of 4, and spend 1 to 2 years as a female (DFO 2015l). In the northwest Atlantic, mating occurs during the late summer to fall in offshore waters, with fertilized eggs remaining attached to the females 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 are pelagic and feed on planktonic organisms. After 3 to 4 months they settle to the seabed. 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

The life cycle of the shortfin squid is approximately one year in length (DFO 2015m). 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. Once the female has spawned she also dies off. The fertilized mass of eggs is pelagic and travels north in the Gulf Stream (DFO 2015m).

Squid larvae (known as 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). During the spring, juveniles and adults migrate to 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 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 (DFO 2015m).

Snow Crab

Snow Crab are a dominant macro-invertebrate on the Scotian Shelf since the decline of groundfish in the late 1980s and early 1990s. They generally are found in large numbers in water depths from 60 to 280 m and on soft-bottom substrates. On the Shelf they are generally found at water temperatures less than 6°C, and are at the southern-extreme of their geographic distribution in the northwest Atlantic (DFO 2015n). They are found in high concentrations on Western, Sable Island, and Banquereau Banks and their respective shelf edges (DFO 2013u).

Snow crab typically feed on shrimp, fish (capelin and lumpfish), sea stars, sea urchins, polychaetes, detritus, large zooplankton, other crabs, mollusks and anemones (DFO 2013u). Atlantic halibut, Atlantic wolffish, and skate species are the main predators of snow crab on the Scotian Shelf, though snow crab does not appear to be an important part of their diet (DFO 2015n).

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 that 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.* 2012). Adult males are defined by their terminal molt and only a portion will recruit into the fishery, with a minimum carapace width of 95 mm. It takes on average eight years for snow crab to be large enough to be retained by the fishery (DFO 2015n).

5.2.5.4 Species at Risk and Species of Conservation Concern

There are various fish SAR and SOCC that may be present on the Scotian Shelf or Slope (refer to Table 5.2.8). Status and presence in the vicinity of the Project for all identified marine fish SAR and SOCC is provided in Table 5.2.8. SOCC in Table 5.2.8 includes species that are listed by COSEWIC as endangered, threatened, or of special concern, but not yet listed in Schedule 1 of SARA. Details on mating, spawning and potential times and locations of species' larvae and eggs are provided in Table 5.2.3. Detailed descriptions for SAR and SOCC species are provided below. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history.

Table 5.2.8 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	Low	Year-round
American eel	*Anguilla rostrata*	Not Listed	Threatened	Transient	November -Silver eel out migration from NS March to July - Larvae and glass eels on the Slope and Shelf
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)		Not Listed	Endangered	Low	Winter – Deep water of Browns and LaHave Banks Summer- Southern Northeast 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)		Endangered	Endangered	Transient	March to November
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered	Transient	March to November

Table 5.2.8 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
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 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
Striped bass (Southern Gulf of St. Lawrence population)	*Morone saxatilis*	Not Listed	Special Concern	Low	June to October

Table 5.2.8 Fish Species of Special Status Potentially Occurring on the Scotian Shelf and Slope

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]	Potential for Occurrence in the Project Area[2]	Timing of Presence
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

Note:

[1] Species of conservation concern (SOCC) listed as endangered, threatened, or of special concern by COSEWIC, but not listed in Schedule 1 of SARA.

[2] This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and catch data for each species within the Project Area.

Sources: BIO 2013a; Campana *et al.* 2013; COSWEIC 2006a, 2006b, 2007a, 2008a, 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 2015

Acadian Redfish

The Acadian redfish live primarily along the Scotian Shelf edge and slope and in deep channels in water depths ranging from 150 to 300 m (DFO 2013 k). Migratory movement information is unknown for the species given they cannot be tagged (gas bladder ruptures when brought to the surface). Dispersal and migration is believed to be limited; however, 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 5 to 12 years (COSEWIC 2010c). They are 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 and larval extrusion occurs in the spring. Larvae may be present in the water column May to August feeding on copepods and fish eggs and 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 until they reach juvenile and adult stages where they will feed on copepods, euphausiids, and fish (COSEWIC 2010c). Abundance estimates for the mature population of Acadian redfish are based on scientific surveys conducted by DFO. The Acadian redfish has shown a substantial (>95 %) decline over one to two generations in areas where they were historically abundant, although in some areas abundance indices have been stable or increasing since the mid-1990s (COSEWIC 2010c). The abundance indices for this species fluctuate widely, but show no overall trends.

American Eel

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). Mature Silver eels spawn in the Sargasso Sea with hatching occurring from March to October and peaking in August. Larvae are transparent and willow-shaped and are transported to North American coastal waters by the Gulf Stream (COSEWIC 2012c). After approximately 7 to 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 and will run into the freshwater streams, 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. Yellow eels will remain in coastal areas or freshwater on average for 9 to 22 years before metamorphosing both morphologically and physiologically into silver eels (COSEWIC 2012c). Nova Scotian silver eels begin their outmigration to the Sargasso Sea in November travelling over 2,000 km to spawn for the only time during their life.

The population of American eels was examined using time series data to estimate the percent change in indices of abundance from the 1950s to the 2000s resulting in an almost uniformly negative (-7.1% to -96.2 %) within the species North American western range, while trends were mixed within the eastern portion of its range (COSEWIC 2012c). The index of recruitment for the Maritimes is based on elver catches and counts in the East River, Chester, Nova Scotia. The index shows wide annual fluctuations in elver recruitment with no apparent trend (COSEWIC 2012c).

American Plaice

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 or sandy sediments are present (DFO 2013i). Females are batch spawners and spawn batches of eggs for up to one month during April and 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 include the Banquereau, Western and Browns Banks (Horseman and Shackell 2009).

American plaice prefer water temperatures ranging from 1 to 4°C on the Scotian Shelf. They are opportunistic feeders consuming a variety of prey items such as polychaetes, echinoderms, mollusks, crustaceans, and small fish. Throughout their Canadian range, American plaice are limited to local movements made in response to seasonal changes in temperatures or prey availability (COSEWIC 2009b).

Estimates of mature population size are obtained from catch rates of fish of reproductive age from fishery-independent research surveys conducted by DFO. Rates of decline in adult abundance over a 36-year (2.25 generation) time series depicted that the Scotian Shelf Population has declined by 67% (COSEWIC 2009b).

Atlantic Bluefin Tuna

Atlantic bluefin tuna are highly migratory, with long and varied routes. 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) and can usually be found in Canadian waters in the summer. They have a life expectancy up to 20 years, maturing 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 that 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, and demersal and sessile fish and invertebrate species (NOAA 2013e).

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

Population estimates for the Atlantic bluefin tuna (mature population) show an initial steep decline from 1970 into the 1990s, with a small increase until the late 1990s, followed by a steady decline to the last data point in 2010. Population (age >9) numbers decreased from 264,842 individuals in 1970 to 66,865 in 1992 (75% decline), increased to 84,306 in 1998 (26%), and then declined to 65,923 in 2010 (22%)(COSEWIC 2011a).

Atlantic Cod

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 (COSEWIC 2010d). Peak spawning has been observed during the spring and 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 to 50 m of the ocean. Prey availability and temperature are the primary factors determining habitat selection for cod.

Laurentian South Population

Cod from this population overwinter in the waters off eastern Cape Breton and the Continental Shelf south of the Laurentian Channel returning to the Gulf between May to October, although there may be a resident population which does not return (COSEWIC 2010d). The Laurentian South population has declined 90 to 91% over the past three generations (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 Northeast Channel and in shallow waters of Browns and LaHave Banks (COSEWIC 2010d). The southern population has declined 59 to 64% over the past three generations (COSEWIC 2010d).

Atlantic Salmon

Atlantic salmon return to natal rivers to spawn after the completion of ocean scale migrations (COSEWIC 2010a). Adult salmon return to freshwater rivers after a feeding stage at sea from May to November and as early as March. Female salmon deposit eggs in gravel nests usually in gravel riffle sections of streams in October and November. 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 begin to hatch in April and remaining 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 and remain in freshwater for 1 to 8 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 May to November from their over wintering at sea locations to their native freshwater streams (COSEWIC 2010a). The majority of Atlantic salmon overwinter in the Labrador Sea and Flemish Cap Area with the major controlling factor for habitat choice of at sea being temperature. Salmon at sea can be found in temperatures ranging from 1 to 12.5°C, with the majority being found at temperatures of 6 to 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; however, 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). The most recent (2008) estimate for the Outer Bay of Fundy population was 7,584 adult salmon (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). The most recent (2008) estimate for the Inner Bay of Fundy population was less than 200 adult salmon (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). The most recent (2008) estimate for the Eastern Cape Breton population was 1,150 adult salmon (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). The most recent (2008) estimate for the Southern upland population was 1,427 adult salmon (COSEWIC 2010a).

Atlantic Sturgeon

Atlantics sturgeon can be found throughout the coastal waters of the Maritimes and on the Scotian Shelf, generally concentrated in water depths less than 50 m and are highly migratory (COSEWIC 2011b). Adults migrate into estuaries and rivers in the autumn between August and October or in the spring between May and 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 response 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 2011b).

Atlantic sturgeon use a variety of habitats at various points in their life cycle including rivers, estuaries, bays, and the open ocean (COSEWIC 2011b). They prey on benthic organisms such as polychaete worms, shrimp, amphipods, isopods, gastropods and small fish (sand lance). Reliable population estimates do not exist for the Atlantic sturgeon, but it is believed there are a minimum of 1,000 to 2,000 adults in the Maritimes population (COSEWIC 2011b).

Atlantic Wolffish

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 typically 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). An examination of wolffish landings in NAFO Division 4X revealed that Atlantic wolffish were concentrated on the western peak of Browns Bank, west of German Bank and in three isolated areas inshore of the 100 m contour line (LGL 2014). Juvenile and adult Atlantic wolffish live on the Scotian Shelf on rocky or sandy substrates; they do not use soft benthic habitats. Atlantic wolffish prey on mostly invertebrates (85%) including whelks, sea urchins, hermit crabs, crabs and scallops. A smaller portion of their diet consists of fish with their main prey being redfish (COSEWIC 2012b).

Atlantic wolffish make short migrations to spawning grounds, which are generally boulder and cave habitat 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 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). The number of Atlantic wolffish individuals in Canadian waters is estimated to exceed 49 million, with over 5 million mature individuals (COSEWIC 2012b). On the eastern Scotian Shelf, the abundance of mature individuals has declined by 99% since 1970, while the abundance of immature individuals has increased over the same period (LGL 2014). On the western Scotian Shelf, both immature and mature abundances have declined since 1970.

Basking Shark

Basking sharks are believed to have a life span of 50 years, with males maturing between 12 to 16 years of age and females maturing between 16 to 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 to 3.5 years and give birth to about six pups with an average length at birth of 1.5 to 2 m. The species feeds on zooplankton that 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. Observations have also been recorded on Georges Bank, the Northeast Channel, and the LaHave and Emerald Banks. Some sightings have also shown the species on Sable Island Bank and over the slope. Basking sharks are frequently seen during summer months, particularly the LaHave and Emerald Basins, where they may mate. They are rarely seen in other seasons but are believed to be found on the Scotian Slope at great depths during the winter. There is limited information regarding population sizes and trends, with total population estimates for Atlantic Canada ranging from a conservative estimate of 4,918 individuals to 10,125 individuals (COSEWIC 2009c).

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 1,200 m.

Blue Shark

Blue sharks are widespread, highly migratory and can be found worldwide in temperate and tropical oceans, generally in the offshore surface water (COSEWIC 2006a). 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 to 12 months, with birth usually occurring in the spring to fall. Abundance indices based on catch rates in or near Canadian waters show varying decline rates of blue sharks between near 0 to 53% since the mid–1990s (COSEWIC 2006a). The length of newborn pups averages 40 to 50 cm, taking four to five years to mature to a length of 193 to 210 cm. Blue sharks are opportunistic predators and prey upon bony fish, squid, birds, and marine mammal carrion.

Blue sharks are commonly found in offshore waters in depths up to 350 m, abundant along the coast of Nova Scotia including the shelf and slope during summer and fall from June to October. Blue sharks can be found in water temperatures between 5.6 to 28°C but prefer temperatures of 8 to 16°C. Temperature is believed to be a primary factor in migration (COSEWIC 2006a). Canadian waters provide habitat for primarily immature individuals although mature species are occasionally observed (COSEWIC 2006a).

Cusk

Cusk are commonly found between the Gulf of Maine and southern Scotian Shelf, particularly along the southwestern Shelf as well as noted as far up the shelf as Sable Island (SARA 2013b). Additionally, cusk can be found within the Gully and the Laurentian Channel. They prefer water depths of 200 to 600 m, inhabit benthic area consisting of a hard and rocky seabed, and feed on invertebrate species.

Cusk are a slow-growing and later-maturing species with males maturing at five years and females at seven (SARA 2013b). Spawning occurs between May and 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 bottom at a size of 50 to 60 mm. Larvae can be found over Georges and Roseway Basins, as well as from Browns to Sable Island Banks and respective shelf edges (Horseman and Shackell 2009). Population trends for the species indicate a decline of 93.4% from 1970 to 2001 (COSEWIC 2003).

Deepwater Redfish

Deepwater redfish have similar life history characteristics as the Acadian redfish, with the major difference being that they release their larvae 15 to 25 days earlier (COSEWIC 2010c). They are closely associated with the seafloor and commonly found inhabiting waters deeper than the Acadian redfish. The deepwater redfish extends from the Grand Banks to Baffin Bay and includes the Gulf of St. Lawrence, Laurentian Channel and the Labrador Sea (COSEWIC 2010c). They can be found in a wide range of habitats, using rocks and anemones as protection from predators. Commonly found inhabiting waters 350 to 500 m deep, the species can be found on the edge of the banks and in deep channels from the Labrador Sea to Sable Island. Redfishes are considered semi-pelagic because they make long daily vertical migration (COSEWIC 2010c). Migratory movement information is unknown because 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). Given the impossibility of rapidly differentiating between deepwater redfish and Acadian redfish, particularly in commercial catches, redfish stock assessments have always been done for all species combined (COSEWIC 2010c). The deepwater redfish has shown a substantial (>95%) decline over one to two generations in areas where they were historically abundant, although in some areas abundance indices have been stable or increasing since the mid-1990s (COSEWIC 2010c). The abundance indices for this species fluctuate widely, but show no overall trends.

Northern Wolffish

Northern wolffish range from northeast Newfoundland and across the North Atlantic with occasional occurrences on the Scotian Shelf (COSEWIC 2012d). On the Shelf, most northern wolffish are found in deep water, up to 1,500 m, in a narrow water temperature range of 3 to 5°C, and it is believed that temperature is a limiting factor in their distribution (COSEWIC 2012d). 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 (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 unlikely that larvae would be found in the vicinity of the Project. This species has only been caught in 30 of 7,200 research tows since 1970 on the Scotian Shelf, preventing an analysis of population trends for the species in this area (COSEWIC 2012d). Analysis of DFO commercial fishery landings data, which covers the periods April to September from 2005 to 2010, indicate that no northern wolffish were harvested in the Project Area within that six-year period (LGL 2014).

Porbeagle Shark

Porbeagle sharks are a pelagic species that can be found from the coast to the open sea; however, they are known to commonly inhabit continental shelves and ocean basins at depths up to 700 m. They have also been found closer to shore, although this is more occasional (SARA 2013a). Generally, porbeagle sharks in Canadian waters can be found at temperatures ranging from 5 to 10°C, with little variation from one season to the next, suggesting that they travel about to remain in the cold waters they prefer (SARA 2013a).

Male porbeagle sharks mature at eight years, with females mature at 13 and have a life expectancy of 25 to 46 years. Mating occurs from late September to November and females are ovoviviparous having a gestation period of eight to nine months. Females leave the Continental Shelf in December travelling at great depths (>500 m), swimming up to 2,500 km to the Sargasso Sea (DFO 2013e). Females give birth here in March and April inhabiting the deep, cool waters. The young 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 from September to November. There is a population which undertakes extensive annual migrations and from January to February, this population can be found in the Gulf of Maine, Georges Bank and the Southern Scotian Shelf. By the spring they can be found on the edge of the Scotian Shelf and in offshore basins. 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).

The most recent population estimate for this species in 2009 was thought to be approximately 197,000 to 207,000 individuals, which included 11,000 to 14,000 spawning females (COSEWIC 2014b). Since 1961, the abundance of this species has declined by 56 to 70%. This decline has been reduced over the last decade, due to a reduction in this fishery.

Roughhead Grenadier

The roughhead grenadier is a benthopelagic species that is closely associated with the seafloor. They are commonly found in water depths of 200 to 2,000 m on or near the continental slope of the Newfoundland and Labrador Shelves, the northeastern slope of the Grand Banks and off the Flemish Cap; however, they have been observed from 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 feeding on invertebrates, small fish, and squid (COSEWIC 2007a).

Roughhead grenadier are a slow-growing and late-maturing fish species with a long life cycle and low population turnover rate. Females mature at approximately 13 to 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 2007a).

Roundnose Grenadier

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 including Labrador and Northeast Newfoundland shelves and Davis Strait, although some captures have been made along the Scotian Slope. It is closely associated with the seafloor and commonly found inhabiting waters 800 to1,000 m in depth but has been found in water depths of up to 2,600 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.

Like the roughhead grenadier, the roundnose grenadier is a relatively long-lived, slow-growing species. Females reach maturity at about 10 years of age and have been reported with a maximum age of 60 years (COSEWIC 2008a). 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

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

The species can reach lengths of over 4 m. Females mature at 2.7 to 3 m at an average age of 17 years old. Females are ovoviviparous and have litters of 4 to 25 pups after a 15 to 18 month gestation period and have an estimated three-year parturition cycle. Pups are born at a length of 70 cm. Shortfin makos have a lifespan ranging from 25 to 45 years (COSEWIC 2006f). There are no reliable population-level stock estimates available for the shortfin mako in the North Atlantic. Trend estimates, based on declines in catch rates in the entire Northwest Atlantic, suggest that the shortfin mako populations may have decreased by up to 50% in the past 15 to 30 years (COSEWIC 2006f).

Smooth Skate

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 has been recorded at shallowest and deepest water depths of 25 m and 1436 m, respectively; however, densest concentrations occur between 150 and 550 m (COSEWIC 2012g). They can be found over a relatively narrow range of temperatures ranging from -1.3 to 15.7°C (BIO 2013a). Smooth skates prefer soft mud substrates 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. Smooth skate are generally slow to reproduce, producing 40 to 100 egg capsules per year. Females mature at an average age of 11 years. Females will lay an egg-capsule on the benthic substrate. Larval smooth skates develop in the egg capsule in one to two years before hatching (BIO 2013a). The estimate for the Laurentian-Scotian population of smooth skates is approximately 5,704,000 individuals (COSEWIC 2012g).

Spiny Dogfish

Spiny dogfish can survive in a variety of habitats occurring world-wide, from the intertidal zone to the shelf slope up to 730 m water depths, and in temperate and boreal waters. They are most abundant between Nova Scotia and Cape Hatteras with the highest concentration in Canadian waters being on the Scotian Shelf. The Atlantic population is believed to consist of resident and migrating species. They prefer a temperature range of 6 to 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 to 30 years. Females mature at 15 years and mate during the fall and early winter. After a gestation period of 18 to 24 months an average of six pups are born live in the winter which are approximately 25 cm in length (COSEWIC 2010b). Population estimates for this species on the Scotian Shelf from 2003 to 2007 are in the range of 150,000,000 individuals (COSEWIC 2010b).

Spotted Wolffish

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, but only occasionally seen on the Scotian Shelf (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.

On the Scotian Shelf, spotted wolffish are found in deep water, in a water temperature range of 2 to 8°C, and it is believed that temperature is a limiting factor in their distribution. The waters of the Scotian Shelf are generally too warm for spotted wolffish (COSEWIC 2012e).

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). Due to the occasional nature of this species on the Scotian Shelf, it is unlikely that eggs or larvae would be found in the vicinity of the Project. On the Scotian Shelf, this species has been caught in only 22 of 7,200 research tows since 1970. As a result, there are insufficient catch rates to estimate their population (COSEWIC 2012e). Analysis of DFO commercial fishery landings data, which covers the periods April to September from 2005 to 2010, indicate that no spotted wolffish were harvested in the Project Area within that six-year period (LGL 2014).

Striped Bass

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 including 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. This species has been considered in recognition of its importance to recreational and Aboriginal fisheries.

The striped bass is anadromous species meaning it 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 such as 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).

Thorny Skate (*Amblyraja radiate*)

The thorny skate can be found from Baffin Bay, Davis Strait, Labrador Shelf, Grand Banks, Gulf of St. Lawrence, Scotian Shelf and Bay of Fundy to Georges Bank. Highest concentrations can be found on the Eastern Scotian Shelf and the Lower Bay of Fundy (COSEWIC 2012a). The species is present in a range of water depths, but primarily from 18 to 1,200 m on substrates including sand, shell hash, gravel, pebbles, and soft muds. They are typically found in water temperatures of 0 to 10°C.

Thorny skates are a slow-growing species reaching maturity at 11 years of age. Females lay 6 to 40 eggs per year. It is believed that peak spawning occurs in the fall and winter months. On the Scotian Shelf, the most recent population numbers from 2008 to 2010 show that there are 21,706,610 thorny skates, including 1,145,152 mature individuals (COSEWIC 2012a).

White Shark

The white shark is rare in the northwest Atlantic (32 records in 132 years), as it is the northern edge of their range. Recorded sightings in the vicinity of the Project include the Bay of Fundy, Laurentian Channel, and Sable Island Bank. They can range in water depth from the surface to 1,300 m, are highly mobile, and migrate seasonally (COSEWIC 2006b). Individuals in Atlantic Canada are likely seasonal migrants belonging to a widespread Northwest Atlantic population (LGL 2014).

Females are ovoviviparous with a gestation period of 14 months, giving birth to an average of 7 pups. It is believed that pupping takes place in the Mid-Atlantic bight (COSEWIC 2006b). There have been no surveys in Canadian waters to determine the population size of the white shark. Information on the global population size is sparse, although most sources agree that the species is relatively rare (COSEWIC 2006b).

White Hake

In general, white hake reside on the Scotian Shelf and upper slope and prefer soft bottom substrates in water temperatures ranging from 5 to 11°C (DFO 2013l). High concentrations have been found on Georges Bank and the offshore banks of the Scotian Shelf. They are generally found near the bottom and are commonly captured over fine sediment substrates such as mud but have also been recorded on sand and gravel (COSEWIC 2013). Depth distribution is adjusted to find temperatures in the range of 4 to 8°C. 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 to 4 years with females maturing at 3 to 5 years. Female white hake can produce several million eggs each during the 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 to 60 mm, which can take 2 to 6 months (DFO 2013l). From June to September, spawning occurs in the Northumberland Strait with peak spawning in June. Additionally, a second summer spawning has been recorded on the Scotian Shelf (COSEWIC

2013). The abundance of juvenile and mature individuals has been estimated (COSEWIC 2013). In the 1970s the abundance of juveniles was estimated to be 12 million, which increased to 32 million in the 1980s and since then has declined to an average of 13 million in 2006-2011 (COSEWIC 2013). The abundance of mature individuals was estimated to be 15 million in the 1970s, declining to 6 million in 1980 and rebounding to 30 million in the mid-1980s. Since then, the adult abundance has declined to an average of 8.3 million between 2006-2011 (COSEWIC 2013).

5.2.6 Marine Mammals

5.2.6.1 Overview

There are three groups of marine mammals that can be found on the Scotian Shelf and Slope including the Mysticetes (toothless/baleen whales), Odontocetes (toothed whales), and Phocids (Seals).

There are six species of Mysticetes and eleven species of Odontocetes known to occur on the Scotian Slope (Stantec 2014a and 2014b) that could potentially be present in the Project Area (refer to Table 5.2.9). On the Scotian Shelf and Slope there is also critical habitat for endangered species including the North Atlantic right whale and the northern bottlenose whale. Critical habitat for the endangered North Atlantic right whale has been identified in Roseway Basin on the Scotian Shelf within 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 also been sightings along the shelf break and within Dawson and Verrill Canyons that are within the Project Area. Table 5.2.10 presents 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 Scotian Slope (Phase 1B and 3B) (Stantec 2012a, 2014b).

Figures 5.2.14 and 5.2.15 display sightings data of Mysticetes and Odontocetes, respectively, between 1911 and 2013 as provided by DFO. Data have been collected from various sources over the years, including sightings from fishing and whaling in the 1960s and 1970s, opportunistic observer programs on fishing vessels, and scientific expeditions by DFO, non-government organizations, and Dalhousie University research teams. The various survey efforts are not consistent or rigorously applied and the lack of sightings does not necessarily represent lack of species presence in a particular area. Given these inconsistencies across all data collections areas, the data have not been completely error-checked nor undergone comprehensive quality control. The data set shown in the figures provides an insight into the long term distribution of the species however it is important to note that it does not give a representation of a typical day, week, month or even year of sightings or animal presence.

Individual species maps are provided in Appendix E and use data from the Ocean Biogeographic Information System (OBIS). This data set combines marine mammal data from a variety of sources including but not limited to:

- Bureau of Land Management (BLM) Cetacean and Turtle Assessment Program (CETAP);
- Canadian Wildlife Services – Environment Canada (CWS-EC) Eastern Canada Seabirds at Sea (ECSAS);
- Programme Intégré de recherches sur les oiseaux pélagiques (PIROP) Northwest Atlantic 1965–1992;
- DFO Maritimes Region Cetacean Sightings;
- National Oceanic and Atmospheric Administration (NOAA); and
- NOAA Northeast Fisheries Science Center (NEFSC) surveys.

Table 5.2.9 Marine Mammals Known to Occur in the Vicinity of the Project Area

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

Table 5.2.9 Marine Mammals Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Potential for Occurrence in the Project Area[1]	Timing of Presence
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Endangered	Endangered	Low	Year-round
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Special Concern	Low	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	Low	Summer to Fall
White-beaked dolphin	*Lagenorhynchis albiorostris*	Not Listed	Not at Risk	Low	Year-round
Phocids (Seals)					
Grey Seal	*Halichoerus grypus*	Not Listed	Not at Risk	High	Year-round
Harbour Seal	*Phoca vitulina*	Not Listed	Not at Risk	Moderate	Year-round
Harp Seal	*Pagophilus groenlandicus*	Not Listed	Not at Risk	Moderate	Winter to early Spring
Hooded Seal	*Cystophora cristata*	Not Listed	Not at Risk	Moderate	Winter to early Spring
Ringed Seal	*Pusa hispida*	Not Listed	Not at Risk	Low	Winter to early Spring

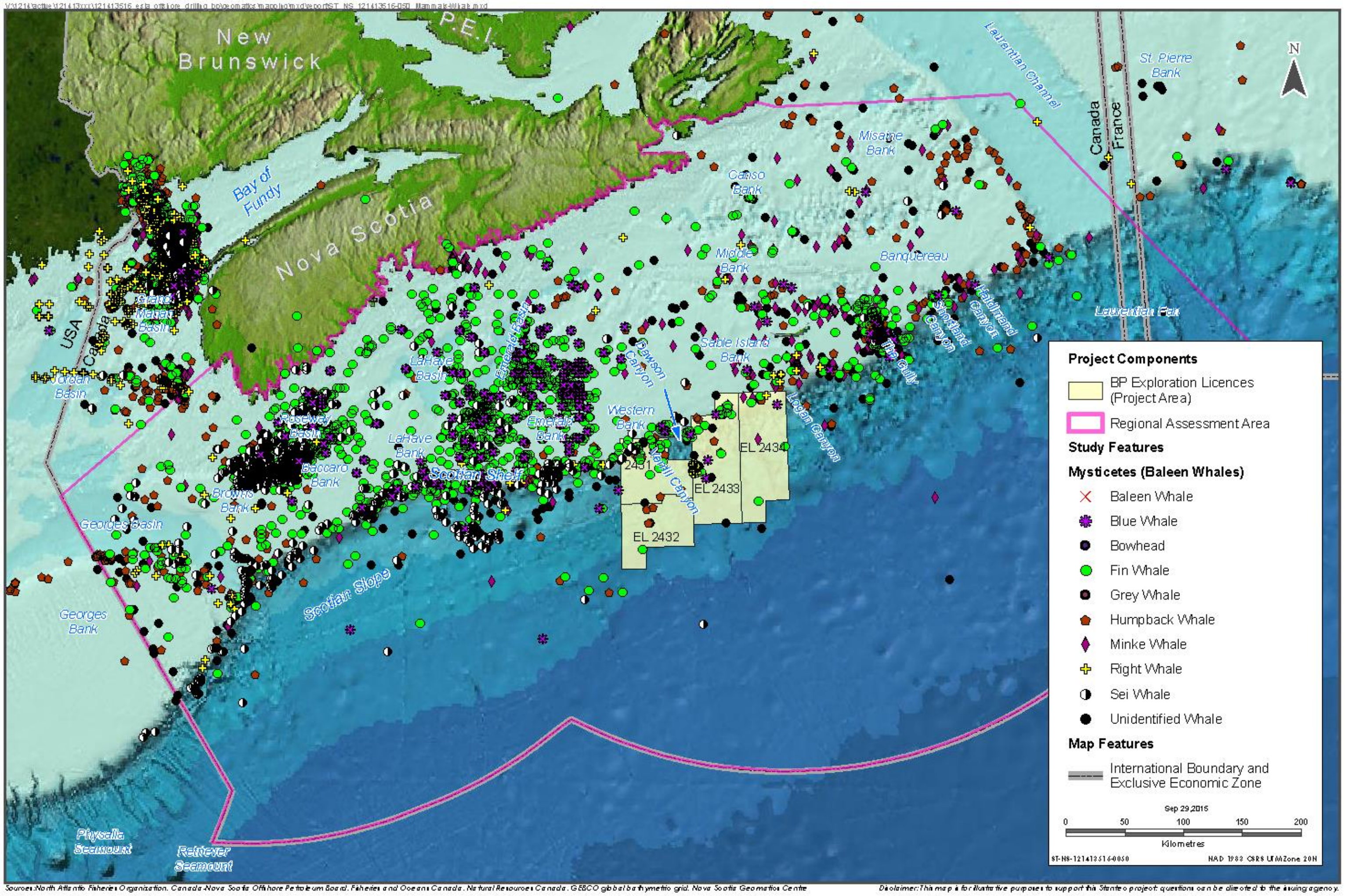
Note:
[1] This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and sightings data for each species within the Project Area.

Sources: Modified from Stantec 2014b and Stantec 2012a

Table 5.2.10 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*						🟦	🟦	🟦	🟦	🟦	🟦	🟦
Bottlenose dolphin	*Tursiops truncates*	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
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	*Lagenorhynchus albirostris*	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Phocids (Seals)													
Grey Seal	*Halichoerus grypus*	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Harbour Seal	*Phoca vitulina*	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Harp Seal	*Pagophilus groenlandicus*	🟦	🟦	🟦									🟦
Hooded Seal	*Cystophora cristata*	🟦	🟦	🟦									🟦
Ringed Seal	*Pusa hispida*	🟦	🟦	🟦									🟦
🟦	Timing of Presence on the Scotian Shelf and Slope												

Source: Modified from Stantec 2014a



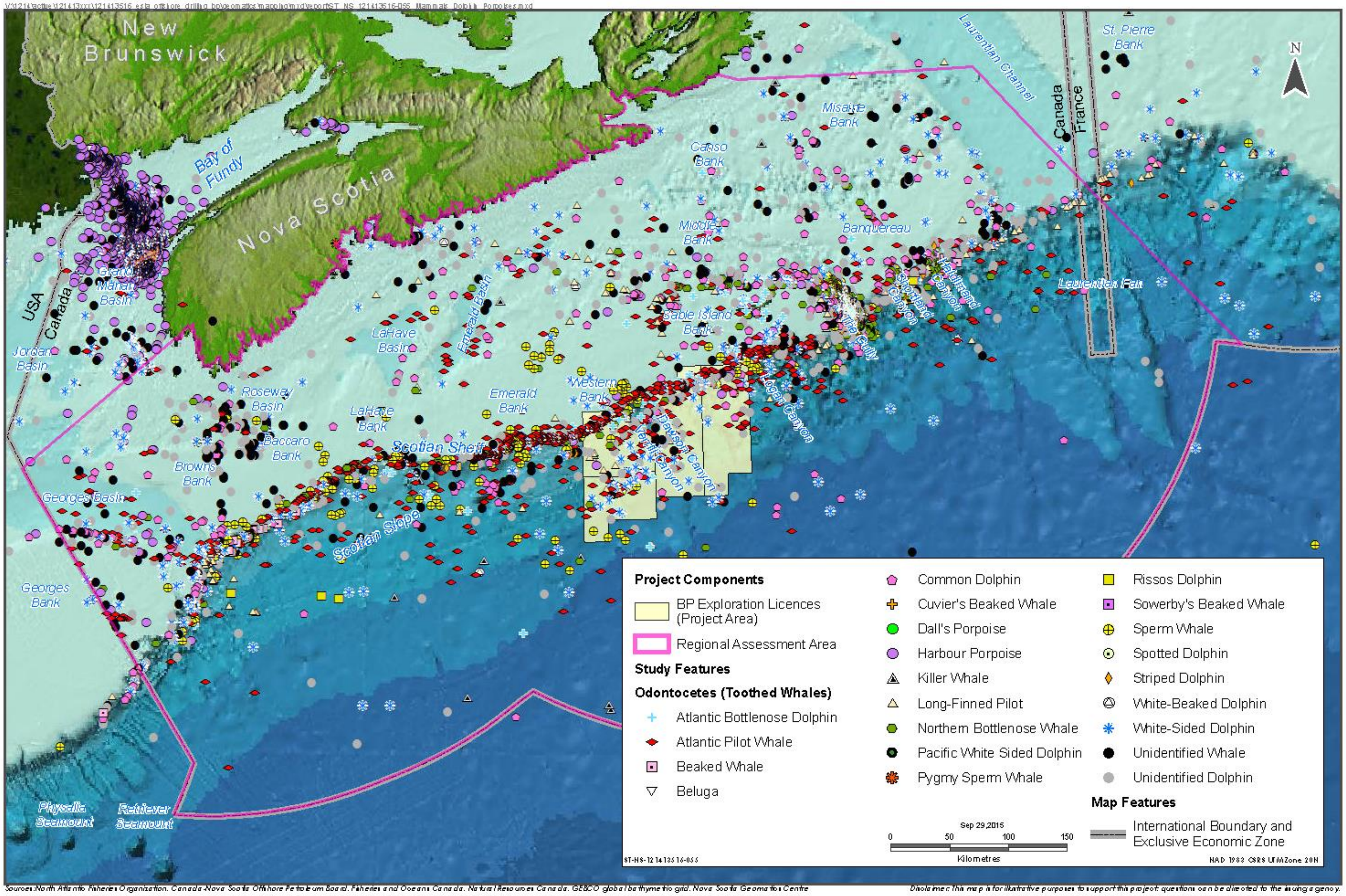
Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Sources:

Data provided from NAFO, CNSOPB, DFO, and NSDNR (n/d).

Figure 5.2.14 Total Mysticetes Sightings (1911–2013) on the Scotian Shelf and Slope

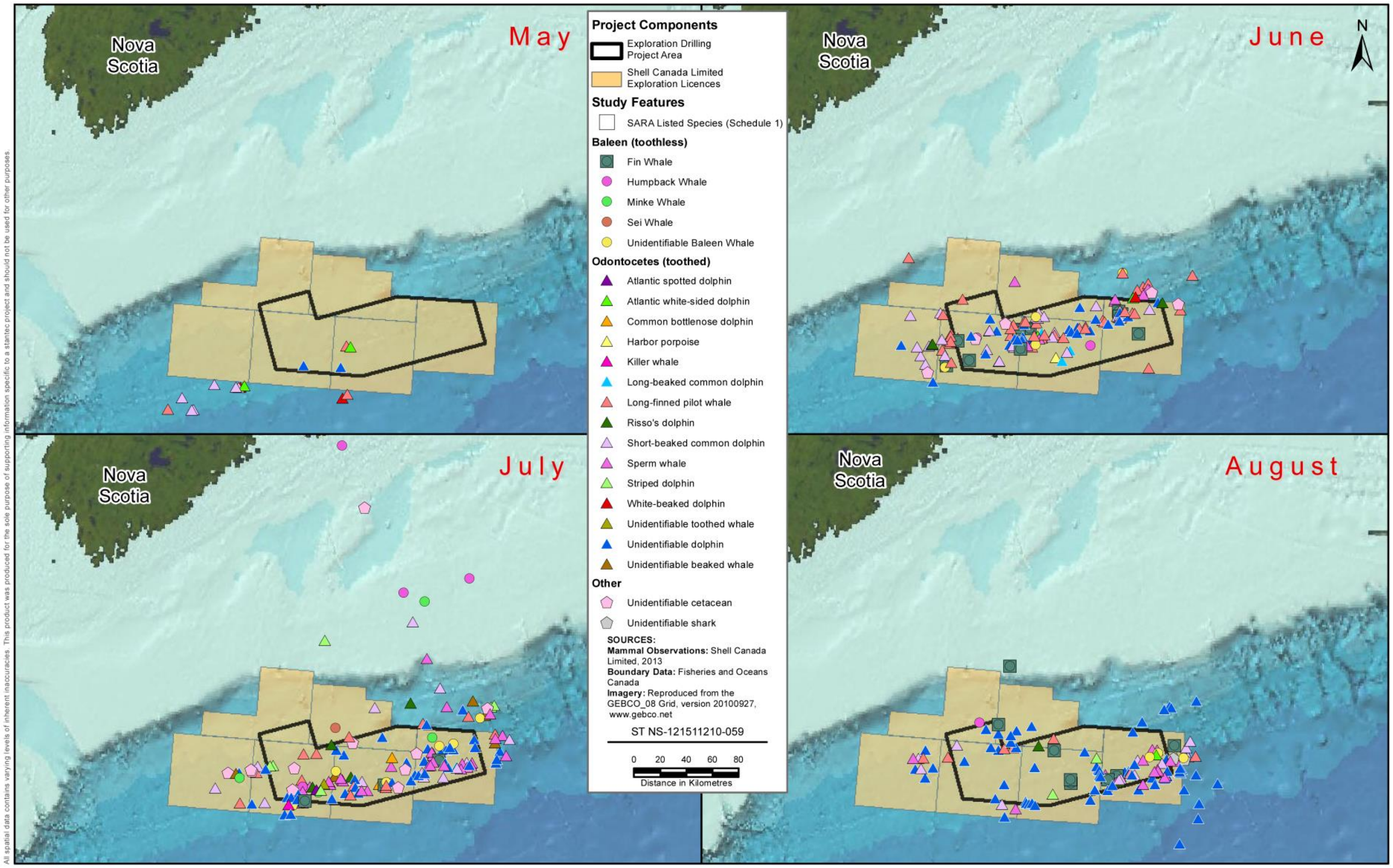


Sources: Data provided from NAFO, CNSOPB, DFO, and NSDNR (n/d)

Figure 5.2.15 Total Odontocete Sightings (1911–2013) on the Scotian Shelf and Slope

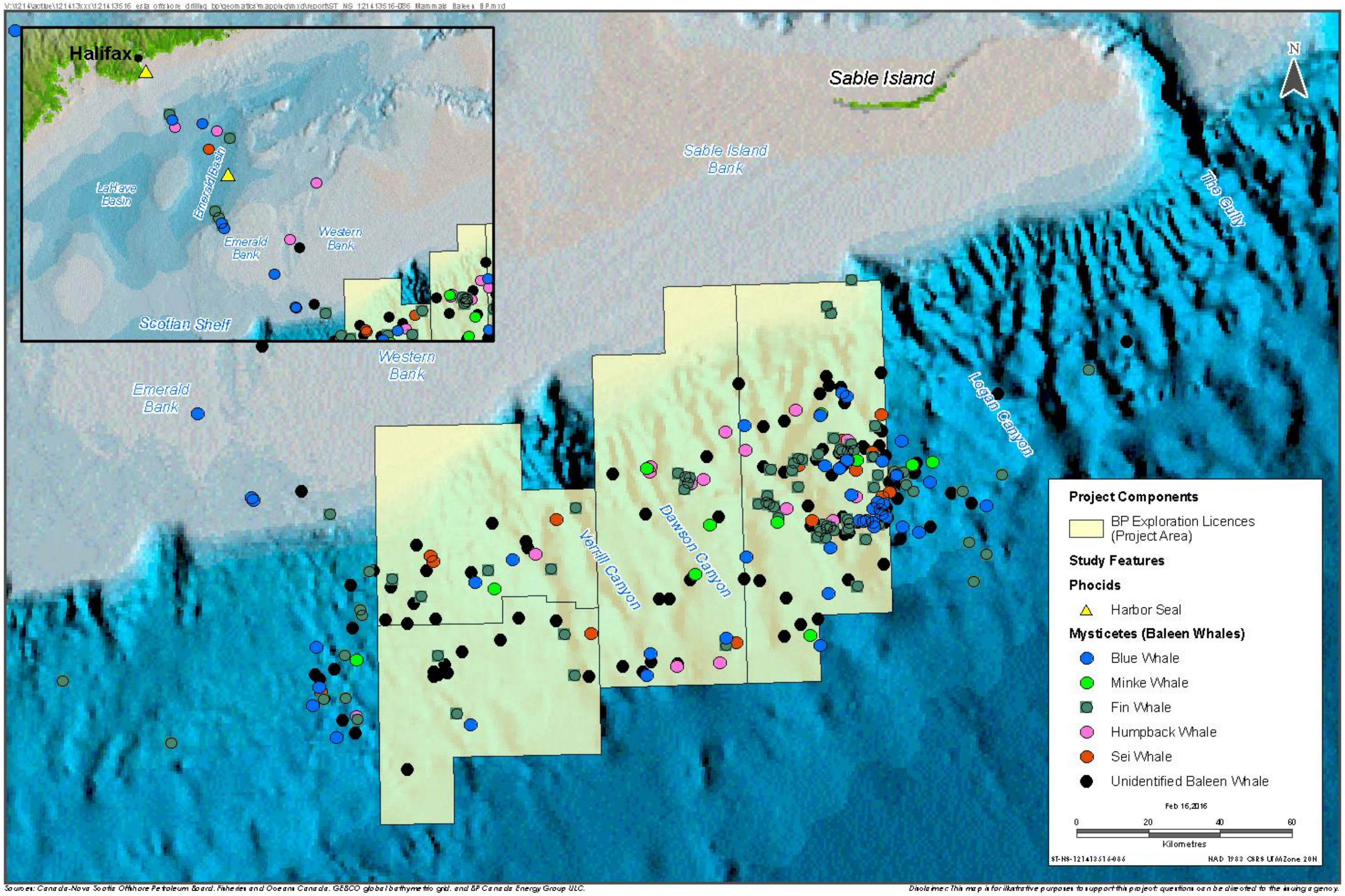
As shown on Figures 5.2.14 and 5.2.15, cetaceans are sighted more often in areas where there are greater bathymetric changes such as along the shelf edge, in the slopes of basins on the shelf, and in the canyons connecting the deep slope waters up to the shallower waters of the shelf. These figures do not include observational data collected during the Shelburne Basin 3D Seismic Survey by Shell Canada Limited between June and August 2013 and the Tangier 3D Seismic Survey by BP conducted in 2014 between May and September. These data for the Shelburne Basin 3D Seismic Survey were recorded daily and reported on a weekly basis and provide some insight on the types of species observed in the area located directly adjacent and west of the Project Area during the summer months (refer to Figure 5.2.16). Similarly, data from the Tangier 3D Seismic Survey provided insight on the types of species observed within the Project Area using visual and acoustic monitoring efforts (refer to Figures 5.2.17 and 5.2.18). 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.

Marine wildlife monitoring during BP's Tangier 3D Seismic Survey identified 15 odontocete (*i.e.*, toothed whale) species, 5 mysticete (*i.e.*, baleen whale) species and one phocid species. Sperm whales (*Physeter macrocephalus*) were overall the most commonly observed species during the monitoring program accounting for 20% of all visual detections (RPS 2014). Long-finned pilot whales (*Globicephala melas*) and short-beaked common dolphins (Delphinus delphis) were the most commonly observed odontocete species, and fin whales *(Balaenoptera physalus*) and blue whales (*Balaenoptera musculus*) the most commonly observed baleen whales (RPS 2014). A summary of marine mammal detections from the Tangier 3D Seismic Survey in 2014 is shown in Table 5.2.11.



Source: Stantec 2014a

Figure 5.2.16 Marine Mammal Observations Collected during the 2013 Shelburne Seismic Survey



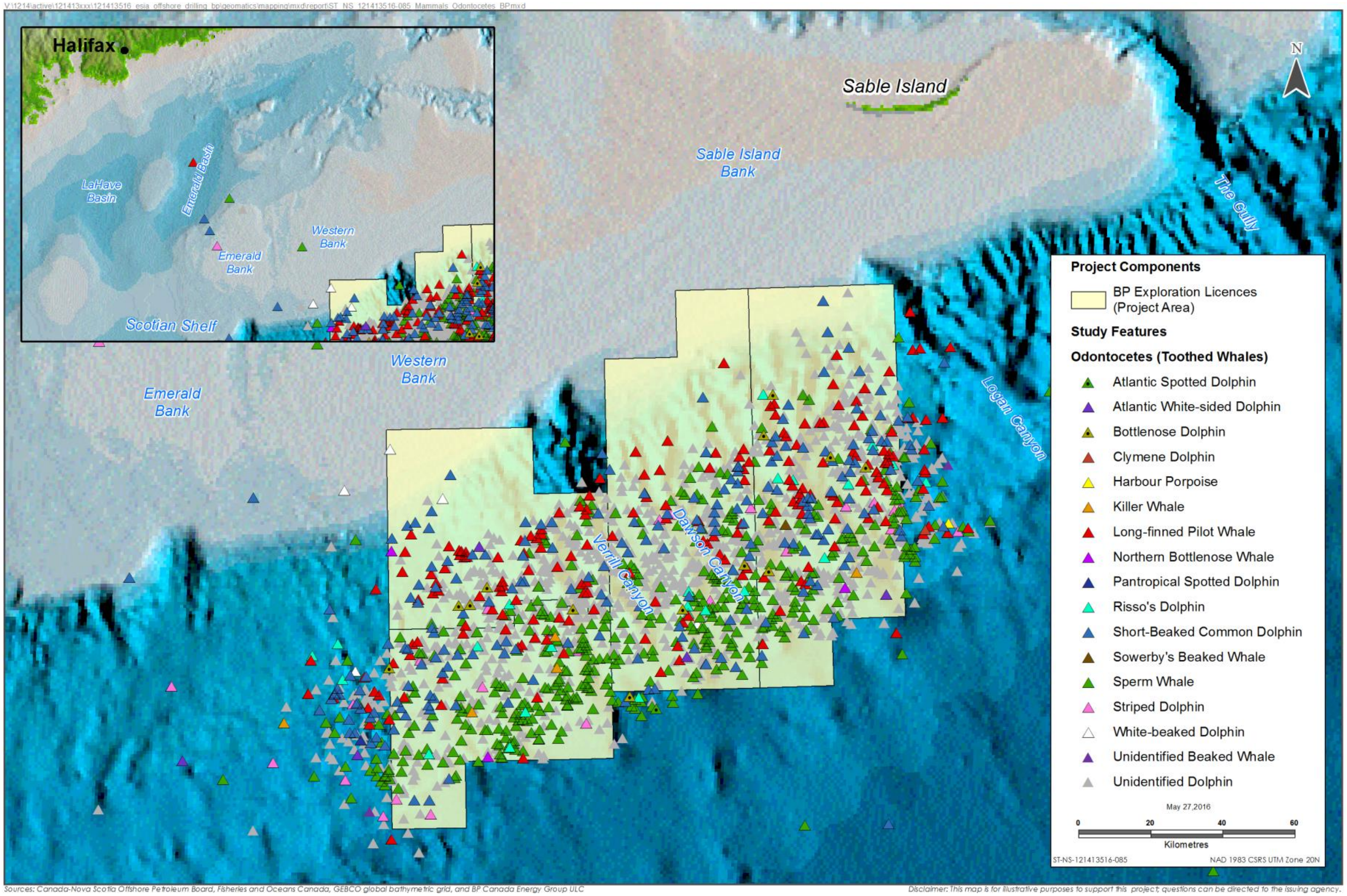
Sources: Canada-Nova Scotia Offshore Petroleum Board, Fisheries and Oceans Canada, GEBCO global bathymetric grid, and BP Canada Energy Group ULC.

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: Data provided from CNSOPB, DFO, and BP Canada Energy Group ULC

Figure 5.2.17 Mysticetes and Phocid Observations Collected during the 2014 Tangier 3D Seismic Survey

V:\1214\active\121413xxx\121413516_esia_offshore_drilling_bp\geomatics\mapping\mxd\report\ST_NS_121413516-085_Mammals_Odontocetes_BP.mxd



Sources: Canada-Nova Scotia Offshore Petroleum Board, Fisheries and Oceans Canada, GEBCO global bathymetric grid, and BP Canada Energy Group ULC

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: Data provided from CNSOPB, DFO, and BP Canada Energy Group ULC

Figure 5.2.18 Odontocete Observations Collected during the 2014 Tangier 3D Seismic Survey

Table 5.2.11 Summary of Marine Mammal Detections during the 2014 Tangier 3D Seismic Survey

Common Name (months/periods of peak abundance)	Number of Visual Detections			Number of Acoustic Detections			Number of Concurrent Visual and Acoustic Detections			Grand Total[2]
	Source Active[1]	Source Inactive	Total	Source Active	Source Inactive	Total	Source Active	Source Inactive	Total	
Mysticetes										
Blue Whale (July and August)	20	22	42	0	0	0	0	0	0	42
Fin Whale (June to August)	41	32	73	0	0	0	0	0	0	73
Humpback Whale (June and August)	12	10	22	0	0	0	0	0	0	22
Minke Whale (June and July)	4	6	10	0	0	0	0	0	0	10
Sei Whale (July and August)	5	13	18	0	0	0	0	0	0	18
Unidentified Baleen Whale (June to August)	53	43	96	1	0	1	0	0	0	97
Odontocetes										
Northern Bottlenose Whale (June)	0	1	1	0	0	0	0	0	0	1
Sowerby's Beaked Whale	0	0	0	0	1	1	0	0	0	1
Sperm Whale (August)	163	40	203	109	25	134	4	1	5	342
Unidentified Beaked Whale (May)	0	1	1	0	1	1	0	0	0	2
Harbour Porpoise (August)	0	1	1	0	0	0	0	0	0	1
Atlantic Spotted Dolphin (September)	1	0	1	0	0	0	0	0	0	1
Atlantic White-Sided Dolphin (September)	0	5	5	0	0	0	0	0	0	5
Bottlenose Dolphin (July)	4	3	7	0	0	0	0	1	1	8
Clymene Dolphin (August)	0	0	0	0	0	0	0	1	1	1
Killer Whale (August)	0	1	1	1	0	1	0	0	0	2
Long-Finned Pilot Whale (June)	92	68	160	2	0	2	0	4	4	166
Pantropical Spotted Dolphin (August)	0	1	1	0	0	0	0	0	0	1
Risso's Dolphin (July and August)	14	9	23	0	0	0	0	0	0	23
Short-Beaked Common Dolphin (June and July)	63	72	135	2	17	19	0	3	3	157
Striped Dolphin (July and August)	5	12	17	0	0	0	0	0	0	17
White-Beaked Dolphin (May)	0	5	5	0	0	0	0	0	0	5
Unidentified Dolphin (June and July)	67	51	118	634	225	859	0	1	1	978
Phocids										
Harbour Seal (August)	0	3	3	0	0	0	0	0	0	3

Note: There is the potential for MMOs to double count an individual, thereby affecting the total number counted.

[1] Seismic source array active.

[2] Grand Total is the total of all observed species.

Source: Modified from RPS 2014

5.2.6.2 Mysticetes (Baleen Whales)

The following section describes mysticetes that may be found in the Project Area or on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of SAR and SOCC mysticetes can be found in Section 5.2.6.4.

Minke Whale (*Balaenoptera acutorostrata)*

Minke whales can be found in every ocean around the world. Minke whales found in Canadian waters belong to the Canadian East stock inhabiting areas from the Gulf of Mexico in the south to the Davis Strait in the north (DFO 2011a). Generally, Minke whales are found along the Continental Shelf feeding on plankton, krill, and small fish including capelin, cod, eels, herring, mackerel, salmon, sand lance, and wolffish. Minke whales are common in Canadian waters during the spring and summer.

Minke whales have a lifespan of 50 years, reaching maturity at approximately six years of age for males and seven years of age for females (DFO 2011a). It is believed that mating occurs during the winter in tropical and subtropical waters, followed by a gestation period of 10 to 11 months. Females give birth to a single calf. Figure 1 in Appendix E represents observation data for minke whales from 1964 to 2013.

Sei Whale (*Balaenoptera borealis*)

In Atlantic Canadian waters sei whales can be found from Georges Bank in the south to Labrador in the north with a large portion of the population on the Scotian Shelf during the summer and early autumn months. The southern portion of their range extends to the Gulf of Maine and Georges Bank with an abundance of sightings on eastern Georges Bank and along the southwest edge of the Bank (DFO 2011a). Sei whales generally use pelagic habitats over deeper water of up to the 2,000 m depth. Along the Scotian Shelf they are most associated with the shelf edge and the upper slope waters feeding 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 to 70 years. Mating and calving occurs at lower latitudes during the winter months followed by a gestation period of 10 to 12 months (DFO 2011a). Calves are weaned from their mothers at approximately six months of age. Figure 2 in Appendix E represents observation data for sei whales from 1964 to 2013.

Humpback Whale (*Megaptera novaeangliae*)

The humpback whale is considered special concern under Schedule 3 of SARA and is not listed under COSEWIC. Humpback whales can be found in every ocean in the world (DFO 2011a). In Atlantic Canadian waters humpback whales are generally sighted in coastal waters from the Gulf of Mexico to southeastern Labrador and are common in the summer (DFO 2011a).

Humpback whales undergo extensive seasonal migrations with Newfoundland and Gulf of Maine subpopulations migrating to the Scotian Shelf and Slope during the summer months to forage. Humpbacks migrate to southern waters to overwinter and breed in tropical waters in the fall and 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 12 in Appendix E represents observation data for humpback whales from 1966 to 2013.

5.2.6.3 Odontocetes (Toothed Whales)

The following section describes odontocetes that may be found in the Project Area or on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of SAR and SOCC odontocetes are provided in Section 5.2.6.4.

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

Atlantic white-sided dolphins are distributed throughout the Continental Shelf and Slope areas of the North Atlantic, primarily found on the Continental Shelf in waters up to 100 m in depth and from western Greenland to North Carolina (NOAA 2013n). There are believed to be three stocks of the species including 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. Generally, they move inshore and to the north in the summer, and offshore and south during the winter (NOAA 2014b). Atlantic White-sided dolphins can be found throughout the RAA year-round and are more common during the summer and fall months. Figure 3 in Appendix E represents observation data for Atlantic white-sided dolphins from 1967 to 2013.

Bottlenose Dolphin (*Tursiops truncates*)

The bottlenose dolphin has been observed in the Project Area, although it has been more commonly observed in and around canyons on the Scotian Slope, including, but not limited to, the Gully. The bottlenose dolphin is one of the most well-known species of marine mammals, as it is the most common cetacean species held in captivity (OBIS-SEAMAP 2014). Bottlenose dolphins are found primarily in coastal and continental shelf waters of tropic and temperate regions, are considered generalists in terms of habitat, and have highly diverse and adaptable behavioral and social systems (OBIS-SEAMAP 2014). They use high-frequency echolocation to locate and capture prey, which can include benthic invertebrates and fish in the nearshore, or pelagic squid and fish in the offshore (NOAA 2014d). The main threats to this species include direct harvests and fisheries bycatch (OBIS-SEAMAP 2014). The Atlantic Ocean population of bottlenose dolphin is assessed by COSEWIC as Not at Risk. Figure 4 in Appendix E represents observation data for bottlenose dolphins from 1968 to 2013.

Long-finned Pilot Whale (*Globicephala melas*)

Long-finned pilot whales can be found from the waters off North Carolina to North Africa and north to Iceland, Greenland and the Barents Sea (Waring *et al*. 2015) and can be found on the Scotian Shelf and Slope year-round. They frequent coastal waters of Cape Breton during the summer months moving further offshore during the winter. The species tend to inhabit areas of high relief and submerged banks as well as being 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 12 to 16 months (Reeves *et al.* 2002; NOAA 2014c). 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. Figure 5 in Appendix E represents observation data for long-finned pilot whales from 1967 to 2013.

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin is a widely distributed cetacean species, inhabiting tropical, sub-tropical, and temperate areas. In the Northwest Atlantic, the species can be found from Newfoundland to Florida (Reeves *et al.* 2002). During the summer and autumn months, the species can be found on the Scotian Shelf and Slope once water temperatures increase above 11°C (NOAA 2013n; Waring *et al*. 2015). Females remain in lower latitudes during calving and lactation periods in the late spring to early summer after a gestation period of 10 to 11 months (Reeves *et al.* 2002). Short-beaked common dolphins feed primarily on schooling fish and squid. Figure 6 in Appendix E represents observation data for short-beaked common dolphins from 1967 to 2013.

Sperm Whale (*Physeter macrocephalus*)

The sperm whale can be found along the Scotian Shelf edge and commonly in the submarine canyons of the shelf as it is regularly seen in the Gully and on the eastern end of the Scotian Shelf and Slope in water depths of 200 to 1,500 m. Sperm whales are also found along the edge of the Laurentian and Northeast Channels and in areas where water mixes to produce areas of high primary productivity. 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 whales breed in tropical and sub-tropical waters where the majority of mating occurs during the spring. The gestation period lasts up to 18 months (Reeves *et al.* 2002) and nursing lasts for at least two years with some calves nursing longer. Sperm whales feed on or near the bottom of the ocean where their primary prey include squid, octopus, skates, sharks, and various benthic fish species. Figure 7 in Appendix E represents observation data for sperm whales from 1919 to 2013.

Striped Dolphin (*Stenella coeruleoalba*)

The striped dolphin can be found from Cape Hatteras to the southern margin of Georges Bank as well as offshore on the continental slope and 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). Striped dolphins have been occasionally sighted on the Scotian Shelf over the winter months. Striped dolphins prey upon small schooling fish species such as herring, capelin, mackerel, and squid (Reeves *et al.* 2002).

Striped dolphins are born in the late summer or early fall after a gestation period of one year. Calving takes place in large schools of 30 or more individuals comprised of adults, calves and juveniles for a period lasting four years (Reeves *et al.* 2002). Figure 8 in Appendix E represents observation data for striped dolphins from 1967 to 2013.

White-beaked Dolphin (*Lagenorhynchus albirostris*)

The white-beaked dolphin is a year-round resident in waters from Cape Cod to Greenland. They are usually found in social groups of 5 to 30 individuals, and occasionally in groups as large as 1500 (NOAA 2012b.) Little information is known about the reproductive cycle of the white-beaked dolphin. It is believed that the species calves from May to September after a gestation period of 11 to 12 months (NOAA 2012b). 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). Figure 9 in Appendix E represents observation data for white-beaked dolphins from 1968 to 2013.

5.2.6.4 Species at Risk and Species of Conservation Concern

There are seven marine mammal SAR and SOCC species that may be present on the Scotian Shelf or Slope (refer to Table 5.2.9 and Figure 5.2.19). Marine mammal SAR and SOCC are defined as those that are listed as endangered, threatened, or of special concern by SARA or by COSEWIC. See below for detailed descriptions of each marine mammal SAR and SOCC. 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 Tables 5.2.9 and 5.2.10.

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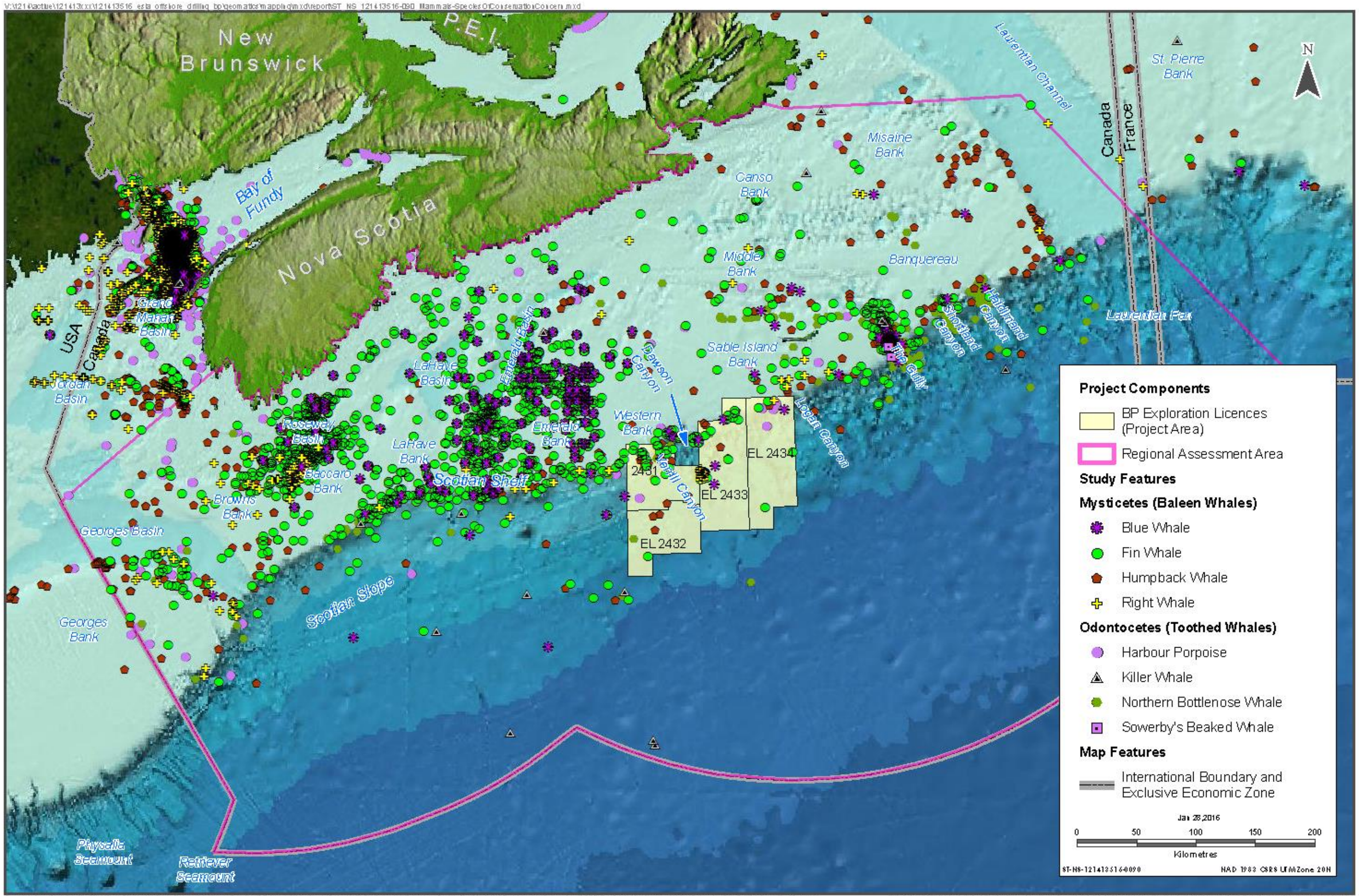


Sources:North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Source: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d)

Figure 5.2.19 Marine Mammal Species of Conservation Concern

Mysticetes (Baleen Whales)

Blue Whale (*Balaenoptera musculus*)

The blue whale is listed as endangered under both SARA (Schedule 1) and COSEWIC. The blue whale has a large range with the Atlantic population observed mainly in the St. Lawrence Estuary and shallow coastal zones where mixing and upwelling produces high numbers of krill (Beauchamp *et al.* 2009; LGL 2014). Blue whales feed in these cold upwelling zones in temperate and polar waters from spring to early winter. Between 20 and 105 blue whales are seen annually in the Gulf of St. Lawrence with a total of 382 individuals catalogued in the Gulf since 1979 (SAR Registry website). Little is known about the population size of blue whales except for the Gulf of St. Lawrence area (LGL 2014). Given the small proportion of the distribution range that has been sampled and considering the low number of blue whales encountered and photographed in a given year, the current data based on photo-identification do not allow for an estimate of abundance of this species in the Northwest Atlantic with a minimum degree of certainty (LGL 2014). DFO suggests that 400 to 600 individuals may be found in the western North Atlantic, while COSEWIC (2002b) estimates that the number of mature adults is less than 250 (LGL 2014).

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 to 1969, although they have been rarely sighted since this time period (COSEWIC 2002b). The blue whale has a low population density and can be found in small migrant herds, surfacing every 5 to 15 minutes for breathing.

Blue whales mate and calve from late fall to mid-winter in the Northern Hemisphere (COSEWIC 2002b). Male and female blue whales reach sexual maturity from 5 to 15 years. Females give birth to a single calf every two to three years after a gestation period of 10 to 11 months. The life expectancy of blue whales is believed to be approximately 70 to 80 years, 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). Figure 10 in Appendix E represents observation data for blue whales from 1966 to 2012.

Fin Whale (*Balaenoptera physalus*)

The fin whale is listed as special concern under SARA Schedule 1 status and COSEWIC. 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. Based on aerial surveys conducted from northern Labrador to the Scotian Shelf in July to August 2007, an estimated 1,967 fin whales occur in this region (LGL 2014). The abundance estimate for the western North Atlantic stock is 3,522 individuals (LGL 2014).

Fin whales reach sexual maturity at 5 to 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 and is followed by a gestation period of 11 to 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 11 in Appendix E represents observation data for fin whales from 1964 to 2013.

North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale is listed as endangered under Schedule 1 of SARA and COSEWIC. 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, including the Grand Manan Basin in the lower Bay of Fundy and the Roseway Basin on the Western 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 522 (Pettis and Hamilton 2014). Figure 13 in Appendix E represents observation data for right whales from 1964 to 2013.

Odontocetes (Toothed Whales)

Harbour Porpoise (*Phocoena phocoena*)

The harbour porpoise is listed as threatened under Schedule 2 SARA and special concern under COSEWIC. Harbour porpoises can be found from the Bay of Fundy to Baffin Island in the Northwest Atlantic. Harbour porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region in the summer from July to September in waters generally less than 150 m deep (Gaskin 1977; Kraus *et al*. 1983; Palka 1995a; Palka 1995b in Waring *et al*. 2015). During the fall from October to December and the spring from April to June, they are widely dispersed from New Jersey to Marine (Waring *et al*. 2015). From January to March, harbour porpoises can be found in waters off New Jersey to North Carolina with some sightings in waters off New York to New Brunswick. 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. Compared to other cetaceans the harbour porpoise reaches sexual maturity at a relatively early age in approximately three years and is highly productive (COSEWIC 2006c). Mating occurs during late spring to early summer followed by a gestation period of 10 to 11 months, followed by a lactation period of six months. Most females mate each year therefore spending their entire adult lives both lactating and pregnant. Figure 14 in Appendix E represents observation data for harbour porpoise from 1966 to 2013.

Killer Whale (*Orcinus orca*)

Killer whale is listed as special concern under COSEWIC and is not listed under SARA. 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 are characterized as relatively uncommon or rare and are now only occasionally sighted in the Gulf of St. Lawrence and the St. Lawrence estuary. Sighting events from 1785 to 2012 found that sightings were more common from June to September and have been more frequent over the last ten years potentially due to increased public awareness and increased boating, people and cameras during these months (Warning *et al*. 2015).

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. Figure 15 in Appendix E represents observation data for killer whales from 1964 to 2012.

Northern Bottlenose Whale (*Hyperoodon ampullatus*)

The northern bottlenose whale is listed as endangered under Schedule 1 SARA and COSEWIC. The northern bottlenose whale is distributed in the North Atlantic from Nova Scotia to the Davis Strait, along east coast of Greenland and from England, Norway, Iceland and the Faroe Islands to the south coast of Svalbard (Waring *et al*. 2015). They can be found along the continental slope at depths of 800 to 1,500 m with a major concentration off the eastern Scotian Shelf 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 located within the Project Area and in deeper waters off the slope. It is thought that northern bottlenose whales from the Gully population spend 40% of their time in the Gully concentration area, 15% of their time in Shortland Canyon, and 15% of their time in Haldimand Caynon. It is unknown where the whales spend the remaining 30% of their time (LGL 2014). The species is non-migratory and can be found year-round in the area. Figure 16 in Appendix E represents observation data for northern bottlenose whales from 1964 to 2013. Females reach sexual maturity at 8 to 13 years of age and males reach maturity at an earlier age of 7 to 9 years (COSEWIC 2011c). 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. O'Brien and Whitehead (2013) used photo-identification data collected in 2010 and 2011 and mark-recapture techniques to estimate the current population size of northern bottlenose whales on the Scotian Shelf. The results of their studies indicate that the current population size is 143 individuals (O'Brien and Whitehead 2013).

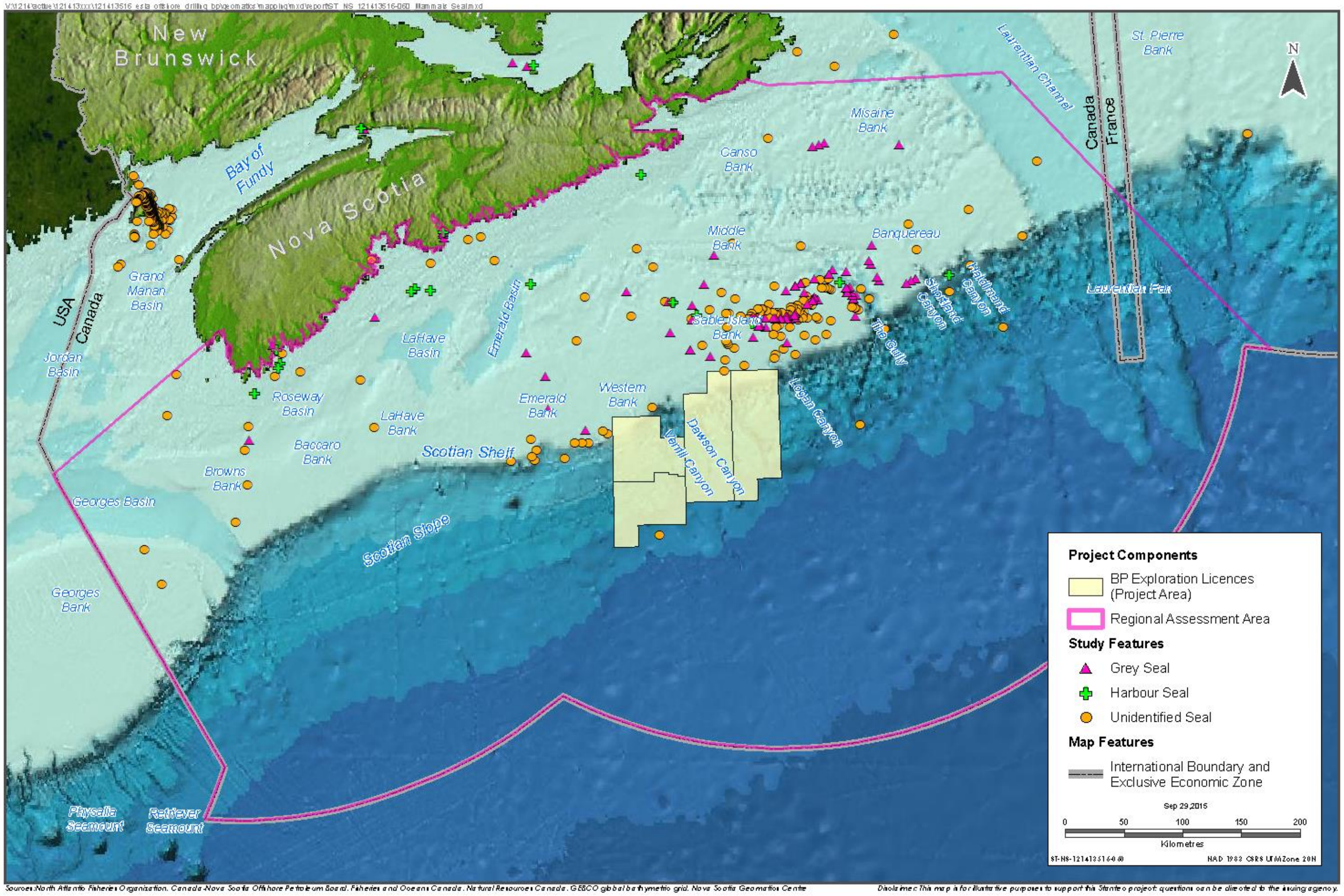
They also used models to examine population trends and to investigate changes in the sex ratio since 1988. Their results indicate that the population size and sex ratios have been stable since before MPA legislation was implemented in the Gully.

Sowerby's Beaked Whale (*Mesoplodon bidens*)

Sowerby's beaked whale is listed as special concern under Schedule 1 SARA and is only found in the North Atlantic with known occurrences along the Scotian Shelf and only rarely seen in coastal waters. Although sightings are rare, the species has been observed in the Gully with significant increase in sightings in the Gully, Shortland, and Haldimand Canyons in recent years. The species were not sighted in the canyons or the Gully before 1994. In the Gully there were 8 sightings between 1995 and 2000, 20 between 2001 and 2006, and 87 in 2011 and 2012 (Whitehead 2013). Whitehead theorizes that this large jump in population size could be explained by a reduction in anthropogenic disturbance as a result of implementing an MPA in the area. They are also found on the Western Scotian Shelf 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 1,500 m (COSEWIC 2006d). The timing and age of breeding for Sowerby's beaked whale is largely unknown. The species feeds mainly on mid-depth to deepwater fish and squid (COSEWIC 2006d). No estimate of population size exists for individuals in Canadian waters. The rarity of sightings suggests that the Sowerby's beaked whale is rare, although this could reflect the limited effort in the deepwater areas and the difficulties of detecting and identifying the species at sea (COSEWIC 2006d). Figure 17 in Appendix E represents observation data for Sowerby's beaked whales from 1998 to 2004.

5.2.6.5 Phocids

Five species of phocids are known to occur on the Scotian Shelf, with Sable Island hosting breeding populations of grey seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*). Other species known to forage in the area include harp (*Pagophilus groenlandica*), hooded (*Cystophora cristata*) and ringed (*Pusa hipsida*) seals. No seal populations on the Scotian Shelf are designated at risk under SARA or by COSEWIC. Phocids are most commonly found on the Shelf (particularly around Sable Island) and nearshore waters and are less likely to be found in the Project Area. Sable Island is a significant area for seals as it hosts the world's largest breeding colony of grey seals (DFO 2011a; Freedman 2014). 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, hooded seal, and ringed seal are considered to be infrequent visitors and have occasionally been observed foraging offshore Nova Scotia (DFO 2011a). Although harp, hooded and ringed seals are not frequently found offshore Nova Scotia, when they are sighted they occur in large numbers. Figure 5.2.20 shows where seal observations have been recorded on the Scotian Shelf and Slope between 1911 and 2013.



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR

Figure 5.2.20 Seal Sightings on the Scotian Shelf and Slope (1911–2013)

5.2.7 Sea Turtles

Four species of sea turtles can be found migrating and foraging on the Scotian Shelf and Slope (Table 5.2.12) with the endangered leatherback sea turtle (*Dermochelys coriacea*) and the loggerhead sea turtle (*Caretta caretta*) the most likely to occur. Critical habitat for the leatherback turtle was not identified in the 2006 Recovery Strategy. DFO has used satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada for the purpose of identifying critical habitat for designation under SARA (DFO 2011b). Research has identified three primary areas of important habitat for leatherback turtles in Atlantic Canadian water (DFO 2013c) which are now being considered for designation as critical habitat under SARA (DFO 2015o): 1) waters east and southeast of Georges Bank, along the southwestern Scotian Shelf near the southwest boundary of the Atlantic Canadian Exclusive Economic Zone (EEZ); 2) the southeastern Gulf of St. Lawrence and waters off western and eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel; and 3) waters south and east of the Burin Peninsula, Newfoundland and Labrador, including parts of Placentia Bay. It is expected that these areas will be included as critical habitat once the amended recovery strategy (DFO 2015o) is finalized.

Figure 5.2.21 depicts sea turtle sightings recorded from 1911 to 2013, according to the DFO Marine Mammals Sightings Database. Figures 5.2.22 and 5.2.23 present the locations where sea turtles were observed during Shell's 2013 Shelburne Basin 3D Seismic Survey and BP's 2014 Tangier 3D Seismic Survey. The leatherback and loggerhead turtles, as well as the green sea turtle (*Chelonia mydas*) were observed during BP's 2014 wildlife monitoring program (RPS 2014). The likelihood of Kemp's ridley turtle (*Lepidochelys kempii*) being present in the Project Area is low.

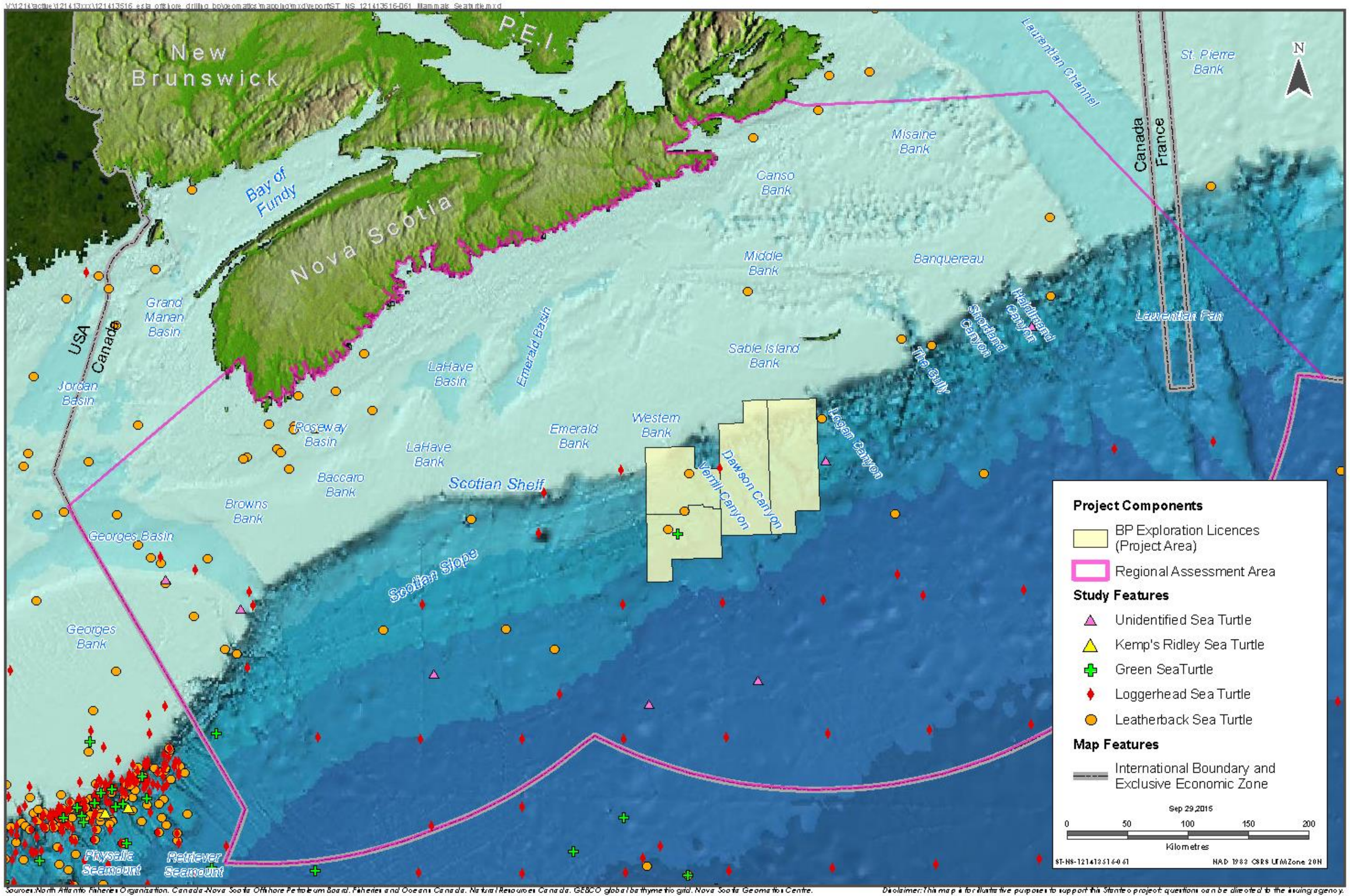
Table 5.2.12 Sea Turtle Species Known to Occur in the Vicinity of the Project Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area[1]	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

Note:

[1] This is based on the analysis of habitat preferences during various life-history stages, distribution mapping, and sightings data for each species within the Project Area.

Source: Modified from Stantec 2014a

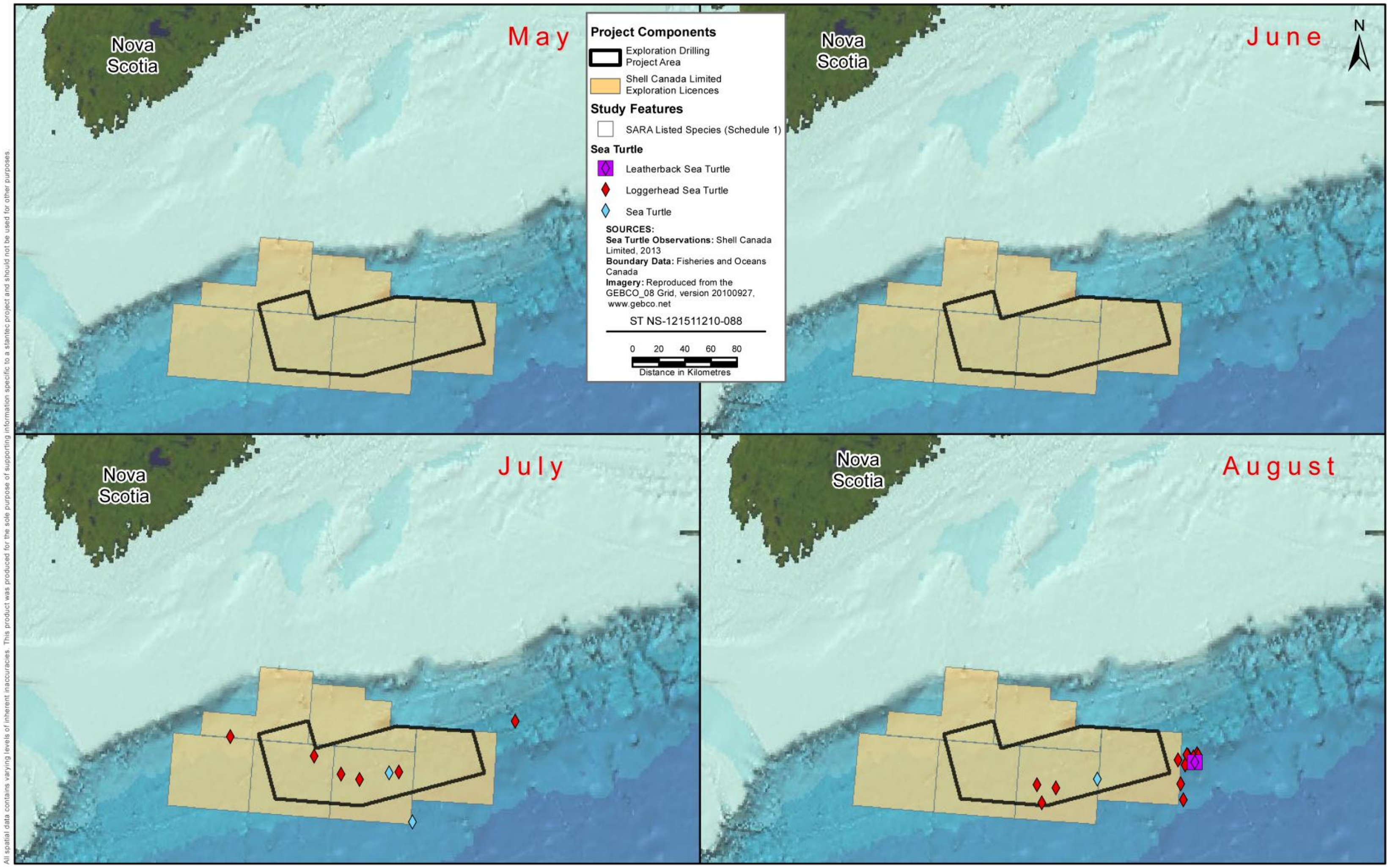


Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre. Ocean Biogeographic Information System

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Sources: NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.21 Sea Turtle Sightings on the Scotian Shelf and Slope (1911–2013)



Source: Stantec 2014a

Figure 5.2.22 Sea Turtle Observations Collected during the 2013 Shelburne 3D Seismic Survey

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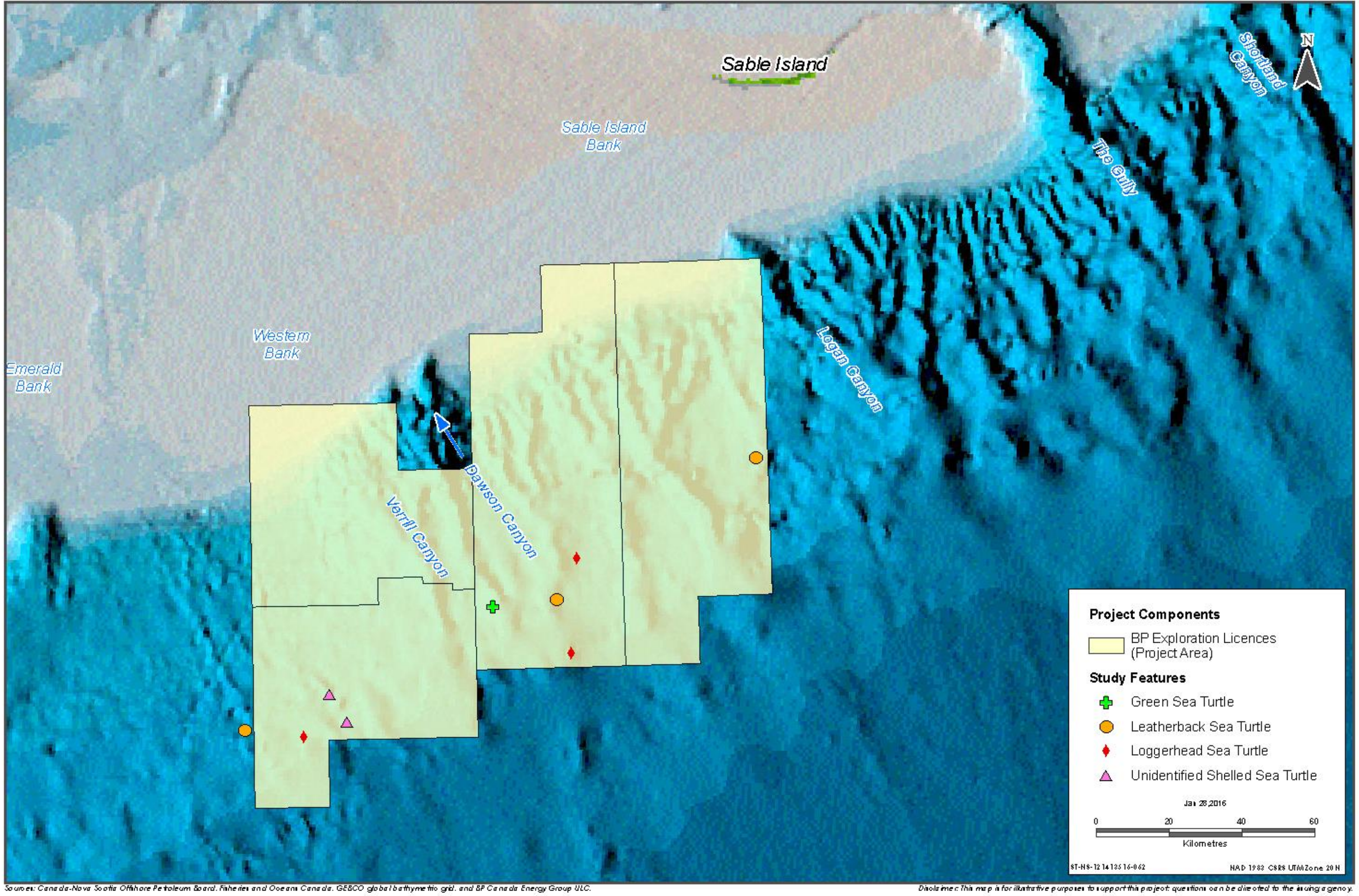


Sources: Canada-Nova Scotia Offshore Petroleum Board, Fisheries and Oceans Canada, GEBCO global bathymetric grid, and BP Canada Energy Group ULC.

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: Data provided from CNSOPB, DFO, and BP Canada Energy Group ULC (n/d)

Figure 5.2.23 Sea Turtle Observation Collected during the 2014 Tangier 3D Seismic Survey

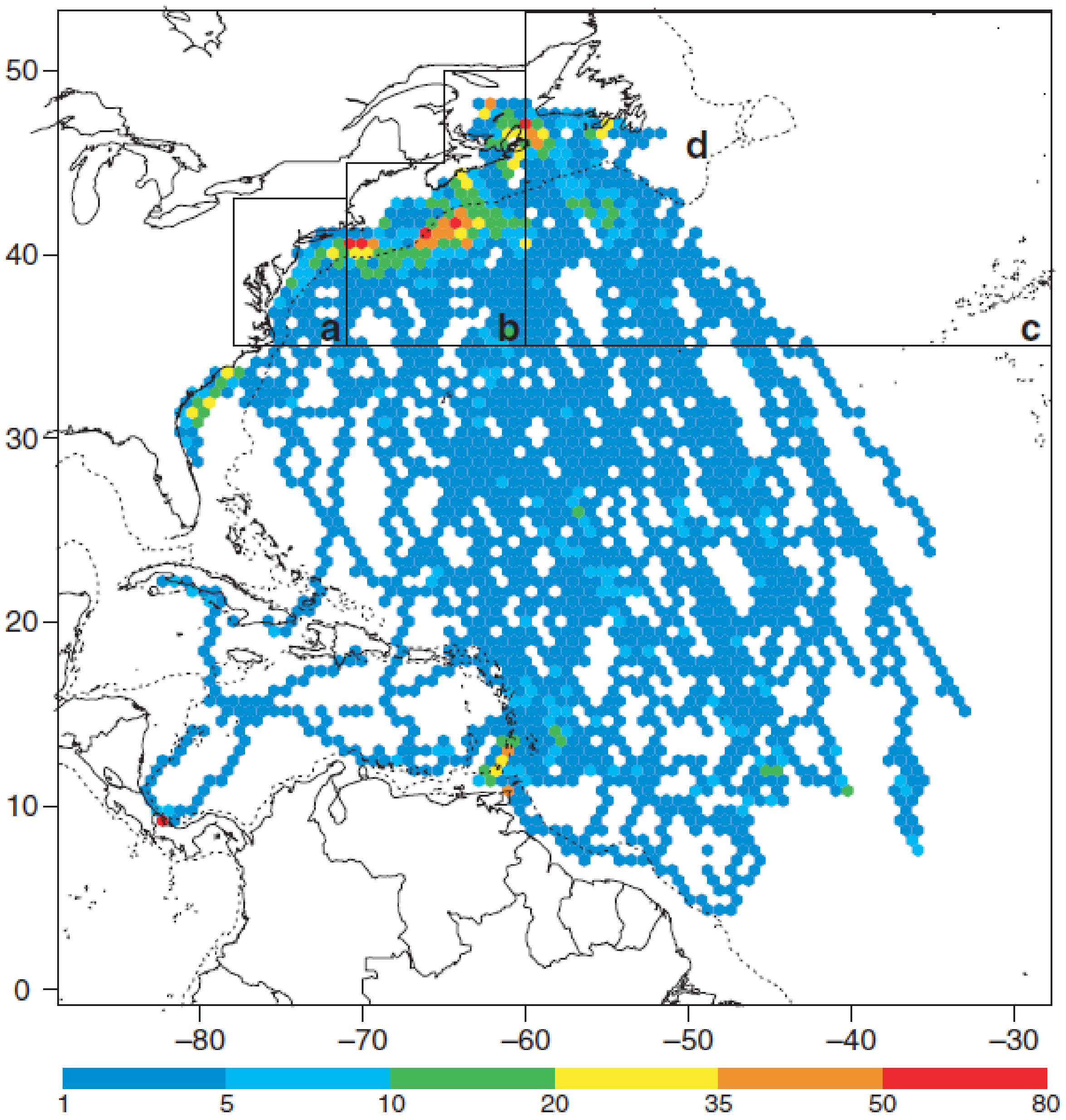
Leatherback Sea Turtle (*Dermochelys coriacea*)

The leatherback sea turtle is the largest and most widely distributed 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 and sighting information indicate that the species is present in Atlantic Canadian waters from April to December with the highest densities from July to September. Generally, the species distribution shifts from the southwest to the northeast as the foraging period progresses (COSEWIC 2012f). Slope waters off the Northeast Channel are also thought to provide habitat throughout the 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 (LGL 2014). The Atlantic population of the leatherback turtle is cautiously considered stable containing approximately 15,000 females (SAR Registry website).

It is believed their distribution in Canadian waters is based primarily on maximizing foraging habits. During the summer and fall months, the species forages on gelatinous zooplankton (primarily jellyfish consuming on average 330 kg/day) in the waters of the Scotian Shelf. The species follows a predictable migratory cycle including 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 5.2.24 depicts the number of days that each turtle spends in a particular area. It should be noted that the 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, a draft Recovery Strategy for the Leatherback Sea Turtle Atlantic population identifies three areas of critical habitat, the closest to the Project Area being located south and southeast of Georges Bank extending to the southwest boundary of the Canadian EEZ on the southwestern Scotian Slope (DFO 2015o).

There are five life-history stages in the leatherback sea turtle's life cycle including: egg and hatching, post-hatchling, juvenile, sub-adult, and adult. The age of maturity is 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 to 4-year intervals. Both the time and duration of nesting varies with geographic location, lasting 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 to 12 day intervals. Nesting is generally nocturnal, with occasional daytime nesting.

Three leatherback sea turtle sightings were recorded (one in June and two in August) during the marine mammal observation program for the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014 (refer to Figure 5.2.23).



Source: James *et al.* 2005

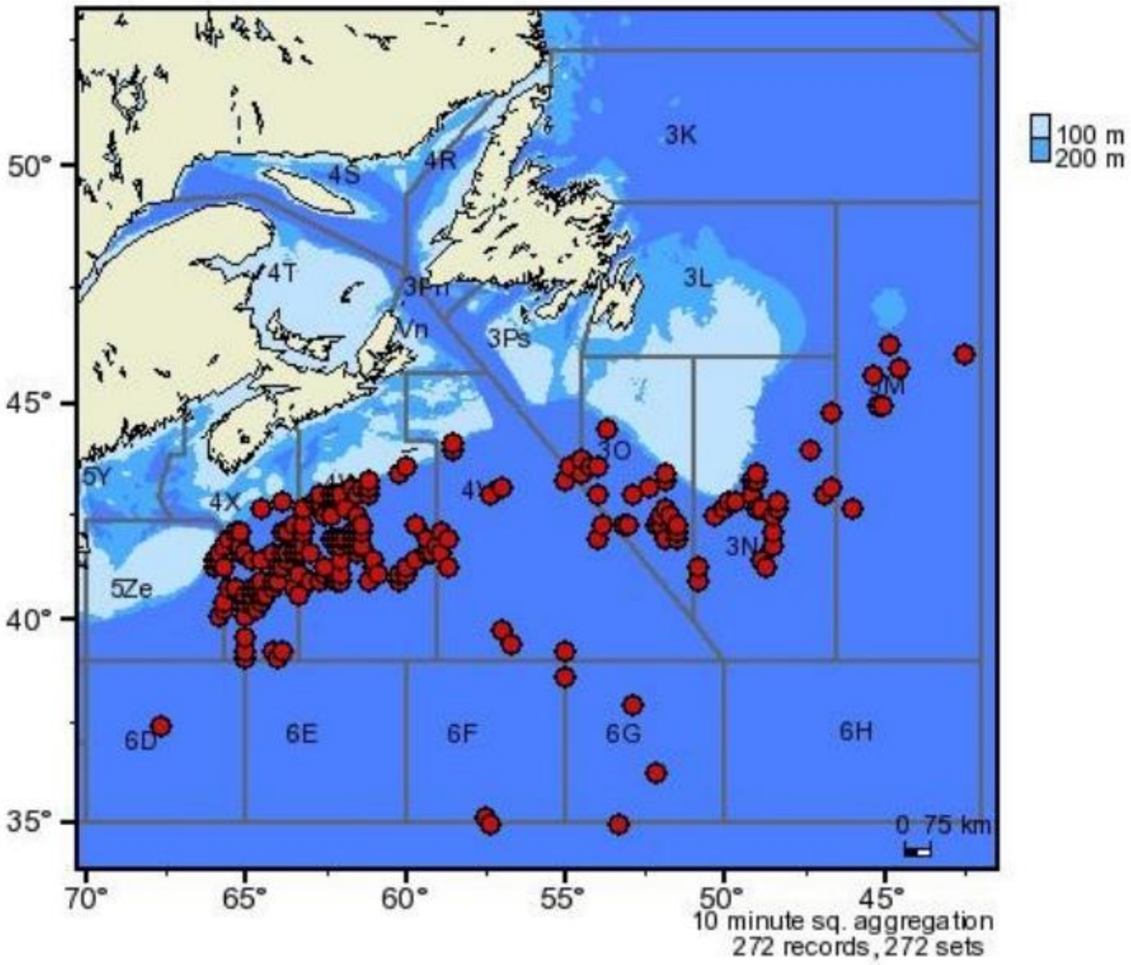
Figure 5.2.24 The spatial use of 38 leatherback turtles equipped with satellite tags in the waters off Nova Scotia. Leatherback Turtles were tagged from 1999–2003 with an average observation period of 218 days. Colour denotes the number of day(s) each turtle was tracked in a particular polygon.

Loggerhead Sea Turtle (*Caretta caretta*)

Immature loggerhead sea turtles occur regularly at the edge of the Scotian Shelf and Slope and are routinely found foraging on the Scotian Shelf and Slope and Georges Bank. They migrate to Atlantic Canadian waters during the spring months returning south for the winter. They are known to breed 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 have shown that some turtles move east and northeast during the winter. Based on observations, the loggerhead sea turtles are found mostly within the 20 to 25°C water temperature contours with loggerheads absent when temperatures were below 15°C. Generally, they are associated with the warm waters of the Gulf Stream in Atlantic Canada and occasionally are found closer to shore when warm core rings break off and intrude over the Scotian Shelf.

Loggerhead sea turtles generally 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 with females returning to the site of their birth to nest. Females nest on a 2 to 3 year interval laying three to four clutches of 112 eggs on average with 14 days inbetween events. Eggs hatch in approximately 7 to 13 weeks.

Three loggerhead turtle sightings were recorded in August during the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014. Figure 5.2.25 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 5.2.25 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, the smallest of sea turtles, is distributed throughout the Gulf of Mexico and along the US eastern seaboard and occasionally 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. Kemp's ridley turtles were not observed during the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014.

Green Sea Turtle (*Chelonia mydas*)

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). The green sea turtle is unique among sea turtles in that it is herbivorous, feeding on plants (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. One green sea turtle was observed in August during the Tangier 3D Seismic Survey on the Scotian Slope between May and September 2014.

5.2.8 Migratory Birds

5.2.8.1 Overview

Waters off the Scotian Shelf are nutrient rich and highly productive due to the complex oceanographic conditions of the area with an estimated 30 million seabirds using the eastern Canadian waters each year (Fifield *et al.* 2009). Throughout the year large numbers of breeding marine birds and millions of migrating birds from the southern hemisphere and northeastern Atlantic can be found using the area (Gjerdrum *et al*. 2008, 2012). Species diversity peaks during the summer months, when northern hemisphere breeders have returned to their breeding grounds and southern hemisphere breeders have returned from their winter breeding season to spend the summer in more northern waters (Fifield *et al.* 2009). 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). During the Tangier 3D seismic program in 2014, 2,736 birds were observed with shearwaters and storm-petrels the most commonly observed (RPS 2014).

Marine related birds can be divided into four groups:

- pelagic seabirds;
- neritic seabirds;
- waterfowl and divers; and
- shorebirds.

Additionally, landbirds (*i.e.*, those with principally terrestrial life cycles) may occur in the marine environment during migration and can occur in coastal areas at any time of the year.

Pelagic seabirds are a marine species, feeding and resting at sea and 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). Large numbers of Great and Sooty Shearwaters (*Puffinus gravis* and *P. griseus*) migrate from the sub-Antarctic through the North Atlantic during the summer months first appearing in April and reaching a peak during July. Also during this time, Wilson's Storm Petrels (*Oceanites oceanicus*) migrate from the same regions with the highest concentrations over Georges Bank and the southern Scotian Shelf (Lock *et al*. 1994). In contrast, the winter seabird fauna consists mainly of Arctic breeding birds. Dovekies (*Alle alle*) can be found wintering in ice-free waters throughout the Atlantic. Northern Fulmars, auks (including Black Guillemot, Thick-billed Murre, Common Murre, Razorbill and Atlantic Puffin), 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 5.2.13).

Neritic seabirds typically feed in shallow coastal waters and return to land to rest at night. Neritic species such as terns, gulls and cormorants have the potential to be found over the Scotian Shelf and Slope. There are approximately 14 species of neritic seabirds that may occur on the Scotian Shelf and Slope throughout the year including the endangered Ivory Gull (*Pagophila eburnea*) and Roseate Tern (*Sterna dougallii*)(Table 5.2.13). Most neritic seabirds are more commonly found in coastal waters and therefore are infrequent visitors of the offshore Project Area. The presence of these species is highest in summer, as some species, including Common and Arctic Terns, migrate to more southern areas for the winter.

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. Generally, eiders nest on coastal islands where fresh water is available and raise their broods in coastal waters. Outside of the breeding season, seaducks are typically found on coastal waters, over reefs and banks where benthic prey are accessible. During the non-breeding season, dabbling ducks forage in fresh water or sheltered coastal waters such as bays, salt marshes and estuaries. 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. Waterfowl are infrequent visitors of the Project Area as they are generally associated with the coastline; however, they could occur in the Project Area and/or Sable Island during migration or as vagrants (Freedman 2014). A few waterfowl species have also been known to breed on Sable Island, albeit in low numbers (generally less than 5 breeding pairs), including the American Duck (*Anas rubripes*), Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), and Red-breasted Merganser (*Mergus serrator*) (Freedman 2014).

During the winter months, waterfowl are distributed fairly evenly along the coast of Nova Scotia. Eiders are the only abundant waterfowl in the coastal area during the summer months (Lock *et al*. 1994). In 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). There are approximately 18 species of waterfowl that regularly occur in association with coastal waters of Nova Scotia including the endangered Harlequin Duck (*Historonicus historonicus*) and Barrows Goldeneye (*Bucephala islandica*), a species of Special Concern (Table 5.2.13).

Many shorebirds nest in wetland or upland habitats using coastal stopover sites for feeding and resting during migration; however, species such as Willet (*Tringa semipalmata*) and Piping Plover (*Charadrius melodus*) raise their young in coastal environments. Most shorebirds forage along coastal beaches, exposed mud flats or salt marshes during migration, with high concentrations of birds often being found associated with sites that provide an abundant food source. The exception is Purple Sandpipers (*Calidris maritima*) that primarily use rocky shorelines during migration and overwintering. Stopover sites can be crucial to the survival of shorebird species as they provide important energy reserves that are necessary for undertaking long, uninterrupted flights (COSEWIC 2007a). 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 therefore often are found offshore. There are approximately 22 species of shorebirds that regularly occur in association with the Scotian Shelf and Slope and associate coastlines, including the endangered Red Knot (*Calidris canutus rufa*) and Piping Plover (Table 5.2.13).

Landbirds may occur in the marine environment during migration and can occur in coastal areas at any time of the year. Landbirds can also be found on Sable Island, the majority of which are migrants or vagrants. The Savannah (Ipswich) Sparrow (*Passerculus sandwichensis princeps)* is the only landbird to nest in large numbers on Sable Island, although there are a few other species that breed in few numbers (*e.g.*, less than 10 breeding pairs) (Freedman 2014).

Some migrant landbirds use the island as a regular stopover area during their overwater flights (*e.g.*, Blackpoll Warbler (*Dendroica striata*), Grey-Cheeked Thrush (*Catharus minimus*)). Migrants are much more abundant on Sable Island in fall than in spring (Freedman 2014), although migrant landbirds found in the marine environment are more abundantly found on coastal islands than on Sable Island.

Vagrant landbirds (*i.e.*, birds occurring well outside their regular range) may also be found in the offshore environment. Sable Island attracts an unusually large number of vagrant species compared to other offshore islands on the Atlantic coast, most likely due to the isolation of Sable Island making it a rare landfall habitat as well as its location along frequent storm tracks (McLaren 1981).

Table 5.2.13 Marine Birds 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					
Northern Fulmar	*Fulmarus glacialis*	-	-	-	Likely
Cory's Shearwater	*Calonectris diomedea borealis*	-	-	-	Likely
Great Shearwater	*Puffinus gravis*	-	-	-	Likely
Sooty Shearwater	*Puffinus griseus*	-	-	-	Likely
Manx Shearwater	*Puffinus puffinus*	-	-	-	Likely
Wilson's Storm-Petrel	*Oceanites oceanicus*	-	-	-	Likely
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	-	-	-	Likely
Northern Gannet	*Morus bassanus*	-	-	-	Likely
Pomarine Jaeger	*Stercorarius pomarinus*	-	-	-	Likely
Parasitic Jaeger	*Stercorarius parasiticus*	-	-	-	Likely
Long-tailed Jaeger	*Stercorarius longicaudus*	-	-	-	Likely
Great Skua	*Stercorarius skua*	-	-	-	Likely
South Polar Skua	*Stercorarius maccormicki*	-	-	-	Likely
Black-legged Kittiwake	*Rissa tridactyla*	-	-	-	Likely
Dovekie	*Alle alle*	-	-	-	Likely
Common Murre	*Uria aalge*	-	-	-	Likely
Thick-Billed Murre	*Uria lomvia*	-	-	-	Likely
Razorbill	*Alca torda*	-	-	-	Likely
Atlantic Puffin	*Fratercula arctica*	-	-	-	Likely
Neritic Seabirds					
Great Cormorant	*Phalacrocorax carbo*	-	-	-	Unlikely
Double-Crested Cormorant	*Phalacrocorax auritus*	-	-	-	Unlikely
Black-headed Gull	*Larus ridibundus*	-	-	-	Unlikely
Bonaparte's Gull	*Larus philadelphia*	-	-	-	Unlikely
Ring-billed Gull	*Larus delawarensis*	-	-	-	Likely
Herring Gull	*Larus argentatus*	-	-	-	Likely

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

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

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

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

Table 5.2.13 Marine Birds of the Scotian Shelf and Slope

Common Name	Species Name	SARA Schedule 1	COSEWIC	NS ESA	Potential to Occur in Project Area[2]
Terrestrial Birds					
Peregrine Falcon	*Falco perigrinus anatum/tundrius*	Special Concern	Special Concern	Vulnerable	Likely
Savannah Sparrow (*princeps* subspecies)	*Passerculus sandwichensis*	Special Concern	Special Concern	-	Likely

Note:

[1] Excluding 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 5.2.26; 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 in the Project Area during the breeding season (*i.e.*, for feeding), migration, and/or overwintering.

Source: Modified from Stantec 2014a

The monitoring program undertaken for the Tangier 3D Seismic Survey included bird monitoring surveys with up to three, one-hour seabird surveys occurring daily between May 17 and September 14, 2014 following the CWS Seabirds at Sea protocol (Gjerdrum *et al.* 2012). Results are presented below in Table 5.2.14. The most commonly observed species was the Greater Shearwater, with a total of 940 observations and accounting for 34% of all seabird sightings. Other very common species include Wilson's Storm-Petrel and Leach's Storm-Petrel. Incidental observations by marine mammal observers indicated the same trend, with Greater Shearwater and Wilson's Storm-Petrels accounting for the first and second most commonly observed species, respectively. During these surveys, vessel crews encountered 19 stranded birds and 26 dead birds. The stranded birds consisted of 18 storm-petrels and one Magnolia Warbler. The majority of deceased birds were passerines (RPS 2014).

Table 5.2.14 Summary of 2014 CWS Bird Surveys by Vessel during the Tangier 3D Seismic Survey

Species	**Number of Individuals Observed by Vessel**						
	Western Neptune	***Ocean Odyssey***	***Geco Diamond***	***Western Patriot***	***Western Pride***	***Western Regent***	**Total**
Atlantic Puffin				2			2
Black-Legged Kittiwake	2			2			4
Common Loon			1				1
Common Murre		3	1	1		1	6
Common Tern				1	1		2
Cory's Shearwater	3	2	55	20	5		85
Double Crested Cormorant		1		2			3
Dovekie			4				4
Great Back-Backed Gull		1			2		3
Great Skua	1	1	3	5		3	13
Greater Shearwater	53	123	146	338	135	145	940
Herring Gull	3	1	3	1			8
Laughing Gull	2		2			1	5
Leach's Storm-Petrel		11	103	13	83	43	253
Little Gull			1				1
Manx Shearwater	10	2	18	8		4	42
Northern Fulmar		1	4	1		4	10
Northern Gannet	1		3	6		3	13
Parasitic Jaeger				5			5
Pomarine Jaeger						1	1
Red-Necked Phalarope		1					1
Sooty Shearwater	4	1	63	17	10	1	96
Thick-Billed Murre		1					1

Table 5.2.14 Summary of 2014 CWS Bird Surveys by Vessel during the Tangier 3D Seismic Survey

Species	Number of Individuals Observed by Vessel						
	Western Neptune	*Ocean Odyssey*	*Geco Diamond*	*Western Patriot*	*Western Pride*	*Western Regent*	Total
Unidentified Alcid		1					1
Unidentified Gull	1	2	20		3	1	27
Unidentified Murre		10	2				12
Unidentified Shearwater	37	13	135	1	35	2	313
Unidentified Storm Petrel	36	63	160	4	99	22	384
Unidentified Tern					2		2
Wilson's Storm-Petrel	1	86	1	402	7	1	498

Source: Modified from RPS 2014

5.2.8.2 Seasonal Distribution of Migratory Birds in Association with the Scotian Shelf and Slope

The following section describes migratory birds which may be found in the Project Area or on the Scotian Shelf or Slope. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) and the BP Exploration (Canada) Limited's Tangier 3D Seismic Survey EA (LGL 2014) have been drawn on extensively for this information such as species life history. Descriptions of SAR and SOCC migratory birds can be found in Section 5.2.8.4.

Information on the distribution and abundance of marine birds in association with the Scotian Shelf and Slope was primarily obtained from the PIROP and ECSAS databases. Seabird observations within these databases are from ship-based surveys and mapped according to season (see Figures 1 to 15 in Appendix F), including spring (March, April, and May), summer (June, July, and August), fall (September, October, and November), and winter (December, January, and February). Data from the ECSAS and PIROP were integrated into common maps, despite variances in the survey methods, to convey information on the relative distribution and abundance of seabirds. Maps are included for pelagic seabirds, neritic seabirds and waterfowl. Shorebirds are not included, as they are unlikely to be found offshore near the Project Area. Species were either mapped individually or combined into guilds or taxonomic groups depending on their abundance and distribution on the Scotian Shelf and Slope. Those which were mapped individually included Black Guillemot (*Cepphus grylle*), Dovekie, Northern Fulmar, Northern Gannet (*Morus bassanus*), and Black-legged Kittiwake. Guilds and 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. Detailed information on the location of colonies and the types and abundances of species they support are provided in Section 5.2.8.3.

Additional information on the densities of seabirds in association with the Scotian Shelf was obtained from Fifield *et al.* (2009) that presented results from a 3.5-year offshore seabird monitoring program (Table 5.2.15). 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. Most of the surveys were conducted from either oil industry supply ships or DFO research/fishery patrol vessels with a small number of surveys conducted from ferries, cargo vessels, seismic ships or sailboats (Fifield *et al.* 2009). The data from this study is encompassed in the larger ECSAS database; however, it has been referenced here to provide 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 5.2.26. As illustrated on Figure 5.2.26, survey effort varies with season and that more effort has been directed at certain locations along the Scotian Shelf and Slope than others. ECSAS and PIROP survey effort has been relatively lower in winter compared to summer, spring, and fall (Figure 5.2.26). Surveys have been more abundant on than off the Scotian Shelf, and more frequent along certain shipping lanes than others (Figure 5.2.26).

Overall, seabirds are present throughout the Scotian Shelf and Slope during the summer months and are often encountered in relatively high abundance. Data from Fifield *et al.* (2009) suggest that the abundance of seabirds on the Scotian Shelf and Slope (and Gulf of Maine) is highest during the summer months (Table 5.2.15). 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). PIROP and ECSAS datasets obtained for this Project indicated the most abundant species observed on the Scotian Shelf and Slope during summer are Great Shearwater (*Puffinus gravis*), phalaropes (red and red-necked) and Wilson's Storm-Petrel (*Oceanites oceanicus*). In addition, Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Great Black-backed Gull (*Larus marinus*), Herring Gull (*Larus argentatus*) and Sooty Shearwater (*Puffinus griseus*) are also abundant during 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) whereas 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). Additionally, 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 for June to August is restricted as they become central-place foragers while attending nests and chicks and therefore at-sea observations in the Project Area are not necessarily indicative of species' abundance within the broader region at this time.

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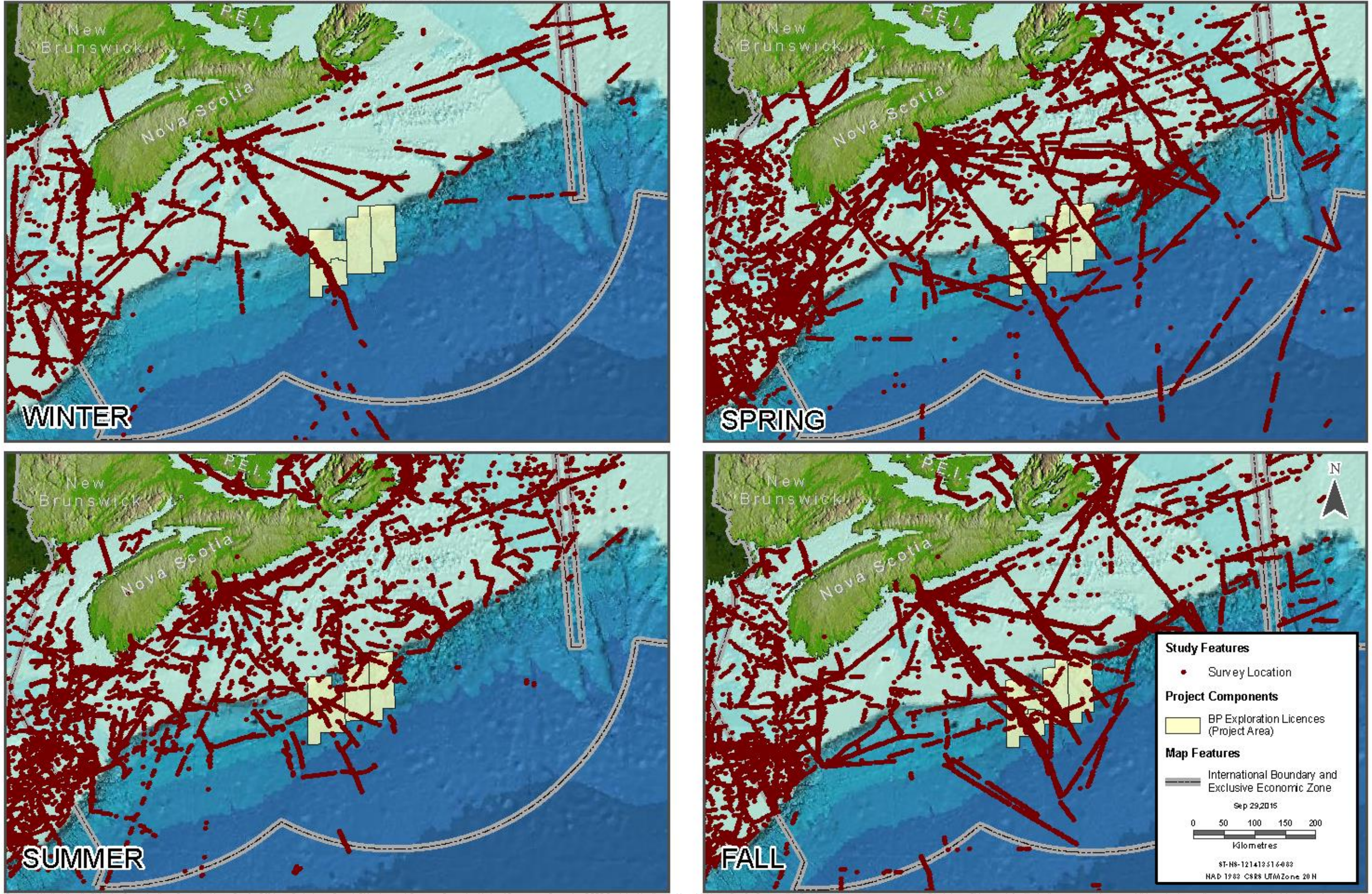

Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre. Programme Intégré de recherches sur les oiseaux pélagiques (PIROP). Eastern Canada Seabirds at Sea (ECSAS)

Disclaimer: This map is for illustrative purposes to support this project: questions can be directed to the issuing agency.

Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.26 Seasonal ECSAS and PIROP Survey Effort on the Scotian Shelf and Slope

Seabirds may be encountered throughout the Scotian Shelf and Slope during the fall; however, 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 5.2.15). Furthermore, during the fall, the weighted mean of seabirds on the Scotian Shelf (and nearby Gulf of Maine) 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 reflect migrating species, the departure of adults and newly fledged young from local seabird colony sites, and an influx of wintering species. ECSAS and PIROP data indicate that the most abundant species along the Scotian Shelf during the fall is Great Shearwater, which would be migrating to the North Atlantic as well as relatively large numbers of Herring Gull, Northern Gannet, Great Black-backed Gull, Black-legged Kittiwake, and Northern Fulmar.

PIROP and ECSAS data indicate that relatively high concentrations of Black-legged Kittiwake are present during the winter, along with the Northern Fulmar, Dovekie, Great Black-backed Gull, Herring Gull, Common Eider (*Somateria mollissima*). The diversity and abundance of species found on the 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.

Data indicate that particularly high concentrations of Dovekie, Northern Fulmar, Herring Gull and Thick-billed Murre are observed along the Scotian Shelf during the spring. Other abundant species include Great Black-backed Gull, Murres, Northern Gannet and Leach's Storm-Petrel. The diversity and abundance of species observed at this time of year is due to the lingering presence of species overwintering 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 Gulf of Maine) during spring months are higher than the concentrations in the Gulf of St. Lawrence, but lower than that found in association with the Newfoundland and Labrador Shelf ocean regions (Table 5.2.15).

Table 5.2.15 Seasonal Weighted Median (and range) of Seabird Densities (birds/km^2) 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)

Table 5.2.15 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
	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)

Source: Modified from Stantec 2014a

Large Alcids

Large alcids, including Common Murre (*Uria aalge*), Thick-billed Murre, Razorbill (*Alca torda*), and Atlantic Puffin (*Fratercula arctica*), are common in the waters off the Scotian Shelf and Slope and may be present in the vicinity of the Project Area during all times of the year, although generally more abundant during the spring. As a group, they are distributed throughout the Scotian Shelf and Slope in association with both coastal features and more offshore waters (Figure 1 in Appendix F). Thick-billed Murres accounted for the majority of PIROP and ECSAS alcid observations with relatively higher occurrences being recorded in spring and winter than the summer and fall. 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).

Breeding activities for these species occur in spring and summer and colonies are located on cliffs and islands (see Section 5.2.8.3 for information on the locations of seabird colonies), where the young are provisioned until fledged. Atlantic puffins typically fledge in August (Nettleship 1972), at which time they can fly, are independent of parents (Harris and Birkhead 1985), and disperse out to sea far from the colonies. Razorbills fledge earlier in the summer and although flightless at the time, they maintain a coastal affinity and are accompanied by one parent (typically the male) that cares for the chick for several weeks (Harris and Birkhead 1985). In addition to some species having flightless young, auks are flightless during a molting period, which may last more than a month, and occurs at sea during late winter for Atlantic Puffins (Harris 1984) and in early fall for Razorbills (Bédard 1985; Freethy 1987).

Dovekie

Dovekies nest in the high Arctic and do not breed in Canada in significant numbers. They occur on the Scotian Shelf and Slope from the fall to spring. Dovekies are at their highest numbers during winter and spring (Figure 2 in Appendix F) and 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 5.2.15).

Black Guillemot

Black Guillemots are largely restricted to coastal areas (Figure 3 in Appendix F). 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). As a result of their preference for coastal areas, Black Guillemots are not expected to regularly occur in the offshore Project Area.

Cormorants

Data on the distribution and abundance of cormorants indicate that they are typically restricted to coastal environments, with only infrequent offshore observations of few individuals (Figure 4 in Appendix F). The majority of the ECSAS and PIROP observations are of Double-crested Cormorants (*Phalacrocorax auritus*) as well as several observations of Great Cormorants. Cormorants are most abundant during the summer and fall months and breed along much of Nova Scotia's coastline, including southwestern parts of the province (NSDNR 2011a).

Cormorants are not expected to regularly occur in or adjacent to the Project Area because of its distance from the coastline.

Black-legged Kittiwake

Black-legged Kittiwakes, pelagic gulls, spend the majority of their time in offshore waters except during the breeding season when they come ashore to nest. High numbers of Black-legged Kittiwakes overwinter on the Scotian Shelf and Slope, and ECSAS and PIROP data indicate that they are the most abundant species recorded during winter. However, their abundances are less for this time of year when compared to more northern ecoregions (Table 5.2.15), such as the Newfoundland and Labrador Shelves (Fifield *et al.* 2009). Black-legged Kittiwakes are also common on the Scotian Shelf and Slope during fall, to a lesser extent in spring, and are relatively uncommon during summer months when the majority of the population is congregated at colony sites at more northern latitudes (Figure 5 in Appendix F). 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.

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 during all seasons (Figure 6 in Appendix F). Large and small gulls are included in this group, with the exception of Black-legged Kittiwakes that have been described separately. The most abundant species recorded during ECSAS and PIROP surveys were Herring Gull and Great Black-backed Gull which both breed along the coast of Nova Scotia. Other gull species recorded and that may be found on the Scotian Shelf include (in order of decreasing abundance) Iceland Gull (*Larus glaucoides*), Ring-billed Gull (*L. delawarensis*), and Glaucous Gull (*L. hyperboreus*), along with several vagrant species. Although seasonal patterns vary depending on the particular species, gulls in general are expected to occur near 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) compared to northerly regions of the Gulf of St. Lawrence or the Newfoundland and Labrador Shelves (Table 5.2.15). The reverse is true in summer (Fifield *et al.* 2009).

Jaegars

Jaegers do not breed in Atlantic Canada but are present in offshore waters of the region during their spring and fall migration to and from their Arctic nesting sites (Figure 7 in Appendix F). The majority of PIROP and ECSAS records on the Scotian Shelf are of Pomarine Jaegars (*Stercorarius pomarinus*), with lesser amounts of Parasitic (*S. parasiticus*) and Long-tailed Jaegers (*S. longicaudus*) also being present. Jaegers may also be present during the summer, although it is more common on the Western Scotian Shelf and Georges Bank during this time (Figure 7 in Appendix F). It is not expected to occur on the Scotian Shelf during the winter season.

Northern Fulmar

Large colonies of Northern Fulmar are located in the Arctic. They do not breed in the vicinity of the Scotian Shelf and Slope in significant numbers and are present in offshore waters year-round (Figure 8 in Appendix F). 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 in the southern portion of the Scotian Shelf near Georges Bank. They are likely present in and around the Project Area all times of the year; however less so during the summer months. 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 5.2.15).

Northern Gannet

Northern Gannets are most common on the Scotian Shelf and Slope during the spring and fall with lesser numbers in the winter and summer (Figure 9 in Appendix F). 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). Generally, birds migrating north during spring are first observed in March with peak migration in Nova Scotia from mid-April to mid-May (Tufts 1986).

Phalaropes

Phalaropes are surface plankton feeders and generally 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 are most common during spring and fall. During these times, they have been encountered in greatest abundance in the waters off southwestern Nova Scotia, near Georges Basin and the Northeast Channel (Figure 10 in Appendix F). The majority of phalaropes recorded are Red Phalaropes, although small numbers of Red-necked Phalarope (*P. lobatus*) have also been encountered during spring and fall.

Shearwaters

Shearwaters are common summer and fall 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 widely distributed along Scotian Shelf and Slope (Figure 11 in Appendix F). 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 11 in Appendix F). 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 Scotian Shelf and Slope include Cory's Shearwater

(*Calonectris diomedea*), Manx Shearwater (*Puffinus puffinus*), Audubon's Shearwater (*P. lherminieri*), and Yelkouan Shearwater (*P. yelkouan*).

Skuas

Although low in abundance, Skuas may be encountered on the Scotian Shelf and Slope throughout the year (Figure 12 in Appendix F). The majority of records in the area are of Great Skua (*Stercorarius skua*) with South Polar Skua (*S. maccormicki*) also frequenting 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 Scotian Shelf and Slope are during the fall.

Storm-Petrels

Storm-petrels arrive in the Scotian Shelf and Slope in spring and stay until late fall with very few records during the winter months. 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 Scotian Shelf and Slope were in summer (Figure 13 in Appendix F). 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 consisting of 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).

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 may be present throughout the region, but were most frequently encountered in proximity to coastal features and in vicinity of their breeding colonies (Figure 14 in Appendix F). Southward winter migration for Common Terns occurs during August and September 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 near 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 the potential to forage near the Project Area. Sable Island has supported between 1,000 and 9,000 pairs of Common, Arctic, and Roseate Terns over the past 50 years, nesting in 3 to 20 colonies across the island (Freedman 2014). 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, however, none of these species are known to regularly frequent close to the Project Area.

Waterfowl

A variety of waterfowl are present in the waters of the Scotian Shelf throughout the year. Waterfowl may occur near the Project Area during the spring and fall months, but generally are infrequently observed in offshore waters and are more closely associated with the coastline (Figure 15 in Appendix F). Common Eiders are one of the most abundant waterfowl species in coastal waters of the Scotian Shelf during the breeding season nesting on islands scattered along the mainland Nova Scotia, with relatively dense aggregations of nesting islands present between Yarmouth and Cape Sable Island, and in Mahone Bay (NSDNR 2013). ECSAS and PIROP data also 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 the waters of the Scotian Shelf and Slope.

5.2.8.3 Areas of Significance to Migratory Birds

While migratory birds can be found throughout the RAA, certain areas are of particular importance and support a large abundance of birds. In the marine environment, birds are associated in areas with upwelling and mixing of water regularly occurs, such as the shelf edge. The Western Gully and the area north of Sable Island also have mixing waters, which result in high levels of phytoplankton, zooplankton and fish (Breeze *et al*. 2002). Seabirds concentrate in these areas because of the abundance of small prey fish. These areas of seabird concentration are discussed in relation to seasonal seabird abundance in Section 5.2.7.2.

Many important terrestrial areas are also of importance to marine-associated birds. Many near-shore islands provide important breeding habitat for large colonies of seabirds. Sable Island is located on the Scotian Shelf and is designated as a Migratory Bird Sanctuary (Breeze *et al*. 2002) and as an Important Bird Area (IBA). Areas of significance to migratory and marine-associated birds are discussed in the following sections.

Sable Island

Sable Island is a crescent shaped, treeless island located approximately 156 km off the coast of mainland Nova Scotia. It is an emergent portion of the Sable Bank, a sandy outwash plain (Freedman 2014). More than 330 species of birds have been identified on Sable Island. A high proportion of these species are vagrants that arrived by displaced winds or by misguided navigational behaviour (Freedman 2014). There have been 30 species recorded as breeding on the island with only seven having more than ten pairs nesting every year (Freedman 2014). Sable Island has supported between 1,000 and 9,000 pairs of Common, Arctic and Roseate Terns over the past 50 years (Freedman 2014). Herring Gull and Black-backed Gull are the only gull species nesting on Sable Island with about 900 pairs and about 45 loose colonies of Herring Gulls and about 400 pairs of Black-backed Gulls that nest more solitarily or in aggregations of a few birds

(Freedman 2014). There are two additional seabird species that have nested on Sable Island including Black-legged Kittiwake and Leach's Storm-petrels. Ipswich Sparrow is the only landbird to nest in large numbers on Sable Island with recent censuses estimate being five to six thousand adult birds summer on the island (Freedman 2014). Waterfowl and Shorebirds known to nest on the island include: Least Sandpiper, Spotted Sandpiper, Semipalmated Plover, Killdeer, Willet, yellowlegs (unspecified as either greater or lesser), American Black Duck, Red-breasted Merganser and occasionally Northern Pintail and perhaps Mallard (Freedman 2014).

The Sable Island National Park Reserve is a breeding site for six species of seabirds including mixed colonies of Common Tern, Arctic Tern, and Roseate Tern, dispersed colonies of Herring Gull, solitary nests of Great Black-backed Gull, and occasional records of Leach's Storm-Petrel (McLaren 1981; Zoe Lucas, unpublished data in Freedman 2014).

Migratory Bird Colonies

The coastline of the Scotian Shelf within the RAA for the Project supports over two hundred colonies of nesting marine birds (Table 5.2.16, Table 5.2.17, Figure 5.2.27 and Figure 5.2.28), ranging in size from a few individuals to thousands of breeding pairs (Table 5.2.17). In general, nesting colonies are distributed all along the coast of mainland Nova Scotia. Areas of dense aggregation include the area between Cape Sable and Yarmouth, the Eastern Shore islands along the southeast coast, and near Country Harbour and Tor Bay.

Leach's Storm-Petrel is the most numerous breeding seabird in the RAA with an estimated 64 014 breeding pairs across 18 colonies (Table 5.2.16). The vast majority (75%) of Leach's Storm-Petrels are found on Bon Portage Island near Cape Sable Island, with other relatively large colonies being found on Country Island, the Bird Islands, Little White Island, Inner Bald Tusket Island and Half Bald Tusket Island (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17).

Table 5.2.16 Summary of Migratory 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	0	0	0	0
Cormorant[3]	Nests	42	0	2850	0
Leach's Storm-Petrel[1]	Pairs	17	1	63 914	100
Great Black-backed Gull[4,6]	Pairs	130	6	3792	978
Herring Gull[4,6]	Pairs	106	6	2991	1421
Razorbill[1]	Pairs	1	0	5	0

Table 5.2.16 Summary of Migratory 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**
Terns[5,6]	Individuals	54	3	3594	4242

Note:
[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 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 5.2.17).

Great Black-back Gulls and Terns are the second and third most abundant breeding seabirds in the RAA (Table 5.2.16). The largest concentrations of Great Black-backed Gulls are found on Sable Island that supports 20% of all nesting areas in the RAA. Larger numbers of Great Black-backed Gulls can also be found on Little Gooseberry Island, Green Island off Little Anse Cape Breton, Devil's Island, Green Island John's Island and Blanche Island. Terns can also be found on Sable Island representing 54% of nesting areas in the RAA. Country Island, South end of The Bar, Dung Cove and The Brothers islands also represent large abundance of Terns. 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.

Approximately 32% of Herring Gulls can be found on Sable Island with smaller colonies found on Devil's Island, Bon Portage Island, Pearl Island and Harbour Island as well as over a hundred other colonies on mainland Nova Scotia.

Cormorant colonies (Double-Crested Cormorants and Great Cormorants are not differentiated in the survey data) are scattered throughout the mainland Nova Scotia (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17). No abundance data are available for the known colony sites, and numbers associated with others are not necessarily accurate (NSDNR, pers. comm. 2014 in Stantec 2014a). Within the subset of cormorant colonies for which abundance data are available, the largest colonies are found on Little Duck Island in Mahone Bay and Blanche Island at the mouth of Port LaTour (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17). Together these two colonies account for 28% of the cormorant nests found in the 42 colonies for which abundance data is available.

Common Eider nesting sites are found on islands scattered along the mainland Nova Scotia with relatively dense aggregations of nesting islands present in the area between Yarmouth and Cape Sable Island and in Mahone Bay (Figure 5.2.27, Figure 5.2.28 and Table 5.2.17). No abundance data are available for these nesting sites.

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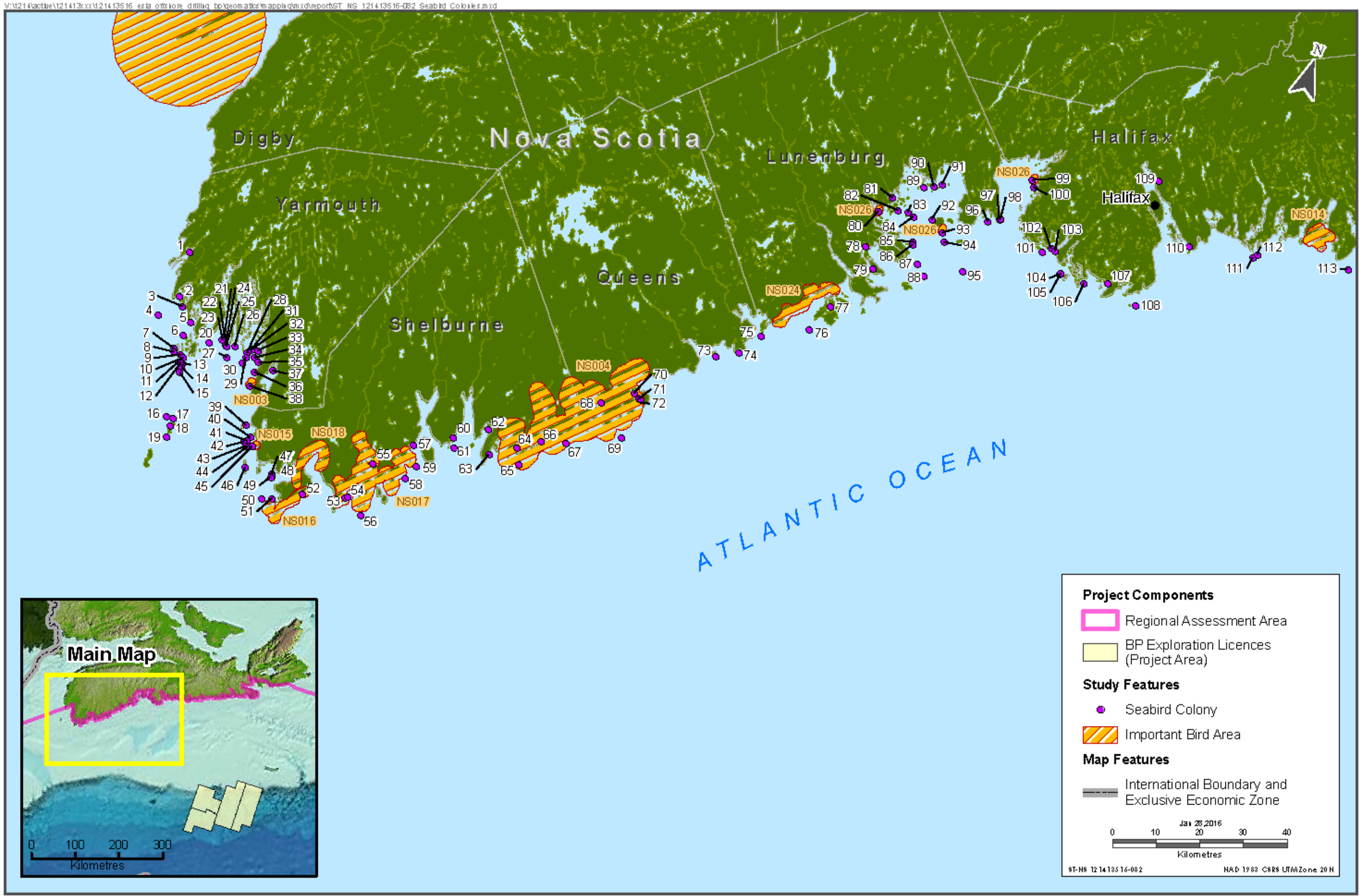
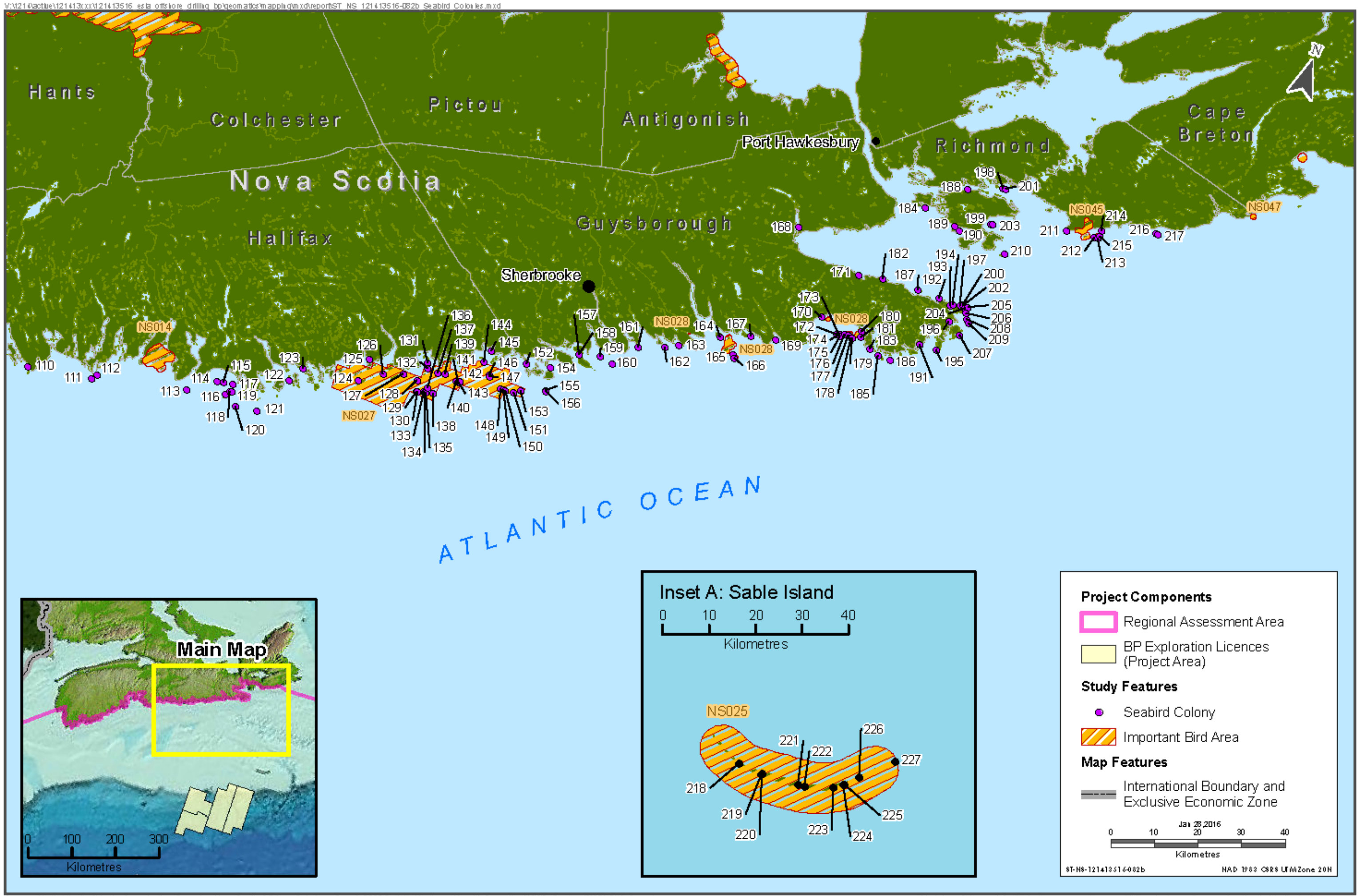


Sources: North Atlantic Fisheries Organization. Canada - Nova Scotia Offshore Petroleum Board. GEBCO global bathymetric grid. Canadian Wildlife Service (CWS). Bird Canada. Nova Scotia Geomatics Centre. Natural Resources Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: Data provided from NAFO, CNSOPB, CWS and NSDNR

Figure 5.2.27 Distribution of Seabird Colonies and Important Bird Areas within the RAA (western portion)



Sources: North Atlantic Fisheries Organization. Canada - Nova Scotia Offshore Petroleum Board. GEBCO global bathymetric grid. Canadian Wildlife Service (CWS). Birds Canada. Nova Scotia Geomatics Centre. Natural Resources Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: Data provided from NAFO, CNSOPB, CWS and NSDNR

Figure 5.2.28 Distribution of Seabird Colonies and Important Bird Areas within the RAA (eastern portion)

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (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	Northern 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	10	
15	Bald Tusket Island							50		
16	Flat Island, (South of Tusket Island)			na		2				
17	Round Island	7		na		5	15			
18	Mud Island	75		na		11				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
19	Noddy Island	80		na		9				
20	Western Bar Island			na		5	45			
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				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
41	Ram Island (GoM)					2				
42	Whale Island				na	7				
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	

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
61	Jordon Bay Gull Rock				140	12	27			
62	North tip of Egg Beach								31	
63	Potato Island					30	20			
64	Small unnamed 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	Unnamed island beside Corkum Island causeway								32	

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
79	Gully Island, Lower South Cove								46	
80	Westhaver Island, Mahone Harbour								29	
81	Crow Island								80	
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					

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
99	Wedge Island				20	35	53		70	
100	Franks George Island, North			na						
101	Dover Castle					18				
102	High Island					31				
103	Gull Island, Inner				na	28				
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			
111	Shut-in Island				present				85	
112	Rat Rock						10			
113	Jeddore Rock				50	20				
114	Duck Island				35				10	
115	Duck Island (CB)					55				
116	Long Island				present					
117	Sugarloaf						14			
118	Goose Island (CB)					7				
119	Goose Island								13	
120	Egg Island				17	9	35		12	

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
121	Bald Rock, Clam Bay					35	9			
122	Small unnamed island west of Tuckers Cove Borgles Island								8	
123	Gravel Island								4	
124	Taylor Head Spit								12	
125	Hen Island, Mushaboom Harbour								6	
126	Sheet Rock				75	28				
127	Hardwood Island sandspit								180	
128	Speck Island				39	15				
129	Pumpkin Island (SH)					9				
130	Pumpkin Island							78		
131	Sandy Island				80					
132	Sandy Island (BH)					44				
133	Brother Islands					25	3			
134	Brother Islands, West							4		
135	Brother Islands, East							25		
136	Horse Island Ledge					4				
137	west end of Big Harbour Island								5	
138	Beaver Island						17			
139	Inside Eastern Harbour Island							7		
140	Bird Islands, East					6		350		

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
141	Bird Islands							1201		
142	Bird Islands, West				60	25		793		
143	East Gunning Rock				11					
144	Harbour Rock Southeast of Ship Island				35					
145	Boson Island								52	
146	Little Halibut Island							39		
147	Middle Halibut Island				39	18		30		
148	Camp Island				present	40	59	88		
149	Unidentified Island east of Camp Island					3				
150	Long Island, White Islands, main					20	2			
151	Round Island					13				
152	Small island west of Hapes Point near shore								85	
153	Little White Island				30	41		616		
154	Thrumcap Island				13	3				
155	Gull Rock				75				24	
156	Gull Ledge					14	2			
157	Point of the Beach					1	15			
158	Spit, east side Liscomb Island								11	
159	Tobacco Island				50	0	22			
160	Wedge Island				35	6	15			
161	Walter Island				70	18	70			

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
162	Fiddler's Head					4	9			
163	Bickerton Island					11				
164	Harbour Island (CH)					66	132			
165	Frying Pan (CH)					21				
166	Country Island							12000	950	
167	Thrumcap Island				present	9				
168	Big Island				10					
169	Shoal Point					25	8			
170	Small unnamed island west of Forster Island, Tor Bay								16	
171	Rock Island					54	6			
172	Topstone Ledge					6				
173	Western Island				present					
174	Middle Sugar Harbour Island					20				
175	Sugar Harbour Island, West					39				
176	Sugar Harbour Island, East					66				
177	Unnamed island, Tor Bay								16	
178	Unnamed island beside Cook's Island								80	
179	Cooks Island					1				
180	Hog Island Spit, Tor Bay								32	
181	Harbour Ledge					4				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
182	Half Island						6		12	
183	Inner Gull Ledge								160	
184	Green Island				present	62	92			
185	Middle Gammon Island					11	2			
186	Millstone Island				150	6				
187	Fox Island					31	13			
188	Berry Island				present	6	4			
189	Crid Islands, East					6				
190	Rocks off Jerseyman Island					5	4			
191	Small unmed island, Dover Bay								12	
192	Tickle Island					28			1	
193	Davis Island								4	
194	Bald Rock				50					
195	Unidentified island south of Dover Bay					3	2			
196	Small unnamed island, Spinney Gully								16	
197	Pigeon Island					29				
198	Ouetique Island				present					
199	Islet, Bay of Rocks				present					
200	Derabies Bar					15				
201	Quetique Island					31	123			
202	Unidentified island northwest of Derabies					17				

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
	Island									
203	Les Rochers					61				
204	Derabie Island					11				
205	Gunning Rocks (East)					8	1			
206	Crow Island				10	50	6			
207	Gull Island, Canso					2				
208	Frying Pan Shoal					41	10			
209	Cranberry Islands				present				8	
210	Green Island off Little Anse Cape Breton					139	59			
211	Red Island				present	4				
212	South Basque Island					14				
213	East Basque Island					12				
214	Flat Rock				present					
215	Basques Islands - Green Island				present					
216	St. Esprit Island				45					
217	Guyon Island					66				
Sable Island										
218	Sable Island-6-eastern Spit					81	82			
219	Sable Island-5					131	183			
220	Main Station								2211	
221	Sable Island (general)							100		

Table 5.2.17 Number of Seabirds Recorded within Colonies of the RAA

Colony #	Name	Atlantic Puffin (pairs)[1]	Black-legged Kittiwake (pairs)[1]	Common Eider[2]	Cormorants (nests)[3]	Great black-backed Gull (pairs)[4]	Herring Gull (pairs)[4]	Leach's Storm-Petrel (pairs)[1]	Terns (individuals)[5]	Razor-bill (pairs)[1]
222	Sable Island-4					134	163			
223	Sable Island-3					236	349			
224	Old East Light								13	
225	East Light								2018	
226	Sable Island-2					225	436			
227	Sable Island-1					171	208			

Note:
na = nesting area
[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.

Important Bird Areas

IBAs are discrete areas that support nationally or globally important groups of birds including birds of conservation concern, areas where large concentrations of birds congregate, or 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.

Fourteen coastal IBAs, including Sable Island, are present within the RAA (Figure 5.2.27 and 5.2.26), the attributes of which are described in Table 5.2.17. The fourteen IBAs are scattered throughout the RAA but many are located in the southeastern portion of Nova Scotia, between Halifax and Cape Breton Island. 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, NS014, NS016, NS017, NS018 and NS024), Roseate Tern (in IBAs NS003, NS025, NS026, and NS028), Harlequin Duck (in IBAs NS004, NS024, and NS028), and Red Knot (in IBA NS016) (Figure 5.2.27, Figure 5.2.28 and Table 5.2.18).

Important shorebird migration habitat is present in IBAs NS004, NS014, NS016, NS018, NS024, NS027, and NS045. These areas contain beaches, mud flats and salt marshes that attract large numbers of shorebirds during fall migration.

IBAs NS004, NS014, NS016, NS017, NS018, NS027, NS045, and NS047 contain regionally significant waterfowl habitat. These areas provide important staging and wintering habitat for sea ducks, American Black Ducks, Harlequin Ducks and geese. Regionally significant colonial water bird nesting areas are present in IBAs NS003, NS015, NS025, and NS045.

Nine of the fourteen IBAs present in the RAA are considered to be globally significant sites (NS003, NS015, NS016, NS024, NS025, NS027, NS028, NS045, and NS047) because they provide important habitat for important congregations of birds (Table 5.2.18). In particular, IBAs are considered globally significant if they support 1% or more of the global population of a bird species during breeding, wintering, foraging, roosting, rafting, or migration (Moore and Couturier 2011). 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 as well as supports almost the entire population of the large Ipswich subspecies of the Savannah Sparrow (*Passerculus sandwichensis princeps*). NS027 (Eastern Shore Islands) provides overwintering grounds for approximately 3.3% of the Eastern population of Harlequin Ducks and is the breeding grounds for congregations of greater than 4,000 Common Eiders. NS028 (Country Island Complex) is a nesting habitat for Roseate, Common and Arctic Terns as well as habitat for over 50,000 pairs (approximately 2%) of the Western Atlantic population of Leach's Storm-Petrels. NS045 (Basque Islands and Michaud Point) provides nesting habitat for up to 3.6% of the North American Great Cormorant population and represents a unique location on Cape Breton Island as it provides habitat for a variety of shorebirds that occur regularly such as Least Sandpipers, Willets, and Common Snipe. In addition, Point Michaud provides breeding grounds for Common Eiders and migration habitat for geese and other waterfowl. NS047 (Rocks off Fourchu Head) supports habitat for at least 2% of the North American Great Cormorant population (IBA website). 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. 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 5% of the global population of Short-billed Dowitchers (*Limnodromus griseus*) have been recorded at this IBA site. 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. NS003 (The Brothers) supports 50% of the breeding population of Roseate Terns in Canada.

The nearest IBA to the Project Area is Sable Island (NS025), located approximately 48 km to the north. The next nearest IBAs to the Project Area are located approximately 185 to 200 km to the north. These include IBAs NS014, NS027 and NS028 (Table 5.2.18). NS025 (Sable Island) is globally and nationally significant as it provides breeding habitat for the North American population of Common Terns, the North American population of Herring Gull and the Great Black-backed Gull. Sable Island also supports almost the entire population of the large Ipswich subspecies of the Savannah Sparrow, populations of Roseate Terns and large numbers of nesting colonial waterbirds. NS027 (Eastern Shore Islands) contains regionally significant waterfowl habitat, and provides important staging and wintering habitat for sea ducks, American Black Ducks, Harlequin Ducks and geese. NS028 (Country Island Complex) is globally and nationally as it supports an important nesting habitat for Roseate Terns and Common and Arctic Terns, and is being considered designated as a potential migratory bird sanctuary by Environment Canada.

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km²)	Status	Bird Species	Description	Conservation Status
Sable Island	NS025	Sable Island, NS	461.89	Globally Significant; Nationally Significant: Threatened Species, Restricted Range Species	Ispwich Savannah Sparrow *(ssp. princeps*), Herring Gull, Great Black-backed Gull, Common Tern, Roseate 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) and National Park Reserve
Musquodoboit	NS014	Dartmouth, NS	28.54	Continentally Significant: Congregatory Species	Canada Goose, American Black Duck, Piping Plover	Supports migration and overwintering habitat for large congregations of geese, and breeding grounds for Piping Plovers.	Provincial Game Sanctuary, Provincial Park (including marine)
Eastern Shore Islands	NS027	Halifax, NS	269.06	Globally Significant: Congregatory Species; Continentally Significant: Congregatory Species; Nationally Significant: Threatened Species, Waterfowl Concentrations	Common Eider (*spp. dresseri*), Harlequin Duck, White-winged, Black and Surf Scoter, Leach's Storm-Petrel	Supports breeding, and large fall and spring congregations of Common Eiders. Also represents an important overwintering habitat for Harlequin Ducks and other waterfowl.	Provincial Wildlife Management Area
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

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km²)	Status	Bird Species	Description	Conservation Status
Country Island Complex	NS028	Country Harbour/Tor Bay, NS	16.35	Globally Significant: Congregatory Species, Colonial Waterbirds/Seabird Concentrations; Nationally Significant: Threatened Species	Roseate Tern, Common Tern, Arctic Tern, Leach's Storm- Petrel	Supports an important nesting habitat for Roseate Terns and Common and Arctic Terns.	Tern Restoration Plan for Country Island. Environment Canada is considering Country Island as a potential Migratory Bird Sanctuary.
Basque Island and Michaud Point	NS045	Near Point Michaud, NS	11.21	Globally Significant: Congregatory Species	Great Cormorant, Common Eider, Canada Goose and a variety of shorebirds (Semi-palmated, Spotted and Least Sandpiper, Willets and Common Snipe).	Basque Island supports large congregations of Great Cormorants. Point Michaud supports a variety of shorebirds and provides nesting habitat for Common Eiders. The vicinity of Point Michaud supports migration habitat for geese and other waterfowl.	Provincial Park (including marine)
Rocks off Fourchu Head	NS047	Fourchu, NS	1.39	Globally Significant: Congregatory Species	Great Cormorant	Supports large congregations of Great Cormorants.	na

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km²)	Status	Bird Species	Description	Conservation Status
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)
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)
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

Table 5.2.18 Important Bird Areas in and Adjacent to the RAA

Important Bird Area	Site ID[1]	Location	Size (km²)	Status	Bird Species	Description	Conservation Status
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 Sandpiper, Short-billed Dowitcher, Black-bellied Plover, Sanderlings, Ruddy Turnstone, Least Sandpiper, White-rumped Sandpiper, Greater Yellowleg, Willet, Black-bellied Plover, Sanderling, Red Knot, American Oystercatcher, Brant, Short-eared Owl, as well as loons, herons, egrets, cormorants, seaducks, bay ducks, alcids, pelagic species, warblers, vireos, tanagers and sparrows.	Nesting Piping Plover and important migratory habitat for a diversity of avifauna.	IBA Conservation Plan written/being written
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
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

Note:
[1]Refer to Figure 5.2.27 and Figure 5.2.28 for location.

Source: http://www.ibacanada.com

5.2.8.4 Species at Risk and Species of Conservation Concern

There are nine migratory bird SAR/SOCC that are known to occur on the Scotian Shelf and Slope and could be present in the RAA: Peregrine Falcon (*Falco perigrinus anatum*), Ivory Gull, Piping Plover, Roseate Tern, Red Knot, Harlequin Duck, Red-necked Phalarope (*Phalaropus lobatus*), Savannah Sparrow (Ipswich subspecies) (*Passerculus sandwichensis princeps*) 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. Information on the regional importance, abundance, and distribution of marine bird SAR/SOCC is provided in the following sections, along with other key information on habitat requirements, general life history, and recovery strategies. The Shelburne Basin Venture Exploration Drilling Project EIS (Stantec 2014a) has been drawn on extensively for this information such as species life history.

Peregrine Falcon

The Peregrine Falcon (*anatum/tundrius*) was listed as Special Concern in Schedule 1 of SARA in 2012. It has been listed as a species of Special Concern under COSEWIC since April 2007. The primary decline of the Peregrine Falcon was attributed to organochlorine pesticides (particularly dichlorodiphenyltrichloroethane [DDT]), which causes reproductive failure (COSEWIC 2007c). Although many types of organochlorine pesticides, including DDT, are no longer used in Canada and the US, they continue to be used in the South American wintering range of the Peregrine Falcon. Between 1970 and 2005, there was an increase in the population of Peregrine Falcons following the restriction of organochlorine pesticide use. Additionally, about 1,500 *anatum* Peregrine Falcons that were raised in captivity were released in Canada from 1975 to 2001 (SAR Registry 2014). By 2005, there was an estimated minimum population size of 696 mature individuals of the *anatum* subspecies in Canada (COSEWIC 2007c).

There are three subspecies of Peregrine Falcon found in Canada (*anatum, tundrius and pealei*), each of which has a distinct geographic distribution. However, only the *anatum/tundrius* subspecies occurs in Atlantic Canada. Its breeding range extends from the interior of Alaska and northern Canada up to southern Greenland, and across continental North American up to northern Mexico, including all Canadian territories and provinces except Prince Edward Island, Nunavut and the Island of Newfoundland (SAR Registry 2014). Peregrine Falcons can be found in various habitat types including wetlands, sea coasts and meadows (NSDNR, no date). Foraging areas are typically associated with coastal habitats. In Nova Scotia, this species is known to nest on the steep cliff ledges along the Bay of Fundy (NSDNR, no date). Most Peregrine Falcons nest on cliff ledges or crevices near good foraging areas, where nests are composed of scrapes in the substrate (COSEWIC 2007c). One brood is raised annually, with a mean clutch size of 3.72 in the mid-latitudes (White *et al*. 2002). The Peregrine Falcon can be found in Nova Scotia throughout the year (eBird 2015). This species is largely terrestrial and is not expected to occur offshore.

A management plan was developed in 2015 with the objective for the Peregrine Falcon anatum/tundrius population to be self-sustaining throughout its Canadian range within the next 10 years (Environment Canada 2015g2015). The primary factor for the collapse of Peregrine Falcon populations was from the use of organochlorine pesticides from the late 1940s through the 1970s. The plan poses a number of conservation measures aimed at reducing threats, conservation, and protection of nesting sites where possible as well as improving knowledge of species populations (Environment Canada 2015g).

Ivory Gull

The Ivory Gull is a rarely encountered vagrant in Nova Scotia listed as endangered on Schedule 1 of SARA and provincially listed as “accidental” (NSDNR 2011b) and “SNA” (*i.e.,* a conservation status is not applicable) (ACCDC 2011). Ivory Gulls nest on flat terrain or on sheer cliffs in the high-Arctic from May to early June and outside their breeding season, they live near the edges of pack ice in 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 such as multiple records in the Halifax area as well as 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 as one was observed on Sable Island in June of 1969 (Tufts 1986). No Ivory Gulls were recorded within the ECSAS and PIROP datasets obtained for the Project.

Until recently, the Canadian Arctic was thought to support 20 to 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 to 600 individuals, representing an approximate 80% decline over the last 18 years (COSEWIC 2006e). 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 of approximately 1000 breeding pairs and the breeding range to historic areas to at least four regional breeding areas 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 2012c). 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.) between the end of March and early May. The young hatch between late May and June onwards, depending on when nesting was initiated which may occur any time after the birds arrive until mid-July with nests 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 2012c). They are unlikely to occur within the Project Area as a result of their coastal affinity but they do have potential to pass through the Halifax Harbour area during migration.

The latest North American population estimate for the *melodus* subspecies obtained in 2006 was 3,323 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 2012c). Data collected since the end of the banding research program in 2003 suggests that the population in southern Nova Scotia is declining (Environment Canada 2012c).

Threats to this species include 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 2012c).

The 2012 recovery strategy for Piping Plover 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)” (Environment Canada 2012c). “Suitable habitat” as identified by Boyne and Amirault (1999) are areas with the following key habitat features: 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 2012c). There are approximately 30 sites identified as critical habitat along the southern coastline of Nova Scotia (Figure 5.2.29).

The short-term population objectives in the recovery plan 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 2012c). Long-term objectives include an increase in the population to 310 pairs across Eastern Canada and to 60 within Nova Scotia. Recovery strategy implementation will be measured annually against whether the population is maintained at 255 pairs and regional productivity target of 1.65 chicks fledged per territorial pair is achieved. Over three consecutive international censuses occurring every five years, recovery strategy implementation will be measured against whether the population is increased to 310 pairs and the population distribution is unchanged from the 1991 International Census (Environment Canada 2012c). The recommended strategy 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 2012c).

Sources: North Atlantic Fisheries Organization. Canada - Nova Scotia Offshore Petroleum Board. GEBCO global bathymetric grid. Canadian Wildlife Service (CWS). Nova Scotia Geomatics Centre. Natural Resources Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: Data provided from CNSOPB, CWS and NSDNR

Figure 5.2.29 Critical Habitat for Piping Plover within the RAA

Roseate Tern

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

Approximately 120 to 150 pairs of Roseate Terns can be found in Atlantic Canada, with another 4,000 pairs estimated to occur in the northeastern United States (Environment Canada 2010b). Those found in Nova Scotia are mainly 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). PIROP and ECSAs data indicate that Roseate Terns are occasionally observed in the waters off Nova Scotia during ship-based surveys, with potential to occur in the Project Area.

Threats to the Roseate Tern include predation from gulls and animals such as foxes as well as high post-fledging mortality and a shortage of males (at least in some United States colonies) (Environment Canada 2010b). The population's restricted distribution makes it vulnerable to localized threats including human development, catastrophic weather events such as hurricanes (Nisbet and Spendelow 1999; Lebreton *et al*. 2003), pollution, and disease (Environment Canada 2010b). 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 2010b).

The Canadian Recovery Plan aims to maintain and enhance breeding productivity and to restore the population's range across broadly distributed colonies (Environment Canada 2010b). 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 include maintaining high numbers of breeding pairs at Country Island(>40 pairs) and The Brothers (>80 pairs), enhancing productivity at managed colonies to high levels, restoring a broader distribution by establishing at least one more managed colony, removing or reducing threats, and maintaining small peripheral nesting colonies on Sable Island and the Magdalen Islands (Environment Canada 2010b). 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 2010b).

Critical habitat has been identified for this species including Sable Island, specific coastal islands of Nova Scotia, and the Magdalen Islands (Environment Canada 2010b). An area of critical habitat for this species that is closest to the Project is Sable Island which at the closest point is 48 km from the ELs (Figure 5.2.30).

Sources: North Atlantic Fisheries Organization. Canada - Nova Scotia Offshore Petroleum Board. GEBCO global bathymetric grid. Canadian Wildlife Service (CWS). Nova Scotia Geomatics Centre. Natural Resources Canada

Source: Data provided from CNSOPB, CWS, and NSDNR

Figure 5.2.30 Critical Habitat for Roseate Tern within the RAA

Red Knot

The Red Knot *rufus* subspecies is a medium-sized shorebird 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 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 (Tufts 1986). In Nova Scotia this species first appears in July, peaking in August and again in September to October (LGL 2014). There are ten areas in Eastern Canada identified in the status assessment for this species as being important sites for Red Knot migration, of which two are in Nova Scotia: southern Cape Breton Island and Cape Sable (COSEWIC 2007b). Other locations in Nova Scotia where Red Knot occur include coastal areas of Sable Island, Yarmouth, Shelburne, Lunenburg, and Dartmouth (Cornell Lab of Ornithology 2014; Tufts 1986). This species is known to occasional stop at beaches in the Halifax Harbour area during migration. Given its coastal affinity, Red Knot is unlikely to occur within the Project Area.

Based on surveys conducted in the wintering range in South America, the estimated Red Knot *rufus* subspecies population in 2006 was 18,000 to 20,000 birds, decreasing 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 most important threat to the Red Knot is the dwindling supply of horseshoe crab eggs in Delaware Bay which is the most important food used during the final spring stopover. Various factors leading to decreased habitat availability during migration in eastern North America are also contributing threats to the population (COSEWIC 2007b).

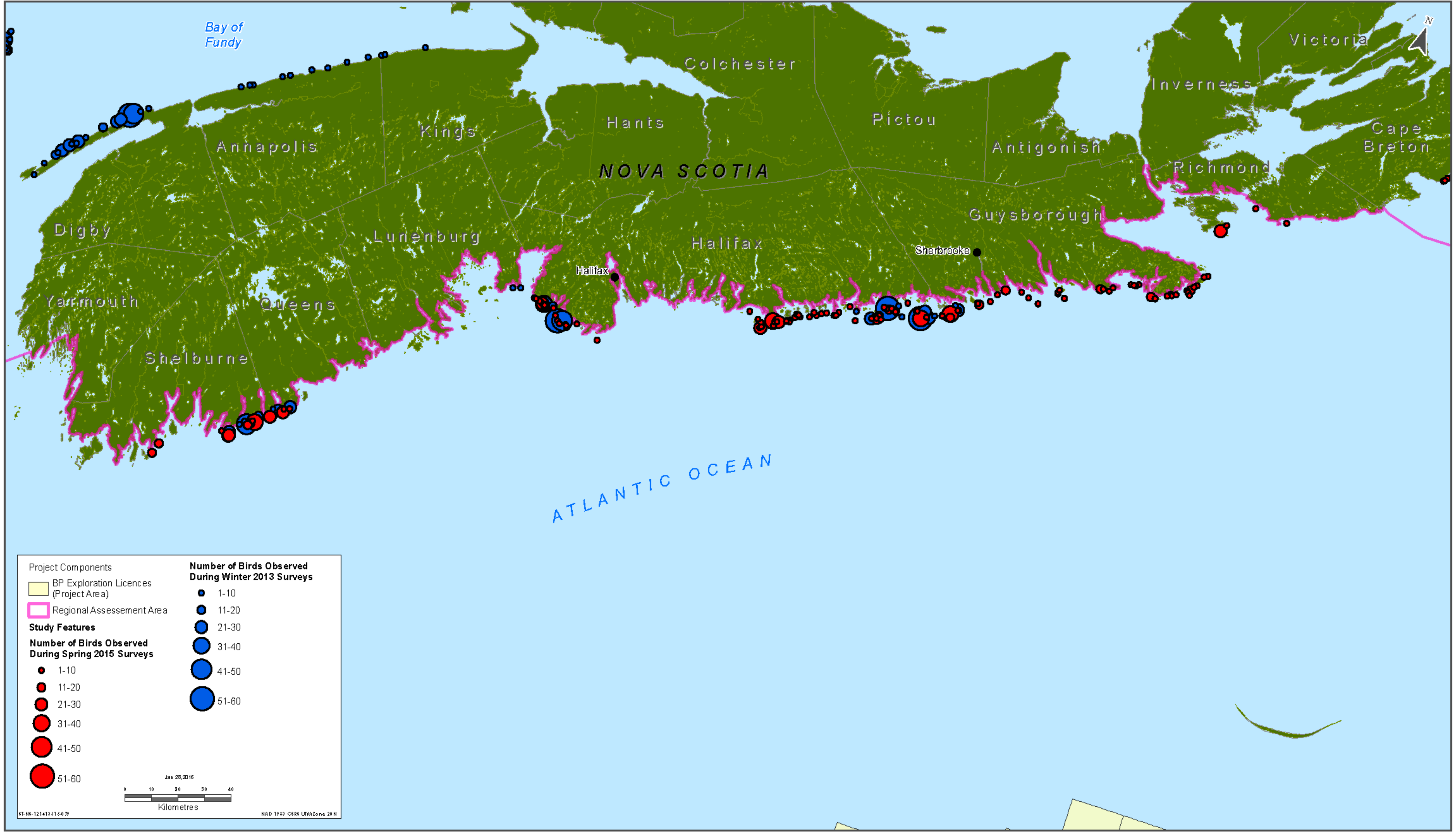
Harlequin Duck

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 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 in Stantec 2014a), they have not been confirmed to be breeding in Nova Scotia. 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 5.2.31). 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 2013b). This species is occasionally observed at the mouth of the Halifax Harbour (Cornell Lab of Ornithology 2014).

In 1990, COSEWIC designated the eastern North American population of Harlequin Duck as endangered due to declines during the 20th century. 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. Wintering population estimates 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 2,925 individuals. Primary Canadian wintering locations include 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. Harlequin Duck dive to feed on small shellfish and shrimp-like animals among these churning waters.

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). This includes threats 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 and had an initial goal of sustaining a population of 2,000 wintering individuals within eastern North America for at least three of five consecutive years (Environment Canada 2007). The long-term goal was to achieve at least 3,000 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. Survey effort from 2005 to 2006 suggests that the 2,000 individual mark was met for these two years (CWS, pers. comm. 2012 in Stantec 2014a). The specific objectives include working 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).



Sources: North Atlantic Fisheries Organization. Canada - Nova Scotia Offshore Petroleum Board. GEBCO global bathymetric grid. Canadian Wildlife Service (CWS). Nova Scotia Geomatics Centre. Natural Resources Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Sources: CNSOPB, CWS and NSDNR

Figure 5.2.31 Known Harlequin Duck Sites within the RAA

Barrow's Goldeneye

Barrow's Goldeneye is a medium-sized diving duck that primarily breeds and winters in Canada and wintering occurring in the inner Gulf and the North Shore of Québec. 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 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 Quebec. Generally, Barrow's Goldeneye breed at high elevations on alkaline wetlands around freshwater lakes. Wintering populations in Quebec are on small fish-less 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 6,800 individuals, the equivalent of 2,100 pairs (Robert *et al.* 2010). Fewer than 1,000 Barrow's Goldeneye winter in the Atlantic Provinces and in Maine (Daury and Bateman 1996; cited in Environment Canada 2011). Although 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).

A management plan has been developed for the eastern population of Barrow's Goldeneye with the main objective 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 6,800 individuals across the species' range (Environment Canada 2011).

Red-Necked Phalarope

The Red-Necked Phalarope was listed as Special Concern by NS ESA in November of 2014 and is currently not listed under SARA. Over the past 40 years, this species has declined at an important staging area in Atlantic Canada. Threats to this species include habitat degradation associated with climate change, pollutants, and oil exposure (COSEWIC 2014a).

Although phalaropes are members of the shorebird family, they are functionally much more like seabirds. Phalaropes are generally pelagic outside of the breeding season and spend up to nine months of the year at sea (Rubega *et al*. 2000). This species breeds in the low Arctic or Subarctic regions of Canada and Alaska, where they build nests near freshwater lakes, ponds or marshes. In the fall, Red-Necked Phalaropes depart from their breeding grounds and migrate southward to their tropical wintering grounds off the coast of South America (Rubega *et al.* 2000). Red-Necked Phalaropes are most likely to occur in the RAA during the spring or fall migration periods and are most abundant in the fall when staging for migration. The Bay of Fundy is particularly important for Red-Necked Phalaropes; mixed flocks of thousands of red-necked phalaropes arrive around Brier Island in August (IBA Canada 2015).

Red-necked Phalaropes forage mostly while swimming and feed on insects, crustaceans and mollusks. They are known for their unusual behaviour of spinning in circles on shallow water, likely to stir it up and bring food to the surface (Elphick *et al*. 2001).

Savannah Sparrow (*princeps* subspecies)

The Savannah Sparrow (*princeps* subspecies, also known as the Ipswich Sparrow) is listed in Schedule 1 of SARA as a Species of Special Concern and assessed as Special Concern by COSEWIC. The Savannah Sparrow is Sable Island's best-known species and the subspecies nests almost exclusively on Sable Island (Freedman 2014). This very restricted breeding range and relatively small population is the reason for its designation. Threats include sea-level rise, increasing frequency and intensity of Atlantic storms as a result of climate change, and shoreline development in its wintering habitat (COSEWIC 2009a). The Savannah Sparrow is one of only two songbird taxa that breed solely in Canada (Freedman 2014). Individuals start arriving on Sable Island in mid-April. As many as four broods of three to five young are raised during the breeding season that lasts until late August (Freedman 2014). The most recent estimate of adults was 5500 individuals in 2013. The Savannah Sparrow breeds in all vegetated habitats of Sable Island; however, the preferred habitat is dense heath (Freedman 2014). During the breeding season the sparrow may use freshwater ponds and their associated riparian habitat when seeking invertebrates to feed their young, often leaving their territory and crossing others to reach the ponds (Freedman 2014). The Savannah Sparrow feed heavily on the seeds of marram grass on arrival on the island, and after breeding but before their autumn departure (Freedman 2014). The sparrows leave Sable Island beginning in late September and early October, with juveniles leaving before adults (Ronconi *et al.* 2014 in Freedman 2014), although up to 300 may winter on the island (Stobo and McLaren 1975, McLaren 1981, Z. Lucas, pers. comm. in Freedman 2014). The Savannah Sparrow winters in the Mid-Atlantic States between Nova Scotia and northern Florida (SAR Registry 2015).

A management plan was developed for the Savannah Sparrow in 2006 with a goal to maintain the breeding population at the current level, maintain the current amount and composition of breeding habitat, and remove or reduce threats to the species and their breeding and wintering habitat (Environment Canada 2006a). The various actions to obtain these goals are to monitor breeding populations and the breeding habitat, examine the conservation status and regulatory compliance of Sable Island, ensure precautionary approach to projects with potential to impact Savannah Sparrow, and implement education and communication programs (Environment Canada 2006a).

5.2.9 Species at Risk

Descriptions of SAR and SOCC have been provided in the applicable preceding sections. SAR species have a status on Schedule 1 under the *Species at Risk Act (*SARA) and SOCC are species designated under COSEWIC and which have the potential of being listed in the future under SARA. SARA came into force in June 2003, and is one part of a three-part Government of Canada strategy for the protection of wildlife species at risk (Species at Risk Public Registry 2016). It complements existing laws and agreements to provide for the legal protection of wildlife species and conservation of biological diversity. The Act aims to prevent wildlife species from becoming extinct, and to secure the necessary actions for their recovery. The Act establishes Schedule 1 as the official list of wildlife species at risk, classifying species as being extirpated, endangered threatened, or a special concern. Once a species is listed, the measures to protect and recover a species are implemented (Species at Risk Public Registry 2016).

COSEWIC was established in 1977 to provide Canadians with a single, scientifically sound classification of wildlife species at risk of extinction. In 2003, with the advent of SARA, COSEWIC was established as an independent body of experts responsible for identifying and assessing wildlife species considered being at risk. Wildlife species that have been designated by COSEWIC may then qualify for legal protection and recovery under SARA.

Table 5.2.19 summarizes the complete list of SAR and SOCC that have the potential to be found within the RAA.

Table 5.2.19 Species at Risk and Species of Conservation Concern with Potential to Occur within the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]
Marine Fish Species			
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)		Endangered	Endangered
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered

Table 5.2.19 Species at Risk and Species of Conservation Concern with Potential to Occur within the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered
Atlantic sturgeon (Maritimes populations)	*Ancipenser oxyrinchus*	Not Listed	Threatened
Atlantic 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
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 (Bay of Fundy population)	*Morone Saxatilis*	Not Listed	Endangered
Striped bass (Southern Gulf of St. Lawrence population)	*Morone Saxatilis*	Not Listed	Special Concern
Thorny skate	*Amblyraja radiate*	Not Listed	Special Concern
White shark	*Carcharodon Carcharias*	Endangered	Endangered
White hake	*Urophycis tenuis*	Not Listed	Special
Marine Mammal Species			
Blue whale (Atlantic population)	*Balaenoptera musculus*	Endangered	Endangered
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Special Concern	Special Concern
North Atlantic right whale	*Eubalaena glacialis*	Endangered	Endangered
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Not Listed	Special Concern
Killer whale	*Orcinus orca*	Not Listed	Special Concern
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Endangered	Endangered

Table 5.2.19 Species at Risk and Species of Conservation Concern with Potential to Occur within the RAA

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation[1]
Sowerby's beaked whale	*Mesoplodon bidens*	Special Concern	Not Listed
Sea Turtle Species			
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead sea turtle	*Caretta caretta*	Not Listed	Endangered
Migratory Bird Species			
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
Peregrine Falcon (*anatum/tundrius* subspecies)	*Falco perengrinus anatum/tundrius*	Special Concern	Special Concern
Red-necked Phalarope	*Phalaropus lobatus*	Not Listed	Special Concern
Savannah Sparrow (*princeps* subspecies)	*Passerculus sandwichensis princeps*	Special Concern	Special Concern

Note:
[1] Species of conservation concern (SOCC) listed as endangered, threatened, or of special concern by COSEWIC but not listed in Schedule 1 of SARA.

Source: Modified from Stantec 2014a

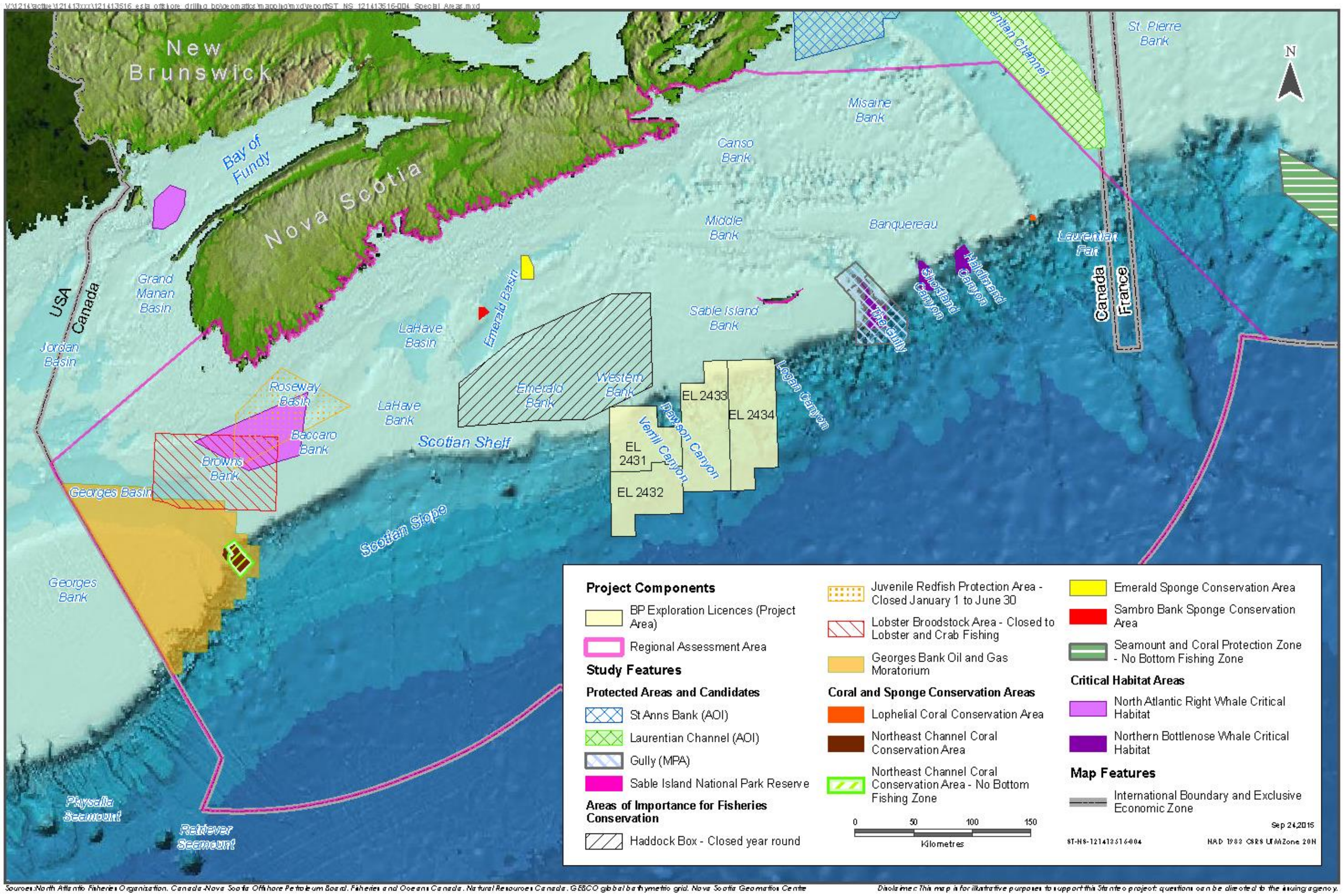
5.2.10 Special Areas

Special Areas include areas on the Scotian Shelf and Slope which have been recognized as being ecologically unique or sensitive and include a *National Parks Act* park, an *Oceans Act* MPA including candidate MPAs, *Species at Risk Act* Critical Habitat areas, *Fisheries Act* closure areas (*e.g.*, significant spawning areas and coral conservation areas), and Ecologically and Biologically Significant Areas (EBSAs). Special Areas located on the Scotian Slope and Shelf are shown in Table 5.2.20, however, most of them are more than 100 km from the Project Area. Special Areas are not equally ecologically significant or sensitive. For example, protected areas such as the Sable Island National Park Reserve and Gully MPA, Shortland and Haldimand Canyons Whale Critical Habitats for the northern bottlenose whale, are afforded more significance given their legal designations and long-term protection (Stantec 2012a). 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 2014a).

The nearest Special Area to the Project Area is the Sable Island National Park Reserve, located 48 km away at its closest point from the ELs and particularly EL 2434 (Figure 5.2.32). Sable Island, located in the open northwestern Atlantic Ocean close to the edge of the Scotian Shelf (continental shelf), was formally proclaimed to be a national park reserve on December 1, 2013 (Freedman 2014). The Island is a significant site with important features including the largest breeding colony of grey seals in the world, a population of wild horses, one of the largest dune systems in eastern North America, an important freshwater lens, a number of species at risk and endemic species, and an extremely dynamic ecology (Freedman 2014).

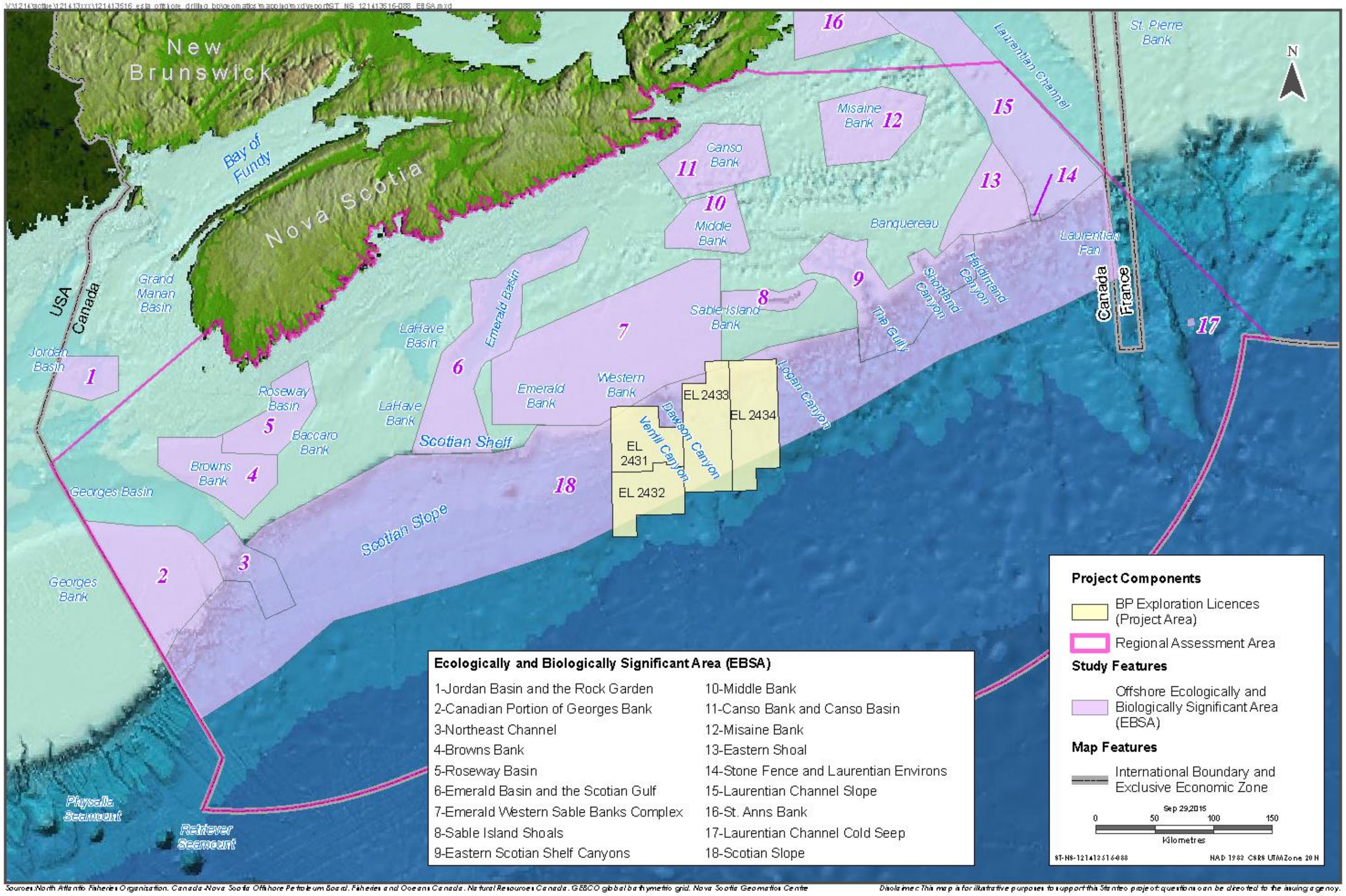
There are several EBSAs, many of which are incorporated in the protected areas described above. EBSAs have been identified based on a compilation of scientific expert opinion and traditional knowledge that was solicited through efforts to support integrated ecosystem-based management efforts on the Scotian Shelf (Doherty and Horsman 2007). EBSAs are areas of particularly high ecological and biological significance that may require greater than usual degree of risk aversion in the management of activities in these areas (DFO 2014b). The classification of an EBSA does not give the area any special legal status; however, they are considered in a broad range of coastal management and planning processes such as environmental assessments, environmental emergency response, sustainable fisheries policies and MPA planning (DFO 2014b). Seventeen EBSAs have been identified on the Scotian Shelf and Slope. Of particular relevance to the Project Area are the EBSAs highlighted in the SEA for the Western Scotian Slope (Stantec 2014b) including the Scotian Slope, which runs through the Project Area and the Emerald-Western-Sable Island Bank Complex which runs north of the Project Area. The Scotian Slope EBSA is recognized as being an area of high primary productivity, high fish species diversity, high small fish and small invertebrate species richness, important for groundfish, migratory route for cetaceans and large pelagic fishes, important for seabirds, and unique habitats and sensitive benthic communities (DFO 2014b). The Emerald-Western-Sable Island Bank Complex was identified as being important for groundfish, high larval fish abundance and diversity, commercial and non-commercial invertebrates, high fish and invertebrate biomass, high fish species diversity, high invertebrate species diversity, and important seabird habitat, as well as the Western Gully area is of significance to cetaceans (DFO 2014b).

Figures 5.2.32 and 5.2.33 depict designated Special Areas including protected areas, fisheries conservation areas, and EBSAs on the Scotian Shelf and Slope. Table 5.2.20 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 2014b).



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.32 Special Areas



Sources: Data provided from NAFO, CNSOPB, DFO and NSDNR (n/d).

Figure 5.2.33 Ecologically and Biologically Sensitive Areas

Table 5.2.20 Special Areas in the RAA

Sable Island National Park Reserve	
Location and Proximity to Project Area	• With its western tip being about 156 km east of the closest landfall on the mainland of Nova Scotia and 290 km southeast of Halifax, Sable Island is a windswept crescent-shaped sandbar 49.5 km long by 1.3 km wide with an area of 29.8 km^2 that emerges from the Atlantic Ocean near the edge of the Continental Shelf (Scotian Shelf) (Freedman 2014). • Approximately 48 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 IBA (Environment Canada 2012d). • 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 the 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 2009a). 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,

Table 5.2.20 Special Areas in the RAA

	and habitat loss. • The 2006 proposed Recovery Strategy for the Roseate Tern (Environment Canada 2006b) 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 2010b) 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 2010b). • 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 71 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 2011b). • 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 2011b). • 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 2011b). • 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

Table 5.2.20 Special Areas in the RAA

	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 2012).
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 71km, 139 km and 171 km respectively from the Project Area on the Eastern Scotian Slope.
Designation and Administration	• In 1994, 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 2011c). • 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 2010b). Critical habitat is protected under SARA through provisions set out in section 32 of the Act.

Table 5.2.20 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). • Various studies have shown the distribution of various cetacean species that use the Gully is not uniform throughout the canyon. Minke whales were observed only in shallow waters at the head of the canyon, sperm whales and Atlantic white-sided dolphins occurred throughout the canyon, and northern bottlenose whales known to prefer the deepest waters at the canyon mouth. These differences in habitat preferences are believed to be driven by the influence of oceanographic processes within the canyon on distribution of prey for these cetacean species (Moors-Murphy 2014). • 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 2011c). • 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 2011c).
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. • Approximately 130 km (Sambro Bank) and 126 km (Emerald Basin) from the Project Area.
Designation and Administration	• In 2013, in accordance with DFO's *Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas* (DFO 2009d), DFO closed two areas on the 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 2009d).

Table 5.2.20 Special Areas in the RAA

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 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 2013d). • Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make the sponges particularly vulnerable to physical impacts and limit recovery (DFO 2013d).
***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 248 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).
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 264 km from the Project Area.

Table 5.2.20 Special Areas in the RAA

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 300 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 production, conservation, processing or transportation of petroleum on George Bank indefinitely. A

Table 5.2.20 Special Areas in the RAA

	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 306 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).

Table 5.2.20 Special Areas in the RAA

	• 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 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).
Scotian Slope EBSA	
Location and Proximity to Project Area	• The Scotian Slope 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.
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 MPA network analysis exercise to address conservation objectives in accordance with the *Oceans Act*.

Table 5.2.20 Special Areas in the RAA

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 scalps 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.
Emerald Bank, Western Bank and Sable Bank Complex EBSA	
Location and Proximity to Project Area	• The Emerald bank, Western Bank and Sable Bank Complex (approximately 17,900 km^2) is located on the Scotian Slope and Shelf north of the Project Area.
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 MPA network analysis exercise to address conservation objectives in accordance with the *Oceans Act*.
Ecological Significance	• Area of highest larval fish diversity potential as a result of a gyre. • Area of concentration of spawning fish (*e.g.*, gadoids). • Juvenile nursery area for haddock, cod, monkfish, yellowtail, skate, flounder. • Recruitment source for downstream Browns Bank. Includes the defined 4W Haddock Box Nursery Area which has been closed to groundfish otter trawl since 1987 and to all groundfish fishing since 1993. Important overwintering area in the slope waters (Doherty and Horsman 2007).

Table 5.2.20 Special Areas in the RAA

Select Fisheries Closure Areas for Fisheries Conservation	
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 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 153 ha are within the Project Area, representing about 0.01% of the total area of the Haddock Box.
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). • Approximately 221km 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 sea 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). • Approximately284 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 2005a). • Approximately 336 km from the Project Area.

Modified from Stantec 2014a and 2014b

5.3 SOCIO-ECONOMIC ENVIRONMENT

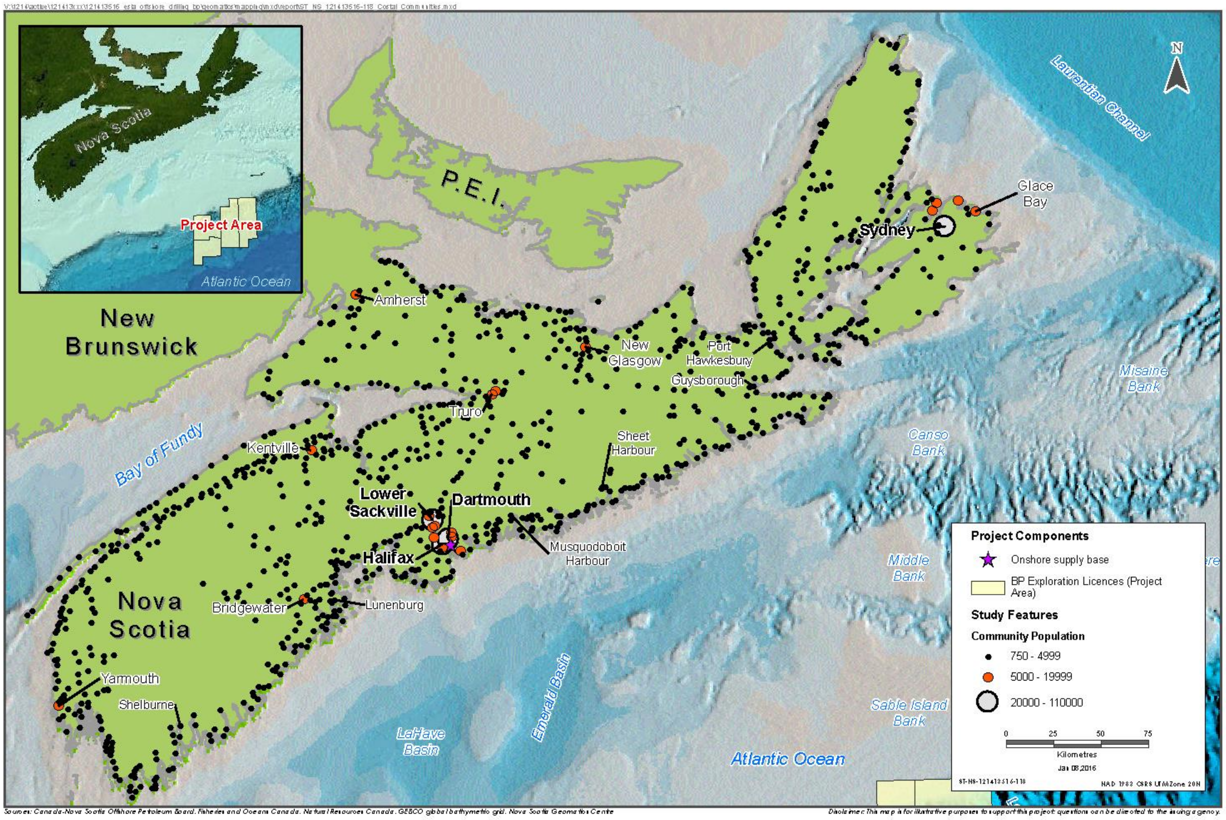
5.3.1 Land and Nearshore Ocean Use

PSVs 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. It extends inland for over 22 km to the northwest with a variable width ranging from approximately 385 m in The Narrows to approximately 4,225 m in the Bedford Basin and reaches depths of up to 70 m in the Bedford Basin and between 20 to 30 m in depth in other areas (Stantec 2014a).

The Port of Halifax accommodates cargo vessels and cruise ships on a year-round basis as well as bulk handling facilities, a high volume roll-on/roll-off terminal, oil wharves, rail facilities, and ferry terminals. Halifax Harbour is therefore 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 vessel layup), including associated noise, light, and other sensory disturbance. The Woodside supply base location has no natural intertidal zone, as the existing shoreline was previously infilled to accommodate present operations. Given this previous disturbance, the potential for previously undisturbed heritage, historic, or archaeological resources to be present on-site is therefore assumed to be low.

5.3.1.1 Communities in Nova Scotia

Halifax Harbour is surrounded by the Halifax Regional Municipality in Halifax County and is bordered by the urban communities of Halifax to the west, Bedford to the north, and Dartmouth to the east. Most of the other coastal communities in Nova Scotia are rural. Statistics Canada distinguishes between urban and rural settings as "population centres" (*i.e.*, areas with population of at least 1,000 and no fewer than 400 persons per square kilometre) and "rural areas" (*i.e.*, all territory lying outside of population centres) (Statistics Canada 2015a). Based on the most recent available Canadian census data, 57% of Nova Scotia's population resides in one of the province's 37 population centres, and 43% reside in the remaining territory of rural areas (Statistics Canada 2011). Nova Scotia's largest population centre is Halifax (population of 297,943), followed by Sydney (population of 31,597). The distribution of population among Nova Scotian communities is shown on Figure 5.3.1.



Sources: Canada-Nova Scotia Offshore Petroleum Board, Fisheries and Oceans Canada, Natural Resources Canada, GEBCO global bathymetric grid, Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.1 Communities in Nova Scotia

At its shortest distance, the Project Area is located approximately 230 to 370 km southeast of Halifax and 48 km from Sable Island National Park Reserve. Sable Island is the nearest permanent, seasonal or temporary residence to the Project Area except for workers inhabiting offshore platforms at the Sable Offshore Energy Project and the Deep Panuke developments.

5.3.1.2 Nearshore Fisheries

At least 69 species of fish have been recorded in the nearshore marine habitat of Nova Scotia within the 40 m depth of water (Stantec 2014a), many of which would be considered species of CRA fisheries. Halifax Harbour is located within NAFO Fishery Unit Area 4Wk and commercial fisheries include a small commercial finfish fishery seaward of McNabs Island consisting of groundfish (cod, haddock, pollock and halibut) and pelagic (herring and mackerel) species. Other areas throughout the harbour, particularly the Bedford Basin, support a bait fishery (pollock, herring, mackerel and smelt) for both commercial and recreational bait (Rozee 2000), typically fished using gillnets and hand-lines. 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 with a total of 15 to 20 lobster fishers using the Harbour (Stantec 2014a). 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; however, the area around McNabs Island supports the majority of lobster fishing activity. Light lobster fishing also occurs in the Bedford Basin, with most traps placed intermittently along the shoreline, one or two traps located around Georges Island and in Tufts Cove. 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).

LFA 34, which extends from the southwest boundary of LFA 33 (Port La Tour, Shelburne County) off southwestern Nova Scotia and into the Bay of Fundy, has the highest landings and most participants of any LFA in Canada (DFO 2013v). Both LFA 33 and LFA 34 share the same fishing season from the end of November to May 31; however, most lobsters are caught during the first three weeks of the season.

Inshore recreational fisheries include American eel, mackerel, herring, and scallop. 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).

Information on offshore fisheries is provided in Section 5.3.5.

Nova Scotia's fishing industry (harvesting and processing) is a major source of direct and indirect employment, provincial income, and is a leading source of export earnings. Fisheries and aquaculture are of particular socio-economic importance to several rural coastal communities in the province, where the health of the industry can noticeably influence population growth, housing markets, and local business activity (CBCL Limited 2009, Government of Nova Scotia 2014). Labour and economy in Nova Scotia is discussed more generally in Section 5.3.2.

5.3.2 Labour and Economy

Nova Scotia has a labour force participation rate of 62%, an employment rate of 56.6%, and an unemployment rate of 8.6% (Statistics Canada 2015b). The majority (81%) of employed Nova Scotians work in the service producing sector, particularly in the health care and trade industries (Table 5.3.1). The labour market in the province has seen modest increases in wages and salaries, with average weekly wage (+1.9%) and compensation of employees (+2.0%) increasing at below historical rates in 2015 (Government of Nova Scotia 2015).

Table 5.3.1 Distribution of Employed People in Nova Scotia, by Industry (2015)

Industry	# of Employed People (thousands)
All Industries	**448.1**
Goods Producing Sector	**83.1**
Agriculture	5.4
Forestry, fishing, mining, quarrying, oil and gas	11.8
Utilities	3.7
Construction	33.6
Manufacturing	28.7
Service Producing Sector	**365.1**
Trade	71.8
Transportation and warehousing	20.5
Finance, insurance, real estate and leasing	23.4
Professional, scientific and technical services	27.8
Business, building and other support services	20.3
Educational services	36.4
Health care and social assistance	72.4
Information, culture and recreation	17.5
Accommodation and food services	30.9
Other services	17.1
Public administration	27.0

Source: Statistics Canada 2015b

Nova Scotia's economy declined 0.9% in 2012, remained stationary in 2013, and grew 0.6% in 2014. Nova Scotia is forecasting economic growth of 1.0% in 2015 and 0.8% in 2016 (Government of Nova Scotia 2015). Table 5.3.2 shows the relative contribution of different industries to Nova Scotia's gross domestic product (GDP).

Table 5.3.2 Annual Percentage Share of Nova Scotia's GDP, by Industry (2010-2014)

Industry	2010	2011	2012	2013	2014
By Category					
All industries	100.00	100.00	100.00	100.00	100.00
Goods-producing industries	21.24	20.50	19.80	19.92	20.08
Service-producing industries	78.76	79.50	80.20	80.08	79.92
By Industry					
Industrial production	13.01	12.16	11.20	11.65	12.05
Information and communication technology sector	4.00	3.91	4.07	4.02	4.15
Energy sector	4.34	4.01	3.42	3.77	4.04
Agriculture, forestry, fishing and hunting	2.24	2.36	2.52	2.60	2.90

Table 5.3.2 Annual Percentage Share of Nova Scotia's GDP, by Industry (2010-2014)

Industry	2010	2011	2012	2013	2014
Mining, quarrying, and oil and gas extraction	2.37	1.98	1.31	1.52	2.28
Utilities	1.81	1.97	2.11	2.22	2.19
Construction	6.24	6.24	6.33	5.94	5.40
Manufacturing	8.58	7.94	7.53	7.65	7.31
Wholesale trade	3.76	3.76	3.19	3.33	3.41
Retail trade	6.73	6.31	6.35	6.60	6.65
Transportation and warehousing	3.23	3.41	3.38	3.29	3.28
Information and cultural industries	3.32	3.37	3.57	3.49	3.50
Finance and insurance	5.60	5.71	5.61	5.75	6.02
Real estate and rental and leasing	15.03	15.15	15.82	15.93	16.02
Professional, scientific and technical services	3.84	3.86	3.95	3.96	3.98
Management of companies and enterprises	0.40	0.39	0.39	0.40	0.43
Administrative and support, waste management and remediation services	2.23	2.27	2.27	2.16	2.16
Educational services	6.93	6.97	6.96	6.63	6.43
Health care and social assistance	9.94	10.11	10.36	10.30	10.35
Arts, entertainment and recreation	0.55	0.55	0.57	0.63	0.62
Accommodation and food services	2.38	2.39	2.45	2.41	2.45
Other services (except public administration)	2.02	2.08	2.10	2.12	2.08
Public administration	12.78	13.18	13.23	13.07	12.54

Source: Statistics Canada 2015b

5.3.3 Human Health

Levels of ambient air pollution are monitored across Nova Scotia, and provincial standards and objectives are in place for O_3, PM, CO, NO_2, SO_2, volatile organic compounds (VOCs), and acid precipitation. These standards and objectives were developed to be protective of human health. Based on the results for the period of 2000 to 2007, NSE concluded that "air quality in Nova Scotia is generally good. Although some pollutants have elevated levels at times, pollutant levels usually meet [provincial] standards and objectives" (NSE n.d.).

Offshore air quality is discussed in Section 5.1.2.2. The location of the Project Area is far from any human receptors that would be sensitive to atmospheric air or noise emissions.

DFO's mandate includes the protection of human health through responsible management of fishery resources and administration of the Management of Contaminated Fisheries Regulations under the *Fisheries Act*, which authorize DFO to close recreational and commercial fishing areas when the presence of biotoxins, bacteria, chemical compounds or other substances in fish habitat may pose a risk to public health (DFO 2014a) (*e.g.*, through exposure to contaminated food sources from harvested fish). Various orders prohibiting fishing for contaminated fish have been issued by DFO for nearshore waters around Nova Scotia. Most recently, on April 10, 2014, DFO issued the Contaminated Fisheries Prohibition Order MAR-STN-2014-004, which closes portions of Ketch Harbour, Sandy Cove and Sambro Harbour, Halifax County, Nova Scotia, to fishing for all species of clams, all mussels, all whelks, all oysters and Bay scallops from May 1 to September 30 each year. Ten Orders were issued in 2013 (for several areas in Guysborough County, Victoria County, and Halifax County) and 12 were issued in 2012 (for several areas in Digby County, Yarmouth County and Inverness County (DFO 2015p).

In 2009, the Nova Scotia Health Research Foundation (NSHRF) commissioned review of demographic and epidemiological data, as well as reports on the status of Nova Scotia's health system, to inform their research priorities. The NSHRF study identified the following six major health issues for Nova Scotia: reducing health disparities; integrated approaches to chronic disease and injury prevention; chronic disease management; re-orienting the health system to emphasize primary health care; implementing sustainable continuing care models; and implementing best practices in recruitment, retention, role sharing and change among health human resources. The study did not include special consideration for major health-related issues affecting Aboriginal peoples in Nova Scotia; however, such issues have been identified elsewhere.

In 2008, the Health Working Committee (HWC) of the Mi'kmaq-Nova Scotia-Canada Tripartite Forum (a partnership between the Nova Scotia Mi'kmaq, the Province of Nova Scotia, and the Government of Canada) conducted community engagement sessions and surveys to identify health priorities, needs and challenges of Mi'kmaq people. Based on this study, the HWC identified the following as the top Mi'kmaq community health priority issues in Nova Scotia: mental health, addictions/substance abuse, non-insured health benefits coverage, elder care, obesity-related issues and funding (HCDA 2008).

The Atlantic Health Partnership (AHP, formerly the Mi'kmaq Maliseet Atlantic Health Board) is comprised of seven Chiefs, appointed by the various Atlantic Tribal Councils, and the Regional Executive Head of Health Canada's First Nations Inuit Health Branch (FNIHB). The AHP has three committees (Public Health and Primary Care, Mental Wellness and Non-Insured Health Benefits) and meets at least three times a year to provide input regarding programs and services delivered by FNIHB for the Atlantic region. Priorities identified by AHP include mental health and addictions, care of Elders, and partnership with Regional and District Health Authorities (HCDA 2008; APC 2014).

5.3.4 Ocean Use and Infrastructure

The following ocean uses and infrastructure, not including fishing, occurs 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; and
- seabed hazards associated with human activities.

These uses are described in the following sections.

5.3.4.1 Oil and Gas Exploration and Production

Development of the offshore petroleum industry can be broadly assigned to three major categories: exploration; production; and decommissioning. There is no current offshore oil and gas activity in the Project Area. Although there have been other wells drilled in the Project Area (Shubenacadie H-100 drilled in 1982, Evangeline H-98 drilled in 1984, Newburn H-23 drilled in 2002 and Weymouth A-45 drilled in 2003), these wells have been plugged and abandoned. Figure 5.3.2 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, significant discovery licences (SDLs), and production licences.

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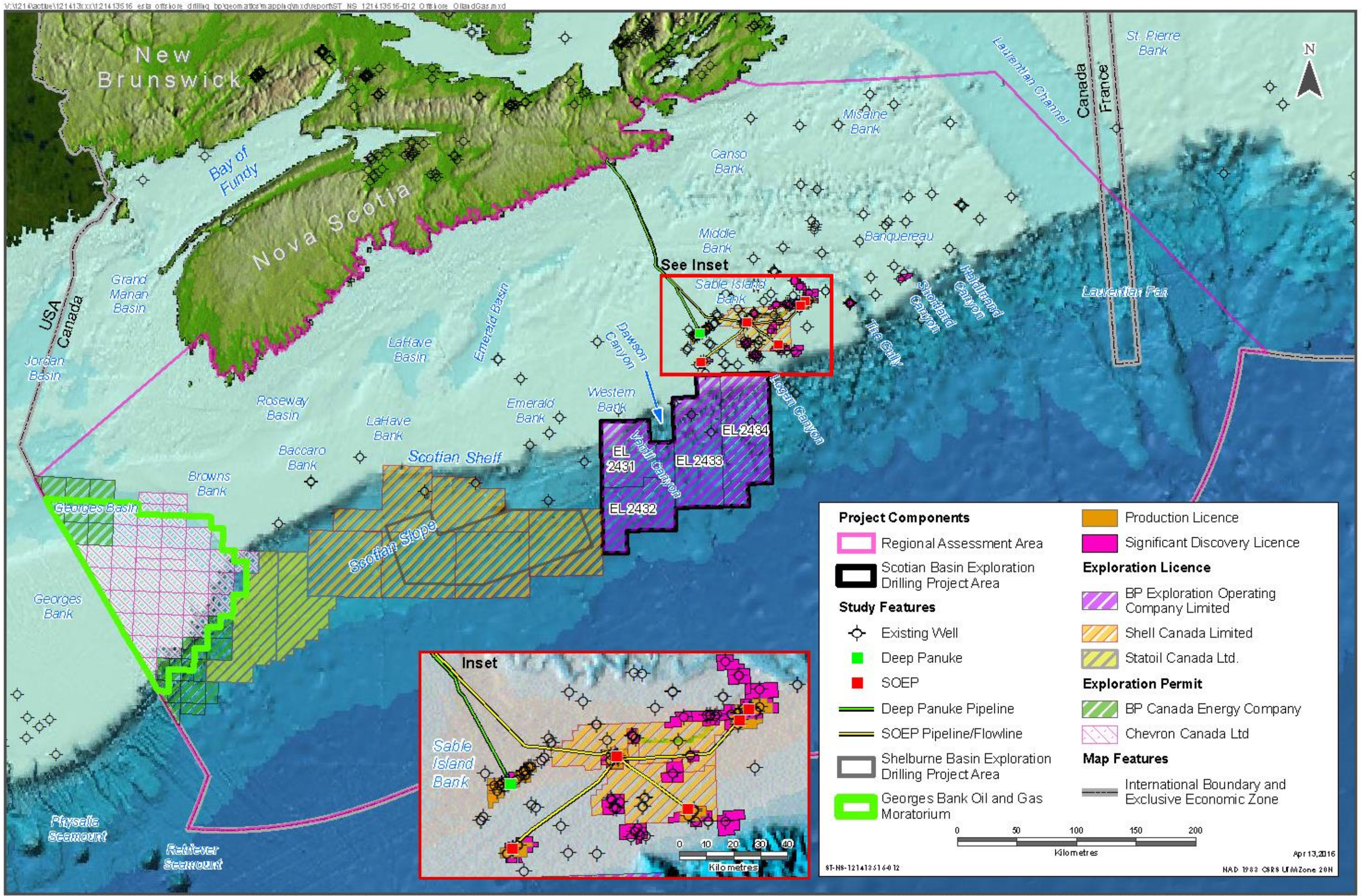

Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Figure 5.3.2 Offshore Nova Scotia Petroleum Activities and Infrastructure

The Shelburne Basin Venture Exploration Drilling Project is located immediately west of the Project Area. Shell initiated exploration drilling in October 2015. In November 2015 Statoil Canada Ltd. (Statoil) acquired exploration rights to two licence areas immediately adjacent to Shell's ELs on the Scotian Slope. Plans for exploration activities by Statoil were not available at the time of EIS preparation. The Sable Offshore Energy Project (SOEP), which comprises a central processing platform, four satellite platforms, subsea wells and flowlines, and a subsea pipeline to shore, is located approximately 11 km northeast from the Project Area. SOEP is operated by ExxonMobil Canada Limited (ExxonMobil) and partners and has been producing natural gas since 1999. There is the now-decommissioned Cohasset-Panuke Project, which was operated by Pan-Canadian (now Encana) and LASMO Nova Scotia Limited from 1992 to1999, and the Deep Panuke Offshore Gas Development Project (Deep Panuke) operated by Encana Corporation (Encana) that commenced natural gas production in 2013 which is located approximately 35 km from the Project Area.

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 2009b) – 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).

5.3.4.2 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. Maritime Forces Atlantic (MARLANT) represents Canada's east coast naval presence and engages in various operations and training activities offshore Nova Scotia. MARLANT, which is headquartered in Halifax, Nova Scotia, uses a range of platforms, including patrol frigates, coastal defence vessels, destroyers, submarines, ship-borne helicopters and long-range patrol aircraft to carry out its missions.

Munitions are known to have been lost, discarded, or disposed offshore in association with past and present military activities within the RAA. The locations of these potential seabed hazards are discussed in Section 5.3.4.6.

DND also conducts naval training activities in designated nearshore and offshore exercise areas, shown on Figure 5.3.3. Maps, coordinates and descriptions of military activities permitted in these exercise areas are provided in the Canadian Coast Guard's Annual Notice to Mariners. 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 5.3.3, the Project Area does not fall within DND exercise areas.

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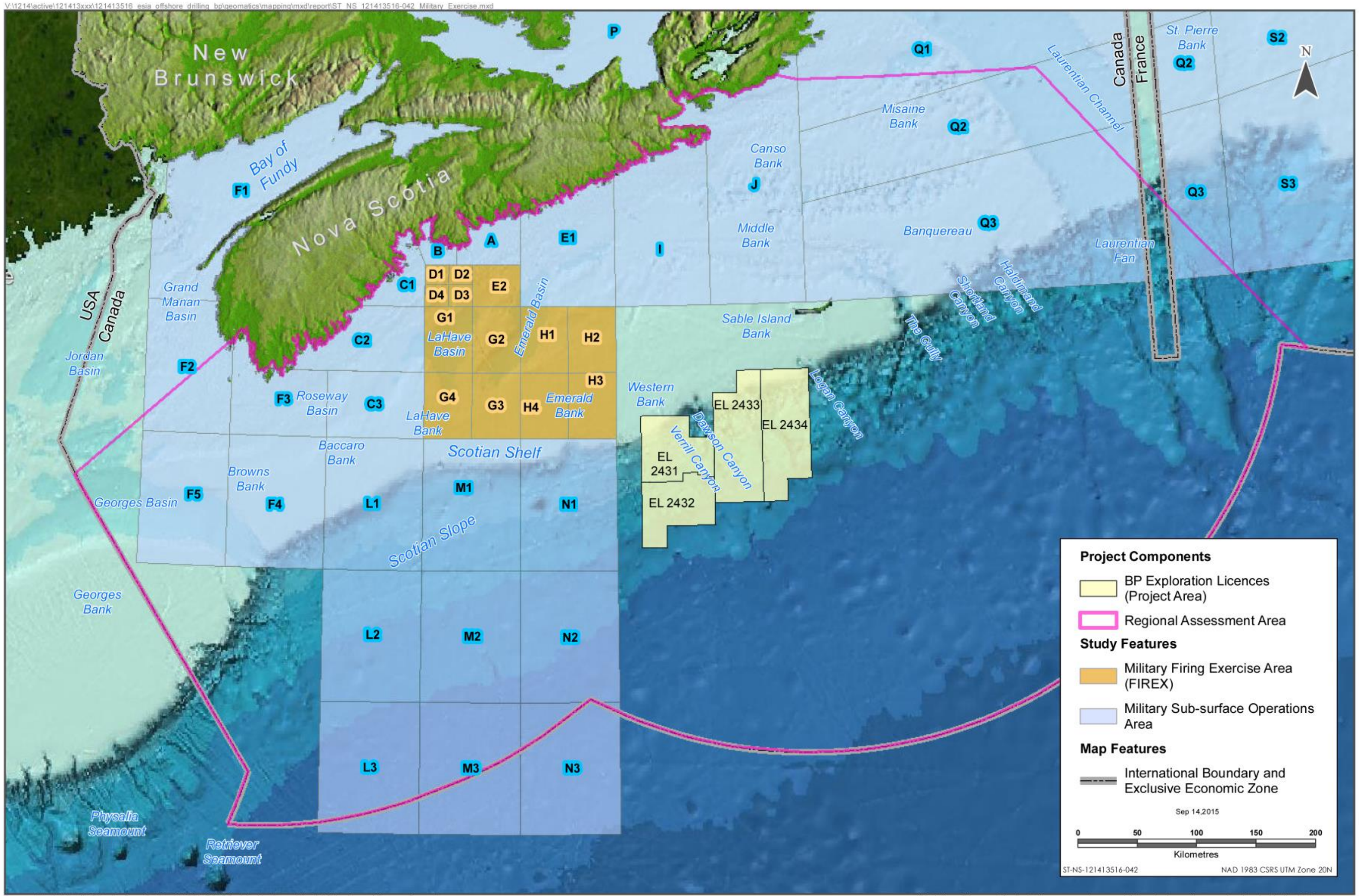


Sources: North Atlantic Fisheries Organization (NAFO), GEBCO global bathymetric grid, Fisheries and Oceans Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.3 Department of National Defence Operations Areas

5.3.4.3 Marine Traffic

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

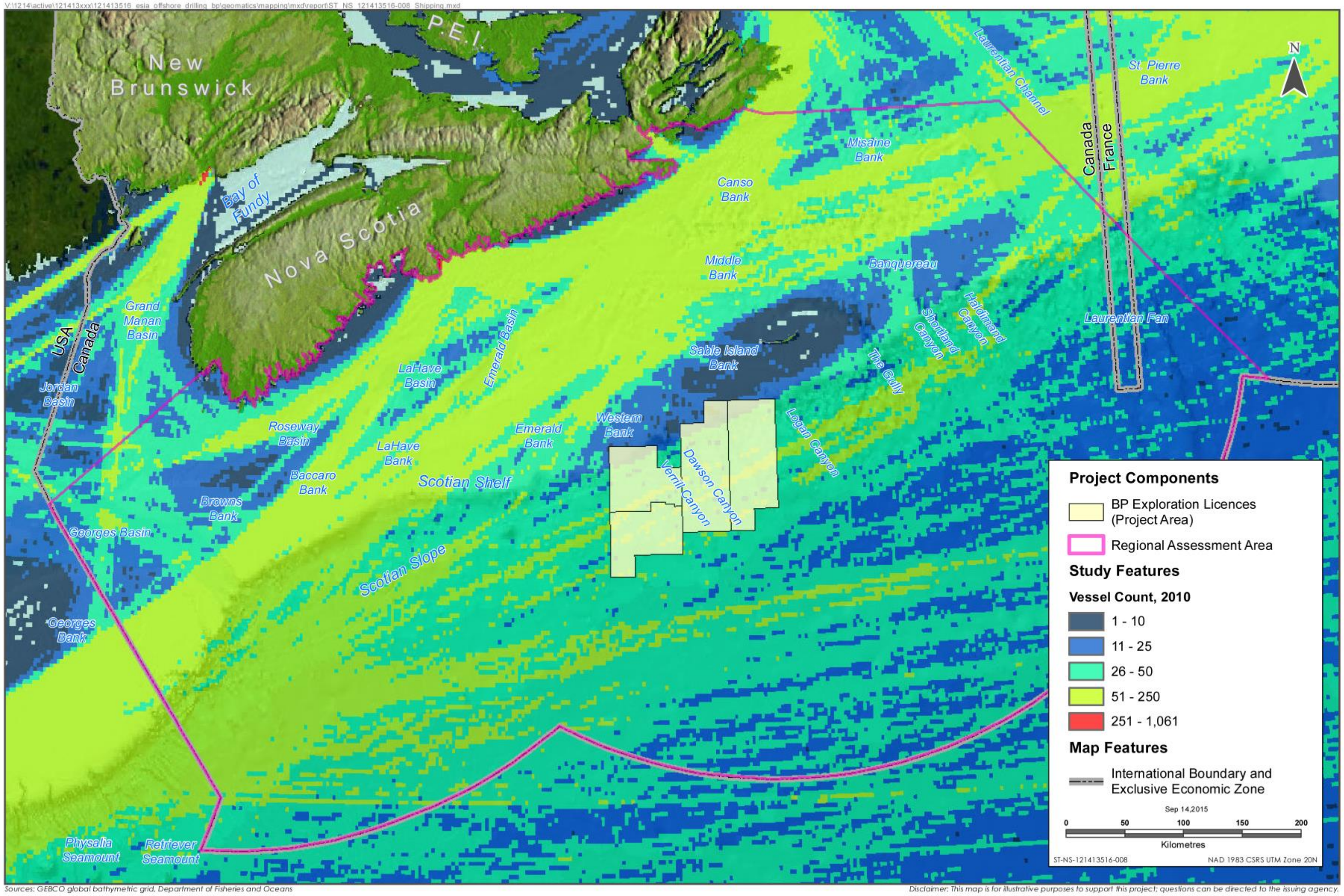
- international shipping over the Scotian Shelf as part of the "great circle route" (*i.e.*, shortest distance over the earth's surface) between Europe and the eastern seaboard of the United States and Canada;
- international and domestic shipping along the coast of Nova Scotia to and from the United 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; and
- 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.

There is no designated shipping corridor through the Project Area with much of the shipping traffic along the Scotian Shelf, adjacent to the Project Area. The Scotian Slope, however, is host to a variety of ocean vessel traffic (refer to Figure 5.3.4). 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 as well as a range of cruise ships, government vessels, and fishing vessels (DFO 2005a). Fishing vessels account for over 70% of marine traffic volume southeast of Nova Scotia between Cape Breton and Yarmouth out to the EEZ (Stantec 2014b). 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 introduction and transfer of non-indigenous (including invasive) aquatic species.

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



Sources: GEBCO global bathymetric grid, Department of Fisheries and Oceans

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.4 Shipping Traffic in 2010

5.3.4.4 Tourism and Recreational Activities

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

In 2003, there were at least 174 marine tourism operators throughout Nova Scotia with the majority associated with whale and seabird watching tours. Sport-fishing and boat tours also represent 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 and 7% participated in a sport-fishing or sightseeing cruise (DFO 2005a).

Whale watching activities tend to be located in areas of whale congregation, particularly around the mouth of the Bay of Fundy and off northern Cape Breton. Most marine tourism activities occur in coastal rather than offshore areas with the vast majority of tourism activities off the coast of Nova Scotia occurring between May and October (DFO 2005a).

As indicated in the SEA for the Western Scotian Slope (Stantec 2014b), recreational fisheries in the vicinity 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 venture to the Hell Hole in southern Nova Scotia and do not typically venture offshore beyond the Shelf Break (DFO, pers. comm. 2014 in Stantec 2014a).

In the past, there has been limited tourism activity on Sable Island, although with the recent designation of Sable Island as a National Park Reserve, it is anticipated that there will be an increase in visitation by tourists. The majority of people travelling to Sable Island are generally involved in various aspects of operational work (*i.e.*, stations staff, maintenance contractors, inspectors), industry-related projects or scientific research and monitoring programs. Tourists have also been able to visit the island for general interest. Tourists include politicians and dignitaries, journalists, artists, students on educational cruises, and ordinary citizens with personal interest for the island (Freedman 2014). Although tourism is not restricted on the island, access is restricted and permission must be applied for and obtained from Parks Canada. There has been no formalized tourism on Sable Island; in the past two decades there have been about 50 to 100 people visiting Sable Island during an average year (Freedman 2014). Travel to the island is generally by private yacht or chartered small fixed-wing aircraft. Yachts generally visit Sable Island in July and August while August through October offers the most favourable conditions to travel by air. In 2014 there were two cruises by Adventure Canada in which Sable Island was the primary advertised destination, along with the nearby marine Gully (Freedman 2014).

5.3.4.5 Marine Research

Marine research activities include various scientific studies such as DFO's annual multi-species trawl surveys to monitor fish populations; ongoing data collection from Environment Canada weather buoys and moorings for the RAPID Climate Change Program; and the DFO Atlantic Zone Off-Shelf Monitoring Program to collect physical, chemical and biological oceanographic data. Figure 5.3.5 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 and monitoring purposes (Figure 5.3.5), including those operated by the Gulf of Maine Ocean Observing System, the United States National Data Buoy Center, and Environment Canada.

The Scotian Shelf and Slope also contain research transects associated with the Atlantic Zone Monitoring Program (AZMP) study which 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 ocean conditions and to relate these changes to the predator/prey relationships of marine resources. The Halifax Line of the AZMP runs through the western portion of the Project Area whereas the Browns Bank Line is to the west of the Project Area. There is also a fixed station (Halifax Station 2) on the Halifax Line located on the Scotian Shelf and outside the Project Area. 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 2014b). These deepwater stations, referred to as the Extended Halifax Line and part of the AZOMP, 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 are shown on Figure 5.3.5 with some moorings located in the Project Area. 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.

Scientists from DFO and Dalhousie University conduct cetacean studies in the region, with a particular focus on the Scotian Shelf population of northern bottlenose whales and trends in cetacean abundance in the Gully and neighbouring submarine canyons. 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 2014b).

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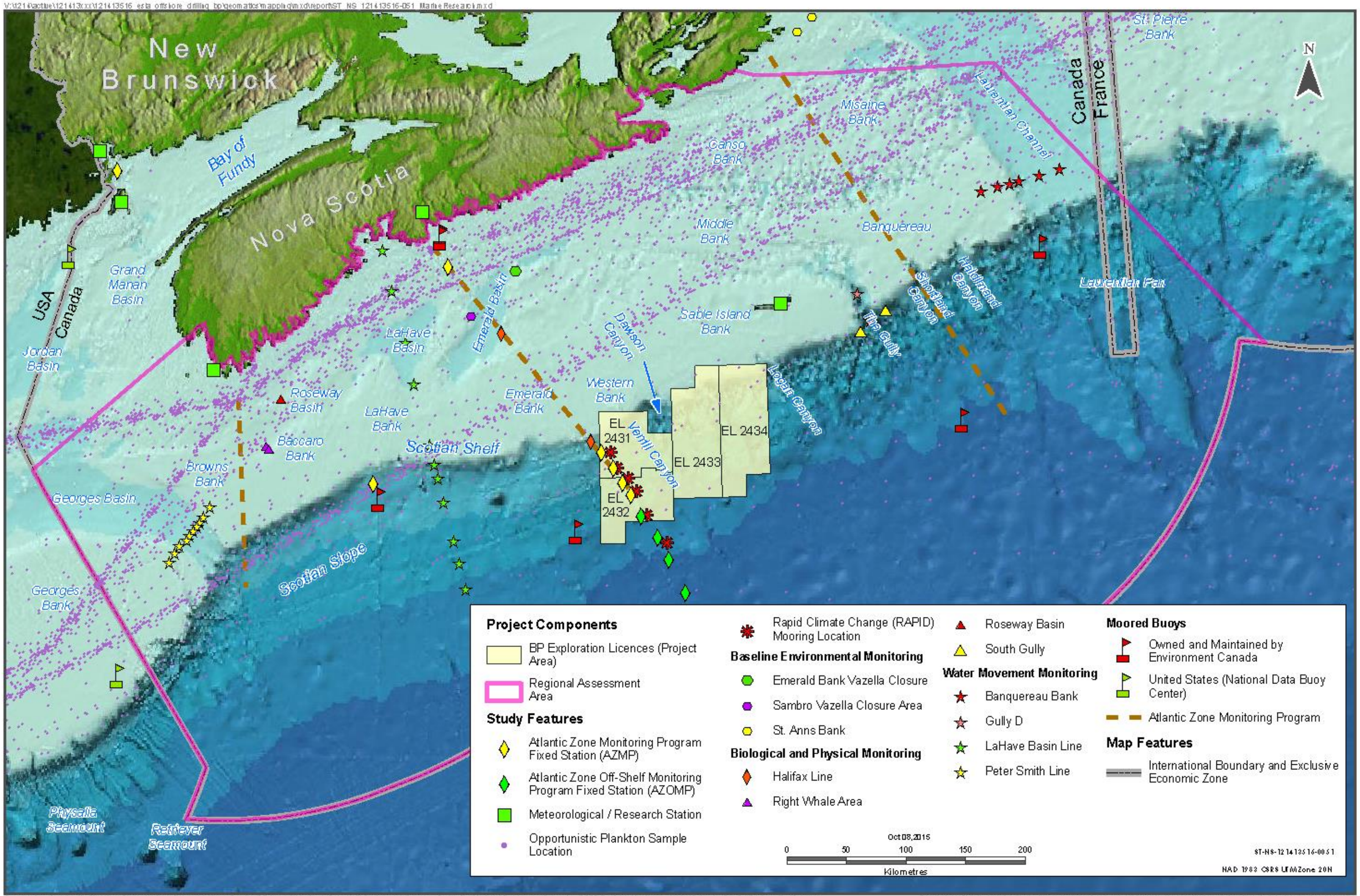

Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.5 Marine Research Locations

5.3.4.6 Seabed Hazards Associated with Human Activities

Seabed hazards associated with human activities on the Scotian Shelf and Slope include pipelines (see Section 5.3.4.1), cables, explosives, shipwrecks, and disposal sites.

In the last 150 years, there have been many submarine cables laid on the seafloor, including copper telegraph cables, telephone cables, and fibre optic cables. As shown on Figure 5.3.6, there are several inactive cables that cross through the Project Area. In 2015, Hibernia Express completed the installation of a subsea fibre optic cable connecting Halifax, NS and Brean, UK; however, this cable is not located within the Project Area. The location of subsea cables are charted and as such will be avoided during the selection of drill sites. BP 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.

Halifax Harbour has been used as a military port for centuries and therefore lost or discarded unexploded ordnances (UXOs) could potentially be 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 military activities. A number of publicly known explosives disposal sites are also located off the coast of Nova Scotia and have been documented by DCC. As illustrated on Figure 5.3.7, there is reportedly an explosive dumpsite located within the southeast corner of the Project Area. The most recent information available from DCC regarding Legacy Sites, explosives disposal sites, and recorded shipwrecks, are shown on Figure 5.3.7.

Sable Island, located approximately 48 km from the Project Area, is known as "*the graveyard of the Atlantic*", with more than 350 shipwrecks recorded on the Island since 1583. The most recent shipwreck around the Island was the sloop Merrimac in 1999 (Freedman 2014). Shipwrecks have occurred for various reasons such as relatively primitive navigation in earlier times, large number of traffic near the island, and the notoriously foggy conditions on the Sable Bank (Freedman 2014).

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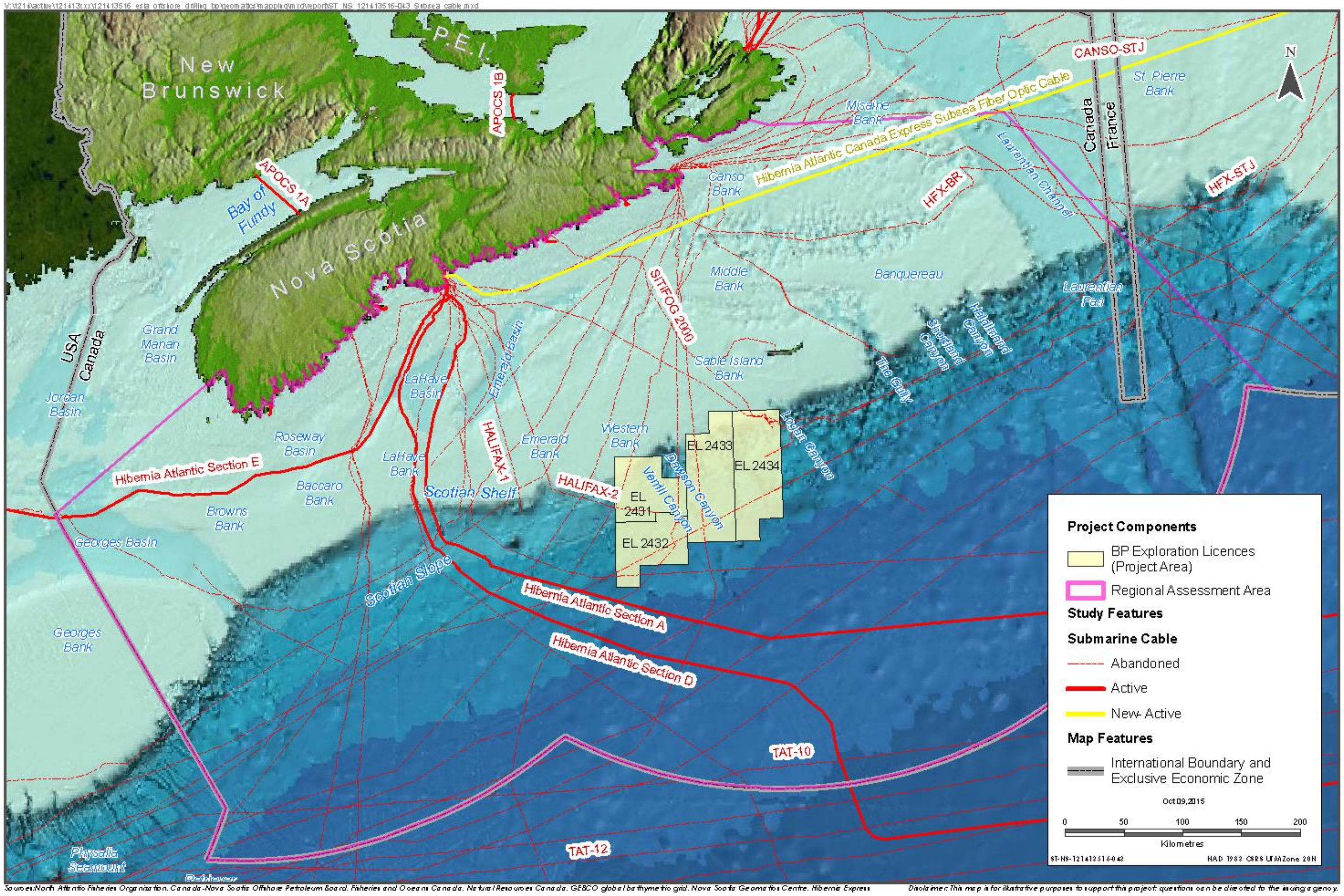
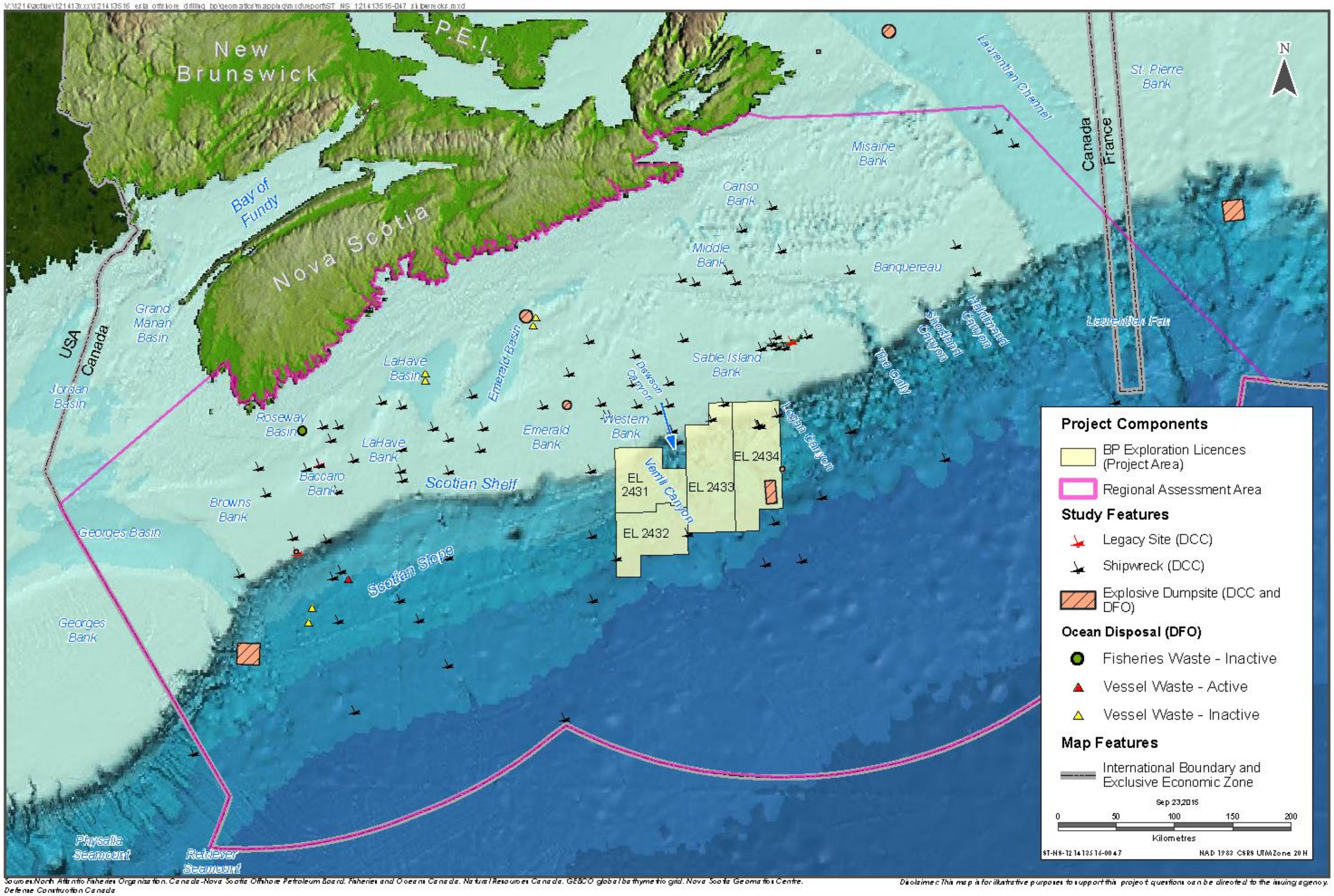


Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre. Hibernia Express

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.6 Subsea Cables



Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre. Defense Construction Canada

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.7 Shipwrecks and Ocean Disposal Sites

5.3.5 Offshore Commercial Fisheries

5.3.5.1 Historical Fisheries

Aboriginal peoples have been harvesting fish and shellfish offshore Nova Scotia for thousands of years, with commercial fishing starting 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 tonnes) (Worcester and Parker 2010). Throughout this period of commercial fishing, groundfish landings dominated (mainly gadoids) with 450,000 tonnes landed in 1973; these landings decreased to less than 15,000 tonnes in 1997. This drastic decrease in landings was the primary factor in the imposition of a 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).

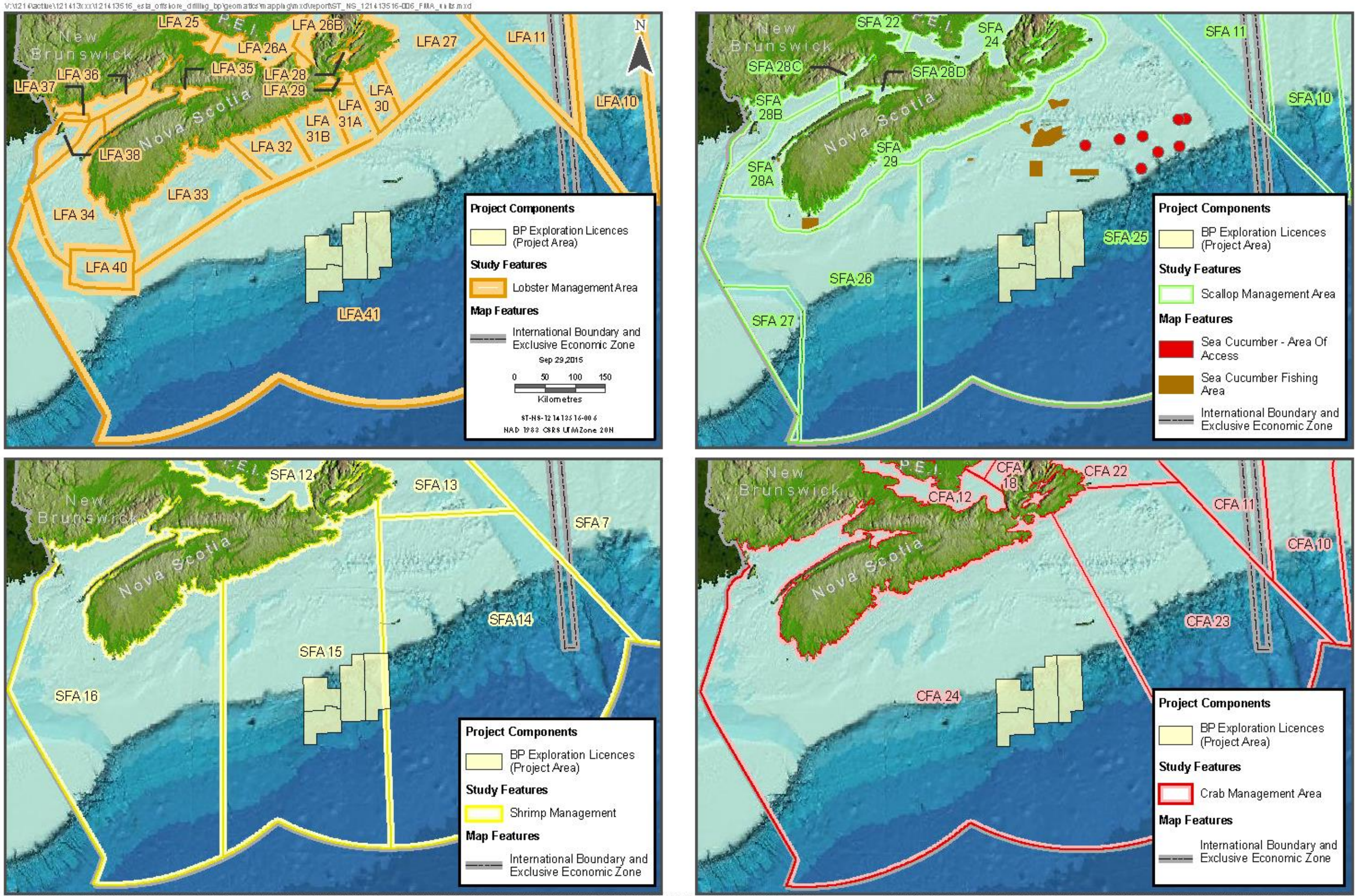
5.3.5.2 Commercial Fisheries

Within and surrounding the Project Area, the socio-economic setting is dominated by commercial fisheries activity. Groundfish, pelagic, and invertebrate fisheries occur on the Scotian Shelf and Slope, with large pelagics (*e.g.*, swordfish, tuna, and shark) as the most commonly harvested fish in the Project Area. Following the collapse of the traditional groundfish stocks (*e.g.*, cod, flatfish and pollock), shellfish stocks have grown significantly in their contribution to revenue and profitability of the Scotian Shelf fishery. Other groundfish species, such as Atlantic halibut and redfish, have also gained in commercial importance (MacLean *et al*. 2013). 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. Management activities to control the commercial fisheries on the Scotian Shelf are outlined in the Integrated Fisheries Management (IFMP) and Conservation Harvesting Plans (CHP) consisting of catch controls including annual quotas and effort regulations (*i.e.*, seasonal and spatial restriction, gear type, configuration and amount)(MacLean *et al*. 2013). To achieve conservation objectives, DFO implements spatial closures, most prominent being the Gully Marine Protected Area, St. Ann's Bank Area of Interest, the Coral Conservation Areas, and Sponge Conservation Areas (MacLean *et al.* 2013). Many of the major species are fished according to quota systems (groundfish), while others are fished according to availability (herring, mackerel and tunas) or specific season lengths (lobster and crab). Licences and quotas are set by DFO for individual species management areas, NAFO Divisions and Unit Areas. Aggregated landings maps included in Appendix G provide an overall picture of fishing activity in the area. Discussion of Aboriginal fisheries is provided in Section 5.3.6.

The Project Area is located within Commercial Fisheries Management Areas for lobster, shrimp, scallop and crab (Figure 5.3.8), and for fish (Figure 5.3.9). Data on commercial fisheries are generally obtained from DFO and based on the NAFO Unit Areas. The Project Area is located within NAFO Unit Area 4Wm, 4Wj, 4Wg and 4Wf, as illustrated in Figure 5.3.9.

Landings data for NAFO Divisions 4W for 2010 to 2013 were acquired from DFO Maritimes Region. These data from NAFO Division 4W, as well as from Divisions 4VN, 4VS, 4X, and 5ZE for comparative purposes, are presented in Table 5.3.3 and characterize the commercial fisheries within a broader region. Species-specific landing data could not be obtained from DFO due to confidentiality issues and updated policies for releasing fisheries data. Landings data from NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf are presented in Table 5.3.4, representing more specific data surrounding the Project Area. Although the landed value of fisheries harvests from these NAFO Divisions and Unit Areas fluctuates between years, the data from 2010 to 2013 was the most recent provided to Stantec by DFO during the preparation of the EIS and illustrates recent trends, presenting a general understanding of the extent and importance of commercial fisheries in Nova Scotia.



Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Figure 5.3.8 Commercial Fisheries Management Areas

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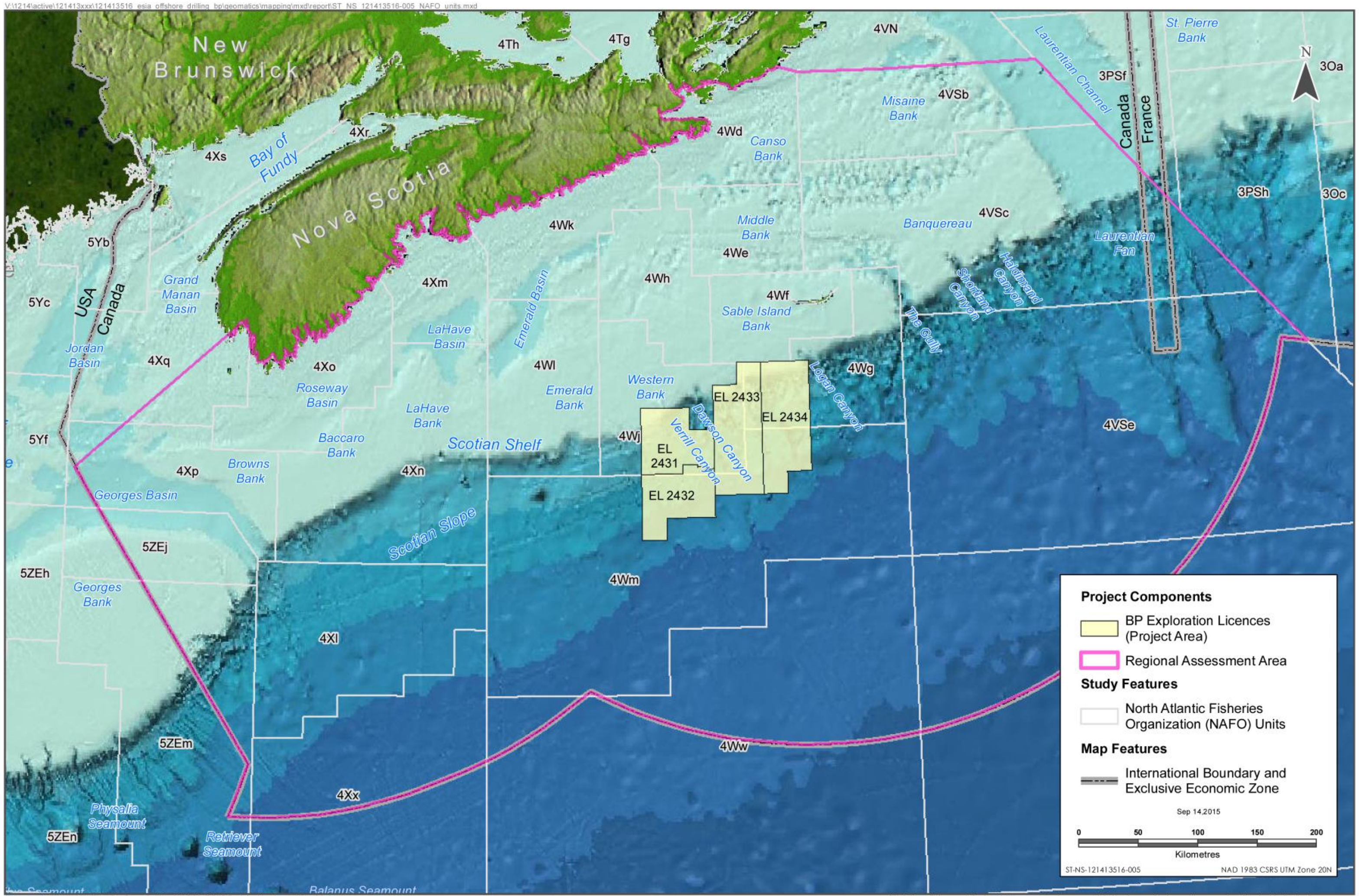


Sources: North Atlantic Fisheries Organization (NAFO), GEBCO global bathymetric grid

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Figure 5.3.9 NAFO Unit Areas

Table 5.3.3 Landed Value of Fisheries Harvest within NAFO Divisions 4VN, 4VS, 4W, 4X, and 5ZE (2010-2013)

Species	2010		2011		2012		2013	
	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								
4VN	907	1282	790	1631	1002	1862	1131	2752
4VS	4884	5752	2685	4632	4509	6686	1991	5048
4W	10 599	10 747	11 205	13 024	13 280	14 354	12 212	16 436
4X	22 282	31 696	21 023	32 177	21 034	33 976	14 839	29 221
5ZE	19 160	24 902	14 276	22 544	7468	14 917	6242	9057
Total Groundfish	**57 832**	**74 379**	**49 979**	**74 008**	**47 293**	**71 796**	**36 415**	**62 514**
Pelagic								
4VN	13	20	37	2397	185	224	211	154
4VS	126	892	131	908	87	493	145	1257
4W	10 863	9347	12 293	9739	2731	10 773	4105	15 981
4X	58 180	22 787	52 803	22 938	48 106	41 593	54 733	46 781
5ZE	529	4381	307	2427	313	2642	313	2791
Total Pelagic	**69 712**	**145 394**	**65 570**	**38 410**	**51 422**	**55 725**	**59 507**	**66 964**
Invertebrates								
4VN	3721	25 805	4126	36 166	4425	34 913	5673	40 587
4VS	33 043	71 082	32 944	79 621	32, 413	72 918	32 452	64 728
4W	14, 182	62 106	13 476	77 517	13 269	74 222	14 184	62 901
4X	49 642	329 402	58 559	361 654	58, 038	360 782	55 608	418 292
5ZE	44 807	60 957	37 902	60 155	33 926	73 488	42 751	118 461
Total Invertebrates	**145 394**	**549 351**	**147 008**	**615 112**	**142 070**	**616 324**	**150 668**	**704 969**
Other Species (*e.g.*, algae, moss and seaweeds)								
4VN	0	0	0	0	0	0	0	0
4VS	0	0	0	0	0	0	0	0
4W	0	0	0	0	0	0	0	0
4X	41 123	3365	16 989	1355	11 811	793	12 556	746
5ZE	0	0	0	0	0	0	0	0
Total Other	**41 123**	**3365**	**16 989**	**1355**	**11 811**	**793**	**12 556**	**746**
Grand Total	**314 061**	**772 490**	**279 546**	**728 886**	**252 597**	**744 638**	**259 145**	**835 193**

Source: Data courtesy of DFO

Table 5.3.4 Landed Value of Fisheries Harvest within the Project Area (NAFO Unit Areas 4Wf, 4Wg, 4Wj, and 4Wm (2010-2013)

Species	2010		2011		2012		2013	
	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								
4Wf	2	16	36	49	143	179	9	55
4Wg	138	1041	530	1783	1075	2264	910	2354
4Wj	134	786	998	1818	1253	1975	1334	2889
4Wm	19	32	52	78	24	61	25	27
Total Groundfish	**293**	**1875**	**1616**	**3727**	**2495**	**4479**	**2278**	**5325**
Pelagic								
4Wf	3	30	1	6	1	6	13	105
4Wg	84	628	90	604	17	133	248	1941
4Wj	33	249	83	634	30	235	97	834
4Wm	29	213	41	281	31	258	142	1146
Total Pelagic	**148**	**1119**	**215**	**1526**	**80**	**632**	**500**	**4025**
Invertebrates								
4Wf	997	1841	1002	1186	819	1323	1069	1885
4Wg	140	528	12	64	35	175	18	48
4Wj	72	95	152	248	201	351	504	1377
4Wm	0	0	6	27	6	13	6	15
Total Invertebrates	**1210**	**2464**	**1171**	**1525**	**1061**	**1862**	**1597**	**3324**
Other Species								
4Wf	0	0	0	0	0	0	0	0
4Wg	0	0	0	0	0	0	0	0
4Wj	0	0	0	0	0	0	0	0
4Wm	0	0	0	0	0	0	0	0
Total Other	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Grand Total	**1651**	**5458**	**3002**	**6778**	**3635**	**6973**	**4375**	**12 674**

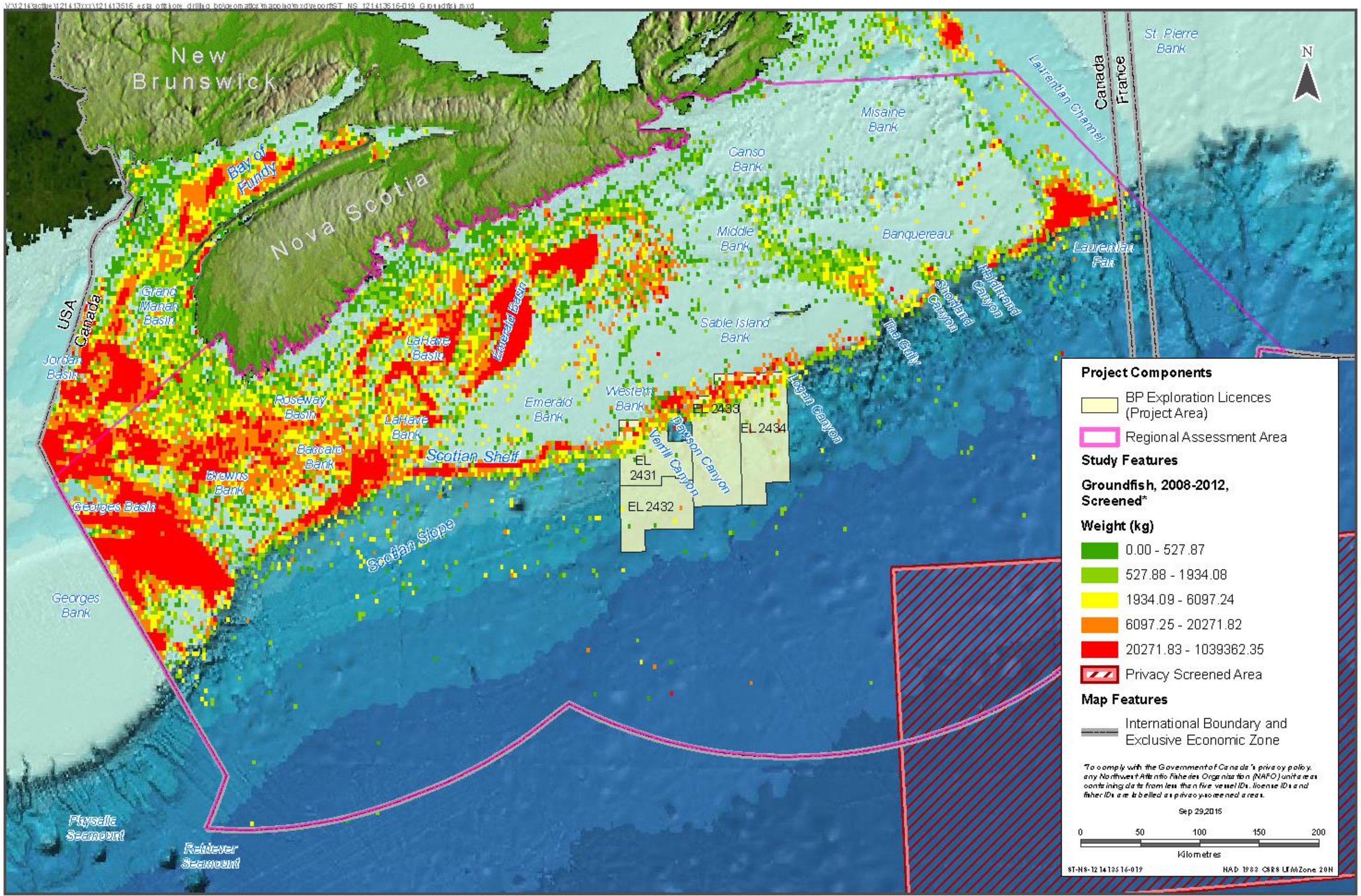
Source: Data courtesy of DFO

From 2010 to 2013 in NAFO Divisions within the RAA (Table 5.3.3), invertebrates dominated the commercial landing values with between 71% and 84% of the total catch in that period, though it represented a smaller amount of the landing weight (46 to 58%). The invertebrate fishery value and landing weights decrease within the Project Area. From 2010 to 2013 within NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf (Table 5.3.4) the value of the invertebrate fishery represented between 22% and 26% of the total landed values. The value of groundfish landings represented the highest commercial value from 2011 to 2013 with between 42% and 64% of the total landed values.

The majority of the harvest for NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf was landed in Nova Scotia. For the entire NAFO Unit Area 4Xn from 2010 to 2013, the landings were dominated by groundfish. The overall fishery landings and values were dominated by the entire NAFO Unit Area 4X from 2010 to 2013.

The fishing effort in NAFO Unit Areas 4Wm, 4Wj, 4Wg and 4Wf for the years 2008 to 2012 are presented in Figures 5.3.10 and 5.3.11 by type of fishery group; the landing data are geo-referenced by latitude and longitude for all groups in which data were provided. Note that not all of the catch data summarized in Tables 5.3.3 and 5.3.4 include harvest location coordinates; therefore, the commercial fishery figures may not illustrate the same information as portrayed in the tables. Species-specific fisheries data for the years 2008 to 2012 are presented in Figures 1 to 28 of Appendix G.

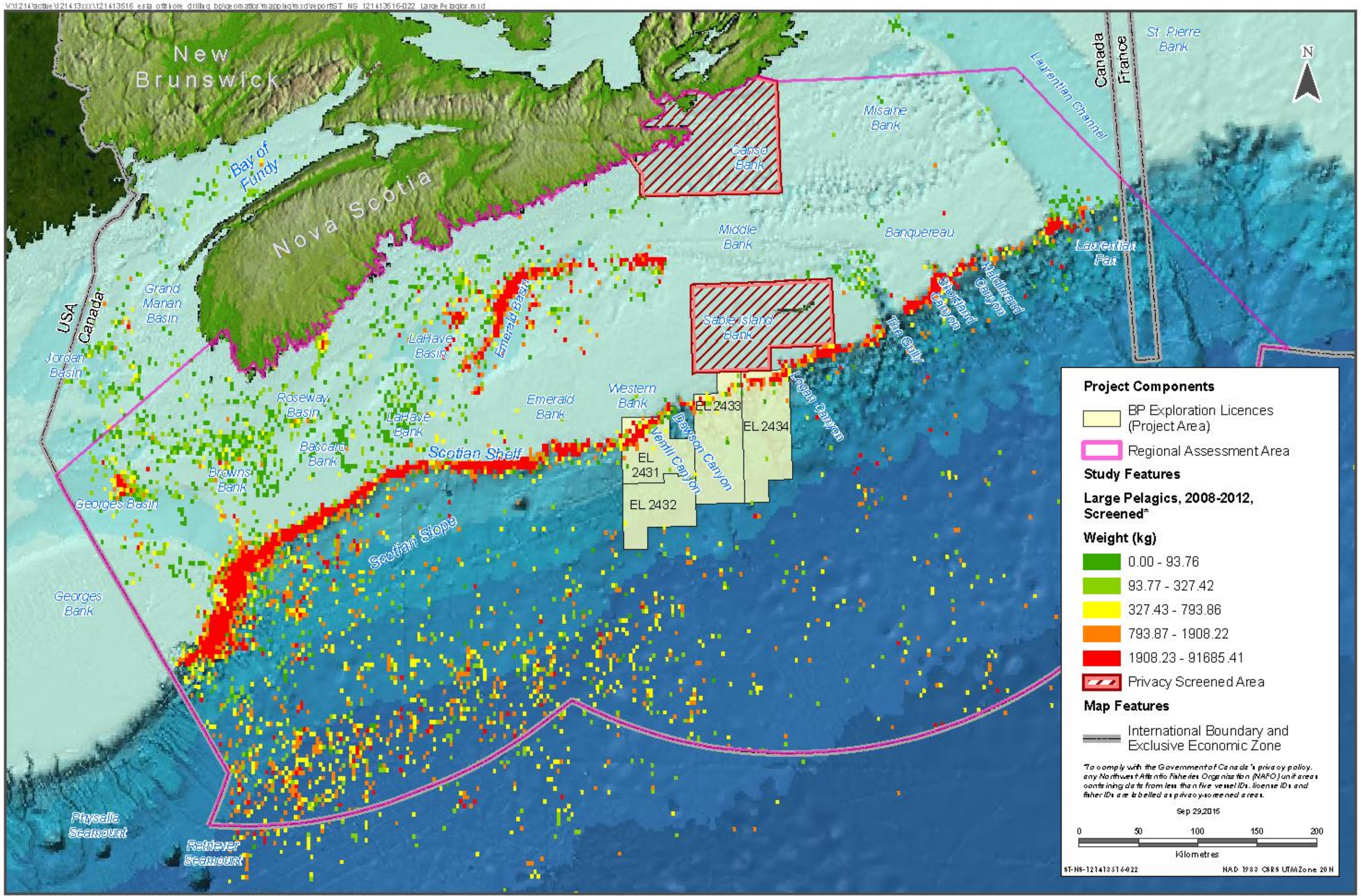
As evident in Figures 5.3.10 and 5.3.11, there is a marked fishing effort within the northern portion of the Project Area along the Shelf break. As shown in Figures 1 to 28 of Appendix G, harvesting in the Project Area includes Atlantic halibut, Greenland halibut, hagfish, swordfish, shark species, white hake, cusk, monkfish and redfish as well as some flatfish, bluefin tuna, herring, other tuna, red hake and silver hake. Based on Figure 5.3.10 a productive harvest location is just north of the Project Area near Western Bank as well as northwest of the Project Area near Emerald Basin. To the northeast of the Project Area near Middle Bank, there is an active snow crab fishing area. Currently, the snow crab fishery is the second most valuable commercial fishery in Nova Scotia and Atlantic Canada and has been active since the mid-1970s (Cook *et al*. 2014).



Sources: North Atlantic Fisheries Organization. Canada-Nova Scotia Offshore Petroleum Board. Fisheries and Oceans Canada. Natural Resources Canada. GEBCO global bathymetric grid. Nova Scotia Geomatics Centre

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Figure 5.3.10 Groundfish Landings, All Gear Types, 2008-2012



*To comply with the Government of Canada's privacy policy, any Northwest Atlantic Fisheries Organization (NAFO) unit areas containing data from less than five vessel IDs, license IDs and fisher IDs are labelled as privacy-screened areas.

Sep 29,2015

Sources: North Atlantic Fisheries Organization (NAFO), Canada-Nova Scotia Offshore Petroleum Board, Fisheries and Oceans Canada, Natural Resources Canada, GEBCO global bathymetric grid

Disclaimer: This map is for illustrative purposes to support this project; questions can be directed to the issuing agency.

Figure 5.3.11 Large Pelagic Landings, 2008-2012

Key Commercial Fish and Invertebrate Species

Geo-referenced species-specific landings data could not be obtained from DFO due to confidentiality issues and updated policies for releasing fisheries data. However, based on previous data (*e.g.*, as presented in LGL 2014) annual commercial fisheries catch weight from the Project Area averaged about 377 tonnes during April to November 2005 to 2010. The primary commercial species likely harvested in the Project Area by landing weight include: sea scallops (33%), swordfish (~20%), herring (~14%), Atlantic halibut (~10%), silver hake (~8%), cusk (~3%) and white hake (~3%)(LGL 2014). During this six-year period, invertebrates accounted for about 34% of the aggregated catch weight flowed by groundfish species (~28%), large pelagic species (~23%) and small pelagic species (~15%)(LGL 2014). In terms of catch value, large pelagics accounted for about 50% with swordfish accounting for about 45% of landings values and an average landings value of about $1.25 million (LGL 2014). Table 5.3.5 includes the average annual species harvest statistics for the Project Area during April to November, 2005 to 2010.

Table 5.3.5 Average Annual Commercial Harvest by Species within the Project Area, April to November, 2005 to 2010

Species	Quantity (t)	% of Total	Value ($)	% of Total
Sea scallops	126	33.4	165 806	13.3
Swordfish	75	19.9	565 775	45.3
Herring	52	13.7	9838	0.8
Atlantic halibut	37	9.8	385 707	30.9
Silver hake	32	8.4	22 336	1.8
Cusk	10	2.8	9805	0.8
White hake	10	2.5	9443	0.8
Redfish	7	1.8	5106	0.4
Porbeagle shark	5	1.3	5104	0.4
Mackerel	4	1.1	3406	0.3
Mako shark	4	1.0	5528	0.4
Hagfish	3	0.9	3328	0.3
Greenland halibut	2	0.6	3410	0.3
Red hake	2	0.5	829	<0.1
Atlantic wolffish	<0.1	<0.1	<1	<0.1
Total	377	97.7	1 249 506	95.8

Source: Modified from LGL 2014

Species descriptions are provided in Section 5.2.5.

Table 5.3.6 lists key commercial fish species and the fishing seasons in which they are typically fished.

Table 5.3.6 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially within the RAA

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species													
Albacore tuna	*Thunnus alalunga*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Bigeye tuna	*Thunnus obesus*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Bluefin tuna	*Thunnus thynnus*	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Herring	*Clupea harengus*	🟥	🟥	🟩	🟩	🟥	🟥	🟨	🟨	🟩	🟩	🟥	🟥
Mackerel	*Scomber scombrus*	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟩	🟩	🟩
Porbeagle shark	*Lamna nasus*	🟩	🟨	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟨	🟨	🟨
Swordfish	*Xiphias gladuis*	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟨
White marlin	*Tetrapturus albidus*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Yellowfin tuna	*Thunnus albacares*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Groundfish Species													
American plaice	*Hippoglossoides platessoides*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Atlantic cod	*Gadus morhua*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Atlantic halibut	*Hippoglossus hippoglossus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Atlantic wolffish	*Anarhichas lupus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Cusk	*Brosme brosme*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Greysole-Witch flounder	*Glyptocephalus cynoglossus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Haddock	*Melanogrammus aeglefinus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Monkfish	*Lophius spp.*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Pollock	*Pollachius virens*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Redfish	*Sebastes mentella /*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨

Table 5.3.6 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially within the RAA

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
(deepwater and Acadian)	*Sebastes fasciatus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Red hake	*Urophycis chuss*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Silver hake	*Merluccius bilinearis*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Turbot – Greenland flounder	*Reinhardtius hippoglossoides*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
White hake	*Urophycis tenuis*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Invertebrate Species													
Lobster[1]	*Homarus americanus*	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Scallop	potential for multiple species	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨
Snow crab	*Chionoecetes opilio*	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	⬜	⬜	⬜
Red crab	*Chaceon quinquedens*	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	⬜	⬜	⬜

Note:

[1] The RAA 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.

🟩	Open Fishing Season * Note all large pelagic fisheries, all groundfish fisheries and the scallop fishery are open year-round; however, there may be closures if catch rates or yields are low.
⬜	Closed Fishing Season
🟥	High Fishing Activity within the Season
🟨	Low Fishing Activity within the Season

Sources: Modified from Stantec 2014a and Stantec 2014b

5.3.5.2.1 Groundfish Fisheries

Within Unit Area 4W, which encompasses the Project Area, the groundfish 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 basin provides high yields year-round. Most fishing vessels utilize trawls and longlines, with longlines used predominantly on the shelf edge and deepwater channels (Stantec 2014a).

Groundfish stocks are fished along the Scotian Slope break in the northern portion of the Project. The following describes current conditions of the three principal groundfish species fished within the Project Area.

Atlantic halibut are most abundant at depths of 200 to 500 m in the deep-water channels running between the banks and along the continental shelf (DFO 2015c). The Atlantic halibut fishery was unregulated until 1988 when a total allowable catch (TAC) of 3,200 tonnes was first established which was then reduced to 850 tonnes in 1995 (DFO 2015c). The TAC has increased several times beginning in 1999 and was set at 2,563 tonnes in 2014 (DFO 2015c).

In 2003, cusk was designated as threatened by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC) due to the decline of abundance beginning in the 1970s (DFO 2008b). Canadian cusk landings have ranged from 790 to 1,490 tonnes between 1999 and 2006 in the 4VWX and 5Zc NAFO units with the vast majority of these landings from the groundfish longline fishery in 4X and 5Zc (DFO 2008b). Cusk are also known to be caught as bycatch in some lobster fisheries with mortalities in 2005/2006 lobster fisheries estimated to be a minimum of 226 tonnes in LFA 34 and 22 tonnes in LFA 41 (DFO 2008b).

There has been a directed fishery for hagfish off Nova Scotia since the late 1980s (DFO 2009g). Landings increased to a peak of approximately 1,800 tonnes in 2004, and declined steadily to approximately 1,300 tonnes in 2006 (DFO 2009g). During the early years of the fishery, landings were derived almost exclusively from NAFO Division 4X; however, since 2000, the fishery has expanded eastward and NAFO Division 4W has also become an important source of hagfish landings (DFO 2009g).

Figure 5.3.10 depicts locations of groundfish species catches within and around the Project Area. Refer to Appendix G for more detailed landings maps.

5.3.5.2.2 Pelagic Fisheries

During the period from 1980 to 2000, pelagic species catch has fluctuated from 8% to 15% of the total landed value on the Scotian Shelf (Stantec 2014b). 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 2014b). As indicated in LGL 2014, the dominant commercially caught large pelagics in and around the Project Area include: swordfish, bigeye tuna, yellowfin tuna, bluefin tuna, albacore tuna, unspecified tunas, mako shark (historically), porbeagle shark (historically) and mahi mahi.

Within Unit Area 4W, 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 2014b). Most fishing vessels use pelagic (floating) longline, though bluefin tuna and swordfish are also angled or fished with electric harpoons (Stantec 2014b).

Swordfish is one of the main large pelagic fish species frequenting the waters off the Atlantic Ocean during the spring to fall (MacLean *et al.* 2013). Atlantic Canadian catches of swordfish were 1,489 tonnes 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 tonnes; this has decreased from 2007 to 2009 where the TAC was 14,000 tonnes. Minimum size limits are in place for the North Atlantic swordfish fishery with 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 tonnes) decreasing to a low of 103 tonnes in 2010 (ICCAT 2012b). In 2012, Atlantic Canadian catches of bigeye tuna totaled 166 tonnes with total worldwide catches of 70,536 tonnes. The historical TAC was reduced in 2009 from 90,000 tonnes to 85,000 tonnes (ICCAT 2012b).

Atlantic Canadian catches of yellowfin tuna were 93 tonnes in 2012 decreasing from 304 tonnes in 2004 (ICCAT 2012c). Total worldwide catches of yellowfin tuna have declined to 100 000 tonnes in 2007 from 193,000 tonnes in 1990 (ICCAT 2012c.) From 2007 to 2011, catches have increased through only by 10% to 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 tendency for a slow continued rebuilding was noted (ICCAT 2012c). Figure 5.3.11 illustrates that the 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). Refer to Appendix G for more detailed landings maps.

5.3.5.2.3 Invertebrate 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 2013w). The scallop fishery, concentrated on Georges Bank and Browns Bank approximately 300 km west of the Project Area, accounts for approximately 70% to 80% of the annual scallops landed in Canada (Stantec 2014b).

Figures 1 to 4 in Appendix G depict locations of invertebrate landings within and around the Project Area. The fishery is predominantly based along the Scotian Shelf break. The primary commercial species likely harvested in the Project Area include: Atlantic sea scallop, cockles, Iceland scallop, Northern shrimp, propeller clam, quahog, sea cucumbers, snow crab, Stimpson's surf clam, striped shrimp and whelks (LGL 2014).

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

Although not fished within the Project Area, an important snow crab fishery is located to the northeast of the Project Area. The snow crab fishery, existing since the mid-1970s, primarily occurs in the Eastern Scotian Shelf (MacLean *et al*. 2013). In the early 2000s, annual landings rose to above 10,000 tonnes with the majority being from the southern area of the Eastern Scotian Shelf (MacLean *et al*. 2013). Many Crab Fishing Areas (CFAs) and sub-areas were merged in 2005 resulting in three divisions; N-ENS (North-Eastern Nova Scotia, formerly CFAs 20-22), S-ENS (South-Eastern Nova Scotia, CFAs 23, 24), and 4X (DFO 2015n). Landings in 2014 for N-ENS and S-ENS were 778 tonnes and 11,267 tonnes, respectively, and 79 tonnes in 4X for the 2013/2014 season (DFO 2015n). In 2014, the TAC was 783 tonnes, 11,311 tonnes and 80 tonnes in N-ENS, S-ENS and 4X, respectively (DFO 2015n).

5.3.6 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 food, social and ceremonial (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 2008c). In response to this decision as well as to provide stable fishery management, DFO developed an Aboriginal Fisheries 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 two types of communal fishing licences to Aboriginal groups, which allow fishing for either FSC or commercial purposes. These licences are held under the name of the Aboriginal community and not under the name of a specific individual.

Aboriginal access to FSC fisheries is through community agreements negotiated under the AFS, imposed licences by the Government of Canada, or community assertion of Aboriginal and Treaty rights with respect to species for which conservation is not a concern (MGS and UINR 2016). In the DFO Maritimes Region, communal FSC licences are held by 16 First Nations and the Native Council of Nova Scotia (NCNS). Eleven of these communal FSC licences are held by groups in Nova Scotia while the remaining five are held by groups in New Brunswick. In the DFO Gulf Region, there are no Aboriginal organizations which hold FSC licences to fish in the RAA.

Following 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) from 2000 to 2007 to provide increased Aboriginal access to the commercial fishery through the issuance of communal commercial licences. The Atlantic Integrated Commercial Fisheries Initiative (AICFI) was subsequently created in 2007 to sustain the public investment made to the Aboriginal commercial fishery through the MRI and provide the 34 Mi'kmaq and Wolastoqiyik (Maliseet) First Nations affected by the Marshall decision with capacity-building support for the successful management of Aboriginal communal commercial fisheries and effective Aboriginal participation in fisheries co-management (DFO 2012a, DFO 2012b).

In order to obtain baseline information on Aboriginal fishing activity and licences, and use of species which may be affected by the Project, BP obtained licencing data from DFO, gathered information during engagement activities (refer to Section 4), and commissioned a Traditional Use Study (TUS). The licencing data from DFO indicates permitted fisheries by Aboriginal organization but does not necessarily imply actual fishing activity. BP commissioned Membertou Geomatics Solutions (MGS) and Unama'ki Institute of Natural Resources (UINR) to undertake a TUS to obtain information on the Aboriginal fisheries occurring in and around the Project Area. The TUS scope of work included conducting a background review of commercial licences and FSC agreements, and interviews with elders, fishers and fisheries managers from a representative subset of First Nations in Nova Scotia and New Brunswick, and the Native Council of Nova Scotia (NCNS). The TUS includes information on target species, general fishing areas, and fishing seasons, along with any additional information pertaining to fish or sensitive areas.

5.3.6.1 Communal Commercial Fisheries

There are 22 Aboriginal organizations from the four Atlantic provinces that hold licences issued by the DFO Maritimes Region and 12 Aboriginal organizations that hold licences issued by the DFO Gulf Region that have communal commercial fishing access in or near the Project Area (Table 5.3.7). Licence areas and species fished for each Aboriginal organization are provided in Appendix I. Table 5.38 summarizes this data by Aboriginal organizations licenced by DFO Maritimes Region.

Table 5.3.7 Aboriginal Organizations with Communal Commercial Licences in the Maritimes and Gulf Regions

Maritimes Region	Gulf Region
Acadia First Nation*	Abegweit First Nation
Afton (Paqtnkek) First Nation*	Bouctouche First Nation
Annapolis Valley First Nation	Eel River First Nation
Apaqtukewag Fishery	Elsipogtog First Nation
Bear River First Nation	Esgenoôpetitj First Nation
Chapel Island (Potlotek) Band Council*	Indian Island First Nation
Conne River Band Council	Lennox Island First Nation
Eskasoni First Nation*	Native Council of PEI
Fort Folly First Nation*	NB Aboriginal Peoples Council
Glooscap First Nation*	Pabineau First Nation
Kingsclear First Nation	Pictou Landing First Nation*
Membertou Band Council*	Tobique First Nation
Millbrook First Nation*	
Mime'j Seafoods Ltd. (NCNS)*	
NB Aboriginal Peoples Council	
Oromocto First Nation	
Shubenacadie (Sipekne'katik) Band	
St. Mary's First Nation*	
Tobique First Nation	
Wagmatcook First Nation*	
Waycobah (We'koqma'q) First Nation*	
Woodstock First Nation*	

*Included in the TUS

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
ACADIA FIRST NATION	
Alewives/Gaspereau	
Clams, Unspecified	Clam Harvest Area - 2, 3, 4
Crab, Green	
Crab, Jonah	
Crab, Snow	NAFO Division 4X
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 33, 34
Mackerel	
Marine Worm	Marine Worm Harvest Areas 2, 3
Ocean Quahaug	
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
Tuna, Unspecified	
AFTON FIRST NATION	
Sea Urchins	Guysborough County Indian Harbour
ANNAPOLIS VALLEY FIRST NATION	
Alewives/Gaspereau	Annapolis County
Crab, Green	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas, 34, 35
Marine Worm	Marine Worm Harvest Area 1
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Digby Annapolis Kings County
APAQTUKEWAG FISHERIES	
Crab, Snow	Crab Fishing Area 24
Lobster	Lobster Fishing Area 27
Mackerel	
Sea Urchins	Richmond
Squid, Unspecified	
BEAR RIVER FIRST NATION	
Clams, Unspecified	Clam Harvest Area 2

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Lobster	Lobster Fishing Areas 34, 35
Tuna, Unspecified	
CHAPEL ISLAND BAND COUNCIL	
Alewives/Gaspereau	
Crab, Snow	Crab Fishing Area 24
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Areas 28, 29
Sea Urchins	Richmond
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
CONNE RIVER BAND	
Swordfish	
Tuna, Restricted	
ESKASONI FIRST NATION	
Alewives/Gaspereau	
Crab, Snow	Crab Fishing Area, 23, 24
Eel	
Groundfish, Unspecified	NAFO Division 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 28, 29
Mackerel	
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
FORT FOLLY FIRST NATION	
Alewives/Gaspereau	
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Area 35
Scallop, Sea	Scallop Fishing Areas (Bay of Fundy) 28B, 28C
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
GLOOSCAP FIRST NATION	
Alewives/Gaspereau	
Groundfish, Unspecified	NAFO Divisions 4X, 5Y, 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Area 34
Mackerel	

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Marine Worm	Marine Worm Harvest Area 1
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
Tuna, Unspecified	
KINGSCLEAR FIRST NATION	
Crab, Rock	Lobster Fishing Area 36
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Area 36, 38
Scallop, Sea	Scallop Fishing Area (Bay of Fundy) 28B, 28C
Sea Urchins	Sea Urchin Fishing Areas 36, 38
MEMBERTOU BAND COUNCIL	
Alewives/Gaspereau	
Crab, Rock	Lobster Fishing Area 27
Crab, Snow	Crab Fishing Area 23
Eel	
Groundfish, Unspecified	NAFO Divisions 4T, 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Area 27
Mackerel	
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Cape Breton
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
Tuna, Unspecified	
MILLBROOK FIRST NATION	
Alewives/Gaspereau	
Clams, Unspecified	Clam Harvest Area 5
Crab, Jonah	Lobster Fishing Area 32
Crab, Snow	Crab Fishing Areas 23, 24
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Hagfish (Slime eel)	NAFO Divisions 4VN, 4VS, 4W
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 32, 35
Mackerel	
Sea Urchins	Halifax County East of Pennant Point; Guysborough County East of Port Bickerton

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Seal Skins/Harp/ Rag.Jacket (NO.)	
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
Tuna, Unspecified	
MIME'J SEAFOODS LTD.	
Alewives/Gaspereau	
Clams, Hard Shell	Clam Harvest Area 2
Clams, Unspecified	Clam Harvest Areas 2, 3, 4, 5
Crab, Green	
Crab, Jonah	Lobster Fishing Area 33
Crab, Snow	NAFO Division 4X, Crab Fishing Area 24
Eel	
Groundfish, Unspecified	NAFO Division 4T, 4VN, 4X, 5Y
Herring	Herring Fishing areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas, 27, 29, 33, 34
Mackerel	
Marine Worm	Marine Worm Harvest Area 4
Scallop, Sea	Scallop Fishing Area 29
Shad	
Squid, Unspecified	
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
NB ABORIGINAL PEOPLES COUNCIL	
Clams, Unspecified	Clam Harvest Area 7
Eel	
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Areas 36, 38
Lobster - Grey Zone	Lobster - Grey Zone
Mackerel	
Scallop, Sea	Scallop Fishing Areas (Bay of Fundy) 28B, 28C
OROMOCTO FIRST NATION	
Alewives/Gaspereau	
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Area 36
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Sea Urchins	Sea Urchin Fishing Area 36
Shad	
Smelts	
SHUBENACADIE BAND COUNCIL	
Alewives/Gaspereau	
Clams, Unspecified	Clam Harvest Areas 1, 5
Crab, Snow	Crab Fishing Area 24
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring/Mackerel	
Lobster	Lobster Fishing Areas 32, 33, 34, 35
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Halifax County East of Pennant Point
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	
ST. MARY'S FIRST NATION	
Alewives/Gaspereau	
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Area 36
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Sea Urchin Fishing Area 36
Shad	
Shrimp, Pandalus Borealis	Shrimp Fishing Areas 4X/5Z - 16
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
TOBIQUE FIRST NATION	
Crab, Jonah	Lobster Fishing Area 38
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Lobster	Lobster Fishing Area 38
Lobster - Grey zone	Lobster - Grey Zone
Mackerel	
Ocean Quahaug	
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Sea Urchin Fishing Area 38
WAGMATCOOK FIRST NATION	
Alewives/Gaspereau	
Crab, Snow	Crab Fishing Area 23
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE

Table 5.3.8 Communal Commercial Licences Issued by DFO Maritimes Region by Aboriginal Organization

Aboriginal Organization / Species Fished	Licence Area Description
Herring	
Lobster	Lobster Fishing Area 27
Mackerel	
Sea Urchins	Victoria South of Cape North
Seal Skins/Harp/Rag.Jacket (NO.)	
Squid, Unspecified	
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
WAYCOBAH FIRST NATION	
Crab, Snow	Crab Fishing Areas 23, 24
Eel	
Groundfish, Unspecified	NAFO Divisions 4VN, 4VS, 4W, 4X, 5Y, 5ZE
Herring	Herring Fishing Areas 17, 18, 19, 20, 21, 22
Herring/Mackerel	
Lobster	Lobster Fishing Areas 27, 29
Mackerel	
Sea Urchins	Victoria South of Cape North
Seal Skins/Harp/Rag.Jacket (NO.)	
Shrimp, Pandalus Borealis	Shrimp Fishing Areas - Louisbourg Hole 1; Misaine Hole 14; Canso Hole 15
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
WOODSTOCK FIRST NATION	
Groundfish, Unspecified	NAFO Divisions 4X, 5Y
Herring	
Herring/Mackerel	
Lobster	Lobster Fishing Areas 36, 38
Lobster - Grey Zone	Lobster - Grey Zone
Scallop, Sea	Scallop Fishing Area 29; Scallop Fishing Areas (Bay of Fundy) 28A, 28B, 28C, 28D
Sea Urchins	Sea Urchin Fishing Areas 36, 38
Swordfish	NAFO Divisions 3L, 3M, 3N, 3O, 3PS, 4VN, 4VS, 4W, 4X, 5ZE
Tuna, Restricted	

Source: Data courtesy of DFO

There are also several Aboriginal organizations in the DFO Gulf Region with communal commercial licences in the RAA. As shown in Table 5.39, most of these licences for fishing within the Project Area (which falls within NAFO Division 4W) are for tuna.

Table 5.3.9 Communal Commercial Licences Issued by DFO Gulf Region by Aboriginal Organization

Aboriginal Organization / Species Fished	**Licence Area Description**
TOBIQUE FIRST NATION	
Groundfish	NAFO Divisions 4X, 5Y
Lobster	LFA 38
Scallop	SFA 28B, 28C
Herring	Areas 17 and 22
Tuna	NAFO Divisions 4W, 4Vs, 4X, 5
PABINEAU FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs, 4X, 5
ESGENOÔPETITJ FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
ELSIPOGTOG FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
INDIAN ISLAND FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
NB ABORIGINAL PEOPLES COUNCIL	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
BOUCTOUCHE FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
EEL RIVER BAR FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
PICTOU LANDING FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
ABEGWEIT FIRST NATION	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
LENNOX ISLAND FIRST NATION	
Groundfish	NAFO Division 4Vn
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
NATIVE COUNCIL OF PEI	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
GLOOSCAP FIRST NATION (MARITIMES REGION)	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5
ST. MARY'S FIRST NATION (MARITIMES REGION)	
Tuna	NAFO Divisions 4W, 4Vs 4X, 5

Source: Data courtesy of DFO

As noted in Table 5.3.7 and as reported in the TUS (Appendix B), all 13 Mi'kmaq First Nation communities in Nova Scotia currently have communal commercial fishing licences for various species that may be harvested from the RAA.

As reported in the TUS, which involved a review of licencing data and interviews with several Aboriginal organizations (refer to Table 5.3.7), there are 25 species being fished by Nova Scotia

Mi'kmaq First Nation communities under communal commercial licences within the RAA and 15 species fished within the LAA. Many of these fisheries occur year-round. As reported in the TUS, the following seven species are targeted within the Project Area: Atlantic cod, bluefin tuna, haddock, mahi-mahi, northern shrimp, shark, and swordfish. Cusk, halibut, and silver hake are harvested as by-catch within the Project Area.

As reported in the TUS, the NCNS (Mime'J Seafoods Ltd.) has communal commercial licences which allow them to harvest approximately 19 species (including by-catch species) within the RAA. Nine of these species may also be harvested by NCNS within the LAA. The following seven species may be harvested by NCNS within the Project Area: albacore tuna, bluefin tuna, bigeye tuna, halibut (by-catch), mahi-mahi (by-catch), swordfish, and yellowfin tuna (MGS and UINR 2016).

The TUS indicates that Fort Folly Mi'kmaq First Nation and St. Mary's and Woodstock Wolastoqiyik (Maliseet) First Nations in New Brunswick hold communal commercial fishing licences for various species that may be harvested from the RAA. Under these licences, these communities report fishing 16 species within the RAA, ten of which may also be harvested within the LAA. Silver hake and swordfish are the only species that may also be harvested within the Project Area (MGS and UINR 2016).

5.3.6.2 FSC Fisheries

As noted in Section 5.3.6, DFO also grants licences for FSC fisheries. In the DFO Gulf Region, there are no Aboriginal organizations which hold FSC licences to fish in the RAA. FSC 2015-2016 fishing licence details for the DFO Maritimes Region is provided in Appendix I. This includes 11 Nova Scotia Mi'kmq communities, the NCNS, and five New Bruswick First Nation communities, which hold FSC licences (Appendix I).

According to the TUS, 44 species (34 fish species and 10 invertebrate species) were identified as being harvested for FSC purposes by Mi'kmaq First Nations throughout Nova Scotia. In particular, they reported harvesting seven fish species and three invertebrate species within the RAA, and one invertebrate species (lobster) within the LAA for FSC purposes. None of the species identified are known to be harvested for FSC purposes within the Project Area (MGS and UINR 2016).

Forty-three species (31 fish species and 12 invertebrate species) were identified as being harvested for FSC purposes by the NCNS. FSC fisheries for 22 of these species are known to occur in the RAA, FSC fisheries for five of these species are known to occur in the LAA (*i.e.*, Atlantic herring, Atlantic mackerel, Greenland halibut, redfish, and silver hake), and no FSC fisheries are known to occur in the Project Area (MGS and UINR 2016).

Lobster is the only species identified as being harvested for FSC purposes by New Brunswick's Fort Folly, St. Mary's and/or Woodstock First Nations, and it is harvested outside of the RAA, in the Bay of Fundy.

5.3.7 Physical and Cultural Heritage

A consideration of physical and cultural heritage is limited to shipwrecks that may be present in and near the Project Area. Locations of known shipwrecks in the vicinity of the Project Area are shown on Figure 5.3.7. As noted above in Section 5.3.2.6, the Project Area is located 48 km from Sable Island, where more than 350 shipwrecks have been recorded on or around the island since 1583. As noted in Sections 5.2.10 and 5.3.3.4, the history of the island has been shaped by these events, including through the introduction of shipwrecked species (*e.g.*, horses) as early as 1518, and the establishment of a government-run, life-saving station from 1801 to 1958 (Freedman 2014).