Middle Scotian Shelf and Slope Strategic Environmental Assessment

FINAL REPORT

Prepared for:
Canada-Nova Scotia Offshore Petroleum Board

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Executive Summary

This Strategic Environmental Assessment (SEA) of potential adverse effects of petroleum exploration activities on the middle Scotian Shelf and Slope is intended to assist the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) and potential Operators with future applications and environmental management planning within the SEA Project Area. The SEA is intended to provide information on the current existing environment, highlighting valued components (VCs) and interactions of potential concern, and referencing mitigation measures and planning considerations to reduce environmental effects and address data gaps and uncertainties.

The SEA examines potential environmental effects that may be associated with the possible offshore petroleum-related activity on the central Scotian Shelf and Slope, and identifies general restrictive or mitigative measures that should be considered if an exploration program application is received. The SEA is not intended to replace project-specific environmental assessments (EAs) that would be required for any proposed exploration program; rather it is intended to support and facilitate future project-specific EAs.

The scope of exploration activities considered in the SEA includes routine activities associated with geophysical surveys (e.g., seismic programs), seabed surveys (e.g., geohazard surveys, geotechnical surveys), exploratory and delineation drilling (including well testing and well abandonment), and associated vessel and helicopter traffic. Accidental events that may result during exploration are also considered.

The “Project Area” considered for the SEA includes the potential area within which exploration rights could be issued and petroleum-related activities could be authorized by the CNSOPB. A larger “Study Area” was established as a buffer around the Project Area to recognize a potential zone of influence of environmental effects from activities that could occur within the Project Area. While predominantly on the banks of the central Scotian Shelf (e.g., Middle, Sable, Western, Emerald and LaHave Banks), the Study Area also extends into Banquereau Bank and into the deeper waters on the Scotian Slope, including Verrill and Dawson Canyons.

There are several fish, marine mammal, sea turtle and bird species with special conservation status known to occur within the Study Area, including the endangered blue whale, North Atlantic right whale, Northern bottlenose whale, leatherback turtle, loggerhead turtle and roseate tern. Special Areas within the SEA Study Area include Western/Emerald Banks Conservation Area, the Sambro Bank Sponge Conservation Area, the Emerald Basin Sponge Conservation Area, the Sable Island National Park Reserve, the Eastern Shore Islands Area of Interest (AOI), and five Ecologically and Biologically Significant Areas (EBSAs).

The Study Area encompasses portions of Northwest Atlantic Fisheries Organization (NAFO) Divisions 4W, 4X, and 4Vs, and is heavily fished, particularly on the banks, with invertebrate and groundfish fisheries comprising the dominant fisheries. Pelagic fisheries are primarily concentrated along the shelf break and in adjacent deeper waters on the Scotian Slope. Other ocean uses in and around the Study

Area include commercial shipping, scientific research, military activity and offshore petroleum exploration activity.

The scope of the SEA was established in recognition of the existing environmental features, potential exploration activities, key relevant legislation and guidelines, and stakeholder interests, focusing on the following VCs:

- Species of Special Status (species listed on Schedule 1 of the *Species at Risk Act* [SARA]); species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife in Canada [COSEWIC]; and/or migratory birds protected by the *Migratory Birds Convention Act* [MBCA]);
- Special Areas (designated areas of special interest due to ecological/conservation sensitivities); and
- Fisheries.

For each VC, the SEA explores potential effects of exploration activities drawing on existing knowledge and current literature, recommends mitigation and planning considerations, and discusses data gaps and uncertainties. Applicable regulatory requirements and guidelines include, but are not limited to, the Nova Scotia Offshore Drilling and Production Regulations and associated guidelines, the Canada-Nova Scotia Financial Requirements Regulations (Federal/Provincial; and associated Guidelines), Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP), Offshore Waste Treatment Guidelines, Offshore Chemical Selection Guidelines, and Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity. In some cases, these requirements may be considered only minimum standards, with enhanced mitigation required on a project-specific basis (e.g., enhanced mitigation for seismic surveys beyond the minimum requirements in the SOCP).

Data gaps and uncertainties exist with respect to understanding potential environmental effects of exploration activities on marine species. Considering these gaps, a precautionary approach to oil and gas exploration should be taken in the vicinity of sensitive areas and the presence of species of special status. Enhanced mitigation and monitoring may be required in some cases, until understanding of potential interactions and effects can be improved and appropriate mitigation developed. Future exploration offers a potentially valuable opportunity to help address current knowledge gaps in the Study Area and understand environmental interactions and effects.

Diligent regulatory compliance and collaboration with regulators in assessing risk of adverse effects and identifying applicable mitigation and monitoring are important in the management of exploration activities in the Project Area so they do not result in adverse environmental effects such that populations of species of special status or the integrity of special areas would be compromised. Stakeholder consultation plays an important role in mitigating environmental effects on fisheries and other ocean users. Additional or alternative mitigation measures may be required at the project level. Several recommendations are provided for Operators to consider in planning exploratory seismic and/or drilling programs on the Scotian Shelf.

List of Acronyms and Abbreviations

2D	Two-dimensional
2DHR	2D high resolution
3D	Three-dimensional
AOI	Area of Interest
AZMP	Atlantic Zone Monitoring Program
BOP	Blowout preventer
BP	British Petroleum
CAC	Criteria air contaminant
CEA Agency	Canadian Environmental Assessment Agency
CEAA, 2012	*Canadian Environmental Assessment Act, 2012*
CEPA	*Canadian Environmental Protection Act*
CFA	Crab Fishing Area
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
COGOA	*Canada Oil and Gas Operations Act*
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPT	Cone Penetrometer Technology
cu.	Cubic
CUPE	Catch per unit effort
DFO	Fisheries and Oceans Canada
E&P	Exploration and Production
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
ECRC	Eastern Canada Response Corporation
EEM	Environmental Effects Monitoring
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EL	Exploration Licence
EPP	Environmental Protection Plan
ESRF	Environmental Studies Research Fund
FLO	Fisheries Liaison Officer
H_s	Significant wave height
IAA	*Impact Assessment Act*

ICCAT	International Commission for the Conservation of Atlantic Tuna
IUCN	International Union for Conservation of Nature
JIP	Joint Industry Programme
LFA	Lobster Fishing Area
MARLANT	Maritime Forces Atlantic
MBCA	Migratory Birds Convention Act
MBS	Migratory Bird Sanctuary
Mcf	Thousand cubic feet
MMcf	Million cubic feet
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSC	Meteorological Service of Canada
NAO	North Atlantic Oscillation
NAFO	Northwest Atlantic Fisheries Organization
NEB	National Energy Board
NEBA	Net Environmental Benefit Analysis
NEFSC	Northeast Fisheries Science Center
NOTMAR	Notice to Mariners
NRCan	Natural Resources Canada
OBM	Oil-based mud
OCSG	Offshore Chemical Selection Guidelines
OERA	Offshore Energy Research Association
OGP	Oil and Gas Producers Association
OSRL	Oil Spill Response Limited
OSV	Offshore supply vessel
OTN	Offshore Tracking Network
OWTG	Offshore Waste Treatment Guidelines
PAM	Passive acoustic monitoring
PIROP	Programme intégré de recherches sur les oiseaux pélagiques
PTS	Permanent threshold shift
RMS	Root mean square
ROV	Remotely Operated Vehicle
SARA	*Species at Risk Act*
SBM	Synthetic-based mud
SEA	Strategic Environmental Assessment
SFA	Scallop Fishing Area
SFSC	Southeast Fisheries Science Center

SIMA	Spill Impact Mitigation Assessment
SOCP	Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment
SOEP	Sable Offshore Energy Project
SOLAS	International Convention for the Safety of Life at Sea
SSIP	Scotian Shelf Ichthyoplankton Program
T_p	Peak wave period
TPH	Total petroleum hydrocarbon
TTS	Temporary threshold shift
VC	Valued Component
VSP	Vertical Seismic Profiling
WAZ	Wide-azimuth seismic survey
WBM	Water-based mud

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1.0 INTRODUCTION

This report is a Strategic Environmental Assessment (SEA) of potential petroleum exploration activities on the central Scotian Shelf (La Have Bank to Banquereau Bank). SEA incorporates a broad-based approach to environmental assessment (EA) that examines potential environmental effects that may be associated with a proposed plan, program or policy, facilitating environmental management considerations at the earliest stages of exploration planning.

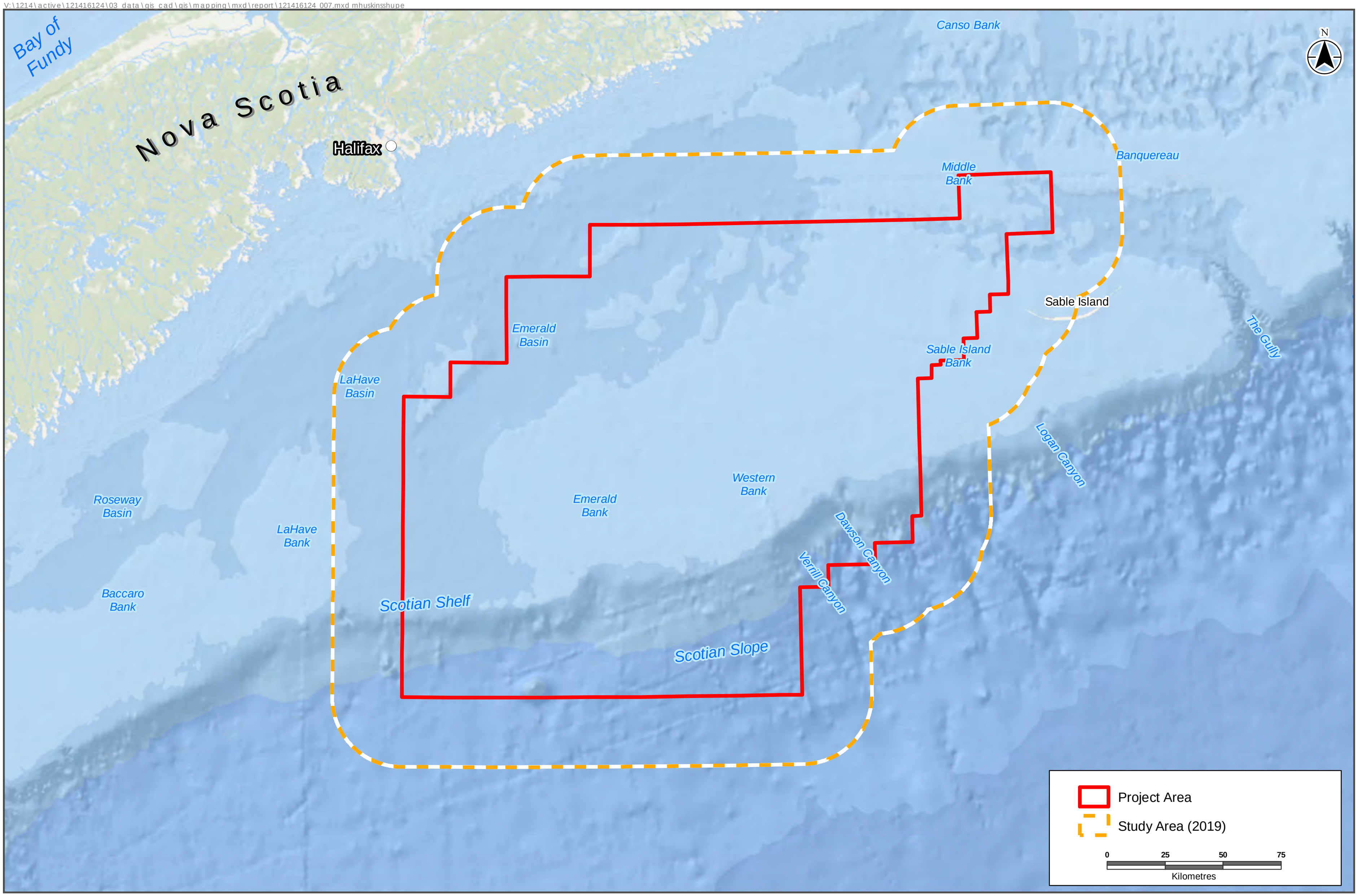
This SEA is intended to assist the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) in its determination with respect to the potential issuance of future exploration rights and authorization of petroleum-related activities within the central Scotian Shelf area, including general restrictive or mitigative measures that should be considered during the exploration program application and the project-specific EA process.

Notable features for environmental management consideration within or directly adjacent to the Project Area include the Western/Emerald Banks Conservation Area (*Fisheries Act,* Marine Refuge), Northeast Channel Coral Conservation Area, Sambro Bank and Emerald Basin Sponge Conservation Areas, Sable Island National Park Reserve, Eastern Shore Islands Area of Interest (AOI), and Ecologically and Biologically Significant Areas (EBSAs). Figure 1.1 illustrates the spatial boundaries for the SEA, which includes the Project Area as defined by the CNSOPB and a larger Study Area that has been delineated in recognition of a potential zone of influence of the most substantive environmental effects that could occur (refer to Section 4.3).

The SEA:

- defines general exploration activities;
- provides an overview of the existing environment within the Study Area;
- broadly describes potential adverse environmental effects associated with offshore oil and gas exploration; and
- identifies general mitigation measures and planning considerations for offshore petroleum exploration activities.

The SEA highlights key potential environmental issues for the CNSOPB and for prospective future operators with interest in the SEA area. The SEA is not intended to replace project-specific EAs that would be required for any proposed exploration program; rather it is intended to support and facilitate future project-specific EAs. The scope of this SEA is based primarily on scoping conducted for previous SEA reports on the Scotian Shelf and Slope (e.g., Stantec 2012a, 2012b, 2013, 2014b, 2017), knowledge of existing environmental conditions (refer to Section 3), applicable regulatory guidance (refer to Section 2.1), review of relevant publications, including project-specific EAs conducted for recent petroleum exploration projects offshore Nova Scotia (Shell 2014; BP 2016), and experience of the study team and government reviewers. Additional information on the objectives and scope of the SEA is included in Section 4.



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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

NAD 1983 UTM Zone 20N

SEA Study Area

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 1.1

2.0 EXPLORATION ACTIVITIES

Since 1960, there has been more than 401,650 line kilometers of two-dimensional (2D) seismic survey work conducted in the Nova Scotia offshore area and over 43,375 km^2 of three-dimensional (3D) seismic coverage. Since the first exploratory well drilled in 1967 (Sable Island C-67), there have been a total of 212 wells drilled in the Nova Scotia offshore area (including exploratory, delineation and development wells), 116 of which are within the Scotian Shelf SEA Study Area. This section provides an overview of regulatory issues and describes routine and accidental oil and gas exploration activities and events.

2.1 REGULATORY CONTEXT

Petroleum activities in the Canada-Nova Scotia offshore are regulated by the CNSOPB, an independent joint agency of the federal and provincial governments. Under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act,* collectively referred to as the Accord Acts, the CNSOPB is responsible for the management and conservation of the offshore petroleum resources in a manner that protects the health and safety of offshore workers and the environment. The CNSOPB reports to the federal Minister of Natural Resources Canada, the provincial Minister of Labour and Advanced Education (with respect to Occupational Health and Safety), and the provincial Minister of Energy and Mines.

Offshore petroleum rights are issued through a competitive bidding process (Call for Bids) in which any person or company can submit a Work Expenditure Bid to secure exploration rights for approved parcels of Crown Reserve Lands. Any person can nominate a parcel of land for the CNSOPB to consider as a Call for Bids parcel. Subject to the federal and provincial ministerial review and approval process set out in the Accord Acts, the CNSOPB may issue exploration rights to the winning bidder in the form of an Exploration Licence (EL). An Exploration Licence has a maximum term of nine years and provides licence owner(s) with the exclusive right to explore, develop, drill and test for petroleum, and to obtain a production licence. The issuance of an Exploration Licence does not itself confer authorization for physical exploration activities within the licence area. All physical activities related to the exploration for petroleum require specific authorization from the CNSOPB. Before carrying out any activity in the offshore, an operator must obtain an Operating Licence and an authorization from the CNSOPB.

Offshore petroleum activities and the CNSOPB's decision-making processes are governed by a variety of legislation, regulations, guidelines, and memoranda of understanding (MOUs). The CNSOPB enters into MOUs with government departments and agencies, such as Environment and Climate Change Canada (ECCC) and Fisheries and Oceans Canada (DFO), to harmonize plans, priorities, and activities of mutual interest. Annual work plan projects are developed with ECCC and DFO and implemented under these MOUs. Expert advice is provided to the CNSOPB during project specific EAs and each department may exercise independent regulatory instruments under their legislation (e.g., *Fisheries Act* authorization and/or *Species at Risk Act* permit).

In addition to the CNSOPB's environmental assessment requirements and processes, the Government of Canada has environmental assessment legislation. The new *Impact Assessment Act* (IAA), which repeals the *Canadian Environmental Assessment Act*, 2012, came into force in August 2019. The IAA legislation established the Impact Assessment Agency of Canada (replacing the Canadian Environmental Assesment Agency) to lead the review of major projects. The new impact assessment process considers a range of environmental, health, social, and economic effects of projects, whereby decisions are based on public interest (as defined by IAA) rather than focused on the significance of adverse effects.

This new federal legislation and its accompanying regulations apply to certain offshore oil and gas activities; however, exploratory drilling projects may be subject to an exemption from IAA if the drilling is proposed in an area for which a regional assessment has been carried out and the proposed activity conforms with the conditions indicated by the Minister (ECCC) for the regional assessment. The Canadian Environmental Assessment Agency/Impact Assessment Agency, in cooperation with the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and relevant federal and provincial government departments, is in the process of conducting a regional assessment focused on offshore exploratory drilling for an area offshore Newfoundland and Labrador. The report is scheduled to be submitted to the Minister in the fall of 2019. The Agency has also contacted the CNSOPB and relevant federal and provincial government departments to initiate a similar regional assessment for Nova Scotia.

Table 2.1 summarizes key federal legislation and guidelines relevant to exploration activities. This list is not intended to be exhaustive but rather indicative of important regulatory information for offshore project planning. It is recommended that proponents conduct their own review of requirements pertaining to their specific project as part of the planning process.

Table 2.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations (and associated Guidelines)	CNSOPB	These Regulations pertain to the geophysical operations in relation to exploration for petroleum in the Nova Scotia Offshore area and outline specific requirements for authorization applications and operations.
Nova Scotia Offshore Drilling and Production Regulations (and associated Guidelines)	CNSOPB	The Regulations outline the various requirements that must be adhered to when conducting exploratory and or production drilling for petroleum.
Offshore Waste Treatment Guidelines (NEB et al. 2010)	National Energy Board (NEB) / CNSOPB/ Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB)	Guidelines to aid operators in the management of waste material associated with petroleum drilling and production operations in offshore areas regulated by the Boards. This document contains key mitigation to be adhered to by operators to allow streamlining of the environmental assessment process.
Canada-Nova Scotia Financial Requirements Regulations (and associated Guidelines)	CNSOPB	These Regulations pertain to an Applicant seeking an authorization with respect to each work or activity proposed to be carried on (Authorization) and the proof that should be provided to demonstrate how it meets the financial requirements set out in the *Canada Oil and Gas Operations Act* (COGOA) or the Accord Acts.
Offshore Chemical Selection Guidelines (NEB et al. 2009)	NEB / CNSOPB / C-NLOPB	The Offshore Chemical Selection Guidelines (OCSG) provide a framework for chemical selection which minimizes the potential

Table 2.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
		for environmental impacts from the discharge of chemicals used in offshore drilling and production operations.
Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017)	CNSOPB / C-NLOPB	These Guidelines describe the various compensation sources available to potential claimants for loss or damage related to petroleum activity offshore Canada-Nova Scotia and Canada-Newfoundland and Labrador. These Guidelines also outline the regulatory and administrative roles which the Boards exercise respecting compensation payments for actual loss or damage directly attributable to offshore operators.
Environmental Protection Plan Guidelines (CNLOPB et al. 2011)	NEB / C-NLOPB / CNSOPB	Guidelines to assist an operator in the development of an environmental protection plan (EPP) that meets the requirements of the Acts and Regulations and the objective of protection of the environment from its proposed work or activity.
Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2007)	DFO / ECCC / CNSOPB / C-NLOPB / Natural Resources Canada (NRCan) / Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) / Provinces of British Columbia/ Newfoundland and Labrador/ Nova Scotia/Quebec	Specifies the minimum mitigation requirements that must be met during the planning and conduct of marine seismic surveys, in order to minimize impacts on life in the oceans. This document contains key mitigation to be adhered to by operators of seismic programs.
Impact Assessment Act (came into force August 2019)	Impact Assessment Agency (replaced the Canadian Enviromental Assessment Agency with coming into force of *Impact Assessment Act*)	The *Impact Assessment Act* (IAA) establishes the Impact Assessment Agency of Canada to lead the federal review of major projects, working with life-cycle regulators and in cooperation with provinces, territories and Indigenous jurisdictions. The list of projects (i.e., Regulations Designating Physical Activities) which are subject to IAA came into force with the legislation. Exploratory drilling projects may be subject assessment under the IAA and regulations except where drilling is proposed in an area for which a regional assessment has been carried out and the proposed activity conforms with the conditions indicated by the Minister (ECCC) for the regional assessment.
Fisheries Act	DFO ECCC (administers Section 36, specifically)	The *Fisheries Act* contains provisions for the protection of fish, shellfish, crustaceans, marine mammals and their habitats. Section 36 of the *Fisheries Act* pertains to the prohibition of the deposition of a deleterious substance into waters frequented by fish. In 2018, amendments to the *Fisheries Act* were proposed (through Bill C-68), including repealing the prohibition against causing serious harm to fish and the definitions of “commercial”, “recreational” and “Aboriginal” in relation to a fishery, and introducing prohibitions against causing the death of fish (other than by fishing) and the harmful alteration, disruption or destruction of fish habitat. Bill C-68 received Royal Assent in June 2019.

Table 2.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Canadian Environmental Protection Act, 1999	ECCC	The *Canadian Environmental Protection Act, 1999* (CEPA) pertains to pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. Among other things, CEPA provides a wide range of tools to manage toxic substances, and other pollution and wastes, including disposal at sea.
Migratory Birds Convention Act, 1994	ECCC	Under the *Migratory Birds Convention Act, 1994* (MBCA), it is illegal to kill migratory bird species not listed as game birds or destroy their eggs or young. (It is legal to kill game birds only during legislated hunting seasons). The Act also prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds
Species at Risk Act	DFO/ECCC/Parks Canada	The *Species at Risk Act* (SARA) is intended to protect species at risk in Canada and their "critical habitat" (as defined by SARA). The main provisions of the Act are scientific assessment and listing of species, species recovery, protection of critical habitat, compensation, permits and enforcement. The Act also provides for development of official recovery plans for species found to be most at risk, and management plans for species of special concern. Under the Act, proponents are required to complete an assessment of the environment and demonstrate that no harm will occur to listed species, their residences or critical habitat, or identify adverse effects on specific listed wildlife species and their critical habitat, followed by the identification of mitigation measures to avoid or minimize effects. Proponents are advised that all activities must be compliant with SARA. Section 32 of SARA states "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated, endangered or threatened species". In some cases, a SARA permit may be issued for activities that would otherwise be prohibited under the Act.
Oceans Act	DFO	The *Oceans Act* provides for the integrated planning and management of ocean activities and legislates the marine protected areas program, integrated management program, and marine ecosystem health program. Marine protected areas are designated under the authority of the *Oceans Act*.
Navigation Protection Act/Canadian Navigable Waters Act	Transport Canada	The *Navigation Protection Act* is intended to protect inland and nearshore navigable waters by regulating the construction of works on those waters (as identified on the list of "Scheduled Waters") by regulating construction of works on these waters and providing the Minister of Transport with the power to remove obstructions to navigation. In 2016, the Minister of Transport announced a review of the *Navigation Protection Act.* The review was conducted concurrently with the review of the environmental assessment process and other federal legislation. Amendments to the *Navigation Protection Act* were proposed in Bill C-69 which received Royal Assent in June 2019.

2.2 CONSULTATION AND ENGAGEMENT

With respect to consultation and engagement with Indigenous groups, the CNSOPB has signed an MOU with the federal and provincial governments (as represented through the Nova Scotia Department of Energy and Mines and Natural Resources Canada) in which the governments can use and rely on, where appropriate, existing CNSOPB practices to assist in discharging the Crown's consultation and accommodation obligations. This MOU can be found in on the CNSOPB website (www.cnsopb.ns.ca) in the References section.

The purpose of the SEA is to provide an evaluation of potential environmental issues in relatively broad terms to allow proactive planning, well before project-specific activities are defined and proposed. An SEA does not trigger the Crown's duty to consult because it is does not result in any regulatory action or activity that could potentially impact Aboriginal or Treaty Rights. Nevertheless, the CNSOPB recognizes and understands the importance of engaging with Indigenous communities to ensure the CNSOPB is making informed decisions and that their interests and concerns will be considered in the assessment process.

As the regulator of the Canada-Nova Scotia offshore, the CNSOPB recognizes that in carrying out the regulatory processes, it is important to engage with Indigenous groups and the public. An opportunity to submit written comments on the draft SEA was provided from March 19, 2019 to April 18, 2019. The opportunity was advertised to the public on the CNSOPB website and the @CNSOPB Twitter account. This opportunity was also communicated to:

- Indigenous groups in Nova Scotia, New Brunswick and Prince Edward Island;
- The CNSOPB Fisheries Advisory Committee;
- Mayors and Wardens of Nova Scotia Municipalities; and
- Other Relevant Government Departments.

The CNSOPB has reviewed all comments submitted. A summary of the issues and concerns raised along with the CNSOPB's responses is provided in Appendix A. The SEA has been based on the information gathered as a result of the public comment period, which helped the CNSOPB to better understand perspectives and concerns, assisting in making informed decisions. The online SEA Public Registry and comments submitted specific for the SEA for the Middle Scotian Shelf and Slope can be viewed on the Public Registry at: https://www.cnsopb.ns.ca/environmental-assessments/public-registry-sea.

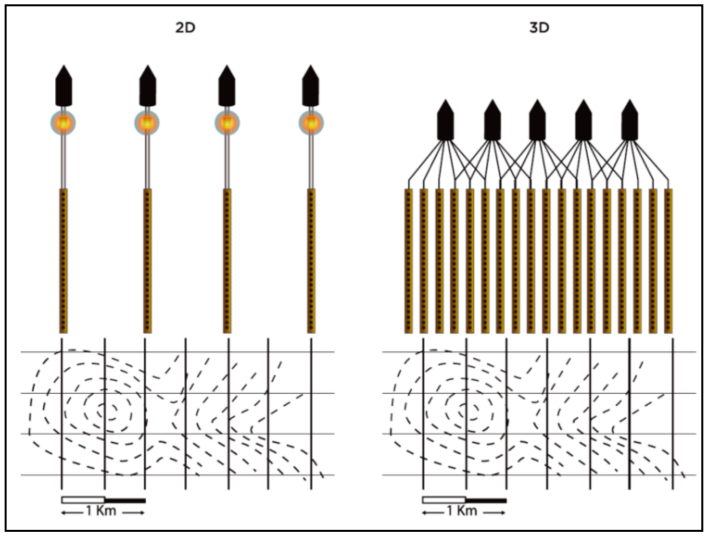
2.3 DESCRIPTION OF ROUTINE OIL AND GAS EXPLORATION ACTIVITIES

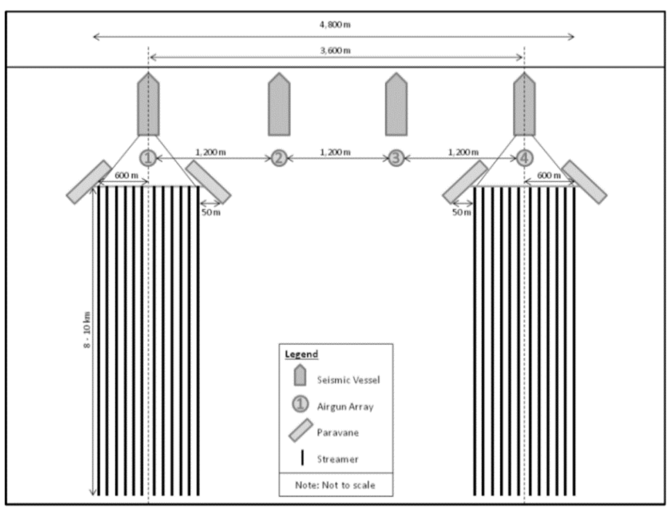
Generic descriptions of potential exploration activities to be considered in the SEA are presented below. Consideration of routine emissions and discharges have been guided by applicable regulations and guidelines including: the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010), Nova Scotia Offshore Drilling and Production Regulations (and associated guidelines), Offshore Chemical Selection Guidelines (NEB et al. 2009), Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017), and Environmental Protection Plan Guidelines (C-NLOPB et al. 2011).

Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys

<table>
<tr><th colspan="2">Geophysical Surveys (2D Seismic, 3D Seismic, 3D Wide-Azimuth Seismic)</th></tr>
<tr><td>Overview</td><td>Seismic surveys are the first step in oil and gas exploration in which sound waves are used to develop an image of subsurface strata and structure features where hydrocarbons could accumulate and be retained.
Sound waves are typically generated by an air source array (e.g., air guns) with reflections from subsurface rock being recorded by hydrophones (streamers) towed behind the survey vessel.
Methods of data acquisition can vary depending on level of information that is required:
Two-dimensional (2D) surveys involve a single seismic cable or streamer towed behind a survey vessel with a single sound source (e.g., air gun), giving an image in horizontal and vertical (2D) dimensions. This method is usually used in frontier exploration areas to produce a general understanding of geological structure.
Three-dimensional (3D) surveys typically cover a specific area with known geological targets identified by previous 2D surveys and employ more than one source and streamer from the same survey vessel. Multiple streamer cables and air gun arrays can produce data sets that can be processed with advanced software to reveal the 3D geometry of the surface at high resolutions.
Use of wide-azimuth (WAZ) seismic surveys is increasing in Canadian waters. This seismic survey involves multiple towed streamers/recording devices and source vessels, providing a broader range of horizontal direction, thus resulting in enhanced data quality and capacity to resolve complex geological features. The configuration of the survey can vary; typically, one or two cable vessels are accompanied by up to four additional vessels towing source arrays only (whereas conventional 3D involves a single vessel towing both a source and receiver array).</td></tr>
<tr><td>Regulatory Context</td><td>A Geophysical Work Authorization is required pursuant to the Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations, and Geophysical, Geological, Geotechnical and Environmental Program Guidelines.
SARA permits and/or Fisheries Act authorizations may be required for seismic surveys.</td></tr>
<tr><td>Equipment and Methods</td><td>For conventional seismic surveys, air guns are typically arranged in arrays of 12-48 guns of various sizes distributed over a horizontal area approximately 20 m inline by 20 m cross line. An array typically has 3-6 sub arrays called strings, with each string comprised of up to 6-8 air guns. The array is towed approximately 200 m behind the vessel and suspended by floats at a depth of 3-10 m. The air guns operate at 2000 psi or 137 bar and fire every 10-15 seconds. The hydrophone streamer is also towed behind the vessel (usually 4500-6000 m in length but can be up to 10,000 m in length). Streamers may be solid or contain a fluid (e.g., kerosene).
2D seismic surveying is the simplest and most inexpensive method, typically using one air gun array and one seismic streamer with distances between survey lines (i.e., ship tracks) spaced at 1 km or greater (refer to Figure 2.1).
3D seismic surveys use a series of parallel passes through an area with a vessel towing one or more air gun arrays with 6-10 seismic streamers at a speed of 5 knots (refer to Figure 2.1).
WAZ seismic surveys use similar technology as conventional seismic (e.g., air guns, streamers) but employs several source vessels (towing air guns) and make successive passes over the target, each time increasing the offset between the streamers and source vessels by the width of the streamer spread (refer to Figure 2.2).</td></tr>
</table>

Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys

<table>
<tr><th colspan="2">Geophysical Surveys (2D Seismic, 3D Seismic, 3D Wide-Azimuth Seismic)</th></tr>
<tr><td></td><td>


Source: OGP 2011
Figure 2.1 Comparison of Typical 2D Seismic Survey Geometry and 3D Seismic Survey Geometry Showing Spacing between Ship Tracks


Source: Shell 2012
Figure 2.2 Typical 3D WAZ Survey Vessel Configuration
</td></tr>
<tr><td>Spatial Extent</td><td>
• 2D data acquisition lines are typically spaced several kilometers apart over a large area (up to thousands of kilometers).
• 3D data sail line separation is typically in the order of 400 to 800 m depending on the number of streamers deployed and their cross-line separation. A small 3D survey is approximately 300 km^2, with larger surveys covering approximately 1,000 to 3,000 km^2.
</td></tr>
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Table 2.2 Generic Description of Exploration Activities - Geophysical Surveys

Geophysical Surveys (2D Seismic, 3D Seismic, 3D Wide-Azimuth Seismic)	
	• WAZ surveys have a larger footprint than conventional seismic surveys (up to 10,000 km^2) given the multi-vessel configuration that is used, although the overall survey area is generally more focused and in the range of 3D surveys. • Propagation of underwater sound increases the spatial extent beyond the physical footprint of the seismic equipment by hundreds of kilometers.
Timing/ Duration	• Conventional seismic surveys (2D and 3D) typically take a few weeks to a month to complete. • 3D WAZ seismic surveys usually occur over a few (up to four) months, depending on the area being surveyed. 3D WAZ seismic surveys take longer to change survey lines (turn), usually 5-7 hours, compared to 2-3 hours for typical 3D seismic surveys.
Routine Emissions	• Emissions associated with geophysical surveys include routine vessel emissions (e.g., exhaust emissions, lights, sewage/ food wastes, bilge water/ballast water) and underwater sound. • Most of the emitted seismic energy lies within the 10–120 Hz range, with energy also in the 500–1000 Hz range. In shallow waters (25-50 m) air guns can be audible at distances up to 75 km, while in deeper waters they can be audible at distances well over 100 km. Airgun sounds have been recorded almost 4,000 km from the survey vessel at levels audible to fin whales. Typical zero-to-peak source levels for exploration seismic arrays are 245-260 dB relative to 1 µPa at 1m**.**
Key Environmental Issues	• Effects of seismic noise on marine wildlife • Spills and unauthorized discharges • Interactions with other ocean users, particularly the fishing industry • Interactions between seismic ship and gear with marine mammals and sea turtles

Sources: Hurley 2009; DFO 2011a; LGL 2013; OGP 2011; Shell 2012; Nieukirk et al. 2012

Table 2.3 Generic Description of Exploration Activities - Seabed Surveys

Seabed Surveys (Geophysical Surveys, Geotechnical Sampling, Environmental Surveys)	
Overview	• Seabed surveys, which can include geophysical, geotechnical or environmental surveys, are undertaken to detect potential hazards (e.g., shallow gas, unstable substrate, wrecks/cables) and characterize surficial geology, bedforms, and benthic habitat in the immediate vicinity of proposed drilling locations.
Regulatory Context	• A Geotechnical/Geological/Engineering/Environmental Program Authorization is required pursuant to the Accord Acts, the *Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations*, and *Geophysical, Geological, Geotechnical and Environmental Program Guidelines*. • SARA permits and/or *Fisheries Act* authorizations may be required for sesabed surveys.
Equipment and Methods	• Geo-surveys are conducted via 2D high resolution (2DHR) digital seismic (low energy) consisting of a small air gun array (160 cubic (cu.) inch versus approximately 3000-6000 cu. inch for typical 2D or 3D seismic survey) and a single streamer 1200 m or less in length towed 2-4 m below the surface. • Additional equipment that may be used for geophysical sampling can include a sub-bottom profiler, multi-beam echo sounder, sidescan sonar, and/or magnetometer. • Geotechnical sampling can involve a variety of technologies including geotechnical boring (well site locations), vibracores and cone penetrometer technology (CPT). • Environmental surveys (benthic photographs/videos, water or sediment samples) may be undertaken to corroborate data and characterize benthic habitat.

Table 2.3 Generic Description of Exploration Activities - Seabed Surveys

Seabed Surveys (Geophysical Surveys, Geotechnical Sampling, Environmental Surveys)	
Spatial Extent	• Seabed surveys are typically focused on targeted drilling locations and do not generally extend more than 1 km from the proposed well site.
Timing/Duration	• The duration of each survey program would be in the order of days, with a total survey program taking a few weeks to a couple of months including port calls and downtime.
Routine Emissions	• Routine emissions include emissions from survey vessels (e.g., exhaust, lights, noise, deck drainage, sewage/food wastes, bilge/ ballast water) and limited noise associated with geophysical and geotechnical sampling.
Key Environmental Issues	• Effects of underwater sound on marine wildlife • Spills and unauthorized discharges from survey vessels • Interactions with other ocean users, particularly the fishing industry

Sources: Hurley 2011; Hurley and Stantec 2010; Corridor Resources Inc. 2010

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
Overview	• Exploration drilling is conducted to confirm the presence and extent of hydrocarbon resources within a targeted geological structure. • Vertical seismic profiling (VSP) or a check-shot survey is undertaken following completion of drilling to correlate seismic data to well data. Receivers are placed at intervals in the well to record energy reflected from a surface seismic source. • If significant hydrocarbons are encountered during drilling, formation fluids may be tested (hydrocarbons separated from produced water and analyzed, with hydrocarbons sent to the rig's flare and produced water treated for disposal). • Once the exploratory well has been drilled, the wellbore is plugged below the seafloor and suspended for future re-entry or abandoned. When being abandoned, the well is plugged with cement and the casing cut below the surface of the seabed. Suspending a well allows re-entry and involves plugging it with cement and capping the top-hole casing. • Depending on the water depth, approval may be sought to leave the wellhead on the seafloor. If the wellhead is removed, it is usually done using mechanical means. A remotely-operated vehicle (ROV) is used to inspect the seabed to ensure no obstructions remain in place. • If hydrocarbons are encountered, the size of the oil and/or gas reserves may be assessed through drilling of appraisal or delineation wells.
Regulatory Context	• A Drilling Program Authorization is required pursuant to the Nova Scotia Offshore Petroleum Drilling and Production Regulations and Drilling and Production Guidelines. • After a Drilling Program Authorization is issued, each well within the drilling program requires a separate Approval to Drill a Well. • SARA permits and/or *Fisheries Act* authorizations may be required for drilling activities.
Equipment and Methods	• Exploration drilling rigs used off the coast of Atlantic Canada are called Mobile Offshore Drilling Units (MODUs). There are three main types of MODUs, the selection of which is generally dependent on physical characteristics of the well site, including water depth and oceanographic conditions, and logistical considerations (e.g., rig availability). In shallow waters (less than 100 m), a jack-up rig is typically used; in deeper waters a drill ship (Photo 1) or semi-submersible rig (Photo 2) is used.

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
	◦ A jack-up rig is towed to the drill site. Once on site, the rig's retractable legs are lowered until they rest on the sea floor, at which point the platform is elevated up the legs until it reaches the desired height above the sea surface (refer to Figure 2.3). ◦ A drill ship is a self-propelled drilling unit that can stay on location using anchors (in waters less than 1,000 m) or a dynamic positioning system (satellite navigation system transmits position to a computer, which controls thruster direction and power to keep the rig on station). Drill ships generally can carry greater loads (e.g., supplies), making them better suited for remote locations where re-supply is more difficult (refer to Figure 2.4 for example). ◦ A semi-submersible rig can be towed or move under its own power to the site and is designed to operate in rough seas. Semi-submersibles can be moored using anchors (in shallower waters) or a dynamic positioning system (refer to Figure 2.4 for example). • Drilling fluids (also referred to as drilling muds) are used to lubricate the drill bit and flush drilled rock cuttings from the bit, carrying them up to the surface. There are three basic types of drilling muds: water-based muds (WBM), synthetic-based muds (SBM), and oil-based muds (OBM). OBMs are no longer used in the Nova Scotia offshore area. • Offshore wells are drilled in stages (sections), with a typical well depth ranging from 2,000 to 5,000 m. • The first section of the well is a large diameter conductor hole (approximately 900 mm drilled several hundred metres into the seafloor. As there is no way to return the drilling muds and cuttings to the MODU before the riser is installed, these muds and rock cuttings are released onto the seafloor. Therefore, WBM is used to drill this portion of the well. • The drill string is then removed, and a steel casing is run and cemented into place to prevent the wall of the hole from caving in and to prevent the seepage of muds and other fluids. • The casing also ensures that there is adequate pressure integrity to allow a blowout preventer (BOP) and the drilling riser to be installed. The BOP is a system of high-pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure. • The drill bit and string are then lowered through the BOP and into the surface hole. The bit begins drilling at the bottom of the hole, and extra joints are added to the drill string as the drill bit cuts the hole. • When a section of the well is complete, the drill string is pulled out and the sections of the casing are joined together, lowered into the well and cemented into place. • For this portion of the well, the drilling riser connects the casing set at the seafloor up to the drilling unit, which allows the return of cuttings and drilling muds to the surface drilling unit where processing takes place. • SBM is often used in drilling lower well sections, particularly if the use of WBM is technically impractical (e.g., due to formation structure, well orientation). • SBM is transported with the cuttings up the riser to the drilling rig for recovery and reuse. Once onboard, the cuttings are removed from the drilling muds in successive separation stages, with some fluids being reconditioned and reused, and spent fluids returned to shore for disposal. • Cuttings (both WBM and SBM) may be discharged at the drill site provided they are treated (SBM) prior to discharge to meet the OWTG (NEB et al. 2010) specified limit of oil on cuttings. Otherwise, cuttings are collected and returned to shore for disposal. • Once the well has been completed, VSP is conducted to obtain accurate "time-to-depth ties". This is necessary as seismic data are recorded in time and wells are drilled in metres. VSP involves placing a string of geophones down the well, with a seismic source (e.g., air guns) suspended from the drilling unit (zero-offset VSP) or another vessel (offset VSP). The seismic source is similar to a seismic survey array but is usually smaller with a peak output pressure of 240-250 dB (refer to Figure 2.5 for example). There are several forms of VSP surveys and equipment, with varying source sizes, duration of activity analysis and sound propagation

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

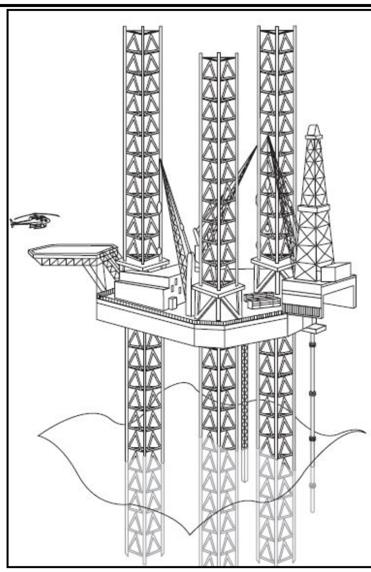
Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
	characteristics. Project-specific EAs should specify the VSP program intensity and highlight the differences between regular seismic programs and VSP. • Once wells have been drilled and evaluation programs completed (if applicable), wells are typically plugged and abandoned. Cement or mechanical devices are used to plug the well and isolate hydrocarbon-bearing intervals within the wellbore, preventing the release of wellbore fluids to the marine environment. • The decision to remove or abandon the wellhead in place is based on safety considerations and the potential for the abandoned wellhead to interfere with other ocean uses (e.g., fishing). Recent deepwater wells drilled offshore Nova Scotia have received approval from the CNSOPB to abandon the wellhead on the seafloor given deep water depths and lack of potential interaction with other ocean users. • Where approval is obtained to abandon the wellhead in place, the only infrastructure that remains on the seafloor is the wellhead. All other infrastructure (including the blowout preventor) is removed. Leaving the wellhead in place does not alter the number, type or placement of barriers within the wellbore. The permanent footprint of the wellhead on the seafloor is representative of the casing size of the conductor section of the well (typically 900 mm). The wellhead would extend approximately 1.5 m to 3.7 m above the seafloor. • In cases where the wellhead is removed, is is done primarily using a mechanical casing/wellhead cutting device. Alternatively, if mechanical separation is unsuccessful, a chemical/directed explosive method is used to detach the wellhead (with the charge set a minimum of 1 m below the sea substrate). An ROV is used to inspect the seabed to confirm no equipment or obstructions remain in place.
	 Source: Petroleum Support 2011 **Figure 2.3 Schematic of Typical Jack-up Rig**

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

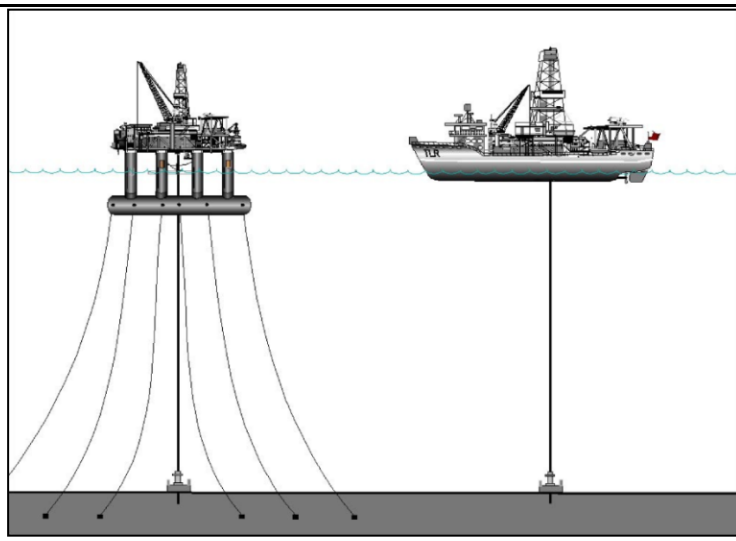
Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
	 Source: MMS 2000 **Figure 2.4 Schematic of Typical Semi-submersible Drilling Rig and Drill Ship**  Source: CNSOPB **Photo 1. Drill Ship MODU**

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

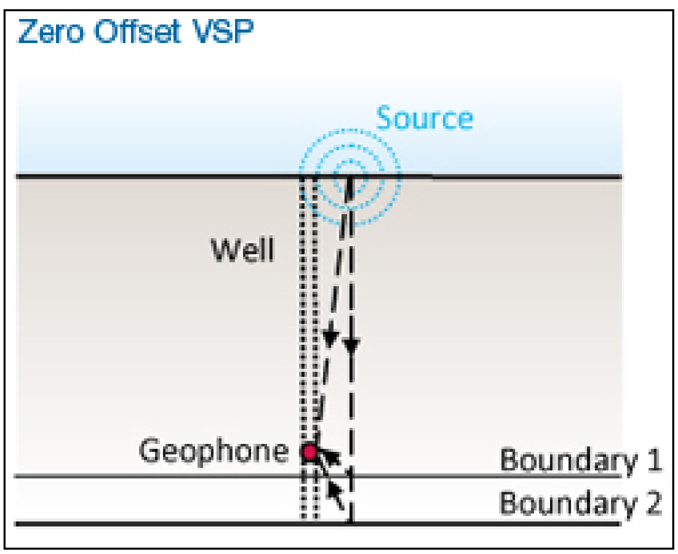
Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
	 Source: CNSOPB **Photo 2. Semi-submersible MODU**  Source: CO2CRC 2011 **Figure 2.5 Schematic of VSP**

Table 2.4 Generic Description of Exploration Activities - Drilling Activities

Drilling Activities (Exploration Drilling, Vertical Seismic Profiling, Well Evaluation and Testing, Delineation Drilling, Well Abandonment)	
Spatial Extent	• A safety zone of 500 m from the MODU (or 50 m beyond the edge of an anchor pattern if applicable) is established while a drilling rig is on location. Only ships supporting the drilling program (e.g., supply vessels) are permitted to enter this zone. • Propagation of underwater sound, atmospheric emissions, and routine discharges (including drill wastes) during drilling operations increase the spatial extent beyond the physical footprint of the drilling rig, and can extend over 150 km from the drill site in the case of underwater sound from DP thrusters.
Timing/ Duration	• The typical duration of an exploratory drilling program ranges from 60-120 days, including drilling, and plugging and abandonment, but can be longer depending on the complexity of the well and operational circumstances. • The duration of VSP operations and well testing (if performed) is in the order of hours to days within this time frame.
Routine Emissions	• Routine emissions include: o Atmospheric emissions such as exhaust and flare emissions (during testing), heat/light emissions from navigation, deck and underwater lights o Drill waste including drilling muds and associated cuttings, provided the cuttings do not exceed 6.9 g/100 g oil on wet solids as per the OWTG (release of whole SBM is not authorized for discharge offshore) o Potentially oily water associated with deck drainage, bilge water, and ballast water o Macerated sewage and food wastes o Noise from standby/supply vessels, MODU, and VSP • Levels of radiated drilling noise are dependent on rig type. Jack-up rigs tend to be relatively quiet compared to other rig types. Semi-submersibles are relatively quiet themselves although dynamic positioning thrusters are a source of noise. Drill ships are noisier than jack-up rigs or semi-submersibles, since heavy machinery is situated close to the hull, thereby radiating more noise into the marine environment. • Miscellaneous solid waste (e.g., paper, domestic waste, scrap metal) is transferred to shore for sorting, recycling, and disposal according to the Nova Scotia Solid Waste-Resource Management Regulations and municipal requirements as applicable. • Whole SBM is not permitted to be discharged offshore and rock cuttings associated with SBM use that do not meet the OWTG minimum requirements after treatment, are shipped to shore for appropriate treatment and disposal.
Key Environmental Issues	• Discharges and emissions resulting in a reduction of water and sediment quality • Attraction and potential stranding/mortality of marine and migratory birds to artificial lighting/flares • Change in benthic habitat due to drilling dischanges and well abandonment (if wellhead left in place) • Behavioral and/or physical effects on marine wildlife due to underwater noise • Temporary loss of access for fishing and other ocean uses within designated safety zone around the MODU for the duration of the drilling campaign. • Spills and unauthorized discharges (including loss of drill muds, blowouts, or exceedances of OWTG)

Sources: CAPP 2006; JWEL 2003; Hurley 2009; Encana 2005

Table 2.5 Generic Description of Exploration Activities - Vessel and Helicopter Traffic

Vessel and Helicopter Traffic (Supply and Servicing)	
Overview	• Vessels and helicopters are used to transport personnel and supplies between a shorebase and drilling location, and facilitate liaison with other ocean users (e.g., “chase” or “picket” vessels during seismic surveys).
Regulatory Context	• Vessels and helicopters must meet local (e.g., multiple CNSOPB occupational health and safety regulations), national (e.g., *Canada Shipping Act*; Canadian Aviation Regulations, Marine Occupational Health and Safety Regulations), and international (e.g., MARPOL, International Convention for the Safety of Life at Sea [SOLAS] conventions) requirements. • Although support vessels and helicopters are not regulated per se by the CNSOPB, once included in the Declaration of Operator, they are subject to inspection by the CNSOPB prior to authorization.
Equipment and Methods	• During seismic surveys, one or two small chase vessels are used to look for fishing activity in the area and to prevent gear loss and entanglement. • An exploration drilling program would likely require 2-3 supply vessels making a total of 2-3 round trips per week, with a dedicated stand-by vessel attending the rig throughout drilling operations. • Helicopters may be used for resupply, crew changes, or medical emergencies, depending on the length of the seismic survey. • Helicopter flights would be used to transport personnel to and from the MODU approximately 4 times per week.
Spatial Extent	• The spatial extent would be related to the transit route between an airport/shorebase to the offshore exploration site.
Timing/ Duration	• Chase vessels would be required for the duration of a seismic exploration program (weeks to months). • Supply and servicing by vessels and helicopters would be required for the duration of a drilling program (e.g., 30-120 days).
Routine Emissions	• Routine emissions include: o Atmospheric emissions such as exhaust emissions and light emissions o Potentially oily water associated with deck drainage, bilge water, and ballast water o Sewage and food wastes o Noise • Miscellaneous solid waste (e.g., paper, domestic waste) is transferred to shore for sorting, recycling and disposal according to the Nova Scotia Solid Waste-Resource Management Regulations and municipal requirements as applicable.
Key Environmental Issues	• Vessel collision with marine mammals/sea turtles • Helicopter strikes with marine and migratory birds • Attraction of species to vessel lights and discharges • Noise effects on marine wildlife and migratory birds • Spills and unauthorized discharges

Sources: Thompson et al. 2000, Husky 2010

2.4 POTENTIAL ACCIDENTAL EVENTS

Potential accidental events that can occur during petroleum exploration programs are focused on unplanned releases into the marine environment. This can occur as a result of a break of a seismic streamer (e.g., release of kerosene or other streamer fluid), blowouts (continuous uncontrolled release of hydrocarbons during drilling that can occur below or above the sea surface), or platform and vessel leaks, spills and releases (e.g., hydraulic fluid, drilling mud, diesel, release of hydrogen sulphide). Of primary concern, and the focus of this SEA, are well blowouts and batch spills of diesel, although it is recognized that even small amounts of hydrocarbons can have detrimental effects on marine wildlife, particularly marine birds. A worst-case scenario accidental event would be a loss of well control resulting an uncontrolled release of crude oil on the Scotian Shelf.

2.4.1 Spills, Blowouts, and other Accidental Events in Atlantic Canada

As of January 1, 2019, there have been 212 wells drilled in the Nova Scotia offshore area and 468 wells in the Newfoundland and Labrador offshore area.

Since the first well was drilled offshore Nova Scotia in 1968, there have been two blowouts. In February 1984, a surface blowout occurred at Shell's Uniacke G-72 exploratory gas well, approximately 16 km from Sable Island. Over the course of the blowout, the well released approximately 70 million cubic feet (MMcf) of gas and 1.7 thousand cubic feet (Mcf) of condensate a day (Angus and Mitchell 2010). Environmental monitoring toward the end of the 10-day blowout revealed a condensate slick that covered 50-90 percent of the water's surface within a radius of several hundred metres of the rig; patches of slick were observed up to 10 km from the rig. Slick trajectory modelling run during the event predicted the slick would affect Sable Island, although monitoring patrols on the Sable Island beach never detected any condensate. While some oiled birds and seals were sighted, the incidence of oiling was not considered exceptional for this area of navigable waters. Monitoring of fish stocks revealed no evidence of tainting and the likelihood of adverse effects on fish stocks was considered to be low (Gill et al. 1985).

A year later, in April 1985 a subsurface blowout occurred at the Mobil exploratory gas well N-91 at West Venture. In this case the natural gas was contained underground with no release to the ocean or to the atmosphere (Angus and Mitchell 2010).

There have been no blowouts in the Newfoundland and Labrador offshore area. However, the biggest oil spill from an offshore oil and gas operation in Canadian history occurred on November 16, 2018 when approximately 250,000 litres of crude oil leaked from a subsea flow line to the South White Rose Drill Centre offshore Newfoundland (C-NLOPB 2018).

The most significant accidental events in the Atlantic Canada offshore petroleum industry, however, have not been spills or blowouts, but safety incidents in which workers' lives have been lost. The most tragic accident of the Canadian offshore petroleum industry was that of the 1982 Ocean Ranger incident in which the semi-submersible drill rig capsized and sank in a storm, killing all 84 crew members while working in the Hibernia oil field, approximately 315 km off the coast of Newfoundland (Angus and Mitchell 2010). In 2009, another tragedy occurred off the coast of Newfoundland as a helicopter carrying workers to offshore oil fields crashed, killing 17 people (C-NLOPB 2010).

All these incidents have resulted in changes to equipment and technology, standard operating procedures, prevention and response procedures, monitoring and reporting processes, and/or regulatory requirements, creating a safer offshore working environment in Atlantic Canada through adaptive management.

Operators are required to report environmental, health and safety incidents to the CNSOPB in accordance with criteria set out in regulations and detailed in the Incident Reporting and Investigation

Guidelines (C-NLOPB and CNSOPB 2018). For significant spills, hydrocarbon releases and unauthorized discharges (e.g., when a substance is discharged from a drilling installation in an amount or concentration that exceeds limits described in the Operator's EPP), the CNSOPB assesses potential environmental impacts. In addition to examining and following up on these incidents, the CNSOPB also monitors whether trends are occurring.

Table 2.6 presents CNSOPB spill statistics (exploration and development) from 1999 to 2018 (as of March 31, 2018) for spills (including chemical spills) offshore Nova Scotia (CNSOPB 2018). Note that this database does not include releases associated with the 1984 Uniacke Blowout as this database commenced in 1999.

Table 2.6 CNSOPB Statistics for Spills to the Marine Environment (1999-2018)

Year	Less Than 1L	1-10L	11-150L	Greater Than 150L	Total Incidents[a]
1999-2000	0	8	3	2	13
2000-2001	11	8	11	2	32
2001-2002	11	9	4	0	24
2002-2003	10	3	4	3	20
2003-2004	6	5	9	5	25
2004-2005	6	0	2	2	10
2005-2006	7	2	3	1	13
2006-2007	4	2	4	2	12
2007-2008	1	3	1	0	5
2008-2009	3	4	0	0	7
2009-2010	9	1	2	1	13
2010-2011	5	2	0	1	8
2011-2012	3	0	2	1	6
2012-2013[b]	6	0	1	0	7
2013-2014	6	1	1	2	10
2014-2015	3	2	1	2	8
2015-2016	5	0	1	0	6
2016-2017	4	1	0	0	5
2017-2018[b]	6	0	1	0	7
TOTAL	106	51	50	24	231

Notes:
[a]Does not include exceedences to authorized discharge limits (e.g., oil in produced water) or gas releases.
[b]Current to March 31, 2018

Source: CNSOPB 2018

The majority of reported spill events were associated with the Sable Offshore Energy Project (SOEP) natural gas development. However, there were some spill events associated with exploration activities including, but not limited to, spills of mineral oil (e.g., kerosene) from streamers during seismic surveys, and releases of drilling fluids during exploration drilling.

Significant environmental incidents are the subject of extensive review and / or investigation by the CNSOPB. Three such incidents are described in the following paragaphs.

In 2004, approximately 354 m^3 of SBM was discharged as a result of an equipment failure during well abandonment activities at exploratory well Crimson F-81 in 2,067 m of water, approximately 60 km south of Sable Island. An investigation of the spill led by the CNSOPB concluded that the impact would be minor with no remediation recommended (CNSOPB 2005).

On March 5, 2016 after securing the well and disconnecting the *Stena IceMAX* drillship from the exploratory well Cheshire L-97 in 2,141 m water depth in advance of severe weather, high waves and heave caused the riser tensioner system to release, resulting in the riser and lower marine riser package falling to the seabed. There were no injuries and no well fluids or synthetic oil-based drilling muds were released. The integrity of the well was not compromised, and the BOP remained securely connected to the wellhead (CNSOPB 2016). An investigation into the incident concluded that leaving the riser in place on the seafloor would not result in serious harm to fish under the *Fisheries Act*, and would not contravene sections 32, 33 or 58 of SARA. However, Shell Canada Limited required a Disposal at Sea permit under CEPA to abandon the structure at sea (CNSOPB 2017).

On June 22, 2018, BP (British Petroleum) Canada Energy Group reported an unauthorized discharge of approximately 136 m^3 of SBM from the *West Aquarius* semi-submersible drilling rig during drilling operations at Aspy D-11 located at a water depth of 2,771 m. The source of the release was part of the piping which forms the drilling mud system, approximately 30 m below the water surface. As of January 15, 2019, the investigation into the incident is ongoing (CNSOPB 2018).

2.4.2 Oil Spill Prevention and Response

The CNSOPB is responsible for the regulation of spills at offshore drilling operations, with activity authorizations issued under the Accord Acts. The CNSOPB holds operators fully accountable and responsible for protection of the environment, ensuring that operators and drilling contractors have the necessary competencies to carry out their work, that they exercise due diligence in incident prevention, and that they demonstrate the capability and capacity to respond to any incidents that may occur (CNSOPB 2013).

In accordance with the *Nova Scotia Offshore Petroleum Drilling and Production Regulations*, operators must prepare and submit, prior to initiation of drilling activity, contingency plans to prevent, mitigate and respond to emergencies, which would include (but not be limited to) spills.

Standard operating procedures to reduce or eliminate the risk of a spill may include: schedule of routine maintenance and testing (especially well control); drilling practices and equipment (with consideration for poor weather/sea state); sound marine practices and good communications for all vessels supporting a drilling program; regular inspections and audits of the practices and procedures; ongoing training and safety meetings for rig personnel; and reporting near misses and other potential problems to help avoid future incidents.

In addition to spill prevention, operators must demonstrate spill response capabilities including the identification of spill response resources on-site and those available locally, nationally and internationally, and describe the arrangements to mobilize the resources to site.

An oil spill is usually classified under three tiers for response planning purposes:

- Tier 1 – poses the least environmental effects and is usually managed offshore/on site
- Tier 2 – requires local shore-based management support and additional resources/ equipment
- Tier 3 – can require local/regional, national and/or international support, as well as a high level of corporate and contract resources (e.g., assistance from Eastern Canada Response Corporation [ECRC] and/or Oil Spill Response Limited [OSRL])

Spill response can include any combination of the following methods:

- Natural attenuation (no intervention)
- Containment and recovery (e.g., use of booms and skimmers)
- In-situ burning (oil is contained within oil-resistant booms and ignited to reduce volume of oil on the surface)
- Chemical dispersant application (surface or subsea application of chemical agents to reduce oil droplet size and promote natural biodegradation and dispersion)
- Shoreline protection and recovery (shoreline recovery techniques informed by shoreline cleanup assessment team depending on shoreline time, degree of oiling, access, etc).

Each of these methods has advantages and disadvantages and effectiveness of any method depends on several variables including nature of spilled product, size of spill, sea state, and logistical variables. In some cases, the spill response method may have its own environmental effects which need to be considered (e.g., chemical dispersant application, in-situ burning). Depending on the size and type of spill, natural dispersion/degradation is a valid option, although it is usually most effective in high winds and sea states.

Operators are required to conduct a net environmental benefit analysis (NEBA), also referred to as a spill impact mitigation assessment (SIMA), as part of their oil spill response planning process. The NEBA/SIMA is a tool used to assess the benefits/drawbacks of spill response tools based on scientific, stakeholder, and policy related inputs and help to understand which response tools should be used under a particular set of circumstances with the goal of minimizing overall harm once a spill has occurred. If, in the event of a spill, an operator proposes to use chemical dispersants, an incident-specific NEBA/SIMA is conducted to inform the regulatory approval process for dispersant application.

Spill response also includes surveillance and monitoring (including a spill-specific Environmental Effects Monitoring [EEM] program), wildlife protection and/or recovery and rehabilitation measures. Compensation of affected parties for associated loss or damage attributed to a spill by the offshore petroleum industry is directed by the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017).

Incident reporting occurs in accordance with the Incident Reporting and Investigation Guidelines (C-NLOPB and CNSOPB 2018), which define incidents and specify reporting procedures, including notification of third parties. All spills are to be reported through written notification within 24 hours of the spill event (C-NLOPB and CNSOPB 2018). Investigations of past incidents have resulted in improvements in technology and safety, environmental, and operational procedures and continue to improve industry performance.

3.0 KEY CHARACTERISTICS OF THE ENVIRONMENT

This section provides an overview of key features of the existing environment in the Study Area that could potentially interact with or influence elements of a petroleum exploration program.

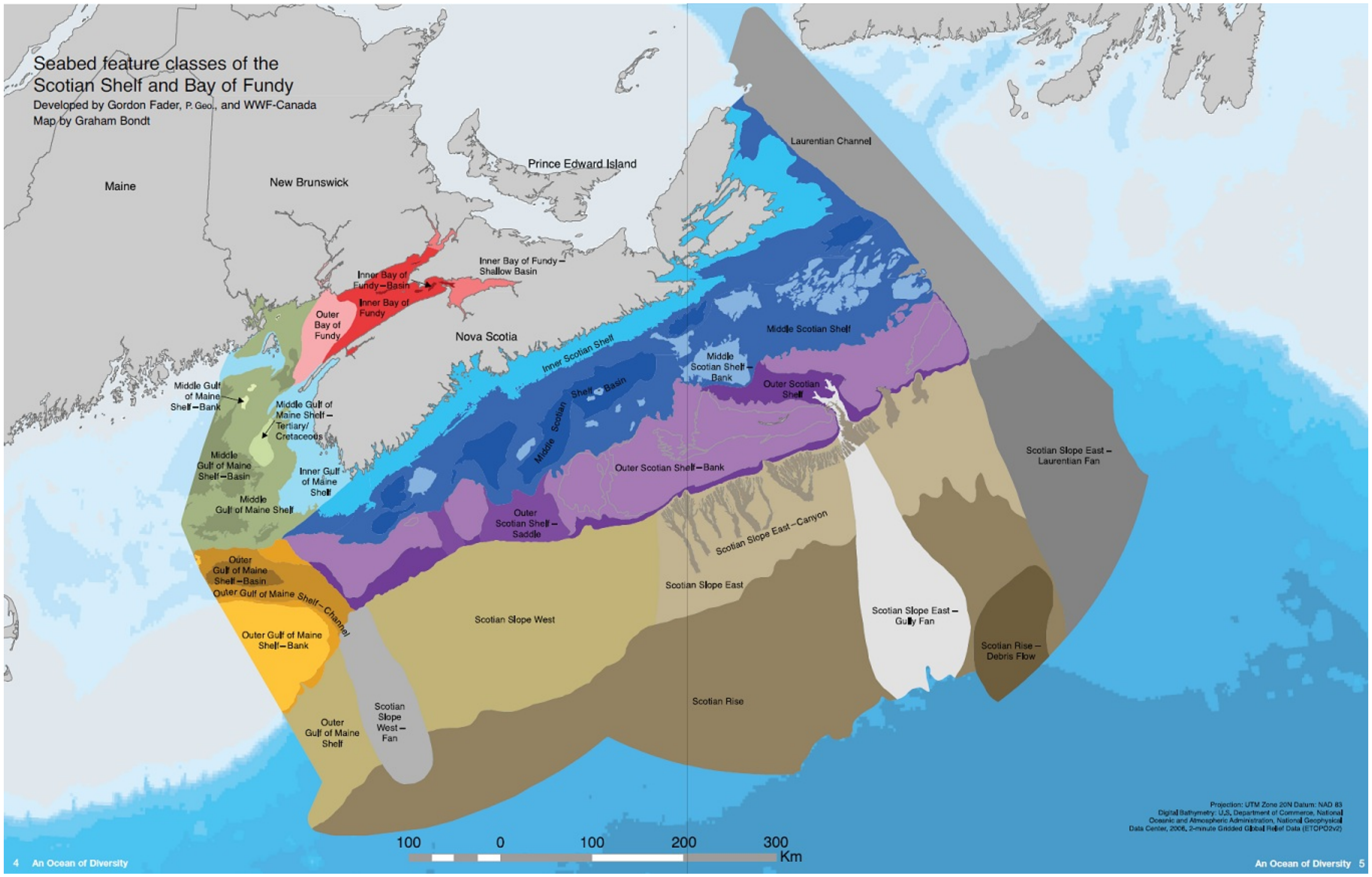
3.1 PHYSICAL CHARACTERISTICS

3.1.1 Oceanography

The Scotian Shelf is part of the North American Continental Shelf off Nova Scotia. The Scotian Shelf is 700 km long and between 125 and 230 km wide. The northeast channel separates the shelf from the Gulf of Maine to the southwest, while the Laurentian Channel is the natural boundary between Newfoundland and the shelf to the northeast (DFO 2011a). The Scotian Shelf is a broad continental shelf made up of several shallow offshore banks and inner basins.

The Scotian Shelf can be divided into the inner, middle, and outer shelf regions. The inner portion of the shelf extends from the coast out to approximately 25 km offshore and is an extension of coastal bedrock (Zwanenberg et al. 2006). The middle shelf is an area of complex topography containing many small-sized banks and basins resulting from repeat glaciation. The outer shelf is a series of relatively flat shallow banks. In the east, Sable Island is an exposed portion of the Sable Island bank, creating a unique feature on the outer shelf regions. The Western and Emerald Banks (Figure 1.1) are also in the Study Area. The average depth of the shelf is approximately 90 m. Georges Bank is located on the outer Gulf of Maine Shelf, west of the Study Area, and is an oval-shaped bank underlain with sandstone and covered in a sand and gravel mixed substrate (WWF 2009). In between Georges Bank and Browns Bank, the Northeast Channel connects the Gulf of Maine with the Atlantic Ocean.

At the edge of the shelf at the 200 m isobath the continental slope begins as the shelf becomes steeper to a depth of 2,000 m. The Western Scotian Slope has a gentle gradient and a relatively smooth seabed. It is an area of low, gentle hills and valleys, sloping towards the Scotian Rise and the abyssal plain. When compared to the Eastern Scotian Slope, the Western Slope has a less dynamic seabed, with fewer canyons (WWF 2009). Dawson and Verill Canyons are located at the southeastern edge of the Study Area (Figure 1.1). At the depths of 2,000 to 5,000 m the slope is more gradual, with this area known as the continental rise (refer to Figure 3.1).



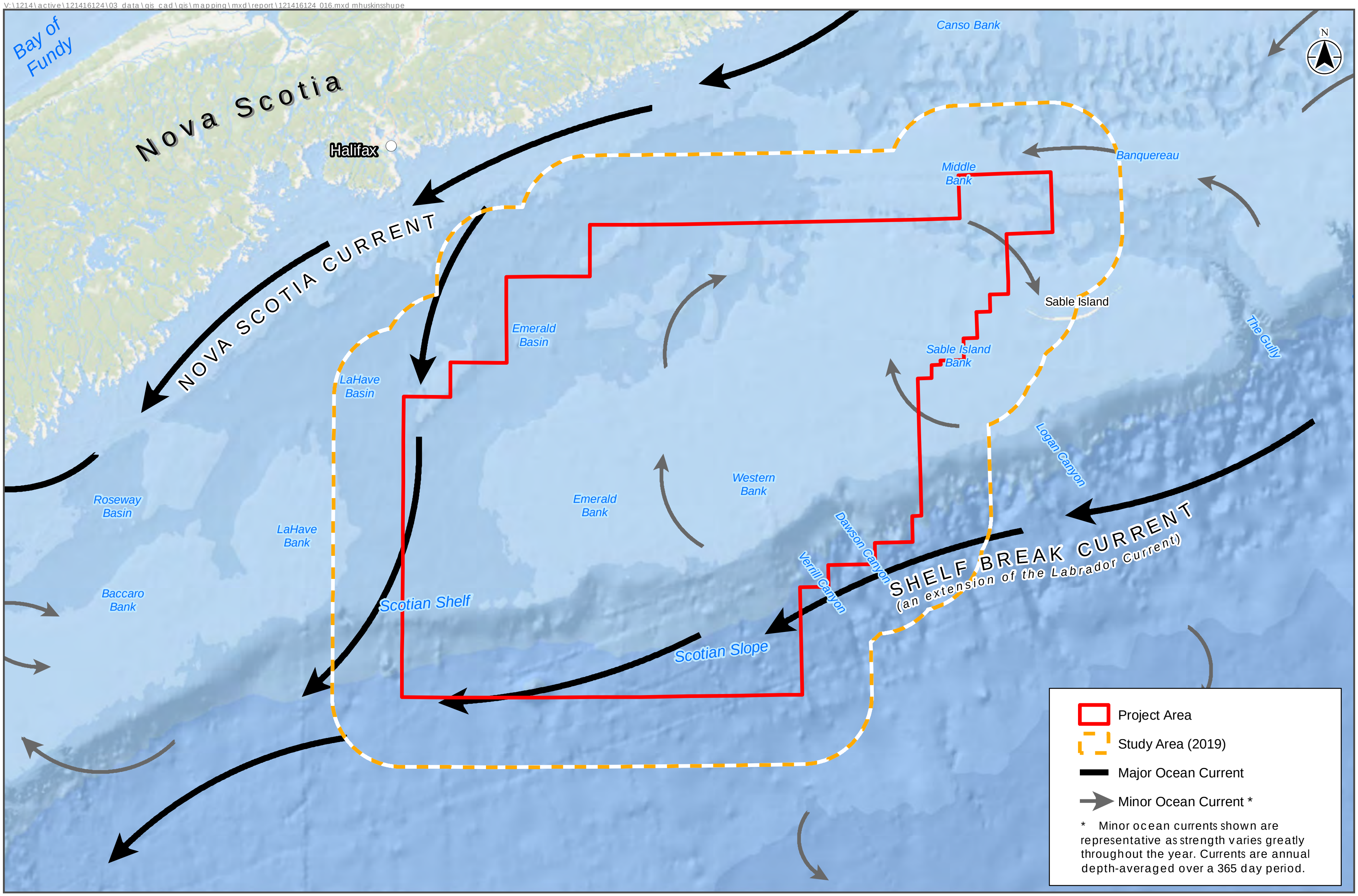
Source: WWF 2009

Figure 3.1 Seabed Features of the Scotian Shelf and Bay of Fundy

The physical environment on the Scotian Shelf is governed by its close proximity to the meeting place of major currents of the northwest Atlantic and its complex bathymetry. The three major currents influencing the movement of water on the Scotian Shelf are the Nova Scotia Current; the Shelf Break Current (an extension of the Labrador Current); and the Gulf Stream (Zwanenburg et al. 2006). Relatively cool, fresh waters flow from the Gulf of the St. Lawrence through the Cabot Strait. A portion of this water turns at Cape Breton to flow southwest along Nova Scotia’s Atlantic coast, while the rest of the flow continues through the Laurentian Channel to the shelf break. At the shelf break it turns and joins the Shelf Break Current to flow southwest along the shelf edge. The Shelf Break Current has the largest transport along 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 (DFO 2011a). 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 temperature and salinity generally increasing to the southwest (Zwanenburg et al. 2006). This flow is strongest in the winter and weakest in the summer. For an overview of currents on the Scotian Shelf refer to Figure 3.2.

The presence of a partial gyre near the Western and Emerald Banks leads to increased retention of larval fish and locally increased zooplankton diversity, a primary larval food source. Correspondingly, larval fish diversity is exceptionally high compared to other areas on the Eastern Scotian Shelf. Further to the southwest, on the Western Scotian Shelf, the Nova Scotia Current flows in a southwesterly direction close to the coastline. As it reaches the Halifax area it branches in an offshore direction, where it joins the Shelf Break Current and continues to flow southwesterly along the shelf break (Breeze et al. 2002) On the shelf, the influence of the warm waters from the Gulf Stream is felt primarily within the deep channels and basins. The depression between Emerald and LaHave Banks, known as the Scotian Gulf, is a well-known area of warm water infiltration. Significant differences in circulation patterns exist between the western and central Scotian Shelf. The water masses of the central and Western Scotian Shelf are more similar to one another than to those found on the Eastern Scotian Shelf (Breeze et al. 2002).

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. Georges Bank is located outside the Study 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 grye (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).



Sources:North Atlantic Fisheries Organization, Canada-Nova Scotia Offshore Petroleum Board, Fisheries and Oceans Canada, Natural Resources Canada, Nova Scotia Geomatics Centre, Brickman and Drozdowski 2012 Miller et al. 1998
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Ocean Currents

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Figure 3.2

On the edge of the Scotian Shelf, deep water lowlands can be found that feed canyons and the Scotian Slope with sediments. At the outer margins, water masses collide to form a “frontal zone” which shifts year to year, in which warm water masses occasionally spill onto the shelf through the lowlands and canyons (WWF 2009). Past the shelf edge (at 200 m water depth) the seabed slopes away relatively rapidly. On the slope, exposed bedrock cliffs and areas of slumping sediments can be found. In between the canyons found on the slope, the seabed is covered by furrows and pits creased by icebergs from the past. The area continues to erode creating a natural disturbance regime that may enhance biological diversity. The canyons found along the Scotian Slope are bathymetrically complex and contain more surface area and a higher variety of habitats compared with those of the surrounding shelf. These canyons act as a transition from the outer shelf to the deep ocean and also act as channels for the transport of sand (WWF 2009).

There are several large submarine canyons that emerge on the outer shelf and continental rise. Some of the major canyons located on the Eastern Scotian Shelf include Haldimand Canyon, Shortland Canyon, Logan Canyon, Dawson Canyon, Verill Canyon, and the Gully (Zwanenberg et al. 2006). Of these, Dawson Canyon and Verrill Canyon are located within the Study Area (Figure 1.1). At 15 km wide and over 65 km long, the Gully is the largest canyon on the Scotian Shelf. The size and shape of the Gully influences water transport to and from the Shelf (DFO 2011b). The Gully is located outside the Study Area, east of Sable Island.

At the edge of the Scotian Slope is the Scotian Rise, where glacial and modern-day erosion have deposited a wide area of sediment. Deep currents, as well as smaller eddies peel off of the Gulf Stream in this area and rework the sand and mud here. These currents can sometimes be intense, disturbing the seabed and bringing fresh nutrients into the ecosystem.

At the shelf edge, outer marginal water masses collide to form a frontal zone which shifts in location from year to year. At this frontal zone, cold slope water mixes with the warm water at the edge of the outer banks, supplying nutrients and promoting phytoplankton growth (WWF 2009). The eddies, which peel off the Gulf Stream, also rework the benthic environment here, disturbing the seabed and bringing nutrients towards the surface waters. This frontal zone is an area of high primary productivity and is also a location where species with planktonic juveniles are deposited after long voyages north on the Gulf Stream (WWF 2009).

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 Western Scotian Shelf is generally warmer than the Eastern Scotian Shelf. This is due to the infiltration of warm Gulf Stream water entering in between Browns and Western Banks. The normal temperatures on the Western Scotian Shelf is 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. Hebert et al. (2018) reviewed observations and model results for air temperature trends, ice cover, sea surface temperatures and physical oceanographic variability during 2016 on the Scotian Shelf, Bay of Fundy and the Gulf of Maine. They note that, due primarily to half freshening and half warming of surface waters, stratification has slowly been increasing on the Scotian Shelf. Annual water temperature anomalies were positive in 2016: +1.3°C (+3.6 SD) for Cabot Strait at 200-300 m depth range (the largest anomaly); +1.2°C (+1.9 SD) for Misaine Bank at 100 m; +1.6°C (+1.9 SD) for Emerald Basin at 250 m (a record high); +1.0°C (+1.2 SD) for Lurcher Shoals at 50 m; and +1.4°C (+2.6 SD) for Georges Basin at 200 m (a record high). In 47 years of observation, the ocean temperature (surface to bottom, across the region) was warmest in 2012 and second-warmest in 2016 (with an averaged normalized anomaly of +2.1 SD relative to the 1981-2010 period) (Hebert et al. 2018).

Ice cover and sea ice are very rare in the Nova Scotia offshore environment (Worcester and Parker 2010). Hebert et al. (2018) note that following above-average conditions in 2015, sea ice coverage returned to that of the 2010-2013 period, which had extremely low coverage and volume. Sea ice is generally transported out of the Gulf of St. Lawrence through the Laurentian Channel and pushed out to the Scotian Shelf via 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 Study Area.

Salinity is an important characteristic of marine waters. It influences the presence of marine life, as different species have different salinity preferences and needs. Salinity stratification also affects the growth of phytoplankton and thus primary production (Breeze et al. 2002). The Labrador Current and Gulf Stream (34-36 ppt) are both more saline than the Shelf Current (31-33 ppt). Periods of low temperatures are generally associated with lower salinities and higher temperatures with higher salinities (Breeze et al. 2002).

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 water depth stratification index increased during the 1990s and from the mid- to late-1990s was at its 50-year maximum on record. In the eastern Gulf of Maine and on Georges Bank changes in stratification have also been noted. Stratification has been increasing steadily from the mid-1980s. Highly stratified water can be found in the deep basins of the Study Area including Emerald Basin (Worcester and Parker 2010).

Strong stratification has the potential to inhibit the vertical mixing of water to a degree to cause dissolved oxygen levels in the deeper layers to become depressed. The waters in the Study 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).

3.1.2 Climatology

The climate of the Scotian Shelf varies between Atlantic, boreal, and sub-arctic climates. The warm Gulf Stream and the cold Labrador Current influence the climate in the area. Air temperatures in the region are measured on Sable Island and have shown an increase of 1°C over the last century (Worcester and

Parker 2010). In 2016, mean annual air temperature anomalies were positive at all sites examined, with values ranging from +0.8°C (+0.9 SD) to +1.2°C (+1.9 SD) above the climatology (Hebert et al. 2018).

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). The Scotian Shelf is primarily affected by advection. 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 index brings increased westerly winds, precipitation, and warmer waters to the Scotian Shelf. 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. Hebert et al. (2018) noted that the largest value in the NAO index 121-year record occurred in 2015, and this value remained positive in 2016 (+4.6 mb, +0.5 SD from the 1981-2010 mean).

Wind climate is an important physical force in the generation of currents and waves, which can affect exploration vessels and marine operations. Wind speed and direction are common parameters to describe wind characteristics. Data on percent wind speed by wind direction were acquired from Environment Canada’s Meteorological Service of Canada (MSC). The MSC50 hindcast data set (1954-2012) was used for grid point 4457 (43.30° N, 62.9° W; water depth 106 m) within the Study Area near Emerald Bank. Wind statistics are presented in Table 3.1 and wind roses depicting these data on a seasonal basis are presented in Figure 3.3.

Most wind speeds at grid point 4457 are between 5 and 10 m/s during spring, summer and fall, and between 10 to 15 m/s during the winter season (December to February). Winds are most commonly from the west, except during the summer (June to August) when they are typically from the southwest. There was no wind speed reported during the summer greater than 15 m/s. Wind speeds exceed 20 m/s in the winter only.

Table 3.1 Seasonal Wind Statistics for Grid Point 4457 (1954-2012)

Season	Mean Wind Speed (m/s)	Most Frequent Direction (from)	Maximum Hourly Wind Speed (m/s)
Winter (Dec-Feb)	9.98	West Northwest	28.68
Spring (Mar-May)	7.54	West	26.37
Summer (Jun-Aug)	5.12	Southwest	30.75
Fall (Sep-Nov)	7.98	West	31.85

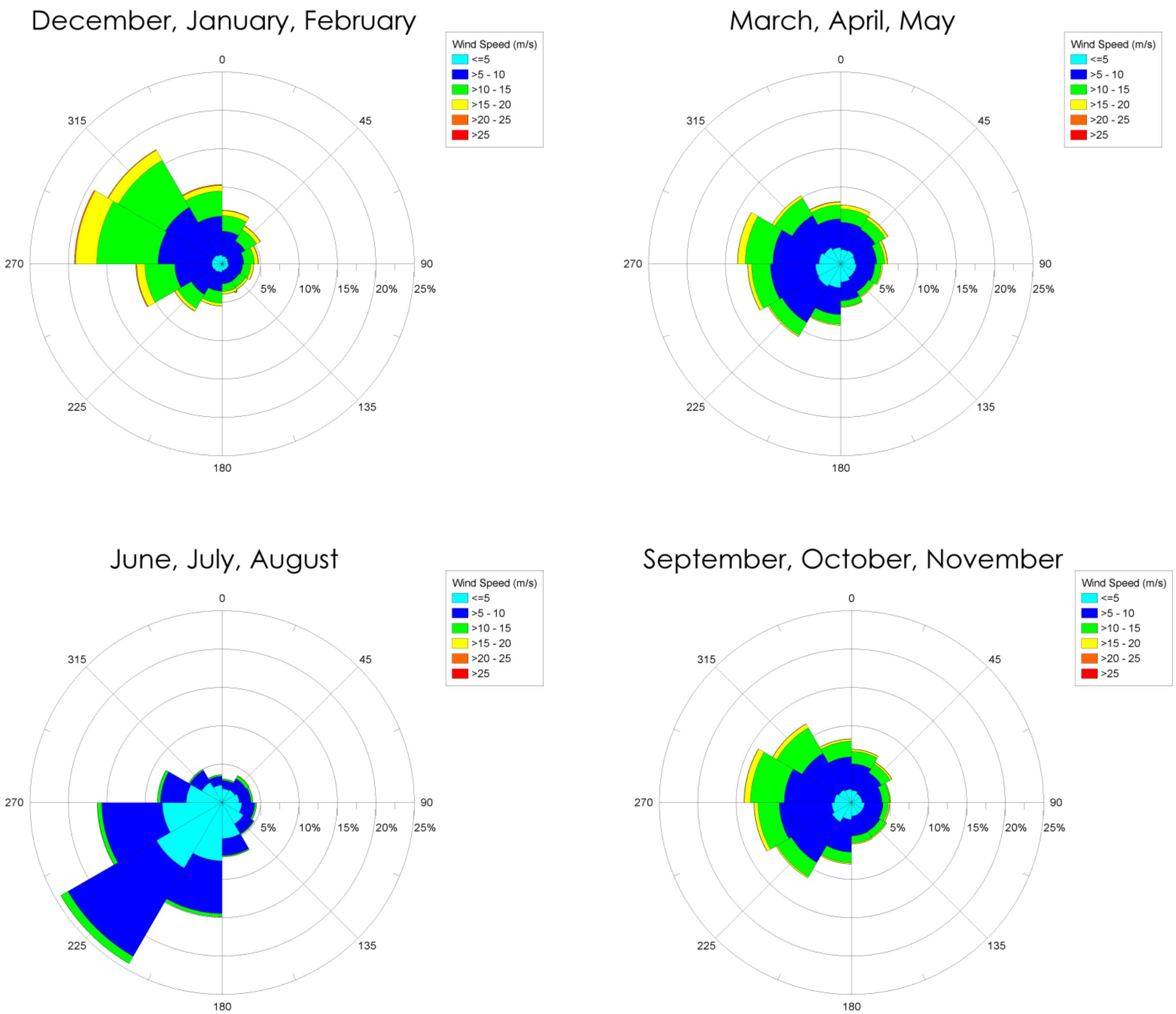


Figure 3.3 Seasonal Wind Roses for Grid Point 4457 (1954-2012)

The wave climate in the Study Area was also assessed by means of the MSC50 data set (1954-2012) for grid point 4457 (43.30 N, 62.9 W; water depth 105.87 m) located within the Study Area. The minimum, maximum, mean and standard deviations of significant wave heights for each season are presented in Table 3.2. Significant wave height (H_s) is the mean wave height of the highest 1/3 of all individual waves from trough to crest (NOAA 2011). Maximum significant wave heights were greatest in the summer and fall seasons, although in general, mean wave heights were greatest in the winter season. The percent occurrence of peak wave period against significant wave heights for grid point 4457 for each season is presented in Tables 3.3 to 3.6. Peak wave period (T_p) refers to the period associated with most energetic waves in the nondirectional wave spectrum at a specific point.

The majority of the significant wave heights occurred at 1 to 1.99 m during the spring, summer, and fall. In the winter, the majority of significant wave heights were nearly evenly divided between 1 to 1.99 m and at 2 to 2.99 m. Generally, the fall and winter months experienced the highest wave heights. The typical peak period was approximately 7 seconds for all seasons.

Table 3.2 Standard Deviation of Significant Wave Height at Grid Point 4457 by Season (1954-2012)

Season	Minimum Significant Wave Height (m)	Maximum Significant Wave Height (m)	Mean Significant Wave Height (m)	Standard Deviation (m)
Winter (Dec-Feb)	0.40	10.95	2.80	1.32
Spring (Mar-May)	0.35	12.77	2.13	1.16
Summer (Jun-Aug)	0.39	13.74	1.38	0.58
Fall (Sep-Nov)	0.44	13.03	2.11	1.08

Table 3.3 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 4457: December, January, February (1954-2012)

Significant Wave Height (m)	Peak Wave Period (s)										Total
	1	3	5	7	9	11	13	15	17	19	
0 - 0.99	<0.01	0.13	0.81	0.56	0.73	0.20	0.07	0.11	0.00	0.00	2.61
1 - 1.99	<0.01	0.25	10.76	7.61	7.17	2.48	0.29	0.40	0.00	<0.01	28.96
2 - 2.99	<0.01	<0.01	1.35	18.78	6.65	4.53	0.31	0.16	<0.01	<0.01	31.77
3 - 3.99	<0.01	<0.01	0.01	7.58	7.34	4.26	0.40	0.11	<0.01	<0.01	19.69
4 - 4.99	<0.01	<0.01	<0.01	0.19	6.04	3.03	0.63	0.09	<0.01	<0.01	9.98
5 - 5.99	<0.01	<0.01	<0.01	0.00	1.66	2.36	0.52	0.07	<0.01	<0.01	4.60
6 - 6.99	<0.01	<0.01	<0.01	<0.01	0.17	1.15	0.24	0.02	<0.01	<0.01	1.59
7 - 7.99	<0.01	<0.01	<0.01	<0.01	0.01	0.36	0.14	0.01	<0.01	<0.01	0.52
8 - 8.99	<0.01	<0.01	<0.01	<0.01	0.00	0.07	0.10	0.01	<0.01	<0.01	0.19
9 - 9.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.08	0.00	<0.01	<0.01	0.08
10 - 10.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.00	<0.01	<0.01	0.02
11 - 11.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12 - 12.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
13 - 13.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	**<0.01**	**0.37**	**12.92**	**34.73**	**29.76**	**18.44**	**2.80**	**0.97**	**0.00**	**0.00**	**100.00**

Table 3.4 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 4457: March, April, May (1954-2012)

Significant Wave Height (m)	Peak Wave Period (s)										Total
	1	3	5	7	9	11	13	15	17	19	
0 - 0.99	<0.01	0.31	2.62	4.74	2.07	0.64	0.31	0.19	0.02	<0.01	10.89
1 - 1.99	<0.01	0.23	11.92	16.93	12.70	2.78	0.46	0.27	<0.01	<0.01	45.29
2 - 2.99	<0.01	<0.01	0.82	12.36	7.92	3.78	0.17	0.05	<0.01	<0.01	25.09
3 - 3.99	<0.01	<0.01	0.01	3.15	4.99	2.99	0.15	0.05	<0.01	<0.01	11.33
4 - 4.99	<0.01	<0.01	<0.01	0.05	2.76	1.64	0.22	0.02	<0.01	<0.01	4.69
5 - 5.99	<0.01	<0.01	<0.01	<0.01	0.61	1.00	0.12	0.02	<0.01	<0.01	1.75
6 - 6.99	<0.01	<0.01	<0.01	<0.01	0.07	0.44	0.07	0.03	<0.01	<0.01	0.61
7 - 7.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.11	0.05	0.01	<0.01	<0.01	0.17
8 - 8.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.05	<0.01	<0.01	<0.01	0.10
9 - 9.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	0.05
10 - 10.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01
11 - 11.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01
12 - 12.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01
13 - 13.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	**<0.01**	**0.53**	**15.35**	**37.23**	**31.13**	**13.44**	**1.64**	**0.65**	**0.02**	**<0.01**	**100.00**

Table 3.5 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 4457: June, July, August (1954-2012)

Significant Wave Height (m)	Peak Wave Period(s)										Total
	1	3	5	7	9	11	13	15	17	19	
0 - 0.99	<0.01	0.25	4.99	16.19	2.32	0.49	0.39	0.04	0.06	0.01	24.72
1 - 1.99	<0.01	0.13	14.01	33.99	12.82	1.45	1.15	0.30	0.07	<0.01	63.92
2 - 2.99	<0.01	<0.01	0.18	5.10	2.92	0.97	0.15	0.13	0.01	<0.01	9.46
3 - 3.99	<0.01	<0.01	<0.01	0.33	0.71	0.33	0.06	0.03	<0.01	<0.01	1.45
4 - 4.99	<0.01	<0.01	<0.01	0.01	0.16	0.11	0.03	0.02	<0.01	<0.01	0.32
5 - 5.99	<0.01	<0.01	<0.01	<0.01	0.01	0.03	0.02	0.01	<0.01	<0.01	0.07
6 - 6.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.02
7 - 7.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	<0.01	0.02
8 - 8.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
9 - 9.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
11 - 11.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12 - 12.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
13 - 13.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	**<0.01**	**0.38**	**19.18**	**55.60**	**18.95**	**3.39**	**1.81**	**0.56**	**0.14**	**0.01**	**100.00**

Table 3.6 Percent Occurrence of Peak Wave Period against Significant Wave Height for Grid Point 4457: September, October, November (1954-2012)

Significant Wave Height (m)	Peak Wave Period(s)										Total
	1	3	5	7	9	11	13	15	17	19	
0 - 0.99	<0.01	0.21	2.25	2.51	2.61	0.85	0.29	0.17	<0.01	<0.01	8.90
1 - 1.99	<0.01	0.22	14.81	15.61	9.87	3.95	1.52	0.49	<0.01	<0.01	46.47
2 - 2.99	<0.01	<0.01	0.86	16.35	6.54	2.97	0.75	0.36	0.01	<0.01	27.86
3 - 3.99	<0.01	<0.01	<0.01	3.49	5.01	2.03	0.32	0.13	<0.01	<0.01	10.99
4 - 4.99	<0.01	<0.01	<0.01	0.04	2.18	1.02	0.19	0.11	0.01	<0.01	3.54
5 - 5.99	<0.01	<0.01	<0.01	<0.01	0.48	0.75	0.11	0.06	<0.01	<0.01	1.40
6 - 6.99	<0.01	<0.01	<0.01	<0.01	0.06	0.36	0.09	0.01	<0.01	<0.01	0.52
7 - 7.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.12	0.04	0.01	<0.01	<0.01	0.17
8 - 8.99	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.05	<0.01	<0.01	<0.01	0.08
9 - 9.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.04
10 - 10.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	0.01
11 - 11.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02
12 - 12.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
13 - 13.99	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	**<0.01**	**0.44**	**17.93**	**37.99**	**26.75**	**12.07**	**3.41**	**1.39**	**0.03**	**0.00**	**100.00**

Table 3.7 provides extreme wave conditions for the grid point 4457 for various return periods as determined by Oceanweather's Inc. Gumbel distribution. The largest waves are originating from the south, southwest and west directions, with the most extreme waves coming from the southwest.

Table 3.7 Extreme Wave Conditions at the Grid Point 4457

Direction	S			SW			W		
Return Period (year)	H_s (m)	T_p (s)	H_{max} (m)	H_s (m)	T_p (s)	H_{max} (m)	H_s (m)	T_p (s)	H_{max} (m)
1	5.68	11.13	10.73	6.60	11.44	12.08	6.32	11.04	11.67
2	8.00	12.84	14.45	8.54	12.80	15.47	7.62	11.85	14.00
5	9.45	13.77	16.80	9.76	13.57	17.60	8.43	12.31	15.47
10	10.42	14.34	18.35	10.57	14.05	19.02	8.98	12.61	16.44
25	11.65	15.02	20.32	11.59	14.63	20.81	9.66	12.96	17.68
50	12.56	15.50	21.78	12.35	15.04	22.14	10.17	13.22	18.59
100	13.46	15.96	23.23	13.11	15.44	23.46	10.68	13.46	19.50
Notes: [1] Based on 57 years of MSC50 hourly wave data from 1954 to 2010									

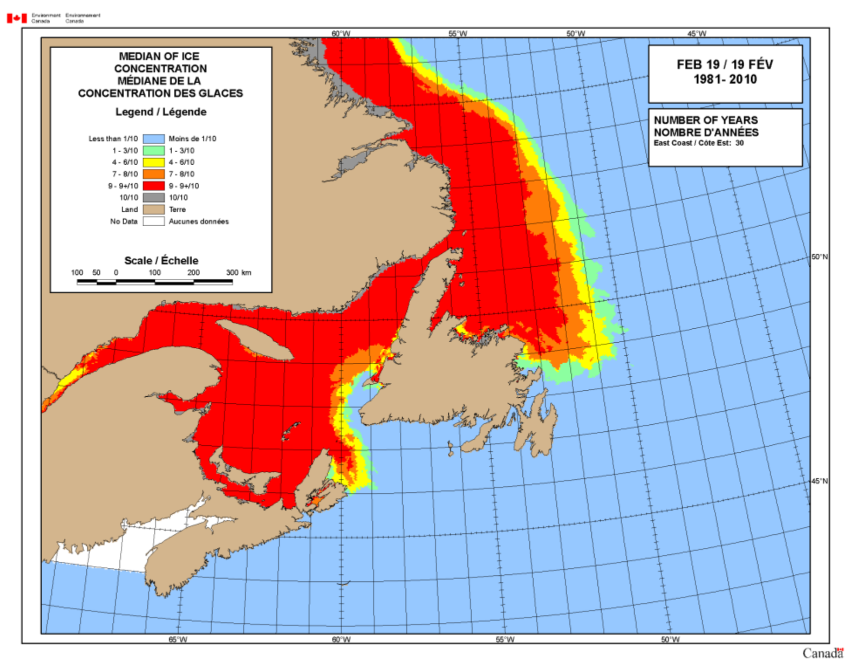
3.1.3 Summary

Table 3.8 summarizes physical characteristics of the Study Area.

Table 3.8 Overview of Physical Characteristics

Physical Characteristics	
Seabed Characteristics (refer to Figure 3.1)	• The middle shelf is characterized by a wide and complex network of valleys, ridges, and small gravel covered banks. • Basins have been smoothed by glaciers and recently filled with the deposition of silt. These basins span across the middle of the Scotian Shelf. In certain areas, boulder-covered till ridges protrude through the mud, silt, and pockmarks. • There are several large and shallow banks that are the defining features of western shelf and outer banks. These include the Sable Island, Western, Emerald, LaHave, Baccaro, Browns, and Georges banks. Of these, Western, Emerald as well as portions of Sable Island and LaHave banks are located within the Study Area. • Sable Island Bank is characterized by complex fields of sand ridges with average heights of 12 m and widths of 6.4 km. Sable Island is surrounded by a shore face that extends to 20 m in depth. Sand ridges occur on the lower part of the shore face and extend offshore on both sides of the island. The larger and more extensive ridges lie along the south side of the island and in the deeper water to the west. • The shallow outer banks tend to have sand and/or gravel benthic structure, with some areas having an extensive shell bed cover. Storms and currents constantly shape the tops of the banks forming sand into a wide variety of ridges, waves and ripples. • The deeper basins are covered in fine silt and clay interspersed with coarse glacial material. • Saddles are areas of slightly deeper water that occur between the banks on the outer Scotian Shelf. Saddles are present between Emerald Bank, LaHave Bank, and Browns Bank on the western Scotian Shelf. They occur at depths less than 200 m and are covered by sand which contains minor amounts of clay, silt and gravel. The saddles form an entrance to the basins of the middle Scotian Shelf for deep warmer slope water masses. • The Western Scotian Slope has a gentle gradient with a relatively smooth seabed. It is an area of low, gentle hills and valleys, sloping towards the Scotian Rise and abyssal plain. Compared to the Eastern Scotian Slope, the western slope has a less dynamic seabed, with fewer canyons. There are a few shallow gullies which reach depths of up to 500 m. The area is extremely productive, hosting many marine mammals and large fish during important life history periods, including feeding and migration. • A series of deep canyons (e.g., Dawson and Verill Canyons) occur along the outer edges of the Scotian Shelf and extend down the slope. These canyons act as transport areas for sand and provide a transition from the outer shelf to the deep ocean. • Between the canyons the seabed is crisscrossed by furrows and pits created by icebergs in the past. This area continues to erode creating a natural disturbance, which may enhance biological productivity. • The Northeast Channel is the largest and deepest channel connecting the open Atlantic Ocean to the Gulf of Maine. It crosses the outer continental shelf between Georges and Browns Banks, connecting the basins of the Gulf of Maine at depths between 200 m to 300 m. Glacial till, a mixture of clay, silt, sand, gravel, and boulders covers large areas of the floor of the Northeast channel. The Northeast Channel is located outside the Study Area. Source: DFO 2011b; Worcester and Parker 2010; Zwanenburg et al. 2006; WWF 2009; Li and King 2007
Climatology	• Climate is strongly influenced by the warm Gulf Stream and the cold Labrador Current • Daily Air Temperature Range: -1.4°C (February) to 17.8°C (August) • Extreme Minimum Air Temperatures: -19.4°C (January) to 4.4°C (August) • Extreme Maximum Air Temperatures: 12.8°C (February) to 29.6°C (July)

Table 3.8 Overview of Physical Characteristics

<table>
<tr><th colspan="2">Physical Characteristics</th></tr>
<tr><td></td><td>• Average Monthly Precipitation: 95.2 mm (July) to 147.0 mm (November)
• Extreme Daily Precipitation: 66.00 mm (April) to 166.1 mm (November)
• Average days per year with fog: 127 days
Source: Environment Canada 2012a</td></tr>
<tr><td rowspan="2">Sea Ice and Icebergs</td><td>• Ice cover is rare in the offshore of the Scotian Shelf.
• Sea ice is generally transported out of the Gulf of St. Lawrence through the Cabot Strait.
• Ice can be transported from the Cabot Strait by north westerly winds and ocean currents onto the Eastern Scotian Shelf, although this is very rare.
• Sea ice which travels onto the Scotian Shelf from the Gulf of St. Lawrence will dissipate and melt before reaching the Central and Western sections of the shelf.
• Localized sea ice can form in coastal areas but will dissipate before entering the Study Area.
Source: DFO 2011b</td></tr>
<tr><td>

Source: Environment Canada 2012b

Figure 3.4 Maximum Extent of Median Sea Ice Concentration (1981-2010)</td></tr>
<tr><td>Wind</td><td>• Average Wind Speeds: 5.12 m/s (18 km/h) (summer) to 9.98 m/s (36 km/h) (winter)
• Most Common Wind Direction (from): West
• Maximum Hourly Wind Speed: 26.37 m/s (95 km/h) (spring) to 31.85 m/s (115 km/h) (fall)
Source: Oceanweather Inc. 2013 (MSC50 (1954-2012) Grid Point 4457)</td></tr>
<tr><td>Waves</td><td>• Monthly mean significant wave height, Hs (m): 1.38 in summer to 2.80 in winter
• Monthly maximum Hs (m): 12.77 in spring to 13.74 in summer</td></tr>
</table>

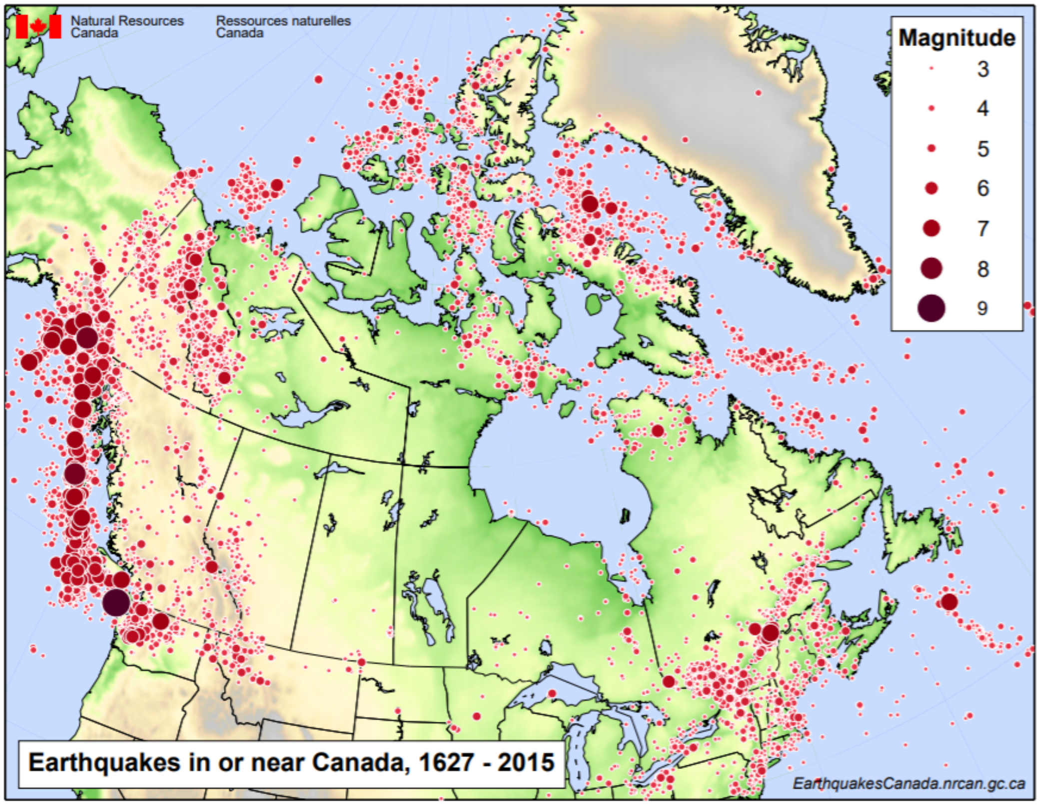
Table 3.8 Overview of Physical Characteristics

Physical Characteristics	
	• The highest maximum significant wave heights occur in summer and fall Source: Oceanweather Inc. 2013 (MSC50 (1954-2012) Grid Point 4457)
Ocean Currents	• Circulation patterns are governed by the complex seafloor topography and by the influence of three major currents: o Cool, relatively fresh (less saline) Nova Scotian Current derived from the outflow of the Gulf of St. Lawrence flowing along the inner, middle, and outer portions of the shelf o Cold Shelf Break Current (Influenced by Labrador Current from the north) flowing along the shelf edge o Warm, higher saline Gulf Stream flowing northeast over the Scotian Slope and mixing with the Labrador Current, creating “slope water”. • The Nova Scotia Current flows in a southwesterly direction close to the coastline. As it reaches the Halifax area it branches in an offshore direction, where it joins the Shelf Break Current and continues to flow southwesterly along the shelf break. • Overall flow is from the Northeast to southwest, with speeds ranging from 0.055–0.3 m/s. Currents are stronger in the winter and weaker in the summer. Source: Worcester and Parker 2010; Zwanenberg et al. 2006; Brickman and Drozdowski 2012; Kennedy et al. 2011
Water Temperature	• The water temperatures found in the Western Scotian Shelf and the Gulf of Maine are among the most variable in the North Atlantic Ocean. • The Western Scotian Shelf is generally warmer than the Eastern Scotian Shelf. • Warm water from the Gulf Stream enters the Western Scotian Shelf between Browns Bank and Western Bank. Warm water can also be found entering the shelf via Verill and Dawson Canyons. • As a result of the influence from the Gulf Stream and from increased vertical mixing in the area, the Western Scotian Shelf has a more dynamic temperature regime than that found in the Eastern Scotian Shelf. • Upper 50 m of water warms in the summer months. • The large variability in the coastal waters of the Scotian Shelf has a significant influence on sound propagation. A strong surface layer condition occurs in many areas during July-October when solar heating has a high effect on surface temperatures. The higher temperature near the surface is often associated with lower salinity produced by runoff that floats on top of the dense ocean water. Sound travels faster in warm water than cold resulting in a net downward refraction of horizontally travelling sound waves. This produces more bottom reflections per kilometer and higher transmission loss. • From November to May, the surface waters are normally colder than the water at depth, resulting in an upward refraction or neutral direction. During these conditions when sound waves are not refracted or are refracted upwards, the effect of the bottom on transmission loss is reduced. • Surface water temperatures correlate to air temperatures and have therefore exhibited a general warming trend in recent years. Between 2010 and 2017, surface and deep-water temperatures were above normal for the Scotian Shelf, with 2012 being the warmest on record. • In 2016-2017, sea surface temperatures in the Study Area ranged from approximately 0°C in February and March, to more than 20°C in August. Source: Worcester and Parker 2010; DFO 2011b; Davis et al. 1998; Johnson et al. 2018; DFO 2018f
Salinity	• Coastal waters: 30-32 parts per thousand (ppt) • Nova Scotian Current: 31-33 ppt

Table 3.8 Overview of Physical Characteristics

Physical Characteristics	
	• Labrador Current: 34-36 ppt • Gulf Stream 34-36 ppt • Salinity is lower near-coast than off-shelf and increases from east to west. Source: Worcester and Parker 2010; Li 2014
Stratification	• There have been increases in stratification in recent years on the Scotian Shelf. • Strong stratification can inhibit vertical mixing and cause depleted dissolved oxygen levels at depth. Increases in stratification can also concentrate phytoplankton, increasing primary productivity. • Stratification is weaker in the spring than in the fall. • Bottom dissolved oxygen concentration is relatively high within the Study Area on the LaHave, Emerald, and Western Banks. Lower dissolved oxygen concentrations can be found at deeper depths in the LaHave and Emerald Basins. Source: Worcester and Parker 2010; Zwanenburg et al. 2006; DFO 2011b; Li 2014
Seismic Activity	• Earthquakes occur throughout southeastern Canada with five zones of high earthquake activity, with the closest zone being the Laurentian slope zone. • The area is located off Canada’s east coast approximately 250 km south of Newfoundland. • In 1929, a 7.2 magnitude earthquake triggered a large underwater landslide in the Atlantic Ocean, triggering a tsunami that killed 27 people on the Burin Peninsula. • Other earthquakes as large as magnitude 5.3 have been recorded in the area. • Earthquakes in this area are generally associated with fault movement in the ocean floor. Source: NRCan 2013

Table 3.8 Overview of Physical Characteristics

Physical Characteristics	
	 Source: NRCan 2018 **Figure 3.5 Earthquakes in or near Canada (1627-2015)**

3.2 BIOLOGICAL CHARACTERISTICS

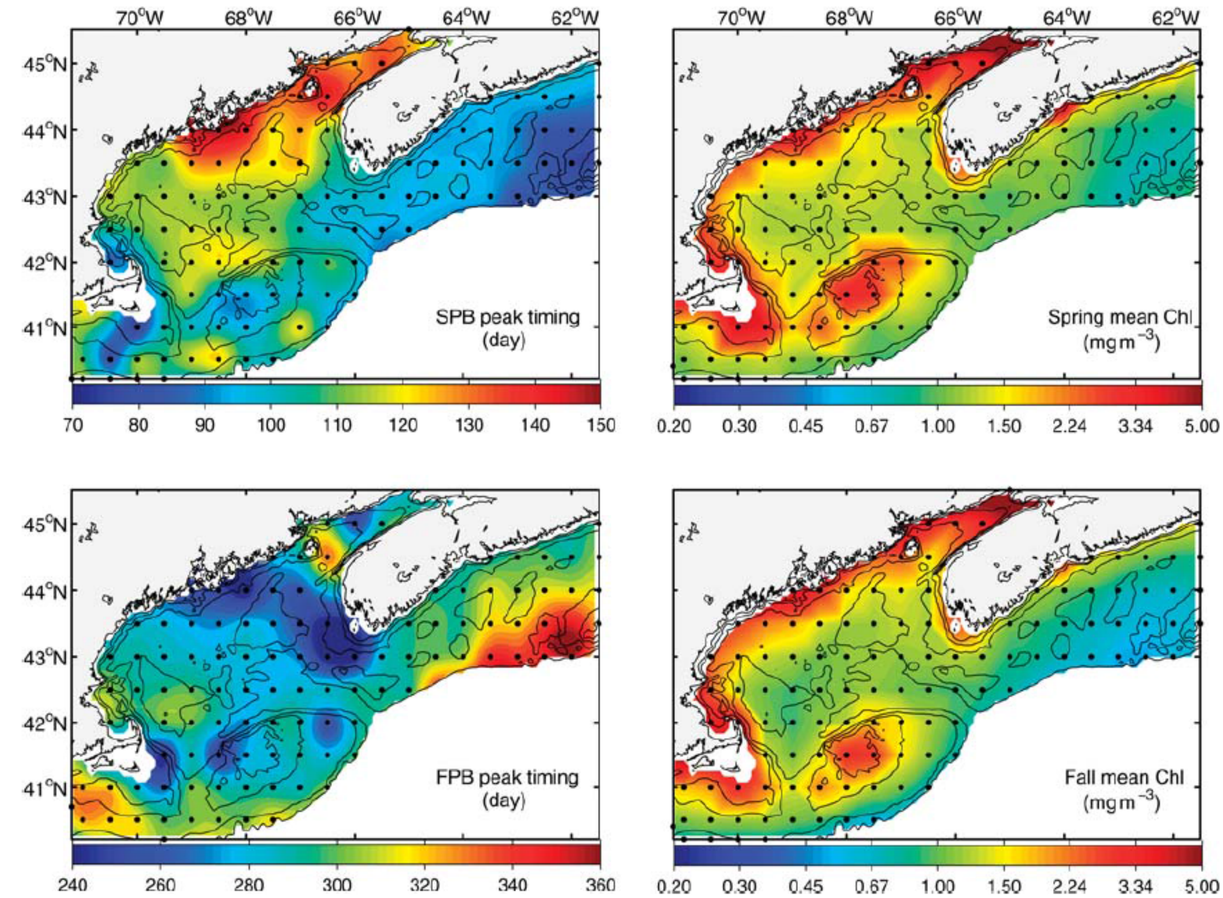
3.2.1 Plankton

3.2.1.1 Phytoplankton

Phytoplankton are the base of the marine food web and as a result, their production sets an upper limit on the production of all higher trophic levels (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), and they play an important role in drawing carbon dioxide out of the atmosphere (Ross et al. 2017). On the Scotian Shelf diatoms and dinoflagellates are generally the forms with the largest cell size and most commonly recognized types of phytoplankton. Their abundance is based on the balance between growth and mortality, which may be strongly influenced by the complex physical oceanographic features of the shelf. There is a distinctive cycle to their abundance characterized by widespread spring and fall blooms related to a high concentration of nutrients, increased wind speeds, and sunlight in the water column.

This 12-month seasonal cycle is driven by the earth's rotation around the sun. The annual phytoplankton cycle on the Scotian Shelf begins in the spring as the energy from the sun increases during the changing of the seasons from the winter solstice to the spring equinox (DFO 2013a). During the winter months, the surface waters are mixed upwards by passing storms increasing the amount of nutrients in the surface layer. As the surface begins to warm, the surface waters stabilize creating an ideal area of nutrients and increasing sunlight, allowing for the rapid growth of phytoplankton. Diatoms have evolved to take advantage of these conditions and make up the majority of the spring bloom on the Scotian Shelf. As the spring bloom flourishes, the nutrients in the upper layer begin to dissipate as they are used by the plankton for growth (DFO 2013a). Into the next season, a summer flora of phytoplankton, which is able to use nutrients regenerated within the ecosystem, begins to take over. The summer season comes to an end with the autumn equinox as water temperatures reach their maxima, which is accompanied by a high abundance of small phytoplankton in a second bloom event. As the fall turns to winter, many phytoplankton communities become inactive, although the occasional winter bloom of well-adapted species can occur (DFO 2013a).

Blooms can vary in temporal and spatial 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 structure and composition of the phytoplankton community in the Gulf of Maine area, including the Western Scotian Shelf, has been described by Li et al. (2011a). Diatoms (which have silica shells) and dinoflagellates (which can swim with flagella) are the most taxon rich groups in these waters (Li et al. 2011a; DFO 2013a). Cyanobacteria as well as 18 classes of other microalgae also occur in the waters of the Western Scotian Shelf. The spring bloom is typically dominated by diatoms, with dinoflagellates contributing significantly to blooms later in the season.



Source: Song et al. 2010.
Notes: SPB = spring phytoplankton bloom; FPB = fall phytoplankton bloom.

Figure 3.6 Spatial Distribution of the Spring Bloom (top panels) and Fall Bloom (lower panels) by Day of Year and Concentration of Chlorophyll during Blooms

Specifically, on the Western Scotian Shelf and in the Gulf of Maine regions, changes in the intensity of low-salinity Scotian Shelf Current inflows can significantly affect the spring blooms in these areas (Song et al. 2010). Other environmental factors such as surface winds can influence the spring bloom dynamics by changing the strength and depth of vertical mixing. Figure 3.6 above depicts the peak timing and mean chlorophyll levels associated with the spring and fall blooms on the Western Scotian Shelf and Gulf of Maine areas. In general, the spring bloom occurs earlier in the eastern regions of the shelf and later on the Western Scotian Shelf and Gulf of Maine (Johnson et al. 2018). The opposite is true for the fall bloom, with the Western Scotian Shelf peak bloom occurring earlier than the Eastern Scotian Shelf bloom (Song et al. 2010). On the Western Scotian Shelf the average peak bloom occurs from mid-March to mid-April. The spring bloom on the Western Scotian Shelf is strong and short-lived, with a late and weak fall bloom counterpart (Song et al. 2010).

Ocean monitoring observations reveal that as surface and near-bottom ocean temperatures on the Scotian Shelf have continued to rise since 2008, changes in phytoplankton and zooplankton communities have also been observed, suggesting changes in prey fields for planktivorous fish, birds and mammals (Johnson et al. 2018). Ross et al. (2017) assessed data from nearly five years of Slocum glider missions observing subsurface phytoplankton populations across the Scotian Shelf. Their research shows that the spring bloom is not triggered by springtime re-stratification of the water column, as a persistent subsurface phytoplankton layer remains throughout the summer. This layer (with an apparent standing stock of approximately one-quarter of that present during the spring bloom) is not visible from satellite, indicating that subsurface observations are critical to monitoring phytoplankton changes (Ross et al. 2017).

3.2.1.2 Zooplankton

Zooplankton are animals that are unable to maintain their horizontal spatial distribution against the current flow (DFO 2011a). The dynamics and abundance of zooplankton determines, in part, how much energy produced from phytoplankton is transferred to higher tropic levels (fish, mammals, birds) (Worcester and Parker 2010). Zooplankton can be divided into three main categories based on size:

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

The mesozooplankton on the Scotian Shelf is dominated by copepods. Three species of copepods of the genus *Calanus* comprise over 70% of the copepod biomass. *Calanus finmarchicus* appears to be a significant link in the food chain. The copepod community in Eastern Nova Scotia is very diverse with high abundances of *Calanus finmarchicus, Pseudocalanus minutus, Centropages typicus* and *Scolecithricella minor*. Other species present are *Acartia longiremis*, *Calanus glacialis*, *Calanus hyperboreus*, *Candacia pachydactyla*, *Centropages bradyi*, *Clausocalanus furcatus*, *Clytemnestra rostrata*, *Corycaeus speciosus*, *Paraeuchaeta* (as *Euchaeta*) *norvegica*, *Paraeuchaeta* (as *Euchaeta*) *tonsa*, *Gaetanus* sp., *Lucicutia flavicornis*, *Macrosetella gracilis*, *Metridia longa*, *Metridia lucens*, *Microcalanus pygmaeus*, *Oithona atlantica*, *Oithona similis*, *Oncaea media*, *Paracalanus parvus*, *Pleuromamma borealis*, *Pleuromamma robusta*, *Scolecithrix danae*, *Temora longicornis*, *Temora stylifera*, *Undinula vulgaris* and unidentified harpacticoids (Locke 2002).

Calanus species require deep water to overwinter and can be found in dense aggregations at depths > 400 m along the Scotian Slope. Euphausiids (krill) play an important role on the Scotian Slope. They can be found at depths between 100 m to 300 m and play an important role in transferring energy from phytoplankton to higher trophic levels. Krill feed on phytoplankton and other small zooplankton and are in turn eaten by juvenile groundfish as well as baleen whales (Zwanenburg et al. 2006).

Food (phytoplankton) and other environmental variables (temperature) are likely the most important variables affecting the abundance of zooplankton on the Scotian Shelf (DFO 2013a). The Scotian Shelf is a dynamic system, where changes in the abundance of long-lived zooplankton species (e.g., *Calanus*) can be influenced by large-scale processes such as the changes in circulation. On the Scotian Shelf zooplankton levels have been lower in more recent years than in the 1960s and 1970s, which is the reverse of the recent phytoplankton trend. Since 2010, zooplankton biomass and *C. finmarchicus* abundance have been lower than average, while non-copepod abundance has been higher than average, (Johnson et al. 2018).

3.2.1.3 Ichthyoplankton

Ichthyoplankton are the eggs and larvae of fish and shellfish. Ichthyoplankton, along with other planktonic early life stages of marine animals, are collectively referred to as the meroplankton because they are planktonic for only a part of their life cycle (NOAA 2007).

One of the major sources of information on zooplankton for the Scotian Shelf is the Scotian Shelf Ichthyoplankton Program (SSIP), which was conducted from 1976-1982. 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 biomass has been found of various ichthyoplankton communities on the Emerald and Western Banks during the spring and summer (Breeze et al. 2002).

3.2.2 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 as an auxiliary source (photoheterotrophs), with the majority of bacteria using organic material as an energy source (heterotrophs) (DFO 2011a). Since most bacteria are secondary producers (rely on organic material for energy) their abundance can be correlated to the abundance of phytoplankton communities. The majority of bacteria rely on material derived from phytoplankton, including waste exuded from plankton cells, cell autolysis, viral lysis, and organic material released from grazers feeding on phytoplankton (DFO 2011a). 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).

3.2.3 Algal Communities

Marine algae include both phytoplankton and macrophytic marine algae, with the latter are commonly referred to as “seaweeds”. Seaweeds in Nova Scotia can be grouped into three main categories: green algae; red algae; and brown algae.

Green algae need a large amount of light and can generally be found closer to the surface in the intertidal or shallow subtidal areas. Red algae can grow at greater depths and are generally found lower in the intertidal zone. Brown algae are the dominant seaweeds in Nova Scotia and can also be found in the subtidal zone (DFO 2011b). Table 3.9 provides an overview of marine vegetation.

Table 3.9 Marine Algae

Middle Shelf	• Phytoplankton is the dominant algae in the region and is found in the upper mixed layer of the ocean. • Coralline algae form pale to pinkish crusts on rock and gravel surfaces on the banks. • Productivity is generally not as great as nearer to shore or closer to the edge of the continental shelf. • Most productivity occurs during the spring and fall phytoplankton blooms. • Occasionally drifting seaweeds can be found, from interactions with slope water and the Gulf Stream further offshore. • The basins and shelf areas of the middle shelf are too deep to sustain plant growth.
Outer Shelf (LaHave, Emerald, and Western Banks)	• Phytoplankton is the primary marine algae in the region. • Phytoplankton productivity is similar to that found in the middle shelf with spring and fall blooms. • The spring bloom typically occurs earlier on the eastern regions of the Scotian Shelf and later on the western regions of the shelf. The fall bloom occurs in the opposite fashion, with blooms occurring first in the west and later on in the east. • The spring bloom typically peaks from mid-March to mid-April on the Western Scotian Shelf. • Encrusting algae may occur on hard substrates on the bank. • The outer edge of the shelf has enhanced plankton productivity due to the interaction of shelf and slope waters which brings nutrients to the surface. • Occasionally, masses of *Sargassum* can be found floating in this area.

Source: NSM 1997; Li et al. 2011a; Li et al. 2011b; Song et al. 2010.

3.2.4 Corals and Sponges

Corals and sponges provide marine fish and invertebrates with protection from strong currents and predators and can serve as nurseries for larval and juvenile life stages, feeding areas, breeding and spawning areas, and resting areas (Campbell and Simms 2009).

Cold water corals, which are the type of corals found in the Study Area, are suspension-feeding invertebrates with delicate appendages that capture food particles from the water column. Cold water corals do not contain symbiotic algae and as a result, can live in deeper waters without the influence of sunlight. Most corals require a hard substrate to attach to, while some can anchor themselves into soft sediment (DFO 2011b).

The Scotian Shelf and Slope, including the Study Area, support a high diversity of corals and sponges (Cogswell et al. 2009). The Northeast Channel Coral Conservation Area is located to the southwest of the Study Area on the southeast corner of Georges Bank, in between Georges and Browns Banks (Deller 2012) (refer to Section 3.2.8). In June of 2002, following successive video surveys conducted by DFO and Dalhousie University, the Northeast Channel Coral Conservation Area was established by DFO (Cogswell et al. 2009). The area of the conservation area is 424 km^2 and consists of a restricted bottom fishing zone (90% of the area) and a limited bottom fishing zone (10% of the area). The area was chosen based on having the highest density of octocorals, specifically the bubblegum coral, *Paragoria arborea*, and the seacorn coral, *Primnoa resedaeformis*, in the Maritimes. In addition to having the highest concentrations of these corals, there was also evidence of recent disturbances to corals in the area from bottom fishing activities (Cogswell et al. 2009).

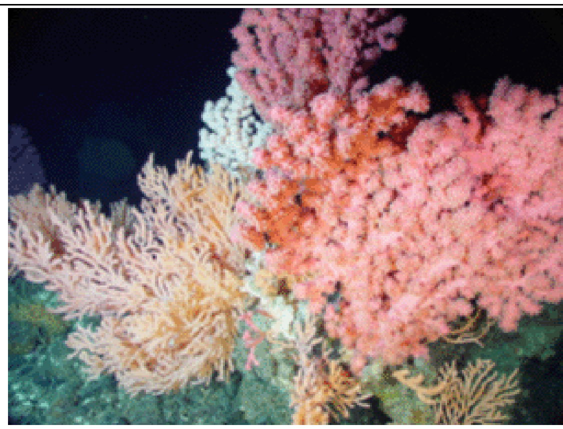
Using primarily multispecies trawl survey data and *in situ* benthic imagery observations, DFO has conducted species distribution modelling (Beazley et al. 2016, 2018) and kernel density analysis to delineate significant benthic areas for corals and sponges for the Maritimes Region, focusing on the Scotian Shelf and Slope (see Kenchington et al. 2016; Beazley et al, 2016, 2018; and Figure 3.10).

Table 3.10 summarizes characteristics of corals in the Study Area.

Table 3.10 Cold-Water Corals

General Characteristics	• Suspension-feeding invertebrates with delicate appendages that capture food particles from the water column. • Do not contain symbiotic algae and can live at depths without the influence of sunlight. • Most require a hard substrate for attachment; few can anchor into soft sediment. • Occur in many sizes and shapes, with some species forming reef structures. • Slow-growing, some maybe over 100 years old. • Two major groups occur on the Scotian Shelf: hard/stony corals (*Scleractinia*) and octocorals, some of which are solitary while others form reefs. • Octocorals include sea pens, sea whips, sea fans, and “soft corals”. • The largest octocorals on the Scotian Shelf are the gorgonian corals, which include bubblegum and seacorn corals.
Locations within the Study Area	• In general, corals are most likely to occur in areas with complex topography and strong currents, although different families of coral can exhibit different habitat preferences. • Depth and slope are important predictors for the presence of sea pen and large and small gorgonian corals. • Large concentrations of large and small Gorgonacea can be found sporadically along the edges of the Banks within the Study Area. • Large gorgonian corals are primarily found in areas containing cobble, boulder, or large rocky outcrops. • Cup corals (*Flabellum* spp.) can be found on the soft sediments in the basins of the Scotian Shelf. • Soft corals (dead man’s fingers, *Alcyonium digitatum,* and red soft coral, *Gersemia rubiformis*) are widespread on the Scotian Shelf where there is a suitable rock substrate for attachment. • Sea pens and small gorgonians have been found on soft sediments. • Significant benthic area for large gorgornians has been identified in the southeast portion of the Study Area on Scotian Slope and in Dawson and Verrill Canyons. • Significant benthic area for sea pens has been identified in the southern portion of the Study Area on the Scotian Slope, and in the northwest and northern portion of the Study Area. • Significant benthic area for small gorgonians has been identified on the shelf break and slope in the southern portion of the Study Area.

Table 3.10 Cold-Water Corals



Source: DFO 2013e

Figure 3.7 Sea corn (*Primnoa resedaeformis*; at left of photograph) and Bubblegum coral (*Paragoria arborea*; at right of photograph) 900 m below surface in Northeast Channel

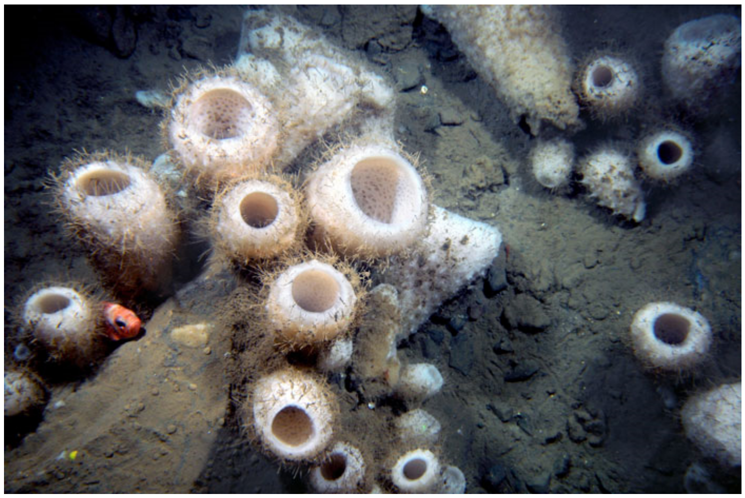
Source: DFO 2011d

Figure 3.8 Sea pens (*Pennatula* sp.) in Emerald Basin

Source: Bryan and Metaxas 2007; DFO 2011b; Zwanenburg et al. 2006; Kenchington et al. 2010; DFO 2006; Beazley et al. 2016

At least 34 species of sponge have been identified off the Atlantic coast. Table 3.11 summarizes the general characteristics of Scotian Shelf sponges and potential distribution in the Study Area.

Table 3.11 Sponges

General Characteristics	• Marine invertebrates that attach themselves to bottom substrates. • Filter feeders, which are generally found at water depths below 300 m. • Sponges provide substrate, shelter, and food for many other species. • Russian hat glass sponge *(Vazella pourtalesi)*, one of the larger sponges present on the Scotian Shelf, is a rare, fragile and barrel-shaped structure forming species of glass sponge.  Source: DFO 2013d **Figure 3.9 *Vazella pourtalesi* (Russian Hats) on the Scotian Shelf**
Locations within Study Area	• Sponge species (Phylum Porifera) are found on the edges of Lahave, Emerald, and Western Banks. • Concentrations of *Vazella pourtalesi* are found in Emerald and LaHave Basins on the central Scotian Shelf and in deepwater between Emerald and LaHave Banks near the edge of the Scotian Shelf. Globally unique sponge grounds containing large aggregations of *Vazella pourtalesi* are found on Sambro Bank and Emerald Basin. This species is only known to exist in two other locations worldwide – Gulf of Mexico and the Azores - and these two locations only contain individuals or small aggregations. • In 2013, DFO closed areas of Sambro Bank and Emerald Basin to bottom–contact fishing to help protect *Vazella pourtalesi*. Together these conservation areas encompass 259 km^2. However, over 99% of the sponge's predicted distribution remains unprotected. • Significant benthic areas for sponges are located in the western, northwestern and northeastern portions of the Study Area.

Source: DFO 2011b; Kenchington et al. 2010; DFO 2013d; Beazley et al. 2016, 2018

Figure 3.10 displays significant benthic areas for corals and sponges on the Scotian Shelf (data courtesy of DFO).

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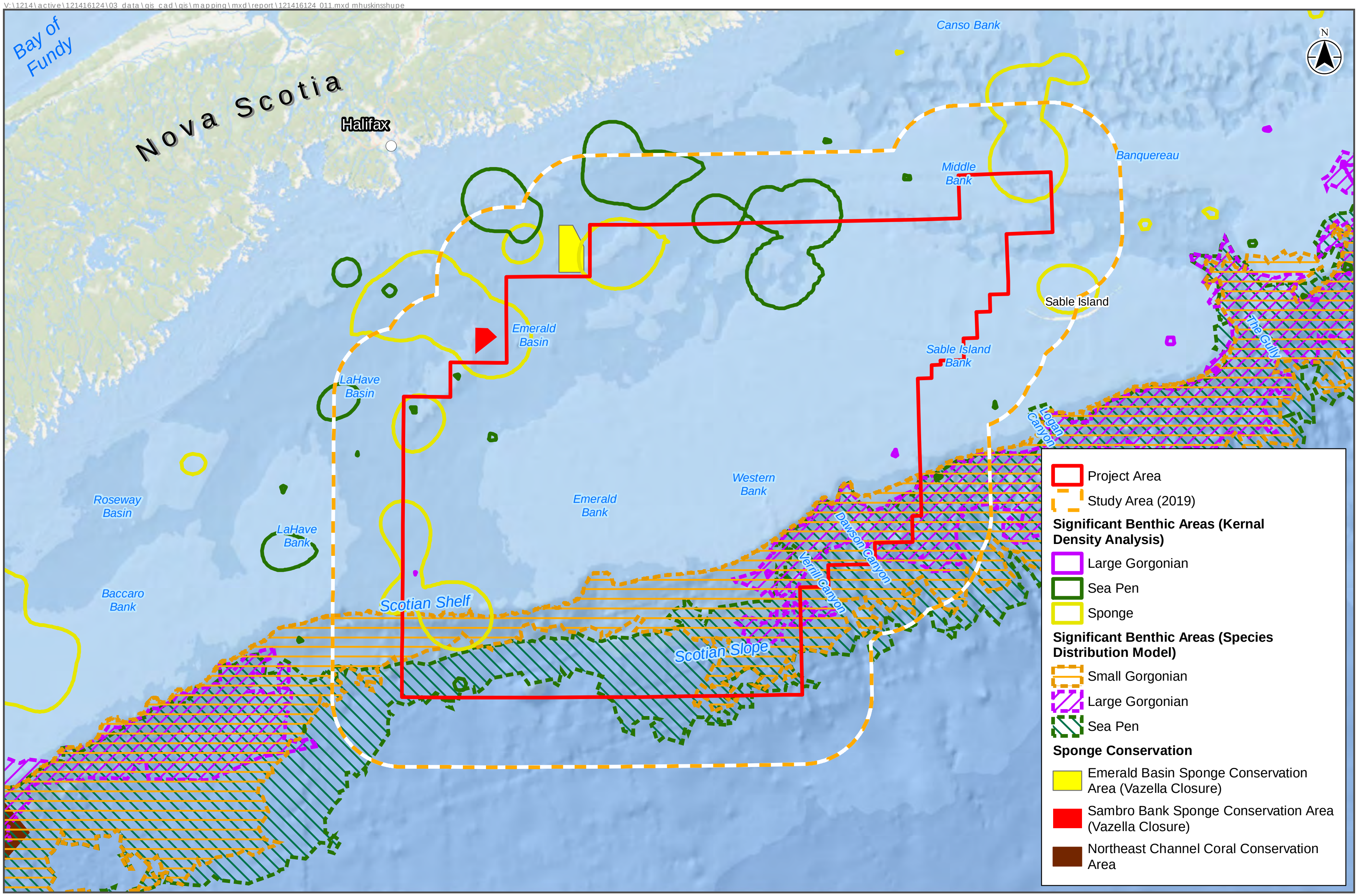

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

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

Coral and Sponge Significant Benthic Areas

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.10

3.2.5 Fish and Invertebrates

Key fisheries species on the Scotian Shelf and Slope are described in three categories: pelagic fish, groundfish, and invertebrates (e.g., shellfish). Pelagic organisms live in the water column and at the surface and include highly migratory species such as tuna, swordfish, and sharks. Groundfish spend most of their life near the bottom of the ocean and include the gadoids (cod, pollock, and haddock), skates, and flatfishes. Groundfish are a major component of Scotian Shelf fisheries. The Project Area is a significant spawning and nursery area for haddock and is also an important spawning area for other groundfish including cod, plaice and yellowtail flounder. Invertebrates play an important role in Scotian Shelf fisheries with over 28 species that have commercial value including crustaceans, bivalves, snails, squid, and echinoderms.

Table 3.12 summarizes reproductive times (mating, spawning/hatching, and peak spawning) for key fisheries species that are likely to occur in the Study Area. Species of importance to Indigenous peoples with potential to occur in the Study Area include American eel and Atlantic salmon; additional species of importance will be identified through consultation and engagement as part of the requirements of a project-specific EA.

Table 3.12 Summary of Spawning and Hatching Periods for Principal Fisheries Species with the Potential to Occur in the Study Area

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Species at Risk														
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, with higher concentration in Eastern Scotian Shelf												
Atlantic wolffish	*Anarhichas lupus*	Nearshore: south of Bridewater and southwest NS Roseway and LaHave Basins												
Cusk	*Brosme brosme*	Georges Basin, Roseway Basin, Browns to Western Sable Island Bank and edges												
Redfish (acadian and deepwater)	*Sebates fasciatus* *Sebastes mentalla*	Scattered over entire Scotian Shelf and Slope												
Porbeagle	*Lamna nasus*	Outside of Study Area												
Roundnose grenadier	*Coryphaenoides rupestris*	Scotian Slope												
Smooth skate	*Malacoraja senta*	Roseway Basin												
Spiny dogfish	*Squalus acanthias*	Roseway, LaHave, and Emerald Basins												
Spotted wolffish	*Anarchias minor*	Outside of Study Area												
Thorny skate	*Amblyraja radiate*	Roseway and LaHave Basins Emerald 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												
Atlantic mackerel	*Scomber scombrus*	Emerald to Banquereau Banks and few along shelf edge												
Black dogfish	*Centroscyllium fabricii*	Eggs and larvae not present in the area, gives birth to pups												
Blue shark	*Priomace glauca*	Not on shelf or slope												

Table 3.12 Summary of Spawning and Hatching Periods for Principal Fisheries Species with the Potential to Occur in the Study Area

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Capelin	*Mallotus villosus*	Nearshore: Halifax Eastern Scotian Shelf outside of the Study Area												
Roughhead grenadier	*Macrourus berglax*	Outside of the Study Area, Potentially Scotian Slope												
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												
Hagfish	*Myxine glutinosa*	Georges Bank												
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 to Sable Island Bank and shelf edge												
Sandlance	*Ammodytes dubius*	Banquereau												
Silver hake	*Merluccius bilinearis*	Browns 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 southwest NS Georges to Banquereau Banks and the shelf edge and slope												
Winter skate	*Leucoraja ocellata*	Browns Bank, Western to Banquereau Banks												
Yellowtail flounder	*Limanda ferruginea*	Nearshore: south of Halifax Georges Bank, Browns Bank, Emerald to Banquereau Banks												

Table 3.12 Summary of Spawning and Hatching Periods for Principal Fisheries Species with the Potential to Occur in the Study Area

Common Name	Scientific Name	Location of Eggs and Larvae	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Invertebrate Species														
Lobster*	*Homarus americanus*	Nearshore Waters												
Jonah crab**	*Cancer borealis*	N/A												
Scallop	Potential for multiple species	Nearshore southwest NS Georges Bank, Browns Bank, Western to Banquereau Banks												
Northern shrimp	*Pandalus borealis*	Nearshore waters												
Sea cucumber**	*Class Holothuroidea*	N/A												
Shortfin squid	*Illex illecebrosus*	Not completely known - Possibly continental shelf south of Cape Hatteras and in the Gulf Stream												
Snow crab	*Chinoecetes opilio*	Nearshore southwest NS and Bridgewater to Halifax												
Stimpson's surf clam	*Mactromeris polynyma*	Banquereau, Inshore southwest NS												

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

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

	Mating Period
	Potential Spawning and Hatching Periods
	Anticipated Peak Spawning Period

Source: Campana et al. 2003; Cargnelli et al. 1999a,1999b; COSWEIC 2006a, 2007, 2008a, 2010a, 2010b, 2012a, 2012b; Government of Newfoundland and Labrador n.d.; Government of Newfoundland and Labrador n.d.; DFO 1996, 2001, 2007, 2009a, 2009b, 2010b, 2011a, 2013d, 2013e, 2013f, 2013h, 2013i, 2013k, 2013l, 2013m, 2013n, 2013o; NOAA 2013a, 2013b; 2013g; SARA 2013a, 2013b; Horseman and Shackell 2009

3.2.5.1 Pelagic Fish

Table 3.13 contains common pelagic species of commercial, recreational and Aboriginal fisheries that are likely to occur within the Study Area. Species of Special Status are discussed in Section 3.2.5.4.

Table 3.13 Pelagic Fish of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in Study Area

Common Name	Scientific Name	Distribution
Albacore tuna	*Thunnys alalunga*	Albacore tuna enter Canadian waters in July and remain until November feeding on forage species. Migration routes are still uncertain. Albacore tuna are distributed sparsely along the Scotian Shelf edge and slope, with higher numbers further offshore above the abyssal plain. Spawning takes place in subtropical waters of the Atlantic Ocean and the Mediterranean Sea. Larvae remain in the spawning grounds until the second year when during the spring, they begin their migration to the North American coast.
Atlantic herring	*Clupea harengus*	Atlantic herring are a small schooling fish and are common along the coast of Nova Scotia and offshore banks. Known to be present in the Roseway, LaHave, and Emerald Basins feeding primarily on zooplankton, krill and fish larvae. Atlantic herring travel from spawning grounds to feeding sites in a seasonal migratory cycle, with spawning locations found in both coastal waters and on offshore banks. Coastal spawning grounds include areas off southwest Nova Scotia, Bay of Fundy, and off Grand Manan Island. Offshore spawning occurs on areas of Georges Bank. Spawning begins in August in the Nova Scotia and eastern Maine regions and in October/November in the southern Gulf of Maine and Georges Bank.
Atlantic mackerel	*Scomber scombrus*	The Atlantic mackerel is a pelagic species found on both sides of the Northern Atlantic Ocean. On the western side of the Atlantic Ocean, they can be found from Cape Hatteras, North Carolina to Newfoundland and Labrador. During the spring and summer months, mackerel can be found in coastal waters. During the fall and winter the species moves offshore to the warmer waters along the continental shelf. Atlantic mackerel feed primarily on crustaceans including copepods, krill, and shrimp. They will also feed on squid and small fish species. The species has two major spawning areas which include the Mid-Atlantic Bight from April to May and the Gulf of St. Lawrence in June and July.
Bigeye tuna	*Thunnus obesis*	Bigeye tuna are a tropical tuna species which can be found in temperate to tropical waters from Nova Scotia to Brazil. Spawning takes place in tropical waters throughout the year with a peak during the summer months. Young individuals typically inhabit tropical waters with mature individuals migrating to northern latitudes. 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.
Black dogfish	*Centroscyllium fabricii*	The black dogfish is a deepwater species found in temperate to boreal waters over the outer continental shelves and slopes of the North Atlantic Ocean. The black dogfish has been observed at depths of up to 1,500 m but are more common from 550-1,000 m. This species has been found along the banks and basins within the Study Area. Reproduction occurs year-round. Females are oviviparous and give birth to up to 40 pups

Table 3.13 Pelagic Fish of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in Study Area

Common Name	Scientific Name	Distribution
		which measure 12-19 cm in length. In Canadian waters they have been observed giving birth in parts of the Laurentian Channel.
Swordfish	*Xiphias gladuis*	Swordfish migrate into Canadian waters in the summer as part of their annual seasonal movement, following spawning in subtropical and tropical areas. Swordfish can be found along the Scotian Shelf edge and slope as well as on the northeast corner of the Emerald Basin. They can be commonly found feeding on the slopes of the banks in cooler, more productive waters. Swordfish feed on a variety of fish species as well as invertebrates including squid.
White marlin	*Tetrapturus albidus*	In the western Atlantic waters, marlin can be found in warm temperate waters and tropical waters. During the summer months marlin migrate into Canadian waters off Nova Scotia. Marlin can be found along the Scotian Shelf edge and slope. They can often be 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.
Yellowfin tuna	*Thunnus albacares*	Yellowfin tuna migrate into Canadian waters, including the Scotian Shelf to feed during the summer months. Yellowfin tuna have similar distributions as the Albacore and Bigeye tunas, sparsely populating the shelf edge and slope with higher numbers further offshore. The species spawns from May to August in the Gulf of Mexico and from July to November in the Southeastern Caribbean.
Bluefin tuna	*Thunnus thynnus*	Bluefin tuna is distributed throughout the North Atlantic, occupying waters up to a depth of 200 m. Adult bluefin tuna enter Canadian waters, including the Scotian Shelf from June to October. Bluefin can be found distributed along the edges and slopes of Study Area.
Blue shark	*Prionace glauce*	The blue shark is a highly migratory species, with its western Atlantic range from Newfoundland to Argentina. The blue shark has been recorded in Canadian waters including the Scotian Shelf most commonly during the summer months. The blue shark mates on the continental shelf during the spring and early summer, moving further offshore afterwards. Blue sharks can be found along the Scotian Shelf edge and slope, as well as on the northeast corner of the Emerald Basin.
Porbeagle shark	*Lamna nasus*	Porbeagle sharks move onto the Scotian Shelf in the early spring. The primary factor affecting distribution is thought to be temperature, with the species typically inhabiting waters between 5-10 °C. Porbeagles can be found in a similar distribution as the blue shark inhabiting the Scotian Shelf edge and slope, as well as on the northeast corner of the Emerald Basin.
Shortfin mako shark	*Leurus oxyringus*	This species migrates into Canadian waters generally in the later summer and early fall, where they are associated with the warm waters of the Gulf Stream. Shortfin makos inhabit similar water as the blue and Porbeagle sharks including the Scotian Shelf edge and slope, as well as on the northwest slope of Sable Island Bank and the northeast corner of the Emerald Basin.

Source: Scott and Scott 1988; Campana et al. 2003; Maguire and Lester 2012; DFO 2011a, 2012a, 2013a; NOAA 2013a, 2013b, 2013c, 2013d, 2013e, 2013f; FLMNH 2013a, 2013b; GMA 2014.
Note: For an in-depth overview of important areas for fish, particularly larval distribution maps, refer to Horsman and Shackell (2009).

3.2.5.2 Groundfish

Table 3.14 summarizes the distribution of groundfish of commercial, recreational and Aboriginal value that are likely to occur within the Study Area. Species of Special Status are discussed in Section 3.2.5.4.

Table 3.14 Groundfish of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Acadian redfish	*Sebastes fasciatus*	Closely associated with the seafloor and commonly found inhabiting waters 150 to 300 m in depth along the Scotian Shelf edge and slope. Mature individuals expected in to occur in the Study Area from May to October. Spawning occurs in fall. Larvae may be present in water column May to August
American plaice	*Hippoglossoides platessoides*	Closely associated with the seafloor and commonly found in water depths of 100 to 200 m where soft/sandy sediments are present. The Maritimes population is common to the Scotian Shelf. Within the Study Area, American plaice can be found along the banks and basins as well as along the shelf edge. The Project Area is an important American plaice spawning area.
Atlantic cod	*Gadus morhua*	A demersal gadoid species usually found within 2 m of the seafloor. Atlantic cod can be found from Greenland to Cape Hatteras and is common in the Study Area on Sable Island Bank, Middle Bank, and is also common on Banquereau Bank. In 1993 a moratorium on cod fishing was put in place and remains in effect today. Cod remains an important commercial species on the southwest Scotian Shelf and is caught as bycatch as part of a multispecies groundfish fishery. The Project Area is an important cod spawning area.
Atlantic halibut	*Hippoglossus hippoglossus*	Atlantic halibut are distributed from north of Labrador to Virginia. Halibut can be found on the banks and basins of the continental shelf and are present within the Study Area. On the Scotian Shelf, halibut are most abundant between 200 and 500 m. They prefer sand, gravel or clay substrates. The Atlantic halibut is a very important groundfish species within the Study Area. The species preys on benthic organisms which range from invertebrates to fish as they increase in size. Females mature at 10 to 14 years and spawn from December to June in deep water ranging from 300 to 700 m. Females can spawn several million eggs which are pelagic.
Haddock	*Melanogrammus aeglefinus*	Haddock are a demersal gadoid species usually closely associated with the seafloor, preferring broken ground, gravel, pebbles, clay, smooth hard sand, sticky sand of gritty consistency, and shell beds. Haddock can be found from Greenland to Cape Hatteras and are common in the Study Area on all of the banks and basins. They can be most commonly found at depths ranging from 50 to 250 m. Haddock feed on a variety of benthic organisms including mollusks, polychaetes, crustaceans, echinoderms, fish eggs, and small fish. They are a species which grows at a fast rate and mature from one to four years of age. Spawning takes place from January to July over rock, sand, gravel and mud bottoms on areas of Georges Bank and eastward to Sable Island Bank and shelf edge. Eggs and larvae are pelagic. The Project Area is a significant haddock spawning and nursery area.

Table 3.14 Groundfish of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Hagfish	*Myxine glutinosa*	Hagfish can be found from the coast of Florida to the Davis Strait and Greenland. They can be found in depths up to 1200 m at temperatures less than 14 °C and salinities less than 32 ppt. The species prefers soft substrates and areas with low current velocity. As a new fishery in the area, hagfish are becoming an important source of income within the groundfish fishery. Hagfish spawn year-round with each female carrying 1 to 30 horny-shelled large eggs. Females deposit eggs in burrows with newly hatched hagfish resembling adults and measure 6 to 7 cm in length. They feed on a variety of infaunal and epifaunal invertebrates.
Monkfish	*Lophius americanus*	Monkfish can be found from the Northern Gulf of St. Lawrence to Cape Hatteras. They have been found inhabiting areas up to 800 m in depth but are most commonly found from 70 to 190 m. Concentrations of monkfish can be found on the banks and basins and the edge of the shelf in the Study Area. Monkfish typically inhabit areas with benthic substrates consisting of sand, mud and shell hash. They are opportunistic feeders and prey on a wide variety of fish and invertebrates. Monkfish reach sexual maturity between three and four years of age. Spawning typically occurs during the summer months from Georges to Sable Island Bank and shelf edge. The eggs are spawned in a thin ribbon-like mucous veil which is pelagic in nature.
Pollock	*Pollachius virens*	Pollock is a gadoid species found from southern Labrador to Cape Hatteras, with major concentrations on the Scotian Shelf, including the banks and basins of the Study Area. Pollock can be found inhabiting areas with sand, mud, rock, and various types of vegetation. Pollock travel in schools between the Scotian Shelf and Georges Bank with some fish traveling into the Gulf of Maine. Pollock mature from four to seven years of age with spawning taking place from September to March. Spawning occurs from Georges Bank to Western Bank. Eggs and larvae are pelagic and float in the surface layers.
Red hake	*Urophycis chuss*	Red hake can be found from the Gulf of St. Lawrence to North Carolina from depths of 10 to 500 m at temperatures of 5 to 12°C. Within the study area red hake can be found in the LaHave and Emerald Basins as well as along the shelf edge. During the spring and summer red hake migrate to shallower waters to spawn, returning to the deeper waters of the shelf edge and slope during the winter months.
Sand lance	*Ammodytes dubius*	In the northwest Atlantic, sand lance can be found from Cape Hatteras to Greenland and are generally found in water depths of less than 90 m. They are generally found along coastal zones and on the shallow waters of offshore banks on sand or small gravel benthic substrates. Sand lance do not make extensive migrations, but will travel between resting and feeding grounds Sand lance mature at two years of age and spawn on sand in shallow water depths during the winter months. 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.

Table 3.14 Groundfish of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Silver hake	*Merluccius bilinearis*	The silver hake can be found from southern Newfoundland to South Carolina. Within the Study Area, this species can be found in the LaHave and Emerald Basins as well as along the shelf edge. The species can be most commonly found at depths from 150 to 200 m feeding primarily on shrimp, krill, and sand lance. Silver hake mature at two years of age. Seasonal migrations occur during the spawning period, from June to September. Spawning occurs from Browns Bank to Sable Island Bank and along the shelf edge. During this time, they move from the deeper waters of the LaHave and Emerald Basins up onto the banks. The eggs and larvae are buoyant for a period of three to five months.
Turbot – Greenland halibut	*Reinhardtius hippoglossoides*	The Greenland halibut can be found in water depths ranging from 90 to 1600 m from western Greenland to the southern edge of the Scotian Slope. Within the Study Area, this species is most common along the shelf edge and slope. Females mature at approximately nine years of age with spawning taking place during the winter and early spring.
White hake	*Urophycis tenuis*	White hake can be found on the continental slopes, ranging from southern Labrador and the Grand banks to the Gulf of Maine. Within the Study Area white hake can be found in the LaHave and Emerald Basins as well as along the shelf edge.
Witch flounder	*Glyptocephalus cynoglossus*	Witch flounder is a deep-water, boreal flatfish that can be found from Labrador to Georges Bank at depths from 100 to 400 m, and can occasionally be found at depths up to 1600 m. They occur most commonly in deep holes and channels and along the shelf edge on muddy bottoms. Spawning occurs from May to October with a peak in July and August. Spawning occurs on the shelf from Georges Bank to Sable Island Bank. Eggs and larvae are pelagic and drift in the currents until settling to the benthos.
Yellowtail founder	*Limanda ferruginea*	Yellowtail flounder is a small-mouthed Atlantic flatfish that inhabits relatively shallow waters of the continental shelf from southern Labrador to Chesapeake Bay. A major concentration of yellowtail flounder occurs on Georges Bank from the Northeast Peak to the Great South Channel. This species prefers sand or sand-mud sediments in water depths ranging from 40 to 80 m. The species feeds on a variety of invertebrates as well as small fish species. Maturity is reached from two to three years of age. Spawning takes place near the substrate on Georges, Browns, Emerald, Western and Sable Island Banks from May to July. The eggs drift to the surface following fertilization and drift during development. The Project Area is an important yellowtail flounder spawning area.

Source: Scott and Scott 1988; Cargnelli et al. 1999a, 1999b; DFO 2001, 2009b, 2009c, 2012a. NOAA 2013k; 2013h; 2013i; 2013j
Note: For an in-depth overview of important areas for fish, particularly larval distribution maps, refer to Horsman and Shackell (2009).

3.2.5.3 Invertebrates

Table 3.15 summarizes invertebrate species of commercial, recreational and Aboriginal value that are known to occur within the Study Area.

Table 3.15 Invertebrates of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
American lobster	*Homarus americanus*	Lobster can be found along the Atlantic coastline and on the continental shelf from Northern Newfoundland to South Carolina. Within the Study Area there are two classifications of lobster; inshore and offshore. The inshore component of the population can be found in LaHave Basin as well as in most locations of the nearshore shelf. The offshore component of the population is present along the edges of the shelf. Adult lobsters are typically found in water depths of less than 300 m but have been found up to 750 m. They prefer substrate with rock and boulder shelter as they use these surfaces as protection from predators as well as sunlight. They have also been found in areas with sand, gravel and mud substrates. During the summer months lobsters migrate to shallower waters to take advantage of warm water temperatures. In the winter they retreat to deeper water to avoid winter storms, ice, and extreme cold-water temperatures. Lobster reproduction takes two years. Immediately after molting, females mate with males and store sperm in the undersides of their bodies in a sperm plug. During this time females are developing eggs internally for 12 months. The next summer eggs are extruded and fertilized with the stored sperm. Females carry the fertilized eggs for 9 to 12 months before hatching. Egg bearing females will move inshore to hatch their eggs during the late spring to early summer.
Snow crab	*Chionoecetes opilio*	Snow crabs can be found from the Gulf of Maine to Greenland at depths from 50 m to 1300 m. This species prefers temperatures in the range of 3 to 4 °C. Within the Study Area, snow crab is a commercially important species; most harvesting occurs on the Banquereau, Middle, and Sable Island Banks.
Jonah crab	*Cancer borealis*	Jonah crab are found from Newfoundland to South Carolina and in the Bermuda Islands at water depths ranging from intertidal to 800 m. Offshore Nova Scotia they are generally found at water depths of 50 to 300 m. Jonah crab feed primarily on benthic invertebrates including mussels, snails, barnacles, as well as dead fish. Within the Study Area, harvesting appears to be concentrated along the shelf break.
Atlantic sea scallop	*Placopecten magellanicus*	Atlantic sea scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina and are prevalent on Browns and Georges Bank, to the southwest of the Study Area. Females can reproduce beginning at two years of age, but do not produce many eggs until four years of age.
Iceland sea scallop	*Chlamys islandica*	Iceland Sea Scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina. They can be found to the west of the Study Area on Browns Bank.

Table 3.15 Invertebrates of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Northern shrimp	*Panadalus borealis*	This species can be found from Massachusetts to Greenland at water depths from 10 to 350 m. The species prefers soft mud benthic substrates. Northern shrimp are important in marine food chains as they are an important prey item for many species of fish and marine mammals. Although a benthic species, northern shrimp will migrate vertically through the water column at night (diel vertical migration) to feed on small crustaceans in the pelagic zone. They also prey on phytoplankton and zooplankton as well as benthic invertebrates. The northern shrimp is a hermaphroditic species (possesses the reproductive organs of both sexes). The species first reaches maturity as a male at the age of 2 to 3 years and by the age of 4 to 5 years they transform into a female, spending the rest of their lives in this state. In the Northwest Atlantic, mating occurs during the late summer to fall in offshore waters, with fertilized eggs remaining attached to the female's abdominal appendages until the following spring. Females migrate to nearshore waters during the late fall to early winter. After approximately 7 to 8 months the eggs hatch during April and May. The larvae remain pelagic and drift in the ocean currents feeding on planktonic organisms. After a period of a few months they settle to the benthic zone and start to resemble adults. Juveniles will remain in coastal waters for over a year before migrating to deeper offshore waters and mature as males. Overall northern shrimp migrate with seasonal changes in water temperature spending the fall and winters in nearshore waters when the water is the coolest and migrating offshore during the spring and summer.
Striped shrimp	*Panadalus montagui*	The striped shrimp can be found from New England to Greenland and Baffin Bay at depths from 20 to 100 m. The species prefers hard substrates including rock, gravel, sand and mud. Within the Study Area, the species can be found in abundance within the valleys and basins separating Sable Island, Banquereau, and Middle Banks.
Shortfin squid	*Illex illecebrosus*	The life cycle of the shortfin squid is approximately one year in length. 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. Females then expel their eggs through jets in their abdomen while at the same time creating one or multiple jelly masses which contains up to 100,000 eggs and measures up to a meter in diameter. The fertilized mass of eggs is pelagic and travels north in the Gulf Stream. When the squid first hatch after 8 to 16 days they are known as paralarvae. Paralarvae are abundant in the convergence zone of Gulf Stream water and slope water where there is an area of high productivity. Once reaching a size of 5 cm the paralarvae become juveniles and feed mainly on crustaceans (euphausiids) at night near the surface waters; they also feed on nematodes and fish. At this stage juveniles grow at a rate of 1.5 mm per day. Once reaching a size of 10 cm juveniles are at the adult stage and can reach sizes of up to 35 cm. During the spring juveniles and adults migrate onto the Scotian Shelf area from the slope frontal zone and feed on fish including cod, mackerel, redfish, sand lance, herring, and capelin. Adults will also cannibalize smaller squid. Juvenile and adult squid

Table 3.15 Invertebrates of Commercial, Recreational and Aboriginal Fisheries Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
		have diel vertical migrations in which they rise vertically in the water column to feed at night and migrate to deeper depths during the day. During the fall months the shortfin squid will migrate off the shelf to spawn presumably in the Gulf Stream and south of Cape Hatteras. Spawning is believed to occur from December to March.
Sea cucumber	*Class* Holothuroidea	The sea cucumber is a benthic species that can be found worldwide. In the western Atlantic it can be found from Greenland to the northern shores of Cape Cod. They prefer sandy or rocky substrates with strong currents and depths of 30 to 300 m or more. Sea cucumbers are prevalent on the northwest corner of Sable Island Bank and on Middle Bank.
Propeller clam	Family Hiatellidae	The propeller clam can be found from Cape Cod to the Gulf of St. Lawrence, commonly found buried in sand a few centimetres deep. The species prefers water temperatures from -1°C to 5.7 °C and salinities ranging from 32.3 psu to 34.2 psu. Within the Study Area the species is prevalent on the western arm of Banquereau Bank.
Stimpson's surf clam	*Mactromeris Polynyma*	The Stimpson's surf clam can be found from Baffin Island to Rhode Island living in sandy bottom areas in aggregations called "beds". The species prefer water temperatures under 15 °C at depths up to 60 m. This species is prevalent on the western arm of Banquereau Bank.
Cockles	Family Cardiidae	The cockle can be found on at depths up to 500 m and prefers sandy and muddy substrates. This species is prevalent on the western arm of Banquereau Bank.
Quahog	*Mercenaria mercenaria*	The quahog can be found from Cape Hatteras to the Arctic in fine to medium grain sand bottoms at depths from 4 to 480 m. This species is prevalent on the western arm of Banquereau Bank.

Source: DFO 2002, 2004, 2012a

3.2.5.4 Fish Species of Special Status

Table 3.16 lists fish species of special status which may be present in the Study Area. Species of special status are those listed on Schedule 1 of the SARA, or species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Populations that are highly unlikely to occur in the Study Area have been excluded (e.g., Atlantic cod Laurentian North population).

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Northern wolffish	*Anarhichas denticulatus*	Threatened	Threatened	Main range is off northeast Newfoundland and across the North Atlantic Ocean with some occurrence on the Eastern Scotian Shelf off Cape Breton. Most commonly found inhabiting the seafloor in water depths of 100 to 900 m. Non-migratory spawning occurs in the fall. Larvae may be present on the seafloor in fall to early winter.
Spotted wolffish	*Anarhichas minor*	Threatened	Threatened	Main range is west of Greenland to the Grand Banks with some occurrence on the Eastern Scotian Shelf off Cape Breton. Most commonly found inhabiting the seafloor in water depths of 50 to 600 m. Non-migratory spawning occurs in the summer. Eggs/larvae may be present on the seafloor in summer to fall.
Atlantic (striped) wolffish	*Anarhichas lupus*	Special Concern	Special Concern	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. Most commonly found inhabiting the seafloor in water depths of 150 to 350 m. Short migrations to spawning grounds in shallow waters during the fall. Eggs/larvae may be present on the seafloor in fall to early winter in the Roseway and LaHave Basins.
White shark	*Carcharodon carcharias*	Endangered	Endangered	Believed to be rare in north Atlantic Canadian waters as it is the northern edge of their range, with 57 confirmed records and 30 tagged white sharks detected in Canadian waters since 1874. Recorded sightings range from the Bay of Fundy to the Laurentian Channel as well as on the Sable Island Bank. Can range in depth from the surface to 1,300 m, are highly mobile and seasonally migrant.
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	The Acadian redfish is closely associated with the seafloor commonly found inhabiting waters 150 to 300 m in depth along the Scotian Shelf edge and slope. They can be found over a wide range of habitats and are known to use rocks and anemones as protection from predators. Mature individuals expected to occur in the Study Area from year-round. Migratory information for the species is lacking because they cannot be tagged. Mating occurs in fall. Larvae may be present in the water column May to August.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
American eel	*Anguilla rostrata*	Not Listed	Threatened	Adult American eels migrating from freshwater streams to the Sargasso Sea may pass through the Study Area. Mature silver eels spawn in the Sargasso Sea with hatching occurring from March to October, peaking in August. The larvae are transparent and willow-shaped and are transported to North American coastal waters via the Gulf Stream. 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. Elvers will run into the freshwater streams with runs peaking from April to June in Nova Scotia. Elvers eventually transform into yellow eels, which is the major growth phase for the species. Yellow eels will spend years maturing in freshwater streams and coastal areas before making a major transformation to return to the Sargasso Sea to spawn. On average, yellow eels will remain in coastal areas or freshwater for 9 to 22 years before metamorphosing both morphologically and physiologically into silver eels. Nova Scotian silver eels will begin their outmigration to the Sargasso Sea in November travelling over 2000 km to spawn for the only time during their life.
American plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened	The American plaice is closely associated with the seafloor and commonly found in water depths of 100 to 300 m where soft/sandy sediments are present. The Maritime population is common to the Scotian Shelf. Within the Study Area, American plaice can be found along the banks and basins as well as along the shelf edge year-round. Females are batch spawners, spawning batches of eggs for up to one month. Spawning occurs in April/May. Eggs and larvae are pelagic and may be present in the water column between May and June. Major spawning areas include Banquereau, Western and Browns Banks.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Atlantic bluefin tuna	*Thunnus thynnus*	Not Listed	Endangered	The Bluefin tuna is a highly migratory species which travels over long and varied routes. The species is distributed throughout the North Atlantic Ocean, occupying waters up to a depth of 200 m. Adult bluefin tuna enter Canadian waters, including the Scotian Shelf from June to October. The bluefin can be found distributed in high concentrations along the the shelf edge and the Northeast Channel (Hell Hole). The species forages on herring, mackerel, capelin, silver hake, white hake, and squid. Spawning takes place in the Gulf of Mexico and the Mediterranean Sea with females producing upwards of 10 million eggs per year. The eggs are buoyant and are fertilized by males in the water column.
Atlantic cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered	Atlantic cod can generally be found in coastal, nearshore and offshore areas from depths of a few meters to 500 meters. Atlantic cod can be found from Greenland to Cape Hatteras and is common on all banks and basins within the Study Area. In 1993 a moratorium on northern cod fishing (Newfoundland and Labrador, Gulf of St. Lawrence, and Eastern Scotian Shelf) was put in place on all directed fishing and remains in effect today. Cod remains an important commercial by-catch fishery on the southwest Scotian Shelf. Cod from this population migrate from the southern Gulf to the waters of the Scotian Shelf off Cape Breton between May to October. Eggs and larvae may be present in upper water column from May to April.
Atlantic cod (Southern population)		Not Listed	Endangered	Atlantic cod from the Southern Population inhabit waters from the Bay of Fundy and southern Nova Scotia including the Scotian Shelf to the southern extent of the Grand Banks. This population overwinters in the deeper waters of Browns and LaHave Banks as well as inshore waters near Nantucket. Atlantic cod have been observed spawning in both offshore and inshore waters year-round. Peak spawning has been observed during the spring with pelagic eggs and larvae. Juvenile cod prefer habitats which provide protection and cover such as nearshore waters with eelgrass or areas with rock and coral.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Atlantic salmon (Outer Bay of Fundy)	*Salmo salar*	Not Listed	Endangered	Atlantic salmon are iteroparous, returning to natal rivers to spawn after the completion of ocean scale migrations. Collectively as a species, adult salmon return to freshwater rivers after a feeding stage at sea from May to November, with some fish returning as early as March. Female salmon deposit eggs in gravel nests in October and November, usually in gravel riffle sections of streams. Spawned-out or spent adults (kelts) return to sea immediately after spawning or remain in fresh water until the following spring. Fertilized eggs incubate in nests over the winter and begin to hatch in April. Hatchlings (alevins) remain in the gravel riverbed for several weeks while living off a large yolk sac. Once the yolk sac has been absorbed, free swimming parr begin to actively feed. Parr will remain in fresh water for one to eight years before they begin a behavioral and physiological transformation and migrate to sea as smolts, completing the life cycle. In general, Atlantic salmon make long oceanic migrations from their over wintering at sea locations to their native freshwater streams. This migration occurs from May to November. Spawned out adults either return to their overwintering location following spawning or wait until the following spring to return to sea. The majority of Atlantic salmon overwinter in the Labrador Sea and Flemish Cap area. This population extends from the Saint John River westward to the U.S border. Migration patterns to the North Atlantic may cause the population to be present in the Study Area; any presence will be transient in nature.
Atlantic salmon (Inner Bay of Fundy)		Endangered	Endangered	This population extends from Cape Split around the Inner Bay of Fundy to a point just east of the Saint John River estuary. It is believed that the majority of the Inner Bay of Fundy Salmon overwinter in the Bay of Fundy and Gulf of Maine.
Atlantic salmon (Eastern Cape Breton population)		Not Listed	Endangered	This population extends from the northern tip of Cape Breton to northeastern Nova Scotia (mainland). Migration to the North Atlantic is not likely to involve crossing the Study Area.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Atlantic salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered	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 means the population may pass through the Study Area with a presence being transient in nature.
Atlantic sturgeon (Maritimes population)	*Ancipenser oxyrinchus*	Not Listed	Threatened	This population is found throughout the coastal waters of the Maritimes and extends out onto the shelf. Concentrated in water depths less than 50 m and highly migratory in nature so any presence in the Study Area is likely transient. Adults migrate into estuaries and rivers in the autumn (August- October) or in the spring (May-June) prior to reproduction. Adults will often overwinter in deep channels and pools in rivers and estuaries downstream of the spawning sites. Adults and large juveniles move both inwards and seawards in 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.
Basking shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	Found throughout the North Atlantic with concentrations in coastal waters of Newfoundland and near the mouth of the Bay of Fundy. They have also been observed on Georges Bank, Northwest Channel, and the LaHave and Emerald Banks. During the summer months they can be found in surface waters, particularly the LaHave and Emerald Basins, where they may mate. During the winter months they are believed to be found on the Scotian Slope in deeper waters. It is believed that the basking shark lives primarily in oceanic front locations where their main food source, zooplankton, is found. They have been shown to be sensitive to low frequency (25 to 200 Hz) pulses.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Cusk	*Brosme brosme*	Not Listed	Endangered	Commonly found between the Gulf of Maine and southern Scotian Shelf. Most common along the southwestern shelf but have been frequently noted as far north on the shelf as Sable Island. Within the Study Area, cusk can be found along the Scotian Shelf and Slope and prefer water depths from 200 to 600 m. The species feeds on invertebrates and inhabits benthic areas with hard and rocky substrates. They can sometimes be found over gravel and mud substrates as well. Cusk mature from five to seven years of age and spawn from May to August. The eggs and larvae are buoyant and float in the surface layers until reaching a size fo 50 to 60 mm. Larvae can be found over Georges and Roseway Basin as well as from Browns Bank to Sable Island Bank and respected shelf edges.
Deepwater redfish (Northern population)	*Sebastes mentalla*	Not Listed	Threatened	Closely associated with the seafloor and commonly found inhabiting waters 350 to 500 m in depth from Sable Island to northern Labrador. They have similar life histories to the Acadian redfish.
Lumpfish	*Cyclopterus lumpus*	Not Listed	Threatened	Broadly distributed across the northwest Atlantic, the highest abundance estimates in the western Atlantic are in the waters near Newfoundland. Lumpfish are associated with diverse habitats, distributed demersally and pelagically in the North Atlantic during different life stages and seasons. At all stages, lumpfish are often observed preventing drift by adhering to stones, lobster pots, seaweed or other objects by means of a pelvic adhesive disk. There are clear temperature preferences that vary with stage; 4 to 12ºC for larvae and young of the year, and near bottom, from -1.9ºC to 12ºC for both juveniles and adults. Opinions differ as to whether lumpfish are short lived and spawn only once or have multiple spawnings and a maximum age of approximately 12 years.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Porbeagle shark	*Lamna nasus*	Not Listed	Endangered	Porbeagle sharks are a pelagic shark species commonly inhabiting continental shelves and ocean basins at depths from 1 to 2800 m. Immature porbeagle sharks inhabit the Scotian Shelf with mature individuals migrating along the shelf waters to mating grounds located on the Grand Banks, off the mouth of the Gulf of St. Lawrence, and on Georges Bank during September to November. Females leave the continental shelf in December, travelling to the Sargasso Sea to give birth in March and April. Young of the year porbeagles begin to show up in Atlantic Canadian waters in June and July. There is a population which undertakes extensive migrations. From January to February they can be found in the Gulf of Maine, Georges Bank and the Southern Scotian Shelf. During the spring they can be found on the edge of the Scotian Shelf and in offshore basins. They migrate northeasterly and can be found off the southern coast of Newfoundland and in the Gulf of St. Lawrence in the summer and fall.
Roundnose grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered	The roundnose grenadier is a continental slope species with the deeper part of its geographic range not well surveyed. It is closely associated with the seafloor and commonly found inhabiting waters 400 to 1,200 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 Seamounts. 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 1,000 m off the bottom. The species feeds in the water column on a variety of prey items including copepods, amphipods, squid, and small fish.
Shortfin mako	*Isurus oxyrinchus*	Not Listed	Special Concern	This species migrates into Canadian waters following food stocks generally in the later summer and early fall, where it is associated with the warm waters of the Gulf Stream. Shortfin makos inhabit the Scotian Shelf edge and slope, as well as the banks and basins within the Study Area.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	The smooth skate can be found from the Grand Banks to South Carolina. In Canadian waters It is common from the Grand Banks along the Scotian Shelf and into the Gulf of Maine area. The species is commonly found at depths ranging from 70 to 480 m, up to depths of 1,400 m at temperatures ranging from -1.3 to 15.7 °C. Smooth skates prefer soft mud bottom substrate consisting of silts and clay, but they have also been found on sand, shell hash, gravel and pebble substrates. Smooth skates primarily feed on small crustaceans and will eat fish once they reach later (largest) stages of their life. The smooth skate is a slow-growing, late-maturing and long-lived species that is capable of spawning year-round with no known observed peak in spawning rates. Females mature at an average age of 11 years. Females will lay an egg-capsule on the benthic substrate. A young, juvenile is developed in the egg capsule for 1 to 2 years before hatching.
Spiny dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	Commonly found from the intertidal zone to the continental slope in water depths up to 730 m. Most abundant between Nova Scotia and Cape Hatteras. The highest concentration in Canadian waters is along the Scotian Shelf. The species follows a general seasonal migration pattern between inshore waters during the summer-fall and offshore waters during the winter-spring. Females mature at 15 years and mating occurs during the spring. After a gestation period of 18 to 24 months an average of six pups are born which are approximately 25 cm in length. Both mating and pupping are believed to occur along the edge of the Scotian Shelf in the spring.
Thorny skate	*Amblyraja radiata*	Not Listed	Special Concern	The thorny skate is common throughout the North Atlantic and is concentrated on the Grand Banks with some occurrence on the Scotian Shelf. On the Scotian Shelf the species has the highest concentrations on the Eastern Banks as well as the lower Bay of Fundy. The species can be found in depths ranging from 20 to 1,400 m on substrates including sand, shell hash, gravel, pebbles, and soft muds. They are a slow growing species with maturity being reached at an age of 11 years. It is believed that peak spawning occurs in the fall and winter months.

Table 3.16 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	SARA Schedule 1 Status	COSEWIC Designation	Life History Characteristics
White hake (Atlantic and Northern Gulf of St. Lawrence population)	*Urophycis tenuis*	Not Listed	Threatened	White hake can be found on the continental slopes, ranging from southern Labrador and the Grand Banks to the Gulf of Maine. Within the Study Area, white hake can be found in the LaHave and Emerald Basins as well as along the Shelf edge. Maturity is reached from two to five years of age. Spawning occurs during the summer months.
Winter skate (Eastern Scotian Shelf-Newfoundland population)	*Leucoraja ocellata*	Not Listed	Endangered	High concentrations have been found on Georges Bank and the offshore banks of the Scotian Shelf. Non-migratory spawning has been observed in the fall. Eggs / larvae may be present up to 22 months after spawning and are attached to the seafloor.

Source: Scott and Scott 1988; Campana et al. 2003; Maguire and Lester 2012; COSEWIC 2006a, 2006c, 2008, 2009a, 2009b, 2009f, 2010a, 2010b, 2010c, 2010d, 2011a, 2012a, 2012b, 2012c, 2012d; DFO 2011a, 2012a, 2013a, 2013c, 2013l, 2013m, 2013n, 2013k, 2013o, 2013p; NOAA 2013l; SARA 2012, 2013a, 2013b

3.2.6 Marine Mammals and Sea Turtles

There are three groups of marine mammals that have the potential to inhabit the Study Area: the mysticetes (toothless/baleen whales), odontocetes (toothed whales), and pinnipeds (seals). In 2007, a large-scale aerial survey of marine megafauna was conducted in the Northwest Atlantic (Lawson and Gosselin 2009). During this survey, 20 species of cetaceans were identified on the Scotian Shelf. Common dolphins were the most prevalent species, followed by long-finned pilot whales and white-sided dolphins. While Lawson and Gosselin (2009) provide data from one of the largest and most comprehensive surveys off eastern Canada to date, it is important to recognize that these surveys were conducted during a limited time period between 21 July to 23 August, 2007; and the Scotian Shelf part of the survey was only a portion of these days. Therefore, this dataset represents only a snapshot in time and the results of this survey may not necessarily be representative of other times of the year, or other years.

Figures 3.11 and 3.14 have been prepared using sightings from DFO's marine mammal sightings database. It should be noted that these data have been collected from various sources over the years, including sightings from fishing and whaling in the 1960s and 1970s and more recently from observer programs on fishing vessels. The database also includes data from scientific expeditions by DFO, non-governmental organizations, and Dalhousie University research teams. Much of the data were collected on an opportunistic basis from vessels in the area, with survey effort not consistent across the Study Area (e.g., lack of sightings does not necessarily represent lack of species presence in a given area) (DFO, pers. comm. 2013). Note that the DFO Maritimes Region Whalesitings Database does not include all data available on cetacean occurrence on the Scotian Shelf and Slope. A more compete picture can be obtained by including sightings data from the North Atlantic Right Whale Consortium Database (which includes multispecies data). Furthermore, DFO's cetacean aerial surveillance efforts have substantially increased in eastern Canada in recent years, and additional cetacean sightings data are available for the Scotian Shelf region that are not necessarily included in the Maritimes Region database.

3.2.6.1 Mysticetes and Odontocetes

Table 3.17 lists cetacean species known to inhabit the Study Area. Special designations by SARA and/or Committee on the Status of Endangered Wildlife in Canada (COSEWIC) are included as applicable. Note that only those species listed on Schedule 1 of SARA are protected under the Act; Schedule 2 and 3 list species which have been previously assessed by COSEWIC as being at risk, but require reassessment according to new criteria, and may eventually be added to Schedule 1.

Six species of mysticetes (baleen whales) have been reported to occur in the Study Area, predominantly in the summer and fall, although all six have been sighted in Scotian Shelf waters throughout the year, including in winter months (refer to Table 3.17). Their year-round presence offshore Nova Scotia is also supported by acoustic evidence (Delarue et al. 2018). Figure 3.11 presents the distribution of baleen whale sightings over the Western Scotian Shelf and Slope, including recorded sightings for the blue whale, fin whale, and North Atlantic right whale. The distribution of fin whale sightings from shipboard and aerial surveys is shown in Figure 3.12. The Canadian range of the North Atlantic right whale is shown (on two maps) in Figure 3.13.

Odontocetes include toothed whales, dolphins and porpoises; 16 species of odontocetes have been reported to occur in the Study Area, particularly along the Shelf Break (refer to Figure 3.14). Critical habitat for the endangered northern bottlenose whale has been designated in the Gully and Shortland and Haldimand Canyons east of the Study Area (see Figure 3.19), although there have been sightings along the Shelf Break and within Dawson and Verrill Canyons in the Study Area. Recorded sightings of northern bottlenose whale off Canada and adjacent waters are shown in Figure 3.15. Critical habitat for the North Atlantic right whale has been designated within the Roseway Basin, to the west of the Study Area (see Figure 3.19).

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Mysticetes (Toothless or Baleen Whales)				
Blue whale (Atlantic population)	*Balaenoptera musculus*	Schedule 1, Endangered	Endangered	Has a large range, including along the Scotian Shelf, but a low population density. Forages for krill in both coastal and offshore waters, especially in areas of upwelling such as the continental shelf during spring, summer and fall. Found in small migrant herds and surfaces every 5 to 15 minutes for breathing. Present on the Scotian Shelf year-round, with peak abundance from May to October in areas of high primary productivity. Within the Study Area, the species has been commonly sighted on Sambro, Emerald and Western Banks and has also been sighted along the Slope. Blue whales have also been sighted to the west of the Study Area between Roseway Bank and Basin. In 2018, DFO identified the Scotian Shelf and Slope break (including the Gully) as “habitat important to the blue whale”. Moors-Murphy et al. (2019) collated data from systematic surveys, opportunistic sighting platforms, acoustic monitoring and Species Distribution Model (SDM) efforts to predict potentially suitable habitat for blue whales off Nova Scotia, Newfoundland and Labrador. Potentially important areas were identified along the continental slope of the Scotian Shelf, especially in deep water near several submarine canyons on the eastern Scotian Shelf and in shallower areas on the western Scotian Shelf (Moors-Murphy et al. 2019). Important features and attributes of important habitats to blue whales include: sufficient quantity and quality of prey; free access to transit corridors; enough physical space to freely maneuver; water of sufficient quality to not result in a loss of function; and an acoustic environment that does not interfere with communication, passive detection of prey or navigation, or impede use of important habitats by blue whales of their prey. There is a possibility that blue whales may be encountered by future operators in the Study Area, and that the important features and attributes could be affected by exploration activity. Any EA for future proposed programs in the Study Area parcels must take into account these important features and attributes of the area for this species.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Schedule 1, Special Concern	Special Concern	Concentrated in the Northwest Atlantic region during summer months (but seen year-round) for feeding, with a high concentration on the Scotian Shelf. This species is the most commonly sighted whale species along the Scotian Shelf. Calving occurs in winter, in lower latitudes. Within the Study Area they are commonly sighted throughout the Scotian Shelf between Western and Roseway Banks, including the Study Area, and on the Scotian Slope. The estimated population size for the western North Atlantic fin whale stock is 3,985 individuals based on surveys conducted in 2006 and 2007.
Humpback whale (Western North Atlantic population)	*Megaptera novaeangliae*	Schedule 3, Special Concern	Not at Risk	Humpback whales are common in the summer and can be sighted from the Gulf of Mexico to southeastern Labrador. Most sightings occur in coastal waters. Humpback whales undergo extensive seasonal migrations and have a number of distinct feeding aggregations. Newfoundland and Gulf of Maine subpopulations migrate to the Scotian Shelf and Slope during the summer months to forage. One feeding aggregation occurs in the Georges Bank and Gulf of Maine region. Few have been sighted within the area during the winter, however most acoustic detections on the shelf edge have occurred during winter months, indicating that at least some individuals occur in Canadian waters year-round (Kowarski et al. 2018). The estimated North Atlantic population (including Gulf of Maine and Scotian Shelf stocks) is 7,698 based on genetic tagging data.
Minke whale	*Balaenoptera acutorostrata*	Not Listed	Not at Risk	The minke whale can be found from the Davis Strait in the north to the Gulf of Mexico. Minke whales have been sighted in the Study Area during the spring, summer and fall, with occasional winter sightings in adjacent Scotian Shelf areas.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1, Endangered	Endangered	Species range is along the Atlantic coast from the southeastern U.S. to the Scotian Shelf and extending into the Gulf of St. Lawrence, with the *Roseway Basin Area to be Avoided* (also SARA-designated Critical Habitat) located on the southwestern Scotian Shelf (see Figure 3.19). They can be found feeding and socializing from the western end of Sable Island Bank to Browns Bank, and have been sighted in Dawson and Verrill Canyons on the Scotian Slope. North Atlantic right whales have been observed and regularly acoustically detected in Emerald Basin, and this area has the highest number of acoustic detections of North Atlantic right whales on the Scotian Shelf outside of Roseway Basin (Davis et al. 2017). Migration patterns typically bring them to the waters of the Scotian Shelf from July to October. Recent information suggests that the species is present in the Gulf of St. Lawrence and, by extension, the Scotian Shelf (assuming the typical north-south migration routes), from late April to mid-January (DFO 2018e). The North Atlantic right whale primarily feeds on copepods and other zooplankton. The western North Atlantic population size was estimated to be 450 individuals as of 2016. In 2017, the North Atlantic right whale suffered an unprecedented population loss of 12 individuals in the Gulf of St. Lawrence and protecting the species is a top priority for DFO. Following this unusual mortality event, there were no right whale deaths in Canadian waters in 2018. Recovery objectives for the North Atlantic right whale include reducing mortality and injury from vessel strikes and entanglements in fishing gear and reducing injury and disturbance as a result of vessel presence or exposure to contaminants and other forms of habitat degradation. While none of the deaths were attributable to petroleum activities, the species regularly transits the Scotian Shelf and Slope area, including the Study Area, possibly residing in the Study Area for weeks or longer. Any future project-specific EAs for programs proposed within the Study Area parcels should take these population losses into account when assessing potential project-related effects on the North Atlantic right whale.
Sei whale	*Balaenoptera borealis*	Not Listed	Not Listed	In Atlantic Canadian waters sei whales can be found from Georges Bank in the south to Labrador in the north. During the summer and early autumn months, a large portion of the population can be found on the Scotian Shelf.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Odontocetes (Toothed Whales)				
Atlantic bottlenose dolphin	*Tursiops truncatus*	Not Listed	Not at Risk	Found in coastal and continental shelf water of tropic and temperate regions and are considered generalists in terms of habitat. This species is occasionally sighted on the Scotian Shelf and Slope in spring, summer and fall, with a few sightings also reported in winter months.
Atlantic spotted dolphin	*Stenella frontalis*	Not Listed	Not at Risk	Found in tropical and warm temperate waters in the Northwest Atlantic. Species distribution ranges from southern New England to as far south as Venezuela. Typically found on the contintental shelf edge and slope. This species does not regularly occur on the Scotian Shelf and Slope.
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Not Listed	Not at Risk	Atlantic white-sided dolphins are distributed throughout the continental shelf and slope areas of the North Atlantic. Atlantic white-sided dolphins prefer depths of less than 100 m, although many sightings have occurred at depths in excess of 100 m. They have been sighted on the Scotian Shelf and Slope in spring, summer and fall, with a few sightings also reported in winter months.
Beluga whale (St. Lawrence Estuary population)	*Delphinapterus leucas*	Endangered	Endangered	Generally found in seasonally ice-covered Arctic and sub-Arctic waters. In eastern Canada, their occurrence outside the Gulf of St. Lawrence is rare. Spring is an important feeding period for this population and the timing and extent of seasonal movements are likely influenced by sea ice, food availability and predation risk. In general, this population occurs in the St. Lawrence Estuary during summer months and then migrates eastward into the northwestern Gulf of St. Lawrence during the fall and winter; as a result, their occurrence on the Scotian Shelf and Slope is rare.
False killer whale	*Pseudorca crassidens*	Not Listed	Not at Risk	Distributed worldwide throughout warm temperate and tropical oceans. Generally found in offshore waters but has been observed in coastal waters. While records of false killer whales in the NW Atlantic are not common, the combination of sighting, stranding, and bycatch records indicate that this species occurs.
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Schedule 2, Threatened	Special Concern	Harbour porpoises are widely distributed over the continental shelves of the northern hemisphere and occur on the Scotian Shelf and Slope year-round. 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.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Killer whale (Northwest Atlantic/Eastern Arctic Population)	*Orcinus orca*	Not Listed	Special Concern	Killer whales occur in the Northwest Atlantic and eastern Canadian Arctic and can be found from Baffin and Hudson Bay to US coastal waters. The size of the Northwest Atlantic-Eastern Arctic population is not known. Killer whales are occasional visitors to the area, although rarely seen.
Long-finned pilot whale	*Globicephala melas*	Not Listed	Not at Risk	Long-finned pilot whales can be found on the Scotian Shelf and Slope year-round. The species can be found frequenting coastal waters of Cape Breton during the summer months and moving further offshore during the winter.
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Schedule 1, Endangered	Endangered	Northern bottlenose whales are found only in the North Atlantic Ocean. The Scotian Shelf population inhabits deep waters (>500 m) along the continental slope off Nova Scotia and southeastern Newfoundland. The majority of sightings to date have been in three adjacent submarine canyons on the eastern Scotian Shelf: the Gully, Shortland Canyon, and Haldimand Canyon. These canyons are located to the east of the Study Area and have been identified as critical habitat for the population under SARA (see Figure 3.19). A Critical Habitat Order was recently published, ensuring legal protection from destruction under SARA. Within the Study Area, there have been sightings primarily along the Shelf Break, including at Dawson and Verrill Canyons and into deeper waters off the slope. This species is non-migratory with mating and calving occurring in August. They are known to be extremely curious and will investigate vessels or equipment. The Scotian Shelf population is small, with an estimated 143 individuals. Underwater sound is of particular concern to this species as it relies on sound to carry out life functions, including foraging, socializing and navigation. The deep-diving behaviour of this species may make them especially vulnerable to physiological impacts from acoustic disturbance.
Risso's dolphin	*Grampus griseus*	Not Listed	Not at Risk	This species is found globally in tropical and temperate waters and occurs in the Northwest Atlantic from Florida to eastern Newfoundland. This species occupies a narrow niche, which is the steep upper continental slope where water depths usually exceed 300 m. This species is sighted occasionally on the Scotian Shelf and Slope.

Table 3.17 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Sowerby's beaked whale	*Mesoplodon bidens*	Schedule 1, Special Concern	Special Concern	Only found in the North Atlantic with some known occurrence along the Scotian Shelf but not often sighted; have been seen in the Gully MPA. In recent years, sightings have significantly increased in the Gully, Shortland and Haldimand Canyons, east of the Study Area. There have been sightings within the Study Area along the shelf edge. Habitat tends to concentrate around shelf edges and slopes. Underwater sound is of particular concern to this species as it relies on sound to carry out its life functions, including foraging, socializing and navigation.
Short-beaked common dolphin	*Delphinus delphis*	Not Listed	Not at Risk	The common dolphin may be one of the most widely distributed cetacean species, inhabiting tropical, sub-tropical, and temperate areas. The species can be found on the Scotian Shelf year-round, commonly during summer and autumn once water temperatures increase above 11°C.
Sperm whale	*Physeter macrocephalus*	Not Listed	Not at Risk	The sperm whale can be found along the Scotian Shelf edge and may be more common in the submarine canyons of the shelf, as it is regularly seen in the Gully. Sperm whales can also be found along the edge of the Laurentian Channel and can be commonly found in areas where water mixes to produce areas of high primary productivity. The sperm whale has been sighted more regularly on the eastern end of the Scotian Shelf at depths of 200 m to 1,500 m, however can also occur at depths of less than 200 m.
Striped dolphin	*Stenella coeruleoalba*	Not Listed	Not at Risk	The striped dolphin can be found from Cape Hatteras to the southern margin of Georges Bank and also offshore over the continental slope and rise in the mid-Atlantic regions. They prefer the warm waters found on the Shelf edge and are often seen in the Gully. Few striped dolphins have been sighted on the Scotian Shelf over the winter months.
White-beaked dolphin	*Lagenorhynchis albiorostris*	Not Listed	Not at Risk	This species is found from Cape Cod to Greenland, often preferring waters less than 200 m in depth. The species is a year-round resident of the area inhabiting waters from Cape Cod to Greenland.

Source: COSEWIC 2008b, 2014; Davis et al. 2017; DFO 1998, 2011a, 2011b, 2013c, 2014a, 2014c, 2017a, 2018d; SARA 2012; Breeze et al. 2002; NOAA 2007b, 2014, 2015, 2016a, 2016b, 2017; OBIS 2019; Waring et al. 2011.

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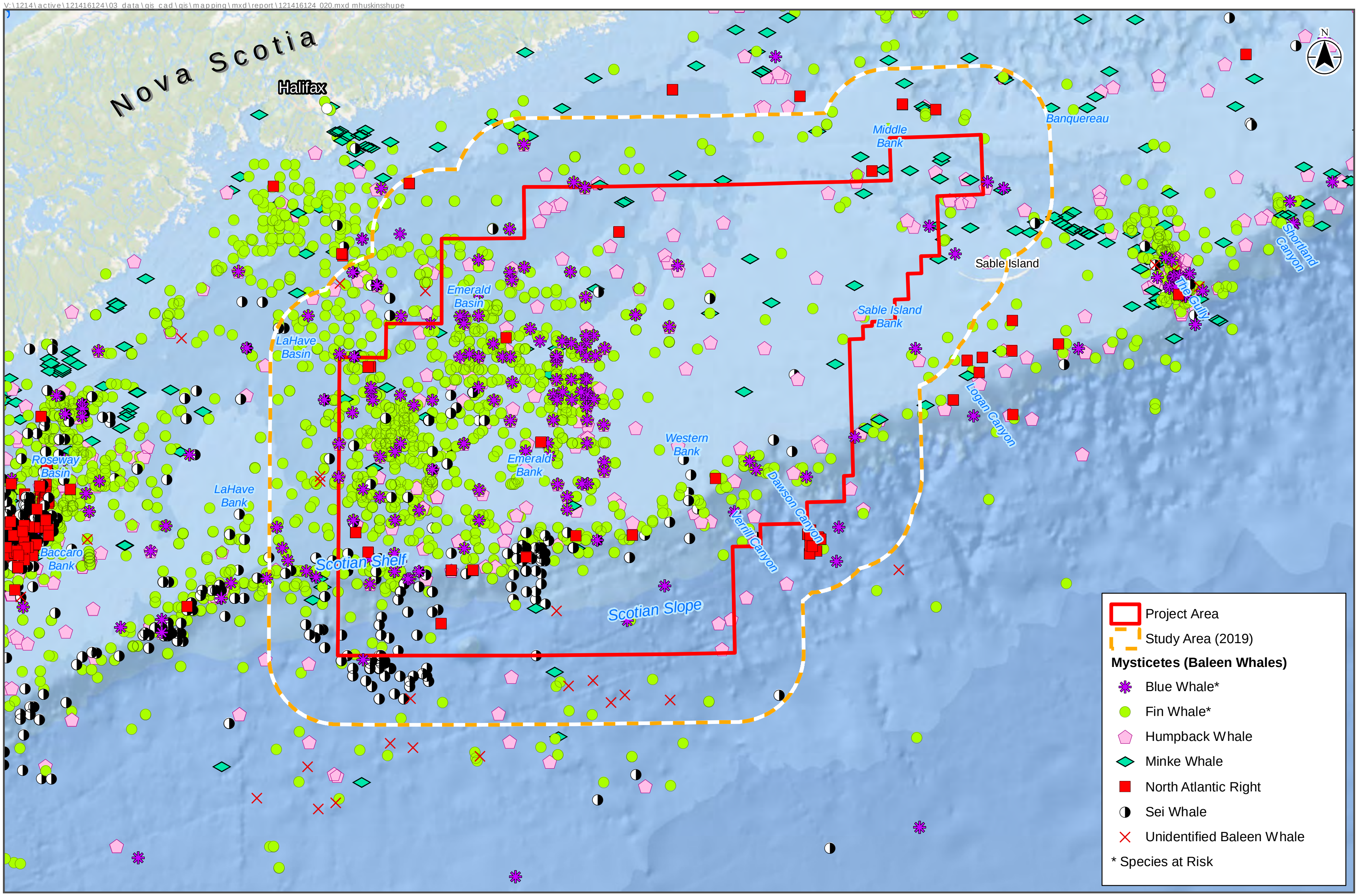

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada, OBIS
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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

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Kilometres

Baleen Whale Sightings in the Study Area

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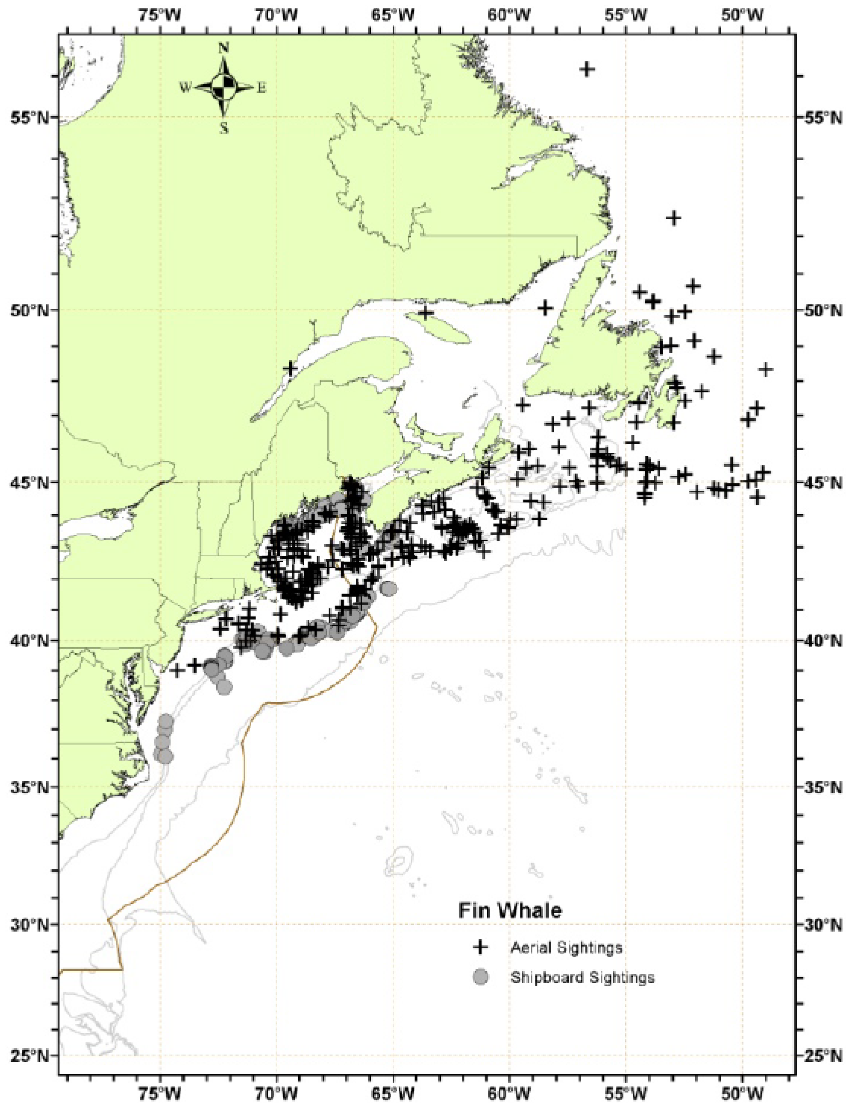
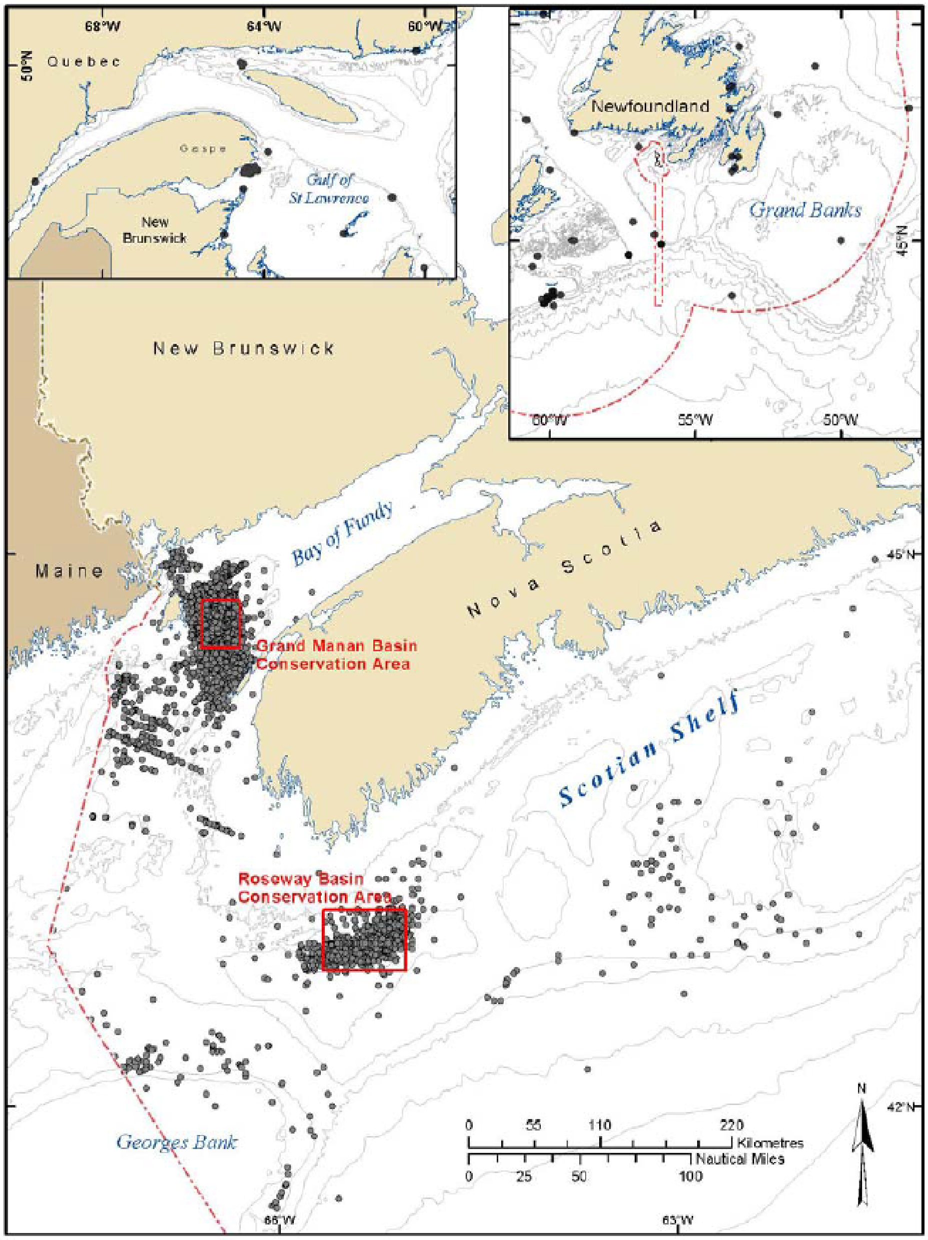
Figure 3.11



Source: National Oceanic and Atmospheric Administration (NOAA) 2017a

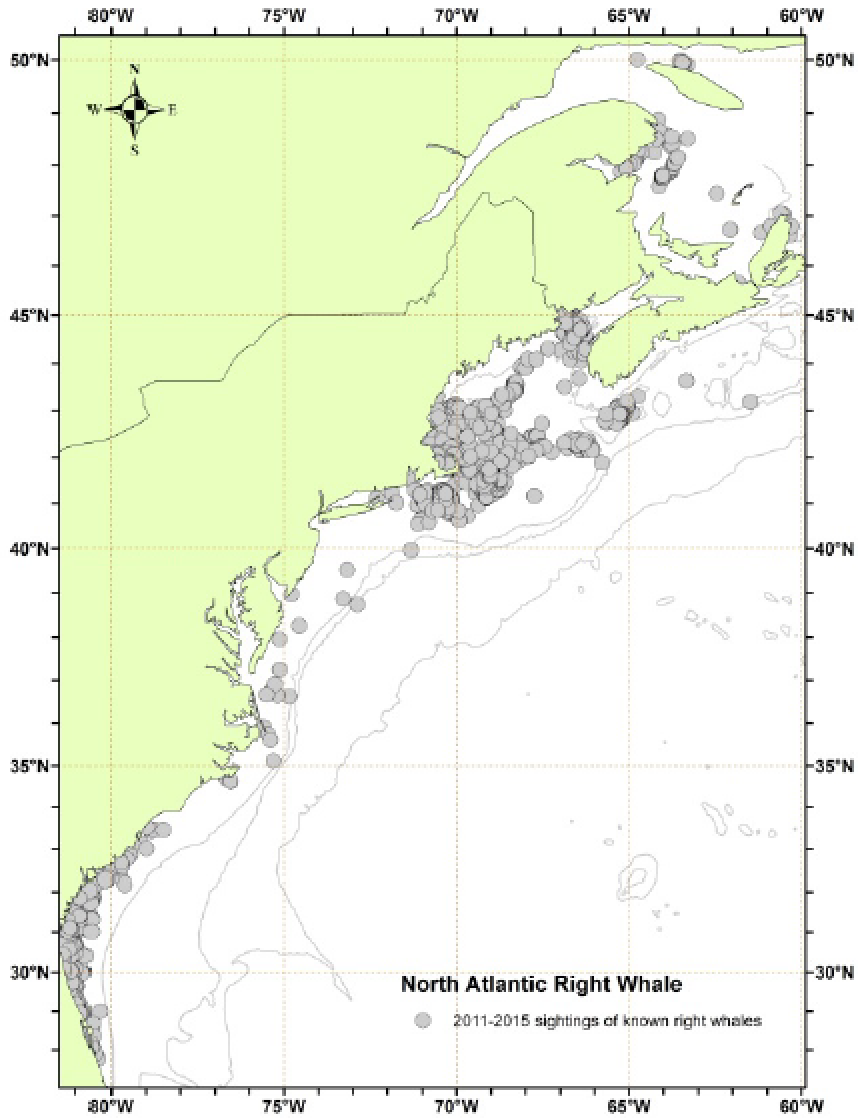
Note: Based on data collected during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011 and DFO's 2007 TNASS survey. Isobaths represent the 100, 1000, and 4000 m depth contours.

Figure 3.12 Distribution of Fin Whale Sightings from Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) Shipboard and Aerial Surveys



Source: Brown et al. 2009

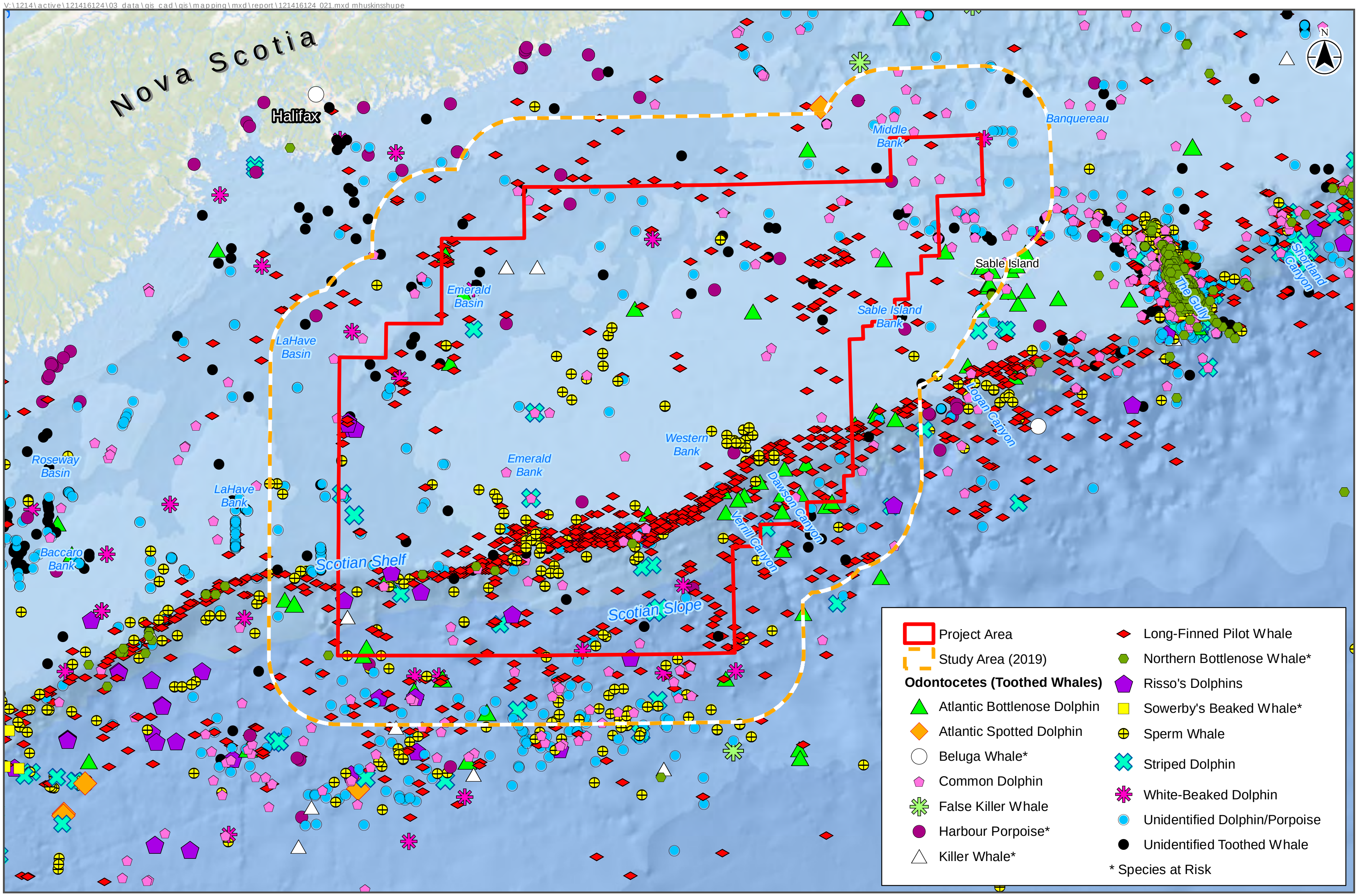
Note: Based on the St. Andrews Biological Station Whale Sightings Database 1992-2005.



Source: NOAA 2017b

Note: Based on sightings of known North Atlantic right whales from 2011-2015, showing the increase of sightings in the Gulf of St. Lawrence. Isobaths are the 100-m, 1000-m and 4000-m depth contours.

Figure 3.13 Canadian Range of the North Atlantic Right Whale Based on the St. Andrews Biological Station Whale Sightings Database (1992-2005) (top panel) and NOAA North Atlantic Right Whale (Eubalaena glacialis) Western North Atlantic Stock: Marine Mammal Stock Assessment Report 2017 (bottom panel)



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada, OBIS
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Kilometres

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Odontocete Sightings in the Study Area

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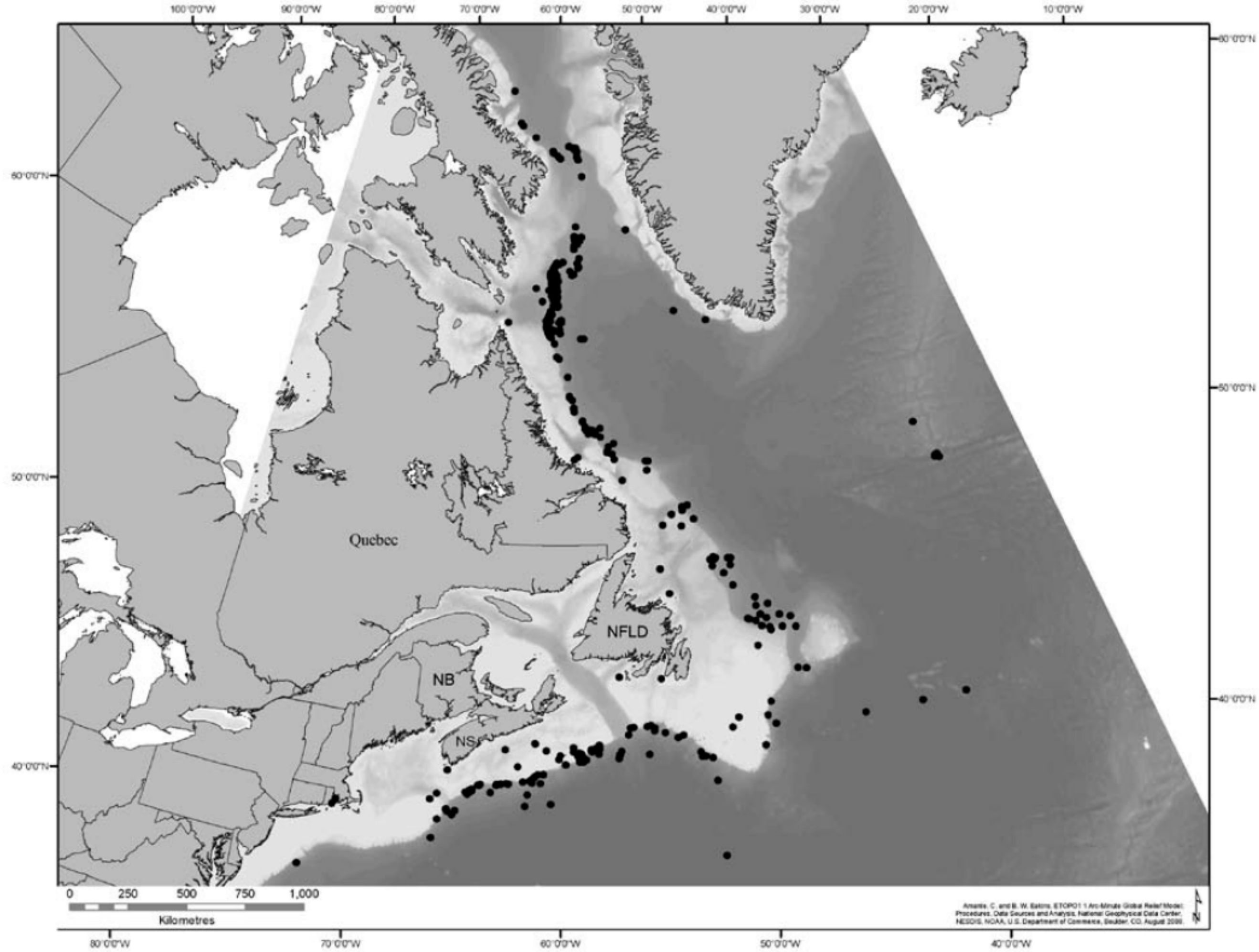
Figure 3.14



Source: COSEWIC 2011b

Figure 3.15 Sightings of Northern Bottlenose Whales off Canada and Adjacent Waters (n= 16,808) (1867 – 2010)

3.2.6.2 Pinnipeds (Seals)

Sable Island is a significant area for seals on the Scotian Shelf. It is important for two breeding populations of seals, containing approximately 80% of the world's largest breeding population of grey seals, as well as a smaller population of harbour seals. Seals feed off Sable Island and in the Gully year-round (DFO 2011b). Table 3.18 lists pinniped species found within the Study Area. No seal populations within the Study Area are designated under SARA or assessed as endangered, threatened, or of special concern by COSEWIC. DFO is not required to record seal sightings in their marine mammal sightings database. Some sightings data were available and are shown in Figure 3.16; however, there is very limited data on seals within the DFO Whalesightings Database and this dataset is not a complete or accurate source of information on seal occurrence in Scotian Shelf waters.

Table 3.18 Pinniped Species found within the Study Area

Common Name	Scientific Name	Potential Occurrence in Study Area
Grey seal	*Halichoerus grypus*	Largest world-wide breeding population, pupping on Sable Island mid-December to late January (approximately 62,054 pups in 2010). Smaller breeding colonies found on coastal islands along southwest Nova Scotia at Flat, Mud, Noddy, and Round Islands (approximately 417 pups in 2010). Forages in Study Area year-round on a wide range of demersal and small pelagic fishes.
Harbour seal	*Phoca vitulina*	Breeding population uses Sable Island for pupping mid-May to mid-June and forages in the Study Area year-round. Expected that Sable Island may become a non-breeding site for harbour seals owing in part to competition with an increasing grey seal population.
Harp seal	*Pagophilus groendlandica*	Occasionally found foraging in Study Area, although generally not found in waters of the Scotian Shelf
Hooded seal	*Cystophora cristata*	Occasionally found foraging in Study Area, although generally not found in waters of the Scotian Shelf.
Ringed seal	*Phoca hipsida*	Occasionally found foraging in Study Area, although generally not found in waters of the Scotian Shelf.

Source: DFO 2011a, 2011b; Worcester and Parker 2010

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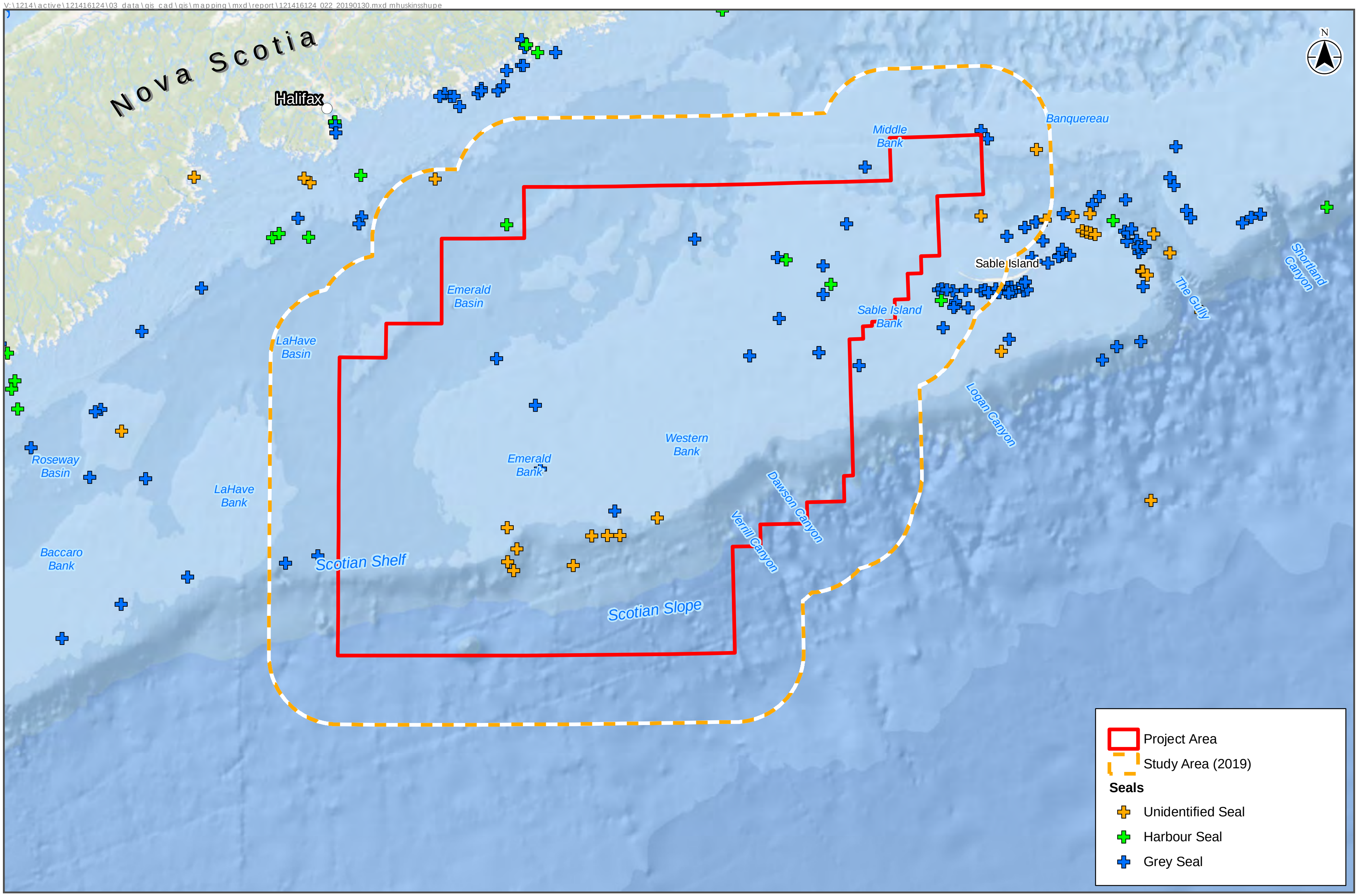

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada, OBIS
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Kilometres

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Seal Sightings in the Study Area

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Figure 3.16

3.2.6.3 Sea Turtles

There are four species of sea turtles that can be found migrating and foraging within the Study Area (Table 3.19), although only the endangered leatherback turtle and the loggerhead turtle are known to regularly forage in Atlantic Canada waters. DFO is using satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada and the information generated by this exercise will be used to propose critical habitat for designation under SARA (DFO 2012b). Draft critical habitat for the leatherback turtle has been identified to the southwest of the Study Area. Sea turtle sightings in the Study Area based DFO's marine mammals sighting database are shown in Figure 3.17.

Table 3.19 Sea Turtle Species Known to Occur in the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1, Endangered	Endangered	The leatherback sea turtle is the most widely distributed and largest of all marine turtles. Data comprised of satellite tracking studies as well as sighting information indicate that the species can be found in Atlantic Canadian waters from April to December. The Western Scotian Slope was noted as a high area of use for foraging by the species with the highest densities found from July to September. The distribution of the species generally shifts from the southwest shelf and slope to the northeast, as the foraging period progresses in the area. Draft critical habitat has been identified for this species to the southwest of the Study Area. Additional areas where the species is found include waters east and southeast of Georges Bank, the southeastern Gulf of St. Lawrence including Sydney Bight, the Cabot Strait, Magdalen Shallows, waters adjacent to the Laurentian Channel, and waters south of the Burin Peninsula off Newfoundland. The species distribution in Canadian waters is believed to be primarily based on foraging habitat. The leatherback turtle forages on gelatinous zooplankton and jellyfish, consuming an average of 330kg/day, between April and December. While foraging, they spend approximately two-thirds of their time in the top 6 m of the water column. Approximately 50% of day and evening hours are spent at the surface. Leatherback turtles begin a migration south in September and October, although they have been observed to be in the vicinity of Georges Bank as late as November/December. Leatherbacks found in Atlantic Canada originate from nesting beaches in the Caribbean, South and Central America, and Florida. The leatherback sea turtle may swim more than 10,000 km between nesting locations in the tropics and foraging areas in the north. The size of the seasonal foraging population in Atlantic Canadian waters is not known; however, sightings data suggest that the population in Canadian Atlantic waters numbers in the thousands.

Table 3.19 Sea Turtle Species Known to Occur in the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Life History Characteristics
Loggerhead turtle	*Caretta caretta*	Schedule 1, Endangered	Endangered	Immature loggerhead turtles occur regularly at the edge of the Scotian Shelf and on the slope and are routinely found foraging on the Scotian Shelf and Slope and Georges Bank in the Study Area. In general, loggerhead sea turtles make predictable migrations from southern breeding grounds in the Southern US (breeding as far north as Virginia), Caribbean, Gulf of Mexico, and South America to temperate foraging grounds in the Northern Atlantic. The largest breeding colony in North America is in Florida. Recent findings have determined that not all loggerhead turtles leave the area during the winter months. Telemetry data has shown that some turtles move east and northeast during the winter. Loggerheads are vulnerable to threats through all of their life stages from egg to adult, in a variety of habitat types. Within Atlantic Canada, small and large juveniles are present. Threats to loggerheads within the broader Northwest Atlantic can affect the number of juveniles that come into Atlantic Canadian waters. Potential threats associated with offshore petroleum exploration include underwater noise, marine pollution (contaminants and debris), and vessel strikes. Any EAs for future proposed programs in the Study Area must take into account the addition of the loggerhead turtle to Schedule 1 or SARA and its sensitivities.
Kemp's ridley turtle	*Lepidochelys kempii*	Not Listed	Not Listed	Kemp's ridley turtle is the smallest of sea turtles. Occasionally seen in the waters of Nova Scotia, it is generally found further south. The Scotian Shelf is not a regular foraging area.
Green turtle	*Chelonia mydas*	Not Listed	Not Listed	The green sea turtle is unique among sea turtles in that it is herbivorous, feeding on plants. 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. A green sea turtle and green sea turtle—loggerhead hybrid recently documented in nearshore waters off Nova Scotia represent the most northerly confirmed records of green turtle in the Northwest Atlantic. There have also been opportunistic sightings of green sea turtles on the Grand Banks in the DFO sightings database, though these are not confirmed sightings. There is some evidence that the green sea turtle occurs regularly on the Scotian Shelf seasonally.

Source: COSEWIC 2010e, 2012e; DFO 2011a, 2012b, 2017b; James et al. 2004, 2005, 2006; NOAA 2013m, 2013n; Shell Canada Limited 2013

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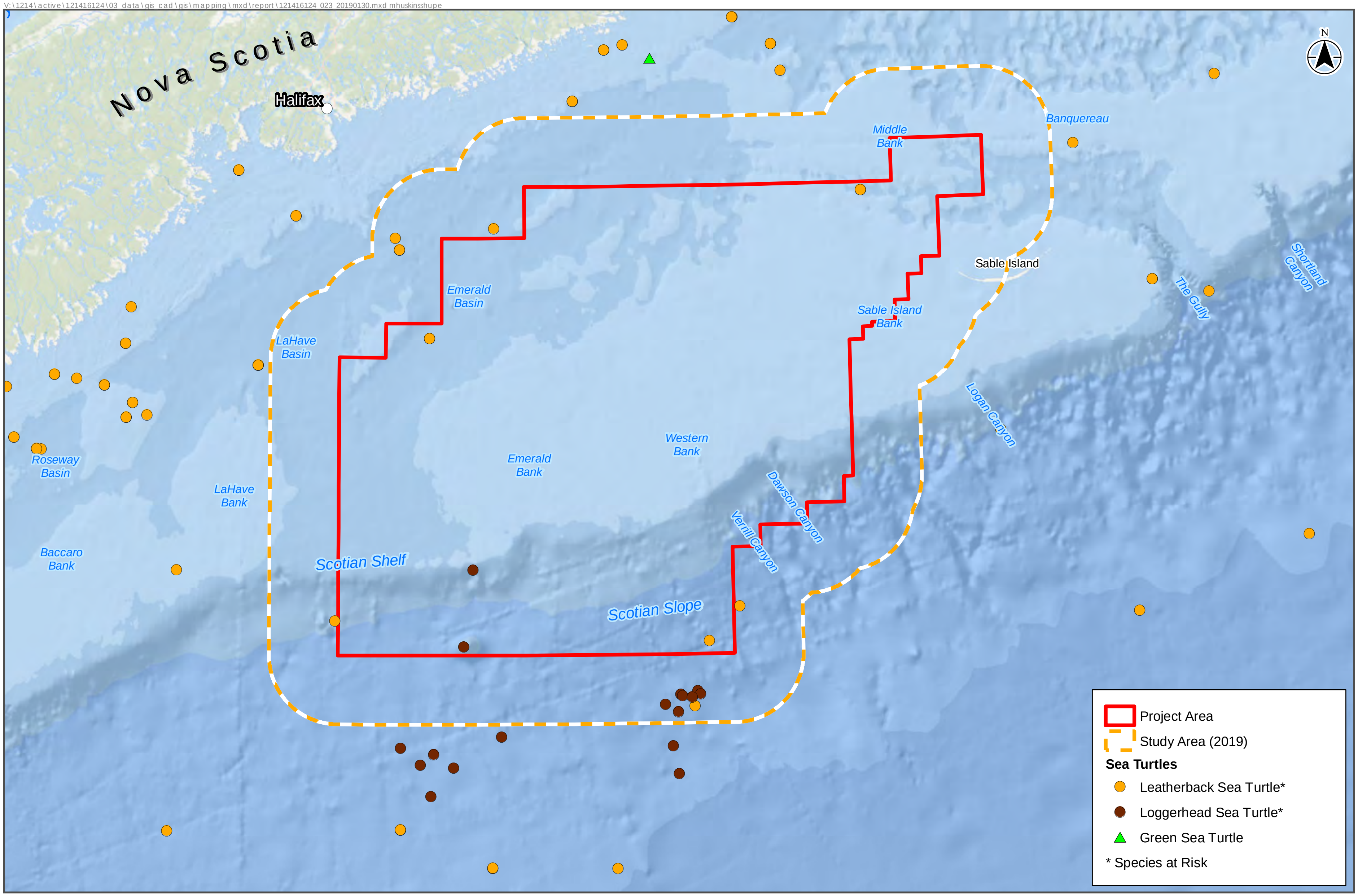

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada, OBIS
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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Sea Turtle Sightings in the Study Area

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Figure 3.17

3.2.7 Marine and Migratory Birds

The waters of the Scotian Shelf are known to be nutrient-rich because of the interaction of a variety of physical drivers (e.g., see Section 3.1, Physical Characteristics) (Fifield et al. 2009). These physical drivers include major current systems, bathymetry, and temperature and salinity patterns; the resulting nutrient-rich waters support highly productive marine ecosystems, including the over 30 million seabirds known to utilize eastern Canadian waters each year (Fifield et al. 2009). The east coast of Canada supports large numbers of breeding marine birds as well as millions of migrating birds from the southern hemisphere and the northeastern Atlantic (Gjerdrum et al. 2008, 2012a). The combination of northern hemisphere breeding birds and southern hemisphere migrants results in bird diversity peaking in the spring (Fifield et al. 2009). During the fall and winter, significant numbers of over-wintering alcids, gulls, and northern fulmars (*Fulmarus glacialis*) use eastern Canadian waters (Brown 1986). Marine birds spend most of their life in the marine environment, and typically only come to land to nest and raise their young.

Table 3.20 lists marine bird species found within the Study Area. Shorebirds known to be present on the Scotian Shelf that could be found in the Study Area are also included. Special designations by SARA and/or COSEWIC are included, as applicable.

Table 3.20 Marine Bird Species Which May Occur in the Study Area

Common Name	Species Name	SARA Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Pelagic Seabirds				
Northern fulmar	*Fulmarus glacialis*	Not listed	Not at Risk	High potential for occurrence – Majority breeds in eastern Canadian Arctic. Found in deep cold waters, showing preference for shelf break habitats. Common in Study Area between January and March.
Great shearwater	*Puffinus gravis*	Not listed	Not at Risk	High potential for occurrence – Breeds in South Atlantic and spends non-breeding season in the North Atlantic. Found in relatively high numbers between May and November.
Sooty shearwater	*Puffinus griseus*	Not listed	Not at Risk	High potential for occurrence – Breeds in southern hemisphere and spends non-breeding season in the North Atlantic. Found in relatively high numbers between April and September.
Cory's shearwater	*Calonectris diomedea borealis*	Not listed	Not at Risk	High potential for occurrence – Breeds in the northeast Atlantic and is most common in August and into the fall.
Manx shearwater	*Puffinus puffinus*	Not listed	Not at Risk	Moderate potential for occurrence – Breeds predominantly in the United Kingdom with small number breeding off southern Newfoundland. Observed in the Study Area during the summer.

Table 3.20 Marine Bird Species Which May Occur in the Study Area

Common Name	Species Name	SARA Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Audubon's shearwater	*Puffinus lherminieri*	Not listed	Not at Risk	Low potential for occurrence – Breeds in the Caribbean and has been sighted on Georges Bank on rare occasion.
Wilson's storm-petrel	*Oceanites oceanicus*	Not listed	Not at Risk	High potential for occurrence – Breeds in southern hemisphere and spends non-breeding season in North Atlantic. Observed in large flocks primarily between May and October.
Leach's storm-petrel	*Oceanodroma leucorhoa*	Not listed	Not at Risk	High potential for occurrence – Breeds in northern hemisphere (southern Labrador to Massachusetts). Species concentrates at fronts and eddies when feeding. Most abundant in Study Area between March and September.
Thick-billed murre	*Uria lomvia*	Not listed	Not at Risk	Moderate potential for occurrence – Breeds in southern Labrador, north shore of Gulf of St. Lawrence and in Newfoundland, with largest colonies in the High Arctic. Found mainly in continental shelf waters. Small numbers winter on Georges Bank (December through May).
Common murre	*Uria aalge*	Not listed	Not at Risk	Moderate potential for occurrence – Most of common murres in Atlantic Canada breed in eastern Newfoundland. Observed in Study Area during winter
Dovekie	*Alle alle*	Not listed	Not at Risk	Moderate potential for occurrence – Breeds in Greenland and present in Study Area between October and March.
Atlantic puffin	*Fratercula arctica*	Not listed	Not at Risk	Low potential for occurrence – Breeds in North Atlantic. Widely dispersed offshore during the winter and only occasionally observed in the Study Area.
Razorbill	*Alca torda*	Not listed	Not at Risk	Low potential for occurrence – Breeds in boreal and low arctic regions of the north Atlantic and may be observed in small numbers in the Study Area between January and May.
Northern gannet	*Morus bassanus*	Not listed	Not at Risk	Moderate potential for occurrence – In North America, breeds in six colonies in Quebec and Newfoundland. Birds dispersed over shelf waters in the winter. May be present in the Study Area during migration between northern breeding colonies and wintering grounds in the south (March through May and October through December).

Table 3.20 Marine Bird Species Which May Occur in the Study Area

Common Name	Species Name	SARA Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Black-legged kittiwake	*Rissa tridactyla*	Not listed	Not at Risk	High potential for occurrence – Widely distributed, with largest breeding colonies in Atlantic Canada found in eastern Newfoundland and Gulf of St. Lawrence. Distributed offshore during migration, often along edge of sea ice, feeding over a variety of water depths. Most likely to occur in Study Area between October and April.
Neritic Seabirds				
Herring gull	*Larus argentatus*	Not listed	Not at Risk	High potential for occurrence – In eastern North America, breeds along Atlantic coast from Baffin Island to Cape Hatteras. Most commonly observed close to land but also seen regularly offshore outside breeding season. Present in Study Area year-round.
Great black-backed gull	*Larus marinus*	Not listed	Not at Risk	High potential for occurrence – Occur only in North Atlantic and breed from North Carolina to Hudson Strait. Most commonly observed close to land but also seen regularly offshore outside breeding season. Common in shelf waters in spring with significant proportion wintering on Georges Bank.
Common tern	*Sterna hirundo*	Not Listed	Not at Risk	Moderate potential for occurrence - Breed at colonies in coastal Nova Scotia and along Gulf of Maine coast. May be present in Study Area during migration in May and September. Tend to occur closer to coastline.
Arctic tern	*Sterna paradisaea*	Not Listed	Not at Risk	Low potential for occurrence – Breed at colonies in coastal Nova Scotia and along Gulf of Maine coast. May be present in Study Area during migration in May and September. Tend to occur closer to coastline.
Roseate tern	*Sterna dougallii*	Endangered	Endangered	Moderate potential for occurrence – Primarily a coastal species. Small population breeds almost exclusively on a small number of islands off Nova Scotia, Sable Island being one of them. Noted to be sensitive to increases in large shipping traffic and any possible beach activity on Sable Island.

Table 3.20 Marine Bird Species Which May Occur in the Study Area

Common Name	Species Name	SARA Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Double-crested cormorant	*Phalacrocorax auritus*	Not listed	Not at Risk	Low potential for occurrence – Common along coast in summer, breeding in the western Gulf of St. Lawrence and on the Atlantic coast of mainland Nova Scotia.
Great cormorant	*Phalacrocorax carbo*	Not listed	Not at Risk	Low potential for occurrence – Common resident in Nova Scotia, breeding in colonies on cliff ledges in Nova Scotia. Fall migration begins in September with a substantial portion of the population wintering off New England.
Black guillemot	*Cepphus grylle*	Not listed	Not at Risk	Low potential for occurrence – Common resident in Nova Scotia, breeding in coastal waters.
Waterfowl and Divers[a]				
Barrows goldeneye	*Bucephala islandica*	Special Concern	Special Concern	Low potential for occurrence – A migratory duck that is largely concentrated in the Rocky Mountains with only a small portion of its population extending east to Atlantic Canada, wintering in coastal areas.
Harlequin duck	*Histrionicus histrionicus*	Special Concern	Special Concern	Low potential for occurrence – Eastern population known to winter in Nova Scotia, along the coast with a preference for coastal islands.
Common loon	*Gavia immer*	Not listed	Not at Risk	Low potential for occurrence – immature loons are known to frequent coastal waters year round and adults frequent coastal waters in the winter months.
Red-throated loon	*Gavia stellata*	Not listed	Not at Risk	Low potential for occurrence – Common transient, breeding in arctic and winters along Atlantic coast
Shorebirds[b]				
Red phalarope	*Phalaropus fulicaria*	Not listed	Not at Risk	High potential for occurrence – Breeds in circumpolar Arctic and migrates to winter in south temperate and subtropical/tropical waters. Generally found in Study Area feeding on the banks during fall and spring migration (particularly during northward migration in spring).
Red-necked phalarope	*Phalaropus lobatus*	Not listed	Special Concern	Moderate potential for occurrence – Occur on Georges Bank during spring and fall migration. Western Bay of Fundy was historically an important fall staging area although numbers have been declining.

Table 3.20 Marine Bird Species Which May Occur in the Study Area

Common Name	Species Name	SARA Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Piping plover (*melodus* subspecies)	*Charadrius melodus melodus*	Endangered	Endangered	Low potential for occurrence – Population inhabits sandy beach ecosystems throughout Atlantic Canada but is not known to inhabit Sable Island. Winters on the southern Atlantic coast of the U.S.
Savannah sparrow (Ipswich sparrow)	*Passerculus sandwichensis princeps*	Special Concern	Special Concern	High potential for occurrence – Population nests almost exclusively on Sable Island. Winters in the mid-Atlantic U.S. and therefore would migrate across Study Area.
Notes: [a] This is not intended to be an exhaustive list of waterfowl. A number of other waterfowl species could occur (e.g., common eider, black scoter, white-winged scoter, surf scoter, long-tailed duck), although interactions with the Study Area are expected to be low. Those listed in the Table above are species of special status that have a low potential for occurrence. [b] This is not intended to be an exhaustive list of shorebirds. A number of other shorebird species could occur, although the Table above concentrates on shorebirds most likely to leave coastal waters and/or those which are species of special status that could occur in the Study Area.				

Source: SARA 2012; DFO 2011a; LGL 2013; Brown 1986; Fifield et al. 1999; Gjerdrum et al. 2012a

Data on pelagic seabird distribution on the east coast of Canada has been collected through various research programs for nearly 50 years. From 1965-1992, data on pelagic seabirds were collected under the Programme intégré de recherches sur les oiseaux pélagiques (PIROP). The PIROP program was designed to be implemented by professional biologists and interested volunteers and employed a simple survey protocol. A series of atlases were produced from these data to summarize pelagic seabird distribution in the northwest Atlantic (Fiefield et al. 2009; Gjerdrum et al. 2012a). Although this program was discontinued in 1992, the PIROP data are still used in offshore EAs (Gjerdrum et al. 2012a).

Following the 2004 crude oil spill at the Terra Nova Floating Production, Storage and Offloading vessel on the northeastern Grand Banks and the subsequent identification of a lack of area-specific seabird abundance information, the Environmental Studies Research Fund (ESRF) funded a 3.5-year project to assess seabird abundance and distribution in multiple areas of oil industry activity in eastern Canada, including the Scotian Shelf. This resulted in the ESRF Offshore Seabird Monitoring Program (Fifield et al. 2009).

In 2005, the Canadian Wildlife Service (CWS) of Environment Canada reinstated the pelagic seabird monitoring program (Eastern Canadian Seabirds at Sea; ECSAS) with the intent to update information on the abundance, distribution and threats of seabirds occurring offshore, to minimize these threats, and increase awareness and support for seabird conservation (Gjerdrum et al. 2012a). Although this program relies on ships of opportunity (in addition to DFO's Atlantic Zone Monitoring Program [AZMP] surveys), it has adopted a more scientifically rigorous data collection protocol than the original PIROP program (Gjerdrum et al. 2012a). Since 2005, almost 100,000 km of ocean track has been surveyed by CWS trained observers.

Fifield et al. (2009), which presents results from the Offshore Seabird Monitoring Program, identifies persistent seasonal and year-round hotspots of high seabird concentration and identifies nine groups of seabirds recognized as the most abundant within their study area (i.e., Grand Banks, Scotian Shelf, Flemish Cap, Laurentian Channel, Gulf of Maine, Orphan Basin/Knoll and the Labrador Sea).

Through their surveying and analysis, Fifield et al. (2009) identified several geographical areas that they deemed to be important to one or more species/groups of seabirds in one or more seasons. The Scotian Shelf and Laurentian Channel were grouped and designated as one of the geographical areas recognized as important, using the absolute densities of seabirds reported by Fifield et al. (2009). Specifically, they determined this to be one of the more productive regions for seabirds in their study area.

Fulmars were abundant in the Scotian Shelf region throughout the year. Table 3.21 summarizes the seasonal abundances of the nine most abundant groups of seabirds in the area. During the spring season, high numbers of gulls, murres and gannets frequented the area (Fifield et al. 2009). The study team found that murres and gannets were joined by large numbers of storm-petrels and shearwaters in the summer. Storm-petrels were particularly abundant on the western Scotian Shelf. Storm-petrels and shearwaters remained in the Scotian Shelf area into the fall season and were joined by gulls (Fifield et al. 2009). Fifield et al. 2009 observed that winter in this region brought large numbers of gulls, murres and other alcids. Table 3.21 is adapted from Fifield et al. (2009) and provides the seasonal weighted median (range in parenthesis) of 1° blocks surveyed of absolute densities (birds/km^2) by species group in the Scotian Shelf – Gulf of Maine ocean region. Individual 1° block density estimates were weighted by block survey effort to compute the overall regional weighted median. Only blocks having at least 25 km of survey effort were included (Fifield et al. 2009).

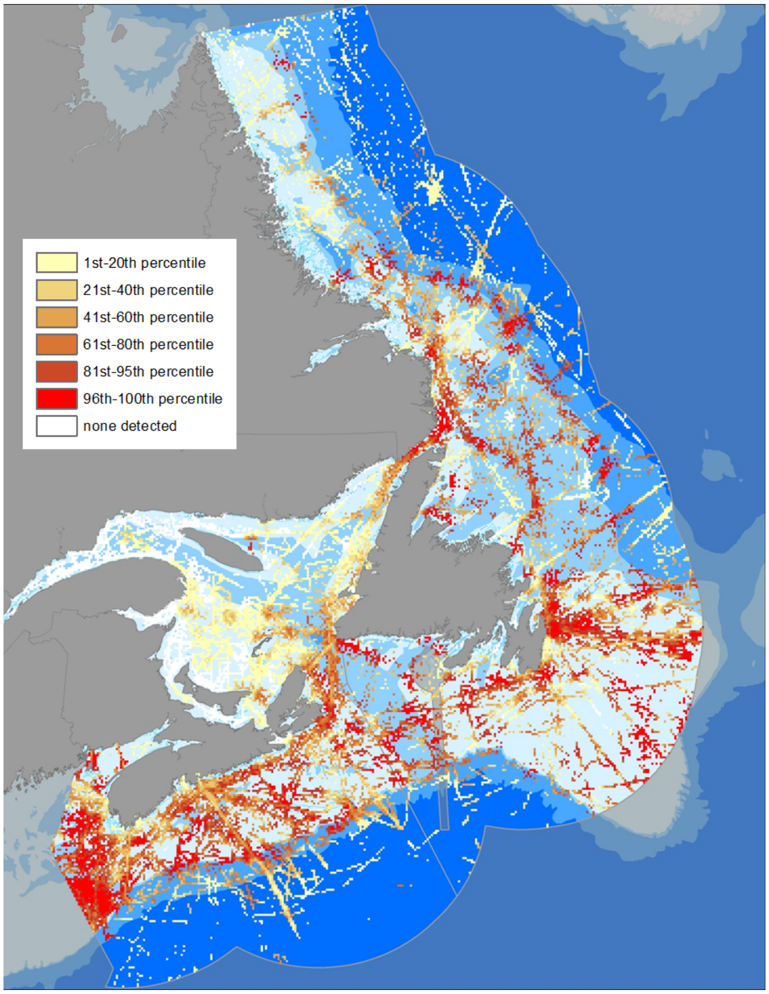
Table 3.21 Summary of Seasonal Abundances in the Scotian Shelf - Gulf of Maine Ocean Region (adapted from Fifield et al. 2009, Table 5)

Species	Season	Scotian Shelf – Gulf of Maine (Median Birds/Km^2) (Full range shown in parentheses)
All waterbirds	Spring	7.92 (0.68 - 25.37)
	Summer	8.30 (1.73 - 148.56)
	Fall	4.23 (0.97 - 21.18)
	Winter	7.67 (4.39 - 29.44)
Northern fulmars	Spring	0.75 (0 - 4.24)
	Summer	0.15 (0 - 1.64)
	Fall	0.30 (0 - 3.31)
	Winter	1.08 (0 -12.37)
Shearwaters *Greater, manx, sooty, cory's, Audubon's and unidentified*	Spring	0 (0 - 0.46)
	Summer	1.78 (0.29 - 84.02)
	Fall	2.20 (0 - 18.40)
	Winter	0 (0 - 3.74)

Table 3.21 Summary of Seasonal Abundances in the Scotian Shelf - Gulf of Maine Ocean Region (adapted from Fifield et al. 2009, Table 5)

Species	Season	Scotian Shelf – Gulf of Maine (Median Birds/Km^2) (Full range shown in parentheses)
Storm-petrels *Wilson's, Leach's and unidentified*	Spring	0 (0 - 1.36)
	Summer	0.78 (0 - 12.74)
	Fall	0.02 (0 - 1.47)
	Winter	0 (0 - 0)
Northern gannets	Spring	0.40 (0 - 1.03)
	Summer	0 (0 - 1.69)
	Fall	0.19 (0 - 2.83)
	Winter	0.04 (0 - 0.22)
Large gulls *Herring, Iceland, glaucous, great black-backed, lesser black-backed*	Spring	1.22 (0 - 21.33)
	Summer	0.08 (0 - 8.39)
	Fall	0.58 (0 - 2.86)
	Winter	0.62 (0 - 2.31)
Black-legged kittiwakes	Spring	0.06 (0 - 3.74)
	Summer	0 (0 - 0.76)
	Fall	0.11 (0 - 1.39)
	Winter	1.96 (0 - 21.31)
Dovekies	Spring	0.71 (0 - 36.98)
	Summer	0 (0 - 2.68)
	Fall	0 (0 - 0.25)
	Winter	2.13 (0 - 10.93)
Murres *Common, thick-billed, unidentified*	Spring	0.88 (0 - 4.37)
	Summer	0.06 (0 - 2.60)
	Fall	0 (0 - 0.14)
	Winter	0.61 (0 - 7.71)
Other alcids *Atlantic puffin, black guillemot, razorbill, unidentified alcid*	Spring	0.14 (0 - 1.53)
	Summer	0.04 (0 - 0.91)
	Fall	0.05 (0 - 0.65)
	Winter	0.37 (0 - 4.69)

The highest density in the entire study area at any time of year was recorded during the summer (May-August) in the Gulf of Maine. This was attributable to large aggregations of great shearwaters found there and in the western Scotian Shelf region. Figure 3.18 demonstrates extensive use of Canadian continental shelf areas by shearwaters, notably on Georges Bank and within the Gulf of Maine, on the Scotian Shelf and on the Newfoundland and Labrador shelves (CWS, pers. comm. 2012).



Source: CWS unpublished data (CWS, pers. comm. 2012)

Note: *Shearwater distribution map presenting relative linear densities of counts of all shearwater species, across all seasons, for Atlantic waters within Canada's Exclusive Economic Zone (EEZ). Estimates for each 5 x 5 km cell are classed within 20% quantiles, with the top quantile split to show the top 5% of estimates. Estimates are corrected according to the number of days cells were surveyed. No interpolation was applied to ascribe values to cells in which no surveys occurred. The latter cells are transparent, revealing the underlying bathymetry. It should be noted that this map highlights "hot-spots" or areas where large numbers of birds congregate. The pattern shown is strongly influenced by the most common species observed, and therefore under-represents less common species, including those of conservation concern. Areas that are not highlighted as hot-spots do not necessarily mean those areas are not also important habitats for birds.*

Figure 3.18 Shearwater Distribution Map

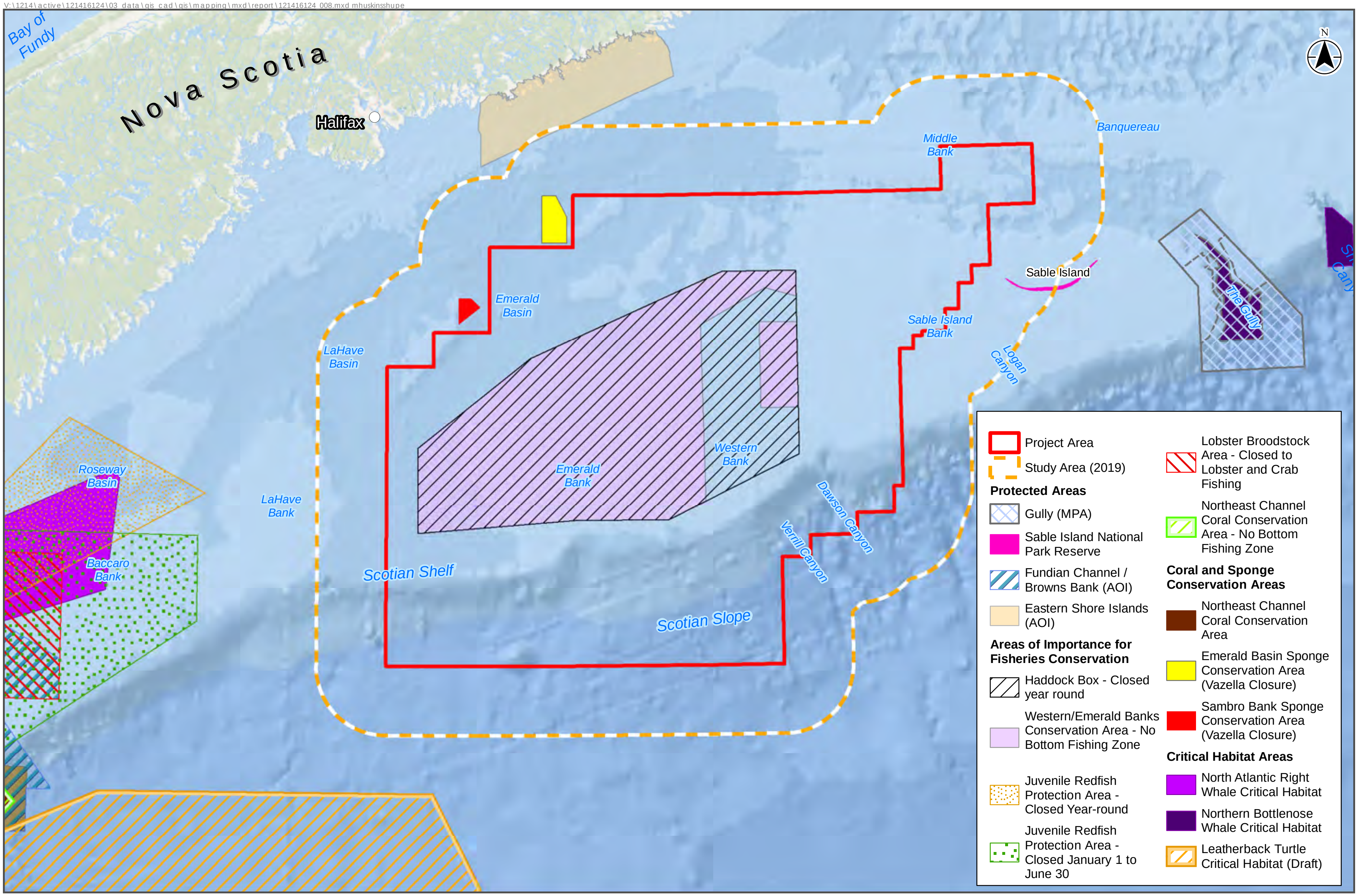
Of the bird species of special status that can occur offshore Nova Scotia, three have moderate or high potential for occurrence in the Study Area. The roseate tern has a moderate potential for occurrence. This species nests in small numbers on Sable Island. In 2007, four pairs of roseate terns were suspected on Sable Island, and two nests were confirmed (COSEWIC 2009c). Critical habitat has been identified for roseate terns on Sable Island. The savannah (Ipswich) sparrow has a high potential for occurrence in the Study Area, nesting on Sable Island and passing through the Study Area during migration as it travels to its overwintering grounds in the mid-Atlantic US. The red-necked phalarope also has a moderate potential for occurrence. This species breeds in the Canadian arctic and sub-arctic and spends winters in tropical areas along South America. Red necked phalaropes may occur in the Study Area during the spring or fall migrations, or while staging in the fall prior to migration (COSEWIC 2014b). Details on these two species, as well as other marine bird species of special status are included in Table 3.21.

Leach's storm-petrel, although not listed federally, has recently been listed as Vulnerable under the International Union for Conservation of Nature (IUCN). The IUCN is an international environmental organization that assesses the conservation status of species and compiles the IUCN Red List of Threatened Species (ICUN 2019). According to the IUCN, the global population of Leach's storm-petrels has declined by ≥30% over three generations. Populations in the western Atlantic are declining, including the population at Baccalieu Island, Newfoundland, which supports the largest leach's storm-petrel colony in this area (BirdLife International 2019). Threats to this species include predation (by native and introduced predators), human disturbance. Like many other seabirds, Leach's storm-petrels are attracted to lights. Lights on offshore oil rigs, as well as flares, can pose a threat, as they may result in collisions with the oil rig, strandings or vessels and platforms, or incineration, in the case of flares (Wiese et al. 2001). Leach's storm-petrels will need to be considered in project-specific EAs for petroleum exploration activities on the Scotian Shelf.

3.2.8 Special Areas

Special Areas within the SEA Study Area include the Western/Emerald Banks Conservation Area (which includes the Haddock Box), the Sambro Bank Sponge Conservation Area, the Emerald Basin Sponge Conservation Area, the Sable Island National Park Reserve, the Eastern Shore Islands AOI (AOIs contain ecologically-sensitive land or species that need extra protection), and five EBSAs. While fisheries closures may not have direct significance to oil and gas activities, they do generally indicate areas of importance for fish spawning and/or protection of juveniles, and therefore have been included for consideration.

Figure 3.19 depicts designated Special Areas, including protected areas and fisheries conservation areas, and Figure 3.20 depicts EBSAs found near the Study Area. Table 3.22 describes the designated Special Areas in the Study Area and Table 3.23 describes EBSAs in the Study Area. EBSAs have been identified based on a compilation of ecological and biological data, 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, King et al. 2016). Using the criteria of uniqueness, aggregation, fitness consequences, naturalness, and resilience, DFO experts identified EBSAs to address conservation objectives in accordance with the *Oceans Act* (Horsman et al. 2011). Although many EBSAs in the Study Area may not yet have official protection under the *Oceans Act*, they warrant consideration for conservation given the ecological and biological significance of the sites. Therefore, EBSAs are considered as Special Areas in the SEA process. The EBSAs presented on Figure 3.20 are based on King et al. 2016. DFO (2012c) outlines DFO's ocean planning process and objectives and how updated criteria are being used to help build a bioregional network of Marine Protected Areas (MPAs) on the Scotian Shelf.



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Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

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

Special Areas

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

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Figure 3.19

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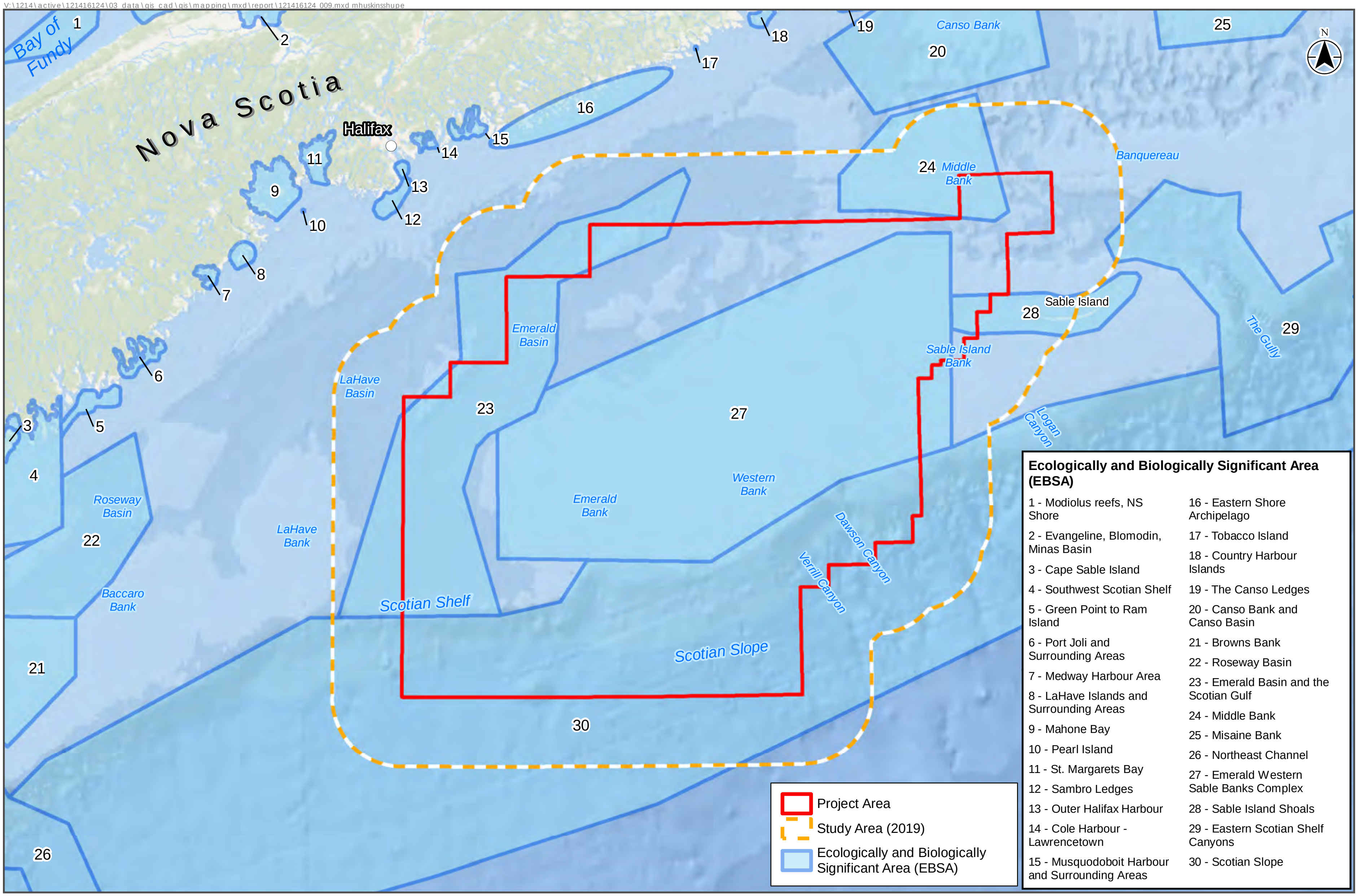

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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

Ecologically and Biologically Significant Areas (EBSA)

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_009

Figure 3.20

Table 3.22 Designated Protected Areas

Eastern Shore Islands AOI (DFO 2018a)	
Location	• This area is approximately 2,134 km^2 and includes nearshore waters and archipelago along the coast of Nova Scotia from Clam Bay to Barren Island, extending approximately 25 km from the coast. It only overlaps slightly with the northwest corner of the Study Area.
Designation and Administration	• In February 2018, DFO identified this region as an AOI. • Selection of this AOI is the beginning of the establishment of a Marine Protected Area (MPA). The final boundary, conservation objectives, management measures and regulations for the future MPA will be informed through information collected through consultation and data analysis. Consultation with Indigenous groups, local communities, industry, and government partners is underway. The collection and analysis of ecological and socio-economic data will be included in the process. • There were five SDLs that were voluntarily amended – 2255B, 2255C, 2255E, 2255Q, and 2255R.
Ecological Significance	• This AOI encompasses a unique, dense archipelago with hundreds of islands. • It provides important habitat for Atlantic salmon within several of its estuaries. • It is an important nesting and foraging area for colonial seabirds and shorebirds. • It provides important foraging areas for harlequin duck, roseate tern and the purple sandpiper. • It contains rich eelgrass and kelp beds. • It provides a nursery area for Atlantic cod, white hake, and pollock, and spawning area for Atlantic herring.
Sable Island National Park Reserve	
Location	• Located 290 km offshore from Halifax, Sable Island is a windswept crescent-shaped sandbar 42 km long by 1.5 km wide that emerges from the Atlantic Ocean near the edge of the Continental Shelf (Parks Canada 2010).
Designation and Administration	• In 2011, the federal government, and the government of Nova Scotia signed a Memorandum of Agreement to Establish a National Park at Sable Island. • To comply with the *National Parks Act*, an *Amending Agreement of Significant Discovery Licence 2255E* was executed on December 21, 2011 (CNSOPB 2011a). • As of December 1, 2013, Sable Island National Park Reserve was offically brought under the protection of 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 2017). • Sable Island was designated as a Migratory Bird Sanctuary (MBS) in 1977 and is administered by the Canadian Wildlife Service (CWS) and is also an Important Bird Area (IBA) (Environment and Climate Change Canada 2018). • Sable Island is protected under the *Special Places Protection Act* for its rich archaeological and heritage resources. Parks Canada maintains a continuous presence on Sable Island, providing operational services to other visitors, researchers and government departments, including ECCC and DFO. Facilities on the Island include several operational buildings, two helicopter landing pads, a communications tower and non-operational infrastructure, including several buildings and two light towers.

Table 3.22 Designated Protected Areas

Ecological Significance	• Over 190 species of plants and 350 species of birds have been recorded on Sable Island. Sable Island contains critical habitat for the SARA-listed roseate tern. The savannah (Ipswich) sparrow, barn swallow, and Sable Island sweat bee are also species at risk that inhabit the Sable Island National Park Reserve. • The Ipswich sparrow (protected under SARA) nests almost exclusively on Sable Island and is the dominant terrestrial bird on the Island. The birds breed on virtually all vegetated areas on Sable Island, including healthy terrain and areas dominated by marram grass. In winter, they occur in coastal dunes, especially in areas with dense beach grass (COSEWIC 2009d). The species' localized distribution makes it particularly vulnerable to potential threats such as chance events (e.g., harsh weather and disease during breeding season), predation, human activity, and habitat loss. • The 2006 proposed Recovery Strategy for the roseate tern (Environment Canada 2006) was the first recovery strategy for a migratory bird posted on the SARA Public Registry to identify "critical habitat" as defined in the Act (200 m buffer zone around tern colonies). The Amended Recovery Strategy for the Roseate Tern (Environment Canada 2010) has the objective to continue to maintain the small peripheral colonies of roseate terns nesting on Sable Island. A former recommended focus on restoration of roseate terns to Sable Island was not attempted on Sable Island (primarily due to financial constraints) and since then, only one or two pairs of roseate terns have nested there each year (Environment Canada 2010). • 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 (Sable Island Green Horse Society 2004). • The Island is inhabited by over 400 wild horses, believed to have been introduced sometime in the mid-1700s (Parks Canada 2011).
Sambro Bank and Emerald Basin Sponge Conservation Areas	
Location	• Sambro Bank Vazella Closure area covers 62 km^2 on Sambro Bank, between LaHave Basin and Emerald Basin on the Scotian Shelf. • Emerald Basin Vazella Closure area covers 197 km^2 in Emerald Basin on the Scotian Shelf.
Designation and Administration	• In 2013, in accordance with DFO's Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas (DFO 2009c), DFO closed two areas on the eastern Scotian Shelf known to contain the highest density of *Vazella pourtalesi* to bottom-contact fishing. • DFO's Sensitive Benthic Areas Policy is guided by the legal and policy framework designed to manage Canada's fisheries and ocean resources including the *Fisheries Act*, the *Oceans Act* and SARA as well as Canada's commitments under several international agreements including Canada's commitment under the United Nations Resolution 61/105 to protect vulnerable marine ecosystems in domestic waters (DFO 2009c).

Table 3.22 Designated Protected Areas

Ecological Significance	• The glass sponge *Vazella pourtalesi* is known to exist in only three locations worldwide – the Gulf of Mexico, the Azores, and in Canada. • The locations on the eastern Scotian Shelf are the only instances where large aggregations have been found and thus are regarded as being globally-unique aggregations; the Gulf of Mexico and the Azores populations exist as individuals or in small aggregations (DFO 2013c). • Slow growth rates, longevity, variable recruitment, and habitat-limiting factors make the sponges particularly vulnerable to physical impacts and limit recovery (DFO 2013c). • Coral and sponges provide habitat for other species – they act as nurseries, refugia, spawning and breeding grounds for other aquatic species (DFO 2010a; Baillon *et al.* 2012; Baker *et al.* 2012a; Baker *et al.* 2012b, as cited in DFO 2015).
Select Fisheries Closure Areas for Fisheries Conservation	
Western/Emerald Banks Conservation Area and the Haddock Box	• The Western/Emerald Banks Conservation Area is a complex benthic-shelf habitat of 10,234 km^2 and is listed pursuant to the *Fisheries Act* as a Marine Refuge, which is an 'Other Effective Area-Based Conservation Measure' that contributes to Canada's Marine Conservation Targets. • It was established to support productivity objectives for groundfish species of Aboriginal, commercial, and/or recreational importance, particularly NAFO Division 4VW haddock (O'Boyle 2011), and to manage the disturbance of benthic habitat that supports juvenile and adult haddock and other groundfish species. • The complex array of sediments and bedforms, including bank and trough habitats, is associated with high adult fish and invertebrate diversity compared to other Eastern Scotian Shelf banks. The Western/Emerald Banks Conservation Area is a key nursery area for juvenile haddock. It also provides important habitat for Atlantic cod, American plaice and winter skate, which are considered depleted species that have been assessed as at-risk by COSEWIC. • The presence of a partial gyre near the Western and Emerald Banks leads to increased retention of larval fish and locally increased zooplankton diversity, a primary larval food source. Correspondingly, larval fish diversity is exceptionally high compared to other areas on the Eastern Scotian Shelf. • Closed year-round to the commercial groundfish fishery by DFO (pursuant to the *Fisheries Act*)*,* scallop fishing continues to occur on the easternmost part of the closed area (O'Boyle 2011). • Encompassed within the Western/Emerald Banks Conservation Area, adult haddock aggregate to spawn within the Haddock Box, including Emerald Bank, from March to June, with peak spawning in March/April (BEPCo. 2004). • The area closure may be playing a role in increasing haddock stocks and abundance of other species (e.g., winter flounder, plaice, silver hake) (O'Boyle 2011).

Table 3.23 Ecologically and Biologically Significant Areas

Emerald Basin and the Scotian Gulf	• The outer edges of this EBSA are approximately at the 200m depth contour (King et al. 2016). It is delineated to include concentrations of the Hexactinellid sponge (*Vazella pourtalesi)* (King et al. 2016). • The area has unique salinity and temperature, where bottom temperatures are warmer than the rest of the Scotian Shelf (Breeze et al. 2002; Loder et al. 2003). • The area has high concentrations of copepods and euphausiids; an important source of food for juvenile fish (Doherty and Horsman 2007; King et al. 2016). • The area provides important nursery area and habitat for silver hake (Sameoto et al. 1994), and important habitat for white hake, sand lance, northern shortfin squid, redfish, pollock, red hake, monkfish, and seabirds (King et al. 2016). • The area has high fish and invertebrate biomass and species richness (King et al. 2016). • Emerald Basin is an area where North Atlantic right whales have been observed and regularly acoustically detected, with the highest number of acoustic detections of North Atlantic right whales on the Scotian Shelf outside of Roseway Basin (Davis et al. 2017).
Middle Bank	• The area lies northwest of Sable Island and is defined approximately by the 110 m depth contour (King et al. 2016). • The area provides important habitat for Atlantic cod during summer/fall and for spawning and as a nursery area (Gagne and O'Boyle 1984, cited in King et al. 2016; Sinclair 1992; MacLean et al. 2009; King et al. 2016). • There is a high genus richness for larval fish (King et al. 2016), high invertebrate and fish biomass (King et al. 2016), and high abundance of American plaice, redfish, silver hake, yellowtail flounder, and witch flounder larvae (King et al. 2016). • Fin whales and minke whales are observed in the area in summer and fall (MacLean et al. 2009). • The area is important habitat for seabirds (King et al. 2016).
Emerald-Western-Sable Bank Complex	• This EBSA overlaps largely with the Western/Emerald Banks Conservation Area, shifted to the east to include ecological features (King et al. 2016) • The area includes important haddock habitat, such as spawning and nursery areas with large areas of gravel and sand-gravel (Frank et al. 2001; Horsman and Shackell 2009; King et al. 2016). It has important habitat for Atlantic cod, including spawning areas (Horsman and Shackell 2009; King et al. 2016), and contains silver hake habitat (Horsman and Shackell 2009). • The area is important habitat for winter skate and yellow flounder (Horsman and Shackell 2009; King et al. 2016), and is a herring spawning area in the fall (Harris and Stephenson 1999). It contains eggs and larvae of haddock, mackerel, pollock, silver hake and yellowtail (King et al. 2016). • The area has a high biomass of fish and invertebrates (King et al. 2016), and high diversity of fish and zooplankton species (Doherty and Horsman 2007; King et al. 2016). • It is important seabird habitat (King et al. 2016).

Table 3.23 Ecologically and Biologically Significant Areas

Sable Island Shoals	• Includes a 10 km area around Sable Island, with the western end extended to include high concentrations of chlorophyll *a* (King et al. 2016). • Sable Island has the largest breeding colony of grey seals in the world; >80% of grey seal pups are born on Sable Island (DFO 2010c). • High concentrations of juvenile haddock, silver hake, Atlantic cod, and yellowtail flounder (Doherty and Horsman 2007; Scott 1987). • Significant breeding populations of terns and gulls (King et al. 2016). • Defined as an Important Bird Area, supporting almost the entire population of the Ipswich savannah sparrow (Bird Studies Canada 2018). • Important habitat for seabirds (King et al. 2016).
Scotian Slope	• Defined approximately as the area between 200 and 3000 m depth along the edge of the Scotian Shelf (King et al. 2016). • High primary productivity caused by enhanced vertical mixing due to steep topography (Breeze et al. 2002). • High concentrations of chlorophyll *a* (King et al. 2016). • Migratory route for leatherback turtle, cetaceans and large pelagic fish (Doherty and Horsman 2007; King et al. 2016) • Sowerby's beaked whale habitat (COSEWIC 2006b). • Important blue whale habitat (Lesage et al. 2018). • Important seabird habitat (King et al. 2016). • High finfish and squid diversity (Doherty and Horsman 2016). • Overwintering area for halibut, mackerel and lobster (Breeze et al. 2002; Doherty and Horsman 2007). • Important habitat for demersal fish including cusk (DFO 2014a), redfish, white hake, thorny skate, Atlantic halibut, longfin hake and Atlantic argentine (Horsman and Shackell 2009; King et al. 2016). • Important habitat for invertebrates including red crab, northern shortfin squid, northern stone crab, American lobster, and sea stars (King et al. 2016). • Submarine canyons occur on the edge of the shelf, providing a wide variety of physical habitats (King et al. 2016). • Northern bottlenose whale habitat, including "critical habitat" (as defined in the SARA) in the Gully, Shortland and Haldimand canyons (DFO 2011c). • Coral species are known to occur along the slope and submarine canyons (Cogswell et al. 2009).

3.3 SOCIO-ECONOMIC CHARACTERISTICS

3.3.1 Fisheries

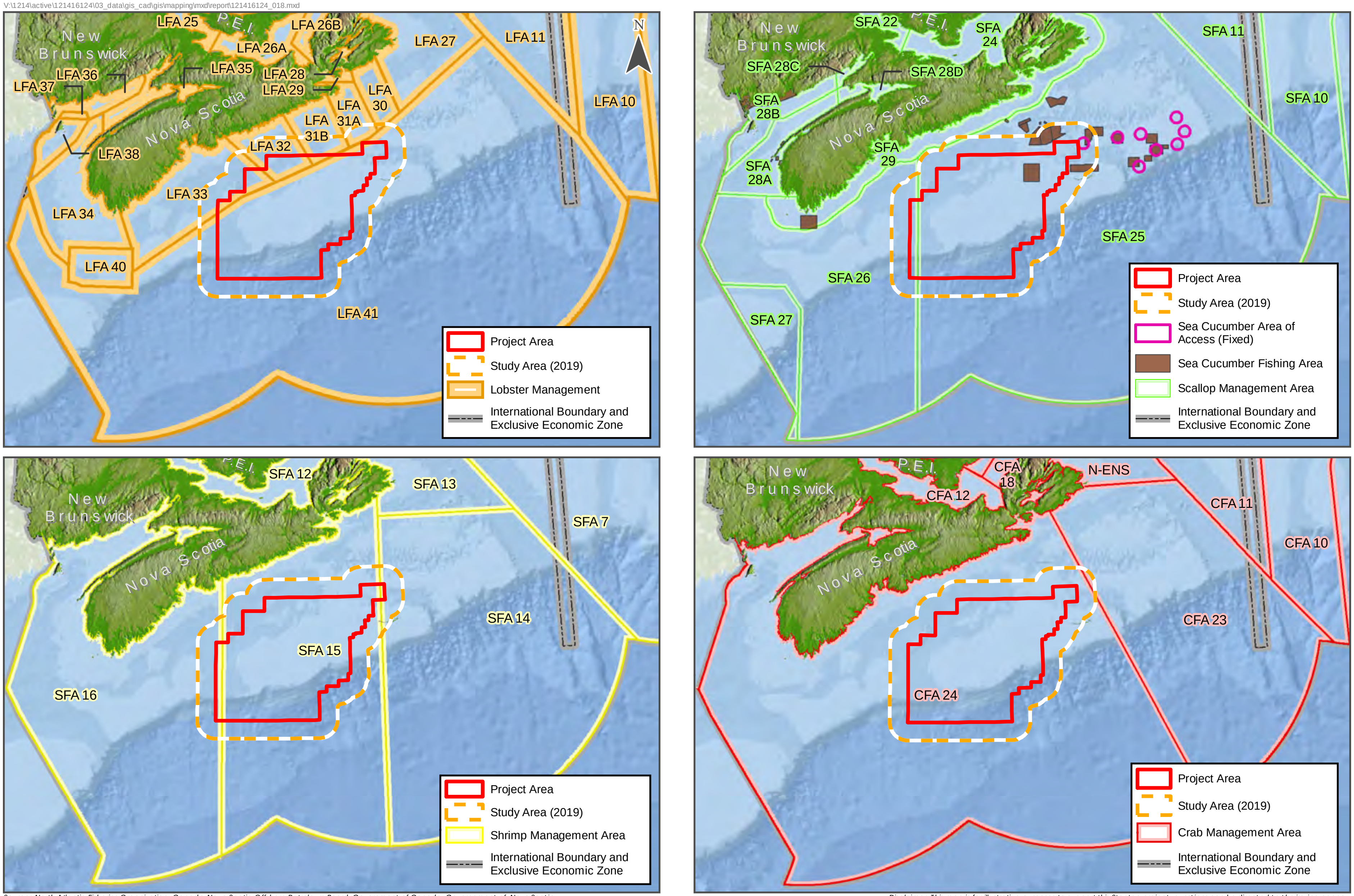
A variety of fisheries exist throughout the Study Area. Some recreational fishing occurs in the offshore region; however, the majority of recreational fishing occurs in coastal and nearshore areas. Recreational fisheries in the offshore area may include fishing charters and tournaments for large pelagics (e.g., tuna, swordfish).

Commercial fishing in offshore Nova Scotia waters started in the mid-1500s and by 1700 Nova Scotia was exporting cod, mackerel, and herring. In 1973, the total landings of fish on the Scotian Shelf peaked, with catches exceeding 750,000,000 kg (750,000 t) (DFO 2011b). In 1977-1978 the overall landed value of fish increased dramatically with the declaration of a 200-mile exclusive economic zone, greatly reducing foreign fishing on the Scotian Shelf.

Throughout most of Nova Scotia’s history, groundfish fisheries dominated the commercial catch, although landings reached a historic low with the collapse of groundfish stocks and in 1993, a moratorium on the groundfish fishery, particularly for cod, was imposed on the Eastern Scotian Shelf (NAFO Divisions 4W, 4Vs, 4Vn, and 3Ps) and remains in effect today (Worcester and Parker 2010).

The Study Area falls within NAFO Divisions 4W, 4X, and 4Vs and contains some of the most important fishing areas in the Northwest Atlantic Ocean. Figure 3.21 displays the NAFO Division boundaries as well as other management areas used to manage other fishing areas including Scallop Fishing Areas (SFAs), Crab Fishing Areas (CFAs) and Lobster Fishing Areas (LFAs). Shellfish fisheries (e.g., sea scallop, lobster, crab), pelagic (e.g., shark, swordfish, tuna, mackerel), and groundfish (cod, halibut, flatfish, haddock, hake) fisheries occur throughout the Study Area, with shellfish fisheries dominating the commercial catch value.

Table 3.24 outlines the number of fishery licences (commercial and communal commercial) that may fish in the Western Scotian Slope and Shelf Region within which the Study Area is located. This data, provided courtesy of DFO, demonstrates the relative context of fisheries operating in the vicinity of the Study Area, based primarily on licensing data from NAFO 4W, 4X and 4Vs. The number of licences and tonnage of landings are determined from fisher-submitted documents and landings totals may not add up due to rounding. It should be noted that the data in Table 3.24 is representative of 2018 licence counts and contains preliminary landings data as of April 3, 2019. This data represents a snapshot in time of fishing activity and this activity may vary among years. For an overall depiction of fishing activity over longer time periods, refer to landings maps in Appendix B (Butler and Coffen-Smout 2017; Serdynska and Coffen-Smout 2017) as well as landing values in Table 3.25 (DFO 2017).



Sources:North Atlantic Fisheries Organization, Canada-Nova Scotia Offshore Petroleum Board, Government of Canada, Governement of Nova Scotia.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 CSRS UTM Zone 20N

0 50 100 150 200
Kilometres

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

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STRATEGIC ENVIRONMENTAL ASSESSMENT

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Commercial Fisheries Management Areas

Figure 3.21

Table 3.24 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (i.e., Commercial and Communal Commercial) (2018P)	Number of Communal Commercial Licences (2018P)	Total Number of Licences with Landings (2018P[1])	Number of Communal Commercial Licences with Landings (2018P)	Landings for all Licences in tonnes (t, 2018P)	Landings for Communal Commercial Licences in tonnes (t, 2018P)
Crab CFA 23/24E CFA 24W	 CFA 23/24E – 115 CFA 24W – 9	 CFA 23/24E – 34 CFA 24W – 3	 CFA 23/24E – 58 CFA 24W – 6	 CFA 23/24E – 19 CFA 24W – *	Total landings for all areas = 6,087 t	Total communal commercial landings for all areas = 2,023 t
Groundfish (All Gear) (Includes cusk, dogfish, flatfish, red hake, white hake, silver hake, halibut, redfish, wolfish) NAFO 4W NAFO 4X NAFO 4VS	Total licences for all areas (some licences may fish multiple areas) = 2,102 4W – 879 4X – 1,850 4VS – 879	Total Communal Commercial licences for all areas (some licences may fish multiple areas) = 32 4W – 14 4X – 30 4VS –14	Total licences with landings for all areas (some licences may have landings from multiple areas) = 510 4W – 177 4X – 378 4VS – 81	Total Communal Commercial Licences with landings for all areas (some licences may have landings from multiple areas) = * 4W – * 4X – * 4VS – *	Total landings for all areas = 14,567 t 4W – 5,879 4X – 6,699 4VS - 1,989	Total Communal Commercial landings for all areas = * t 4W – * 4X – * 4VS – *
Hagfish NAFO 4W NAFO 4X NAFO 4VS	Total licences for all areas (some licences may fish multiple areas) = 7 4W – 5 4X – 4 4VS – 2	Total Communal Commercial licences for all areas = 1 4W – 1 4X – 0 4VS – 1	Total licences with landings for all areas (some licences may have landings from multiple areas) = * 4W – * 4X – * 4VS – *	Total Communal Commercial licences with landings for all areas = * 4W – * 4X – * 4VS – *	Total landings for all areas = * t 4W – * 4X – * 4VS – *	Total Communal Commercial landings for all areas = * t 4W – * 4X – * 4VS – *
Large Pelagics (Vessel-based licences that are valid to fish all of DFO Maritimes Region. Some licences are issued	All large pelagics = 858	All large pelagics = 14	Shark = 43 Swordfish (harpoon & longline) total = 87 4W – 57 4X – 64	Shark = * Swordfish (harpoon & longline) total = * 4W – * 4X – *	Shark = 33 t Swordfish total = 581 t 4W – 323 t 4X – 127 t 4VS – 131 t	Shark = * Swordfish total = * t 4W – * t 4X – * t 4VS – * t

Table 3.24 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (i.e., Commercial and Communal Commercial) (2018P)	Number of Communal Commercial Licences (2018P)	Total Number of Licences with Landings (2018P[1])	Number of Communal Commercial Licences with Landings (2018P)	Landings for all Licences in tonnes (t, 2018P)	Landings for Communal Commercial Licences in tonnes (t, 2018P)
out of DFO Gulf Region). NAFO 4W NAFO 4X NAFO 4VS			4VS – 16 Tuna (Bluefin) total = 121 4W – 89 4X – 48 4VS – 6 Other large pelagic (albacore tuna, bigeye tuna, yellowfin tuna, tuna unspecified, white marlin, mahi mahi) total = 61 4W – 36 4X – 49 4VS – 12	4VS – * Tuna (Bluefin) total = 9 4W – 5 4X – 6 4VS – 0 Other large pelagic total = 0 4W – 0 4X – 0 4VS – 0	Tuna (Bluefin) total = 217 t 4W – 109 t 4X – 91 t 4VS – 17 t Other large pelagic total = 253 t 4W – 104 t 4X – 126 t 4VS – 22 t	Tuna (Bluefin) total Communal Commercial landings for all areas = 14 t Other large pelagic total = 0 4W – 0 4X – 0 4VS – 0
Lobster (Inshore and Offshore) LFA 41 LFA 30 LFA 31A LFA 31B LFA 32 LFA 33	LFA 41 - 1 LFA 30 - 20 LFA 31A - 71 LFA 31B - 70 LFA 32 - 149 LFA 33 - 658	LFA 41 - 0 LFA 30 - 0 LFA 31A - 0 LFA 31B - 0 LFA 32 - 3 LFA 33 - 18	LFA 41 - * LFA 30 - 18 LFA 31A - 61 LFA 31B - 69 LFA 32 - 135 LFA 33 - 581	LFA 41 - N/A LFA 30 - N/A LFA 31A - N/A LFA 31B - N/A LFA 32 - * LFA 33 - 14	LFA 41 - * LFA 30 - * LFA 31A - 889 t LFA 31B - 1165 t LFA 32 - 1062 t LFA 33 - 7971 t	LFA 41 - N/A LFA 30 - N/A LFA 31A - N/A LFA 31B - N/A LFA 32 - * LFA 33 - *

Table 3.24 Fishery Licence and Landing Information of the Southwest Scotian Slope and Shelf Region

Fishery	Total Number of Licences (i.e., Commercial and Communal Commercial) (2018P)	Number of Communal Commercial Licences (2018P)	Total Number of Licences with Landings (2018P[1])	Number of Communal Commercial Licences with Landings (2018P)	Landings for all Licences in tonnes (t, 2018P)	Landings for Communal Commercial Licences in tonnes (t, 2018P)
Mackerel (Vessel-based licences that are valid to fish all of DFO Maritimes Region) NAFO 4W NAFO 4X NAFO 4VS	1,711	27	94 4W – 22 4X – 81 4VS – *	0	423 t 4W – 34 t 4X – 613 t 4VS – *	N/A
Scallop (Vessel-based licences that are valid to fish all of DFO Maritimes Region) SFA 25 SFA 26	6 (Offshore) SFA 25 – 6 SFA 26 – 6	0 SFA 25 – 0 SFA 26 – 0	6 SFA 25 – * SFA 26 – 6	N/A	Total landings for all areas = 40,101 t	N/A

Notes:
[1]Data for reporting 2018 is preliminary (denoted by 2018P) and as such, may be incomplete and/or subject to change without notice.
[*]To protect confidentiality, landings totals are denoted by an asterisk (*) in instances where less than five separate licence holders have been active.

Source: DFO, pers. comm. 2019

Table 3.25 summarizes landings weight and values for each of the three NAFO divisions (4W, 4X, and 4Vs) for pelagic, groundfish, shellfish and other (e.g., marine algae) fisheries for 2011-2016. DFO does not distribute data from NAFO units with few licences in order to protect privacy. Therefore, actual landing weights and values may be higher. Detailed data per NAFO Unit are provided in Appendix B (DFO 2017). Table 3.26 summarizes fishing seasons for key commercial fisheries with potential to occur in the Study Area. Additional details on the pelagic, groundfish, and shellfish (invertebrate) fisheries are provided in the following sections. Spatial data for fisheries landings 2010 to 2014 are provided in Appendix B (Butler and Coffen-Smout 2017; Serdynska and Coffen-Smout 2017) to illustrate a regional context of fisheries activities in and around the Study Area.

Table 3.25 Landed Weight and Value of Commercial Fish Species in NAFO Divisions 4W, 4X, 4Vs (2011-2016)

	2011		2012		2013		2014		2015		2016	
	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)	Landed Weight (t)	Landed Value ($'000)
Groundfish												
4VS	2,607	4,506	3,974	6,092	793	3,745	1,351	5,479	1,600	7,036	1,540	6,795
4W	10,221	12,019	12,604	13,642	9,881	13,916	9,459	13,618	8,018	13,865	7,532	13,468
4X	20,306	31,455	20,390	33,396	14,142	28,435	11,482	25,311	11,141	29,171	12,870	33,540
Total Groundfish	**33,134**	**47,980**	**36,967**	**53,130**	**24,816**	**46,096**	**22,292**	**44,409**	**20,759**	**50,072**	**21,942**	**53,803**
Pelagics												
4VS	83	544	62	389	139	1,227	212	1,537	279	2,116	210	2,472
4W	12,131	8,671	2,463	6,166	3,854	9,851	2,288	9,142	3,644	8,175	3,486	13,701
4X	51,533	18,319	46,487	20,922	54,289	25,304	47,109	22,957	48,345	25,652	48,412	22,590
Total Pelagics	**63,748**	**27,533**	**49,012**	**27,478**	**58,281**	**36,382**	**49,610**	**33,636**	**52,268**	**35,942**	**52,108**	**38,762**
Shellfish												
4VS	8,036	37,821	7,759	33,049	7,325	23,568	7,508	35,058	7,424	23,738	6,392	38,857
4W	11,272	74,584	11,127	72,065	11,045	58,022	11,746	81,670	12,112	86,653	10,023	101,677
4X	56,379	356,803	55,979	356,344	53,725	412,950	69,470	591,847	69,027	725,031	68,833	743,045
Total Shellfish	**75,686**	**469,208**	**74,865**	**461,457**	**72,095**	**494,539**	**88,724**	**708,574**	**88,564**	**835,421**	**85,248**	**883,578**
Other Species												
4VS	0	0	0	0	0	0	0.1	1	0	0	0	0
4W	0	0	0	0	0	0	0.1	1	<0.1	1	0	0
4X	596	245	319	131	200	90	13	6	<0.1	0.2	0	0
Total Other Species	**596**	**245**	**319**	**131**	**200**	**90**	**13**	**8**	**<0.1**	**1**	**0**	**0**
Grand Total	**173,164**	**544,966**	**161,163**	**542,197**	**155,392**	**577,107**	**160,638**	**786,626**	**161,590**	**921,437**	**159,298**	**976,143**

Source: DFO 2017

Table 3.26 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within Study Area

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species													
Albacore tuna	*Thunnys alalunga*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Bigeye tuna	*Thunnus obesus*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
Blue marlin	*Makaira nigricans*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Bluefin tuna	*Thunnus thynnus*	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Red	Red	Yellow
Mackerel	*Scomber scombrus*	Green	Green	Green	Green	Green	Yellow	Red	Red	Red	Green	Green	Green
Porbeagle shark	*Lamna nasus*	Green	Yellow	Red	Red	Red	Red	Green	Green	Green	Yellow	Yellow	Yellow
Swordfish	*Xiphias gladius*	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Red	Red	Yellow
White marlin	*Tetrapturus albidus*	Green	Green	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green
Groundfish Species													
American plaice	*Hippoglossoides platessoides*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic cod	*Gadus morhua*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Atlantic halibut	*Hippoglossus hippoglossus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Cusk	*Brosme brosme*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Greysole-witch flounder	*Glyptocephalus cynoglossus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Haddock	*Melanogrammus aeglefinus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Hagfish	*Myxine glutinosa*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Mahi mahi	*Coryphaena hippurus*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Mako shark	*Leurus oxyringus*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Monkfish	*Lophius spp.*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Pollock	*Pollachius virens*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Redfish (deepwater and Acadian)	*Sebastes mentella / Sebastes fasciatus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Red hake	*Urophycis chuss*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Silver hake	*Merluccius bilinearis*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow

Table 3.26 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within Study Area

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Atlantic wolffish	*Anarhichas lupus*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Turbot–Greenland halibut	*Reinhardtius hippoglossoides*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
White hake	*Urophycis tenuis*	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Green	Yellow	Yellow
Invertebrate Species													
Lobster*	*Homarus americanus*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Northern shrimp	*Panadalus borealis*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Scallop	potential for multiple species	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow
Sea cucumber	Class *Holothuroidea*	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Yellow
Snow crab	*Chionoecetes opilio*	White	White	White	Green	Green	Green	Green	Green	Green	White	White	White
Stimpson's surf clam	*Mactromeris polynyma*	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green

*Note: The Study Area falls within multiple LFAs (30, 31a, 31b, 32, 33, and 41) with different fishing seasons. See below for the various Lobster fishing seasons (DFO 2018b):
LFA 30: May 20 – July 20
LFA 31a: April 29 – June 30
LFA 31b: April 19 – June 20
LFA 32: April 19 – June 20
LFA 33: last Monday in November – May 31
LFA 41: Open year-round.

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

Data sources: Breeze and Horsman 2005

Indigenous groups in Nova Scotia also conduct commercial fishing, which occurs under communal commercial licences issued to Aboriginal organizations. Communal commercial licences for fishing in waters offshore Nova Scotia are issued through DFO Maritimes Region and Gulf Region, giving access to 34 different Aboriginal organizations to waters offshore Nova Scotia.

3.3.1.1 Pelagic Fisheries

During the period from 1980-2000 pelagic species have shown fluctuations in catch and have ranged from 8% to 15% of the total landed value on the Scotian Shelf (Worcester and Parker 2010). In 2012 pelagic species accounted for approximately 9% ($55 million) of the total landed value of commercial landings in the Maritimes Region (DFO 2013b). 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 (DFO 2012a).

Figures B.1 to B.8 in Appendix B (Butler and Coffen-Smout 2017) demonstrate pelagic fisheries in the Study Area are concentrated primarily along the shelf break (e.g., swordfish) or in deeper waters off the Scotian Slope (e.g., tuna). Table 3.27 summarizes information regarding fishing seasons and gear types.

Table 3.27 Pelagic Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Bluefin tuna	• Season is open year-round with the main season taking place during the summer and fall months • Catch limits are governed by the International Commission for the Conservation of Atlantic Tuna (ICCAT) • Gear used is either direct fishing by angling (rod and line), tended line trap, or electric harpoon and indirect fishing by longline
Albacore tuna Bigeye tuna Yellowfin tuna	• Season is open year-round with the main season taking place from July to November • Gear used is pelagic (floating) longline, with some trolling using rod and line • Mainly fished for along the shelf edge and slope
Swordfish	• Season is open year-round with the main seasons taking place from June to July for harpoon, and July to November for longline • Catch limits are governed by the ICCAT • Gear used includes pelagic longline and harpoon • Mainly fished for along the shelf edge and slope
Porbeagle shark Mako shark	• A large proportion of sharks are caught as bycatch in the swordfish longline fishery. • There is a direct fishery for porbeagle sharks using pelagic longline gear and angling. • The main commercial fishery occurs along the Scotian Slope.

Source: DFO 2011d

3.3.1.2 Groundfish Fisheries

Groundfish landings dominated the Nova Scotia fishery until the early 1990s. Between 1991 and 1995, groundfish landings dropped by 80% (DFO 2012a). In 2012 groundfish species accounted for approximately 10% ($63 million) of the total landed value of commercial landings in the Maritimes Region. The collapse in groundfish stocks in the 1990s and the moratorium for cod and haddock fishing in 4W, 4Vs, 4Vn, and 3Ps has had a profound effect on the Scotian Shelf ecosystem and fisheries. Within those fisheries management areas, the longline fishery for Atlantic halibut is presently the major groundfish fishery in operation (Worcester and Parker 2010).

Landings of Western Scotian Shelf/Bay of Fundy cod averaged 20,000 t annually over several decades but declined after 1990 to a range of 3,000-5,000 t since 2000 (DFO 2012a). Atlantic cod and witch flounder stocks on the Western Scotian Shelf are considered to be at a critical state. Haddock, halibut, winter flounder, are considered to have healthy stock status (DFO 2012a).

Figures B.9 to B.23 in Appendix B (Butler and Coffen-Smout 2017) depict locations of groundfish species catches within and around the Study Area. Table 3.28 summarizes information regarding fishing seasons and gear types.

Table 3.28 Groundfish Fishery Seasons and Gear Type

Fishing Seasons and Areas	• Groundfish fishery is open during all seasons. • Fishing occurs in NAFO divisions 4W, 4X and 4Vs. • Cod and haddock fisheries have been closed since 1993, and species can only be caught and kept through by-catch. • Some seasons are more important than others based on the seasonal movement of fish species. • Most intensive fishing occurs in the summer from July to September where fishing activity is widespread on the Scotian Shelf. • The central shelf basins and valleys yield high landings year-round. • In the fall months there is less fishing pressure and landings, as many fishermen fishing for groundfish switch to lobster in late November. • Halibut catch is concentrated along the shelf break, Roseway Basin, and Browns and Baccaro Banks. Cod, haddock, and pollock landings are concentrated on the LaHave, Baccaro and Brown Banks and Georges Bank and Basin.
Gear Type	• The main gear types used are trawls and longlines. • Longlines are used most frequently on the shelf edge and deep-water channels and basins. • Handlines and gillnets are rarely used.
Other Information	• The collapse and closure of the cod and haddock fisheries has resulted in a switch from groundfish as the main target to invertebrates (shellfish) in 4W. Groundfish remain an important fishery in 4X.

Source: Breeze and Horsman 2005

3.3.1.3 Shellfish Fisheries

Since the 1990s, the total value of the shellfish fishery has surpassed that of groundfish fishery in Nova Scotia. In 2012, shellfish species accounted for approximately 81% ($508 million) of the total landed value of commercial landings in the Maritimes Region (DFO 2013b). Within the Western Scotian Shelf region, there are no invertebrate stocks considered to be at a critical health level (DFO 2012a).

LFA 34, located to the west of the Study Area off southern Nova Scotia, has the highest landings of lobster of any area in Canada, accounting for 40% of Canadian landings and 23% of the world landings (Worcester and Parker 2010). The snow crab fishery is the third most valuable commercial fishery in Atlantic Canada, and the fourth most valuable fishery in Nova Scotia (Hubley et al. 2018). Commercial fishing for lobster and crab in the Study Area is concentrated on Georges Bank outer shelf and upper slope, Georges Basin, Southeast Browns Bank outer shelf and upper slope east of the Northeast Channel, and West Browns Bank (DFO 2011b). The scallop fishery, concentrated on Georges Bank and Browns Bank in the Study Area, accounts for approximately 70-80% of the annual scallops landed in Canada (DFO 2011a).

Figures B.24 to B.29 in Appendix B (Butler and Coffen-Smout 2017; Serdynska and Coffen-Smout 2017) depict locations of shellfish landings within and around the Study Area. Table 3.29 summarizes information regarding fishing seasons and gear types.

Table 3.29 Shellfish Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Clam species (propeller, Stimpson's surf, quahog)	• Clam fishing occurs mainly on Banquereau Bank; the western arm is located within the Study Area. • The fishing season is open year-round. • Hydraulic clam dredges are the main type of gear used.
Crab	• CFAs 23 and 24 are located within the Study Area. • Snow crab is the primary crab species harvested in the Study Area, although Jonah crab, rock crab, stone crab, porcupine crab and spider/toad crab are also caught. Jonah crab are harvested in the same areas as the offshore lobster fishery. • The fishing season for CFAs 23 and 24 runs from April 2 - September 30. • Gear used are crab traps, which are either conical or rectangular in shape.
Lobster	• Within the Study Area, inshore and offshore lobsters are fished within LFAs 30 to 33 and LFA 41. • Has been historically fished with traps and trawls although use of trawls has been significantly reduced in recent years. Trawls for lobster are multiple traps attached on one line which is the preferred method used in offshore areas. • Fishery season is open year-round subject to Total Allowable Catch.
Northern shrimp	• Shrimp Fishing Areas 14-16 fall within the Study Area. • The fishing season is open year-round. DFO creates quotas based on information received from the Eastern Scotian Shelf Shrimp Advisory committee. • The gear used are shrimp trawls.
Sea cucumber	• Main fishery is harvested from May to November using modified scallop drags. • Also caught as by-catch in the scallop fishery.
Sea scallop	• Scallop Fishing Areas 25 and 26 are located within the Study Area. • The fishing season is open year-round. There is a lull in fishing activity during the winter months.

Table 3.29 Shellfish Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Clam species (propeller, Stimpson's surf, quahog)	• Clam fishing occurs mainly on Banquereau Bank; the western arm is located within the Study Area. • The fishing season is open year-round. • Hydraulic clam dredges are the main type of gear used.
	• The gear used for fishing is mainly scallop drags.
Exploratory	• There is the possibility of exploratory fisheries occurring in the Study Area. • Exploratory whelk fishing surveys are ongoing.

Source: Breeze and Horsman 2005; DFO 2011a, 2014, 2018b

3.3.2 Other Ocean Uses

In addition to the fisheries described above, there are several other ocean activities and uses occurring within and around the Study Area, including commercial shipping, military exercises, petroleum decommissioning, telecommunication cables, and scientific research (refer to Table 3.30).

Table 3.30 Other Ocean Uses In and Around the Study Area

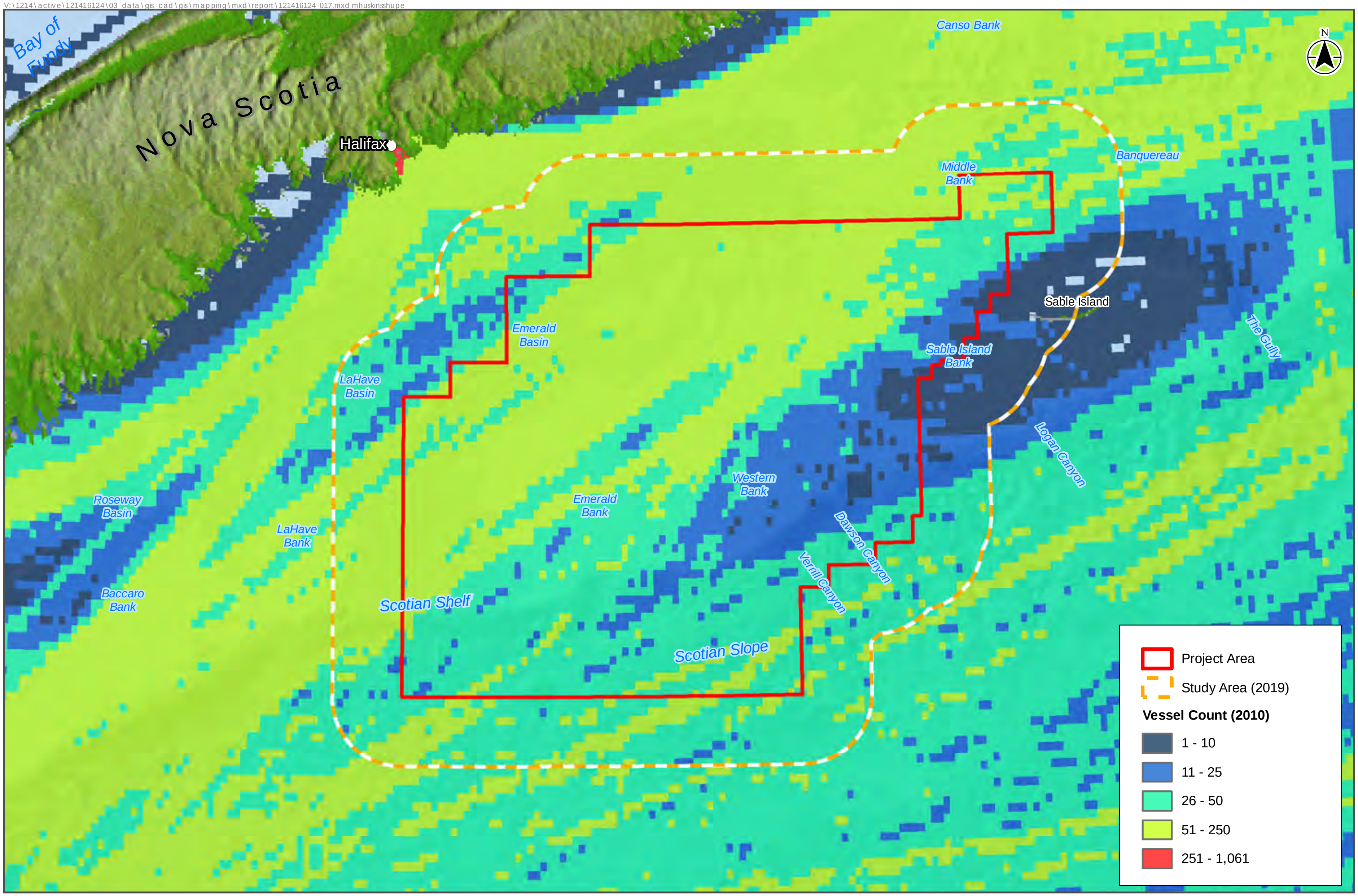
Use	Description
Commercial Shipping (refer to Figure 3.22)	• There is heavy vessel traffic throughout the Study Area, except for the area around Sable Island, which has relatively low amounts of traffic. • The Study Area is heavily used for domestic and international commercial shipping consisting of mostly tankers and bulk and containerized cargo carriers, as well as a range of fishing vessels, cruise ships and various government vessels. • There are four distinct regional traffic patterns including: international shipping over the Scotian Shelf as part of the "great circle route" (i.e., shortest distance over the earth's surface) between Europe and the eastern seaboard of the United States and Canada; international and domestic shipping along the coast of Nova Scotia bound to and from the United States, Bay of Fundy, Gulf of St. Lawrence and Newfoundland; shipping through the Cabot Strait, a major sea route linking trans-Atlantic shipping lanes to the St. Lawrence Seaway and the Great Lakes; and traffic associated with the major ports of Halifax, Saint John, Port Hawkesbury (Strait of Canso) and Sydney (DFO 2011a). • Fishing vessels account for over 70% of marine traffic volume southeast of Nova Scotia (essentially between Cape Breton and Yarmouth out to the EEZ) (Pelot and Wootton 2004). • A designated ballast water exchange zone exists in the southern portion of Study Area, extending from the Scotian Slope to the EEZ, providing ships the opportunity to exchange ballast waters mid-ocean to reduce the risk of alien species introduction and transfer.
Offshore Petroleum Activity – Petroleum Exploration (refer to Figure 3.23)	• A review of current applications on the CNSOPB website as of February 1, 2019 indicates there are no active applications for seismic exploration or exploration wells in the Nova Scotia offshore. • There are three active exploration licences offshore Nova Scotia but no applications for work authorizations.

Table 3.30 Other Ocean Uses In and Around the Study Area

Use	Description
	• In 2018 BP Canada Energy Group ULC drilled an exploration well on its consolidated licence 2434R on the Scotian Slope. This well was plugged and abandoned in December 2018. In January 2019, BP surrendered 50% of its lands and paid a drilling deposit to extend the initial term of its licence to January 2020 (CNSOPB 2019). There is currently no application for any additional wells on BP's consolidated licence. • Equinor Canada Ltd. was awarded ELs 2435 and 2436 in a Call for Bids process in 2015. No work program authorization applications have been submitted to the CNSOPB for exploration activity on these licences.
Offshore Petroleum Activity - Decommissioning (refer to Figure 3.23)	Sable Offshore Energy Project (SOEP) • Gas production has ceased at all gas fields at SOEP. The final two fields were permanently shut down on December 31, 2018. Well plugging and abandonment activites are ongoing and are expected to be complete by the fall of 2019. • All platforms are being de-inventoried of hydrocarbons and left unmanned, with only navigational aids functional, until removal in 2020. All pipelines are being cleaned and flushed of hydrocarbons until the point that they are environmentally benign. Prior to removal of the platforms, the pipelines will be disconnected and left in place on the seabed, in a manner that is non-hazardous to other users of the sea. Deep Panuke • Gas production ceased from the Deep Panuke field in May of 2018. The platform is now completely hydrocarbon free, and the gas export pipeline and flowlines to the wells are depressurized but still contain hydrocarbons. The export pipeline and well flowlines will be cleaned and flushed of hydrocarbons until the point that they are environmentally benign in the summer of 2019. • All five wells in the Deep Panuke field will be plugged and abandoned, tentatively starting in the fall of 2019. Tentatively, the platform will be removed from the field in summer of 2020, and the cleaned pipeline and flowlines will be disconnected and left on the seabed in a manner that is non-hazardous to other users of the sea.
Seabed Cables (refer to Figure 3.24)	• There are numerous inactive cables on the Scotian Shelf and Slope, some of which are more than 100 years old (Breeze and Horsman 2005). Many of these inactive cables run thought the Study Area. • Several active submarine telecommunications cables make landfall in Nova Scotia. Two of these cables, Hibernia Atlantic Section A and Hibernia Atlantic Section D, pass through the southwestern corner of the Study Area. However, only one of these cables (Hibernia Atlantic Section A) intersects the Project Area. A very small portion of this line passes through the southwest corner of the Project Area.
Shipwrecks and Legacy Sites (refer to Figure 3.24)	• As illustrated on Figure 3.24 there are several shipwrecks existing within the Study Area. • There are two explosive dumpsites within the Study Area (only one of which is located in the Project Area).
Military Activity (refer to Figure 3.25)	• Canada's east coast naval presence is provided through Maritime Forces Atlantic (MARLANT), which has its headquarters in Halifax.

Table 3.30 Other Ocean Uses In and Around the Study Area

Use	Description
	• MARLANT engages in a range of operations and activities 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, including fisheries and environmental protection (DFO 2011a). • MARLANT also conducts naval training activities in designated exercise areas off Nova Scotia. Exercise areas may also be used by foreign vessels or aircraft during periodic multinational exercises or with permission from the Government of Canada. Maps, coordinates and descriptions of military activities permitted in these exercise areas are provided in the Canadian Coast Guard's Annual Notice to Mariners (DFO 2011a). • Operators are requested to consult with DND during Project-specific EAs to present project locations and timing to confirm no adverse interactions with military activity.
Scientific Research	• There are several ongoing scientific research programs on the Scotian Shelf, some of which occur in the Study Area. • The Gulf of Maine Ocean Observing System and Environment Canada owns and operates buoys on the Scotian Slope. The Halifax Line of the AZMP runs through the Study Area. There is also a fixed station (Halifax Station 2) in the Study Area, on the Halifax Line. This transect and station are each sampled by DFO on a bi-weekly or monthly schedule during the ice-free season. The AZMP is a comprehensive environmental monitoring program designed and implemented by DFO in 1999. The program was introduced to increase DFO's capacity to understand, describe, and forecast the state of the ocean environment and to relate these changes to the predator-prey relationships of marine resources. The Atlantic Zone Off-Shelf Monitoring Program (AZOMP) collects data from the Scotian Slope and rise. It essentially extends the Halifax line (referred to as the extended Halifax Line) further offshore. Physical, chemical and biological characteristics have been collected at least once a year along this line since 2006. • 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 since 1931 (Sir Alister Hardy Foundation for Ocean Science 2005; DFO 2011a). • 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 (DFO 2011a) which are generally conducted in the winter and summer within the Study Area. • Scientists from Dalhousie University (Whitehead Lab) conduct cetacean studies within the Study Area. • The Ocean Tracking Network (OTN), based at Dalhousie University, and DFO jointly operate a fixed and semi-permanent series of almost 200 acoustic receivers along the ocean bottom of the Halifax Line. There is the potential that these receivers could be impacted by seismic surveys in the area.



Sources: North Atlantic Fisheries Organization, Canada-Nova Scotia Offshore Petroleum Board, Government of Canada, Governement of Nova Scotia.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Vessel Traffic

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_017

Figure 3.22

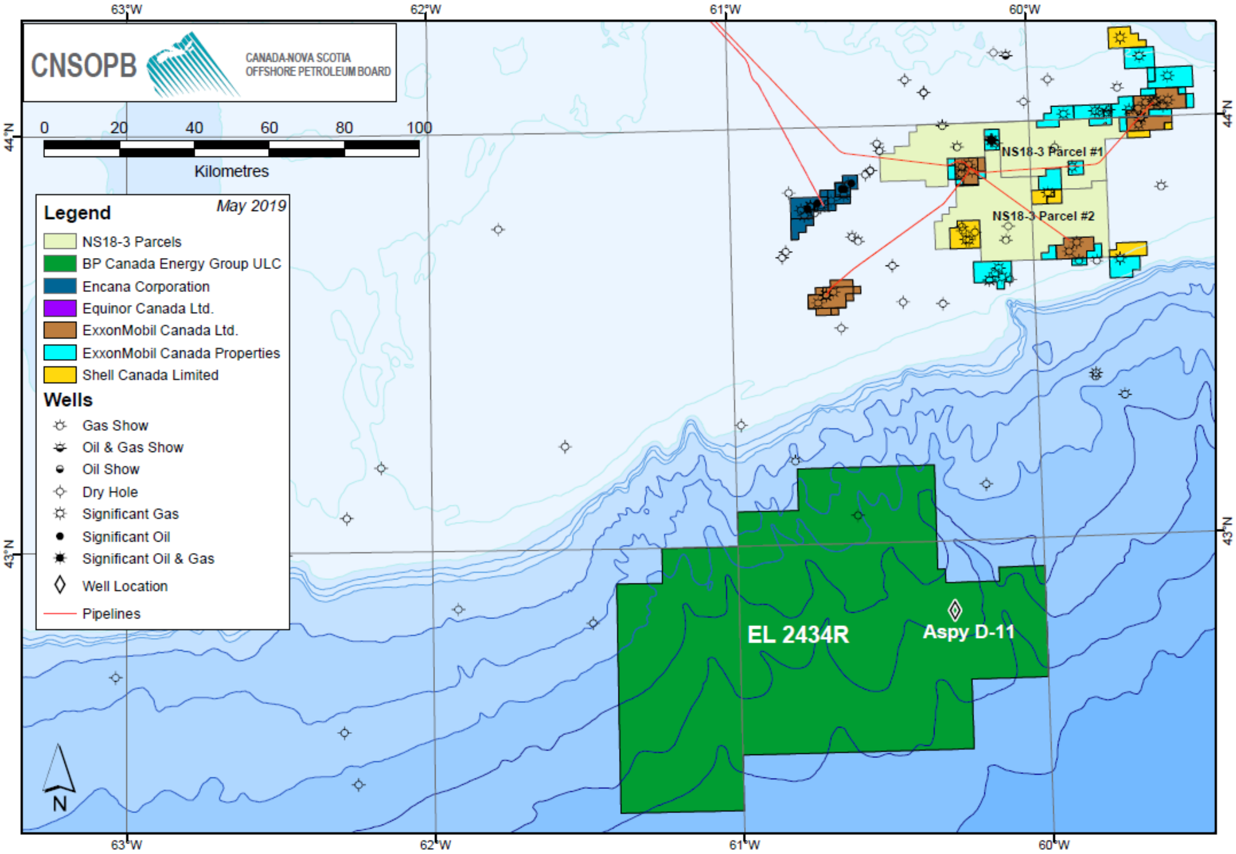


Figure 3.23 Offshore Oil and Gas Activity as of May 2019 within the Vicinity of the Study Area

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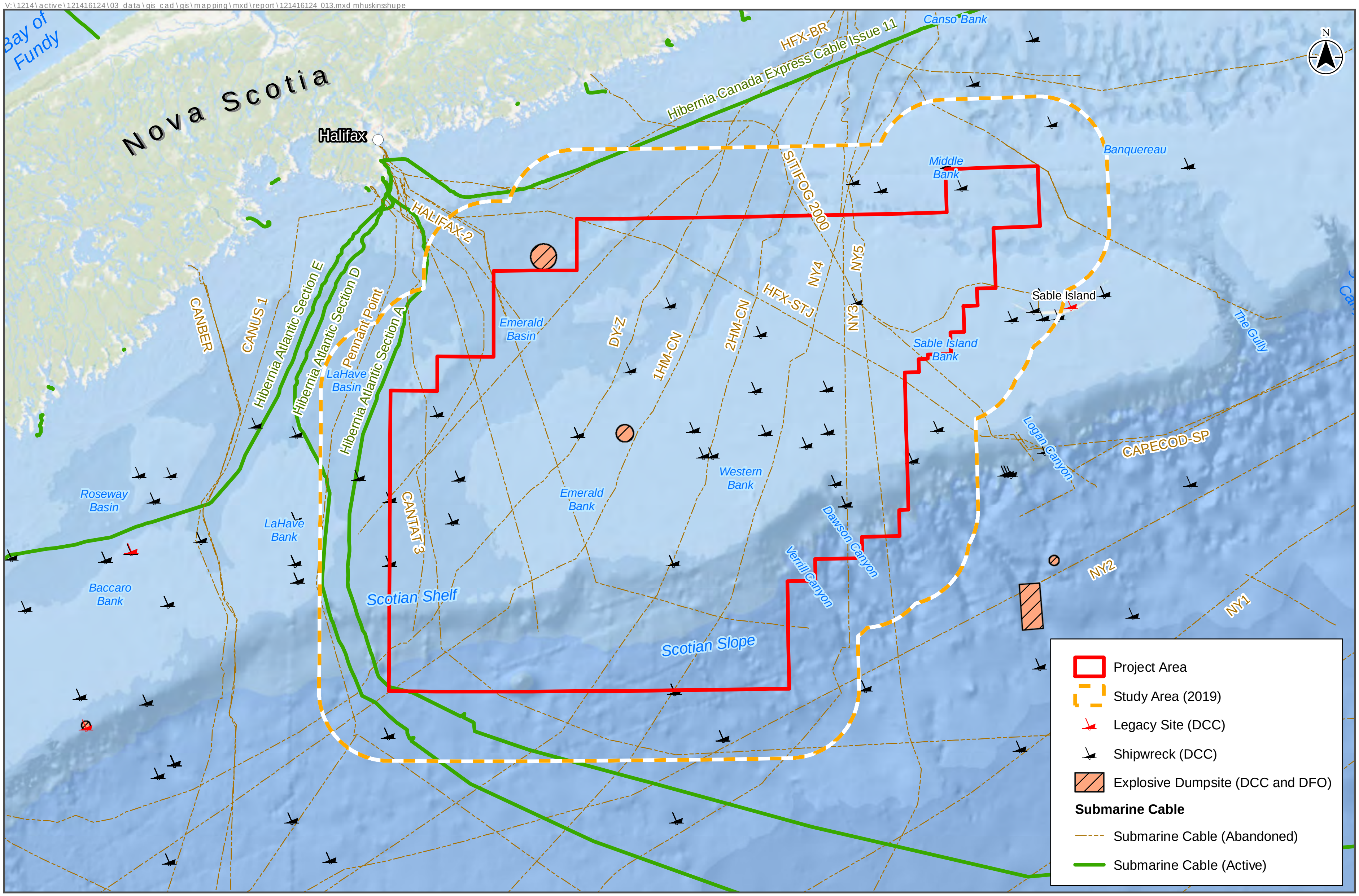

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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0 25 50 75
Kilometres

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

Seabed Hazards

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_013

Figure 3.24

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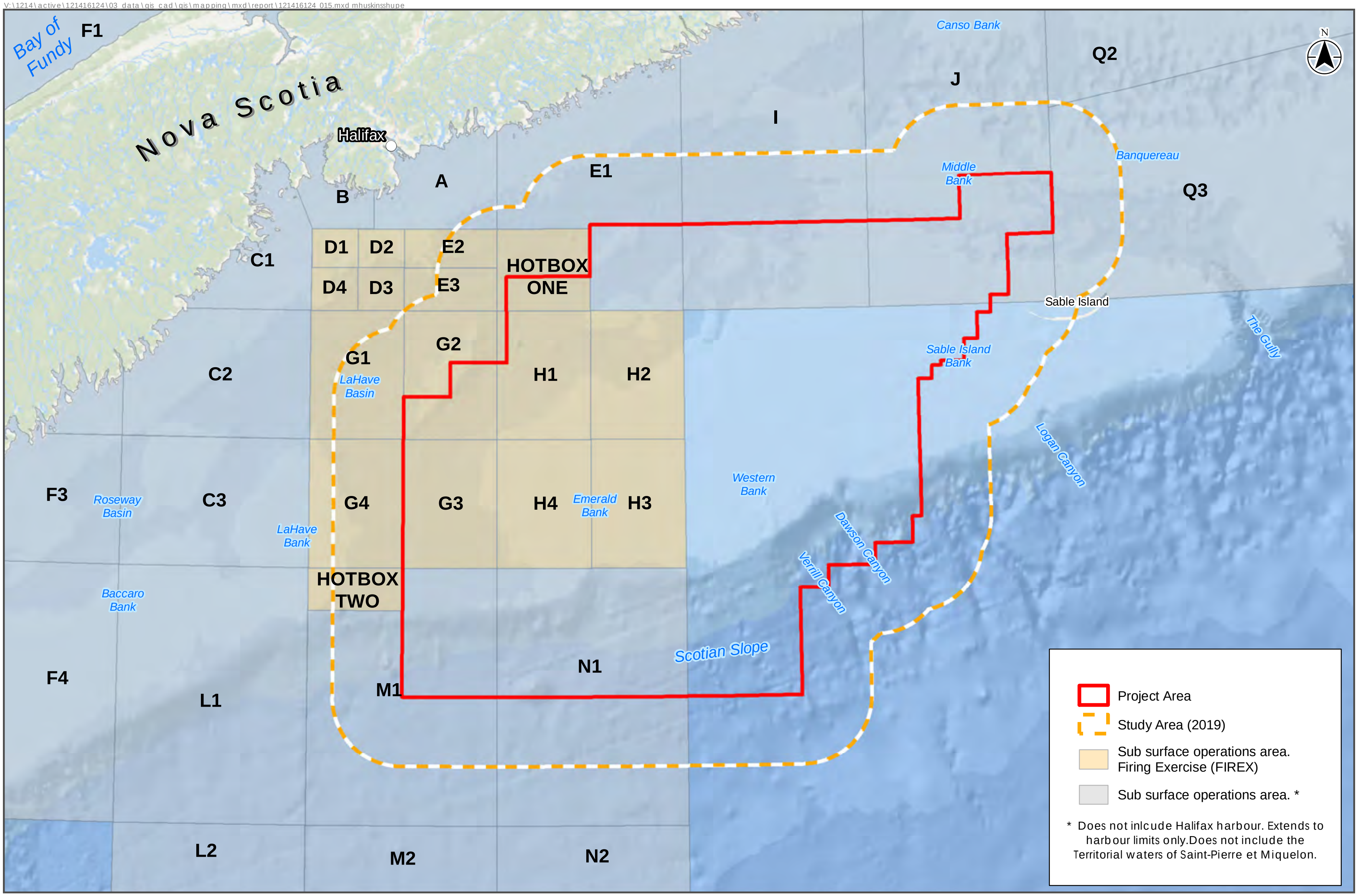


Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Military Firing Practice and Exercise Areas

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT
121416124_015

Figure 3.25

4.0 STRATEGIC ENVIRONMENTAL ASSESSMENT APPROACH

4.1 OVERVIEW OF SEA APPROACH

Environmental assessment is a systematic process for incorporating environmental considerations into decision-making. Although environmental assessment has traditionally been applied primarily to individual projects, decision makers and planners have sought to expand the scope of assessment to policies, plans and programs, hence the development of strategic environmental assessment (SEA).

The federal government's approach to SEA is set out in the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals which describes a SEA process that:

- allows environmental issues to be identified and addressed at the earliest stages of planning, and typically focuses on "regional-scale" environmental concerns;
- can facilitate the consideration of stakeholder issues and concerns early in the planning process, and demonstrates accountability and due diligence in decision-making; and
- can also help to define the environmental components and potential effects which may require consideration in subsequent project-specific EAs by identifying the key environmental issues associated with a particular sector and/or region.

The CNSOPB's approach to SEA is less broad than the Cabinet Directive and more sector-specific (oil and gas exploration). In this case, information from the SEA will assist the CNSOPB:

- with respect to potential issuance of future exploration rights within the CNSOPB SEA Project Area outlined on Figure 1.1; and
- to identify general restrictions or mitigation measures that should be considered for application to consequent exploration activities within this area.

The approach and methods used in this SEA were chosen to help deliver a focused SEA which is useful to both the CNSOPB in its decision making, but also for operators in their future project planning and approval processes.

4.2 SCOPING CONSIDERATIONS

The scope of environmental assessment, including definition of components and activities to be assessed as well as spatial and temporal assessment boundaries, must be established at the outset of the analysis to ensure the analysis remains focused and manageable. A stand-alone scoping document was not prepared for this SEA. The scope was based primarily on scoping conducted for previous SEA reports on the Scotian Shelf and Slope (i.e., Stantec 2012a, 2012b, 2013, 2014, 2017); knowledge of existing environmental conditions including any changes that have occurred, and new information that has become available, since the previous SEAs were published (refer to Section 3); applicable regulatory guidance including updated legislation and guidelines (refer to Section 2.1); review of relevant publications, including project-specific EAs conducted for recent petroleum exploration projects offshore Nova Scotia (Shell 2014; BP 2016); and experience of the study team and government reviewers.

Section 2.1 provides an overview of the regulatory context for exploration activities that contributed to scoping of the SEA.

In addition to relevant regulations and guidelines, the following key documents informed issues scoping for the SEA. Numerous other sources were drawn on for the effects assessment – refer to Section 10 for a complete list of references consulted:

- Environmental Impacts of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies (Cordes et al. 2016)
- Scotian Basin Exploration Drilling Project Environmental Impact Statement (BP 2016)
- Shelburne Basin Venture Exploration Drilling Project Environmental Impact Statement (Shell 2014)
- Environmental Assessment of Shell Canada Ltd.'s Shelburne Basin 3D Seismic Survey in Exploration Licences 2423, 2424, 2425 and 2426 (LGL 2013)
- Environmental Assessment of BP Exploration (Canada) Ltd.'s Tangier 3D Seismic Survey (LGL 2014)
- Strategic Environmental Assessment Sydney Basin and Orpheus Graben Offshore Cape Breton Nova Scotia (AMEC Foster Wheeler 2016)
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Western Scotian Shelf (Phase 3A) (Stantec 2014a)
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Western Scotian Shelf (Phase 3A Addendum) (Stantec 2017)
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Western Scotian Slope (Phase 3B) (Stantec 2013)
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Eastern Scotian Shelf – Middle and Sable Island Banks (Phase A) (Stantec 2012a)
- Strategic Environmental Assessment for Offshore Petroleum Exploration Activities - Eastern Scotian Slope (Phase 1B) (Stantec 2012b)
- Strategic Environmental Assessment – Petroleum Exploration Activities on the Southwestern Scotian Shelf (Hurley 2011)
- A Synopsis of Nova Scotia's Offshore Oil and Gas Environmental Effects Monitoring Program Summary Report (CNSOPB 2018)

4.3 SPATIAL AND TEMPORAL BOUNDARIES

Temporal assessment boundaries consider the temporal extent of project activities (e.g., time of year, frequency and duration of project activities). Temporal boundaries for this SEA include consideration of all components and activities that may be associated with exploration programs as described in Section 2. Oil and gas production activities are not addressed in the SEA except to the extent that they may contribute to cumulative effects.

The spatial assessment boundary for exploration activities to be considered in this SEA is shown in Figure 1.1. The Project Area boundary represents the area within which exploration activities could potentially occur. However, it is also important to consider the extent of zones of influence (spatial and temporal extent of effects) when defining assessment boundaries. Spatial ecological boundaries are determined by the distribution and movement patterns of the environmental component in relation to the potential zones of influence of the project.

Recent project-specific environmental assessments for offshore exploration in Atlantic Canada have included acoustic modelling, drilling waste dispersion modelling, and spill trajectory modelling which demonstrate that a project zone of influence can extend tens or even hundreds of kilometres from the source location (e.g., Project Area). When oil spill modelling is conducted, assuming no mitigative response and using conservative effects thresholds, this zone of influence extends to thousands of kilometres. This has resulted in delineation of considerably extensive study areas encompassing broad regions.

For the purpose of this SEA, a study area of 30 km has been established around the Project Area. This study area boundary encompasses most substantive project effects of routine activities (e.g., deposition of drill waste and other marine discharges), and accidental events (e.g., blowout involving condensate, most diesel batch spills) and allows for a more focused and site-specific account of environmental and socio-economic features in the SEA Project Area. However, it is acknowledged that some potential project effects including underwater sound and oil spill from a blowout scenario could extend beyond this boundary in some circumstances.

Oil spill trajectory modelling studies conducted for the Shelburne Basin Venture Exploration Project (RPS ASA 2014 in Shell 2014) and the Scotian Basin Exploration Project (BP 2016), both on the Scotian Slope, predicted, in the case of an unmitigated well blowout scenario, that surface oiling and water column oiling effects (using conservative effects thresholds) could extend thousands of kilometres, including beyond international boundaries. However, it is important to recognize that these modelling scenarios represent worst credible case scenarios and assume no spill response action is taken other than installation of a capping stack system after 30 days of an uncontrolled release from the well.

Project-specific environmental assessments within the SEA Project Area would include site-specific modelling to help define appropriate study area boundaries to capture effects of routine activities and reasonable worst-case accidental events.

4.4 SELECTION OF VALUED COMPONENTS

An environmental assessment is usually structured to focus on environmental and socio-economic components that are valued by society and/or which can serve as indicators of change. These “valued components” (VC) become the basis for the environmental assessment, around which the analysis of project effects and identification of mitigation is focused.

Table 4.1 presents a preliminary screening of issues that was undertaken to identify appropriate VCs for the assessment. In cases where a component has not been carried forward as a VC for assessment, it is generally because experience and research has shown that the component is unlikely to be adversely affected by petroleum exploration activities, particularly given implementation of standard mitigation.

Table 4.1 Selection of Valued Environmental Components

Environmental Component	Scoping Considerations	VC Selected
Atmospheric Environment	Air emissions from exploration activities are expected to produce a very minor, localized effect on ambient air quality. Light and sound emissions are assessed in the context of relevant biological VCs (i.e., receptors). Although exploration projects will generate GHG emissions and criteria air contaminants (CACs), these emissions are generally short-term (weeks to months), do not generally meet threshold for regulatory reporting, and are controlled through existing regulatory standards. In 2016, the Province of Nova Scotia endorsed the Pan-Canadian Framework on Clean Growth and Climate Change (NSE 2018). Amendments to Nova Scotia's Environment Act were made to address GHG emissions, including the development of a cap-and-trade program which came into effect January 1, 2019. Offshore oil and gas facilities are specifically excluded from this program. Emission standards for vessels have been established under the *Canada Shipping Act* and MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships. The Offshore Waste Treatment Guidelines also include provisions for air emissions including GHG minimization. It is acknowledged that malfunctions and accidental events (e.g., blowout) may have adverse environmental effects on air quality. Rather than an "Atmospheric Environment" VC per se, the appropriate focus for this assessment is on potential effects of air quality as a result of a blowout on selected VCs (i.e., receptors).	Not further assessed as a VC. Considered in terms of light and sound emissions on Species of Special Status and accidental events for Special Areas VC.
Water Quality	Effects on water quality from exploration activities are expected to be managed through compliance with the following guidelines and legislation: • Nova Scotia Offshore Area Petroleum Geophysical Regulations • Offshore Waste Treatment Guidelines • Offshore Chemical Selection Guidelines • *Fisheries Act* • MARPOL 73/78 Compliance with the above requirements will reduce or eliminate potential adverse effects on water quality from routine activities. However, malfunctions and accidental events (e.g., oil spills) may have an environmental effect on water quality. While water quality is not included as a VC in this SEA, indirect effects to receptors from potential direct effects to water quality are assessed in the context of the relevant VC.	Not assessed further as a VC. Considered as applicable for receptor VCs.

Table 4.1 Selection of Valued Environmental Components

Environmental Component	Scoping Considerations	VC Selected
Marine Fish	Fish species of special status, important feeding, nursery, and/or spawning grounds for fish (e.g., Emerald Bank), and commercial and Aboriginal fisheries resources are addressed under relevant VCs (Species of Special Status, Special Areas, and Fisheries). To ensure the SEA is focused on the most substantive potential effects, fish species that are not species of special status, do not support fishery resources or other fish species of special status, or are not present in such abundance for a special area to be designated for that species, are not addressed in the effects assessment section of the SEA.	Species of Special Status Special Areas Fisheries
Marine Benthos	Discharges of drilling mud and rock cuttings during exploration drilling can result in smothering or toxic effects on the marine benthos. Based on past environmental effects monitoring results and other research studies, these effects are understood to be limited spatially and temporally. However, in recognition of sensitive and/or commercially important benthic species that may occur within the SEA Study Area (e.g., sponges, corals, scallop, and lobster), these effects are assessed in the Special Areas and Fisheries VCs.	Special Areas Fisheries
Marine Mammals and Sea Turtles	The potential for environmental effects on marine mammal and/or sea turtle Species of Special Status that may occur within the SEA Study Area, as well as those species that may occur in nearby designated environmentally sensitive areas, are assessed in the Species of Special Status and Special Areas VCs, respectively.	Species of Special Status Special Areas
Marine and Migratory Birds	It is recognized that the attraction of any avian species to lights on platforms/vessels or to flares during drilling operations/well testing, may cause injury or death from collisions or may disrupt migrations. Increased vessel presence may also result in the physical displacement of marine bird species as well as increase the attraction and number of predator species as a result of waste disposal practices. Noise disturbance from seismic equipment may cause direct (e.g., physiological) or indirect (e.g., foraging behavior) effects on marine birds. There is also the potential for exposure to contaminants from accidental spills (e.g., fuel, oil, streamer fluids) and operational discharges (e.g., deck drainage, gray water, and black water). Licence holders/operators will be expected to identify any necessary mitigation measures (i.e., should birds land on project-related vessels, and implement the *Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada* (ECCC 2016). A permit is required under the MBCA to implement this procedure.	Species of Special Status Special Areas
Species of Special Status	The Species of Special Status VC includes consideration of the following species and their critical habitat which may be present in the SEA Study Area and determined to be potentially affected during exploration activities: species listed on Schedule 1 of SARA; species assessed as endangered, threatened, or of special concern by COSEWIC; and/or migratory birds protected by the MBCA.	Species of Special Status

Table 4.1 Selection of Valued Environmental Components

Environmental Component	Scoping Considerations	VC Selected
Special Areas	Designated areas of special interest due to their ecological and/or conservation sensitivities (e.g., MPAs, existing or future coral conservation zones, fish conservation areas) could be affected by exploration activities in the SEA Study Area. The Special Areas VC includes consideration of the Western/Emerald Banks Conservation Area and Haddock Box, Sable Island National Park Reserve, sponge conservation areas (Emerald/Sambro Bank), critical habitat for species at risk designated under SARA, and ecologically and biologically significant areas (EBSAs). The scope of the VC also includes inhabitants of the special areas which may not be covered under the Species of Special Status VC. Designated areas of special interest due to their ecological and/or conservation sensitivities (e.g., MPAs, existing or future coral conservation zones, fish conservation areas) could be potentially affected by exploration activities in the SEA Study Area.	Special Areas
Fisheries	Key fisheries (including relevant fish species) that could be affected by exploration activities in the SEA Study Area are considered. The focus of the assessment of the Fisheries VC is on potential disruptions to commercial fishing activities, including Aboriginal fisheries interests as applicable, through environmental effects on fisheries resources, displacement from current or traditional fishing areas, or gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests. This VC also includes food, social and ceremonial species of importance to Indigenous groups (e.g., American eel, Atlantic salmon) and commercial fisheries. Key fisheries to consider on the Scotian Shelf portion of the SEA Project Area include groundfish such as cusk, cod, haddock, pollock, halibut, hake (white, red, silver), monkfish, and redfish. Inshore and offshore lobster, crab, and scallop fisheries will also be considered as relevant. Key fisheries on the Scotian Slope consist primarily of large pelagics including tunas, swordfish, and sharks.	Fisheries
Other Ocean Uses	Other ocean uses (e.g., marine shipping, military use, research surveys, and other petroleum development activities) could be affected by exploration activities. Aside from petroleum development activities, other ocean users are anticipated to have only intermittent overlap with potential exploration activities in the SEA Project Area, with potential effects minimized through liaison and early communication of activities to other ocean users. Although other petroleum activities in the area (i.e., development) would present longer-term occupation of the area, it is not anticipated that exploration activities would interfere with petroleum development activities, as communication of planned exploration activities could be considered sufficient mitigation. The Other Ocean Uses VC is considered to be more appropriate for consideration of potential cumulative effects with exploration activities. To the extent that fisheries research surveys may interact with exploration activities, these interactions are addressed under the Fisheries VC.	Not further assessed as a VC. Other Ocean Uses considered in cumulative effects assessment (Section 7).

In summary, the following VCs are assessed in this SEA:

- Species of Special Status
- Special Areas
- Fisheries

It is noted that additional VCs may be required in project-specific EAs, to be specified in EIS guidelines provided by the CEA Agency and/or Scoping Documents provided by the CNSOPB. Information regarding some of the issues discussed in Table 4.1 that have not been nominated as VCs may be required for context for a complete assessment (e.g., physical oceanographic and atmospheric conditions).

4.5 POTENTIAL EXPLORATION ACTIVITY-ENVIRONMENT INTERACTIONS

Table 4.2 considers potential interactions between selected VCs and exploration activities. These interactions are explored in greater depth for each VC in Section 5, drawing on existing literature and expert knowledge to provide a current understanding of environmental effects and mitigation, indicating data gaps and uncertainties where applicable. Project-specific EAs will be required to reference the most current peer-reviewed scientific literature available in determining activity-environment interactions and assessing potential effects on VCs.

Table 4.2 Potential Environmental Interactions of Petroleum Exploration Activities and Selected VCs

Exploration Activity	VC			Nature of Interactions
	Species of Special Status	Special Areas	Fisheries	
Seismic surveying	✓	✓	✓	• Interference with fisheries and other ocean uses during routine operations. • Underwater sound issues (e.g., hearing loss, behavioural effects) on species of special status, CRA fish species and spawning areas, and species which may be inhabiting Special Areas Degradation of habitat quality of Special Areas due to underwater sound.
Seabed surveying (i.e., geophysical, geotechnical data collection)	✓	✓	✓	• Localized disturbance to marine benthos, including areas designated to protect benthic habitat and benthic species, including species of special status and CRA fish species.
Exploratory/delineation drilling, testing (e.g., VSP) and well abandonment	✓	✓	✓	• Attraction (due to lights and/or flares) of bird species of special status and CRA fish species to MODU. • Lethal and sublethal effects (e.g., smothering, toxicity, reduced growth or reproductive potential) of operational discharges (i.e., drill mud and cuttings) on species of special status and CRA fish species, particularly bottom-dwelling fish and invertebrates. • Underwater sound issues (e.g., hearing loss, behavioural effects) on species of special status and CRA fish species. • Degradation of habitat quality of Special Areas due to underwater sound and waste discharges. • Interference with fisheries and other ocean uses (e.g., loss of access due to safety zone).
Vessel and helicopter traffic	✓	✓		• Noise disturbance to Special Areas and species of special status. • Interference of vessel traffic with fisheries and other ocean users.
Accidental events	✓	✓	✓	• Lethal and sublethal effects of spilled hydrocarbons on species of special status and CRA fish species. • Degradation of habitat quality of Special Areas. • Fouling of gear and/or establishment of fishing exclusion areas.

5.0 POTENTIAL EFFECTS OF EXPLORATION ACTIVITIES

This section discusses potential effects of routine exploration activities and accidental events on VCs, including species of special status, special areas and fisheries. Mitigation and planning considerations are referenced to address potential effects, and data gaps and uncertainties are acknowledged. Note that to minimize duplication, potential effects and mitigation measures are additive, with each VC building on the information provided in the previous VC (e.g., the mitigations identified in the Special Areas VC should be considered in addition to those identified in the Species of Special Status VC).

5.1 SPECIES OF SPECIAL STATUS

The Species of Special Status VC considers potential effects of exploration activities on fish, marine mammals, sea turtles and birds of special status as defined in Section 3.2.

5.1.1 Potential Effects on Species of Special Status

Potential effects of exploration activities on species of special status include physical harm, increases in mortality risk (e.g., increases in mortality, impacts on species population-level success) and behavioural changes (e.g., masking, displacement from critical spawning, feeding, nursery areas).

5.1.1.1 Seismic and Seabed Surveys

Seismic surveys use an artificially-generated energy source (airguns) to reveal subsurface geology and identify potential oil and gas reservoirs. Airguns are towed behind a survey vessel and emit compressed air into the water at regular intervals, generating high-energy, low-frequency sound waves (with most sound produced between 10 and 300 Hz) (Carroll et al. 2017) that travel through the water and seabed. The sound energy reflects off the layers of rock and is recorded by hydrophones (streamers) also towed behind the survey vessel. Computer processing converts the sound signals into seismic data, creating 2D or 3D images of the subsurface geologic features. Depending on the information required, seismic data may be acquired through 2D (greater area), 3D (greater resolution) or wide-azimuth (wider offset data) seismic surveys.

Surveys may also be conducted prior to spudding a well, to identify seabed features and subsurface conditions that may interfere with well-drilling operations (i.e., geohazards), and to characterize the seabed and benthic habitat. The wellsite surveys are typically conducted using 2DHR digital seismic, similar to a standard 2D seismic program but likely with reduced impacts compared to standard 2D seismic as it uses a small-volume compressed air source or device. Additional data collection techniques may include sidescan sonar, sub-bottom profiling, multibeam echo sounder and/or camera imagery. Seabed surveys may also involve physical collection of seabed samples through geotechnical surveys (e.g., core sampling, vibrocores, cone penetrator technology) and environmental sampling to characterize benthic habitat (e.g., grab samples).

Seismic and seabed surveys could result in adverse physiological and behavioural effects to species of special status, potentially increasing mortality risk and/or resulting in population-level effects (Table 5.1).

Table 5.1 Potential Effects of Seismic and Seabed Surveys on Species of Special Status

Physiological and Behavioral Effects on Fish and Invertebrates	• Effects of underwater sound on fish and invertebrates are still being studied (Hawkins et al. 2014); there is a gap in the scientific literature for most fishes and invertebrates, particularly related to sound thresholds and recovery from impact: few data on physical impacts such as barotrauma (damage to internal organs); no data on masking of natural sound cues; and substantial gaps in understanding potential impacts on metabolic rate, reproduction, larval development, foraging and intraspecific communication (Carroll et al. 2017). • There are no well-documented cases of large-scale fish mortality due to exposure to seismic sound under regular operating conditions. Exposure to seismic pulses at very close range (<15 m from air gun) may affect fitness and survival of fish and invertebrates through abnormal development and mortality to eggs and larvae, with more frequent and severe effects occurring at distances <1.5 m (Dalen et al. 2007; Payne 2004). • Field-based seismic exposure studies on scallops found no mortality attributable to seismic exposure (Przeslawski et al. 2018); conversely, Day et al. (2017) reported significantly increased mortality rates, disrupted behavioral patterns (during and following exposure) and physiological changes. • Laboratory-based seismic exposure studies observed significant developmental delays and body abnormalities in 46% of scallop larvae (de Soto et al. 2013). No evidence of mortality or overt gross pathology was observed in lobster from eight hours of recorded seismic survey soundtrack, and no mortality or altered general pathology or protein, glucose or triglyceride serum concentrations over a 6-month period following seismic exposure (Payne et al. 2015). • As eggs and/or larvae may be present throughout the water column, adverse effects on developmental stages are possible (at close range) even for demersal species (e.g., redfish species, cod and cusk) (DFO 2011a). • There is evidence of injury to hearing organs of adult fish from sound levels lower than those expected in close proximity to seismic sources (McCauley et al. 2003, cited in DFO 2011a). Repetitive firing of air guns on caged fish resulted in severe damage to sensory hair cells of inner ear after 18 hours of exposure, and damaged cells were not regained after 58 days (DFO 2011a). Peak sound levels corresponded to those encountered <500 m from the source (180-190 dB RMS). Note that experimental animals were caged and could not reduce exposure levels by natural avoidance/flight response. As most fish species swim away from the sound source when not caged, permanent and/or severe damage to hearing organs from seismic surveys is considered unlikely. • Seismic exposure has potential to elicit short-term behavioural impacts on fish. Startle responses are commonly reported (e.g., changes in swimming patterns, changes in vertical distribution), with such short-term effects observed up to a 30-km radius (Worcester 2006). • Hawkins and Popper (2017) note that key life functions are not likely to be affected by brief startle responses that do not change the overall behaviour of the animals. Effects of seismic sound in displacing fish from their usual habitat is of most concern during spawning season, on nursery and foraging grounds and possibly during seasonal migrations. Should seismic surveys coincide with spawning (or travel to spawning grounds), spawning success could be affected; energy may be expended through avoidance behaviour, delayed spawning could impact year class sizes and recruitment. • Research on potential population, community and ecosystem -level impacts from seismic surveys is inconclusive (Lee et al. 2011). Disrupted behavioural patterns could delay and/or displace migration, spawning and feeding, potentially resulting in population-level impacts, should this coincide with ecologically-important life history events such as spawning (Worcester 2006; Boudreau et al. 2001). • Virtually all research on impacts of anthropogenic underwater sound has focused on (and only reported values for) the pressure component of sound (Carroll et al. 2017); many fish species (especially those lacking a gas-filled bladder, such as all elasmobranchs and marine invertebrates) are sensitive only to the particle motion component of sound (Edmonds et al.

Table 5.1 Potential Effects of Seismic and Seabed Surveys on Species of Special Status

	2016; Solan et al. 2016). Seismic surveys result in large vertical and horizontal particle motion components (in addition to pressure components) when the acoustic energy encounters the seabed; particle motion is a priority research area in understanding impacts of seismic sound on demersal and benthic species (Hawkins and Popper 2017). • Evidence suggests that exposure to seismic sound may cause substantial mortality in zooplankton populations (McCauley et al. 2017), potentially impacting species at higher trophic levels. Experimental airgun signal exposure decreased zooplankton abundance and caused a two- to three-fold increase in dead adult and larval zooplankton, with impacts observed out to 1.2 km (the maximum range sampled). It should be noted that aspects of this research have received criticism in the scientific community. Considering the concern around this issue, and that the Study Area overlaps with an area of high larval fish and zooplankton density, a comprehensive assessment of this issue will be required during Project-specific EAs.
Physiological and Behavioral Effects on Marine Mammals	• Potential effects of seismic surveys on marine mammals include behavior disruption (e.g., feeding, breeding, resting, migration); change in vocalizations; masking of sounds necessary for communication and navigation (conspecific sounds); localized displacement; physiological stress; and physical injury including temporary or permanent hearing damage (Hildebrand 2005; Weilgart 2007; Dalen et al. 2007; Southall et al. 2008 and Moore et al. 2012, cited in Cordes et al. 2016; DFO 2011a). • Temporary threshold shift (TTS) can occur with brief exposure to loud sounds, temporarily increasing hearing thresholds (Davis et al. 1998). TTS and permanent threshold shift (PTS) are important considerations; some marine mammals (e.g., seals) do not avoid seismic arrays, and prolonged exposure to continuous loud sound can cause permanent hearing damage.Exposure experiments and noise propagation modelling suggest potential hearing damage within a few 100 m to kms from the sound source, with avoidance behaviors generally detected over greater distances (Southall et al. 2008 in Cordes et al. 2016). • Alterations in swimming behaviour (diving and foraging) could produce acute physiological effects such as gas exchange problems resulting from repetitive shallow dive patterns (Zimmer and Tyack 2007). The extent of effects varies depending on species of marine mammal, sound level/proximity to seismic source, and pre-exposure activity (Dalen et al. 2007). • In addition to physiological effects, potential behavioural effects of airgun sounds on marine mammals include changes in dive and respiratory patterns, displacement and migratory diversion, changes in social behaviour, changes in vocalization patterns, changes in time budget, and changes in cognitive processes, and ecological effects such as hampered passive acoustic detection of prey, predators and conspecifics, hampered avoidance of anthropogenic threats, and hampered use of critical habitat or reduced occupancy (Theriault and Moors-Murphy 2015). • Masking can be described as: “The process by which the threshold of hearing for one sound is raised by the presence of another (masking) sound; and the amount by which the threshold of hearing for one sound is raised by the presence of another (masking) sound, expressed in dB” (American National Standards Institute, 2008). Erbe et al. (2016) note that, as underwater sound may interfere with the abilities of marine mammals to receive and process relevant sounds and could potentially impact individual fitness, offshore oil and gas activities (as well as other noise-generating activities in marine mammal habitats) require careful consideration with respect to possible auditory effects. They identify several priority research areas for increasing understanding of the process of masking, the risk of masking by various anthropogenic activities, the biological significance of masking, and anti-masking strategies, and state that such research is needed before masking can be incorporated into regulation strategies or approaches for mitigation (Erbe et al. 2016). • Little is known about the hearing of mysticetes (baleen) whales (e.g., blue, fin and North Atlantic right whales), but it is assumed they are sensitive to low to medium frequency sounds (Dalen et al. 2007). Mysticetes produce communication sounds in the very low frequency range (<100 Hz)

Table 5.1 Potential Effects of Seismic and Seabed Surveys on Species of Special Status

	and can hear sounds in the low frequency range (<1000 Hz), within the range of seismic activity (Clark and Gagnon 2006, cited in DFO 2011a). There is documented evidence of blue whales changing vocalization patterns and frequencies during seismic surveys (Di Loro and Clark 2009, cited in DFO 2011a). • Anthropogenic sound can greatly reduce the ability and range of cetacean communications, as cetaceans rely on low and mid frequency communication (as evidenced on the West coast of Canada, Williams et al. 2013). Fin whales lose only <1% of their communication space under chronic natural ocean sound; humpback whales can lose 80-94% of their communication space within the 71-708 Hz communication range in the noisiest environments and 35-52% in moderate environments (Williams et al. 2013). Killer whales in British Columbia were shown to lose up to 97% of their communication space in the mid frequency range (1.5 to 3.5 kHz). • In the Northwest Atlantic, Moulton and Holst (2010) reported significantly lower sighting rates and observations of whales swimming away from active air guns, as compared to when the airguns were not active. Blue, minke and fin whales were all observed keeping greater distances from seismic ships while airgun arrays were operational. • Blue, sei and minke whales have often been seen in areas where seismic surveys are ongoing and operational (Stone and Tasker 2006). Studies conducted in during seismic surveys in the U.K. from 1997 to 2000 reported similar sighting rates (in good visibility) of mysticetes (primarily fin and sei whales) when air gun arrays were operational versus silent (Stone 2003; Stone and Tasker 2006); however, the whales did show localized avoidance and remained at significantly farther distances when the array was operational. It is noted that during BP's 2014 3D seismic program along the Scotian Shelf edge and slope, there were five shutdowns due to the presence of blue whales in the safety zone, including four whales over a period of 48 hours in August. • Odontocetes (toothed whales) (e.g., long-finned pilot whale, Northern bottlenose whale, Sowerby's beaked whale, sperm whale) appear more sensitive than mysticetes to seismic sound, tending to show the strongest lateral distance/avoidance and moving out of the immediate area, whereas mysticetes and killer whales demonstrated more localized avoidance to seismic sound (i.e., orient themselves away from the sound but do not leave the area) (Stone and Tasker 2006). • Harbour porpoises have been observed displaying avoidance behaviour to seismic operations. The harbour porpoise was the species affected by the lowest received airgun sound (<145 dB re 1 μParms at a distance of > 70 km) during seismic operations in Washington state (Bain and Williams 2006). Statistically significant differences in travel directions were observed between periods of operational versus non-active airguns during U.K. seismic operations from 1997 to 2000 (Stone 2003; Stone and Tasker 2006). • There is virtually no data on responses of beaked whales to seismic surveys; however, it is likely they would exhibit avoidance behaviour to seismic vessels: most beaked whales avoid approaching vessels in general (Würsig et al. 1998) and may dive for extended periods of time when approached by a vessel (Kasuya 1986). There is no conclusive evidence of seismic surveys causing similar strandings (LGL 2013). • An assessment of the effects of seismic sound on cetaceans for the Shelburne Basin 3D Seismic Survey predicted that baleen whales (including the North Atlantic right whale) and odontocetes (including the Northern bottlenose whale) would have to occur within <30 m from the operating airgun array to experience hearing impairment (198 dB SEL criterion for Permanent Threshold Shift). Behavioral or disturbance effects were predicted to occur within approximately 8-26 km from the operating air gun array, based on a 160 dB rms isopleth (LGL 2013). Proposed thresholds for behavioral responses and auditory damage or other physical injury for cetaceans have been identified at sound pressure levels of 160 dB rms (root mean squared) and 180 dB rms, respectively (Compton et al. 2007). • Several cetacean species at risk occur in the Study Area (refer to Section 3.2.6), including the endangered North Atlantic right whale. There is a lack of data on North Atlantic right whale

Table 5.1 Potential Effects of Seismic and Seabed Surveys on Species of Special Status

	responses to seismic sound; based on predicted sound modeling results and expected avoidance behavior, hearing impairment effects on the North Atlantic right whale are not likely to occur. Depending on proximity of the air gun array and timing of the survey, disturbance effects (e.g., displacement from feeding and socialization area) could occur, with potential adverse effects on species of special status. • Critical habitat for the Northern bottlenose whale is located east of the Study Area; the species could occur in the Study Area, primarily along the shelf break, and could be affected by seismic sound. Deep-diving species may be more sensitive to seismic sound, as sound may concentrate in water layers at depth, travelling farther as a result. Seismic arrays produce significant acoustic energy in the 1-20 kHz range, which overlaps with the hearing range of beaked whales (DFO 2010b). The maximum acoustic energy from seismic arrays is in the 20-160 Hz frequency range, substantially lower than the peak hearing range for Northern bottlenose whales (predicted and assumed from their vocalization range). • Wensveen et al. (2019) studied responses of Northern bottlenose whales to naval sonar in a remote area near Norway. They found that tagged whales in this largely acoustically pristine region exhibited behavioural characteristics typical of beaked whales (such as sustained avoidance and cessation of feeding) at low received exposures, with no indication of the source distances modulating the behavioural effects of sonar. Avoidance threshold SPLs estimated for each whale ranged from 117 to 126 dB re 1 µPa. Most of the tagged whales that responded conducted a deep dive, with some modifying a shallow dive. In one experiment, the tagged whale that was nearest to the source dove for 130 minutes, diving nearly to the seafloor (Wensveen et al. 2019). There have been no documented cases of harm or mortality to Northern bottlenose whales in Canadian waters due to anthropogenic sound (DFO 2011c). • Potential indirect effects of seismic surveys on odontocetes in the Study Area (particularly Northern bottlenose whale and Sowerby's beaked whale) may result from effects on squid, their main prey. Trials with caged squid found startle and avoidance responses (McCauley et al. 2000a); squid emptied their ink sacs and jetted away from the activated air gun, remaining as far away as possible from the sound source (McCauley et al. 2000a), suggesting that squid could exhibit avoidance behaviour during seismic surveys. As an important prey item for top predators, such avoidance behaviour in squid could indirectly impact whales in the Study Area, depending on the timeframe of avoidance in a given area (McCauley et al. 2000a). • Multiple Canadian and international agencies conducted the Gully Seismic Research Program in 2003, observing marine mammals before, during and after exposure to seismic exploration in the Gully and adjacent shelf edge. Marine mammals, including endangered species (e.g., blue whale and Northern bottlenose whale), were observed during the Marathon and Encana seismic programs (Lee et al. 2005), although marine mammals avoided the seismic arrays at close range (<100 m) and appeared to be less vocal when seismic sources were active (Potter et al. 2005). The results from Lee et al. (2005) provide data on species presence and behaviour during seismic surveys; however, data was not collected before or after the seismic vessels were present. Therefore, direct comparisons of cetacean behaviour before, during and after seismic operations could not be made. Several peer-reviewed papers resulted from this monitoring study (Cochrane 2007; Gosselin and Lawson 2004; Lee et al. 2005; McQuinn and Carrier 2005; Potter et al. 2007; Thomsen et al. 2011); nevertheless, very little information was gleaned about whale behavior in the presence of active seismic programs. • There have been no documented cases of marine mammal mortality or injuries due to seismic surveys (Dalen et al. 2007); however, behavioural effects are possible and detrimental effects suffered by one species at risk can translate into detrimental effects on the population (DFO 2011a).
Physiological and Behavioral	• There is relatively little research on effects of seismic activities on sea turtles; available information indicates that turtles hear at low frequency range (similar to seals) (e.g., 100-900 Hz (Office of Naval Research website 2002; Environment Australia 2003; Ketton and Bartol 2005). A size/age difference in hearing range and response to underwater sound was observed for

Table 5.1 Potential Effects of Seismic and Seabed Surveys on Species of Special Status

Effects on Sea Turtles	loggerhead and green sea turtles, with smaller younger individuals having a greater hearing range than larger, older individuals (Ketton and Bartol 2005). Martin et al. (2012) demonstrated the loggerhead turtle has low frequency hearing (best sensitivity between 100 and 400 Hz). Dow Piniak et al. (2012) determined that leatherback sea turtle hearing sensitivity overlaps with frequencies and source levels produced by low-frequency anthropogenic sources including seismic source arrays, offshore drilling and vessel traffic. • Studies indicate that seismic surveys have short-term effects including changes in hearing sensitivity (Moein et al. 1994; McCauley et al. 2000b), behavioural effects (e.g., increased and erratic swimming behavior) (McCauley et al. 2000a) and physiological responses. Exposure to low frequency sounds may cause displacement from areas near the sound source and increased surfacing behaviour, potentially leading to displacement from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team 2006). • An additional potential adverse effect on sea turtles is entanglement in seismic gear. Some work has been conducted on developing mitigation measures (e.g., turtle exclusion devices, referred to as turtle guards), however the effectiveness of these measures is not well known. Turtle guards are expected on seismic vessels operating in Nova Scotian waters under an authorization overseen by the CNSOPB.
Physiological and Behavioural Effects on Marine and Migratory Birds	• Baseline data for the evaluation of effects of oil and gas exploration activity on seabirds at sea in the Northwest Atlantic is sparse (Wiese et al. 2001). Available studies focus primarily on established drilling platforms, with a lack of data specific to exploration-based seismic surveys. The greatest potential for effects on marine birds from seismic and seabed surveys is associated with sound disturbance (i.e., underwater sound from air guns). • Sound created by air guns is focused downward below the surface of the water. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds with heads above water or in flight. The nature of a seismic and seabed survey program will result in only temporary incremental increases in ambient sound and disturbance from the vessel in any one area. While it is possible that diving birds within close range of seismic activity could be startled by the sound, the presence of the ship and associated seismic equipment in the water will have already indicated unnatural stimuli to any birds in the vicinity (LGL 2005b). Air guns will undergo a ramping-up process, which encourages birds to move away from the sound source before it reaches maximum volume. It is unlikely that non-diving birds would be affected by the underwater sound of air guns. • No effects on movement or diving behaviour of moulting long-tailed ducks were observed from seismic surveys in the Beaufort Sea (Lacroix et al. 2003); however, the authors note that the study was not designed to detect more subtle disturbance effects. Overall, a precautionary note must be applied to any environmental interactions and effects discussion with respect to the effects of sound emissions on marine birds. Scientific data gaps associated with the environmental effects of sound emissions limit the degree of certainty associated with environment effects predictions. • There is a potential for attraction of migratory and marine birds to vessel lights during the relatively short operation period of seismic vessels. Guidance for handling birds stranded on seismic vessels as a result of attraction and/or disorientation is provided in ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada* (ECCC 2016), and per conditions of authorization (such as a bird handling permit). • Potential interactions between marine/migratory birds and vessel lighting is further discussed in Section 5.1.1.2.

5.1.1.2 Exploratory Drilling

Key potential adverse effects from routine exploratory drilling activities include burial and toxicity effects to seabed fauna and habitat-forming benthic species from discharges of drilling muds and cuttings; marine and migratory bird attraction to highly-illuminated drilling rigs and incineration during flaring/well testing; and impacts of underwater sound on fish and marine mammal species of special status such as masking, and displacement from critical spawning, feeding and nursery areas (Table 5.2).

Table 5.2 Potential Effects of Exploratory Drilling on Species of Special Status

Burial and Toxicity of Benthic Fauna and Habitat-forming Species	• Discharge of drilling muds and cuttings can result in smothering of benthic species, obstruction of filter-filtering mechanisms and gills, and health effects as result of chronic exposure of bentonite, barite or other drilling fluid components (Järnegren et al. 2017; Lee et al. 2011). • Effects of offshore petroleum activities on deep-sea sponges have been identified at the community level (decrease in diversity and density of benthic communities associated with deep-sea sponges from physical disturbance); individual level (interrupting filtration from increased sedimentation); and cellular level (decreasing cellular membrane stability from exposure to drilling muds) (Vad et al. 2018). • Given the vital role of benthic-pelagic coupling in aquatic ecosystems (i.e., the exchange of energy, mass and nutrients between benthic and pelagic habitats), impacts to benthic species and habitats may result in subsequent adverse effects to non-benthic biota (Griffiths et al. 2017). • Effects of drilling waste discharges on commercial fish species are discussed in Section 5.3.1.2.
Physiological and Behavioural effects on Marine and Migratory Birds	• Food and sanitary discharges from MODUs can attract birds, as they are drawn to an associated increase in attracted prey (Burke et al. 2012). Section 5.1 of the MBCA prohibits the deposition of oil, oil wastes and other substances harmful to migratory birds; *Fisheries Act* (Section 36), which prohibits the deposition of a deleterious substance into waters frequented by fish, also protects seabirds in the marine environment. • Seabirds are highly visually oriented and can become disoriented at night in the presence of illuminated vessels, drill rigs and flares, with resulting collisions, incineration and mortality. Weather, season, age of the birds and the lunar phase can affect the extent of attraction (Montevecchi 2006). Night-flying birds such as storm-petrels can be particularly attracted to vessel lighting (LGL 2005b). Birds may become disoriented and fly into vessel or platform lights or infrastructure, becoming injured and stranded. • Low-light conditions from inclement weather will also prompt vessel lighting; it is suggested that seabird disorientation occurs most frequently during periods of drizzle and fog, as moisture droplets in the air refract the light and greatly increase the illuminated area, enhancing the attraction (Wiese et al. 2001). • A Norwegian study on bird impacts associated with offshore drilling found that the impact of flaring on flocks of birds is negligible and is only considerable at night during migration periods (OSPAR Commission 2007). The study concluded that sound associated with drilling did not affect bird migrations and that 10% of birds were affected by light emitted from the main deck of offshore oil installations. • Seabird monitoring as part of the SOEP EEM has shown little to no effect on birds transiting to and from nearby Sable Island or the Scotian Slope (CNSOPB 2011b).
Physiological and Behavioural Effects on Marine	• Underwater sound from drilling can potentially cause a temporary avoidance of an area by marine species of special status. Continuous sound generated by a drill rig may cause prolonged avoidance by some demersal fishes (prey species) from the immediate area (e.g., up to 400 m) (ICES 1995, cited in JWEL 2003), and aggregations of fish species of

Table 5.2 Potential Effects of Exploratory Drilling on Species of Special Status

Mammals and Fish	special status could be displaced from critical spawning, feeding and nursery areas (refer to Table 5.1 for potential effects of underwater sound on fish and invertebrates). • Thompson et al. (2000) reports avoidance of marine mammals from a drill rig is expected to be limited beyond 100 m whereas avoidance from a drill ship may range from 1 to 10 km. The North Atlantic right whale is known to exhibit long distance avoidance behavior.

5.1.1.3 Vessel Traffic

Incremental increases in overall vessel traffic from vessels associated with seismic and exploratory drilling operations may result in adverse physiological and behavioural effects on marine mammals and bird species (Table 5.3).

Table 5.3 Potential Effects of Vessel Traffic on Species of Special Status

Physiological and Behavioural Effects on Marine and Migratory Birds	• An increase in vessel traffic can increase artificial light within the Study Area, potentially attracting migrating birds. Nocturnal disturbance from light may lead to increased opportunities for predators, collisions due to attraction to vessels, exposure to vessel-related risks and the disruption of natural conditions (CWS, pers. comm. 2012). Increased vessel presence during seismic surveys and exploratory drilling may physically displace migratory birds from foraging grounds for short periods of time (CWS, pers. comm. 2012). • Increased vessel presence may lead to increase in and/or attraction of predator species due to waste disposal practices. Sanitary and food wastes disposed of into the marine environment could attract species which prey on marine and/or migratory birds. • Incremental addition of vessels associated with exploration is not anticipated to substantially affect mortality rates from vessel collisions, as the increase in vessels will be temporary and nominal compared to existing traffic in the Study Area. With proper mitigation, including following guidance provided in ECCC's Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016), vessel-related adverse effects on bird species of special status are anticipated to be minimal. • There is a small potential for attraction of migratory and marine birds to vessel lights during the relatively short operation period of support vessels. Birds stranded on vessels as a result of attraction and/or disorientation should be handled using the instructions outlined in and per conditions of authorization (such as a bird handling permit).
Physiological and Behavioural Effects on Marine Mammals	• Vessel strikes have been known to be a considerable cause of marine mammal mortality; an increase in vessel traffic due to oil and gas exploration could increase the number of mortalities of marine mammals due to vessel impacts. The species most frequently affected by vessel strikes include the following: o North Atlantic right whales o Fin whales o Humpback whales o Gray whales • The North Atlantic right whale is the species most affected by vessel strikes, with mortalities twice as frequent as for any other whale species (Vanderlaan and Taggart 2007). In fact, it is anticipated that the species will be extinct within 200 years unless anthropogenic-induced mortalities are curbed. Right whales tend to be easily injured because they are slow moving and have a low profile in the water, making them difficult to detect. Results have shown that reducing vessel speed can reduce the number of deaths

Table 5.3 Potential Effects of Vessel Traffic on Species of Special Status

	by vessel impact; therefore, vessel speed limits may be warranted in highly-populated and important habitat areas. • Increased vessel presence can increase levels of sound below the 1-kHz range (Wright 2008). Increased ambient sound can mask biologically-significant sounds (e.g., masking can result in the disruption of breeding in animals that use sound during mating and reproduction, and of foraging in animals that use sound to detect prey) and important acoustic environmental cues used to navigate and to detect predators (Wright 2008). The potential for masking is greatest for marine mammals that produce and perceive sounds within the same range as that produced by vessels. Baleen whales are those most susceptible to increased levels of sound below the 1-kHz range. Recent studies on North Atlantic right whales indicate that these species will adjust their vocalizations in the presence of vessel sound (Wright 2008). Some species can alter their communications to avoid being masked by anthropogenic sounds, although these alterations are not optimal behaviour for these species, as these alterations may be costly for survival and reproductive success. • While the Study Area falls within feeding and migratory paths of some marine mammal species, the increase in vessel presence due to exploratory operations is not expected to be substantial. With proper mitigation, considerable adverse effects of vessel traffic on marine mammals are not expected.

5.1.1.4 Well Abandonment

Wellheads may be abandoned in place or removed by mechanical means (the well is plugged and well casing is cut and removed just below the surface of the seafloor) or explosive means (explosive charges are set in the well casing and detonated approximately 1 to 10 m below the seabed floor). There is little predicted interaction between species of special status and mechanical separation of wellheads from the seabed or from leaving wellheads in place. However, adverse effects including mortality of fish and invertebrates, marine mammals and sea turtles could occur if blasting is required for wellhead removal. It is considered a last resort.

It is expected that blasting-related effects on marine mammals and sea turtles can be avoided with the implementation of mitigation, including the depth at which detonation occurs, monitoring of the blast site, and delay of detonation until any observed marine mammal or sea turtle is further than 1 km from the blast site. A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column, and most of the initial shock pulse and energy from the explosion will be absorbed by the seafloor. However, high-impact seabed activities produce substrate vibrations that travel as compressional (longitudinal), transverse (shear) and/or surface ("ground-roll" or interface) soundwaves, the latter of which may be of substantial concern for benthic species (Hawkins et al. 2014).

5.1.1.5 Accidental Events

While unlikely to occur, a large-scale accidental event, such as an uncontrolled subsea blowout, is the aspect of exploratory activities that would be most likely to result in significant adverse effects on marine life. Spill scenarios may include (but not necessarily be limited to) a spill from a broken streamer during a seismic survey; subsea or surface blowout during drilling; loss of drilling fluid or drilling muds during drilling; or batch spill of diesel or condensate from a drill rig or vessel. Although a batch spill of crude oil or diesel is most likely to have the most far-reaching effects, even a small spill can result in adverse effects on marine life, particularly for bird species of special status.

Bacteria (specifically heterotrophic bacteria) are natural microbial agents and play a role in remediating hydrocarbon contamination in the marine environment. When there is a spill of crude oil or hydrocarbons, the bacteria capable of degrading the substance proliferate and multiply quickly (ASM 2011). In coordination with other physical processes including evaporation, dissolution, dispersion, and photo-oxidation, bacteria will eventually clean up the spill by consuming the hydrocarbon compounds which are biodegradable (ASM 2011). It should be noted that this process occurs over a long time period and depends on a variety of factors including the volume of oil spilled, sea-state, and weather conditions.

Oil spill trajectory modelling studies conducted for the Shelburne Basin Venture Exploration Project (RPS ASA 2014 in Shell 2014) and the Scotian Basin Exploration Project (BP 2016), both on the Scotian Slope, predicted that, in the case of an unmitigated well blowout scenario, surface oiling and water column oiling effects (using conservative effects thresholds) could extend thousands of kilometres, including beyond international boundaries. These modelling scenarios represent worst credible case scenarios and assume no spill response action is taken other than installing a capping stack system after 30 days of an uncontrolled release from the well.

Project-specific modelling would be conducted as part of project-specific EAs to help define appropriate spatial boundaries and to evaluate potential effects of credible worst-case accidental events. Additionally, as part of the oil spill response planning process, operators would prepare a NEBA (or SIMA) to evaluate the benefits and drawbacks of spill response tools in minimizing overall harm were a spill to occur. In the event of a spill, an incident-specific NEBA/SIMA would be conducted to inform the regulatory approval process for dispersant application.

The potential effects of accidental spills on Species of Special Status are summarized in Table 5.4.

Table 5.4 Potential Effects of Accidental Spills on Species of Special Status

Effects of Chemical Dispersants	• Chemical dispersants are often used in the event of an accidental spill to remove oil from the water's surface (Adams et al. 2014). The dispersion of oil increases the concentration of petroleum hydrocarbons in the water column and at the same time increases the rate of decomposition through dilution and biodegradation. However, in the case of the Deepwater Horizon accident, dispersant use was shown to impede hydrocarbon degradation by microorganisms (Kleindienst et al. 2015, cited in Cordes et al. 2016). • Advancements in dispersant formulas have decreased their toxicity but have shifted the concern from the toxicity of the dispersant itself to the toxicity of the dispersed oil mixtures. Chemically-dispersed oil is known to reduce larval settlement, cause abnormal development, and produce tissue degeneration in sessile invertebrates (Epstein et al. 2000; Goodbody-Gringley et al. 2013; and DeLeo et al. 2016, cited in Cordes et al. 2016). • Adams et al. (2014), exposed embryos of Atlantic herring and rainbow trout to chemically-dispersed crude oil. Atlantic herring embryos experienced delayed development as well as edema; similar responses were found for rainbow trout embryos. Embryos with delayed development may be less viable in a natural environment and as a result subject to high rates of predation. The study concluded that the toxicity of the petroleum hydrocarbons did not change with chemical dispersion; however, chemical dispersion of oil increases the bioavailability of petroleum hydrocarbons, by increasing the surface area to volume ratio of oil droplets and the rate of partitioning of hydrocarbons from droplets into aqueous solution (Adams et al. 2014).

Table 5.4 Potential Effects of Accidental Spills on Species of Special Status

Effects on Fish and Invertebrates	• Alterations in fish larvae mortality have been documented with increasing concentrations of oil contaminants in the surface microlayer (DFO 2011a). • Sublethal effects on fish can include changes in biochemical responses of enzyme systems, increased frequency of histopathological changes and diseases in bottom fish, and degradation of ichthyoplankton communities in response to oil contaminants. • Spawning events of fish are generally restricted in time and place; therefore, year class strength can be impacted if a spill coincides with a spawning event. Several studies have shown that oil presence can have both lethal and sublethal effects (reduced growth and abnormal development) in eggs, larvae and juveniles. • The effects of oil on mature fish are difficult to study in the field as mature fish can generally avoid a spill, provided the affected area is adequately small. As a result, fish can mainly be affected by spills from the egg stage until maturity and full mobility is reached.
Effects on Marine Mammals and Sea Turtles	• Depending on the scale and nature of the spill, marine mammals can be affected in several ways (Marine Mammal Commission 2011), including: o Direct contact, ingestion or inhalation of oil (or other product), its metabolites or dispersants; o Injury and/or disturbance from spill response activities; and o Short and long-term ecological changes resulting from the spill and response efforts. • Exposure to oil and its metabolites is known to be harmful to marine mammals. Inhalation of by-products can cause respiratory irritation, inflammation, or emphysema (Marine Mammal Commission 2011). The ingestion of oil may cause gastrointestinal inflammation, ulcers, bleeding, diarrhea, or maldigestion. Certain inhaled or ingested by-products may cause damage to organs such as the liver, kidneys, adrenal glands or spleen, or may cause reproductive failure. Chemical contact can result in skin and eye irritation, inflammation, burns to mucous membranes, mouth and nares, or increased susceptibility to infection. Oil can also physically foul the baleen of mysticetes whales, which can inhibit feeding. • Response activities to contain and remove oil can impact marine mammals and sea turtles. The increased marine and air traffic associated with a large spill can disrupt foraging, habitat use, daily and migratory movements and behavior. The increased vessel traffic as mentioned above can increase risk of vessel strikes. • Oil spills can indirectly affect marine mammals and sea turtles by altering the marine ecosystem and the key features of their habitat such as contamination, shifts and reduction in prey biomass (Marine Mammal Commission 2011).
Effects on Marine and Migratory Birds	• Marine birds are highly susceptible to oiling and extremely vulnerable to associated effects. Feathers readily absorb oil, decreasing their ability to insulate birds from the cold, and reduce their waterproofing and buoyancy abilities. Contact with a small amount of oil can lead to death through hypothermia and starvation, and birds can die from ingesting petroleum products while preening. • During certain times of year, large numbers of birds congregate on the waters' surface while migrating; if an oil or fuel spill were to occur in such a location at times when large numbers of birds have congregated, a global population of a species could be greatly impacted (DFO 2011a).

5.1.2 Mitigation and Planning Considerations

Table 5.5 summarizes mitigation and planning considerations to mitigate potential effects of exploration activities on species of special status. When a project application is under review, the CNSOPB works closely with DFO to determine if enhanced mitigation for Species at Risk is required. Mitigation measures are developed on a program-by-program basis depending on the location and species present. Adherence to the SOCP for seismic surveys is a key mitigation measure; however, the requirements described in the SOCP should be considered minimum requirements, and additional mitigation may be specified on a project-specific basis, particularly with respect to minimizing potential adverse effects to species of special status. CNSOPB will work in collaboration with DFO to identify and develop enhanced mitigation requirements beyond the SOCP, as required.

For SARA-listed species, DFO will conduct a thorough review of proposed oil and gas exploration activities and determine whether a SARA permit is required, and what mitigations must be implemented to protect SARA-listed species.

Mitigation and planning considerations for Species of Special Status are summarized in Table 5.5. Note that, to minimize duplication, mitigation measures are additive (e.g., several seismic survey mitigations are also applicable to exploratory drilling).

Table 5.5 Mitigation and Planning Considerations for Species of Special Status

Seismic and Seabed Surveys	• Carefully plan project activities well in advance of operations to ensure adherence (at a minimum) to the SOCP. • Consider additional enhanced mitigation measures (beyond requirements of SOCP), as required, to minimize potential adverse effects to Species of Special Status. • Conduct detailed acoustic modelling as input to project-specific EA for seismic programs proposed in the Project Area; results may be used in determining appropriate safety zones for shutdown of seismic air source array and VSP testing. • Model TTS/PTS in project-specific EAs, using the most current scientific literature. • Use trained wildlife observers, with experience in identifying all marine mammals that occur in the Study Area, to visually monitor and record marine mammal, sea turtle and marine bird interactions and help enforce safe operating distances. • Establish a safety zone around the seismic air source array (with a minimum radius of 500 m, to be determined through modelling), to be monitored visually by a qualified Marine Mammal Observer and/or through passive acoustic monitoring (PAM) (in low visibility conditions). • Implement shutdown procedures (i.e., shutdown of seismic source array) if a marine mammal listed on Schedule 1 of SARA or any sea turtle is observed within the defined safety zone. • Enhanced mitigation may be required for seismic surveys (e.g., the 30- minute observation period outlined in the SOCP may be extended to 60 minutes to account for longer diving times) any time a beaked whale is observed during the course of a survey. • Implement mitigation measures in a manner that intends to protect and avoid harming, killing or disturbing migratory birds. Refer to Environment Canada's Avoidance Guidelines in planning and conducting activities, while assuring compliance with the MBCA, 1994 and with the SARA. • Conduct seabird monitoring using guidance from the Eastern Canadian Seabirds at Sea (ECSAS) Standardized Protocol for Pelagic Seabird surveys from Moving and Stationary Platforms (Gjerdrum et al. 2012b). • Reduce bird attraction by limiting high-intensity lighting, reducing horizontal light emissions, and minimizing flaring, when safe to do so.
Exploratory Drilling	• Conduct project-specific drill waste deposition modelling to predict extent of drilling mud and cuttings seabed deposition.

Table 5.5 Mitigation and Planning Considerations for Species of Special Status

	• Season-specific acoustic modelling at the project level may be required (on a case by case basis) to evaluate potential adverse effects on marine mammals from drilling activity-associated sound. • Conduct pre-drilling ROV investigation to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB. • Avoid areas with known aggregations of corals, sponges, and other sensitive features during drilling activities. • Refer to the Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016). • Develop an EPP for exploratory drilling activities, including selecting and screening chemicals to be discharged in accordance with the Offshore Chemical Selection Guidelines (NEB et al. 2009) and managing offshore waste discharges and emissions from the MODU and offshore supply vessels (OSVs) in accordance with the Offshore Waste Treatment Guidelines (NEB et al. 2010) and MARPOL, as applicable. • Adhere to *Nova Scotia Offshore Petroleum Drilling and Production Regulations* and associated Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017). • Implement best practices for bulk transfer and hose handling procedures. • Provide advanced notice of flaring during periods of migratory bird vulnerability and plans of the associated mitigation to prevent harm to, or killing of, migratory birds. • Conduct a post-drilling ROV survey to verify drill waste deposition modelling predictions (e.g., confirm that the muds and cuttings are within the predicted zone of influence).
Vessel Traffic	• Adhere to Transport Canada Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction. • Use existing vessel routes to the extent practical to avoid transiting near migratory bird nesting colonies. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard’s Annual Notice to Mariners (NOTMAR).
Well Abandonment	• Design wells and casings to facilitate effective mechanical cutting and removal of the wellhead, avoiding explosive means of separation where possible. • If use of explosives is necessary, follow the recommendations set out in the Guidelines for the use of Explosives in or near Canadian Fisheries Waters (Wright and Hopky 1998).
Accidental Events	• Conduct spill fate and behavior modelling as input to project-specific EA for drilling programs proposed in the Project Area. • Prepare project-specific NEBA/SIMA, as required. • Develop engineering design and process safety management protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards. • Implement Emergency and Oil Spill Response Plan accepted by the CNSOPB (with input from DFO and Parks Canada, as applicable), including emergency contingency measures and response plans for addressing significant weather scenarios. • Use non-fluid filled streamers for seismic surveys, where possible. • Implement bulk transfer and hose handling procedures per best management practice. • In the event of a spill, develop an EEM Plan to address post-spill monitoring of effects, with the scope of the EEM Plan directly related to the severity of potential spills. • Use turtle guards on seismic arrays.

5.1.3 Data Gaps and Uncertainties

The specific distribution of species of special status in the Study Area is a data gap in this assessment. Although Lee et al. (2005) provide information on species presence and behavior during seismic surveys on the Scotian Shelf, data on cetacean presence and behavior was not collected prior to the seismic vessels operating in the study area nor after they left; therefore, comparisons of cetacean behavior before, during and after the seismic operations could not be made. Concerns regarding potential effects of seismic on beaked whales (e.g., Northern bottlenose whale) remain a data gap.

Possible effects of seismic surveys on sea turtles may include exclusion from critical habitats, damage to hearing and entanglement in seismic survey equipment. Nelms et al. (2015) found that few studies have investigated the potential for seismic surveys to cause behavioural changes or physical damage, indicating a crucial knowledge gap.

Continued research and wildlife monitoring during future oil and gas activities may further knowledge, particularly if monitoring surveys are standardized and data is shared for future use. The most relevant studies are those that are conducted while the species are exposed to actual seismic surveys. Future seismic surveys present a research opportunity to fill knowledge gaps regarding seismic sound and cetacean and sea turtle species at risk, and the use of a trained marine mammal observers onboard during seismic and drilling activities is particularly important. Similarly, trained marine bird observer(s) onboard during seismic and drilling activities could address the substantial gap in quantified effects on seabird distribution from oil and gas exploration activities. In a study on the Grand Banks, Burke et al. (2012) determined that systematic observations by independent biologists on vessels and platforms are needed to generate reliable assessments of risks to marine birds as opposed to the industry-based self-reporting of seabird monitoring currently undertaken.

There is a general lack of information regarding the deeper areas of the marine benthic environment on the Scotian Slope. The ongoing erosion of Dawson and Verill Canyons and areas in between may enhance the biological productivity in the area, which would attract species, including those of special status. As oil and gas lease areas off Eastern Canada are concentrated in the same regions as suitable habitat for blue whales and other species of special status, evaluation of potential risks and impacts to these species should reference up-to-date information on presence and potential overlap with project activities (Moors-Murphy et al. 2018).

Data gaps also exist for the hearing abilities of sea turtles, many shark species and nearly all invertebrates. There have been a limited number of studies focused on a few species of sharks, limiting our understanding of how they interpret sounds and if they can be impacted by the effects of anthropogenic sound. Similarly, there is relatively little data to determine if sound impacts turtle species and to what degree. The particle motion component of sound is a priority research area in understanding impacts of seismic sound on benthic species (Hawkins and Popper 2017).

With respect to effects of exploration activities on Species of Special Status, most of the data gaps and uncertainties are related to effects (and species thresholds) and monitoring of seismic sound. This gap in knowledge is widely recognized and seismic-related research is the focus of various research funding initiatives including the Exploration and Production (E&P) Sound and Marine Life Joint Industry

Programme (JIP), Offshore Energy Research Association (OERA) and ESRF Program, including the following current projects (ESRF 2019):

- Assessment of the Potential Risks of Seismic Surveys to Affect Snow Crab Resources (2014-01S): Aims to investigate potential effects of seismic exploration activity on commercial snow crab catch rate using scientific measures of changes in crab behaviour (i.e., movement), commercial catchability, and physiological effects in response to seismic air gun operations.

- Acoustic Modeling and Monitoring on Canada's East Coast (2014-02S): Recording the natural soundscape on Canada East Coast and studying seismic sound propagation to create new knowledge on the natural soundscape in the region, generate accurate models of the effects of seismic surveys, and validate particle motion models for seismic airguns.

- Assessing the Quality of Marine Mammal Detections using Three Complementary Methods (2014-03S): Evaluating the comparative effectiveness and efficiency of three different methods of detecting marine mammals in the field.

Understanding sound thresholds (PTS/TTS) for various species is an important data gap, in which more definitive research is required. Given the scientific data gaps, Theriault and Moors-Murphy (2015) state that it is not currently possible to quantify acoustic thresholds for many of the potential effects of underwater sound on cetaceans, and that establishing thresholds is challenging due to a lack of standardized descriptors for such metrics. Proponents will likely be required to conduct Project-specific underwater sound modelling and are encouraged to use the most up-to-date guidelines for assessing potential effects of underwater sound on sensitive species. Site-specific acoustic and spill modelling as inputs to future project-specific EAs could further inform potential environmental effects analysis and appropriate mitigation (including delineation of buffers from critical habitat).

5.2 SPECIAL AREAS

Special Areas within the SEA Study Area are described in Section 3.2.8 and include Protected Areas (Western/Emerald Banks Conservation Area and Haddock Box, the Sambro Bank Sponge Conservation Area, Emerald Basin Sponge Conservation Area, Sable Island National Park Reserve, Eastern Shore Islands AOI) (Figure 3.19) and five EBSAs (Figure 3.20). All Special Areas within this report have independent conservation needs. For example, some Special Areas are fisheries closure areas to help protect stocks or sensitive benthic habitat. While these designations indicate ecological sensitivities that should be considered, they do not necessarily dictate the same level of enhanced mitigation that may be applicable in proximity to critical habitat for endangered species.

As described in Section 3.2.8, DFO experts identified EBSAs along the Scotian Shelf to address conservation objectives in accordance with the *Oceans Act* (Horsman et al. 2011) (Figure 3.20). These were identified based on a compilation of ecological and biological data, 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; King et al. 2016). While the EBSAs do not necessarily have official protection under the *Oceans Act*, they are regions of ecological and biological significance. The identified EBSAs will be considered in a broad range of coastal and oceans management and planning processes in the Scotian Shelf, including in the design of a network of

MPAs; however, not all EBSAs will be part of the MPA network (King et al. 2016). Management needs will be evaluated for each EBSA, wherein certain EBSAs or its parts may be protected as an MPA (or other spatial protection tool), and activity-specific mitigation measures may be developed for other EBSAs while some may not require any additional management measures (King et al. 2016).

5.2.1 Potential Effects on Special Areas

Exploratory oil and gas activities may have long or short-term environmental effects on Special Areas, affecting the biodiversity, abundance and/or presence of species within these areas, ecological integrity and habitat value, and/or socio-economic value. The analysis of potential environmental effects on Special Areas is closely linked to effects on Species of Special Status (Section 5.1) and Fisheries (Section 5.3).

5.2.1.1 Seismic and Seabed Surveys

Although seismic surveys will not affect the physical structure of the Special Areas themselves, they may affect the quality of habitat and the species found within these areas, thereby potentially affecting the biodiversity and integrity of the Special Areas. Seismic surveys have a greater impact on some species than others (particularly marine mammals) and the effects can vary according to oceanographic conditions (e.g., depth is an important consideration as sound attenuates more rapidly with range in shallower water).

Potential effects of seismic and seabed surveys on Special Areas are summarized in Table 5.6.

Table 5.6 Potential Effects of Seismic and Seabed Surveys on Special Areas

Effects on Areas of Significance for Fish and Invertebrates	• Seismic sound can affect the fitness and survival of fish and invertebrates at very close range (see Species of Special Status, Section 5.1.1.1). • Horsman and Shackell (2009) provide an in-depth overview of important areas for fish on the Scotian Shelf; important larval areas for yellowtail flounder, witch flounder, silver hake, white hake, American plaice, Atlantic cod, haddock, mackerel, pollock, redfish, red hake, cusk, herring, Atlantic wolffish, and monkfish are located within the Study Area (Horsman and Shackell 2009). • Long-term and/or permanent effects (i.e., mortality) on larvae and eggs have been observed at close range, which may affect fish species even demersal species with pelagic larvae and eggs (e.g., redfish, American plaice, Atlantic cod).
Effects on Areas of Significance for Marine Mammals and Sea Turtles	• Section 5.1.1.1 describes potential effects of seismic sound on marine mammals and sea turtles. Although mysticetes (e.g., fin, blue, and North Atlantic right whales) are assumed to be sensitive to sound frequencies similar to those emitted by seismic surveys, odontocetes (e.g., Northern bottlenose whales) appear to be more sensitive, particularly within a 1-km radius of the array. • Low-frequency sound associated with seismic activity may interfere with vocalizations in areas of ecological importance and/or biological significance. Based on data on effects of sound pressure levels on cetaceans, an isopleth of 160 dBRMS has been identified for the inducement of behavioral responses (e.g., avoidance) and 180 dBRMS for the likely inducement of auditory damage and other physical injury (Compton et al. 2007). Acoustic modeling conducted for the Shelburne Basin 3D Seismic Survey Environmental Assessment (LGL 2013) predicted that sound pressure levels of 180 dBRMS could propagate approximately 1 km from the source, depending on water depth and season. Critical habitat for the endangered Northern bottlenose whale has been designated in the

Table 5.6 Potential Effects of Seismic and Seabed Surveys on Special Areas

	Gully and Shortland and Halimand Canyons to the east of the Study Area, although Northern bottlenose whale has been observed in the Study Area, including in Dawson and Verrill Canyons. • Based on a systematic literature review and analysis, Gomez et al. (2016) noted that more severe behavioural responses were not consistently associated with higher received levels, indicating that generic multi-species received levels should not be exclusively relied upon for monitoring and regulation of acoustic effects from activities on cetacean behaviour. • Critical habitat for the North Atlantic right whale has been designated to the west of the Study Area, within Roseway Basin. Depending on the proximity of the air gun array to the critical habitat and the timing of the survey, the quality of habitat could be degraded by underwater sound and disturbance effects could occur (e.g., displacement from feeding and socialization area), having serious effects on this endangered population if not managed through applicable mitigation measures. • In 2018, DFO identified the Scotian Shelf and Slope Break (including the Gully) as "habitat important to the blue whale." There is a possibility that blue whales may be encountered by Operators in the SEA Project Area, and that habitat features and attributes that are important to blue whales could be affected by exploration activities (DFO 2018d), particularly seismic surveys, if they are conducted during the summer months. • Although monitoring of marine mammals was conducted during seismic programs in the vicinity of the Gully (Cochrane 2007; Gosselin and Lawson 2004; Lee et al. 2005; McQuinn and Carrier 2005; Potter et al. 2007; Thomsen et al. 2011), there remain data gaps regarding whale behavior in the presence of active seismic programs; therefore precautionary planning designated to protect cetaceans should be undertaken for seismic operations in the vicinity of the Special Areas.
Effects on Sensitive Benthic Areas	• Special Areas with sensitive benthic habitat-forming species such as high-density coral and sponge (*Vazella pourtalesi)* conservation areas and overwintering areas for shellfish (e.g., Scotian Slope/Shelf Break EBSA 30, Sambro Bank and Emerald Basin) may be adversely affected by seabed surveys. • Seabed surveys involve localized disturbance of seabed substrate and benthos, using a variety of tools and techniques such as 2D high-resolution digital seismic (low-energy), multi-beam echo-sounders, and seabed core sampling (Hurley 2011). The most sensitive benthic communities are those with high vulnerability and low recovery rate (e.g., deep-sea coral and sponge communities) and the least sensitive benthic communities have a low vulnerability and high recovery rate, for example communities dominated by scavengers and mobile species (DFO 2005; Burbidge 2011). • Seabed surveys that directly contact the seabed may impact benthic species and habitats through direct mortality, smothering or clogging of filter-feeding mechanisms and gills from local sedimentation (Järnegren et al. 2017; Lee et al. 2011). Irreversible damage including mortality to corals and sponges or other sensitive areas by removal of entire organisms or physical alteration may be caused by seabed surveys. • Seismic sound from seabed surveys may affect juvenile fish and invertebrates near the seabed (refer to Section 5.1.1.1).

5.2.1.2 Exploratory Drilling

Special Areas containing sessile benthic species (corals and sponges) and other benthic species (haddock, Atlantic cod, wolffish, surf-clam, winter skate, and others) are more susceptible than pelagic species to effects from exploratory drilling (Hurley 2011). Effects could include direct physical impact or mortality; drilling mud and cuttings discharge can smother benthic species and result in toxic effects, causing acute and chronic long-term impacts such as reduced growth or reproductive potential (see

Section 5.1.1.2). Effects of exploratory drilling may be of particular concern should activities occur in proximity to Special Areas that are important to marine or migratory birds (e.g., Sable Island National Park Reserve, Eastern Shore Islands AOI, Sable Island Shoals) and/or groundfish (e.g., the Haddock Box, Western/Emerald Banks Conservation Area). The Project Area overlaps entirely with the Western/Emerald Banks Conservation Area. Given the area's importance and complex habitat (refer to Table 3.22), this overlap, and potential effects of exploration activities, will be a key focus of DFO's regulatory review of proposed oil and gas activities within the Project Area.

Potential effects of exploratory drilling on Special Areas are summarized in Table 5.7.

Table 5.7 Potential Effects of Exploratory Drilling on Special Areas

Effects on Benthic Species	• Special Areas with habitat-forming benthic species (e.g., Scotian Slope/Shelf Break EBSA 30, Sambro Bank and Emerald Basin) are particularly vulnerable to adverse effects from exploratory drilling, given the potential effects noted in Section 5.1.1.2. • Significant mortality occurred in cold-water coral (*Lophelia pertusa*) larvae exposed for 24 hours to an increased drill cuttings sediment load (Järnegren et al. 2017). The larval cilia became clogged and prevented the larvae from swimming actively, which could have wider implications given that larvae of many species use cilia for swimming and feeding. The study concluded that while adult L. pertusa can survive (at least temporarily) under extreme sediment load, all or part of the cohort may be lost should cuttings release occur during larval development (Järnegren et al. 2017). • Exposure to barite (a primary component of WBM) has been shown to result in toxicity in deep-water sponges (Edge et al. 2016). • EEM programs at production drilling sites offshore Nova Scotia (Deep Panuke and SOEP) have consistently observed less adverse effects than predicted. No toxic responses (as demonstrated by amphipod mortality testing) have been observed at any site since 2003 (CNSOPB 2011b). Of the 24 metal chemical test parameters monitored in sediment at SOEP, elevated concentrations were only detected for total petroleum hydrocarbon (TPH) and barium (from the drill muds and cuttings piles deposited on the seafloor), and these only extended out to 500 m and returned to baseline concentrations within four years post-drill (CNSOPB 2018). Relative to development drilling, exploratory drilling is generally considered to present less risk of impact to benthic species and habitats, with fewer associated activities, smaller seabed footprints and shorter timeframes. • Ecological changes from exposure to WBM were detected at Terra Nova up to 1-2 km from the discharge source, including enrichment effects on some tolerant taxa (e.g., polychaete family Phyllodocidae and bivalve family Tellinidae) and decreased abundance of sensitive taxa (e.g., polychaete families Orbiniidae and Paraonidae) (Paine et al. 2014).
Effects on Marine and Migratory Birds	• As described in Section 5.1.1.2, marine and migratory birds could interact with illuminated vessels or MODUs and become exposed to contaminants from waste disposal, operational discharges, and spills, or be incinerated by flaring (Hurley 2011; DFO 2011a). These interactions could be of particular concern should exploratory drilling be proposed within the vicinity of Special Areas such as Sable Island National Park Reserve, Sable Island Shoals (EBSA 28) or Eastern Shore Islands AOI.
Effects on Fish and Invertebrates	• Underwater sound from exploratory drilling and DP thrusters (semi-submersibles or drill ships) may result in behavioural effects to fish and invertebrates, disrupting or dispersing spawning aggregations of fish (refer to Table 5.1 for potential effects of underwater sound on fish and invertebrates). These interactions could be of particular concern should exploratory drilling be proposed where underwater sound may propagate to Special Areas that provide important spawning and nursery habitat for fish (e.g., the Haddock Box, Western/Emerald Banks Conservation Area).

Table 5.7 Potential Effects of Exploratory Drilling on Special Areas

Effects on Marine Mammals	• Underwater sound from exploratory drilling and DP thrusters (semi-submersibles or drill ships) may result in behavioural effects to marine mammals such as temporary avoidance (see Section 5.1.1.2). These interactions could be of particular concern should exploratory drilling be proposed where underwater sound may propagate to Special Areas that provide important or critical habitat for marine mammals. Recent acoustic modelling for drilling programs offshore Nova Scotia suggested that underwater sound levels exceeding behavioural thresholds could extend over 150 km from the drill site in winter (BP 2016).

5.2.1.3 Vessel Traffic

The high volume of shipping activity and vessel traffic on the Scotian Shelf may result in effects on marine habitats and communities, including ship-source pollution, shipboard wastes, sound, and collisions between vessels and marine life (Burbidge 2011). Vessel traffic from oil and gas exploration activities is expected to be minimal, with minor associated environmental effects on Special Areas in the Study Area (refer to Section 5.1.1.3 for more details). However, potential vessel-related adverse effects to birds (refer to Section 5.1.1.3) may particularly be of concern in Special Areas that are important to marine and migratory birds (e.g., Sable Island National Park Reserve, Sable Island Shoals (EBSA 28), Eastern Shore Islands AOI).

Results from EEM programs (Cohasset-Panuke Project and SOEP) suggest that offshore oil and gas activities have had little to no impact on benthic communities, fish health, or seabird populations (CNSOPB 2011b). However, the number of oiled seabirds in the Scotian Shelf region increased 3.2% annually between early 1970s and 2000 (Coffen-Smout et al. 2001; DFO 2009b; Burbidge 2012); ship-source oil pollution is estimated to result in the oiling of thousands of seabirds annually in the region. More than 7,000 seabird corpses were recovered on Sable Island between 1993 and 2002 (Sable Island Bank region EEM program); 40% of birds had some oiling, mostly weathered crude and heavy fuel oil mixed with varying amounts of lubricants and diesels (Sable Island Green Horse Society 2004). While primarily attributable to large ocean-going vessels rather than oil and gas exploration and development activities on the Scotian Shelf, this demonstrates the prevalence of hydrocarbon contamination and vulnerability of bird species in the area.

5.2.1.4 Well Abandonment

Well abandonment may adversely affect benthic organisms through physical alteration, mortality or contamination, with juvenile fish and invertebrates those most susceptible to impacts (JWEL 2003). Little interaction with fish and fish habitat is expected during mechanical separation of wellheads from the seabed; however, as described in Section 5.1.1.4, well abandonment requiring blasting is likely to result in mortality, mainly to infauna community (JWEL 2003). The areal extent of adverse effects from well abandonment is likely limited to within the previously-disturbed drilling zone of influence for mechanical separation. The zone of influence would likely extend over a larger area when blasting is required. Conversely, leaving wellheads in place, where feasible, would minimize potential adverse effects to Special Areas.

5.2.1.5 Accidental Events

Potential accidental spills during exploration activities can result in short or long-term contamination and toxicity of the water column, sediments and biota. Although the risk of large-scale accidental spills is low given the established preventive measures, the consequences can be severe and far reaching, resulting in both lethal and sub-lethal effects (refer to Section 5.1.1.5).

All Special Areas in the SEA Study Area are considered to be vulnerable to potential effects that could result from a large accidental spill such as a subsea blowout of crude oil. As described in Section 5.1.1.5, oil spill trajectory modelling studies conducted for the Shelburne Basin Venture Exploration Project (RPS ASA 2014, cited in Shell 2014) and the Scotian Basin Exploration Project (BP 2016) conservatively predicted that an unmitigated well blowout scenario could result in surface oiling extending thousands of kilometres, beyond international boundaries. However, these modelling scenarios represent worst credible case scenarios and assume no spill response action is taken, aside from capping stack installation after 30 days.

There are several important spawning and nursery areas in the Study Area that would be vulnerable to the effects of a spill (e.g., Western/Emerald Banks Conservation Area and the Haddock Box, Emerald-Western-Sable Bank Complex, Eastern Shore Islands AOI). The severity of effects from a spill is greatly influenced by the time of year; should a large oil spill coincide with a spawning event, considerable loss of fish eggs, larvae and juveniles could result, in turn affecting fisheries resources and possibly population viability. Many major commercial species in the Study Area have pelagic eggs and/or larvae and therefore would be vulnerable to a spill. Convergence zones could concentrate oil and early life stages together in surface waters, magnifying deleterious effects (DFO 2011a). In areas where there are high rates of vertical mixing, the quantity of petroleum product entrained in the water column could be increased (DFO 2011a).

Should a spill extend to the Sable Island National Park Reserve, numerous ecosystem components could be adversely affected. Marine birds are particularly vulnerable to spills, as coming into contact with even a small quantity of oil can have serious health effects. A wide-spread spill that dispersed in or near a Special Area of particular importance to birds (e.g., Sable Island National Park Reserve, Sable Island Shoals EBSA 28, Eastern Shore Islands AOI) could result in wide-spread deleterious health effects and potential mortality to marine birds.

The Scotian Slope/Shelf Break is an area of high biodiversity, containing several ecologically important features including corals, pelagic species such as sharks and tuna, whales, seabirds, and many others (Doherty and Horsman 2007). Given the potential ecological importance of this area and the fact that it has not been identified as being resilient (Doherty and Horsman 2007), it is likely highly vulnerable to impacts from accidental spills.

As indicated in Section 5.1.1.5, oil spills can indirectly affect marine mammals by altering the marine ecosystem and the key features of their habitat such as contamination and shifts and reduction in prey biomass (Marine Mammal Commission 2011). Were a spill to reach the Roseway Basin or the Gully, adverse environmental effects on North Atlantic right whales and northern bottlenose whales (respectively) could result due to degradation of habitat quality and prey.

5.2.2 Mitigation and Planning Considerations

Management planning for Special Areas, EBSAs and the MPA network is currently underway. Operators are advised to maintain regular communication with DFO to obtain up-to-date information when planning exploratory programs. It is further recommended to work collaboratively with DFO on mitigation measures regarding Special Areas identified in this report. When a project application is under review, the CNSOPB works closely with DFO and Parks Canada to determine if enhanced mitigation for Special Areas is required. Mitigation measures are developed on a program-by-program basis depending on the location, species, and special areas present.

Table 5.8 summarizes mitigation and planning considerations for Special Areas for each of the key exploration activities. These mitigation measures for Special Areas are intended to supplement more generally protective measures referenced in Section 5.1.2. Note that, to minimize duplication, mitigation measures are additive (e.g., several seismic survey mitigations are also applicable to exploratory drilling).

Table 5.8 Mitigation and Planning Considerations for Special Areas (additional to those identified in Section 5.1.2)

Seismic and Seabed Surveys	• Schedule surveys to minimize interaction with peak haddock spawning in the Western/Emerald Banks Conservation Area and the Haddock Box (March/April). • Operators proposing to conduct exploratory activities within the vicinity of the Sable Island National Park Reserve would be required to develop a Code of Practice, including specifying minimum safe working distances for seismic vessels from the Reserve. • Potential avoidance (on a case by case basis) of intrusive seabed surveys in areas with known concentrations and/or high diversity of corals or sponges, such as the Sambro Bank and Emerald Basin Vazella Closure areas.
Exploratory Drilling	• Conduct underwater sound modelling to inform the analysis of effects of underwater sound on Special Areas. • Conduct pre-drilling ROV investigation to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB. • Avoid areas with known aggregations of corals, sponges, and other sensitive features during oil and gas drilling activities. • Conduct project-specific drill waste deposition modelling to predict extent of sediment deposition. • Conduct a post-drilling ROV survey to verify drill waste deposition modelling predictions (e.g., confirm that the muds and cuttings are within the predicted zone of influence). • Consult DFO's Sensitive Benthic Areas Policy (DFO 2009c) for activities in sensitive benthic areas; while intended for fisheries management, the policy describes protection mechanisms to protect these habitats. • Consider and evaluate technologies that may reduce the quantity of generated solids when drilling in areas with sensitive benthic species and habitats (e.g., narrower boreholes, which require less drilling fluid and generate less drilling waste, minimizing discharge of fines, particle distribution and risk of sedimentation) (DNV 2013). • Adhere to the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010), Nova Scotia Offshore Drilling and Production Regulations (and associated guidelines), Offshore Chemical Selection Guidelines (NEB et al. 2009), and Environmental Protection Plan Guidelines (C-NLOPB et al. 2011).

Table 5.8 Mitigation and Planning Considerations for Special Areas (additional to those identified in Section 5.1.2)

	• As Sable Island is now a designated National Park Reserve, Operators proposing to conduct activities in the vicinity must communicate with Parks Canada in determining appropriate mitigation measures and commitments. Per amended Accord Acts legislation, no exploratory drilling is permitted on or within one nautical mile (approximately 1.85 km) of the Reserve, and surface access rights are limited to those activities with a low impact on the environment. The CNSOPB is drafting guidance in early 2019 to define low-impact exploration activities that may be permitted, and Parks Canada is currently preparing the Management Plan for the Sable Island National Park Reserve.
Vessel Traffic	• Develop and maintain Code of Conduct to specify minimum safe working distances for OSVs and helicopters from Sable Island National Park Reserve. • Use existing vessel routes to the extent practical to avoid transiting near migratory bird nesting colonies. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard's Annual NOTMAR.
Well Abandonment	• Mitigation measures as described in Section 5.1.2 (Mitigation and Planning Considerations for Species of Special Status).
Accidental Events	• Mitigation measures as described in Section 5.1.2 (Mitigation and Planning Considerations for Species of Special Status).

5.2.3 Data Gaps and Uncertainties

Several data gaps and uncertainties have been identified in this section and for the other VCs identified in this assessment. There are large data gaps associated with the understanding of areas and timing of critical life-cycle stages of various species (see Section 5.1.3). Despite the uncertainties pertaining to environmental effects from oil and gas activities, it is important to take a precautionary approach in the vicinity of Special Areas, particularly those of well-known ecological importance.

A key source of uncertainty pertaining to the Special Areas VC is the ongoing management and planning processes in the Scotian Shelf and Slope, including the design of a network of MPAs. The final report of the National Advisory Panel on Marine Protected Areas recommended that oil and gas exploration be prohibited in MPAs (DFO 2018c). Although there are no MPAs in the Project Area, and not all EBSAs will be part of the MPA network, the management needs for individual EBSAs are currently being assessed (King et al. 2016). EBSA management measures may include spatial management (MPA designation or other spatial protection tool) or activity-specific mitigations, while additional management measures may not be required in some EBSAs. When planning for offshore exploration programs, it is recommended that operators obtain up-to-date information from DFO on a regular basis and work collaboratively with the CNSOPB, DFO and Parks Canada (as applicable) on mitigation measures for Special Areas.

Predicting received sound levels in Special Areas and understanding sound thresholds (PTS and TTS) for various species are important data gaps, in which more definitive modelling and research is required. Proponents will likely be required to conduct Project-specific underwater sound modelling and are encouraged to use the most up-to-date guidelines for assessing potential effects of underwater sound on sensitive species.

While the environmental effects of fisheries activities on corals and sponges on the Scotian Shelf and Slope are understood and becoming better documented, little research has been conducted on the effects of seismic or drilling activities on corals and sponges.

5.3 FISHERIES

5.3.1 Potential Effects on Fisheries

Potential environmental effects of exploration activities on fisheries include effects to the fisheries resource (e.g., direct effects on fished species indirectly affecting fishing success) and effects on fishing activity (e.g., displacement from current or traditional fishing areas, gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests).

5.3.1.1 Seismic and Seabed Surveys

Potential issues of concern related to environmental effects of seismic and seabed surveys on fisheries include:

- physiological and behavioural effects on fisheries resources (commercial and recreational fish species) which may affect habitat quality and catchability; and
- fisheries gear loss and damage due to possible interaction with seismic equipment.

Potential effects of seismic and seabed surveys on Fisheries are summarized in Table 5.9.

Table 5.9 Potential Effects of Seismic and Seabed Surveys on Fisheries

Physiological Effects on Fisheries Resources	• Seismic exposure can affect the fitness and survival of fish and invertebrates at very close range (see Species of Special Status, Section 5.1.1.1). • Seismic surveys may displace adult fish from spawning grounds (Worcester 2006); the Study Area includes important spawning and/or nursery areas for commercially-important fish species (including LaHave, Emerald, Western and Sable Banks). • Injury and mortality to fish and invertebrates occur within immediate proximity of an operating air gun (1.5-5 m, depending on species and development stage), with eggs and larvae most vulnerable (Payne 2004; Dalen et al. 2007; DFO 2011a). • There are no well-documented studies to date of acute post-larval fish or invertebrate mortality as a result of exposure to seismic sound under normal seismic operating conditions (DFO 2011a). • Sublethal effects (e.g., reduction in feeding, growth or reproduction rate, histochemical changes) have been measurable in some studies (e.g., Payne et al. 2007), while other studies have detected no significant difference between exposure and control groups (e.g., Payne et al. 2008; Harrington et al. 2010), or effects have been measurable but temporary (e.g., DFO 2004).
Behavioural Effects of Fisheries Resources	• Seismic exposure may result in behavioural effects on fish and invertebrates (see Species of Special Status, Section 5.1.1.1). • Effects of seismic surveys on invertebrate and fish behavior (e.g., startle response, changes in swimming speed and direction, and changes in vertical distribution (Worcester 2006) may affect catchability. • No evidence of reduced catch or abundance of invertebrates following seismic activities, and conflicting evidence for fish, with studies showing increased, decreased or unchanged catches (Carroll et al. 2017).

Table 5.9 Potential Effects of Seismic and Seabed Surveys on Fisheries

	• Scare effects can entail catch reductions that will vary from species to species and between various types of fishing gear (Dalen et al. 2007). Depending on the relative location of the seismic survey air gun, the fish species being harvested, and the fishing gear, effects on fish behavior can vary. • Gausland (2003) reported higher catches in the immediate track of a seismic survey where bottom trawling was used. Løkkeborg et al. (2009) demonstrated that differences in species reactions with Greenland halibut, redfish and ling increasing their level of swimming activity, thus making them more liable to be taken in gillnets and reducing efficiency of longline catch. • No literature has been found documenting major startle or movement responses in crustaceans exposed to seismic sound (Payne et al. 2008). Catch rates are less likely to be affected for sedentary benthic species (e.g., lobster) as these are not likely to disperse (DFO 2011a). No measurable change in catch rates was observed during a study of effects of 2D seismic surveys on snow crab catch rates along the Newfoundland Grand Banks (Morris et al. 2018). • Parry and Gason (2006) investigated the effects of seismic exploration on catch per unit effort (CUPE) of rock lobster and found no evidence of declining catch rates in the weeks or years following any of the 33 seismic surveys conducted in western Victoria, Australia from 1978 to 2004.
Gear Loss and Damage	• Damage to fishing gear or vessels can occur as a result of physical contact with seismic vessels and equipment. • Fixed gear (e.g., crab pots, lobster traps, longlines, gill nets) generally poses a greater potential for conflict with seismic surveys since it is difficult to detect and can be set out over long distances in the water (LGL 2005b). • Groundfish and pelagic longline fisheries can have gear that can extend more than 60 km in length behind the vessel. Both seismic and longline fishing activities result in large areas of influence associated with each activity as well as the turning radii associated with each type of vessel. Changing wind, waves and tides can also result in considerable drift of longline fishing gear (DFO 2011a). There have been no seismic/longline gear entanglements offshore Nova Scotia to date. • Mobile gear (e.g., trawls, seines), towed behind vessels, has a lower risk of conflict since the activity is more visible and seismic survey ships and fishing vessels can communicate with each other and exchange information about operating areas and activities (LGL 2005a). • The path and length of time of possible interaction between seismic vessels and fisheries will be increased should WAZ seismic surveys be employed (i.e., multiple seismic vessels used in parallel to tow sound arrays, resulting in a much greater vessel footprint). These seismic programs also run for longer periods of time compared to traditional 2D and 3D seismic programs.

5.3.1.2 Exploratory Drilling

Exploratory and delineation drilling and ancillary activities can affect fisheries primarily through potential physiological and behavioural effects on fisheries resources (e.g., lethal or sublethal effects, smothering of benthic species from discharge of drilling mud and cuttings, health effects as a result of chronic exposure of bentonite, barite or other drilling fluid components, and displacement from critical spawning, feeding, nursery areas) and loss of access.

Potential effects of exploratory drilling on Fisheries are summarized in Table 5.10.

Table 5.10 Potential Effects of Exploratory Drilling on Fisheries

Physiological and Behavioural Effects on Fisheries Resources	• Metals and organic compounds in drilling muds (including WBM) may accumulate in tissues, reducing growth and reproduction, tainting exposed organisms (for human consumption) and/or bioaccumulating (passing up the food chain and impacting predator species), even at relatively low concentrations (Lee et al. 2011). • Laboratory studies have linked prolonged exposure of bentonite and barite to sublethal effects affecting scallop growth and reproduction at bentonite concentrations as low as 2 ppm (Cranford and Gordon 1992; Cranford et al. 1999; Barlow and Kingston 2001). However, these studies did not account for active wind and tidal mixing and changes in biophysical benthic conditions. • Laboratory studies involving exposure of snow crabs (Andrews et al. 2004) and lobster (Hamoutene et al. 2004) demonstrated minor metabolic differences between experimental and control group individuals, neither of which would be expected to impact fisheries success. It is noted that all of these experiments involved exposure concentrations much higher than would be realized in an open ocean environment where drilling fluids and cuttings would be diluted and dispersed. • Concentrations of drilling mud constituents and metals were monitored in surf clams near exploratory drill rigs in cold-water environments (Neff 2010). No correlation was found between the concentration of drill mud constituents and metals in surf clams near drill rigs and in those located in reference sites. The concentration of PAHs was measured in tissues of invertebrates and fish species in a drilling area in the Alaskan Beaufort Sea; no regional differences in PAH levels in amphipod, clam, and fish tissues were observed (Neff 2010). No effects on fishing success in the Study Area are anticipated due to routine drilling discharges. • Benthic habitat monitoring as part of the SOEP EEM found no obvious effect on fauna or habitat beyond the drill waste piles. Each year since 1998 the EEM program has demonstrated an increase in biomass and potential growth related to maturing communities of marine species (CNSOPB 2011b). Taint and body burden monitoring demonstrated no tainting effects between the 250 m and 1000 m sampling sites. Tainting was only encountered once in Jonah crabs collected directly from the platform structure at Venture (within safety zone). The results of the SOEP EEM program are consistent with EEM programs conducted elsewhere in Atlantic Canada (e.g., Hibernia, White Rose, Terra Nova), concluding no significant effects on fish health and fish habitat. Fisheries are therefore not likely to be affected by drilling discharges. • Underwater sound from exploratory drilling and DP thrusters may result in behavioural effects to fish and invertebrates (refer to Table 5.1 for potential effects of underwater sound on fish and invertebrates).
Loss of Access	• Safety zones are established to prevent damage to oil and gas infrastructure, reduce likelihood and effects of environmental incidents, and maintain the safety and security of industry personnel (Stantec 2010). However, they may also represent lost fishing opportunity, particularly for sedentary species (e.g., surf clam) or migratory species with a well-defined area and timing. Fisheries that are concentrated within specific areas on the Scotian Shelf (e.g., red hake, silver hake, offshore lobster) would be most affected by an exclusion zone. Any drilling program activities that displace fishing activity in these concentrated areas will result in a temporary direct loss of access to the fishery. Commercial fishers cannot move to alternative fishing grounds if exploration activities prevent them from accessing key fishing locations. Restrictions on invertebrate, pelagic or demersal fishing activity in certain areas can also potentially result in overcrowding of other areas and can potentially affect net income of commercial fishers. • Drilling programs generally last up to 120 days, during which time access to marine space by fishers or other ocean users is excluded from a 500 m radius (0.8 km2) safety exclusion zone around the drilling project. A larger exclusion zone may be in effect for

Table 5.10 Potential Effects of Exploratory Drilling on Fisheries

	certain fisheries (e.g., longline), to ensure gear does not drift into drilling rigs (Thompson et al. 2000). • Loss of access associated with a given exploration or delineation drilling program is anticipated to be minimal; however, cumulative loss of access due to several drilling (and production activity where applicable) programs may result in a displacement and demonstrated financial loss to fishing interests. There are typically no more than two exploratory wells drilled per parcel and exploration licences generally last for five years; however, should concurrent programs be proposed in areas of key fishing grounds, timing of fishing seasons and scheduling of drilling programs will be an important consideration.

5.3.1.3 Vessel Traffic

Supply vessels typically travel back and forth between MODUs and the shore base two to three times a week during an active exploration program, potentially interacting with fixed fishing gear that could be present within the travel route. The discussion in Section 5.3.1.1 regarding interactions between seismic vessels and drilling equipment is also applicable to OSVs.

5.3.1.4 Well Abandonment

As described in Sections 5.1.1.4 and 5.2.1.4, well abandonment may involve mechanical means or, in rare circumstances, may require blasting. Interactions with fisheries are not anticipated with the former, however blasting could result in injury or mortality of fish, particularly to juvenile fish and invertebrates due to shock waves produced by the explosion.

5.3.1.5 Accidental Events

Accidental events such as releases from a well blowout, batch spill, or SBM release during drilling could affect fisheries through adverse effects to resources, fishing exclusion (e.g., during spill and clean-up), fouling of gear (e.g., through oiling), or reduced marketability (e.g., real or perceived taint). The severity of effects of a spill on fish (including eggs, larvae, juvenile and adult fish) depends on the properties of the spilled product, and magnitude (e.g., volume), timing, and location (e.g., water depth, temperature, wind and wave energy, proximity to sensitive locations) of the spill. The potential environmental effects on fisheries from a large-scale spill could be considerable.

While spills can result in biophysical effects on fish (see Section 5.1.1.5) and impacts to special areas (see Section 5.2.1.5), which could in turn result in a subsequent loss of fish catch or fish value, there is also a high potential for effects on fisheries to occur as a result of perceived fish taint. For example, following the Uniacke blowout (involving condensate) near Sable Island in 1984, a no-fishing zone was established despite no evidence of taint (Zitko et al. 1984). Negative public perception of fisheries resources in the event of a spill could affect marketability and therefore result in reduced income for commercial fishers harvesting in proximity to the affected area.

5.3.2 Mitigation and Planning Considerations

Table 5.11 summarizes mitigation and planning considerations for Fisheries for each of the key exploration activities. These mitigation measures for Fisheries are intended to supplement more generally protective measures referenced in Section 5.1.2 and 5.2.2. Note that, to minimize duplication, mitigation measures are additive (e.g., several seismic survey mitigations are also applicable to exploratory drilling). Engagement with the CNSOPB and stakeholders (e.g., commercial fishers) early in project planning is crucial to mitigating effects of exploration activities on fisheries and other ocean users. This mitigation also addresses potential conflicts with ocean research and military training activities.

Table 5.11 Mitigation and Planning Considerations for Fisheries (additional to those identified in Sections 5.1.2 and 5.2.2)

Seismic and Seabed Surveys	• Schedule surveys to minimize interaction with peak haddock spawning in the Western/Emerald Banks Conservation Area and the Haddock Box (March/April). • Fisheries Liaison Officer (FLO) familiar with Nova Scotia offshore fisheries to be present on the seismic survey vessel(s) to communicate with fishing vessels in the area and to avoid potential conflict with fishing activities/gear. For conventional (single vessel) seismic programs FLOs may be trained as marine wildlife observers and perform both tasks. • Adhere to the *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2017). • Issue “Notice to Shipping” on location and scheduling of survey activities. • Commence seismic data acquisition only if survey area is confirmed to be clear of fixed fishing gear (e.g., lobster traps) or floating longline gear (e.g., for large pelagics such as tuna and swordfish). • Consult with key organizations representing fishing interests (including commercial and Aboriginal fisheries) in the area during the EA planning stage and just prior to commencement of any work to coordinate seismic program activities with the fishing industry and to reduce potential conflict with fishing activity during peak fishing times. • Consult with DFO to ensure survey area and timing minimizes potential for conflict with research vessel program plans. • Consult with DND to ensure survey areas and timing minimizes the potential for conflict with exercises and/or training.
Exploratory Drilling	• Issue “Notice to Shipping” on location and scheduling of drilling activities. • Consult with key organizations representing fishing interests (including commercial, Aboriginal and recreational) in the area during the EA planning stage.
Vessel Traffic	• Use of common routes by supply vessels and alternate routes around key fishing grounds particularly when fishing is at its peak. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard’s Annual NOTMAR.
Well Abandonment	• If regulatory approval is being sought to abandon the wellhead on the seafloor, consult with fisheries interests and other ocean users to confirm lack of interaction with fishing gear.
Accidental Spills	• Establish ongoing communication with key fisheries stakeholders and other ocean users in the event of a spill and during spill response activities, including but not limited to issuance of a Notice to Shipping/Mariners. • Adhere to *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2017).

5.3.3 Data Gaps and Uncertainties

There are large data gaps associated with the understanding of areas and timing of critical life-cycle stages of various commercial species. The understanding of these areas could potentially change during the lifetime of the SEA; therefore, project-specific EAs should reference updated information as applicable. Ongoing consultation with the fisheries stakeholders is important to confirm specific fishing locations and seasons, and these may be an important consideration should several concurrent seismic, exploration and/or delineation drilling programs be proposed in the Project Area.

6.0 POTENTIAL EFFECTS OF THE ENVIRONMENT ON EXPLORATION ACTIVITIES

Offshore exploration activities require careful consideration of environmental conditions in the operating area. Potential effects of the environment on activities are relevant to environmental assessment in that effects to activities or projects may, in turn, result in associated effects to the environment, primarily through accidental events (e.g., spills caused by equipment failure during extreme weather events). Aspects of the environment potentially affecting offshore exploration activities include:

- Fog and ice;
- Seismic events and tsunamis;
- Hurricanes, winds and extreme weather events;
- Marine life (biofouling and presence of species of special status);
- Climate change; and
- Sediment and seafloor stability.

The interactions between these physical forces and exploration activities need to be considered in both normal and extreme circumstances. Extreme conditions may affect program schedule and operations including the timing of seismic and drilling programs and provisions of supplies and service support.

Detailed analyses of meteorology and oceanographic conditions are included in operators' engineering feasibility and design to ensure safety of personnel, and protection of equipment, vessels and the natural environment. The Offshore Physical Environment Guidelines (NEB et al. 2008) provide detailed requirements for operators regarding the observation, forecasting and reporting of physical environment data to ensure safe and prudent conduct of operations, emergency response, and spill countermeasures. It is important to note that project-specific design and operational planning require a comprehensive analysis of risks presented by these physical factors.

An overview of potential environmental conditions which could potentially affect exploration activities is provided below.

Ice

Sea ice typically forms in the western and northern coastal zones of the Gulf of St. Lawrence during December; by the end of January the sea ice starts to flow through the Cabot Strait under the influence of surface currents and wind (refer to Figure 3.4). Some years, ice, as a mixture of drift ice and locally formed ice, may extend as far as Halifax and to the southwest towards Sable Island, although this is rare. The spring breakup of ice normally commences in March and recedes to patches within the Gulf of St. Lawrence by mid-April. In severe years, ice may stay longer on the Scotian Shelf until May or June. If ice does migrate to the Scotian Shelf, it is not anticipated to result in substantial operational issues (CAPP 2012).

Sea spray can form for a large portion of the year (Nov-Apr) as it only requires air temperatures below -2°C, wind speeds of 10 km/h and water temperatures below 6°C (JWEL 2003). When working under these conditions, Operators require de-icing equipment.

Fog

Fog is often present on the Scotian Shelf, with approximately 35% of days reporting fog with a visibility less than 1 km. This increases to 65% of days in July as warm tropical air masses move north and cause large fog banks and stratiform clouds (Hurley 2011). Impacts of fog on exploration activities pertain primarily to delay due to poor visibility and inability to detect species of concern for avoidance. Table 6.1 presents historical data for visibility acquired from the Sable Island weather station.

Table 6.1 Hours of Visibility per Month Recorded at the Sable Island Weather Station (1971-2000)

	Visibility (hours with)											
	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
1-9 km	179.9	147.8	140.3	158.1	1158.8	153.2	183.7	175.7	122.1	106.9	132.5	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
Note: Visibility in kilometers (km) is the distance at which objects of suitable size can be seen and identified.												

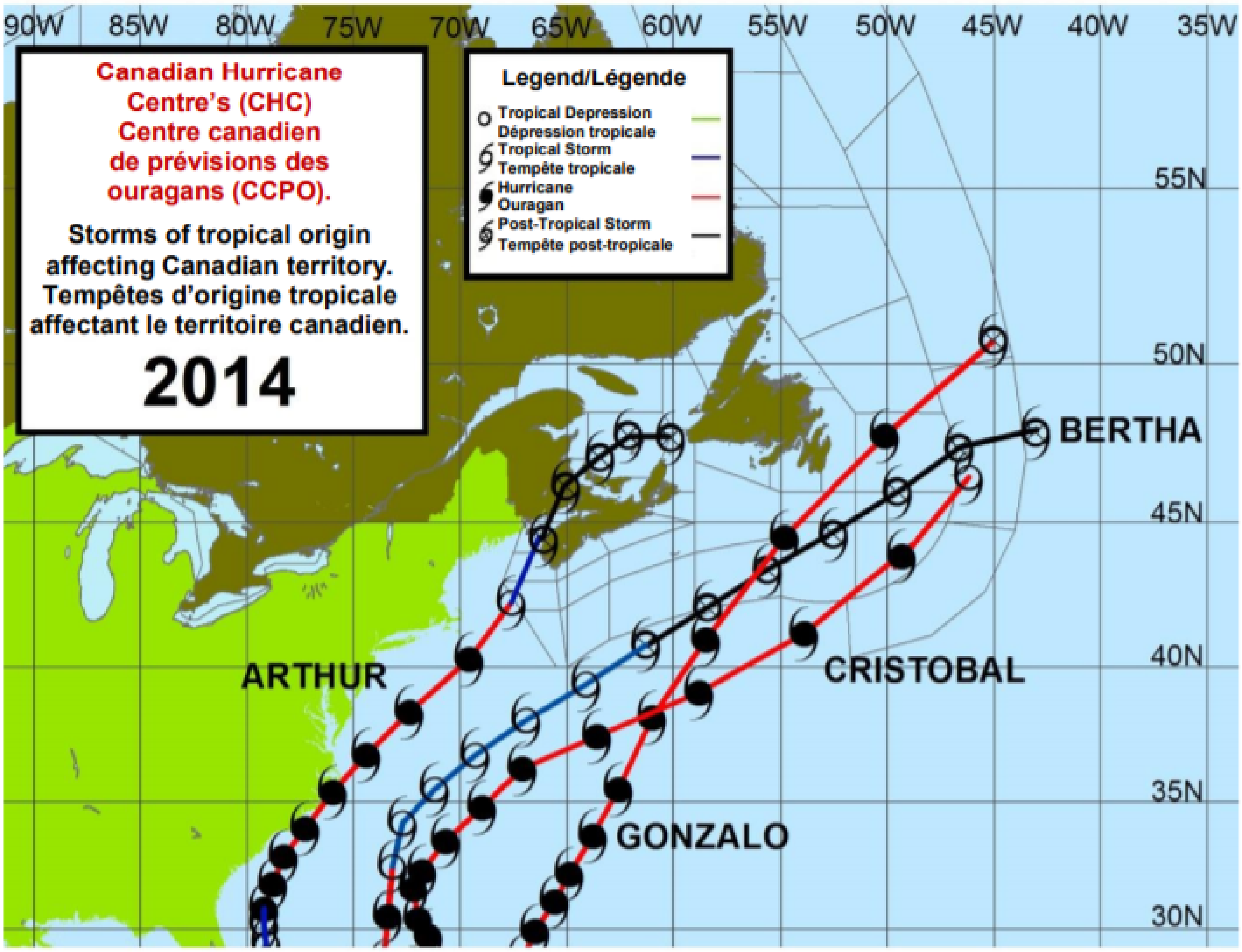
Source: Environment Canada 2012a

Seismic Events and Tsunamis

The Scotian Shelf is an area of known seismic activity with recorded earthquakes, and fault zones occurring on the Shelf. While the area is seismically active (refer to Figure 3.5), events tend to be of a low magnitude. Given the short duration of exploration activities the probability of a significant seismic event or tsunami occurring during an exploration program is low. Guidance on planning and designing for seismic activity and other geological instabilities can be found in the American Petroleum Institute’s design document Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design (API 2005).

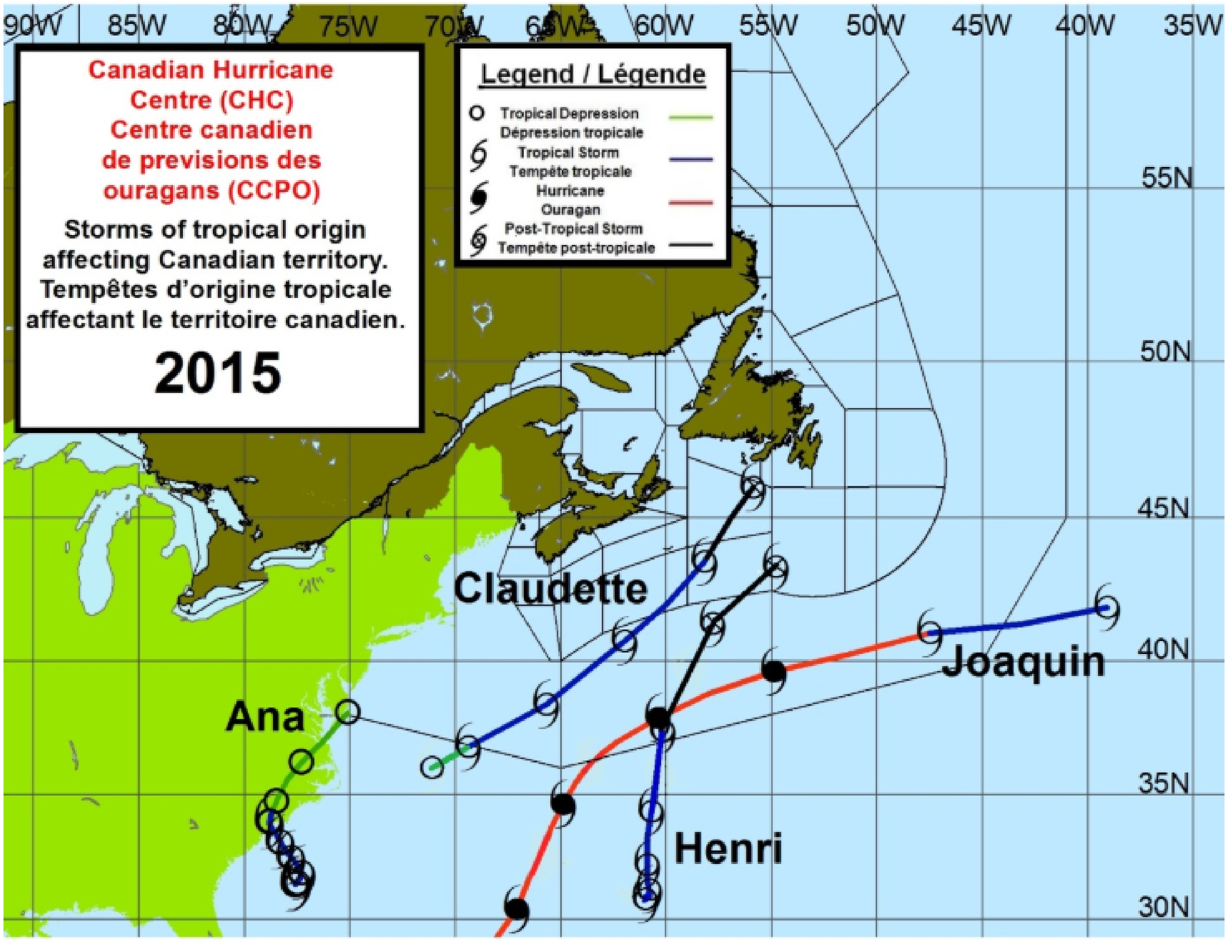
Hurricanes, Wind and Extreme Weather Events

The Scotian Shelf lies in the path of occasional hurricanes and tropical storms that travel up the eastern coast of North America in the late summer and fall. Figures 6.1 to 6.3 illustrate the tracks for storms originating in the tropics which have tracked through Atlantic Canada between 2014 and 2016.



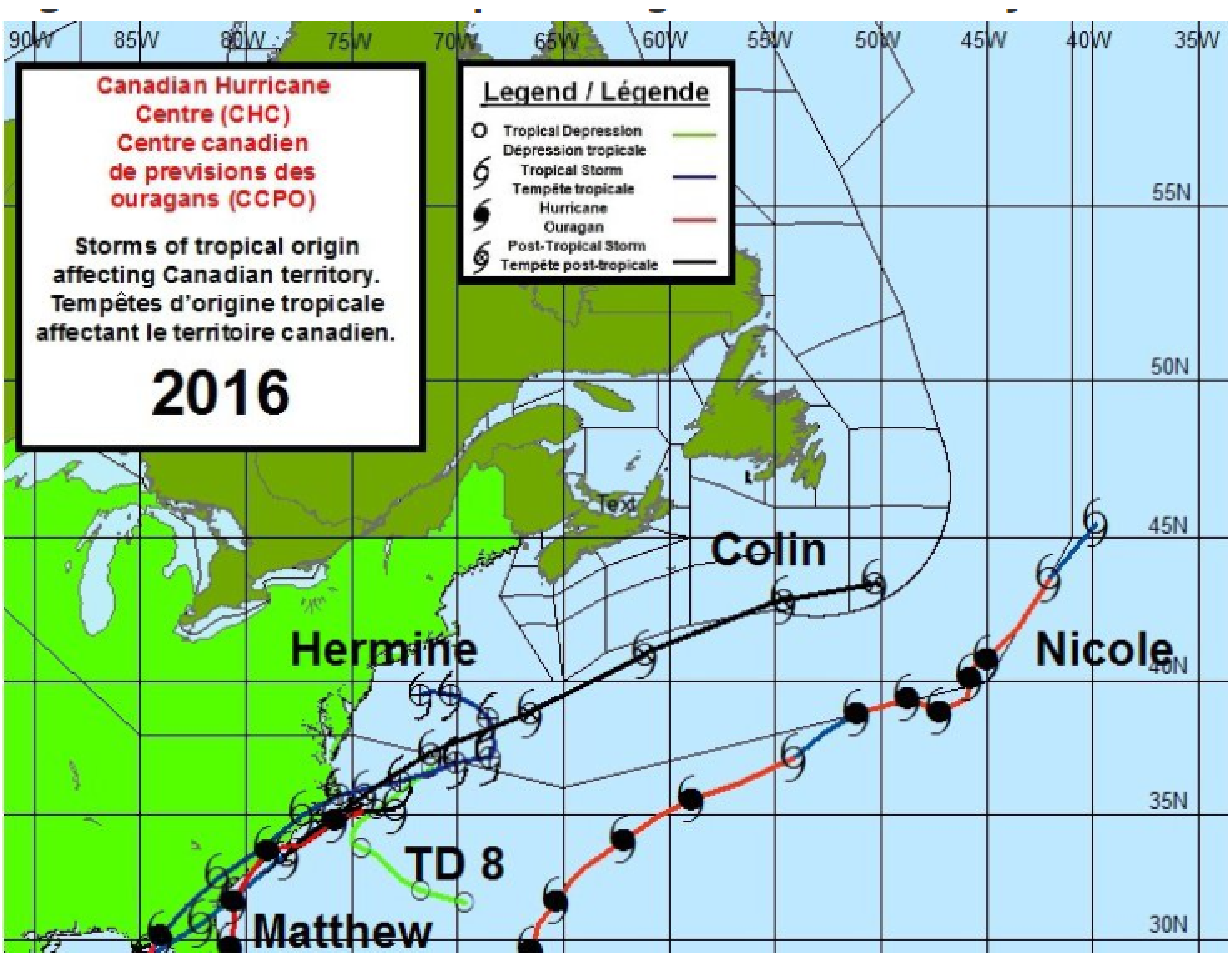
Source: Environment and Climate Change Canada 2017

Figure 6.1 2014 Atlantic Canada Extratropical Storm Tracks



Source: Environment and Climate Change Canada 2017

Figure 6.2 2015 Atlantic Canada Extratropical Storm Tracks



Source: Environment and Climate Change Canada 2017

Figure 6.3 2016 Atlantic Canada Extratropical Storm Tracks

These large storm events pose many risks to exploration activities including reduced visibility, increased wave height, increased wind speeds and heavy precipitation. Winter storm events are also an important consideration as they have the potential to add significant weight to any equipment or vessels very quickly in the form of ice or snow.

Average wind speeds range from 17.5 km/h in September to 31.5 km/h in January while wind speeds can be sustained at 130 km/h during severe storm events. A detailed analysis of meteorological and oceanographic conditions should always be maintained to ensure storm events and high wind and wave events are anticipated and avoided.

Marine Life

The biological environment could affect exploration activities in several ways, including;

- Biofouling of instrumentation or equipment;
- Structure colonization by mussels, barnacles, urchins or sea grasses; and
- Presence or migration of species of special status could halt or delay work.

Given the timeframe anticipated for exploratory work (typically up to 120 days for drilling), it is unlikely that biofouling or colonization of structures or equipment would occur. Presence of species of special status could delay seismic or drilling activities, particularly if they are present within the 500 m safety zone. Planning of programs should take into consideration known distribution of species of special status including known migration routes and timing.

Climate Change

While many of the effects of climate change are expected to be realized over relatively extended time scales (increased temperatures, rising sea levels), others such as large storm events could occur over shorter time scales. Climate models predict an increase in intensity and frequency of large storm events. The Scotian Shelf lies in the path of occasional tropical storms and hurricanes and is thus directly exposed to any increases in storm intensity attributed to climate change. A detailed analysis of meteorological and oceanographic conditions should always be maintained to ensure storm events and high wind and wave events are anticipated and avoided to the extent practical.

Sediment and Seafloor Stability

A variety of sediment types exist on the Scotian Shelf with silty sediments having settled in deep basins while sand and gravel cover the shallow banks and tend to slump over the shelf edge. The Northeast Channel in the Western Scotian Shelf is considered a route of active sediment transport and feeding a shelf-break sediment fan onto the slope and into deeper water (see Figure 3.1; WWF 2009). The Shelf contains few canyons (Dawson and Verrill Canyons) which create steep banks, possible areas of slope instability and avenues for sediment transport between the Shelf and the deep ocean. Sediment scour, liquefaction of sediments from seismic events and slope failure could all adversely affect exploration drilling activities. Scour and/or deposition could occur around footings of jack-up drilling rigs. Periodic monitoring of footings (where applicable) should be carried out, particularly during the winter storm season, to avoid adverse effects associated with sediment transport and seabed stability.

Summary

In summary, it is expected that vessels and equipment would be designed and installed (where applicable) based on appropriate environmental design criteria to ensure integrity of facilities and safety and protection of workers and the natural environment. Although effects of the environment require consideration in project-specific planning, design, and monitoring plans, these effects are expected to be manageable to comply with regulatory requirements, and industry best practices to minimize risk to workers and the environment.

7.0 POTENTIAL CUMULATIVE EFFECTS

"Cumulative environmental effects" is a term generally used to describe environmental change resulting from several anthropogenic alterations with environmental effects overlapping in both time and space. These effects could result from the activities of several large-scale projects or activities or the combined effects of multiple smaller projects or activities. SEA allows for cumulative effects assessment at a broad scale before individual project development to assist with planning and environmental management on a regional basis and to inform project specific assessments

Cumulative effects assessment requires consideration of existing baseline conditions (which includes effects already experienced due to other past or present physical activities), predicted residual effects of the project, and potential effects from likely future physical activities, then evaluating how these effects may combine to result in cumulative effects on receptors (e.g., VCs). Considered in isolation, residual effects of a project may not be considered to be significant; however, when considered in the context of other stressors created by other physical activities in the past, present or future, the cumulative effects may be significant and/or require additional mitigation measures.

Since data gaps and uncertainties at the SEA level of analysis limit the confidence of cumulative effects predictions, the focus of this section is on the characterization of potential interactions and effects associated with other physical activities to help provide context for a cumulative effects assessment and help identify potential mitigation and planning considerations to reduce potential cumulative effects.

An important component of assessing cumulative environmental effects involves the identification of past, present and likely future projects and activities that could interact in combination with proposed project activities to provide context for the cumulative effects assessment. Section 3.3 describes fisheries and other ocean uses which could potentially combine with effects from exploration activities to result in cumulative effects. Table 7.1 presents a summary of these physical activities which could result in potential cumulative effects with petroleum exploration in the SEA Study Area.

Table 7.1 Potential Cumulative Environmental Interactions

Past, Present and Likely Future Projects and Activities	Status in SEA Study Area	VC			Potential Cumulative Environmental Interactions
		Species of Special Status	Special Areas	Fisheries	
Geophysical/ Geotechnical Programs	There are currently no geophysical or geotechnical programs occurring or proposed in the Study Area. However, these activities have occurred in the past and are likely to occur in the future.	✓	✓	✓	• Underwater sound emissions resulting in physical and/or behavioural effects on marine fish, mammals, sea turtles and migratory birds, including potential behavioral effects on fisheries species affecting catchability • Localized disturbance to marine benthos due to geotechnical sampling • Displacement of fisheries and/or interference with fishing gear • Air emissions and effluent discharges from vessel • Vessel collision with marine mammals or sea turtles resulting in increased risk of mortality or physical injury to individuals • Attraction of migratory birds to lighting and stranding potentially resulting in injury or mortality • Risk of accidental hydrocarbon releases resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear
Exploratory Drilling Programs	There are currently no exploratory drilling programs occurring or proposed in the Study Area. However, these activities have occurred in the past and are likely to occur in the future.	✓	✓	✓	• Attraction of migratory birds and/or fish due to lighting (including flaring) and effluent discharges • Lethal and sublethal effects (e.g., smothering, toxicity, reduced growth or reproductive potential) on marine fish from operational discharges (i.e., drill mud and cuttings) • Change in benthic habitat due to deposition of drill muds and cuttings

Table 7.1 Potential Cumulative Environmental Interactions

Past, Present and Likely Future Projects and Activities	Status in SEA Study Area	VC			Potential Cumulative Environmental Interactions
		Species of Special Status	Special Areas	Fisheries	
					• Underwater sound emissions resulting in physical and/or behavioural effects on marine fish, mammals, sea turtles and migratory birds • Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals • Interference with fisheries and other ocean uses (e.g., loss of access due to safety zone) • Risk of accidental hydrocarbon releases resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear
Oil and Gas Production Projects (including development and decommissioning)	There are currently no active oil and gas production projects in the Study Area. Gas production has ceased at SOEP and Deep Panuke and decommissioning activities are underway and expected to be completed by 2020. There are not likely to be any new production projects in the SEA Study Area in the foreseeable future.	✓	✓	✓	• Attraction of migratory birds and/or fish due to lighting (including flaring) and effluent discharges • Lethal and sublethal effects (e.g., smothering, toxicity, reduced growth or reproductive potential) on marine fish from operational discharges (i.e., drill mud and cuttings, produced water) • Change in benthic habitat due to deposition of drill muds and cuttings and/or installation of infrastructure (e.g., subsea systems) • Underwater sound emissions resulting in physical and/or behavioural effects on marine fish, mammals, sea turtles and migratory birds • Interference with fisheries and other ocean uses (e.g., loss of access due to safety zone)

Table 7.1 Potential Cumulative Environmental Interactions

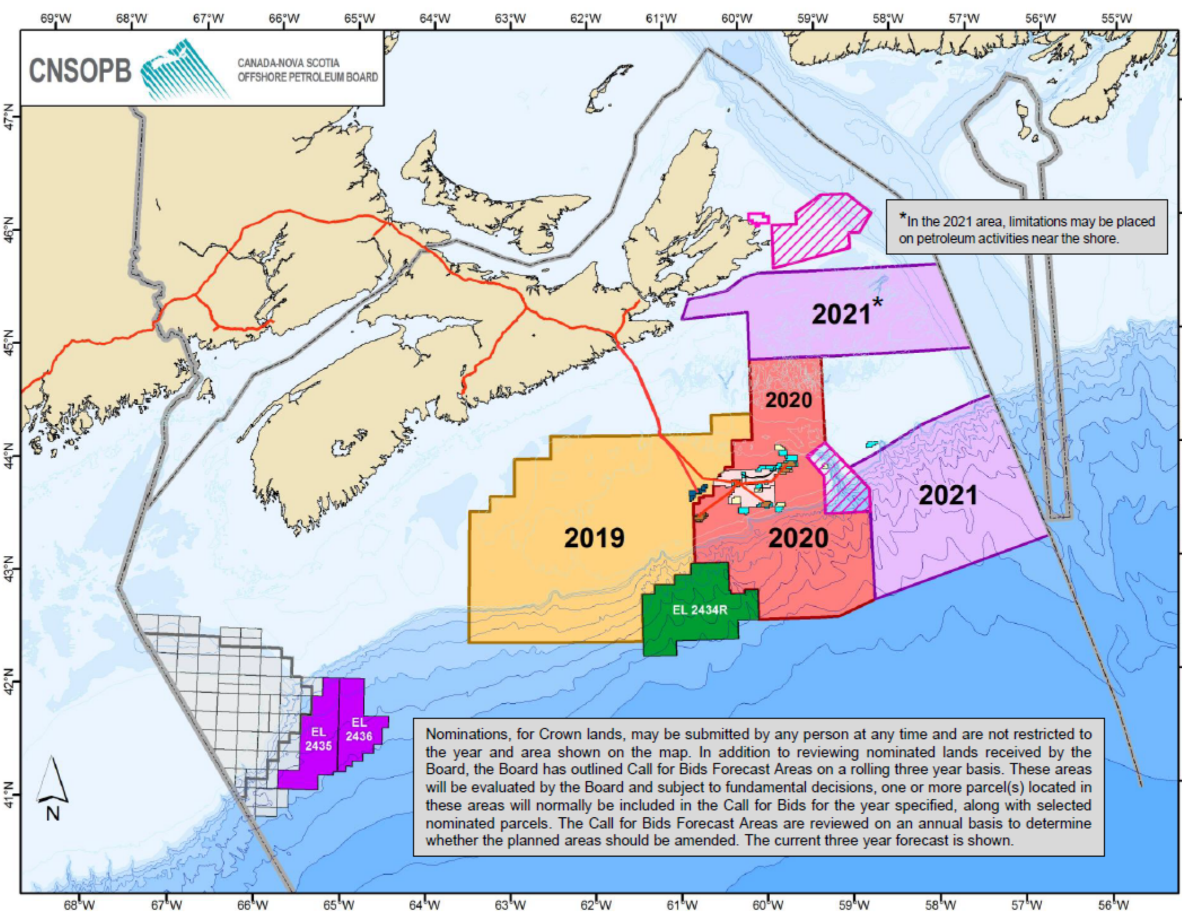
Past, Present and Likely Future Projects and Activities	Status in SEA Study Area	VC			Potential Cumulative Environmental Interactions
		Species of Special Status	Special Areas	Fisheries	
					• Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals • Risk of accidental hydrocarbon releases from vessel resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear
Fisheries	Fisheries have occurred in the SEA Study Area for hundreds of years and are expected to continue into the future. Groundfish, pelagic and shellfish fisheries can occur year-round in the SEA Study Area, although there are specific areas (e.g., Sambro Bank and Emerald Basin Sponge Conservation Areas, Western/Emerald Banks Conservation Area, the Haddock Box) where certain fisheries are prohibited. Fisheries activities are expected to continue be an important ocean use in the future.	✓	✓	✓	• Direct mortality of targeted fisheries species and bycatch species through harvesting • Entrapment and entanglement of mammals, sea turtles, and marine birds in fishing gear resulting in physical injury or mortality • Change in benthic habitat (including potential loss of corals and sponges) due to bottom contact fishing • Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals • Attraction of migratory birds to lighting potentially resulting in strandings • Air emissions and effluent discharges from vessel • Risk of accidental hydrocarbon releases from vessel resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear

Table 7.1 Potential Cumulative Environmental Interactions

Past, Present and Likely Future Projects and Activities	Status in SEA Study Area	VC			Potential Cumulative Environmental Interactions
		Species of Special Status	Special Areas	Fisheries	
Shipping	The Study Area is heavily used for domestic and international commercial shipping consisting of mostly tankers and bulk and containerized cargo carriers, as well as a range of fishing vessels, cruise ships and various government vessels. Shipping activity has occurred in the past and present and will continue in the future.	✓	✓	✓	• Underwater sound emissions resulting in sublethal effects on marine fish, mammals, sea turtles and migratory birds • Air emissions and effluent discharges from vessel • Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals • Attraction of migratory birds to lighting potentially resulting in strandings • Risk of accidental hydrocarbon releases from vessel resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear
Marine Research/Military Activities	Marine research and military activities have occurred in the past and present and are likely to occur in the future. The specific effects may vary depending on the specific research methods or military training activities, but primarily involve vessel traffic and the generation of underwater sound and emissions.	✓	✓	✓	• Underwater sound emissions resulting in sublethal effects on marine fish, mammals, sea turtles and migratory birds • Air emissions and effluent discharges from vessel • Vessel collision with marine mammals or sea turtles resulting in physical injury or mortality to individuals • Attraction of migratory birds to lighting potentially resulting in strandings • Risk of accidental hydrocarbon releases from vessel resulting in injury or mortality to marine fish, mammals, sea turtles and migratory birds; degradation of habitat quality of special areas; and/or fouling of fishing gear

As shown in Table 7.1, potential environmental interactions and effects are very similar among different marine activities. However, the magnitude, geographic extent, frequency, and duration of these effects will vary depending on the specific activity under consideration. Most effects are expected to be temporary and may not overlap spatially or temporally with exploration activities to result in cumulative effects. Specific details on timing and location of activities will require confirmation through engagement with other ocean users during a project-specific environmental assessment to determine the context for a cumulative effects assessment.

The CNSOPB is responsible for authorizing all petroleum related activities in the Nova Scotia offshore and therefore has the authority to reduce spatial and temporal overlap of activities and associated environmental effects. The most recent Potential Call for Bids (2019-2021) process may provide an indication of location of possible future exploration work offshore Nova Scotia (Figure 7.1).



Source: https://www.cnsopb.ns.ca/sites/default/files/pdfs/2019-2021_CNSOPB_Call_for_Bids_Forecast_.pdf

Figure 7.1 CNSOPB Potential Call for Bids Forecast Areas

Depending on industry interest in future call for bids processes, future exploration licences may be established within these forecast areas. Therefore, these areas provide a reasonable indication of potential locations for future geophysical/geotechnical programs as well as exploration drilling programs. Other ocean uses, including fishing, shipping, marine research surveys and military activities are expected to continue in the future as they have been occurring in the SEA Study Area.

Taking a collaborative approach and exploring cumulative environmental effects at an ecosystem level is key to managing cumulative effects effectively. DFO has an ongoing mandate for Integrated Oceans Management on the Scotian Shelf. The overall purpose of integrated oceans management is for decision makers responsible for ocean-based activities to manage these activities in a manner that will sustain a healthy marine environment and provide due consideration for other ocean users. It includes the promotion of ecosystem approaches to management, conflict avoidance and mitigation, and effective intergovernmental coordination for ocean management. By implementing an integrated management approach, the health of marine ecosystems will be maintained, user conflicts will be addressed, the cumulative effects of human activities will be limited, and sustainable use of the ocean will be maximized and diversified (DFO 2002).

Intergovernmental cooperation and collaboration around management of ocean resources has allowed ocean users and regulators to better understand the nature of cumulative effects on the marine ecosystem and identify applicable adaptive management strategies. For example, EEM programs conducted by the offshore petroleum industry are designed in cooperation with various regulators, scientific experts and interested stakeholders so that data on ecosystem effects can be shared with other interested parties to inform future mitigation and environmental management decisions. Continued cooperation and information sharing among ocean users and applicable regulators will help to manage potential cumulative effects on the marine environment.

8.0 CONCLUSIONS AND RECOMMENDATIONS

This SEA of potential adverse effects of petroleum exploration activities on the middle Scotian Shelf and Slope is intended to assist the CNSOPB and potential Operators with future applications and environmental management planning within the SEA Project Area. The SEA is intended to provide information on the current existing environment, highlighting VCs and interactions of potential concern, and referencing mitigation measures and planning considerations to reduce environmental effects and address data gaps and uncertainties.

This SEA is intended to contribute to, but in no way replace, project-specific EA that will be required of proponents in consideration of the specific aspects of their projects and activities, timing of those activities and specific aspects of local conditions within the authorized exploration lease areas. It is also noted that, at the time of this SEA preparation, federal legislation in Canada with potentially important implications for environmental assessment in the offshore industry is currently pending. Proposed new legislation could affect several aspects of project planning and the approval process and must be carefully tracked by proponents. It is also noted that, this SEA is focused primarily on petroleum exploration activities and not development projects; however, the conditions described in the Study Area are generally applicable.

Key mitigation measures for Species of Special Concern, Special Areas and Fisheries are summarized in Table 8.1.

Table 8.1 Summary of Key Mitigation for Exploration Activities in SEA Study Area

Exploration Activity	Proposed Mitigation Measure
Seismic and Seabed Surveys	• Carefully plan project activities well in advance of operations to ensure adherence (at a minimum) to the SOCP. Consideration of additional enhanced mitigation measures (beyond requirements of SOCP), as required, to minimize potential adverse effects to species of special status. • Conduct detailed acoustic modelling as input to project-specific EA for seismic programs proposed in the Project Area; results may be used in determining appropriate safety zones for shutdown of seismic air source array and VSP testing. • Model TTS/PTS in project-specific EAs, using the most current scientific literature. • Use trained wildlife observers, with experience in identifying all marine mammals that occur in the Study Area, to visually monitor and record marine mammal, sea turtle and marine bird interactions and help enforce safe operating distances. • Establish a safety zone around the seismic air source array (with a minimum radius of 500 m, to be determined through modelling), to be monitored visually by a qualified Marine Mammal Observer and/or through PAM (in low visibility conditions). • Implement shutdown procedures (i.e., shutdown of seismic source array) if a marine mammal listed on Schedule 1 of SARA or any sea turtle is observed within the defined safety zone. • Enhanced mitigation may be required for seismic surveys (e.g., the 30- minute observation period outlined in the SOCP may be extended to 60 minutes to account for longer diving times) any time a beaked whale is observed during the course of a survey.

Table 8.1 Summary of Key Mitigation for Exploration Activities in SEA Study Area

Exploration Activity	Proposed Mitigation Measure
	• Implement mitigation measures in a manner that intends to protect and avoid harming, killing or disturbing migratory birds. Refer to Environment Canada's Avoidance Guidelines in planning and conducting activities, while assuring compliance with the MBCA, 1994 and with the SARA. • Conduct seabird monitoring following the Eastern Canadian Seabirds at Sea (ECSAS) Standardized Protocol for Pelagic Seabird surveys from Moving and Stationary Platforms (Gjerdrum et al. 2012b). • Reduce bird attraction by limiting high-intensity lighting, where safe to do so; reducing horizontal light emissions; and minimizing flaring, particularly during drizzle and fog. • Schedule surveying to minimize interaction with peak haddock spawning in the Western/Emerald Banks Conservation Area and the Haddock Box (March/April). • Operators proposing to conduct exploratory activities within the vicinity of the Sable Island National Park Reserve would be required to develop a Code of Practice, including specifying minimum safe working distances for seismic vessels from the Reserve. • Potential avoidance (on a case by case basis) of intrusive seabed surveys in areas with known concentrations and/or high diversity of corals or sponges, such as the Sambro Bank and Emerald Basin Vazella Closure areas. • FLO familiar with Nova Scotia offshore fisheries to be present on the seismic survey vessel(s) to communicate with fishing vessels in the area and to avoid potential conflict with fishing activities/gear. For conventional (single vessel) seismic programs FLOs may be trained as marine wildlife observers and perform both tasks. • Adhere to the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017). • Issue “Notice to Shipping” on location and scheduling of survey activities. • Commence seismic data acquisition only if survey area is confirmed to be clear of fixed fishing gear (e.g., lobster traps) or floating longline gear (e.g., for large pelagics such as tuna and swordfish). • Consult with key organizations representing fishing interests (including commercial and Aboriginal fisheries) in the area during the EA planning stage and just prior to commencement of any work to coordinate seismic program activities with fishing industry and to reduce potential conflict with fishing activity during peak fishing times. • Consult with DFO to ensure survey area and timing minimizes potential for conflict with research vessel program plans. • Consult with DND to ensure survey areas and timing minimizes the potential for conflict with exercises and/or training.
Exploratory Drilling	• Conduct underwater sound modelling to inform the analysis of effects of underwater sound on Special Areas. • Conduct project-specific drill waste deposition modelling to predict extent of drilling mud and cuttings seabed deposition. • Season-specific acoustic modelling at the project level may be required (on a case by case basis) to evaluate potential adverse effects on marine mammals from drilling activity-associated sound. • Conduct pre-drilling ROV surveys to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB.

Table 8.1 Summary of Key Mitigation for Exploration Activities in SEA Study Area

Exploration Activity	Proposed Mitigation Measure
	• Avoid areas with known aggregations of corals, sponges, and other sensitive features during oil and gas drilling activities. • Refer to guidance in the Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada (ECCC 2016). • Develop an EPP for exploratory drilling activities, including selecting and screening chemicals to be discharged in accordance with the Offshore Chemical Selection Guidelines (NEB et al. 2009) and managing offshore waste discharges and emissions from the MODU and OSVs in accordance with the Offshore Waste Treatment Guidelines (NEB et al. 2010) and MARPOL, as applicable. • Adhere to Nova Scotia Offshore Petroleum Drilling and Production Regulations and associated Drilling and Production Guidelines (C-NLOPB and CNSOPB 2017). • Implement best practices for bulk transfer and hose handling procedures. • Provide advanced notice of flaring during periods of migratory bird vulnerability and plans of the associated mitigation to prevent harm to, or killing of, migratory birds. • Conduct a post-drilling ROV survey to verify drill waste deposition modelling predictions (e.g., confirm that the muds and cuttings are within the predicted zone of influence). • Issue “Notice to Shipping” on location and scheduling of drilling activities. • Consult with key organizations representing fishing interests (including commercial, Aboriginal and recreational) in the area during the EA planning stage.
Vessel and Helicopter Traffic	• Adhere to Transport Canada Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction. • Use existing vessel routes to the extent practical to avoid transiting near migratory bird nesting colonies. • Follow Section 5 General Guidelines for Aquatic Species at Risk and Important Marine Mammal Areas in the Canadian Coast Guard’s Annual Notice to Mariners (NOTMAR). • Develop and maintain Code of Conduct to specify minimum safe working distances for OSVs and helicopters from Sable Island National Park Reserve. • Use of common routes by supply vessels and alternate routes around key fishing grounds, particularly when fishing is at its peak.
Well Abandonment	• Design wells and casings to facilitate effective mechanical cutting and removal of the wellhead, avoiding explosive means of separation where possible. • If use of explosives is necessary, follow the recommendations set out in the Guidelines for the use of Explosives in or near Canadian Fisheries Waters (Wright and Hopky 1998). • If regulatory approval is being sought to abandon the wellhead on the seafloor, consult with fisheries interests and other ocean users to confirm lack of interaction with fishing gear.
Accidental Spills	• Conduct spill fate and behavior modelling as input to project-specific EA for drilling programs proposed in the Project Area. • Prepare project-specific NEBA/SIMA, as required. • Engineering design and process safety management protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards.

Table 8.1 Summary of Key Mitigation for Exploration Activities in SEA Study Area

Exploration Activity	Proposed Mitigation Measure
	• Implement Emergency and Oil Spill Response Plan accepted by the CNSOPB (with input from DFO and Parks Canada, as applicable) to address spill prevention and response. • Develop emergency contingency measures and response plans for addressing significant weather scenarios. • Use non-fluid filled streamers for seismic surveys, where possible. • Implement bulk transfer and hose handling procedures per best management practice. • Develop an EEM Plan to address post-spill monitoring of effects, with the scope of the EEM Plan directly related to the severity of potential spills. • Establish ongoing communication with key fisheries stakeholders and other ocean users in the event of a spill and during spill response activities, including but not limited to issuance of a Notice to Shipping/Mariners. • Adhere to Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017); Canada-Nova Scotia Offshore Petroleum Financial Requirements Regulations (Federal); the Canada-Nova Scotia Offshore Petroleum Financial Requirements Regulations (Provincial); and the Guidelines Respecting Financial Responsibility Requirements for Work or Activity in the Newfoundland and Nova Scotia Offshore Areas (December 2000).

With diligent regulatory compliance and collaboration with regulators in assessing risk of adverse effects and identifying applicable mitigation and monitoring, exploration activities in the Project Area are not anticipated to result in adverse environmental effects such that populations of species of special status or the integrity of special areas would be compromised. With the implementation of recommended mitigation and ongoing communication with fisheries stakeholders, exploration activities in the Project Area are not expected to result in unacceptable environmental effects on fisheries. Stakeholder consultation will play an important role in mitigating environmental effects on fisheries and other ocean users.

Planning for a successful environmental management and approval process for offshore petroleum exploration projects in Nova Scotia must consider many factors, some of which have lengthy schedule requirements and must be well integrated with other aspects of technical and engineering planning. A list of key considerations is provided below, although this list should not be considered exhaustive. In planning for exploratory seismic and/or drilling programs on the Scotian Shelf, Operators should consider the following:

- Consult the “Requirements to Operate" and “Activity Authorizations” sections of the CNSOPB website (https://www.cnsopb.ns.ca/offshore-activity/requirements-operate; https://www.cnsopb.ns.ca/offshore-activity/activity-authorizations).

- Plan for regulatory compliance, including knowing the applicable acts and regulations and tracking evolving legislation (e.g., new federal *Impact Assessment Act* and *Canadian Navigable Waters Act*, amended *Fisheries Act*).

- Conduct an EIS (*Impact Assessment Act*) and/or EA (CNSOPB) based on project-specific guidelines issued by the Impact Assessment Agency of Canada (replacing the *Canadian Environmental Assesment Agency*) and/or CNSOPB and plan for associated timelines.
- Plan and conduct early engagement with Indigenous groups, stakeholders (e.g., fishers), and regulators.
- Engagement with Indigenous groups and consultation with stakeholders will play an important role in mitigating environmental effects, identifying key issues to be addressed in the EIS/EA, and demonstrating diligence during the regulatory review process. In particular, it is expected that information will be gathered on Indigenous fisheries during project-specific assessments.
- Consult relevant sections of CEA Agency and/or CNSOPB -issued Scoping Documents and Operator EIS/EAs and Information Requests prepared for past seismic and exploratory drilling programs (available from the CNSOPB Public Registry Archive and CEA Agency Registry websites).
- Consult DFO's "Projects Near Water" website for information regarding DFO's regulatory review process (http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html).
- Reference updated information as applicable in project-specific EAs. Review and incorporate the latest information on the existing environment within the SEA Study Area and the most recent scientific literature, particularly related to current data gaps and emerging issues.
- Conduct site-specific acoustic and spill fate modelling for project-specific EAs for exploration projects proposed in SEA Project Area and implement mitigation and monitoring plans as applicable.
- Consult with the CNSOPB, DFO and Parks Canada (where applicable) to assess risk of adverse effects to Species of Special Status and Special Areas and work collaboratively on potential project-specific mitigation measures.
- Carefully plan project activities well in advance of operations to ensure adherence (at a minimum) to the SOCP and consider adherence to the SOCP as the minimum requirement. Additional mitigation may be specified on a project-specific basis, particularly with respect to minimizing potential adverse effects to species of special status. CNSOPB will work in collaboration with DFO to identify and develop enhanced mitigation requirements beyond the SOCP, as required.
- Apply industry standard best practices in all aspects of project planning and design.
- Maintain regular communication with DFO regarding management planning for Special Areas, EBSAs and the MPA network, which is currently underway, to obtain up-to-date information in planning exploratory programs.
- Design project-specific EEM and observation programs for species of special status, where warranted, such that they may be used to increase knowledge and scientific understanding, particularly where data can be collected and analyzed using standardized methods.

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9.2 OBIS DATA SOURCES REFERENCED AND/OR FOR USE AS FUTURE INFORMATION SOURCES

Fig 3.11

Baleen Whales

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Fig 3.14

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Figure 3.16

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Fig 3.17

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Leatherback Turtle

Boisseau, O. 2014. Visual sightings from Song of the Whale 1993-2013. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1158) on 2019-01-11.

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9.3 PERSONAL COMMUNICATION

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APPENDIX A

Indigenous and Stakeholder Comments and CNSOPB Response Table

<table>
<tr><th>Specific Issue and/or Concern Identified</th><th>CNSOPB Comments</th></tr>
<tr><th colspan="2">Government Policy and the CNSOPB Mandate</th></tr>
<tr><td>Oppose all forms of exploration for fossil fuels in the Canada-Nova Scotia offshore

No drilling should be permitted at all</td><td>It is important to understand that whether or not oil and gas activity may take place in the Canada-Nova Scotia offshore area is a matter of government policy. The CNSOPB’s role is to enforce the Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act (Federal Version) and the Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act (collectively called, the “Accord Acts”) legislation and regulations that are put in place by governments.</td></tr>
<tr><td>Concern that the CNSOPB has competing mandates: regulating for environmental performance and ensuring economic benefits from oil and gas</td><td>The CNSOPB was established in 1990 jointly by the federal and provincial governments as the independent, lifecycle regulator of petroleum activities in the Canada-Nova Scotia offshore area. Our mandate includes the oversight of health, safety and environmental protection, resource management, and industrial benefits, along with rights issuance.

Our job is to ensure that the petroleum companies operating within our jurisdiction do so in compliance with federal and provincial law set out in the Accord Acts, along with their associated regulations.

We strive to achieve excellence in the implementation of all facets of our regulatory mandate, and we have the necessary technical competencies and expertise to achieve this. Our decision-making is structured such that safety of offshore workers and protection of the environment are paramount.

Our expertise in terms of environmental protection includes:
• Environmental assessment, including both Strategic Environmental Assessment (SEA) and project-specific environmental assessment (EA) of the full spectrum of petroleum exploration and development activities such as seismic acquisition, drilling, development, production and decommissioning and abandonment
• Risk assessment and mitigation
• Stakeholder consultation
• Marine biology
• Fisheries
• Marine spatial planning
• Species at risk
• Marine sound
• Habitat management
• Environmental protection
• Spill preparedness and response
• Environmental effects monitoring
• Management systems
• Organizational culture
• Compliance monitoring (including auditing, inspecting/surveying, and incident investigation)

As part of our activity authorization review process, our team of experts diligently ensures that an operator proposing to undertake work in the Canada-Nova Scotia offshore area clearly demonstrates how they will responsibly perform all offshore activities. This includes properly identifying environmental hazards and assessing associated risks well in advance of project commencement, identifying the types of mitigation to be implemented, and ensuring that effective monitoring and compliance processes will be in place throughout the duration of a project.</td></tr>
</table>

Specific Issue and/or Concern Identified	CNSOPB Comments
	We have Memorandums of Understanding in place with other government agencies such as Fisheries and Oceans Canada and Environment and Climate Change Canada to further supplement our expertise, to support information sharing, and for the coordination of our regulatory activities. The CNSOPB also participates in the International Regulators' Forum (focused on offshore safety) and the International Offshore Petroleum Environmental Regulators' Forum (focused on environmental protection). These forums bring together offshore oil and gas regulators from around the world to share best practices and experiences, and to work collaboratively to raise the bar globally in terms of the industry's safety and environmental performance. Canada is the current Chair of the International Regulators' Forum. Learnings from these forums are brought back and applied in a manner that ensures continuous improvement in our regulatory oversight of petroleum-related activities that take place in our offshore area.
Strategic Environmental Assessment (SEA) Practice	
Some principles for SEAs are not being adopted; specifically, principles recognized by the Organization for Economic Cooperation and Development and the International Centre for Environmental Management, such as: • clear development and sustainability goals for the offshore economy in Nova Scotia in general and the offshore oil and gas sector • provide justification for the preference of offshore oil and gas over various other economic development options such as renewable energy development • analyze the possible impacts and benefits of offshore oil and gas in Nova Scotia in comparison to potential alternatives within a framework of sustainability objectives • address the linkages and trade-offs between environmental, social and economic considerations • it does not include an effective and independent SEA quality assurance system	The purpose of SEAs conducted by the CNSOPB is to inform both the Call for Bids process, and potential future operators, of the possible environmental effects of exploration activity within a defined area. It is important to note that the SEAs conducted by the CNSOPB serve a unique and dedicated purpose as a high level document that is meant to inform project-specific EAs. The process is unique to Canadian offshore areas open for receiving applications for petroleum exploration. If successful bids are received in response to a Call for Bids for offshore parcels, Exploration Licence(s) are issued to successful bidders. If an operator subsequently indicates that it plans to submit an application for an activity authorization, a project-specific EA must first be conducted. A project-specific EA takes into account the SEA and further evaluates potential effects to determine the precise mitigation measures that would need to be implemented. Many of the principles of the Organization for Economic Cooperation and Development's document Applying Strategic Environmental Assessment: Good Practice Guidance for Development Cooperation (OECD; http://www.oecd.org/) are incorporated into the SEAs conducted by the CNSOPB, such as customization to the Canada-Nova Scotia offshore context, involvement of key stakeholders and public involvement. It is important to note that governments are responsible for economic benefits and policy related to oil and gas in the Canada-Nova Scotia offshore area.

Specific Issue and/or Concern Identified	CNSOPB Comments
Current and future Call for Bids should recognize the importance of marine refuges and treat them as they do MPAs, such as the Gully, removing them from the bidding process	The SEA study area includes a marine refuge – the Western/Emerald Banks Conservation Area. No human activities that are considered incompatible with the conservation objectives of the Western/Emerald Banks Conservation Area (fisheries restricted zone) by the Minister of Fisheries and Oceans will be permitted in the area. Whether or not a specific proposed petroleum exploration program is incompatible with the objectives of the Western/Emerald Banks Conservation Area (fisheries restricted zone) can only be determined at the time that an application is received and an environmental effects analysis, via an EA, is completed. Before any activity may be authorized for exploration or development in the Canada-Nova Scotia offshore area, a project-specific EA is required. EAs in the Canada-Nova Scotia offshore area are governed by the Federal/Provincial *Accord Acts* and the *Canadian Environmental Assessment Act, 2012* (*CEAA 2012*). Part III of the *Accord Acts* promotes environmental protection. The *Accord Acts* EA process is applicable to geophysical and geotechnical programs, including seismic programs. *CEAA 2012* applies to "Designated Projects" as defined by that Act, namely exploration drilling programs, development programs and some decommissioning programs. The EA process predicts environmental effects of proposed physical activities. Project-specific EAs identify potential environmental effects, propose measures to mitigate adverse environmental effects, predict whether there will be significant adverse environmental effects after mitigation measures are implemented, and typically include a follow-up program to verify the accuracy of predictions and the effectiveness of those mitigation measures. Determining the need for area-based mitigation measures is part of the project-specific EA process. Through the activity authorization process, spatial and/or temporal restrictions may be put in place for specific projects.
Fisheries	
Concerns around the impacts of exploration on fisheries (general)	Potential impacts and mitigation measures for fish and fish habitat are assessed during the EA process for any proposed offshore oil and gas activity. A SEA is one of the first steps in our process of understanding the larger environmental setting and marine environment should offshore oil and gas activity be proposed. Should an operator propose to undertake an offshore activity, a project-specific EA must be conducted as part of our authorization process. EAs in the Canada-Nova Scotia offshore area are governed by the Federal/Provincial *Accord Acts* for undesignated projects and the *CEAA 2012* for designated projects. A project-specific EA takes into account the SEA and further evaluates the potential effects on fisheries that are within the area of the proposed project to determine the mitigation measures that are needed to minimize or eliminate adverse effects. Should offshore activity ultimately be authorized by the CNSOPB, some of the protocols that may be required include:

Specific Issue and/or Concern Identified	CNSOPB Comments
	• Operators are required to conduct offshore activities in a manner that minimizes the impact on fisheries, marine fish resources, and fish habitat. The presence of installations and associated support vessels for offshore petroleum exploration and development activities may require the use of space, which may also be occupied by commercial fisheries. • Standard marine protocols to communicate and avoid collision with other vessels, including a Notice to Mariners, are required for all offshore activities under CNSOPB jurisdiction. The CNSOPB requires a 500-meter safety zone around drilling and production installations, where non-project vessels are restricted from entering. Outside of this zone, petroleum operators are required to work with commercial fishing vessels to minimize interactions. As well, if interference with fishing equipment occurs, operators are expected to follow the CNSOPB Compensation Guidelines Respecting Damages Related to Offshore Petroleum Activity (March 2002). In addition to the above protocols, the CNSOPB requires a fisheries liaison officer to be present on all seismic vessels using sound source arrays, to minimize navigational interactions with active fisheries present in the area. Knowledgeable fisheries liaison officers help ensure effective communication between petroleum operators and fishers. The CNSOPB also evaluates other offshore activities during the EA process to determine if there is a need for a fisheries liaison officer.
Marine Sound	
Concerns around the impacts to environmentally sensitive species from seismic sound	Seismic surveying is a technique used to obtain detailed images of the various types of rock layers located under the earth's surface. Before an authorization is granted, all proposed seismic surveys must undergo a project-specific EA, a process that predicts how a seismic survey could impact the marine environment. The EA also sets out precautions (mitigations) that need to be taken to minimize or eliminate any potential impacts. The CNSOPB requires operators to adhere to the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment, which was developed by a group of federal and provincial government departments, the Offshore Boards, and other experts in marine science and policy. The Statement of Practice outlines the minimum requirements that must be met in order to minimize the effects on marine wildlife. It also outlines when enhanced mitigation is appropriate, such as within or near the critical habitat of a species at risk. We understand there are concerns and that there is conflicting research and data on the impacts of seismic. We work with our colleagues worldwide to understand and remain current on international best practice with respect to the mitigation of potential effects of seismic sound from petroleum activities in the marine environment. We also engage with scientific experts at the regional, national and international level to remain informed of the most up-to-date scientific research related to the effects of sound on marine life, and to understand how it relates to the specific species within Canada-Nova Scotia offshore waters. This knowledge is applied when reviewing every application for seismic activity. One of the key priority research areas for the Environmental Studies Research Fund (ESRF) is the effects of noise on the marine environment (https://www.esrfunds.org/home).

Specific Issue and/or Concern Identified	CNSOPB Comments
	As part of our efforts to proactively mitigate issues, we require that project-specific EAs include modeling of worst-case scenarios within proposed project areas, and a buffer zone is always included around the project area to help mitigate the potential effects from sound propagation on marine wildlife.
Comparison of the effects of sonar and seismic sound	Seismic surveys, which are conducted for the purpose of exploring for oil and gas, do not make use of sonar as a sound source. Sonar sound and seismic sound are two different ways of conducting marine surveying, and they do not create the same type of sound. As a result, they have a different effect on the probability that marine life will be harmed by their use. When looking at these two types of surveying, the most important distinctions are: 1. Since naval sonars operate over a much wider frequency range than airguns, there is a greater potential for affecting a wider variety of marine species; 2. Because sound from naval sonars is often directed horizontally away from the source, there may be a larger overall zone of influence inside of which marine life may be affected; 3. Less is known about the effects of high-powered sonar on marine life than the effects of airguns because sonar is largely used for private/confidential military activities; 4. For seismic activity, mitigation is put in place to reduce or eliminate possible effects from petroleum-based seismic exploration. The CNSOPB considers the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment as an outline of the minimum requirements that must be met in order to minimize the effects on marine wildlife. Enhanced mitigation may be required, such as within or near the critical habitat of a species at risk.
There is a lack of baseline data required to understand the impacts of petroleum activities	The CNSOPB actively seeks to remain informed of current research on the potential effects of petroleum activities on the marine environment at the local, national, and international level. The CNSOPB maintains Memorandums of Understanding with both Fisheries and Oceans Canada and Environment and Climate Change Canada to aid in this regard. The CNSOPB participates in the International Offshore Petroleum Environmental Regulators' Forum. This forum brings together offshore oil and gas regulators from around the world to share best practices and experiences, and to work collaboratively to raise the bar globally in terms of the industry's environmental performance. Learnings from this forum are brought back and applied in a manner that ensures continuous improvement in our regulatory oversight of petroleum-related activities that take place in our offshore area. CNSOPB environment staff also attend scientific conferences, workshops and courses to remain current in their knowledge. Environmental Effects Monitoring programs, as well as observation data obtained during offshore oil and gas programs, also adds directly to the local knowledge base. This knowledge is applied when reviewing future applications for offshore exploration. The ESRF has sponsored studies on oil and gas exploration and development on frontier lands (e.g. the Canada-Nova Scotia/Newfoundland and Labrador offshore areas), including such topics as environmental effects on fish, bird and animal habits and habitats, iceberg detection and flow patterns, oil spill prevention and countermeasures,

Specific Issue and/or Concern Identified	CNSOPB Comments
	dispersant effectiveness in cold waters and ice, frontier social and economic issues, improving accuracy of ocean and weather forecasting, and verification of codes and standards. All ESRF studies are subject to a scientific/technical peer review. Reports that are deemed to be scientifically or technically significant are published in the ESRF Technical Report Series (see ESRF; https://www.esrfunds.org/home). In the Atlantic offshore region, the ESRF is currently targeting both the effects of noise and spills on the marine environment as research priorities this year.
Marine Refuges	
Concerns around the protection of the Western/Emerald Banks Conservation Area, and marine refuges in general	No human activities that are considered incompatible with the conservation objectives of the Western/Emerald Banks Conservation Area (fisheries restricted zone) by the Minister of Fisheries and Oceans will be permitted in the area. Whether or not a specific proposed petroleum exploration program is incompatible with the objectives of the Western/Emerald Banks Conservation Area (fisheries restricted zone) can only be determined at the time that an application is received and an environmental effects analysis, via an EA, is completed. Activity applications can be submitted to the CNSOPB, however an EA must first be completed, and it must demonstrate that the proposed activity is compatible with the conservation objectives if authorization of the proposed activity is to be contemplated.
Capping stacks and the amount of time required to get one to Nova Scotia in the event of a blow-out	Spill prevention, preparedness and response measures are contemplated at the project-specific EA stage, and are fully evaluated during CNSOPB's review of each application received from an operator to conduct a drilling program. Capping stacks are strategically located globally to enable the efficient deployment to the many countries who have offshore drilling taking place at any given time. It is important to understand that the primary means to contain the well is the blowout preventer (BOP), which is connected to the wellhead at all times. A capping stack may be required in the unlikely event that crude oil or natural gas flows uncontrollably from an oil or gas reservoir that has been penetrated during a drilling program. An uncontrolled flow occurs when the well control techniques are not able to control the pressure of the surge from a well and, ultimately, the BOP fails to close and seal in the well. In the event of a blowout, the operator would initiate the mobilization of a capping stack immediately. At the well site, as a first step, other direct well containment methods would be activated. This would include the deployment of a remote operating vehicle to the ocean floor to latch on and manually activate the BOP to seal the well and, if successful, would then negate the need for a capping stack. At the same time, necessary preparatory work on the seafloor, such as debris removal and preparation of the BOP (or the wellhead) for installation of the capping stack would be initiated. Depending upon the amount of debris and damage, preparatory work may still be ongoing when the capping stack arrives at the wellsite. It's important to note that in order to deploy the capping stack a heavy-lift vessel is required. Currently and typically, there are no such heavy-lift vessels located in Atlantic Canada or the eastern seaboard of the United States. Heavy-

Specific Issue and/or Concern Identified	CNSOPB Comments
	lift vessels are available in close proximity to where capping stacks are located. Should a capping stack ever need to be mobilized, the heavy-lift vessel would collect the stack and sail directly to the well location. The CNSOPB is aware of advancements that are continuing to be made in the development and commercialization of air freightable capping stacks and other technology. Depending upon the circumstances of an actual blowout incident, the mobilization and deployment of an air freightable capping stack could potentially shorten the response time for capping the well in comparison to relying on an ocean freightable capping stack.
The effectiveness of the current procedures for spill prevention and response are not evaluated in the SEA	Spill prevention, preparedness and response is contemplated at the project-specific EA stage when a project location has been determined. Our job is to hold operators accountable and that includes ensuring that operators have the appropriate processes and procedures in place aimed at preventing spills from occurring and for responding to and minimizing the effects of spills that may occur. Regulations enforced by the CNSOPB require that specially-designed systems and safeguards must be in place at all times and that personnel are extensively trained to prevent accidental releases of oil or gas. Rigorous risk management practices are mandated to identify potential hazards and for evaluating and managing the associated risks. Oil and gas companies are required to develop spill response plans, which must be acceptable to the CNSOPB before any offshore activity may be authorized. These plans must include detailed descriptions of how a company plans to respond should there be a spill. Within these plans, companies must demonstrate that they have the necessary equipment and trained personnel prepared to respond to a spill. This includes having agreements in place with internationally-recognized companies specializing in spill response to bring in the necessary equipment and resources that would be deployed if there was a large oil spill. Every spill, no matter how small (down to millilitres) must be reported to the CNSOPB, not only for notification but for root cause analysis, trend analysis over time to minimize probability of reoccurrence, as well as for formal investigation purposes when appropriate. More information on spill prevention, preparedness and response can be found on our website: https://www.cnsopb.ns.ca/environment/spill-prevention-preparedness-and-response
Auditor General's concerns about the CNSOPB's level of preparedness for a major spill which have not been addressed	On February 5, 2013, the CNSOPB issued an action plan to address the recommendations from the Commissioner of the Environment and Sustainable Development (CESD) Report. It can be found it here: https://www.cnsopb.ns.ca/sites/default/files/inline/cesd_news_statement_feb_5.pdf On August 7, 2015 the CNSOPB issued an update on CESD Audit Accomplishments. It can be found here: https://www.cnsopb.ns.ca/environment/cesd-audit

Specific Issue and/or Concern Identified	CNSOPB Comments
New Scientific Information	
An update on information currently being studied, and on information that has recently been published, was provided (by DFO) on topics/subtopics related to: • oceanographic conditions • climatology • phytoplankton, zooplankton, and ichthyoplankton • coral and sponges • whale sightings and habitat • seismic effects on deep diving whales • hurricanes, wind and extreme weather It was suggested that the SEA incorporate the information within, or references to, the studies with the SEA	A summary of the information within the studies, or in some cases contextualized references to the studies, were added to this revised version of the SEA, such that potential future operators conducting EAs will have current knowledge of this information.
Update species at risk COSEWIC assessment information is available for White Shark, Winter Skate, Shortfin Mako, Roughhead Grenadier and the Lumpfish	All updates have been included in this revised version of the SEA.
Fossil Fuels	
Before proceeding with long-term investment in the offshore oil and gas industry, the province of Nova Scotia and the CNSOPB may want to consider the business case for fossil fuels	It is important to understand that the CNSOPB does not set energy, economic development, climate change or environmental policy, or draft legislation or regulations. These responsibilities reside with governments. We have passed these comments on to governments.
Aboriginal Rights and Treaty Rights	
The SEA does not directly assess Aboriginal rights and treaty rights	The purpose of the SEA is to provide an evaluation of potential environmental issues in relatively broad terms to allow proactive planning well before project-specific activities are defined and proposed. A SEA does not trigger the Crown's duty to consult because it is does not result in any regulatory action or activity that could potentially impact Aboriginal rights or treaty rights.

Specific Issue and/or Concern Identified	CNSOPB Comments
	When a regulatory action is proposed (e.g. Call for Bids, licence issuance, activity authorization, environmental assessment and development plans), it may trigger the Crown's duty to consult. When it does, the CNSOPB's processes then assess potential impacts on Aboriginal rights and treaty rights.
CNSOPB groups Aboriginal fishing rights with commercial and recreational. It should be clearly stated that Aboriginal fishing rights take precedence over commercial and recreational fisheries	We acknowledge that Aboriginal groups have asserted section 35 rights. Any potential impacts to Aboriginal rights and treaty rights will be given full consideration when completing a project-specific EA.
CNSOPB should clearly assess how potential exploration and accidents may impact Aboriginal rights and treaty rights and how to best mitigate these potential impacts	The CNSOPB has a Memorandum of Understanding with the federal and provincial governments (as represented through the Nova Scotia Department of Energy and Natural Resources Canada) in which the governments can use and rely on, where appropriate, existing CNSOPB practices to assist in discharging the Crown's consultation and accommodation obligations. Regulatory actions that may trigger the Crown's duty to consult include Call for Bids, licence issuance, activity authorization and development plans. The MOU can be found here: https://www.cnsopb.ns.ca/sites/default/files/pdfs/signed_mou-aboriginal_consultation-cnsopb-doe-nrcan_0.pdf As noted in the MOU, when the duty to consult is triggered, a rights scan is conducted by the Crown. The CNSOPB uses this information to consider potential impacts on Aboriginal rights and determine if any mitigation is necessary and if any accommodations need to be made within the scope of the CNSOPB's statutory and regulatory authorities, including through terms and conditions of authorizations.
CNSOPB has not engaged with Mi'kmaq of Nova Scotia during the drafting of the SEA	A letter was sent to Indigenous communities on March 19, 2019, to provide an opportunity to comment on the draft SEA before it is finalized. Please see Appendix A for the list of Indigenous communities contacted.
The SEA will impact Aboriginal and treaty rights by guiding future oil and gas exploration	The purpose of the SEA is to provide an evaluation of potential environmental issues in relatively broad terms to allow proactive planning well before project-specific activities are defined and proposed. A SEA does not trigger the Crown's duty to consult because it is does not result in any regulatory action or activity that could potentially impact Aboriginal or treaty rights. The SEA is not intended to replace project-specific EAs that would be required for any proposed exploration program. Project-specific EAs may trigger the Crown's duty to consult. • For undesignated projects, the EA is administered by the CNSOPB per the *Accords Acts* and, potential impacts on Aboriginal and treaty rights is assessed as part of the CNSOPB's processes. • For designated projects, the EA is administered by the Canadian Environmental Assessment Agency (CEA Agency) as per the *CEAA 2012*.

Specific Issue and/or Concern Identified	CNSOPB Comments
Participant funding is required to adequately review the SEA	There is no participant funding program at the SEA stage in the lifecycle of an offshore project.
The SEA does not consider important questions related to regulatory effectiveness and oversight	The purpose of the SEA is to provide an evaluation of potential environmental issues in relatively broad terms to allow proactive planning, well before project-specific activities are defined and proposed. Regulatory effectiveness and oversight applies to everything within the CNSOPB's mandate. You can learn more about our role and our oversight of offshore oil and gas activities on our website: https://www.cnsopb.ns.ca/what-we-do/life-cycle-approach We strive to achieve excellence in the implementation of all facets of our regulatory mandate, and we have the necessary technical competencies and expertise to achieve this.
Mi'kmaq have a number of fishing licenses in and surrounding the updated 2021 Call for Bids Forecast Area, which may allow for exploration activity that will impact Mi'kmaw fishing of specific species This area encompasses migration routes for Atlantic Salmon and American Eel, which are species of concern and culturally significant species to the Mi'kmaq	The SEA documents all fishing licenses, including those of the Mi'kmaq. Within the SEA, commercial, recreational and Aboriginal fisheries (including relevant fish species) that could be affected by exploration activities in the Study Area are considered. Species of importance to Indigenous peoples with potential to occur in the Study Area are specifically mentioned (American Eel and Atlantic Salmon). The focus of the assessment within the Fisheries section is potential disruptions to commercial fishing activities, including Aboriginal fisheries interests as applicable, through environmental effects on fisheries resources, displacement from current or traditional fishing areas, or gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests. This section also includes food, social and ceremonial species of importance to Indigenous groups (e.g., American Eel, Atlantic Salmon) and commercial fisheries. Reproductive times (mating, spawning/hatching, and peak spawning) for key commercial, recreational or Aboriginal fisheries species that are likely to occur in the Study Area are assessed as well (American Eel and Atlantic Salmon; Table 3.12). The SEA also notes that, "…additional species of importance will be identified through consultation and engagement as part of the requirements of a project-specific EA." The SEA documents sensitive species. Atlantic Salmon is assessed as an endangered species (COSEWIC designation), and American Eel is assessed as a threatened species (COSEWIC designation), as well (Table 3.16).

Appendix A

Indigenous Communities Contacted

Nova Scotia:

- Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO)
- Acadia First Nation
- Annapolis Valley First Nation
- Bear River First Nation
- Eskasoni First Nation
- Glooscap First Nation
- Membertou First Nation
- Paqt'nkek Mi'kmaw Nation
- Pictou Landing First Nation
- Potlotek First Nation
- Wagmatcook First Nation
- Waycobah First Nation
- Sipekne'katik First Nation
- Millbrook First Nation
- Native Council of Nova Scotia (Mime'j Seafoods Limited)
- Mi'kmaw Conservation Group, The Confederacy of Mainland Mi'kmaq (was added on April 1, 2019, at KMKNO's request)

PEI:

- Mi'kmaq Confederacy of PEI
- Lennox Island First Nation
- Abegweit First Nation
- Native Council of Prince Edward Island

New Brunswick:

- Wolastoqey Nation of New Brunswick (WNNB)
- Kingsclear First Nation
- Oromocto First Nation
- Tobique First Nation
- St. Mary's First Nation
- Woodstock First Nation
- Mi'gmawe'l Tplu'taqnn Inc. (MTI)
- Buctouche First Nation
- Eel River Bar First Nation
- Esgenoopetitj First Nation
- Fort Folly First Nation
- Indian Island First Nation
- Pabineau First Nation
- Elsipogtog First Nation
- Eel Ground First Nation
- Metepenagiag First Nation
- New Brunswick Aboriginal Peoples Council
- Peskotomuhkati Nation at Skutik

APPENDIX B

Composite Fishery Landings Maps and Landings Values per NAFO Unit

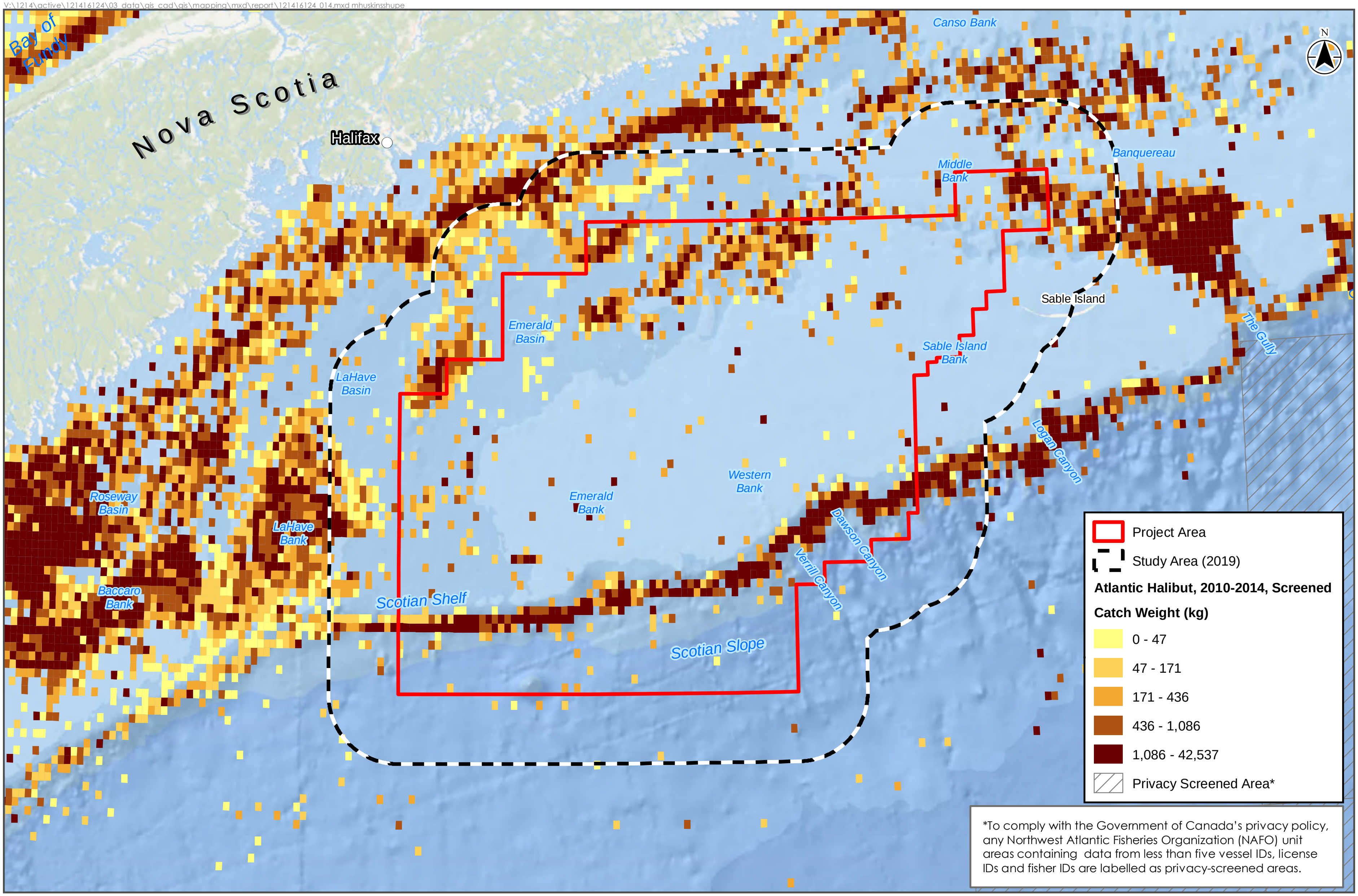
Table B.1
2011 – 2016 Landed Weight and Value of Commercial Fish Species in NAFO areas 4Vs, 4W and 4X, by NAFO Unit
Weight in tonnes, value in 1,000 CND$
*Denotes the NAFO Unit overlaps with the Study Area

NAFO Unit	2011		2012		2013		2014		2015		2016	
	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)
Groundfish												
4VSb	0	0	4	39	6	78	10	128	25	334	80	1,161
4VSc*	2,606	4,486	3,962	5,965	783	3,612	1,341	5,352	1,569	6,615	1,446	5,433
4VSu	2	20	8	88	4	54	0	0	6	88	14	201
4Wd	8	105	23	252	39	455	41	534	62	829	83	1,231
4We*	21	274	34	410	43	568	45	610	59	793	41	602
4Wf*	1	13	0	0	4	51	5	64	11	153	5	84
4Wg*	124	1,361	1,070	2,260	200	1,688	312	1,914	128	1,753	101	1,403
4Wh*	2,350	2,010	4,681	3,418	2,702	2,239	1,706	1,596	2,014	1,869	3,261	2,859
4Wj*	957	1,784	1,082	1,834	649	2,074	1,161	1,851	146	1,205	202	1,347
4Wk*	3,509	3,349	3,175	2,870	4,014	4,344	3,779	4,459	2,757	4,092	1,687	2,894
4Wl*	3,238	2,970	2,527	2,489	2,209	2,247	2,391	2,433	2,823	2,962	2,142	2,913
4Wm*	3	43	0	0	1	10	12	69	5	68	0	0
4Wu	9	110	10	107	21	240	7	88	12	143	9	136
4Xm*	1,308	1,298	370	607	313	872	358	1,094	571	1,436	1,404	2,380
4Xn*	5,106	6,917	4,890	8,450	2,157	4,456	1,657	4,732	1,124	3,619	1,258	3,883
4Xo	2,078	5,934	1,885	5,784	1,675	7,407	1,273	5,718	1,343	8,148	1,101	9,881
4Xp	5,699	7,806	7,162	8,827	4,759	6,289	3,130	3,970	3,331	5,187	3,411	5,045
4Xq	4,246	5,507	4,608	6,083	3,550	5,491	3,097	4,829	2,871	5,124	3,643	5,806
4Xr	1,027	2,056	807	1,883	866	1,980	1,133	2,544	962	2,532	950	3,161
4Xs	485	1,118	366	942	653	1,396	673	1,559	748	1,876	1,020	2,565
4Xu	358	818	301	821	169	543	160	866	191	1,249	83	818
Total Groundfish	**33,134**	**47,980**	**36,967**	**53,130**	**24,816**	**46,096**	**22,292**	**44,409**	**20,759**	**50,072**	**21,942**	**53,803**
Pelagics												
4VSc*	83	544	61	389	139	1,227	212	1,537	279	2,116	210	2,472
4VSu	0	0	2	1	0	0	0	0	0	0	0	0
4Wd	14	328	12	305	13	281	19	356	39	465	74	352
4Wf*	0	0	0	0	0	0	6	43	0	0	19	220
4Wg*	87	577	16	123	247	1,939	162	1,249	176	1,168	121	1,382
4Wh*	16	31	251	1,555	153	735	167	1,026	90	449	273	2,899
4Wj*	80	609	26	217	95	813	180	1,442	243	1,834	194	2,146

NAFO Unit	2011		2012		2013		2014		2015		2016	
	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)
4Wk*	11,250	4,113	1,918	2,459	2,720	2,561	1,261	2,055	2,814	1,964	2,260	3,435
4Wl*	491	2,438	144	1,003	248	1,875	237	1,748	152	1,062	158	1,523
4Wm*	40	273	30	248	139	1,126	117	1,050	130	1,233	122	1,223
4Wu	109	35	38	19	183	133	132	113	0	0	263	520
4Ww	43	267	27	237	57	388	8	60	0	0	0	0
4Xl	76	540	117	1,261	60	516	56	462	158	1,332	12	108
4Xm*	573	995	160	353	153	419	135	418	476	1,591	772	1,007
4Xn*	328	2,014	450	3,243	173	1,424	302	2,467	256	2,109	85	878
4Xo	2,059	804	2,120	1,557	2,457	1,752	3,490	1,555	3,891	2,497	5,635	2,737
4Xp	100	1,105	85	949	63	630	127	1,103	92	891	51	540
4Xq	27,913	6,959	37,362	11,215	23,266	8,278	32,982	12,189	32,097	11,402	26,353	10,719
4Xr	6,464	1,709	5,232	1,368	9,857	3,829	8,334	3,347	9,846	3,631	10,926	4,477
4Xs	13,576	3,061	653	272	14,488	5,681	666	349	973	843	4,199	1,755
4Xu	378	714	270	401	3,656	1,818	967	650	537	1,253	365	287
4Xx	66	418	37	305	116	957	50	418	18	102	14	80
Total Pelagics	**63,748**	**27,533**	**49,012**	**27,478**	**58,281**	**36,382**	**49,610**	**33,636**	**52,268**	**35,942**	**52,108**	**38,762**
Shellfish												
4VSb	1,507	8,586	1,660	8,245	1,794	7,176	1,754	9,638	1,437	4,828	1,408	10,222
4VSc*	6,415	28,545	5,921	23,919	5,531	16,392	5,529	24,154	5,846	18,547	4,984	28,635
4VSu	114	690	178	884	0	0	225	1,266	141	362	0	0
4Wd	4,897	36,210	5,320	38,094	5,466	32,246	6,891	45,841	7,271	51,493	4,984	50,802
4We*	4,728	23,665	3,762	15,422	3,091	8,431	2,568	13,543	2,903	9,554	2,761	19,999
4Wf*	142	794	196	985	240	1,108	111	622	49	157	128	927
4Wh*	4	0	10	1	6	0	7	0	2	0	5	0
4Wj*	0	0	0	0	504	1,375	3	0	0	0	0	0
4Wk*	1,497	13,914	1,827	17,562	1,473	13,865	2,071	21,143	1,874	25,430	2,143	29,940
4Wl*	4	0	12	0	12	0	4	0	7	0	0	0
4Wu	0	0	0	0	253	996	92	519	6	19	2	7
4Xm*	1,705	15,140	1,871	15,707	1,714	17,897	2,400	27,263	2,437	33,481	2,723	39,808
4Xo	12,000	93,878	12,732	96,379	11,045	106,450	15,071	167,534	17,123	222,437	17,732	237,204
4Xp	8,160	11,437	3,343	7,139	6,013	14,989	6,188	15,779	4,446	13,470	3,326	9,911
4Xq	13,333	105,186	15,114	102,507	12,340	117,755	15,436	152,668	13,910	177,312	12,335	163,528
4Xr	10,506	70,287	11,308	73,848	10,182	79,767	12,591	107,845	11,403	121,067	12,857	125,712
4Xs	10,558	60,622	11,462	60,384	12,320	75,780	17,575	120,197	19,540	156,759	19,747	166,593
4Xu	118	254	150	379	111	310	209	560	169	505	113	289
Total Shellfish	**75,686**	**469,208**	**74,865**	**461,457**	**72,095**	**494,539**	**88,724**	**708,574**	**88,564**	**835,421**	**85,248**	**883,578**

NAFO Unit	2011		2012		2013		2014		2015		2016	
	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)	Landed Weight (t)	Landed Value ($000)
Other Species												
4VSc*	0	0	0	0	0	0	0.1	1	0	0	0	0
4Wk*	0	0	0	0	0	0	<0.1	0.2	0	0	0	0
4Wl*	0	0	0	0	0	0	<0.1	0.7	<0.1	1	0	0
4Xm	0	0	0	0	0	0	0	0	<0.1	0.2	0	0
4Xo	304	128	215	88	157	70	13	6	0	0	0	0
4Xu	292	117	104	43	43	20	0	0	0	0	0	0
Total Other Species	**596**	**245**	**319**	**131**	**200**	**90**	**13**	**8**	**<0.1**	**1**	**0**	**0**
Grand Total	**173,164**	**544,966**	**161,163**	**542,197**	**155,392**	**577,107**	**160,638**	**786,626**	**161,590**	**921,437**	**159,298**	**976,143**

Source: DFO 2018



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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

Dogfish Landings

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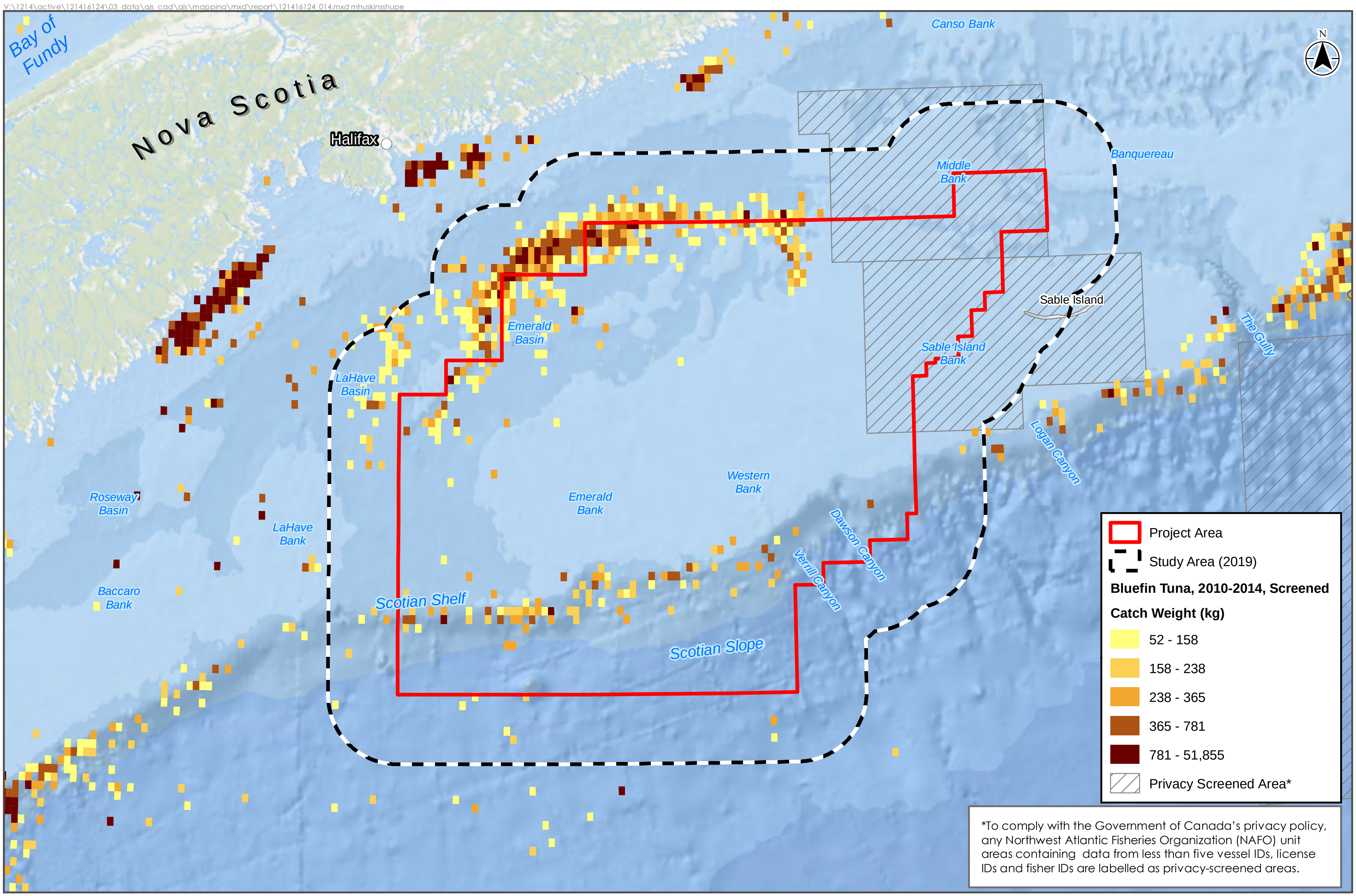
STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_014

Figure B.1



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Bluefin Tuna Landings

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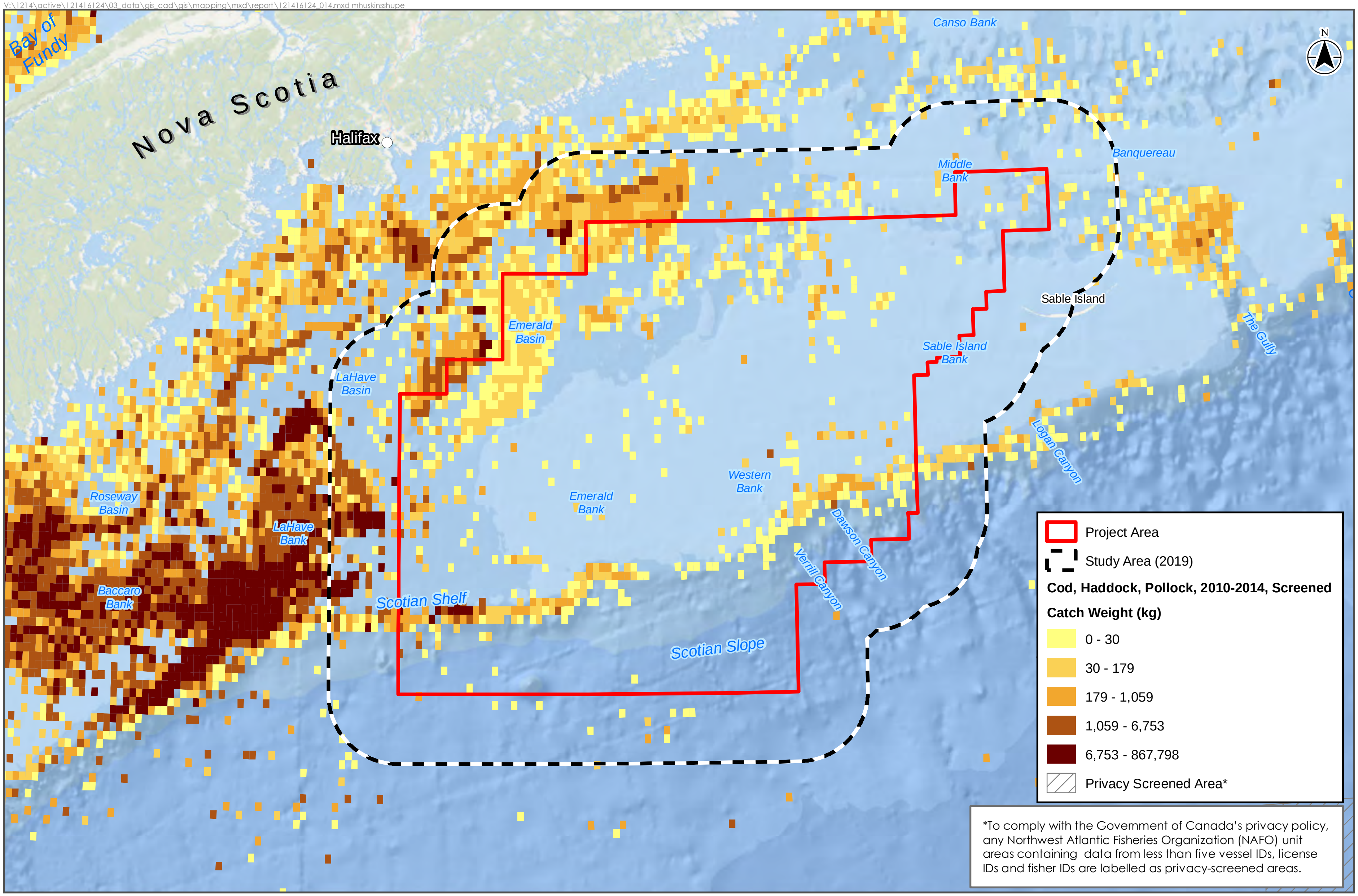
Figure B.2



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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Other Tuna Landings

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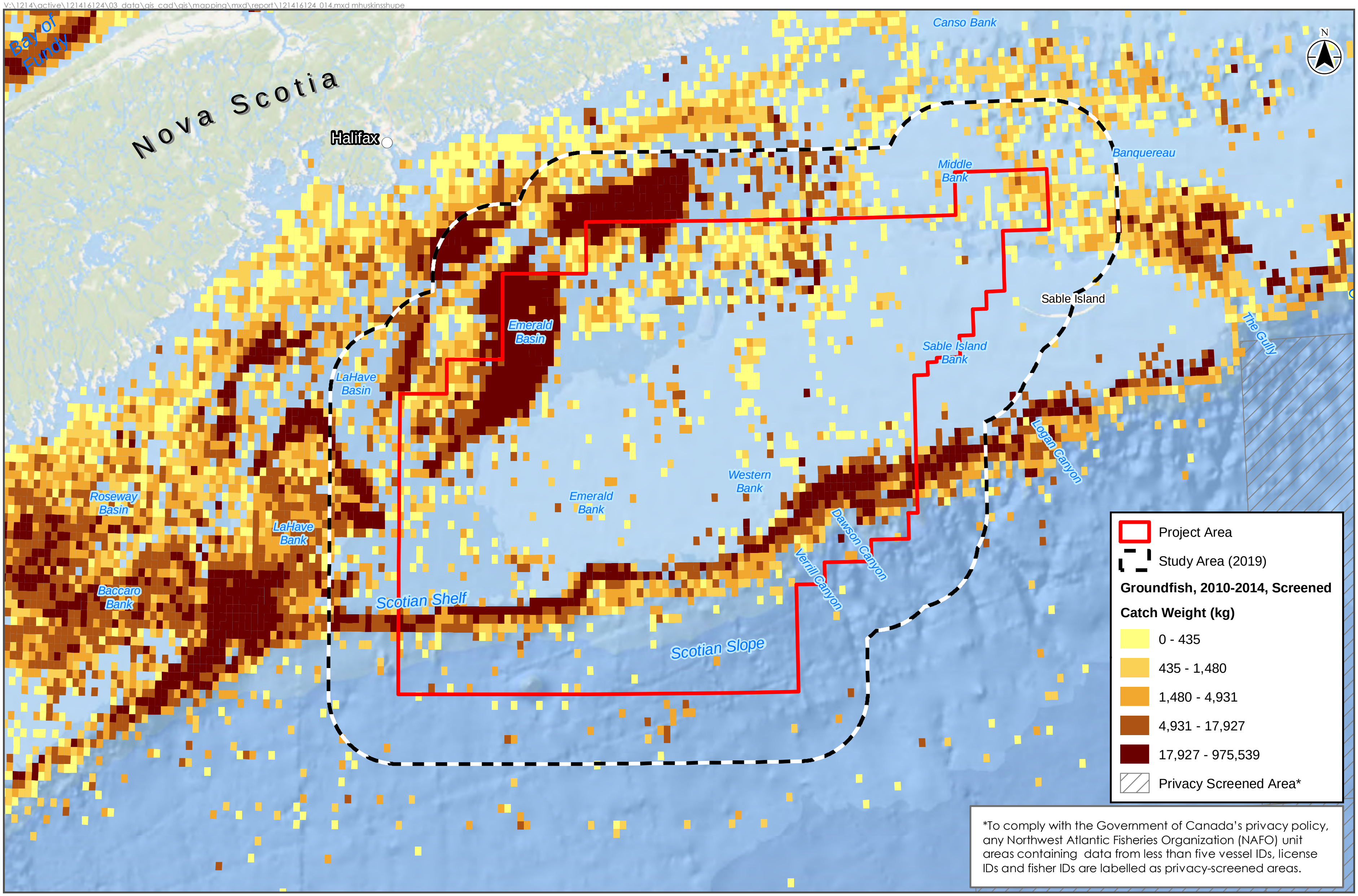
Figure B.3

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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Porbeagle, Mako, Blue Shark Landings

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Figure B.4

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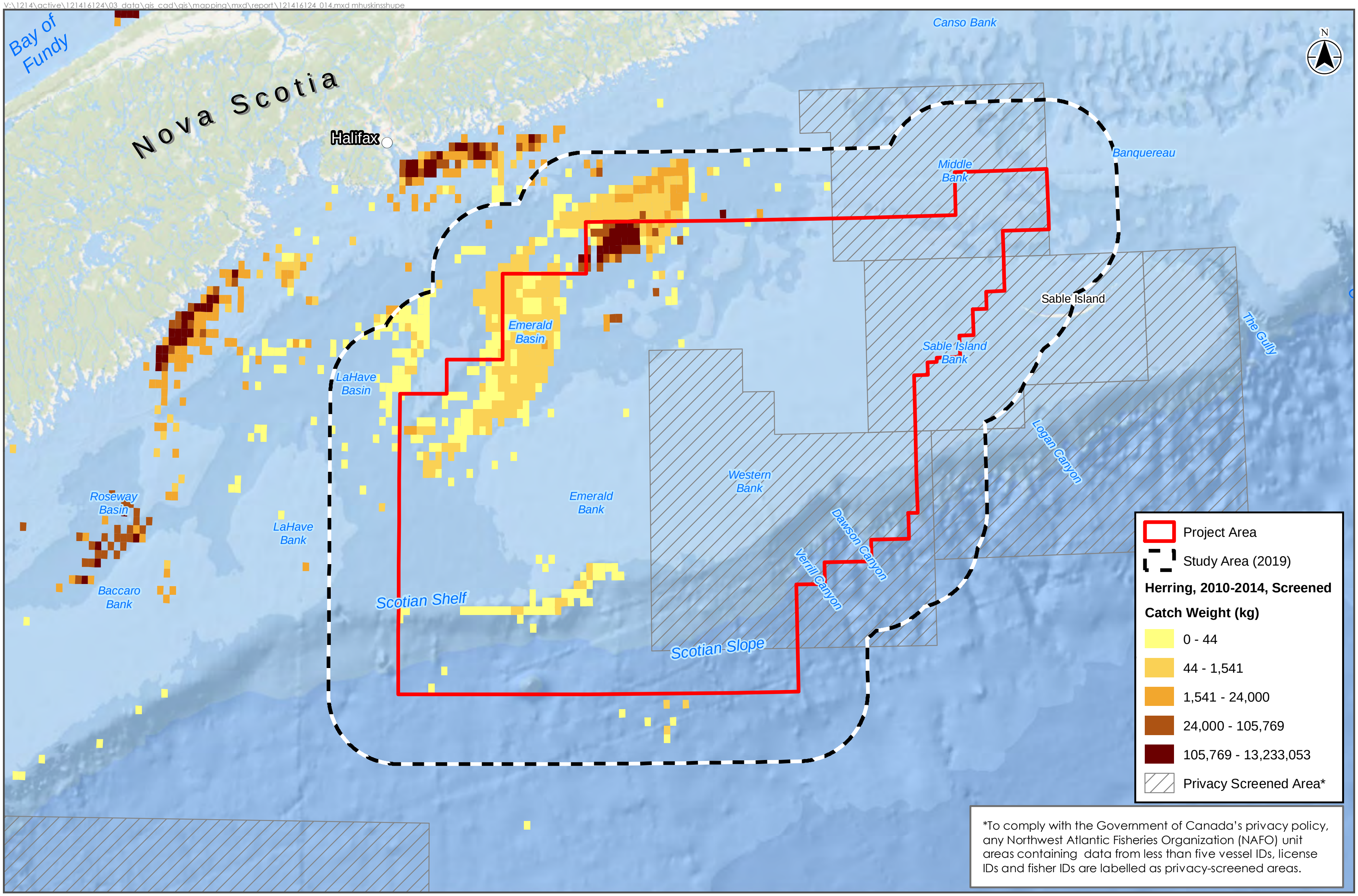

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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Swordfish Landings

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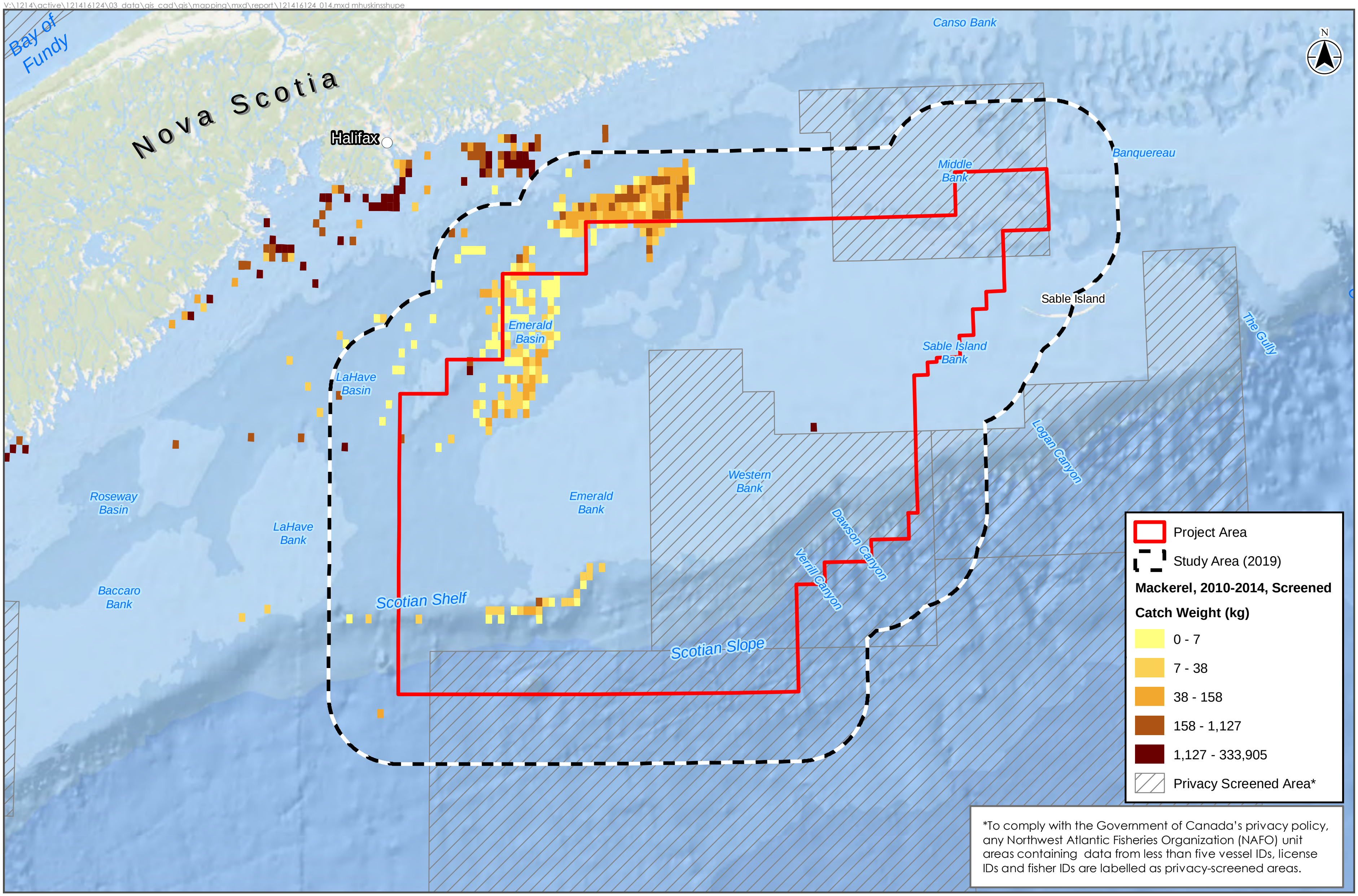
121416124_014

Figure B.5

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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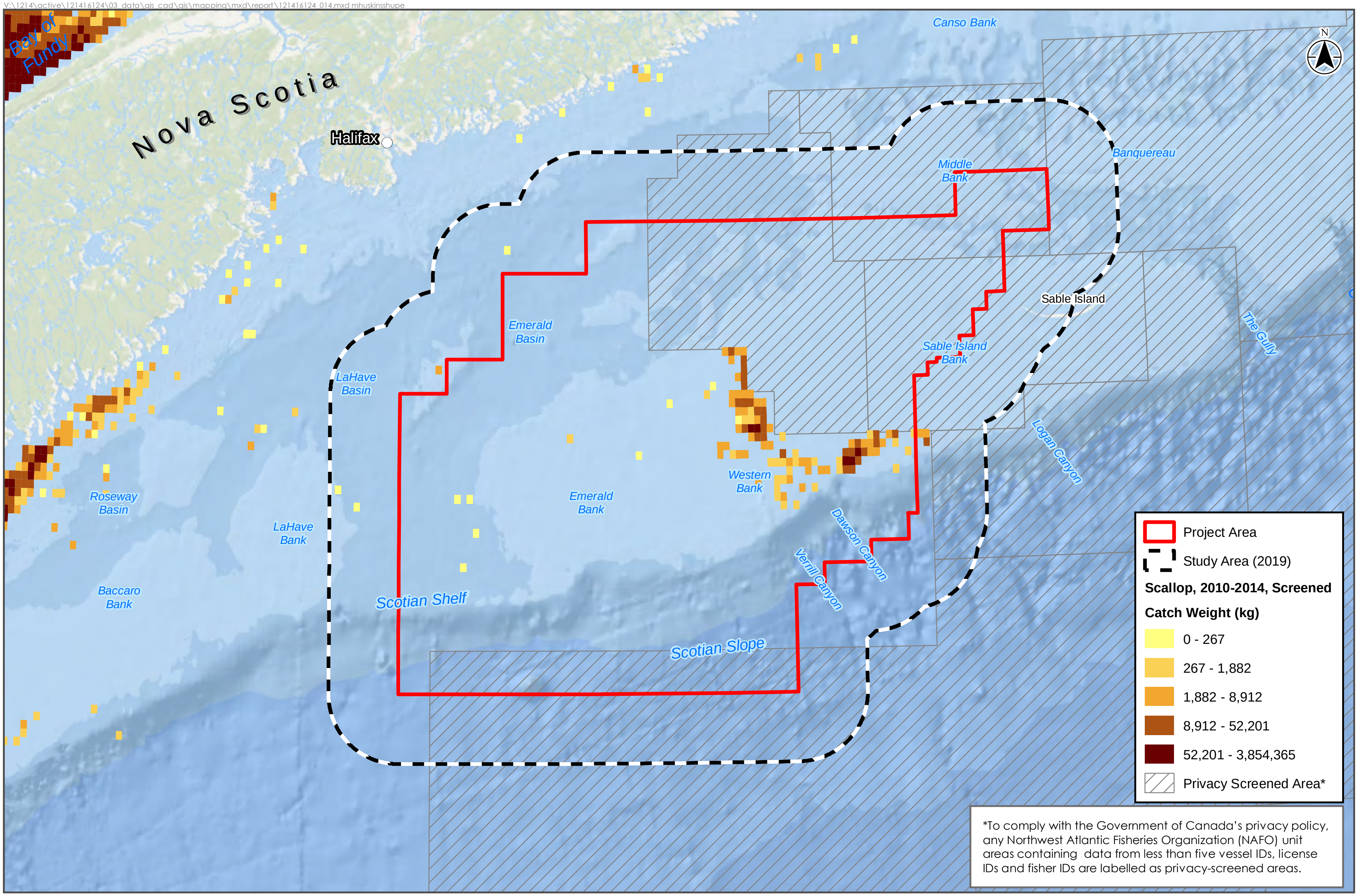
121416124_014

Herring Landings

Figure B.6

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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Mackerel Landings

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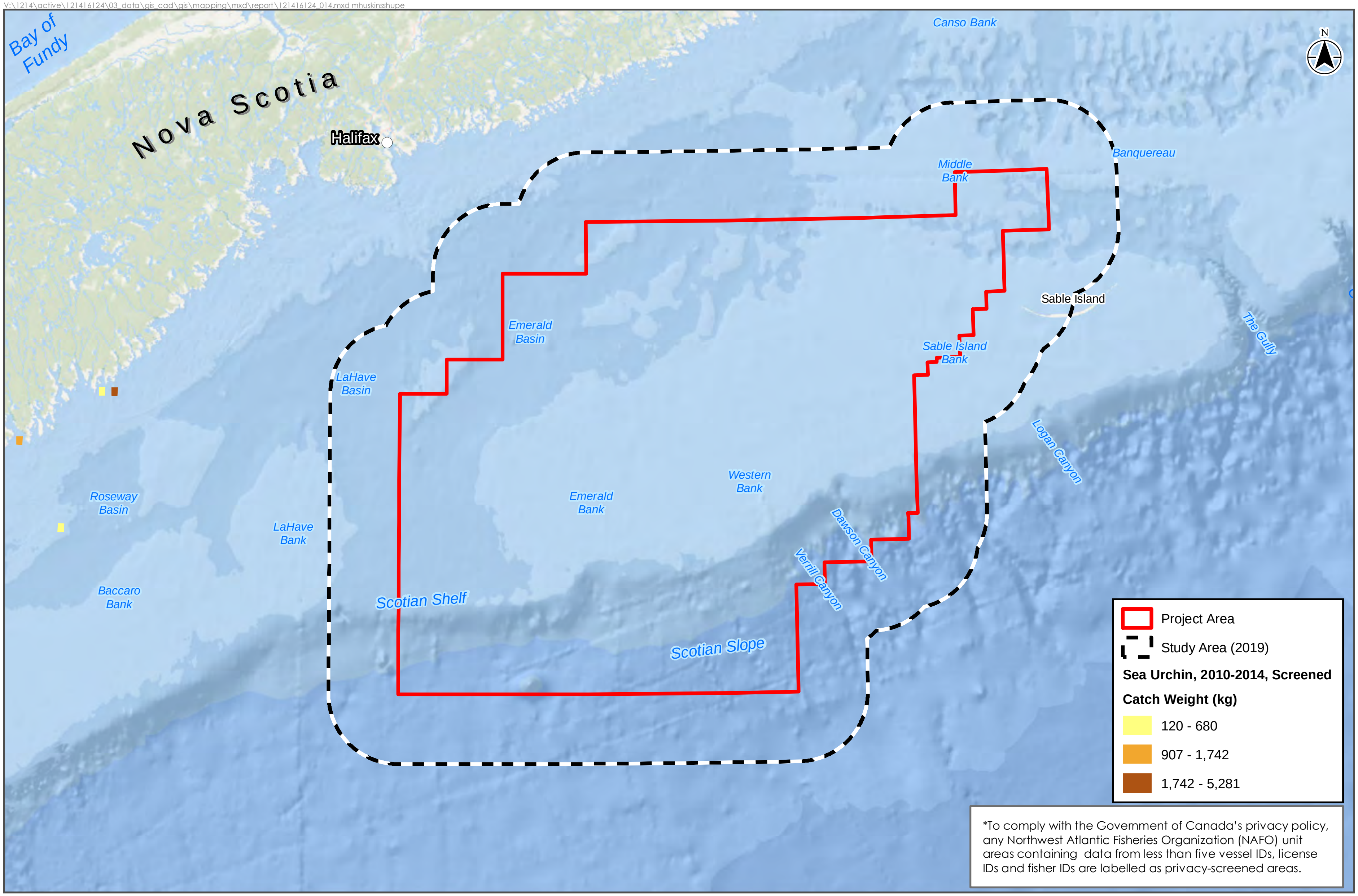
Figure B.7

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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Large Pelagics Landings

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Figure B.8

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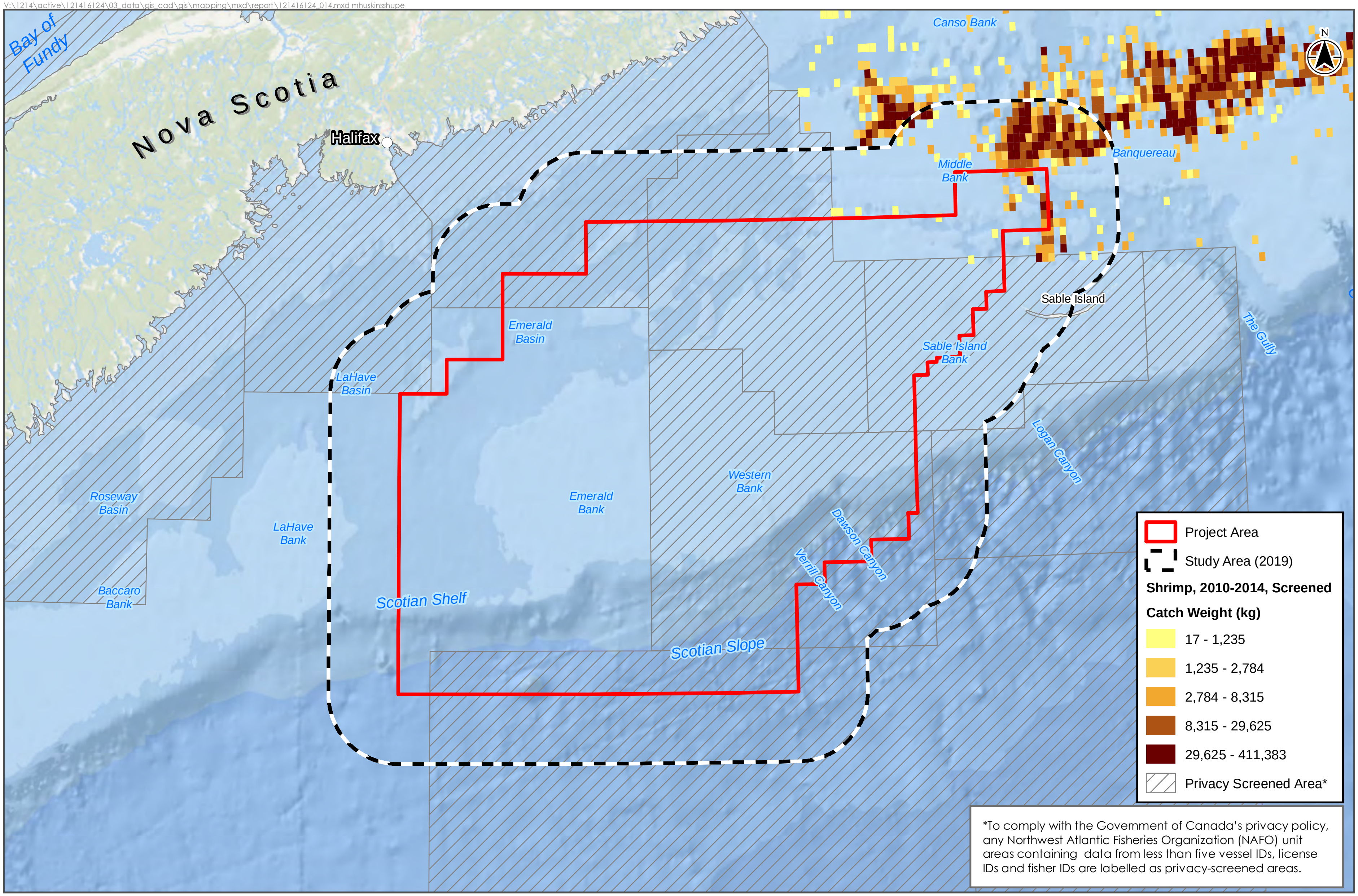

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Atlantic Halibut Landings

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121416124_014

Figure B.9

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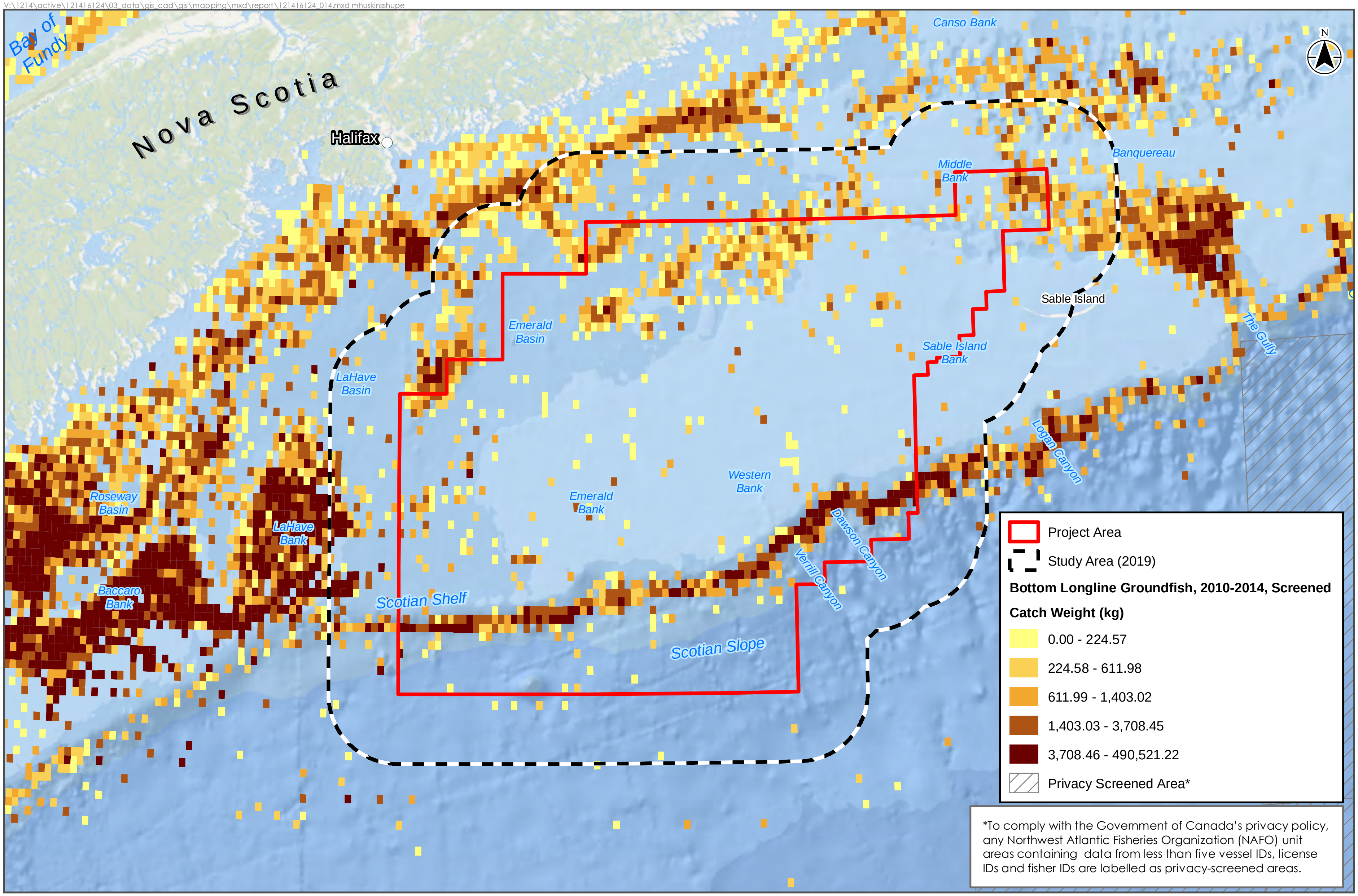

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Cod Landings

Stantec

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121416124_014

Figure B.10

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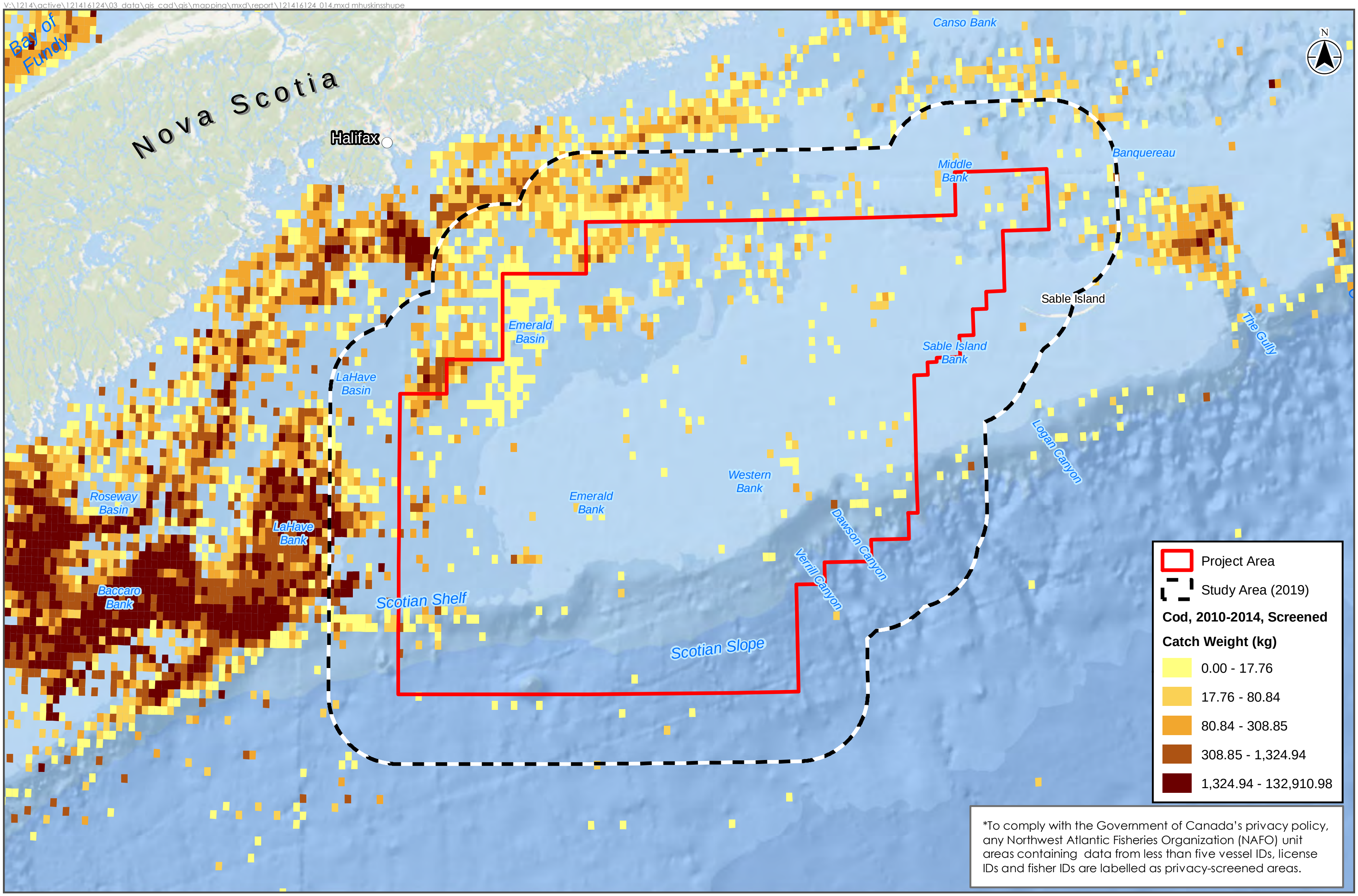

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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Cusk Landings

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121416124_014

Figure B.11

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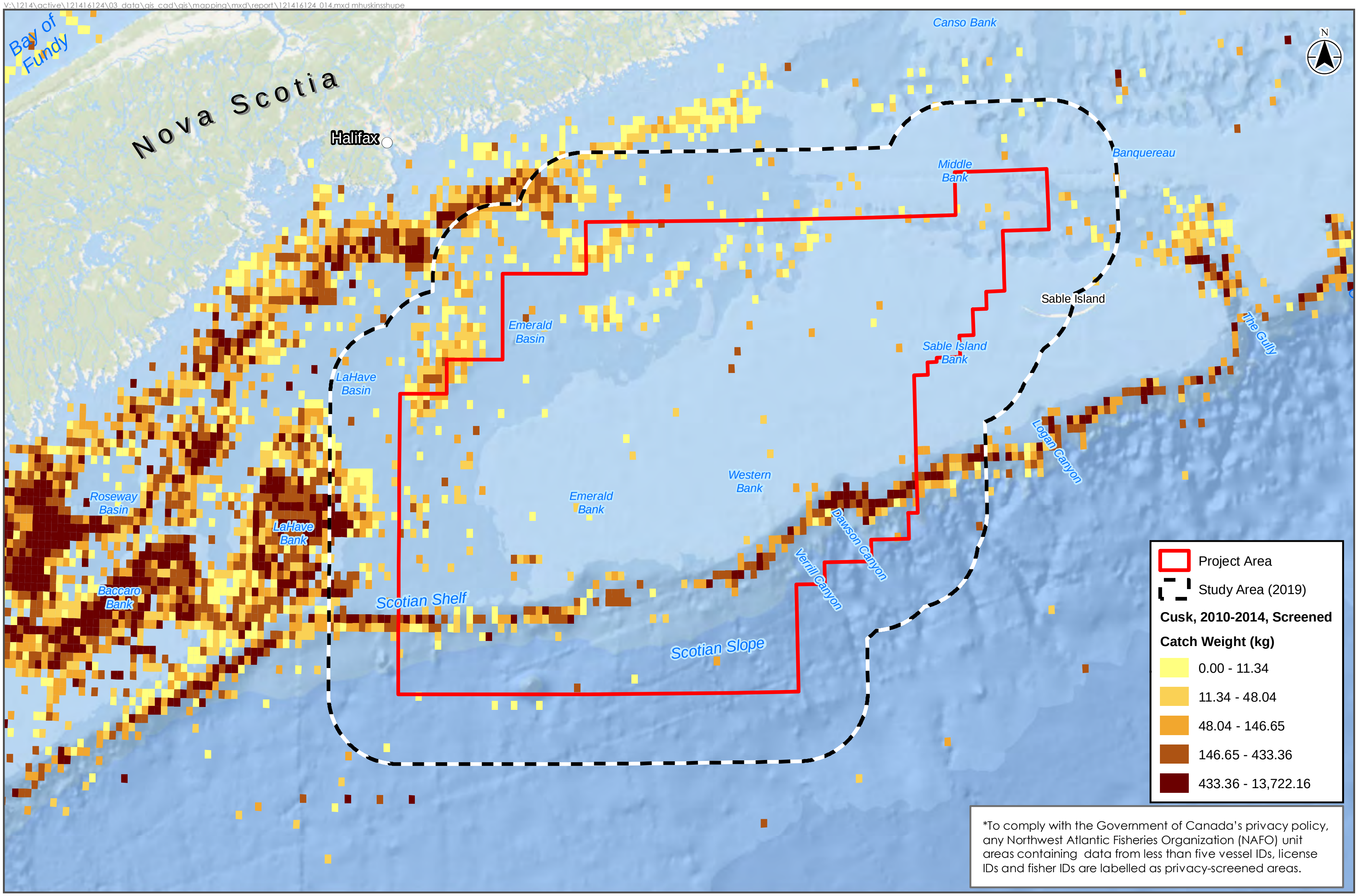

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Flatfish Landings

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121416124_014

Figure B.12

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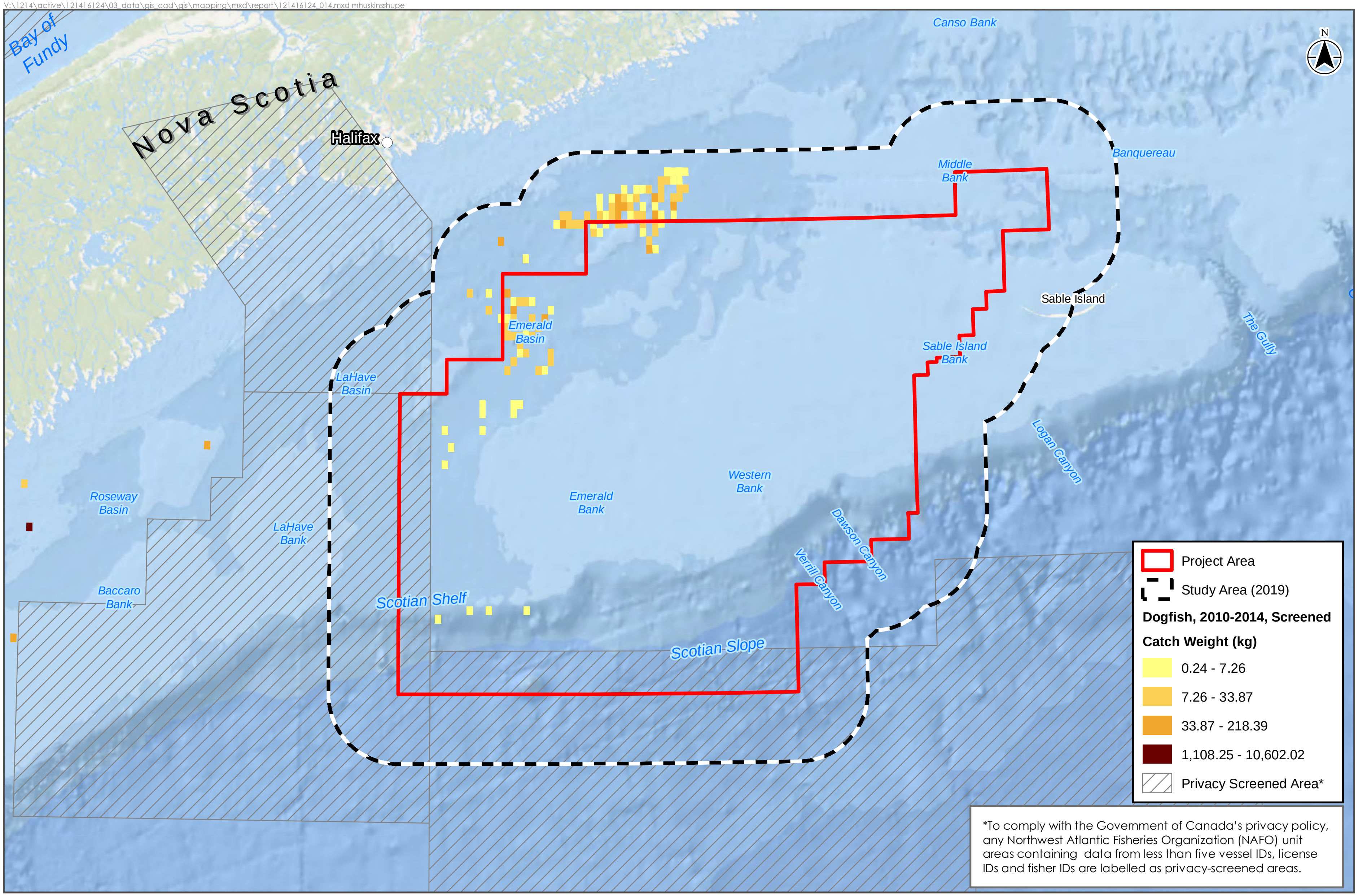

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Greenland Halibut Landings

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121416124_014

Figure B.13

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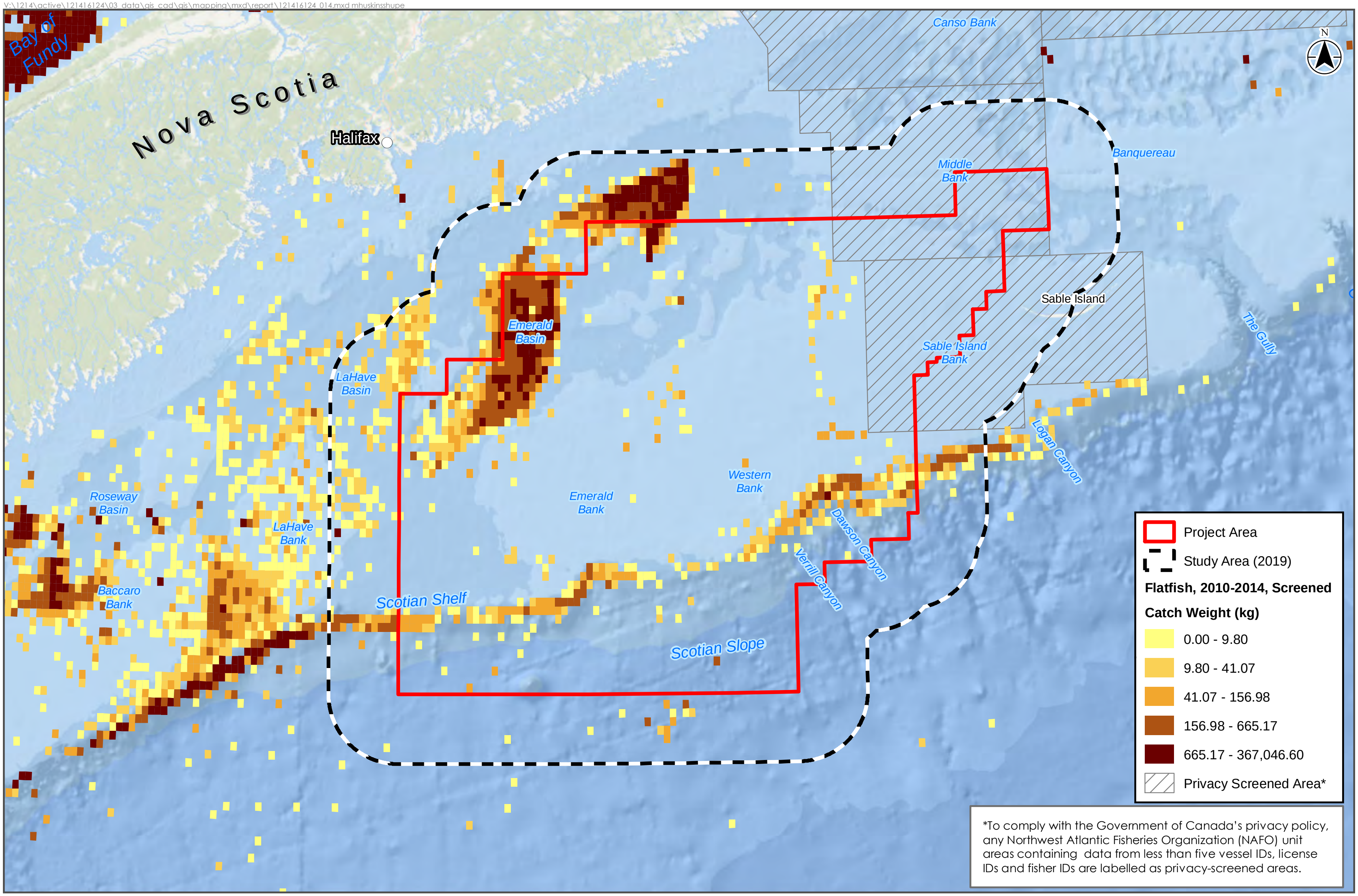

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Hagfish Landings

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121416124_014

Figure B.14

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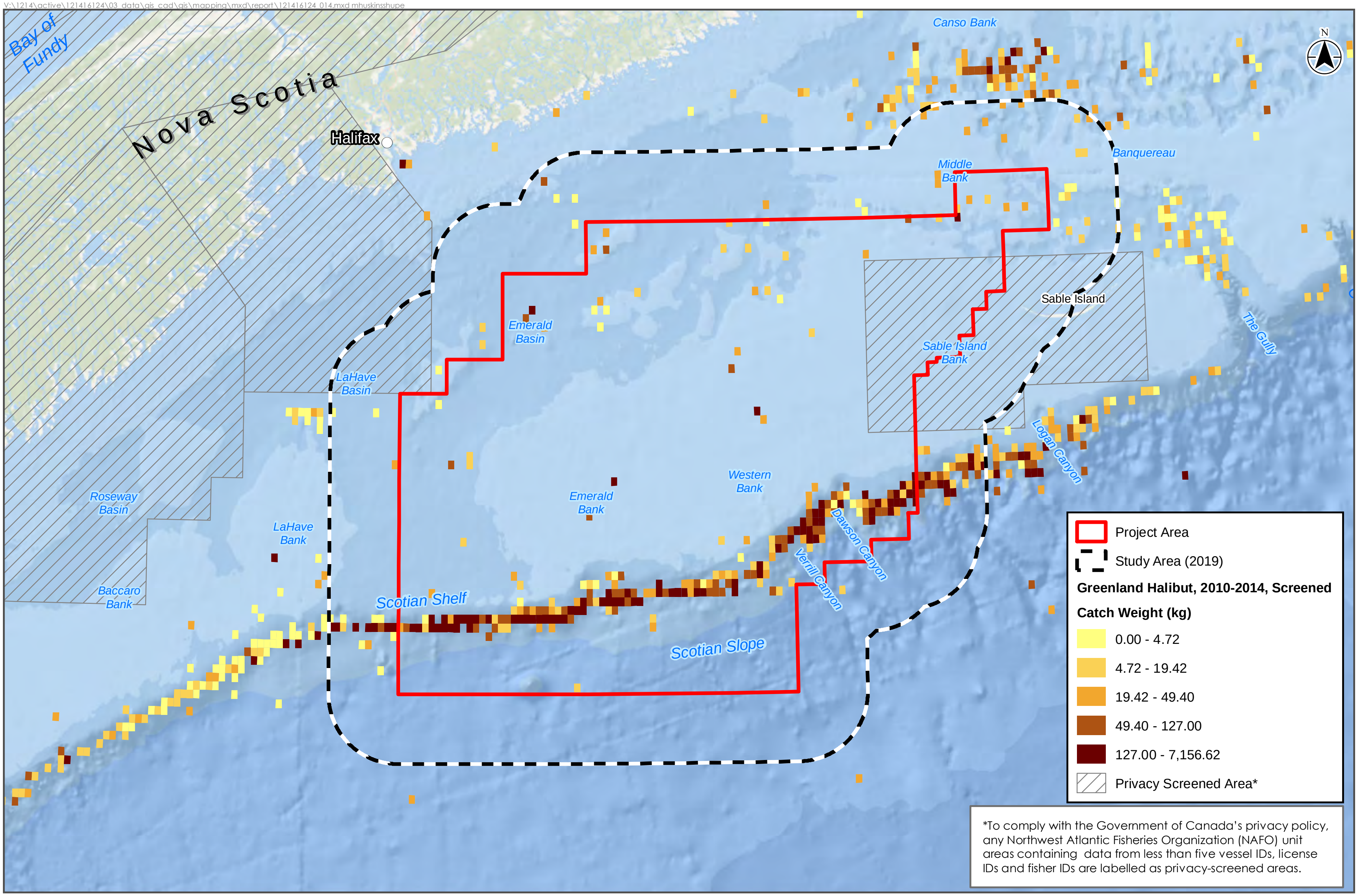

Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Monkfish Landings

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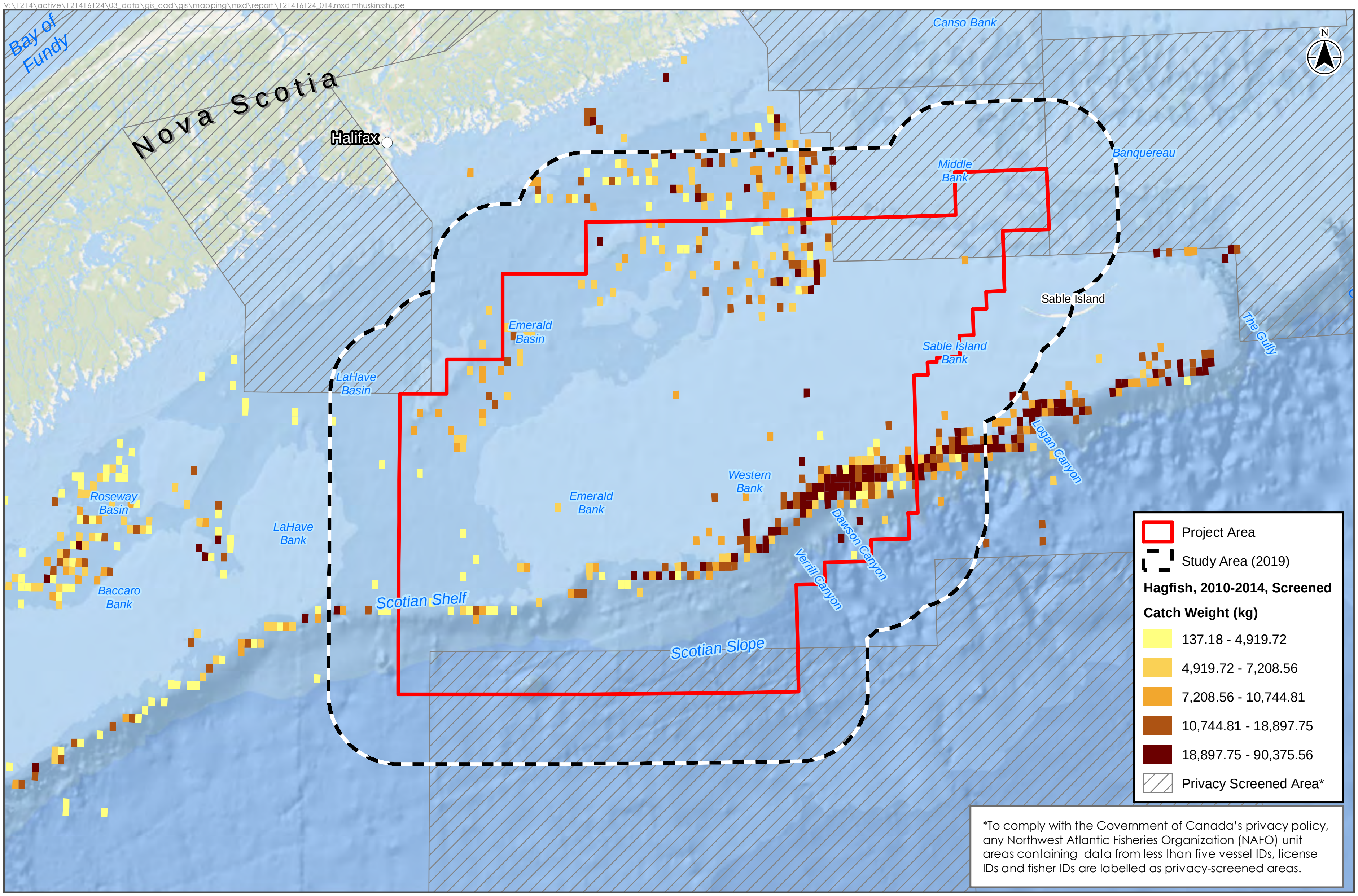
STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_014

Figure B.15

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

Red Hake Landings

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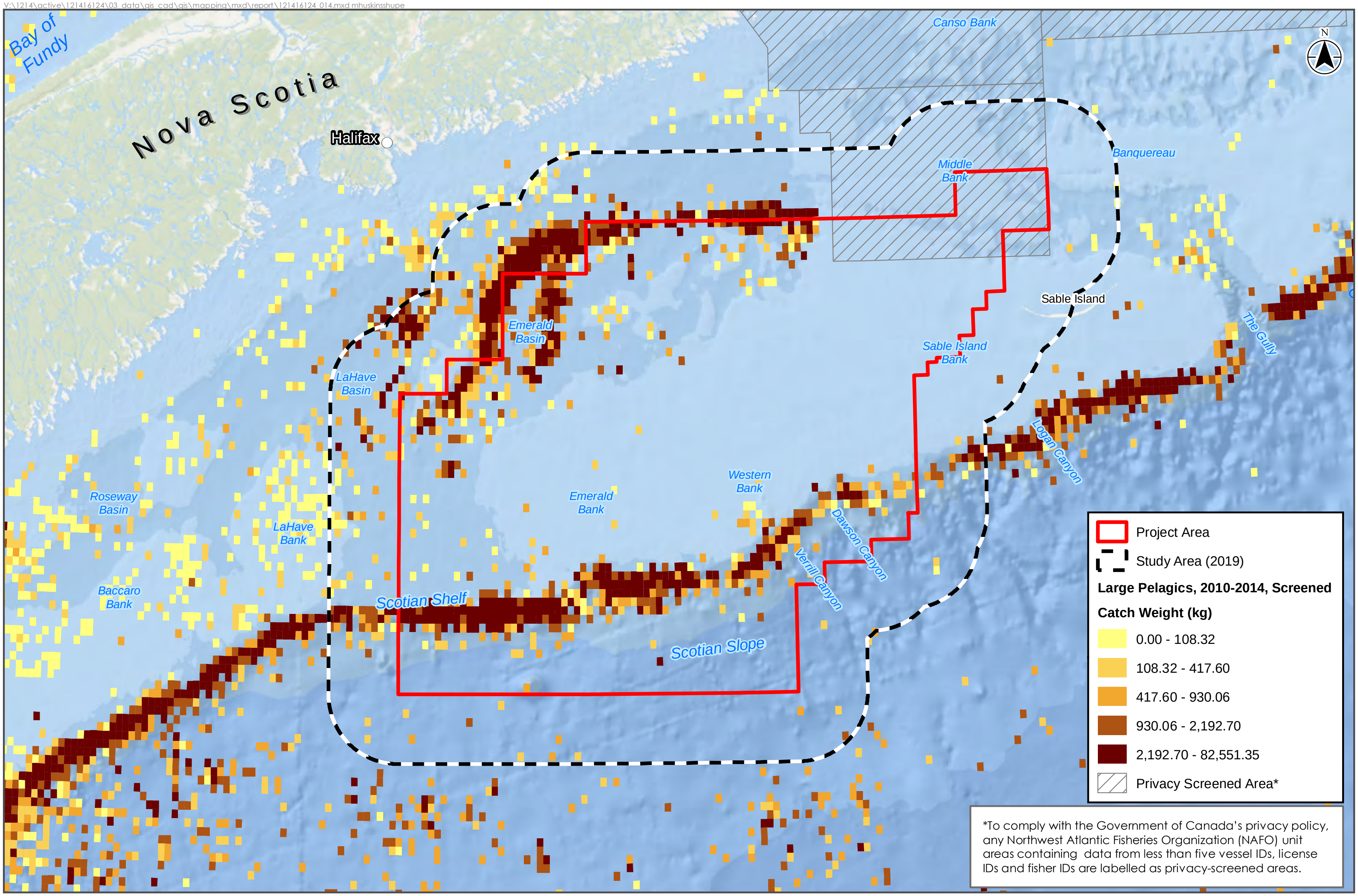
STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_014

Figure B.16

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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

0 25 50 75
Kilometres

NAD 1983 UTM Zone 20N

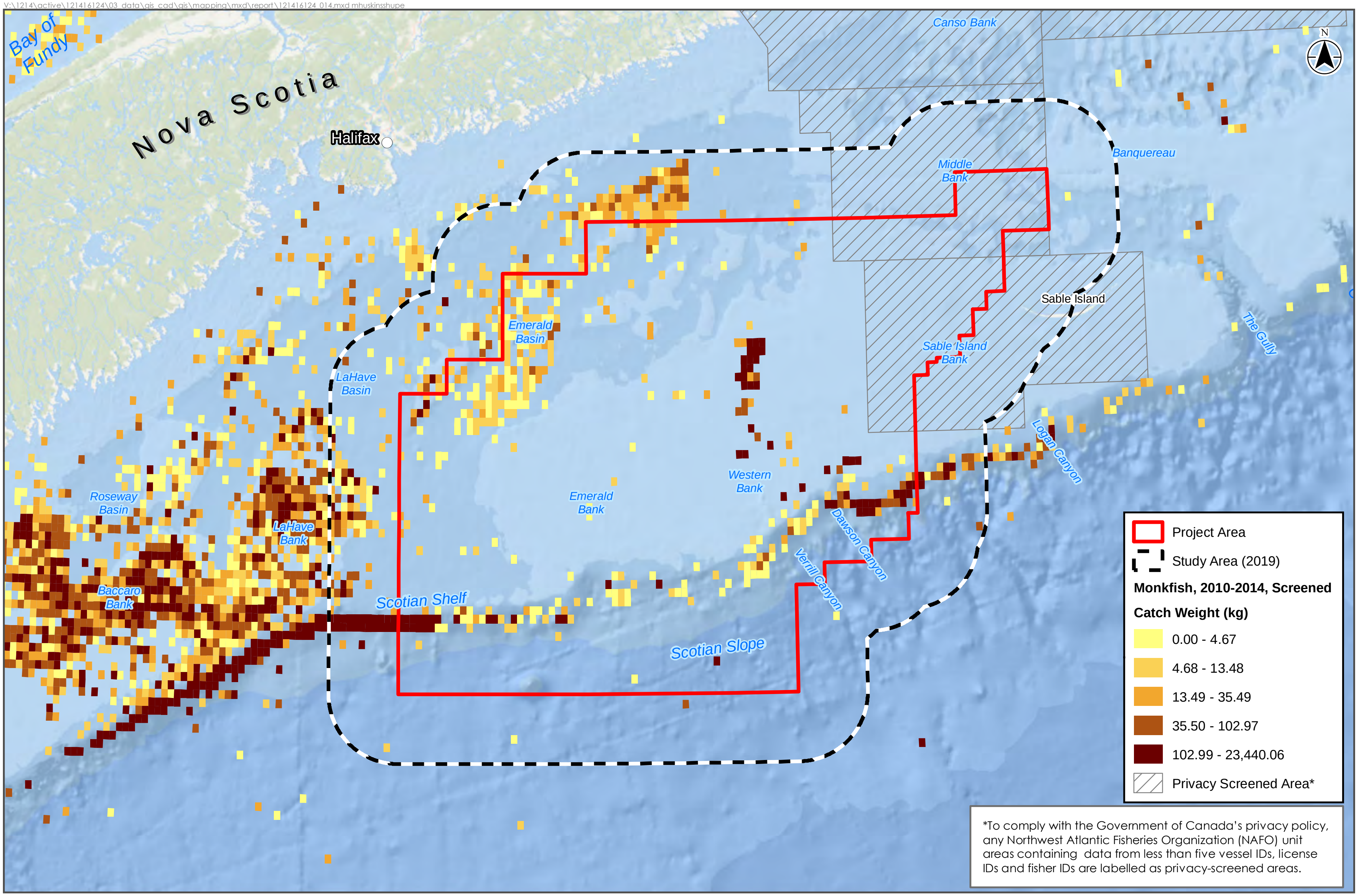
Redfish Landings

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_014

Figure B.17



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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

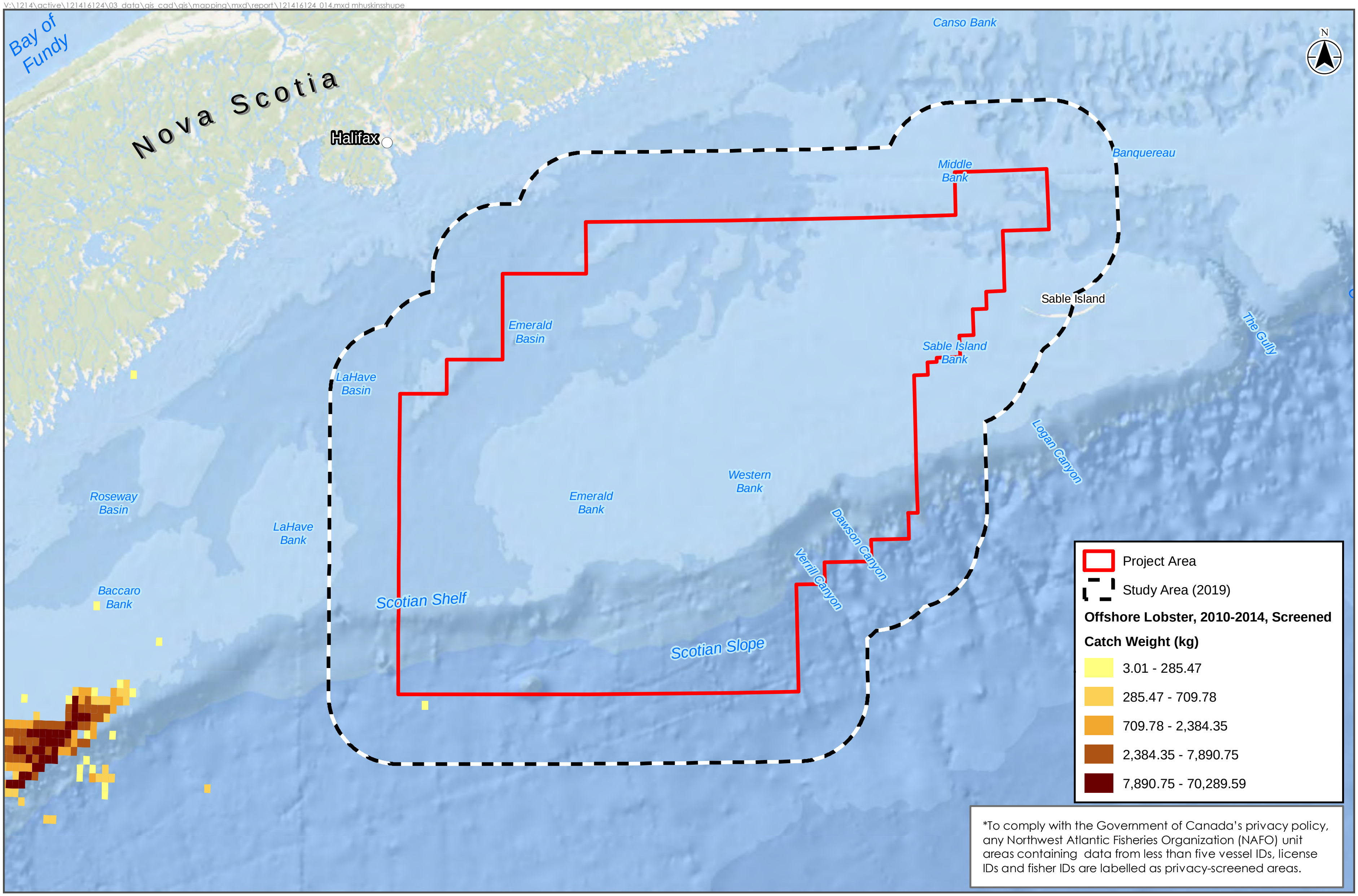
Sliver Hake Landings

Stantec

STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_014

Figure B.18



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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White Hake Landings

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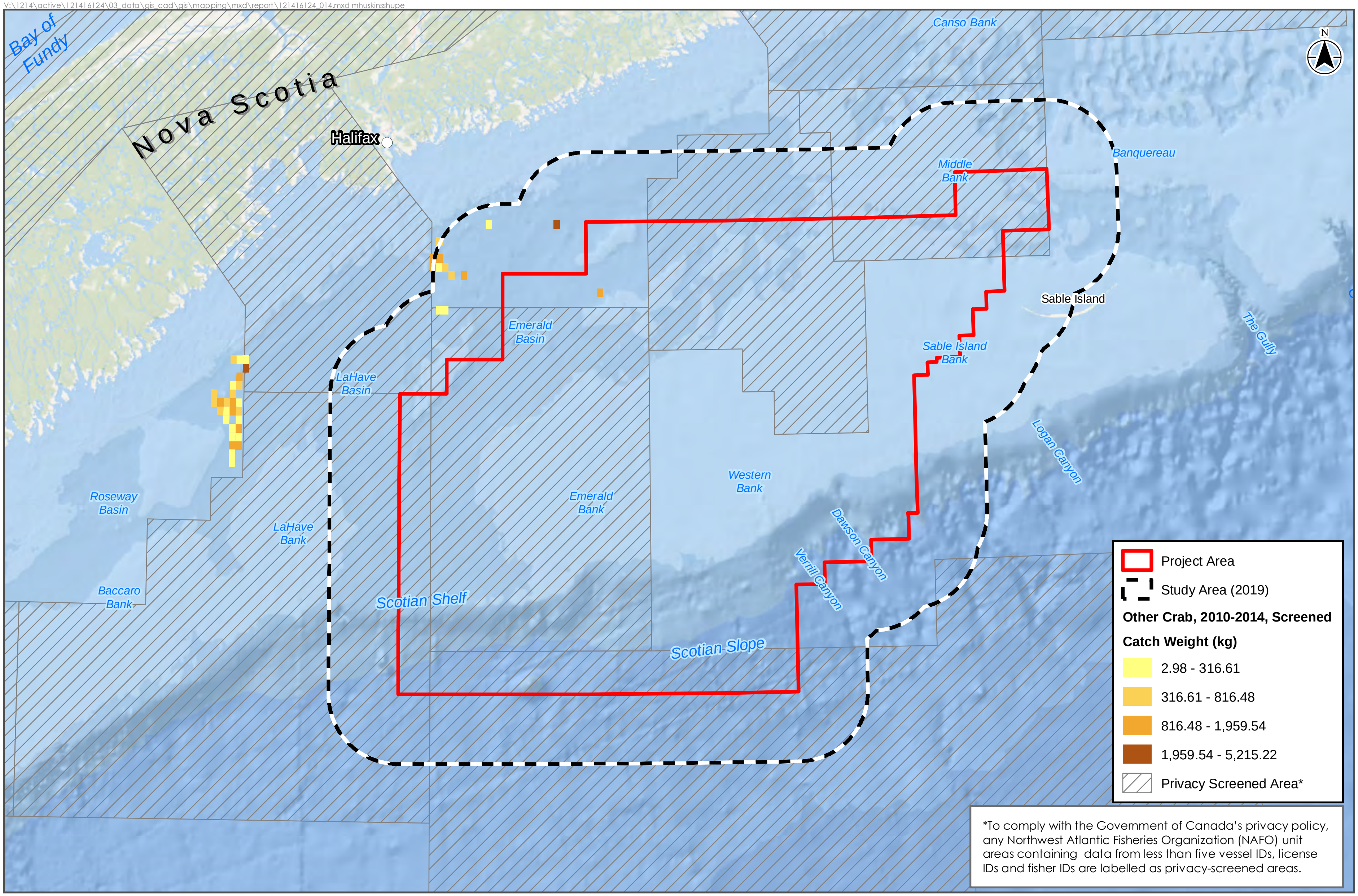
STRATEGIC ENVIRONMENTAL ASSESSMENT

121416124_014

Figure B.19



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

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Wolffish Landings

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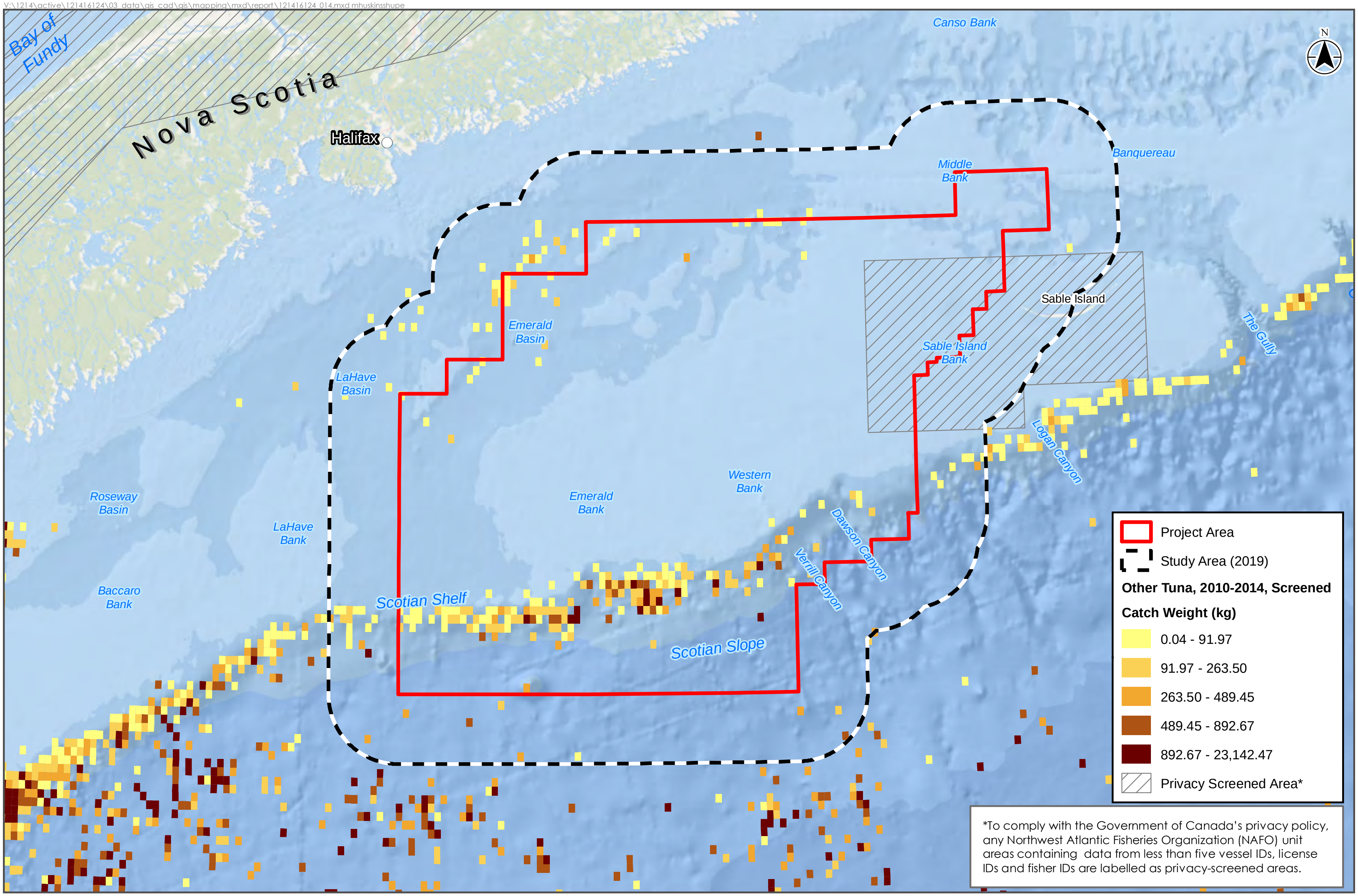
121416124_014

Figure B.20

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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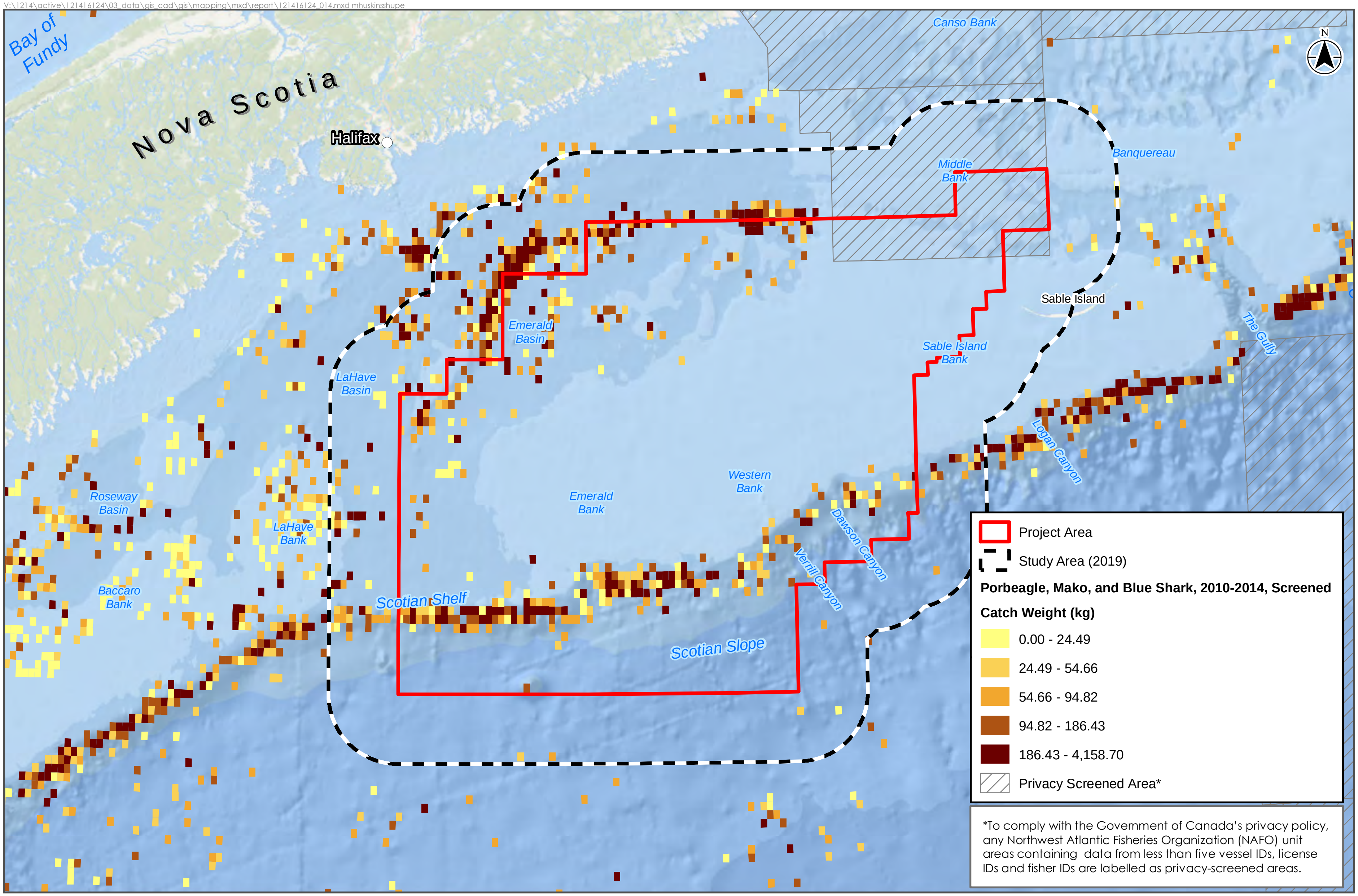
121416124_014

Cod, Haddock, and Pollock Landings

Figure B.21



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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Groundfish - Longline Landings

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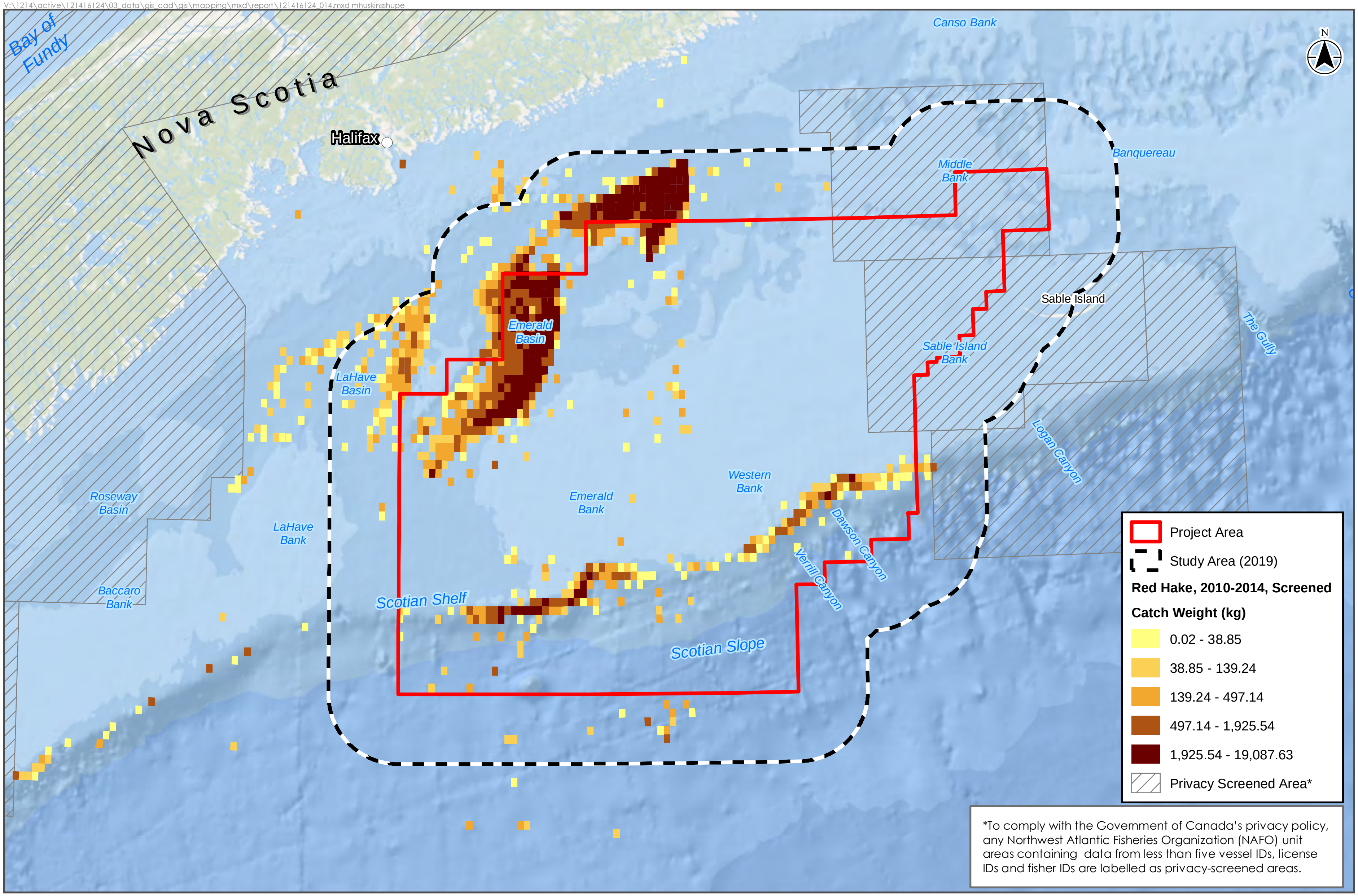
121416124_014

Figure B.22

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

NAD 1983 UTM Zone 20N

0 25 50 75
Kilometres

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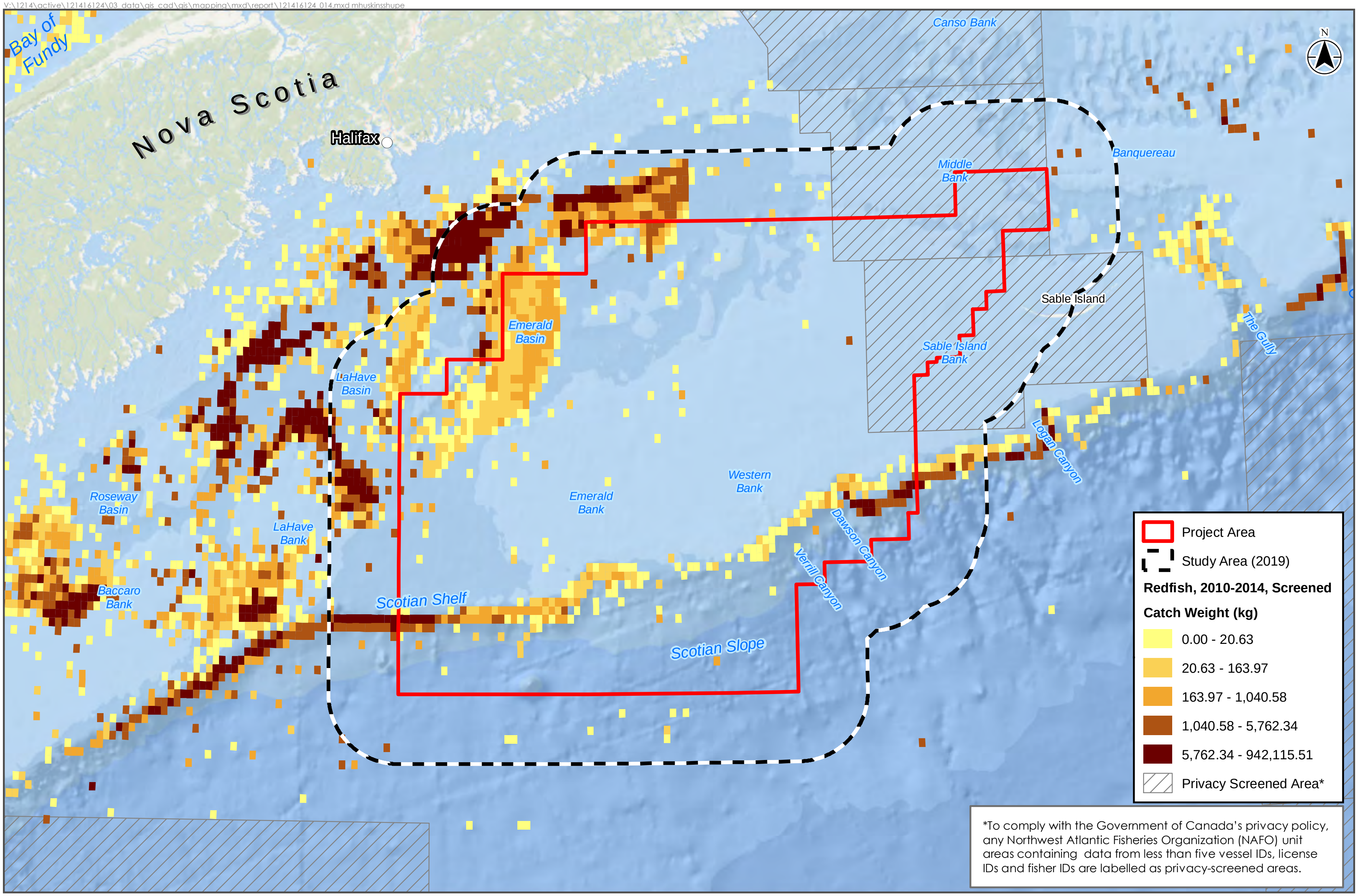
121416124_014

Groundfish Landings

Figure B.23

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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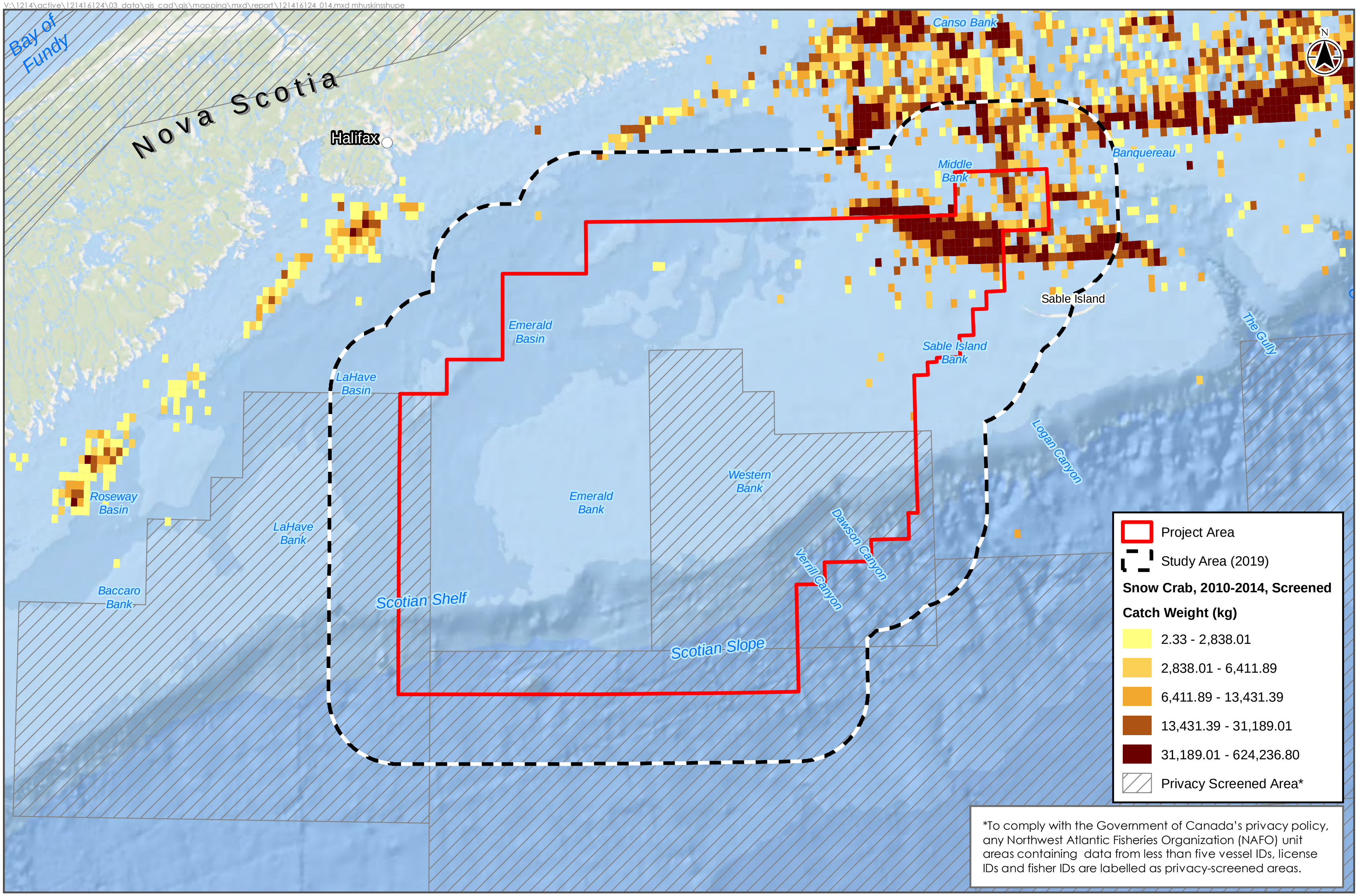
Offshore Lobster Landings

Figure B.24

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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Scallop Landings

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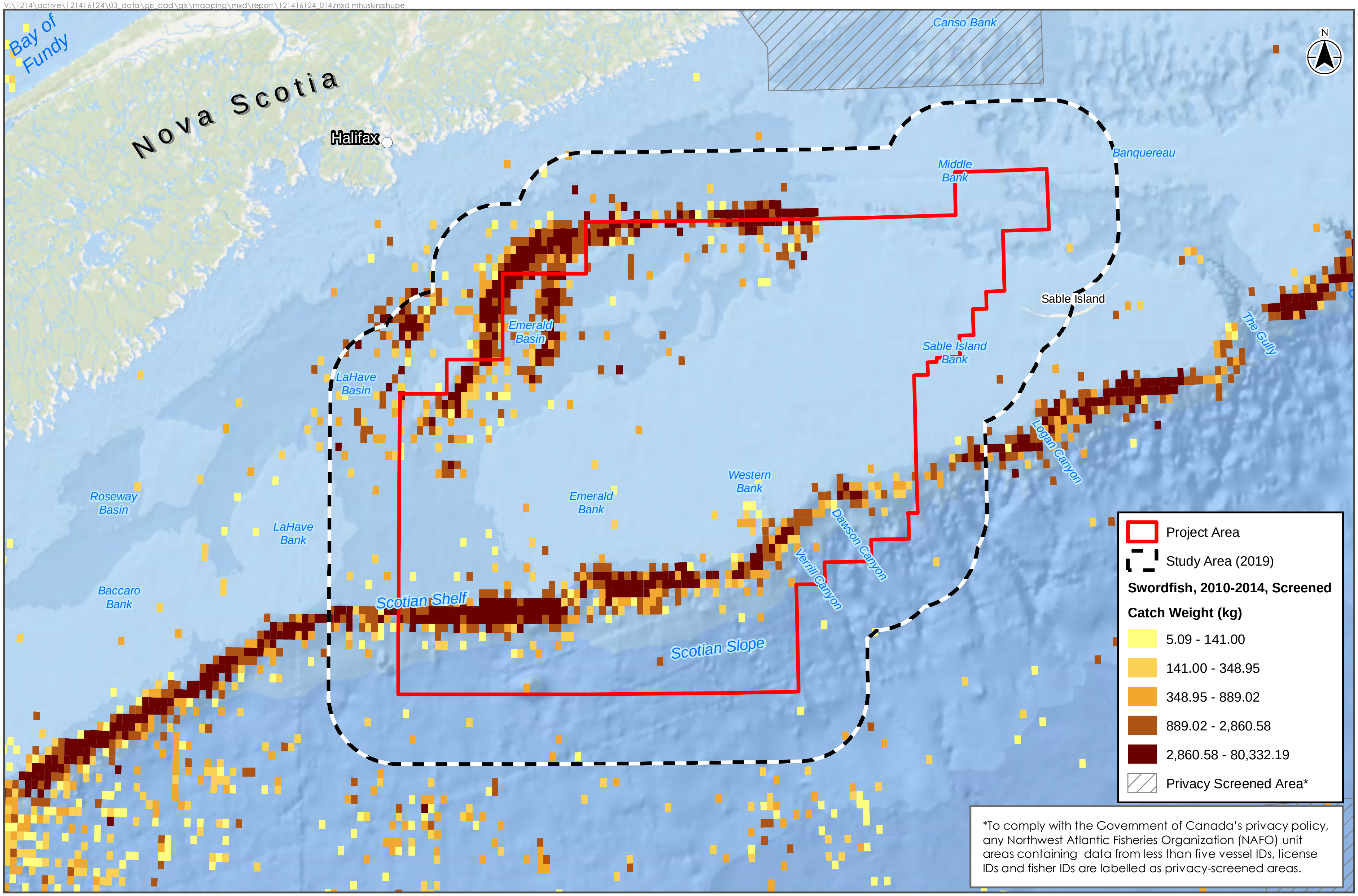
Figure B.26

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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0 25 50 75
Kilometres

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Snow Crab Landings

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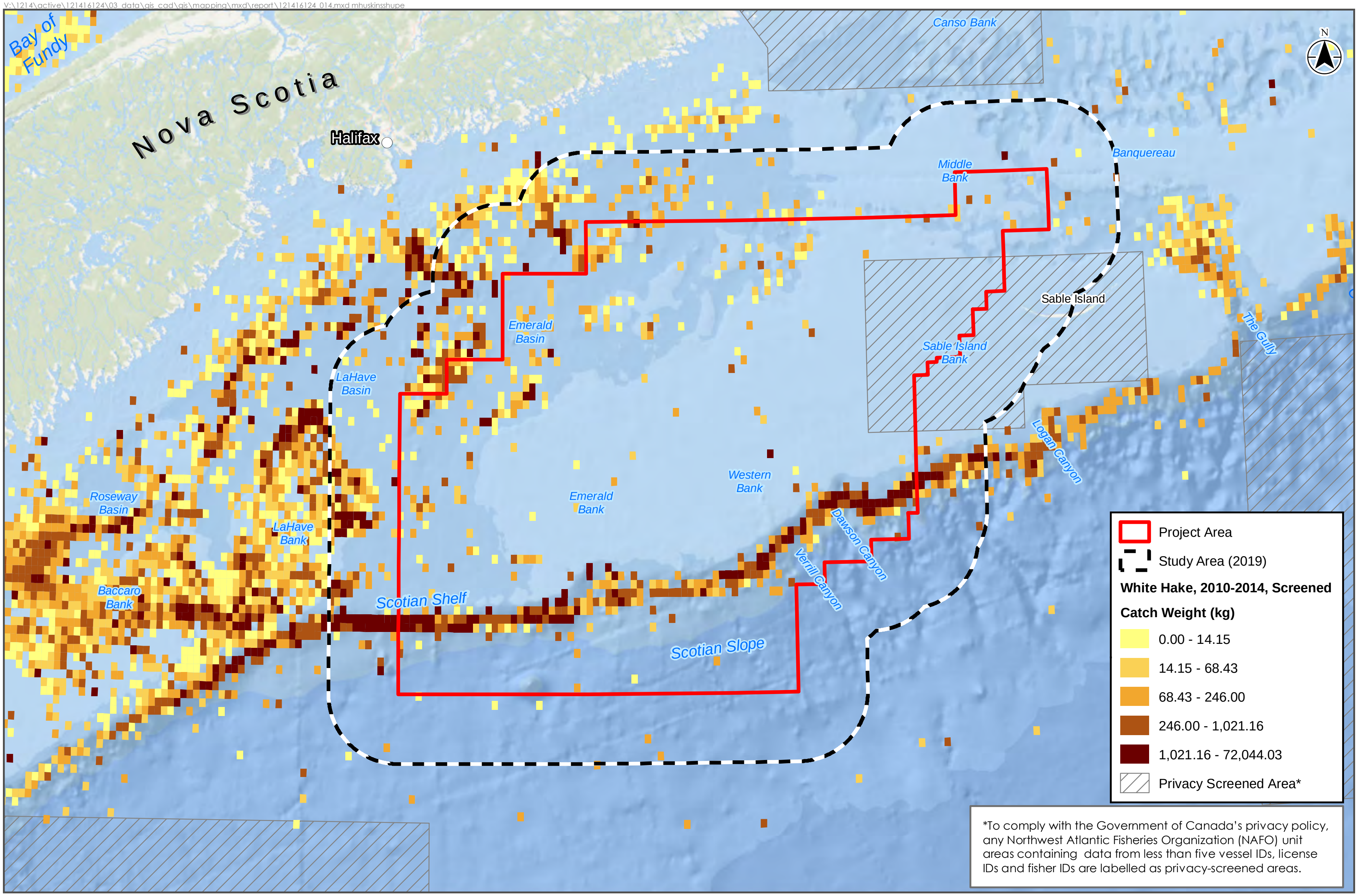
Figure B.27



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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0 25 50 75
Kilometres

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Other Crab Landings

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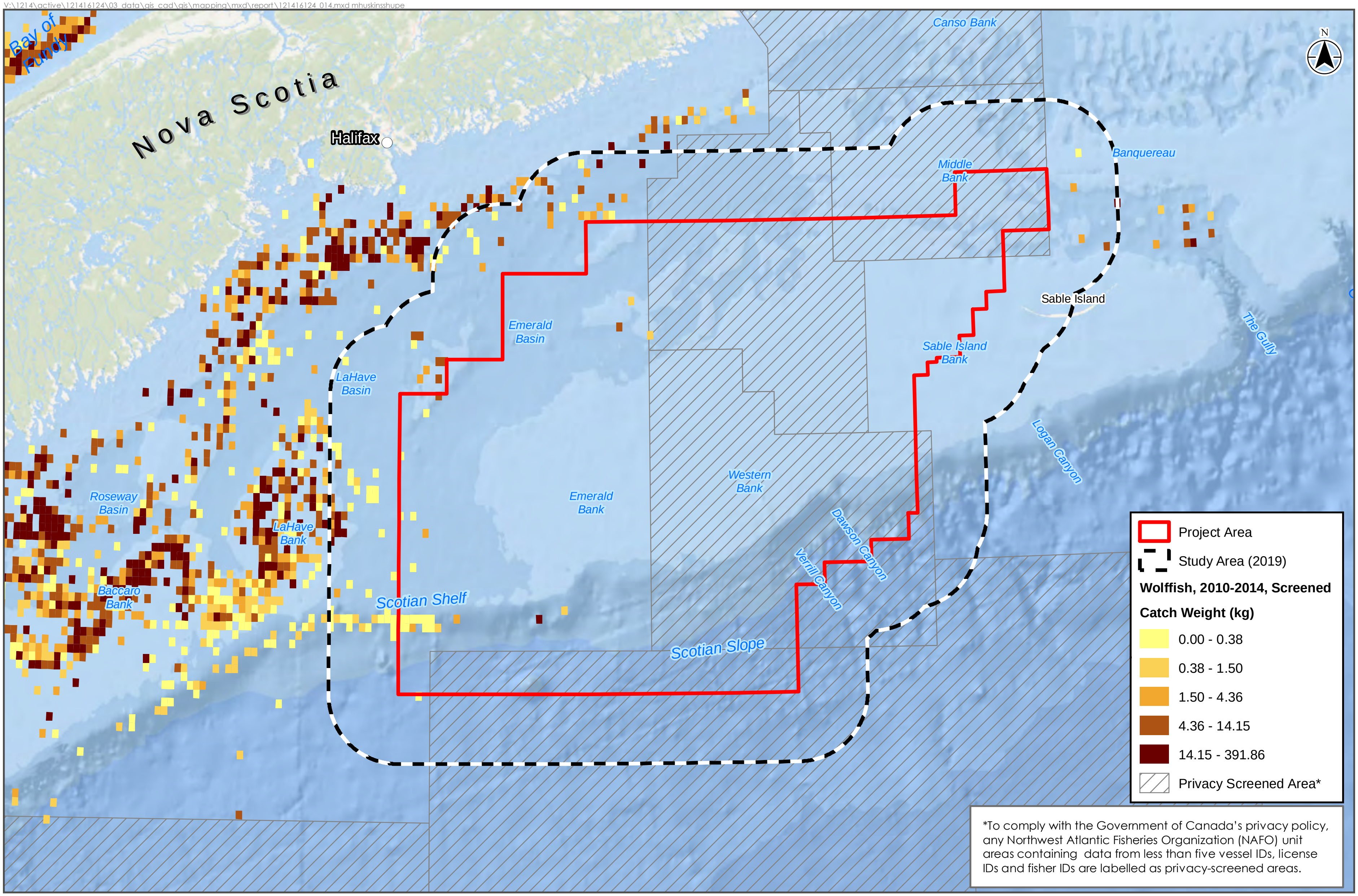
Figure B.28

V:\1214\active\121416124\03_data\gis_cad\gis\mapping\mxd\report\121416124_014.mxd mhuskinsshupe



Sources: Base Data - Canada Nova Scotia Offshore Petroleum Board, Government of Canada, Fisheries and Oceans Canada.
Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Fisheries Landings Data: Butler and Coffen-Smout 2017

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0 25 50 75
Kilometres

Shrimp Landings

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121416124_014

Figure B.29