FINAL

Strategic Environmental Assessment
Middle and Eastern Scotian Slope and Sable Island Bank Areas

Submitted to:

Canada-Nova Scotia Offshore Petroleum Board
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IMPORTANT NOTICE

LIST OF ACRONYMS AND ABBREVIATIONS

2D, 3D, 4D	Two, three and four dimensional seismic surveys
ACWD	Atlantic Colonial Waterbirds Database
AIS	Automatic Identification System
AZMP	Atlantic Zone Monitoring Program
AZOMP	Atlantic Zone Off-Shelf Monitoring Program
BIO	Bedford Institute of Oceanography
CEOTR	Coastal Environmental Observation Technology and Research
CCG	Canadian Coast Guard
CCGS	Canadian Coast Guard Ship
CCPFH	Canadian Council of Professional Fish Harvesters
CEE	Cumulative Environmental Effects
CFA	Crab Fishing Area
CHP	Conservation Harvesting Plan
CHS	Canadian Hydrographic Service
CIS	Canadian Ice Service
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
CPT	Cone Penetrator Technology
CIS	Canadian Ice Service
COOGER	Centre for Offshore Oil, Gas and Energy Research
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSAS	Canadian Science Advisory Secretariat
CSEM	Controlled Source Electromagnetics
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
DSOW	Denmark Strait Overflow Water
DWBC	Deep Western Boundary Current
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
ECSAS	Eastern Canadian Seabirds at Sea
EEZ	Exclusive Economic Zone
EL	Exploration Licence
EPP	Environmental Protection Plan
ESRF	Environmental Studies Research Fund

FLO	Fisheries Liaison Officer
FSC	Food, Social and Ceremonial
FV	Fishing Vessel
HR	High Resolution
Hs	Significant Wave Height
HURDAT2	Hurricane Data 2nd generation, Atlantic Hurricane Database
IBA	Important Bird Area
ICCAT	International Commission for the Conservation of Atlantic Tuna
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IFMP	Integrated Fisheries Management Plan
IIP	International Ice Patrol
ITQ	Individual Transferable Quota
IUCN	International Union for Conservation of Nature
Kg	Kilograms
Km / km	Kilometres
LFA	Lobster Fishing Area
LSW	Labrador Sea Water
M / m	Metres
MARLANT	Canada's Maritime Forces Atlantic
MBCA	Migratory Birds Convention Act
MBS	Migratory Bird Sanctuary
MCTS	Marine Communications and Traffic Services
MEOPAR	Marine Environmental Observation, Prediction and Response Network
MMO	Marine Mammal Observer
MOC	Meridional Overturning Circulation
MPA	Marine Protected Area
MSC50	Meteorological Service of Canada 50
NATO	North Atlantic Treaty Organization
NAFO	Northwest Atlantic Fisheries Organization
NAVWARN	Navigational Warning
NEB	National Energy Board (now Canada Energy Regulator)
NOTMAR	Notices to Mariners
NMi	Nautical Mile
NRCan	Natural Resources Canada
NS	Nova Scotia
NSDNRR	Nova Scotia Department of Natural Resources and Renewables
NSERC	Natural Sciences and Engineering Research Council
NSESA	Nova Scotia Endangered Species Act
OBIS	Ocean Biogeographic Information System

OBM	Oil-based Mud
ODAS	Ocean Data Acquisition System
ODI	Ocean Data Inventory
OERA	Offshore Energy Research Association
OTN	Ocean Tracking Network
OWTG	Offshore Waste Treatment Guidelines
PIROP	Programme Intégré de recherches sur les oiseaux pélagiques
PSU	Practical Salinity Unit
RCP	Representative Concentration Pathways
ROPOS	Remotely Operated Platform for Ocean Sciences
ROV	Remotely Operated Vehicle
RV	Research Vessel
SAR	Species at Risk
SARA	Species at Risk Act
SBM	Synthetic-based Mud
SCC	Supreme Court of Canada
SEA	Strategic Environmental Assessment
SFA	Shrimp Fishing Area / Scallop Fishing Area (depending on context)
SiBA	Significant Benthic Area
SOEP	Sable Offshore Energy Project
SOCC	Species of Conservation Concern
SOCP	Statement of Canadian Practice with Respect to the Mitigation of Seismic Noise in the Marine Environment
sp.	species
SSS	Sidescan Sonar
SW	Slope Water
Tp	Peak Wave Period
T / t	Metric Tonnes
TAC	Total Allowable Catch
UA	Unit Area
UNCLOS	United Nations Convention on the Law of the Sea
UXO	Unexploded Ordnance
VC	Valued Component
VMS	Vessel Monitoring System
VSP	Vertical Seismic Profiling
WAZ	Wide Azimuth Seismic
WRP	Wildlife Response Plan
WBM	Water-based Mud
WWF	World Wildlife Fund

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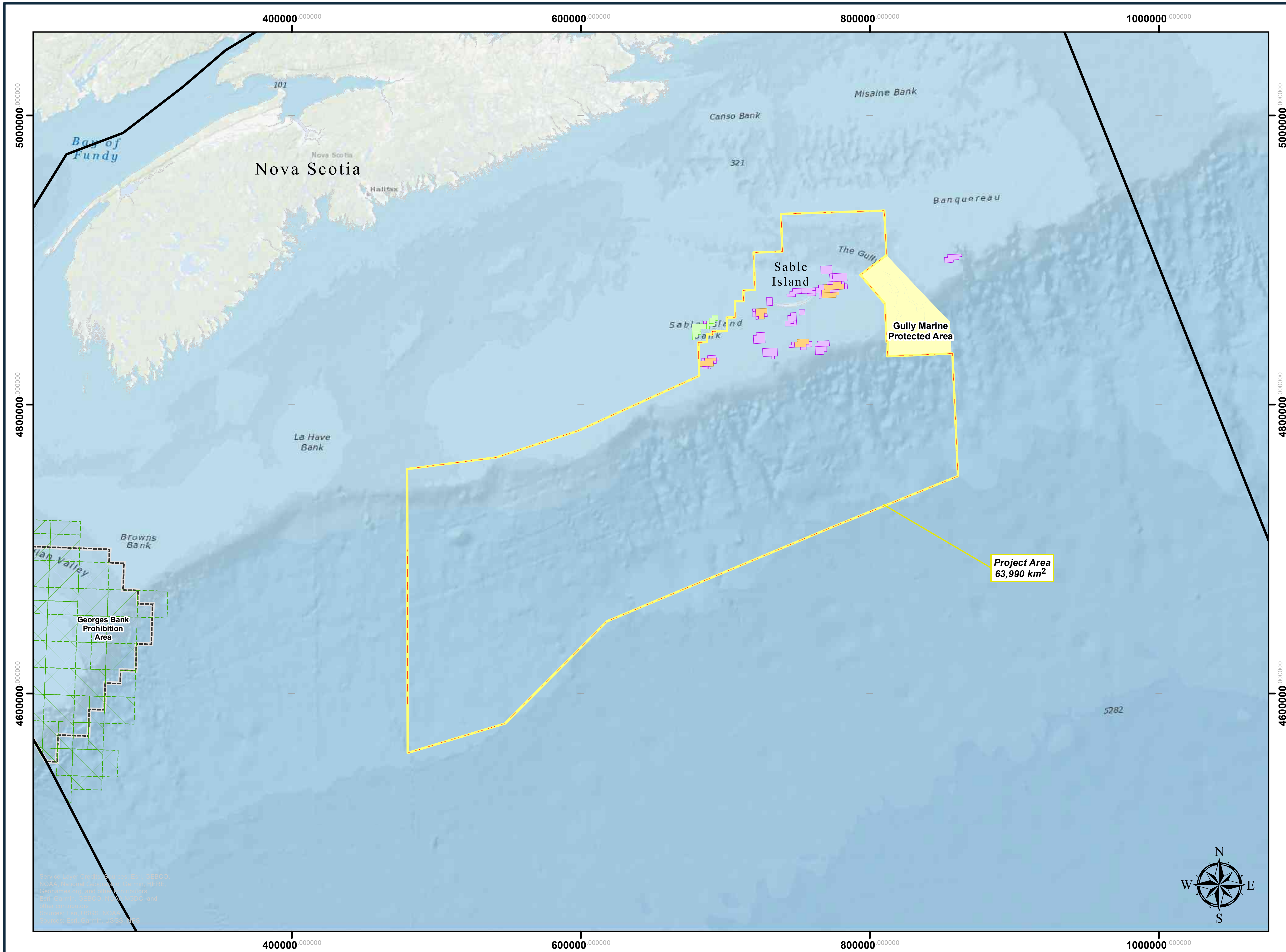
1 INTRODUCTION

This document describes the nature, purpose, and results of the Strategic Environmental Assessment (SEA) of potential offshore petroleum exploration activities in the Middle and Eastern Scotian Shelf and Sable Island Bank Areas (the Study Area) off southeastern Nova Scotia.

The Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) is an independent joint agency of the Governments of Canada and Nova Scotia responsible for regulation of petroleum activities in the Canada-Nova Scotia offshore area. The CNSOPB was established in 1990 pursuant to the *Canada-Nova Scotia Offshore Petroleum Accord Implementation Acts* (*Accord Acts*). The CNSOPB is responsible for ensuring that offshore petroleum exploration and development activities in the Canada-Nova Scotia offshore area proceed in a safe and environmentally responsible manner. To facilitate this, the CNSOPB conducts SEAs in portions of the Canada-Nova Scotia offshore area that may have potential for offshore oil and gas exploration.

The CNSOPB has conducted SEAs for various portions of the Canada-Nova Scotia offshore area since 2003. These SEAs provide information on the regional physical and biological and socioeconomic setting and associated environmental considerations, which help to inform regulatory decisions regarding potential future offshore oil and gas activities in the areas being studied. In particular, the information and findings of these SEAs help to inform CNSOPB's planning and decision-making processes regarding the potential issuance of future Exploration Licences (ELs). More information on the CNSOPB is included in Section 2.1. CNSOPB recommends that the information within SEAs be used by operators to assist in the preparation of project specific environmental assessments.

This SEA for the Middle and Eastern Scotian Slope and Sable Island Bank Areas includes a Project Area of approximately 63,990 km^2 and is located off southeastern Nova Scotia (Figure 1-1).



LEGEND:

- Project Area
- Canada-NS Offshore Area
- Former Permits
- ExxonMobil Canada Ltd. Production Licences
- Georges Bank Prohibition Area
- Ovintiv Canada ULC Production Licences
- Significant Discovery Licences
- Marine Protected Area

KEYMAP

CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

TITLE:
PROJECT OVERVIEW

PROJECT:
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 3	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 1-1

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\TE211002_FIGURE_1-1_ProjectOverview.mxd User: candace.macdonald Date: 5/11/2022

1.1 Nature, Purpose and Context of the SEA

SEAs are high-level environmental assessments (EAs) conducted to proactively study the environment and specific valued components in relation to a defined area. SEAs typically consider the broader ecological setting compared to project-specific EAs, which focus on site and activity specific issues. The SEA process allows for the identification, analysis and incorporation of environmental issues at the earliest stages of consideration of any potential future offshore activities.

The CNSOPB approach to SEA broadly aligns with international standards, within the context of their mandate to oversee all activities through the full lifecycle of an offshore oil or gas project. This SEA for the Middle and Eastern Scotian Slope and Sable Island Bank Areas focuses on providing a general description of the existing environmental setting, and on identifying and addressing overall environmental issues and key potential interactions.

A SEA is not intended to be a replacement for a project-specific EA review process or to exempt project-specific EAs. The objective of SEA is to provide the type and level of information necessary to inform decision-making before project-specific activities are defined and proposed. Future offshore oil and gas activities within the Study Area, and the Canada-Nova Scotia offshore area in general will require review and approval under, and/or compliance with, a range of applicable legislation and regulations. However, the SEA will provide relevant information for consideration in the early planning phases of individual projects.

The CNSOPB's regulatory responsibilities under the *Accord Acts* include issuance and administration of petroleum exploration and development rights in the Canada-Nova Scotia offshore area through a structured and transparent rights issuance process. As part of that process, an EL may be issued for Crown Lands through an established Call for Bids process, which has a maximum term of nine years and provides licence owner(s) with the right to explore, the exclusive right to develop, drill and test for petroleum, and the right to obtain a production licence. Activities associated with ELs may include the acquisition of seismic data or other geophysical surveys, geotechnical surveys, and the drilling and abandonment of wells (either exploration or delineation).

Issuance of an EL does not confer authorization for offshore exploration activities within the licence area. All offshore activities including exploration for petroleum in the Canada-Nova Scotia offshore area require specific authorization(s) from the CNSOPB. Prior to carrying out any offshore activity, an Operator must demonstrate to the satisfaction of the CNSOPB that such activities can be conducted in a safe and environmentally responsible manner. Special precautions, such as detailed, project-specific EAs, stringent mitigation measures and environmental effects monitoring may be required in some cases.

2 POTENTIAL OFFSHORE OIL AND GAS EXPLORATION ACTIVITIES

The following sections provide an overview of the CNSOPB and the various planning and regulatory processes that apply to offshore oil and gas activities in the Canada-Nova Scotia offshore area.

This is followed by a general description of the components, equipment and activities that are typically associated with oil and gas exploration in the region and elsewhere, as well as an overview of any previous petroleum activities that have occurred in the Study Area.

2.1 Canada-Nova Scotia Offshore Petroleum Board

The CNSOPB is responsible for the regulation of petroleum activities in the Canada-Nova Scotia offshore area, reporting to the federal Minister of Natural Resources Canada (NRCan), the provincial Minister of Labour, Skills and Immigration (with respect to occupational health and safety), and the provincial Minister of Natural Resources and Renewables (NSDNRR). The *Accord Acts*, administered by the CNSOPB, implement the 1986 *Canada-Nova Scotia Offshore Petroleum Resources Accord* and govern all petroleum operations in the Canada-Nova Scotia offshore area. The CNSOPB's overall mandate is to apply the provisions of federal-provincial *Accord Acts* legislation governing offshore oil and gas activities, including:

- Health and safety of offshore workers;
- Protection of the environment;
- Management and conservation of petroleum resources;
- Canada-Nova Scotia employment and industrial benefits;
- Issuance of licences for exploration and development; and
- Resource evaluation, data collection, curation and distribution.

CNSOPB's associated decision-making processes are structured in a manner that recognizes safety as paramount, and environmental protection as second only to safety.

The CNSOPB's management and regulatory activities include issuing and administering offshore licences and petroleum rights through an established and well-defined process that is open and transparent, an overview of which is provided as follows:

a. <u>Crown Reserve Lands / Nomination of Lands</u>: a preliminary step that provides interested parties with the opportunity to identify and suggest lands of interest for potential inclusion in a subsequent Call for Bids. Crown lands can be nominated by any person or company.

b. <u>Calls for Bids</u>: a formal announcement by the CNSOPB that a licence is available to be awarded for a particular offshore area through a competitive bidding process as nominated by any person or company. A Call for Bids specifies the type of interest (licence) to be issued and associated terms and conditions, the format in which the bid is to be submitted, closing date and criteria to be used in evaluating bids. The issuance of a Call for Bids and the eventual issuance of an EL are "fundamental decisions" within the legislation, and as such are subject to review and approval by the federal Minister of Natural Resources and the provincial Minister of Natural Resources and Renewables.

c. <u>Exploration Licence</u>: Based on the outcomes of a Call for Bids and their subsequent review by the CNSOPB and Ministerial approvals, an EL may be granted to the successful bidder. ELs provide licence owner(s) with the right to explore, and the exclusive right to drill and test for petroleum and to potentially obtain a Production Licence. ELs have a maximum nine-year term. The issuance of an EL does not, in and of itself, authorize the licence holder to carry out physical offshore exploration activities. Various project-specific regulatory approvals and authorizations are required to demonstrate that they can undertake work in a manner that adheres to all applicable regulatory requirements including but not limited to safety and environmental protection.

d. Authorizations and Approval: The CNSOPB's regulatory role also includes issuing specific authorizations and approvals pertaining to offshore oil and gas exploration (e.g., seismic acquisition) and development projects and activities in the Canada-Nova Scotia offshore area. Operators are required to meet certain requirements, such as the relevant provisions of the *Accord Acts* and regulations as well as applicable CNSOPB guidelines and policies. Prior to issuing any such authorizations, the CNSOPB requires that adequate and appropriate supporting information be provided on the operator's plans and capabilities, which depending on the specific nature of the proposal, may include one or more of the following:

- Canada-Nova Scotia Benefits Plan;
- Development Plan (for development related activities);
- Safety Plan;
- EA;
- Environmental Protection Plan;
- Spill Contingency Plan;
- Wildlife Response Plan;
- Emergency Response Plan;
- Financial Security;
- Summary of Proposed Operations;
- Certificate of Fitness (if applicable), and
- Declaration of Operator.

e. Environmental Assessment: EA is a regulatory review process that is applied to operators proposing to work in the Canada-Nova Scotia offshore area as part of their application to conduct offshore activities. Depending on the activity, project-specific EAs are required by the CNSOPB and the Impact Assessment Agency of Canada. The purpose is to identify and evaluate potential environmental effects of proposed projects, to ensure that these issues can be considered and incorporated into project planning and decision making. Project level EA's for offshore oil and gas related activities are regulated by numerous acts, regulations, guidelines, and memoranda of understanding (MOUs). For example, the MOUs between the CNSOPB and Environment and Climate Change Canada (ECCC) and Fisheries and Oceans Canada (DFO), are designed to align plans, priorities, and activities of mutual interest.

2.2 Description of Offshore Oil and Gas Exploration Activities

Various types of oil and gas exploration activities may occur following the issuance of ELs and other authorizations and approvals by the CNSOPB. If authorized by the CNSOPB, offshore exploration may include some or all of the following activities: seismic surveys, seabed surveys, offshore drilling which may include vertical seismic profiling (VSP), well abandonment, and vessel and helicopter traffic. Tables 2-1 to 2-4 provide descriptions of the purpose, methodology and equipment, spatial and temporal boundaries, emissions and key environmental concerns of each exploration activity. More detailed descriptions of these activities are typically included in project-specific regulatory approval documentation.

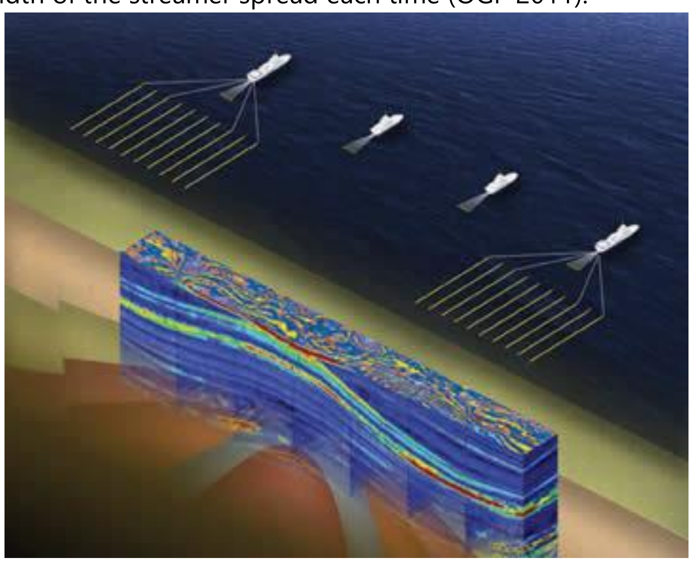
Table 2-1: Description of Offshore Exploration Activities – Seismic Surveys

Seismic Surveys (including Vertical Seismic Profiling)
Purpose
• Geophysical (seismic) investigations may be conducted prior to drilling to understand what is below the subsea surface. Reflection seismology estimates properties of the subsurface from reflected seismic waves. • Surveying methods fit into two general categories: 1) those that use natural fields of the Earth (i.e., gravity, magnetic, electromagnetic); and 2) those that require of artificially generated (i.e., air guns) energy input. • Vertical Seismic Profiling (VSP) is used to make seismic borehole measurements near the end of drilling to correlate with / confirm surface seismic data. • Also referred to as a check-shot survey, a VSP may be undertaken following completion of drilling to confirm well depth.
Methods and Equipment (Natural Source Methods)
• Gravity surveying measures variations in the Earth's gravitational field due to density differences between subsurface rock types. A geological body, whose density differs greatly from its surroundings, will cause a change in the Earth's gravitational field, which is known as a gravity anomaly. These anomalies allow the interpreter to learn about the size, depth and rock type of various features. Gravity data can be collected easily from an aircraft or a marine vessel using a gravimeter. Due to the relative ease of collecting the data from a ship, gravity data is often recorded in conjunction with a marine seismic data acquisition program. • Magnetic surveying investigates subsurface geology by mapping anomalies in the Earth's magnetic field that result from varying magnetic properties in underlying rock. Most of the minerals that compose rocks are essentially non-magnetic. However, some iron rich minerals can produce significant magnetic anomalies. While the nature of magnetism makes it a more suitable survey type for mining prospects, it can provide large scale information about regional geologic structure. Magnetic surveys are performed on land, at sea and in the air using a magnetometer and are likewise often completed in conjunction with other surveys. • Electromagnetic surveying measures the ground's response to propagating electromagnetic fields. Electromagnetic fields are comprised of alternating electrical and magnetic fields, as the changing of one field generates the other. As such, any conductive body beneath the surface will produce strong secondary electromagnetic fields, thus making this a useful tool in remote sensing for ore bodies. Electromagnetic principal can also be used for hydrocarbon exploration. Controlled Source Electromagnetics (CSEM), for example, is a marine geophysical technique used to map potential hydrocarbon accumulations below the seafloor. A dipole source that transmits an electromagnetic field is towed by the ship just above the seafloor. The field is altered by the underlying lithology, subsequently detected and recorded by a receiver array positioned on the seafloor. Interpretation of the data can help identify layers that are conductive or resistive. Typically, for hydrocarbon exploration, one looks for the more resistive features, as hydrocarbon bearing formations are relatively more resistive than the surrounding layers.

Seismic Surveys (including Vertical Seismic Profiling)

Methods and Equipment (Artificial Source Methods)

- In an offshore seismic survey, high-energy sound sources (airguns) are towed behind a survey vessel while it travels along a track line in a prescribed grid crossing known or suspected hydrocarbon accumulations. During the survey, the sound source is fired at regular intervals and directs high energy (low frequency) sound bursts toward the seafloor, which can penetrate below the surface. The reflected sound energy is then recorded by sensitive hydrophones (streamers, up to several km in length) which are towed behind the vessel. Computer-based data processing systems convert the reflected sound (acoustic signals) into seismic data that can be used to map possible hydrocarbon accumulations within the survey area.
- Several methods of data acquisition may be used depending upon the desired level of information:
    - Two-dimensional (2D) seismic surveys are typically used to explore large areas to identify sites / zones that may warrant further study, and typically use single source arrays and streamers, spaced at 1 km or more.
    - Three-dimensional (3D) seismic surveys enable greater resolution of potential and known oil and gas fields and provide more detailed data on the surveyed area. They may concentrate activity over a relatively small geographic area. 3D surveys typically use a series of parallel passes through an area with a vessel towing one or more air gun arrays with multiple (e.g. 6-10) seismic streamers at typical spacing of several hundred metres.
    - Wide Azimuth seismic surveys attempt to capture wider offset data than conventional seismic surveys. Wide Azimuth seismic surveys typically involve several vessels (towing air guns) making successive passes over the target area, increasing the offset between the streamers and the source vessels by the width of the streamer spread each time (OGP 2011).

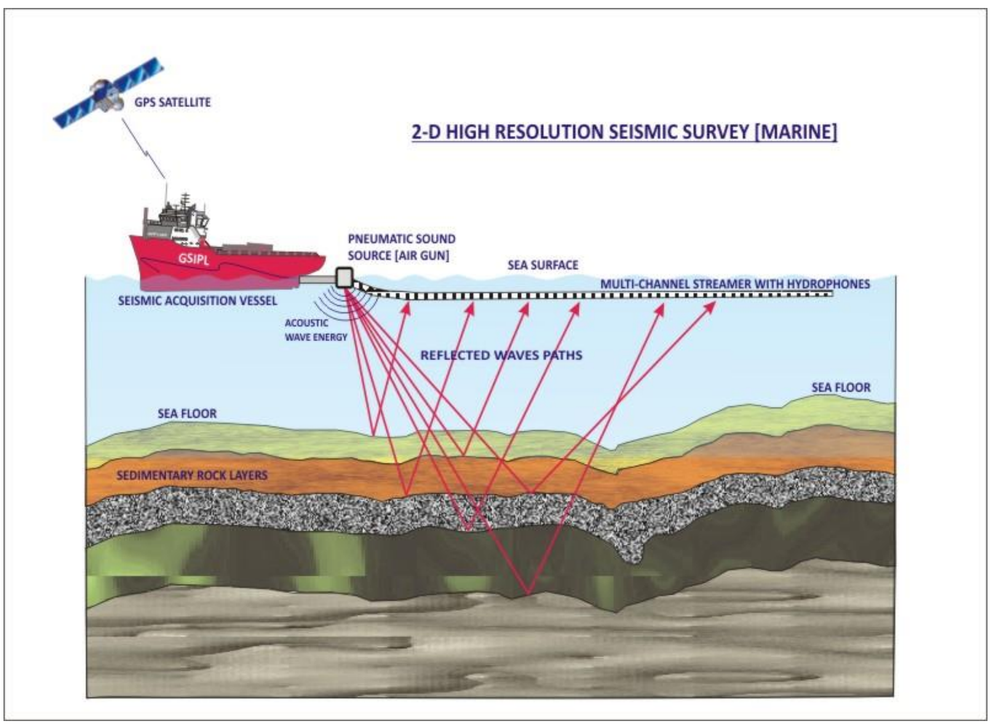


Source: AAPG 2008

    - 3-D Wide Azimuth is the combined use of 3D and wide azimuth technologies. In recent years, 3-D Wide Azimuth exploration has been applied to larger survey areas, thus generating greater precision and detail on substrate structure.

Seismic Surveys (including Vertical Seismic Profiling)
Methods and Equipment (Vertical Seismic Profiling)
• VSP is undertaken by placing a string of receivers (geophones) in the well to record reflected seismic energy originating from a seismic source at the surface. • VSP check-shots are recorded at multiple intervals down the well. The acoustic source is triggered approximately 5 times to create a sonic wave that is recorded by the geophones, digitized and transmitted to the surface recording equipment.
Typical Duration (temporal boundaries)
The following timelines provide a relative estimate only, as actual time frames are dependent on the size of the area being surveyed: • 2D seismic surveys typically cover a larger area in a short-term duration at a given location (weeks). • 3D surveys tend to be of longer duration (several weeks, up to months) • Wide Azimuth surveys may be completed over several months. • VSP takes hours to days when carried out within the time frame of a typical drilling program (30 – 90 days)
Geographic Area (spatial boundaries)
• 2D Seismic Surveys cover relatively large geographic areas (up to thousands of km2). Survey line spacing typically varies from a few kilometers to tens of kilometers. • 3D Surveys tend to concentrate activity over a relatively small geographic area with survey lines typically spaced tens to several hundred metres apart. • Wide Azimuth Surveys are generally similar in size to 3D surveys but cover a large area during each survey pass due to the multi-vessel configuration. • Attenuation of sound from seismic surveys through the marine environment increases spatial boundaries. Sound propagation is influenced by a variety of activity and site-specific factors. • Attenuation of sound from VSP may increase beyond the dimensions of the drilling rig. Sound propagation is influenced by activity and site-specific factors (e.g., sound from air guns can propagate to distances up to 75 km and more than 100 km in deeper water)
Emissions
• Potential emissions and discharges that may be associated with marine-based seismic surveys include vessel discharges (e.g., deck drainage, sanitary waste), atmospheric emissions (e.g., exhaust and fugitive emissions), noise and general presence of vessels and lights associated with offshore survey activity. • Sound from air guns can propagate to distances up to 75 km and more than 100 km in deeper water.
Key Environmental Issues
• Effects of underwater noise (seismic) on marine wildlife. Effects of lighting emissions (e.g., deck lighting) on wildlife (e.g., marine and migratory birds). Effects of flares on wildlife (e.g., marine and migratory birds). • Interference with other ocean users (e.g., fishing industry, shipping) with safety zones and gear interactions. • Interaction of vessels and gear with marine wildlife (e.g., marine mammals and sea turtles). • Spills and unauthorized discharges.

Table 2-2: Description of Offshore Exploration Activities – Seabed Surveys

Seabed Surveys
Purpose
• Seabed surveys are often conducted in advance of well drilling to identify seabed features (obstructions, aggregations of habitat forming corals or sponges, shipwrecks / submarine cables, unstable substrate) and subsurface conditions (presence of shallow natural gas) that may interfere with drilling operations.
Methods and Equipment
• 2D High Resolution (HR) surveys are conducted 2DHR digital seismic. The technique is like a standard 2D marine seismic program except the source is a small volume compressed air source or a device that generates an acoustic pulse from an electrical discharge. The streamer used is also much shorter and is towed (along with the source) at shallower depths than conventional 2D seismic programs, which allows for higher frequency content from the source and therefore higher resolution data. • Side-scan sonar, sub-bottom profiling, multi-beam echo-sounder and seafloor imagery data may also be gathered to aid in studying marine life and determining seafloor surface integrity for drilling equipment. • Geotechnical data may also be collected during surveys to verify the integrity of the seabed for drilling equipment, this can include core sampling, vibrocores and cone penetrator technology (CPT). • Remotely operated vehicle (ROV) and autonomous underwater vehicles may be used to conduct visual surveys of the seafloor to assess for fish and invertebrate presence, fish habitats, and surficial substrate. • Environmental sampling (e.g., water sampling, sediment sampling) may be undertaken to characterize benthic habitat.  Source: GSIP 2009

Seabed Surveys
Typical Durations (temporal boundaries)
• Depending on data acquisition type (geophysical, geotechnical, environmental), a seabed survey can range from days up to a month.
Geographic Area (spatial boundaries)
• Seabed surveys are focused on the target drilling location and do not generally extend more than 1 km from the proposed well site, although they can potentially cover a much larger area.
Emissions
• Potential emissions and discharges that may be associated with survey vessels include vessel discharges (e.g., deck drainage, sanitary waste), atmospheric emissions (e.g., exhaust and fugitive emissions), noise and general presence of vessels and lights associated with offshore survey activity. • Limited sound from geophysical and geotechnical sampling.
Key Environmental Issues
• Effects of underwater noise (e.g., seismic) on marine wildlife. • Effects of lighting emissions (e.g., deck lighting) on wildlife (e.g., marine and migratory birds). • Interference with other ocean users (e.g., fishing industry, shipping) through safety zones and gear interactions. • Interaction of vessels and gear with marine wildlife (e.g., marine mammals and sea turtles. • Spills and unauthorized discharges.

Table 2-3: Description of Offshore Exploration Activities – Offshore Drilling

Offshore Drilling (Including Vertical Seismic Profiling and Well Abandonment)
Purpose
• Exploration wells are used to determine the presence of petroleum resources at a location. Based on results, delineation wells may then be drilled to define the extent and characteristics of the hydrocarbon field. • Once drilling and any associated well testing is completed, offshore wells are typically abandoned.
Methods and Equipment
• Several types of offshore drilling rigs are typically used in Atlantic Canada. The type of rig chosen is based primarily on the characteristics of the physical environment at the proposed drill site, particularly water depth, planned drilling depth, anticipated weather conditions and associated mobility requirements. • Jack-up rigs are typically used in shallow water depths of between 10 and 100 m. These units are towed to a drill site, the rig's retractable legs are lowered to the sea floor, and the platform is then elevated until it reaches the desired height above the sea surface. • Semi-submersible drilling units are typically used in relatively deep waters (70-1,000 m on anchor or at greater depths using dynamic positions systems) or in areas where increased mobility is required due to ice or other factors and operational risks. These units can either be towed to the drill site or move under their own power and are designed for drilling in rougher seas. • Drill ships, mobile type of drilling installations, are used in areas of relatively deep water. These ships contain complete drilling systems and are almost entirely self-contained and can therefore operate at

Offshore Drilling (Including Vertical Seismic Profiling and Well Abandonment)
remote sites with limited support. Drill ships can be anchored to the bottom in water depths of approximately 200-1,000 m, with dynamic positioning systems allowing some drill ships to operate in waters depths up to 3,000 m. • The main drilling components of an offshore drilling rig include: o Derrick to hoist and lower the drill pipe and casing section; o Drill string, drill bit and pipe handling equipment; o Rotation Equipment (electric or hydraulic motors for turning the drill string and drill bit); and o Drilling Fluids System that handles fluids (drilling mud) that lubricate and cool the drill bit and hole, circulate cuttings and carry them back to the surface, and maintain pressure in the well. • 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 (WBMs), synthetic-based muds (SBMs), and oil-based mud (OBMs). • Drilling muds are transported with the cuttings up the riser to the drilling rig for recovery and reuse. At surface, the cuttings are removed from the drilling mud by specialized separation equipment. Treated cuttings that meet regulatory criteria may be discharged at the drill site or returned to shore for disposal. (NOTE – Discharge of OBM is not permitted in the Canada - Nova Scotia offshore area) • Offshore drilling installations also contain support infrastructure and facilities such as transportation facilities (for helicopters and support vessels), work areas, safety equipment and crew accommodations. • Drilling typically occurs in a number of stages: o Conductor hole: Initially a large diameter (approximately 1 m wide) hole is drilled at the beginning of the well, which is used to install and set the equipment required for drilling the well to depth. WBM is used to drill this portion of the well, and as there is no equipment in place to return it to the drilling unit at this early stage (before the riser is installed), these drilling muds and rock cuttings are released onto the seabed. o Casing installation: Once the conductor hole is completed, the drill string is removed, followed by the running and cementing of steel pipe and the installation of the blow-out preventer and drilling riser. The casing helps to strengthen and stabilize the wall of the conductor hole and to prevent seepage of muds and other fluids during drilling. The blowout preventer 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 during drilling. The drilling riser connects the casing set at the seafloor up to the drilling unit, and therefore allows muds and cuttings to travel back to the rig for processing, reuse and / or disposal. o Well drilling: With the casing and associated equipment in place, the drill bit and riser are lowered into the conductor hole from the derrick. Drill pipe sections are added as drilling progresses. As sections are completed, the drill string is pulled out of the well and the sections of the casing are joined together, lowered into the well, and cemented into place. o Well evaluation and testing: If significant hydrocarbons are found during exploration drilling, formation fluids, which may contain hydrocarbons and / or water, are collected and tested.

Offshore Drilling (Including Vertical Seismic Profiling and Well Abandonment)
o Well abandonment: Cement mixtures or mechanical devices are used to plug the well, the casing is cut and removed just below the surface of the seafloor and all equipment is removed. Wellheads are removed from the seafloor, often using a mechanical cutting device. If this device fails, a chemical / directed explosive method to detach the wellhead may be employed. An ROV or other equipment is used to inspect the seabed to ensure that no equipment or obstructions remain.
Typical Durations (temporal boundaries)
• Exploration drilling may take from 30 to 120 days (including well testing) depending on well complexity.
Geographic Area (spatial boundaries)
• To encompass the drilling platform and a safety zone that is usually the greater of either the area within a 500 m radius of the drill unit or, if the unit is anchored, a zone 50 m from the anchor pattern as per the requirements of the *Collision Regulations* under the *Canada Shipping Act*.
Emissions
• Effects of underwater noise (e.g., seismic, drilling, dynamic positioning) on marine wildlife • Effects of lighting emissions (e.g., deck lighting, flaring) on wildlife (e.g., marine and migratory birds). • Effects on water and sediment quality from discharges and emissions • Effects on benthic habitat from drilling discharges and subsea infrastructure • Interference with other ocean users (e.g., fishing industry, shipping) through safety zones • Spills and unauthorized discharges (e.g., drilling mud spill, blowouts, *Offshore Waste Treatment Guidelines for Drilling and Production Activities on Frontier Lands* [OWTG] exceedances). • Atmospheric emissions (exhaust and fugitive emissions)
Key Environmental Issues
• Smothering of benthic habitat and fauna in the immediate vicinity of the well. • Effects of drilling noise on marine wildlife. • Spills and unauthorized discharges. • Potential interference with traditional ocean users (fishing industry). • Interaction of vessels and gear with marine wildlife • Potential for blowouts.

Table 2-4: Description of Offshore Exploration Activities – Marine Vessel and Helicopter Traffic

Marine Vessel and Helicopter Traffic
Purpose
• Supply vessels and helicopters are used to transport personnel, equipment and materials to and from drilling rigs during offshore drilling programs. Supply vessels typically make several round trips per week to the drilling unit throughout a drilling program, and a dedicated stand-by vessel also usually attends the rig throughout drilling. Personnel and limited materials are transported to and from the drilling rig by helicopter. • Other vessels are used for various purposes during seismic survey operations.

Marine Vessel and Helicopter Traffic
Methods and Equipment
• Supply vessels that carry equipment and bulk supplies (e.g., cement, potable water, fuel and mud product). • Dedicated stand-by vessels attend rigs while on location. • Helicopters may be used for supply, crew changes, and/or medical emergencies during seismic surveys and drilling operations. • One or two small vessels are used to monitor for fishing activity and to prevent gear loss and entanglement.
Typical Durations (temporal boundaries)
• Vessels and helicopters are required for the duration of drilling programs (30 – 120 days or longer for deep water drilling). • Two to three supply vessel trips per week. • Three or four helicopter flights per week to transport personnel to and from the rig.
Geographic Area (spatial boundaries)
• The transit route(s) between the onshore supply base and heliport and the offshore drilling site. • Confined to the dimensions of the rig. • Standby / support vessels typically remain within a defined area surrounding the drill unit as a safety precaution. The safety zone is usually the greater of either the area within a 500 m radius of the drill unit or, if the unit is anchored, a zone of 50 m from the anchor pattern as per the requirements of the *Collision Regulations* under the *Canada Shipping Act*.
Emissions
• Atmospheric emissions such as exhaust, fugitive emissions and light. • Oily water associated with deck drainage, bilge water and ballast water. • Sewage and food waste. • Noise from vessels and helicopters • Miscellaneous solid waste (i.e., 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
• Effects of underwater noise on marine wildlife. • Interaction of helicopters with marine and migratory birds (e.g., bird strikes). • Effects of lighting emissions (e.g., deck lighting) on wildlife (e.g., marine and migratory birds). • Interference with other ocean users (e.g., fishing industry, shipping) through safety zones and gear interactions. • Interaction of vessels and gear with marine wildlife (e.g., marine mammals and sea turtles). • Spills and unauthorized discharges.

2.2.1 Management of Routine Discharges, Emissions, and Solid Waste from Planned Offshore Exploration Activities

The CNSOPB requires operators to prepare an Environmental Protection Plan (EPP) for drilling activities to manage routine discharges, emissions and wastes (an EPP is not required for seismic programs). The EPP identifies types and quantities of potential discharges/emissions/wastes and mitigation measures to minimize any associated environmental impacts. Typical emissions, discharges and waste types include air emissions, heat / light emissions, noise, bilge and ballast water, deck drainage, drilling muds (oil, synthetic and enhanced mineral oil based), solid waste and municipal-type waste (e.g., organic, plastic, construction material wastes). Mitigation measures for each source are discussed in Chapter 5. At a minimum, the following regulations and guidelines apply:

- *Air Quality Regulations* (*Nova Scotia Environment Act*)
- *Nova Scotia Solid Waste-Resource Management Regulations*
- *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*
- *Ballast Water Control and Management Regulations*
- *Ambient Air Quality Objectives* (*Canadian Environmental Protection Act*)
- *Canada Shipping Act and Collision Regulations*
- *Vessel Pollution and Dangerous Chemicals Regulations* (*Canada Shipping Act, 2001*)
- *Offshore Waste Treatment Guidelines (OWTG)*
- *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands*
- *Pollution Preventions Provisions (Fisheries Act)*

The primary guidelines for managing routine emissions and discharges associated with offshore exploration activities are the OWTG (NEB et al. 2010) and the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands* (NEB et al. 2009).

2.2.2 Environmental Protection Systems for Accidental Events and Malfunctions

During an offshore exploration drilling or production project, an accidental event or malfunction such as a large oil spill is an unlikely, although possible, occurrence. Environmental incidents that may be associated with offshore drilling activities include potential blowouts (subsea and surface), as well as other possible spills of hydrocarbons or other substances from a drill rig, production platform and / or associated vessel activities, which may vary considerably in terms of their nature, scale, duration and potential environmental consequences.

The CNSOPB requires each offshore operator to prepare a spill response plan to address spill prevention and response for accidental spills of hydrocarbons and unauthorized discharges. These plans include contingency measures to address extreme weather scenarios, potential health effects on responders, and interactions with other ocean users. Each operator is also expected to take preventative steps to avoid spills, leaks and discharges and contain any that occur. Preventative steps include identifying and assessing potential sources and causes of leaks and spills, ensuring system redundancy and adjusting process equipment and operating practices accordingly. In the event of an accidental event or malfunction, operators are required to prepare Incident Notifications and / or Incident Investigation Reports, depending on the nature of the incident.

All accidental events and malfunctions can potentially impact wildlife. As such, the CNSOPB requires offshore operators to prepare a Wildlife Response Plan (WRP) following ECCC-CWS's *Guidance for Wildlife Response Plans* (ECCC 2021a). The WRP should address all the various procedures and strategies required to mount an effective wildlife response. Operators are recommended to consult with ECCC when developing WRPs. ECCC is available to review WRPs prior to their implementation.

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

To date, there have been two blowouts in Canadian waters, both of which took place in the Canada - Nova Scotia offshore area (Angus and Mitchell 2010). The first was in February 1984 at Shell's Uniake G-72 exploratory gas well approximately 16 km from Sable Island, at a water depth of 153 m. The subsequent release was approximately 2 million m^3 (70 million ft^3) of gas and 48 m^3 (1,700 ft^3) of condensate per day for 13 days. 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, though monitoring patrols on Sable Island's beaches did not detect any condensate. While some oiled birds and seals were sighted, the incidence of oiling was not considered exceptional for this area. Monitoring of fish stocks revealed no evidence of tainting and the likelihood of adverse effects on fish stocks was considered low (Gill et al. 1985). The second blowout was in April 1985 at a Mobil exploratory gas well, at a water depth of 38 m. This event did not result in any release of hydrocarbons to the ocean or the atmosphere (Angus and Mitchell 2010).

There have been no occurrences of subsurface blowout incidents in the Canada-Newfoundland and Labrador Offshore area, however, there have been various accidental discharges in recent years. In November 2018, there was an accidental crude oil release of 250,000 L to the environment from a subsea flowline from the South White Rose Drill Centre. This spill represents the largest oil spill from an offshore oil and gas operation in Canadian waters. In July 2019, there was an accidental release of 12,000 L of crude oil to the environment from the Hibernia Platform (CNLOPB 2022). Other spill incidents in the Canada-Newfoundland and Labrador Offshore area includes an accidental release of 28 m^3 (28,000 L) of SBM fluid from the Transocean Barents in April 2018 associated with drilling activities for the Suncor Terra Nova project. In July 2020, there was an exceedance (320 L) of produced water discharge (combination of seawater, drilling and production fluids) from the Hibernia Platform as they were bringing a new well online.

2.3.1 Spills in the Canada-Nova Scotia Offshore Area

Operators are required to report environmental, health and safety incidents to the CNSOPB in accordance with criteria established in regulations and detailed in the Incident Reporting and Investigation Guidelines (CNLOPB and CNSOPB, 2018). For significant spills (as defined by the Guidelines), hydrocarbon releases and unauthorized discharges, the CNSOPB assesses the potential environmental impacts. In addition to examining and monitoring the results of these incidents, the CNSOPB also monitors whether trends are occurring.

Since 1999, the oil and gas industry has reported 250 spills in the Canada - Nova Scotia offshore area. Ninety (90) percent of these spills have been 150 L or less, 70 percent have been 10 L or less and nearly half (48 percent) have been less than one (1) L (Table 2-5). These spills have included natural gas, condensate / water mixture, condensate / methanol mixture, oil / water mixture, hydraulic oil, lubricating oil, gear oil and diesel (CNSOPB 2021a).

There have been two notable drilling fluid spills in the Canada-Nova Scotia Offshore area. This includes an accidental release of 354 m^3 (354,000 L) of SBM fluid resulting from equipment failure during abandonment activities at exploration well Crimson F-81 in 2004. In June 2018, there was an accidental release of approximately 136 m^3 (136,000 L) of SBM fluid from the Seadrill West Aquarius semi-submersible drilling rig during drilling operations at exploration well Aspy D-11.

Table 2-5: CNSOPB Statistics for Spills to the Marine Environment (1999 - 2021)

Year	< 1 L	1 - 10 L	11 - 150 L	> 150 L	Total Incidents
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	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	6	0	1	0	7
2018-2019	5	3	1	0	9
2019-2020	5	0	0	0	5
2020-2021	5	0	0	0	5
Total	121	54	51	24	250
Percentage of Total	48%	22%	20%	10%	100%
Note: Current to December 31, 2020					

Source: CNSOPB 2021a

2.3.2 Environmental Protection Systems for Accidental Events and Malfunctions

During an offshore seismic or exploration drilling program, an accidental event or malfunction such as a large hydrocarbon spill is an unlikely, although possible, occurrence. Environmental incidents possibly associated with offshore seismic program include fuel spills and streamer discharge. Drilling activities have the potential for blowouts (subsea and surface), as well as smaller spills of hydrocarbons or other substances from a drill rig, and / or associated vessel activities, which may vary considerably in terms of their nature, scale, duration and potential environmental consequences.

Drilling technology continues to advance, and operators are expected to make use of best available technology appropriate for their operation. Before any operator can carry out activity in the Canada-Nova Scotia offshore area, they must submit an application to the CNSOPB, which demonstrates that they can meet all of the stringent safety and environmental regulatory requirements during their program, and that any potential risks have been mitigated to as low as reasonably practicable. This includes drilling deepwater wells. The specifics of well depth and associated risks and mitigations required must be assessed in detail in project-specific IAs. This includes spill modelling, which considers well design and the surrounding environment, including depth and any other pertinent topographical features.

As one component of their application, each offshore operator is required to prepare a Spill Response Plan to address spill prevention and response for accidental spills of hydrocarbons and unauthorized discharges. These plans are to include contingency measures to address extreme weather scenarios, potential health effects on responders and interactions with other ocean users. Each operator is also required to prepare a Wildlife Response Plan following ECCC-CWS's Guidance for Wildlife Response Plans (ECCC 2021a). The WRP should address all the various procedures and strategies required to mount an effective wildlife response. Operators are recommended to consult with ECCC when developing WRPs. ECCC is available to review WRPs prior to their implementation. Each operator is also expected to take preventative steps to avoid spills, leaks and discharges from reaching the environment. Preventative steps include identifying and assessing potential sources and causes of leaks and spills, ensuring system redundancy and adjusting process equipment and operating practices accordingly. In the event of an accidental event or malfunction, operators are required to prepare Incident Notifications and / or Incident Investigation Reports, depending on the nature of the spill.

Additionally, the following procedures and practices are required or accessible for prevention and preparedness for accidental releases:

- Approval to Drill a Well – Well Design and Well Control Aspects
- Blow out Preventers
- Spill Response Plans
- Relief Well Drilling
- Booms and barriers
- Mechanical Recovery
- In-situ Burning
- Dispersants

Steps to minimize effects of accidental releases include spill containment measures and effective spill response training. Reporting procedures for spill incidents, which are outlined in the Spill Response Plan, are to be consistent with the latest version of the CNSOPB Incident Reporting and Investigation Guidelines (April 2018), which includes mandatory reporting to the CNSOPB immediately, no later than within 24 hours of the incident. In some instances, reporting to other authorities may be required (e.g., federal or provincial departments or other regulatory agencies), these agencies include, but are not limited to:

- Joint Rescue Coordination Centre, a rescue coordination centre operated by the Royal Canadian Air Force

(RCAF) and the Canadian Coast Guard (CCG)

- Transport Canada Marine Safety
- Transport Canada Aviation
- Environment and Climate Change Canada
- Nova Scotia Department of Labour and Workforce Development

Subsea well blowouts and large batch spills have the potential to produce the detrimental effects on marine animals. Although there has not been a blowout involving oil (there have been 2 gas blowouts) in the Canada – Nova Scotia offshore area, oil should still be considered appropriately in accident scenario planning.

3 EXISTING ENVIRONMENT

This Chapter includes an overview of the existing environment within the Study Area based on available environmental information and datasets and identifies where data and information are lacking. Existing environment components are discussed in terms of the physical environment (e.g., oceanography, climatology including climate change), biological environment (e.g., marine fish and fish habitat, marine and migratory birds, marine mammals and sea turtles) and socio-economic components (e.g., commercial fisheries, Indigenous use, and other ocean uses). This information is used as a basis for identifying potential environmental issues and interactions, required mitigation and associated planning considerations to avoid or reduce potential adverse environmental effects.

Sable Island is designated as an Important Bird Area and a National Park Reserve. It is referred to as a geographic feature, Sable Island, when not referring specifically to marine birds or a special area.

3.1 Physical Environment

These sections provide an overview of relevant aspects of the physical environment of the Study Area, including its marine geology, bathymetry, climatology, oceanography and ice conditions.

3.1.1 Key Information Sources

Key information sources are listed in Table 3-1. Detailed references are included in Chapter 10 and cited throughout.

Table 3-1: Key Information Sources: Physical Environment

Topic	Sources
Marine Geology	NRCan Earthquakes Canada Geological Survey of Canada
Bathymetry	Canadian Hydrographic Service (CHS)
Climatology	Fisheries and Oceans (DFO)- Meteorological Service of Canada 50 (MSC50) wind and wave hindcast International Comprehensive Ocean-Atmosphere Data Set (ICOADS) global marine observations dataset HURDAT2
Oceanography	DFO-MSC50 wind and wave hindcast DFO-Ocean Data Inventory (ODI)
Ice Conditions	Canadian Ice Service (CIS) Sea Ice Climatic Atlas for the East Coast: 1981 - 2010 International Ice Patrol (IIP) Iceberg Sightings Database

3.1.2 Marine Geology

The Study Area is located on the Scotian Shelf and Slope. The shelf has an average width of 200 km with an average water depth of 125 m (Bell and Howie 1990). It is bordered by two glacially modified channels, the

Laurentian Channel in the north and to the south by the Northeast Channel (Wade and MacLean 1990). The shelf is relatively shallow (< 100 m in some places) and may have been emergent during glacial lowstands (Piper 2005). The inner shelf is highly irregular from numerous mounds of glacial debris and the underlying bedrock (MacLean and King 1971, King 2001, King et al. 2001). The Scotian Shelf basement rock is comprised of lower Paleozoic metasediments (part of the Meguma Group) intruded by isolated pockets of Devonian granites (King 1976, Bell and Howie 1990). The undifferentiated Meguma group and Devonian granites extend seaward from Nova Scotia to outcrops of Jurassic, Cretaceous, Late Cretaceous and Tertiary formations (King and MacLean 1974). Terrestrial outcrops of Precambrian and Cambrian age sediments, metasediments, and volcanics extend seaward onto the northern edge of the shelf (MacLean and King 1971). Overlaying this basement rock are a series of Mesozoic-Cenozoic sedimentary basins and banks (Wade and MacLean 1990). The largest banks in the area are Sable Island, Western, and Banquereau. The seabed across the banks north of The Gully (e.g., Misaine, Atrimon, and Banquereau) are generally smooth and in water depths of <100 m (MacLean and King 1971). The Study Area encompasses the Scotian slope between the sediment banks and the Scotian rise located offshore. Sediment deposition in the area began in the middle Triassic and continues to present, the sedimentary units consist of limestones, shales, and sandstones (Wade and MacLean 1990). Total thickness of sediment can exceed 5 km on both the shelf and slope (Byrne et al. 2014).

Sable Island (within the Study Area) is the only emergent portion of the Sable Island Bank. The entire bank has been exposed previously during past successive glacial retreats (Shaw et al. 2002). Unlike other areas of the Atlantic Canadian shelf, the bank has a thick deposit of unconsolidated sediments consisting of post-glacial sand over glaciogenic deposits (Amos and Miller 1990). It was formed from the deposition of a series of glaciogenic sheets following multiple glacial ice extensions (King 2001). The post-glacial sands form large sand ridges which cover most of the bank and occur in water depths less than 40 m to 80 m (Li et al. 2012). From these processes, the morphology and migration of these sand ridges are influenced by storms that pass through the area from storm-driven currents, waves, and other processes. The sand ridges of Sable Island Bank are oriented NE-SW and migrate eastward (Li and King 2007). The ridges have an average height of 3.5 m and 1.1 km wavelength in the South Sable area off the island and an average of 4.6 m in spaced 1.7 km the CoPan area with the largest ridges occurring in depths ranging from 20 to 35 m (Li and King 2007). Ridge size also decreases from west to east due to changes in water depth, grain size, and decreased dynamic conditions (Li and King 2007). While these ridges overall are considered dynamically stable with a migration mode of nearly zero, portions of the sand ridges can migrate up to 40 m annually (Li et al. 2012). The ridges tend to decrease in size from west to east and as they approach onshore (Li et al., 2012). Super imposed on the sand ridges are megaripples, sand waves, and large wave ripples that are more active (Li and King 2007, Li et al. 2012). The megaripples on the bank are likely formed under wave-dominant combined flows during storm events (Li and Amos 1999a). Shore-normal channels are perennial features on the southern shoreface of the island and are similar to gutters (generally in depths shallower 20 m) that have been preserved in the local geological record and were formed during rapid storm-driven downwelling (Amos et al. 2003). The turbidity during the formation of the gutters could indicate that inner shelf turbidity currents could lead to the formation of channels (Amos et al. 2003). Some gutters continue from shallow waters (<20 m) and from linear sand waves in intermediate depths (Li and King 2007). Sable Island itself is morphologically similar to a barrier island and is comprised of reworked sand and gravel with its boundaries and topography ever changing due to local currents (see Section 3.1.5), storms, and sediment deposition (Byrne et al. 2014). The core of the island is comprised of glacial deposits sourced from through tunnel valleys from several readvances of the glacier margin (King 2001). During storms, areas to the southwest of Sable Island can experience net daily sediment transport on a 2 to 3 orders of magnitude higher than fair weather intervals (Li et al. 1997). The increased wind-driven currents, tidal currents, and waves in general during storm events cause sediment suspension and bedload transport (Li and Amos 1999a, b). Sediment mobilization on the bank is affected yearly by tidal currents and wave actions that combined affect 93% of the bank (Li et al., 2012). The impact of a recent study has found that the coastline of Sable Island is mainly in retreat with losses evident in the centre and centre-west of the island, and the southern side in net retreat which is somewhat offset by net advance on the northern side (Eamer et al. 2021). The island morphology is likely being influenced either by bank migration and sediment transport or losing sediments due to ongoing sea-level rise (Eamer et al. 2021). The bank edge and upper slope are subject to relatively low energies with the occasional ribbon being the only bed form (Li et al. 2012).

The slope has undergone several changes that have formed unique geomorphological features in the area. The slope steeply declines away from the shelf and is incised with a series of transverse submarine canyons, the largest of which is The Gully. The surficial geology of the slope is a gradient comprised of mainly mud, sand, till (at the shelf edge), and bedrock outcrops (Piper and Campbell 2002). The seafloor is mainly mud in water depths > 600 m (Hill and Bowen 1983) and winnowed sands over topographic highs (Piper 2001). The upper slope is underlain by seaward prograded till tongues, iceberg pits, and scours (Piper et al. 2002, Piper and Campbell 2002). The continental slope transitions from bioturbated mud to foraminifera-rich mud (Piper and Campbell 2002). Numerous circular salt diapirs occur within the Jurassic sediment layer along the slope (the Slope Diapiric Province) (Wade and MacLean 1990). Pockmarks are widespread on the eastern Canadian margin and the Scotian Slope (Fader 1991).

There are several major incised submarine canyons along the slope including Logan Canyon, Dawson Canyon, Verrill Canyon, Mochican Channel, Shortland Canyon, and The Gully (Mosher et al. 2004, Campbell et al. 2008 a, b, c). The submarine canyons were formed during successive periods of glaciation and deglaciation but were influenced by the free meltwater in diverse ways (King 2015). Significant shelf-edge progradation that was prodeltaic have been documented on the Scotian margin (Flynn 2000). The lithologies present on the canyon walls include, shale, mud-stone, chalk, siltstone, and conglomerate (Wade and MacLean 1990). The canyon heads and floors are overlain with muddy fine sand (Piper and Campbell 2002). Studies have found slope failures in some canyon heads (The Gully and Shortland Canyons) (King 2015, Normandeau and Campbell 2020). Logan Canyon was filled repeatedly with successive glaciations and the characteristics of the glacial deposits made it less susceptible to mass failure (King 2015). During periods of deglaciation including the Last Glacial Maximum (LGM), many of the canyons were active through the generation of turbidity currents that could transport large volumes of sediment. These currents could be significant, evidence in the Laurentian Fan showed some in that region sustaining for weeks and forming beds over 1 km thick (Skene and Piper 2003). Evidence obtained in The Gully showed that turbidity current activity was highest for 7 ka after the LGM with events occurring at a rate of more than 100 turbidities per 1000 years (Normandeau and Campbell 2020). This rate drops off after approximately 17 ka BP and turbidity currents extending to the continental rise diminish in the late Holocene (Normandeau and Campbell 2020). As the ice sheet retreated the supply of glaciogenic sediments diminished becoming trapped on the shelf and flushing and filling turbidity currents ceased, and turbidity currents became rare on the slope (Normandeau and Campbell 2020). The triggers of turbidity currents and the flushing of sediment to deeper waters are influenced by the type of sediment supply on the slope which is ultimately controlled by the glacial sediment supplied and sea level (Normandeau and Campbell 2020).

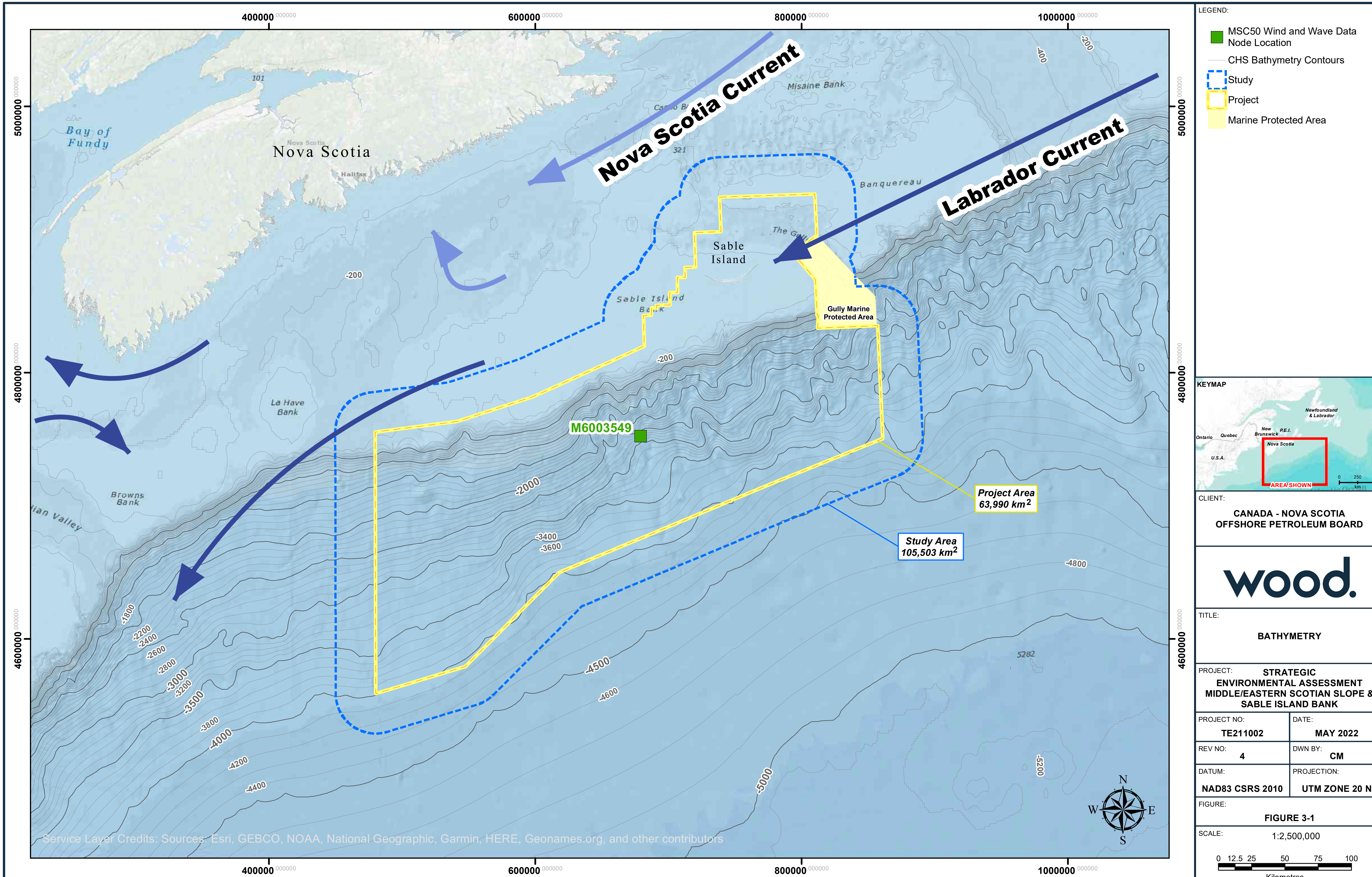
Throughout the Study Area there is evidence of mass sediment failures, including rotational slumps, slides and debris-flow deposits (Mosher et al. 2004). Several forms of failures have been identified through multibeam bathymetry and seismic reflection including retrogressive, slump, slide, bedding-plane detachments, turbidity currents, and debris-flow deposits among others (Mosher et al. 2004). The surficial geology along the Scotian

Slope south of Sable Island consists of glaciomarine sediments consisting of proglacial muds deposited by subsequent failures and mass movements (Campbell et al. 2008a, b, c). Mass-transport deposits of poorly sorted mud and sandy mud are found throughout this section of the slope (Campbell et al. 2008a, b, c). These are the results of local slides from failures along the canyon walls, or canyon heads (Jenner et al. 2007). The western head of The Gully has a large area of asymmetric bedforms indicative of sand transport downslope to deep-water areas of the canyon (Fader and King 2003, Cameron et al. 2008). Other failures have been observed along the northern edge of the slope. One major mass-transport deposit, covering more than 14,000 km^2, has been observed in the Laurentian Fan (Normandeau et al. 2019a). The landslide retrogressed upslope and the debris flow extended downslope for nearly 90 kms (Normandeau et al. 2019a). While a failure of this size is considered a rare event with four or five sediment failures within the past 17 ka (Jenner et al. 2007), a large submarine landslide event (similar to the 1929 Grand Banks earthquake-induced landslide) could occur once every 1000 years (Normandeau et al. 2019b, Normandeau and Campbell 2020). Seismic events could also trigger synchronous failures in multiple separate canyons along the slope (Jenner et al. 2007).

The western North Atlantic margin is considered stable with few slope instabilities and the Scotian Shelf is not considered seismically active. The largest fault zone in the region is the Cobequid-Chedabucto-southwest Grand Bank fault zone which is northeast of the Scotian Shelf and Laurentian Channel (Pe-Piper and Piper 2004). Within the past ten years there have been approximately 100 earthquakes in the Nova Scotia offshore which ranged between 1.8 and 4.3 magnitude (Earthquake Canada 2021). These mainly occur along the Laurentian Slope Seismic Zone which is adjacent to the Study Area (Earthquake Canada 2021). The 1929 Grand Bank earthquake, that initiated a tsunami, originated in this zone. Also, there is evidence that slopes within the Laurentian Fan levee have instabilities that could fail without an external trigger (Normandeau et al. 2019b). Submarine slope failures in the geological record, pore pressures, and earthquakes in the area are crucial factors when considering slope instability in the Scotian Slope region (MacKillop et al. 2019).

3.1.3 Bathymetry

The Study Area is located over the Sable Island Continental Shelf and includes a portion of the Sable Island and Banquereau Banks to the north (Figure 3-1). To the northeast, the Study Area extends to the edge of The Gully Marine Protected Area (MPA). The Gully's size, shape and location influence currents and local circulation patterns in the area. Water depth ranges from about 100 m on the Sable Island and Banquereau Banks to more than 4,000 m at the southern extent of the Study Area along the Continental Shelf. In this region, ocean canyons run down from the continental slope with deep sea depths of between approximately 2,000 m to 4,000 m.



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3.1.4 Climatology

The following sections provide an overview of the key climatological conditions and characteristics of the Study Area, including wind, air temperature, precipitation, fog and visibility, and tropical systems.

3.1.4.1 Wind Conditions

A primary characterization of the wind climatology of the Study Area is provided with statistics derived from the most recent release of the MSC50 wind and wave hindcast. The MSC50 dataset includes hourly wind and wave parameters of the North Atlantic Ocean (Swail et al. 2006, DFO 2020a). The hindcast data were produced through the kinematic reanalysis of substantial tropical and extra-tropical storms in the North Atlantic. The dataset covers hourly wind and wave parameters, from 1954 to 2018, for the North Atlantic Ocean and includes consideration of periods with sea ice coverage. Ice concentration data that were considered are mean monthly values through 1961 inclusive and then CIS mean weekly ice concentrations for 1962 onwards. Given the poorer resolution of ice information from 1954-1961, this period of the MSC50 dataset was excluded from the present analysis. The 1962-2018 periods are considered for waves and, for consistency, winds.

The overall resolution of MSC50 hindcast data grid points (nodes) is quite high, with one point every 0.1° latitude by 0.1° longitude (approximately 8.5 km east-west and 11.7 km north-south near 43°N). To provide a characterization over the Study Area, one location at 42.9°N, 60.8°N in the centre of the Study Area, 130 km southwest of Sable Island was selected (Figure 3-1).

The MSC50 wind speeds are 1-hour average wind speeds for a height of 10 m above sea level. Wind speed measurements are frequently averaged over shorter durations (e.g., 10 minutes for marine reports and two minutes for aviation, and a one-minute average is used for the categorization of tropical cyclones). Wind gusts are typically for one, two or five second durations. Several formulas (e.g., ISO 2005), can be used to scale winds to averaging times <1 hour and for different reference elevations (e.g., between 10 m and drilling installation anemometer height or vice versa), and are frequently applied in design criteria studies applying measured and hindcast data sets.

Wind conditions are summarized with monthly and annual statistics presented in Table 3-2. Annual and monthly wind roses are presented in Figure 3-2 and Figure 3-3. Mean hourly wind speeds for the Study Area range from 5.6 m/s (20.2 km/h or 10.9 knots) in July to 10.9 m/s in December and January, while the strongest winds of 30.3 m/s occur in December. The maximum wind speeds indicate that gale force winds, in the range from 17.5 to 24.2 m/s, occur from April to July, while storm force winds, in the range from 24.7 to 32.4 m/s, can occur during the rest of the year.

The prevailing winds annually are southwesterly (24.7%), westerly (17.1%) or northwesterly (10.1%). Monthly wind roses indicate that northwesterly winds are dominant during the period from November to March, while southwesterly winds are most frequent during the warmer months from May to September.

Table 3-2: Monthly and Annual Wind Statistics (1962-2018)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Wind Speed (m/s)													
M6003549	10.9	10.8	10.1	8.5	6.8	6.2	5.6	6.1	7.3	8.9	10.0	10.9	8.5
Standard Deviation of Wind Speed (m/s)													
M6003549	4.2	4.2	4.3	3.8	3.3	3.0	2.7	2.8	3.2	3.7	4.0	4.2	4.2
Most Frequent Direction (from)													
M6003549	NW	NW	NW	W	SW	SW	SW	SW	SW	W	NW	NW	W
Maximum Speed (m/s)													
M6003549	28.5	29.2	27.7	24.6	20.9	23.9	23.7	27.2	29.4	27.9	26.6	30.3	30.3
Direction of Maximum Wind Speed (from)													
M6003549	N	SW	N	W	NE	SW	S	S	S	NE	N	SW	SW

Source: DFO 2021a

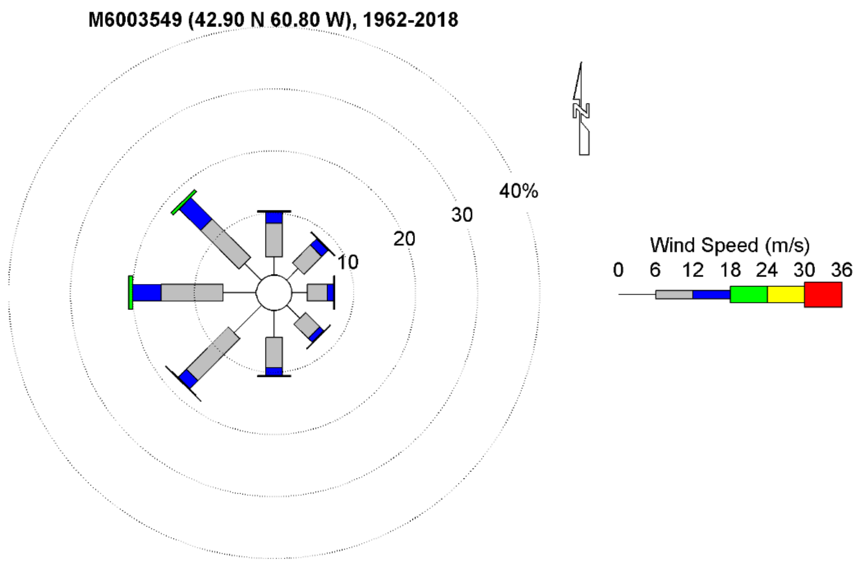


Figure 3-2: Annual Wind Rose, MSC50 Node M6003549 (1962-2018)

Source: DFO 2021a

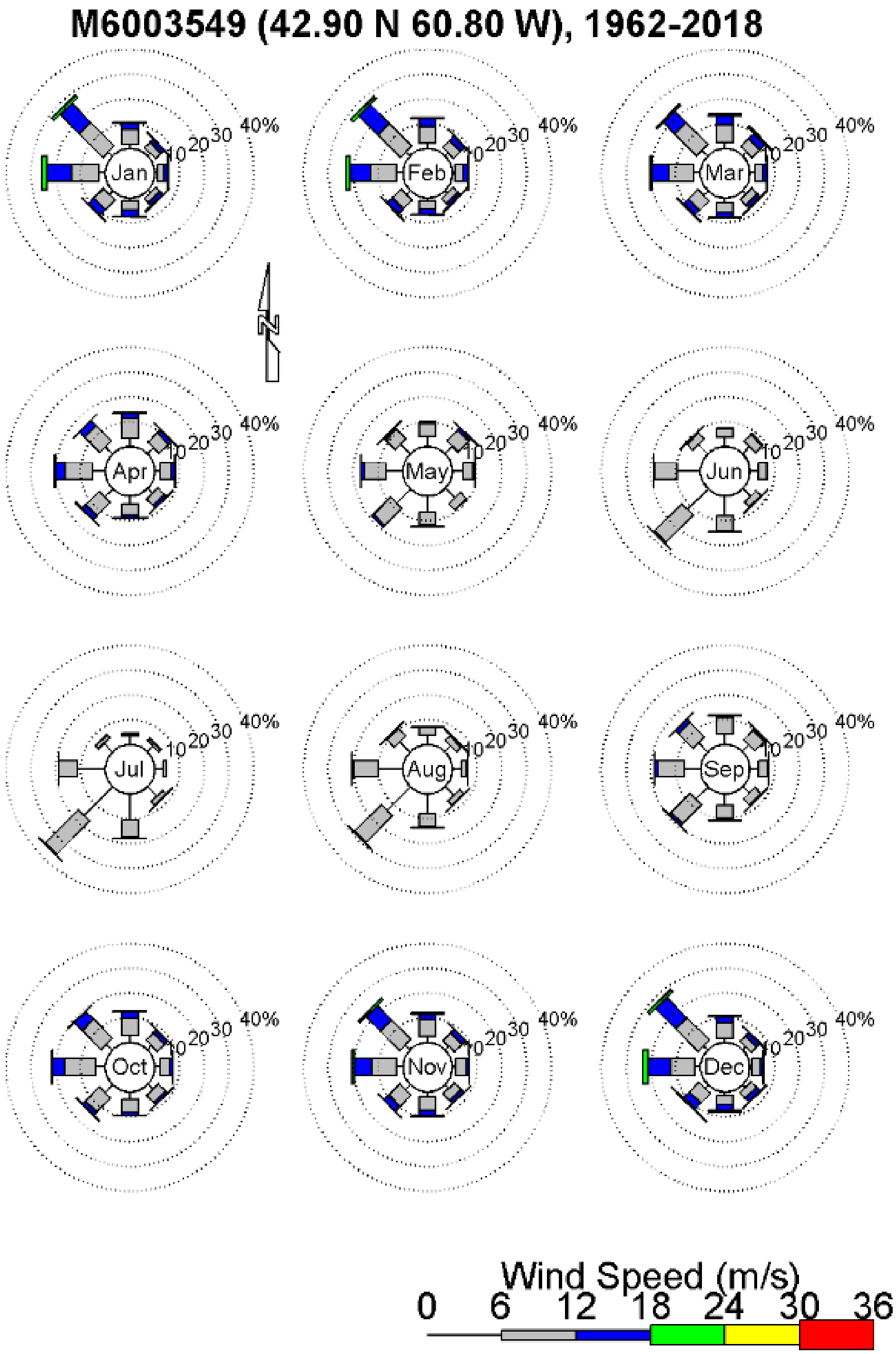


Figure 3-3: Monthly Wind Roses, MSC50 Node M6003549 (1962-2018)

Source: DFO 2021a

3.1.4.2 Air Temperature

Atmospheric properties over the ocean surface, including air temperature, precipitation and visibility have been characterized using the ICOADS. ICOADS represents the most extensive available database of observations of atmospheric and sea conditions. The dataset consists of global marine observations recorded from 1662 to the present, compiled by the United States National Centre for Atmospheric Research (Freeman, et al., 2017).

Air temperature conditions have been characterized by selecting all ICOADS observations for the period January 1990 to December 2019, inclusive (Research Data Archive et al. 2021) for a box which covers the Study Area.

Monthly air temperature statistics for this region are plotted in Figure 3-4 and presented in Table 3-3. The air temperature values exhibit strong seasonal variations, with mean temperatures ranging from 0.3°C in February to 19.6°C in August. The coldest observed air temperature on record (-20.1°C) was in January, while during the summer months the coldest observed temperatures were around 0.1°C in June. The highest temperature measured was 33.1°C in September.

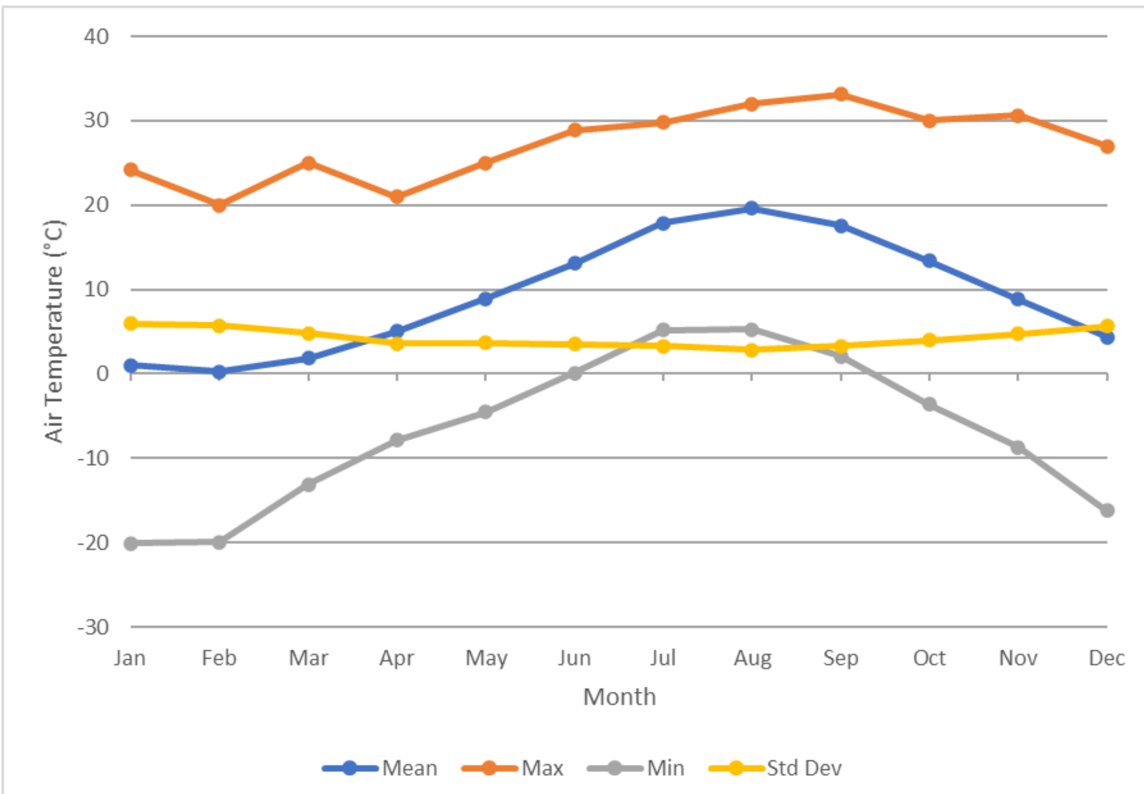


Figure 3-4: Monthly Air Temperature

Source: Research Data Archive et al. 2021

Table 3-3: Monthly Air Temperature (°C) Statistics (1990-2019)

Month	Mean	Maximum	Minimum	Standard Deviation
January	1.0	24.2	-20.1	5.95
February	0.3	20.0	-19.9	5.71
March	1.8	25.0	-13.1	4.78
April	5.1	21.0	-7.9	3.63
May	8.9	25.0	-4.5	3.66
June	13.1	28.9	0.1	3.55
July	17.8	29.8	5.2	3.27
August	19.6	32.0	5.3	2.83
September	17.6	33.1	2.1	3.32
October	13.4	30.0	-3.6	3.98
November	8.8	30.6	-8.7	4.75
December	4.3	27.0	-16.2	5.61

Source: Research Data Archive et al. 2021

3.1.4.3 Precipitation

The ICOADS database contains observations of several precipitation types and thunderstorm occurrence. Every occurrence of a weather state is recorded and categorized as an event based on the type (but not the amount), of precipitation during that event. The frequency of occurrence of the different precipitation types and thunderstorms have been calculated as a percentage of the total monthly and annual weather observations for the period 1990 to 2019 (Figure 3-5 and Figure 3-6).

It is expected that there would be a considerable degree of variability of precipitation patterns within localized regions of the Study Area. Therefore, it would be prudent for project-specific planning and implementation to consider and account for the expected site-specific conditions and variability in the occurrence and rates of precipitation based on the nearest and most current weather records applicable to the site. The statistics represented in Figure 3-5 and Figure 3-6 are the percentage of a certain distinct weather state (e.g., rain, thunderstorms, hail, etc.) for all weather reports available on record for that month (e.g., January). The weather states have been consolidated from 50 different ICOADS classifications; separating (without overlap) rain from freezing rain and snow (although some overlap may exist between these states and mixed rain/snow, hail, and thunderstorm, which represent a small percentage of the data). The frequency of occurrence (i.e., the percent of time the given condition(s) occurs in each period) can most closely be characterized as representing unspecified periods of time, for a percentage of all days.

The data indicates that most of the observed precipitation events are in the form of rain or snow, while other precipitation types, such as mixed rain and snow, freezing rain, and hail, occur far less frequently. The monthly frequency of precipitation is lowest in August and September and highest during the months of January and February. The frequency of presence of snow is highest for the month of January, while the frequency of presence of rain is highest in the month of November.

Freezing rain and drizzle are relatively infrequent, occurring less than one percent of the time during any given month. Minimum temperatures from June through September do not fall below 0.0°C, therefore, records indicating the freezing precipitation for these months are likely in error. Thunderstorms are the main generating mechanism of hail, and therefore the observation of hail is expected during thunderstorms.

During some months, the frequency of hail is higher than that of thunderstorms (Table 3-4). This may be due to other forms of precipitation, such as ice pellets, being inaccurately categorized as hail by observers. There is a year-round potential for thunderstorms and hail, with the highest frequency of occurrence occurring in the month of October.

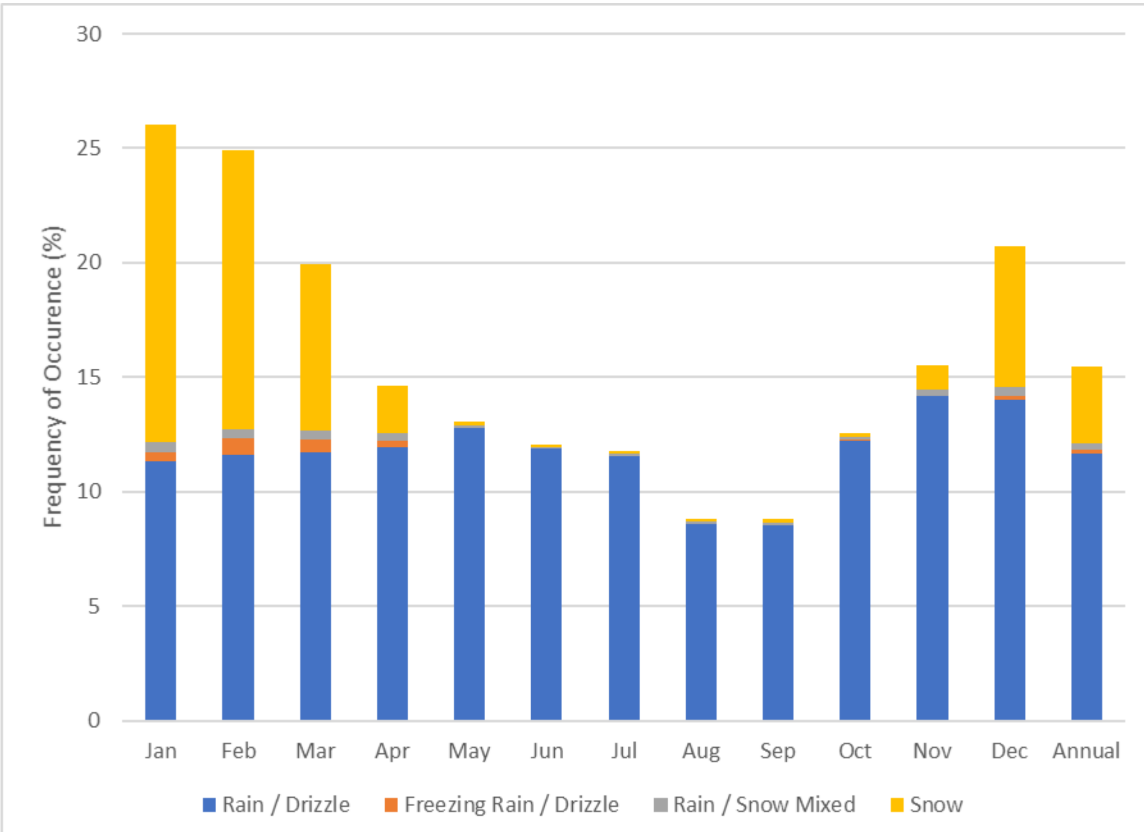


Figure 3-5: Frequency of Occurrence of Precipitation Types (1990-2019)

Source: Research Data Archive et al. 2021

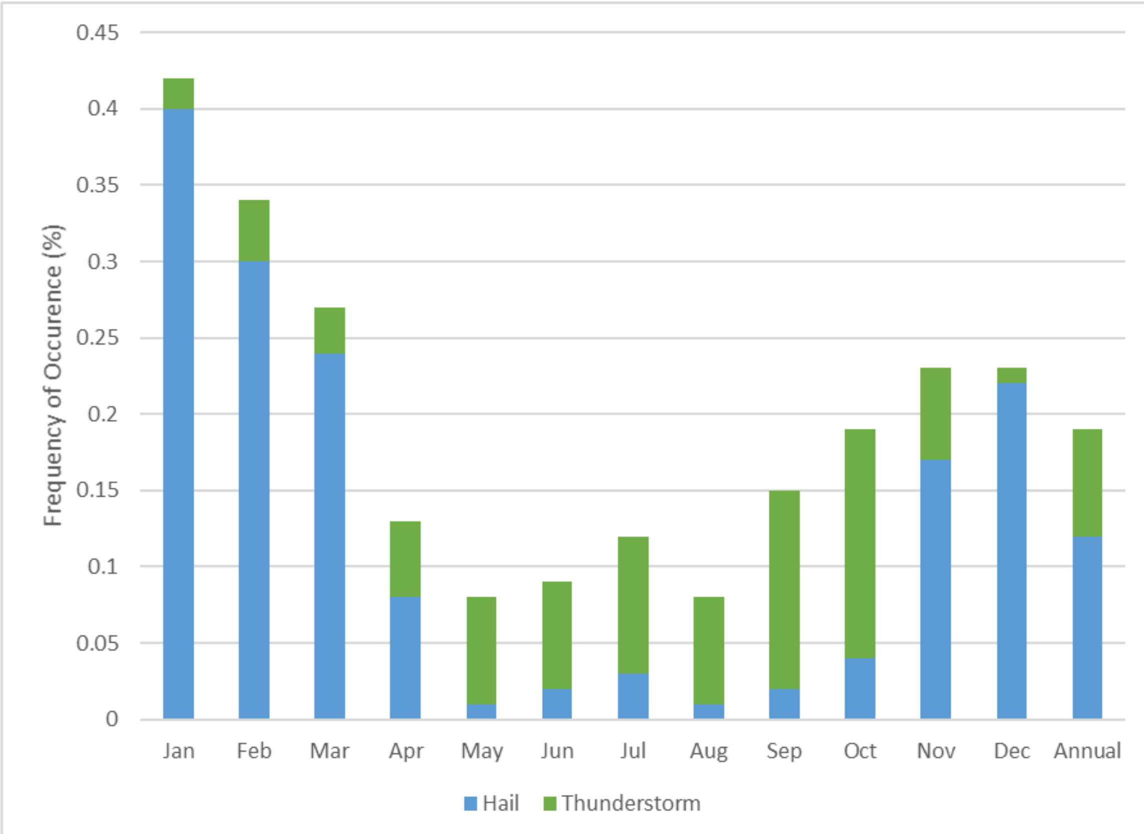


Figure 3-6: Frequency of Occurrence of Hail and Thunderstorms (1990-2019)

Source: Research Data Archive et al. 2021

Table 3-4: Monthly and Annual Frequency of Occurrence of Precipitation and Thunderstorms (1990-2019)

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Jan	11.32	0.41	0.44	13.87	0.40	0.02
Feb	11.62	0.71	0.39	12.18	0.30	0.04
Mar	11.69	0.58	0.40	7.25	0.24	0.03
Apr	11.92	0.27	0.39	2.03	0.08	0.05
May	12.76	0.03	0.09	0.19	0.01	0.07
Jun	11.87	0.02	0.07	0.09	0.02	0.07
Jul	11.57	0.00	0.08	0.10	0.03	0.09
Aug	8.57	0.01	0.12	0.09	0.01	0.07
Sep	8.51	0.02	0.13	0.12	0.02	0.13
Oct	12.22	0.03	0.13	0.16	0.04	0.15
Nov	14.15	0.04	0.26	1.08	0.17	0.06

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Dec	14.02	0.17	0.4	6.10	0.22	0.01
Annual	11.67	0.18	0.24	3.37	0.12	0.07

Source: Research Data Archive et al. 2021

3.1.4.4 Fog and Visibility

The cold Labrador Current runs along the northern portion of the Study Area and often interacts with the warm Gulf Stream moving northeast along the Scotian Shelf. The combination of these two currents can produce heavy fog within the Study Area. Visibility is affected by the presence of fog, the number of daylight hours, as well as frequency and type of precipitation. For this characterization, visibility from the ICOADS dataset has been classified as very poor (<0.5 km), poor (0.5 to 2 km), fair (2 to 10 km) or good (> 10 km). The monthly and annual frequencies of occurrence of each state are shown in Figure 3-7 and Table 3-5.

Fog and visibility conditions and seasonal variability are expected to vary across the Study Area, along with air temperatures and precipitation rates. Therefore, site-specific conditions and the possible implications of these would have to be characterized from local visibility datasets for project-specific planning and analysis.

It is clear from the ICOADS database that visibility within this sub-region varies considerably throughout the year. Good or fair visibility combined occur 89 percent of the time annually. Good visibility (greater than 10 km) is most frequent from September to December, and least frequent in June and July. The combined percent occurrence of very poor and poor visibility ranges from 4 percent in December and January to 23 percent in June and July. Very poor visibility peaks at 19.4 percent of the time in June. Annually, visibility is very poor 8.2 percent of time, poor 2.6 percent of the time, fair 14.9 percent of the time, and good 74.4 percent of the time.

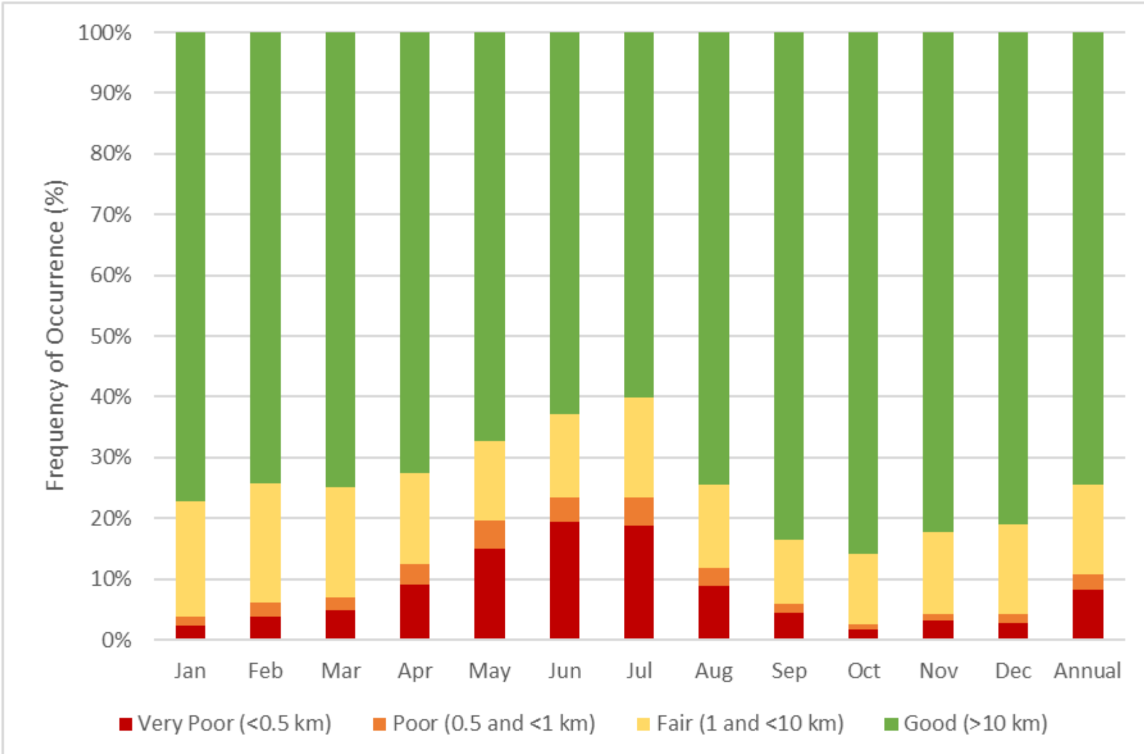


Figure 3-7: Frequency of Occurrence of Visibility States (1990-2019)

Source: Research Data Archive et al. 2021

Table 3-5: Monthly and Annual Frequencies of Occurrence (%) of Visibility States (1990-2019)

Month	Very Poor (<0.5 km)	Poor (0.5 – 2 km)	Fair (2 – 10 km)	Good (>10 km)
Jan	2.2	1.5	19.1	77.1
Feb	3.9	2.3	19.6	74.2
Mar	5.0	2.1	18.1	74.8
Apr	9.1	3.3	15.0	72.6
May	15.0	4.7	13.0	67.2
Jun	19.4	4.0	13.8	62.9
Jul	18.9	4.6	16.4	60.1
Aug	9.0	2.9	13.6	74.5
Sep	4.4	1.5	10.7	83.5
Oct	1.8	0.8	11.5	85.9
Nov	3.1	1.2	13.4	82.3
Dec	2.8	1.3	14.9	80.9
Annual	8.2	2.6	14.9	74.4

Source: Research Data Archive et al. 2021

3.1.4.5 Tropical Systems

Tropical systems, whether they are weakened hurricanes, tropical storms or post-tropical (extra tropical) storms, do affect portions of the Study Area. Hurricanes and tropical systems feed off warm ocean waters south of the Gulf Stream. Tropical systems tend to weaken as they move north due to the colder water temperatures. However, the warm waters of the Gulf Stream can result in these systems maintaining their strength as the move over the Study Area.

Low pressure systems that form in the tropical Atlantic Ocean that develop into tropical storms typically transition into post-tropical storms when they reach Canadian waters as they are no longer able to draw upon energy from the warmer ocean to the south. This means that tropical storms obtain characteristics of extratropical (northern latitude) storms: they develop frontal systems or merge with existing low-pressure systems that have frontal systems. That is, the energy of the storm changes from being mainly due to the heat and moisture of the warm waters of the southern North Atlantic to energy due to cold versus warm air temperature contrasts. This process is known as extratropical transitioning. Post-tropical storms often retain energy due to high moisture content and deep convection. This energy can be released into kinetic energy (winds) when a significant pool of cold air moves into the west side of the storm. For this reason, post-tropical storms are often more volatile than typical extratropical storms and can regenerate in intensity, often very rapidly.

Tropical systems can affect the Study Area anytime during the Atlantic hurricane season (June 1 to November 30) and are also known to occur outside of the season, but most activity generally occurs between August and October. One of the main reasons for the increased activity during this time of year is the shift of the Bermuda High to the east, allowing systems over the Caribbean to track northward towards Atlantic Canada. The Bermuda High is a dominant ridge of high pressure over the Atlantic typically centred near Bermuda, which guides weather systems over the southern Atlantic Ocean towards the southeastern United States and provides the dominant southwesterly flow to Eastern Canada during the summer.

Nineteen storms of tropical origin have passed through the Study Area for the period of 1980 – 2019. Of these storms, three were Category 1 Hurricanes. The most intense of these storms was Hurricane Dean which crossed with maximum sustained wind speeds of 38.5m/s (75 knots) and a central pressure of 975mb. A list of all tropical storms to affect the Study Area from 1980 – 2019 is provided in Table 3-6, and their storm tracks provided in Figure 3-8 (Landsea and Franklin 2013). It is noted the Hurricane Juan tracked west of the Study Area on September 29, 2003, a Category 2 system, with a windspeed of 46.0 m/s. A more comprehensive study considering storms passing within a specified distance of a project should be undertaken for project-specific planning and analysis.

The numbers of tropical systems that have affected the Study Area by month from 1980 to 2019, are shown in Figure 3-9, which illustrates that the most frequent occurrence is in September and October (Landsea and Franklin 2013).

Table 3-6: Tropical Storms Passing Through the Study Area (1986-2018)

Name	Date	Category	Lat (°N)	Lon (°W)	Wind (m/s)	MSLP (hPa)
CHARLEY	1986-08-20 06:00	Tropical Storm	41.6	-62.5	20.6	1004
UNNAMED	1988-08-31 12:00	Tropical Depression	43.0	-62.0	15.4	N/A
DEAN	1989-08-08 00:00	Category 1	41.7	-62.1	38.5	975
BERTHA	1990-08-01 18:00	Category 1	42.4	-61.5	33.4	975
BARRY	1995-07-09 12:00	Tropical Storm	42.3	-63.1	25.7	993
EDOUARD	1996-09-03 18:00	Extratropical	42.7	-63.0	25.7	995
BONNIE	1998-08-30 00:00	Tropical Storm	42.9	-61.5	23.1	1000
EARL	1998-09-05 12:00	Extratropical	42.5	-61.0	25.7	990
HELENE	2000-09-25 06:00	Tropical Storm	41.6	-62.2	30.9	986
LESLIE	2000-10-08 06:00	Extratropical	43.0	-60.0	20.6	1003
UNNAMED	2000-10-29 06:00	Extratropical	44.0	-60.0	25.7	980
GASTON	2004-09-01 12:00	Extratropical	43.0	-59.6	23.1	999
WILMA	2005-10-26 00:00	Extratropical	42.5	-60.0	30.9	978
UNNAMED	2006-07-18 00:00	Tropical Storm	42.4	-62.1	20.6	999
CHANTAL	2007-08-01 00:00	Tropical Storm	42.5	-60.0	23.1	994
CRISTOBAL	2008-07-23 00:00	Tropical Storm	43.3	-60.7	23.1	1001
OPHELIA	2011-10-03 00:00	Category 1	42.8	-59.6	36.0	972
CHRIS	2018-07-12 12:00	Tropical Storm	43.3	-59.2	30.9	987
MICHAEL	2018-10-13 00:00	Extratropical	43.1	-61.5	18.0	975

Source: Landsea and Franklin 2013; National Hurricane Centre 2012; Bowyer 2003

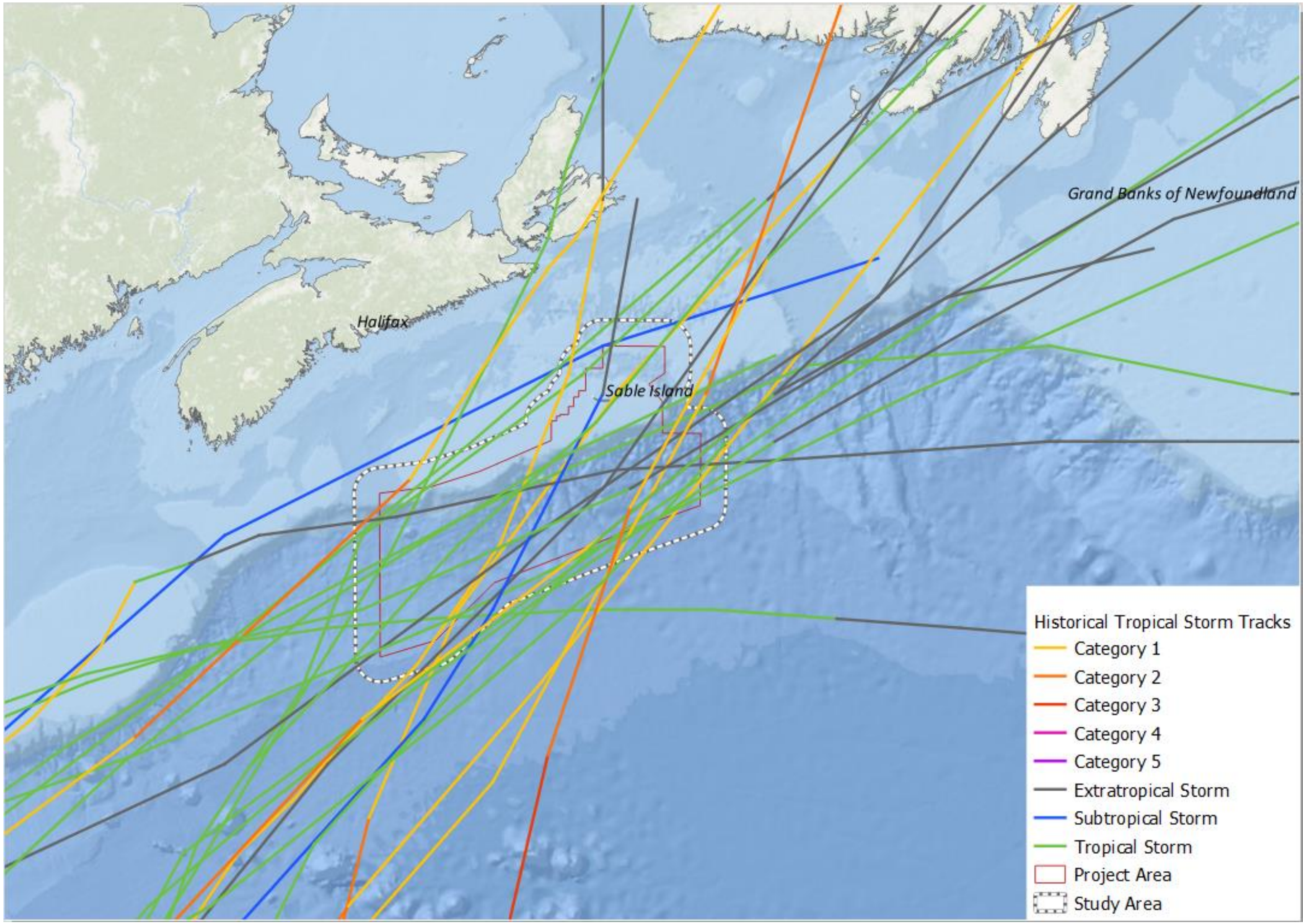


Figure 3-8: Storm Tracks of Tropical Storms Passing Through the Study Area (1980-2019)

Source: Landsea and Franklin 2013

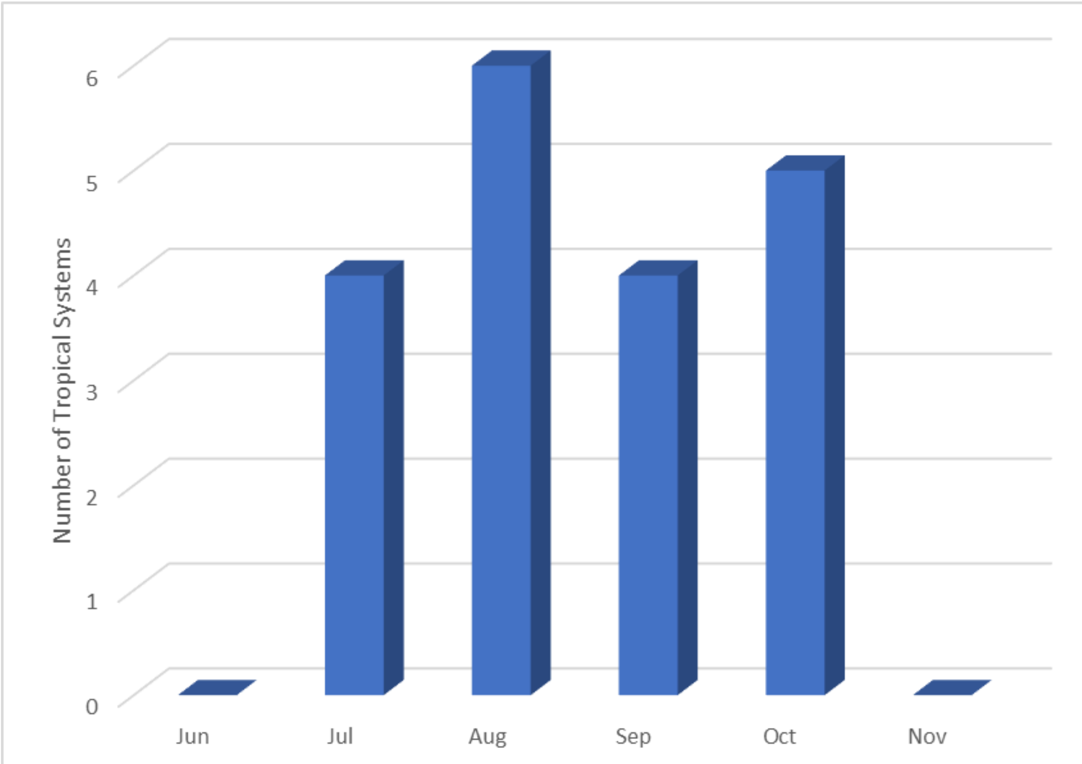


Figure 3-9: Number of Tropical Systems Affecting the Study Area by Month

Source: Landsea and Franklin 2013

3.1.5 Oceanography

3.1.5.1 Waves

The wave climate within the Study Area was characterized by descriptive statistics derived from the MSC50 wind and wave hindcast dataset (DFO 2020a). The wave hindcast was conducted by using the wind field reanalysis to force a third-generation wave model (Swail et al. 2006) over the North Atlantic Ocean. The model used was Oceanweather's OWI-3G, adopted onto a 0.5-degree grid on a basin-wide scale. Inscribed in the 0.5-degree model was a further refined 0.1-degree shallow water implementation of the OWI-3G model, which allowed for shallow water effects to be accounted for in the maritime region. The MSC50 methodology and results have been extensively documented and validated (Swail and Cox 2000; Woolf et al. 2002; Caires et al. 2004).

As presented earlier for wind conditions, an MSC50 grid point location was selected to provide a representative illustration of conditions. This provides an overview for general illustration and SEA purposes. This is in keeping with the approach for, and the type and level of information that has been included in, other SEAs in the Eastern Canada offshore area. It should be reiterated, however, that the intent here is to provide a regional overview for general illustration, rather than detailed oceanographic information for design and operational purposes.

The wave climate is described in terms of the significant wave height (Hs, defined as four times the square root of the total variance of the wave energy spectrum), and the peak wave spectral period (Tp, defined as the period of waves with the highest contribution to the energy spectrum). Ocean waves are due to the effects of wind on the air/water interface. Winds are due to the dominant local and regional weather systems encountered and exhibit a pronounced seasonal variability. Wind waves (or sea) will be generated in the immediate area of wind, developing quickly within an hour. Swells are what remains of the wind waves after they propagate away from where they were generated. Swells are long waves that contain a lot of wave energy and can take days to subside. The range of wave periods for wind waves and swells overlap considerably with wind waves having periods up to 15 seconds (s) for large winds speeds, while swells of only a few seconds are possible.

Mean wave heights range from approximately 1.5 m in July to 3.4 m in December through February (Table 3-7).

The most severe sea states occur during winter with maximum significant wave heights up to 15.2 m in March and 13.6 m in January. These maximum wave heights are reported for directions from the southwest and west. Associated wave peak periods for these maximum waves are 14 to 17 s. In contrast, maximum significant wave heights are less than half (6.8 m) in May, with associated peak periods of 11 s.

Table 3-7: Monthly and Annual Wave Statistics (1980-2019)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Hs (m)													
M6003549	3.4	3.4	3.1	2.5	1.9	1.7	1.5	1.6	2.0	2.5	3.0	3.4	2.5
Standard Deviation of Hs (m)													
M6003549	1.6	1.6	1.6	1.2	0.9	0.7	0.6	0.7	1.0	1.2	1.4	1.6	1.4
Most Frequent Direction (from)													
M6003549	W	W	W	SW	SW	SW	SW	SW	SW	W	W	W	SW
Mean Tp (s)													
M6003549	8.9	8.9	8.8	8.4	7.7	7.4	7.4	7.4	8.1	8.1	8.5	8.9	8.2
Maximum Hs (m)													
M6003549	13.6	12.7	15.2	11.3	6.8	9.3	8.7	12.5	11.3	12.9	11.9	12.7	15.2
Direction of Maximum Hs (from)													
M6003549	W	SW	SW	W	W	SW	S	SW	SW	NE	W	SW	SW
Tp of Maximum Hs (s)													
M6003549	14.8	14.0	17.3	14.1	11.2	12.9	13.3	15.8	13.5	15.7	14.3	14.5	17.3
Maximum Tp (s)													
M6003549	15.8	17.1	17.3	14.9	17.7	18.0	17.7	21.0	17.5	17.3	16.4	18.7	21.0

Source: DFO 2021a

Annual and monthly wave roses are presented in Figure 3-10 and Figure 3-11.

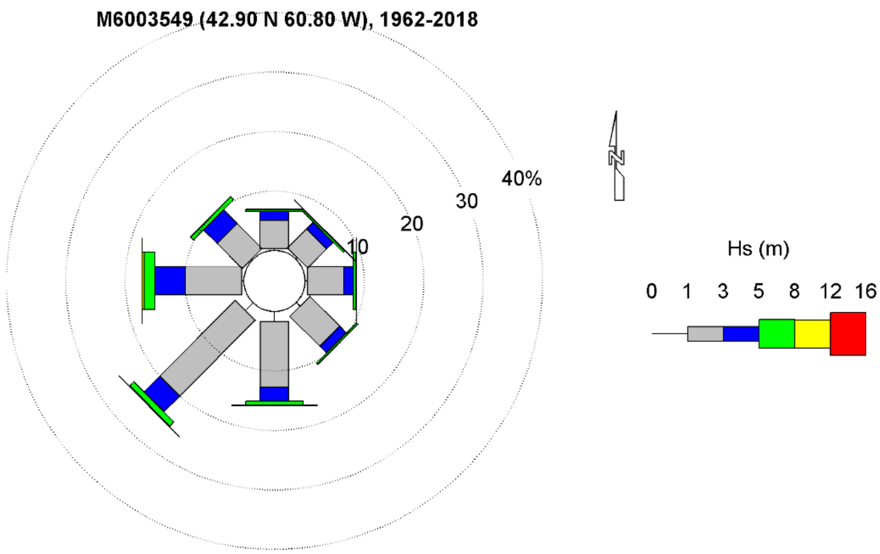


Figure 3-10: Annual Wave Rose, MSC50 Node M6003549 (1962-2018)

Source: DFO 2021a

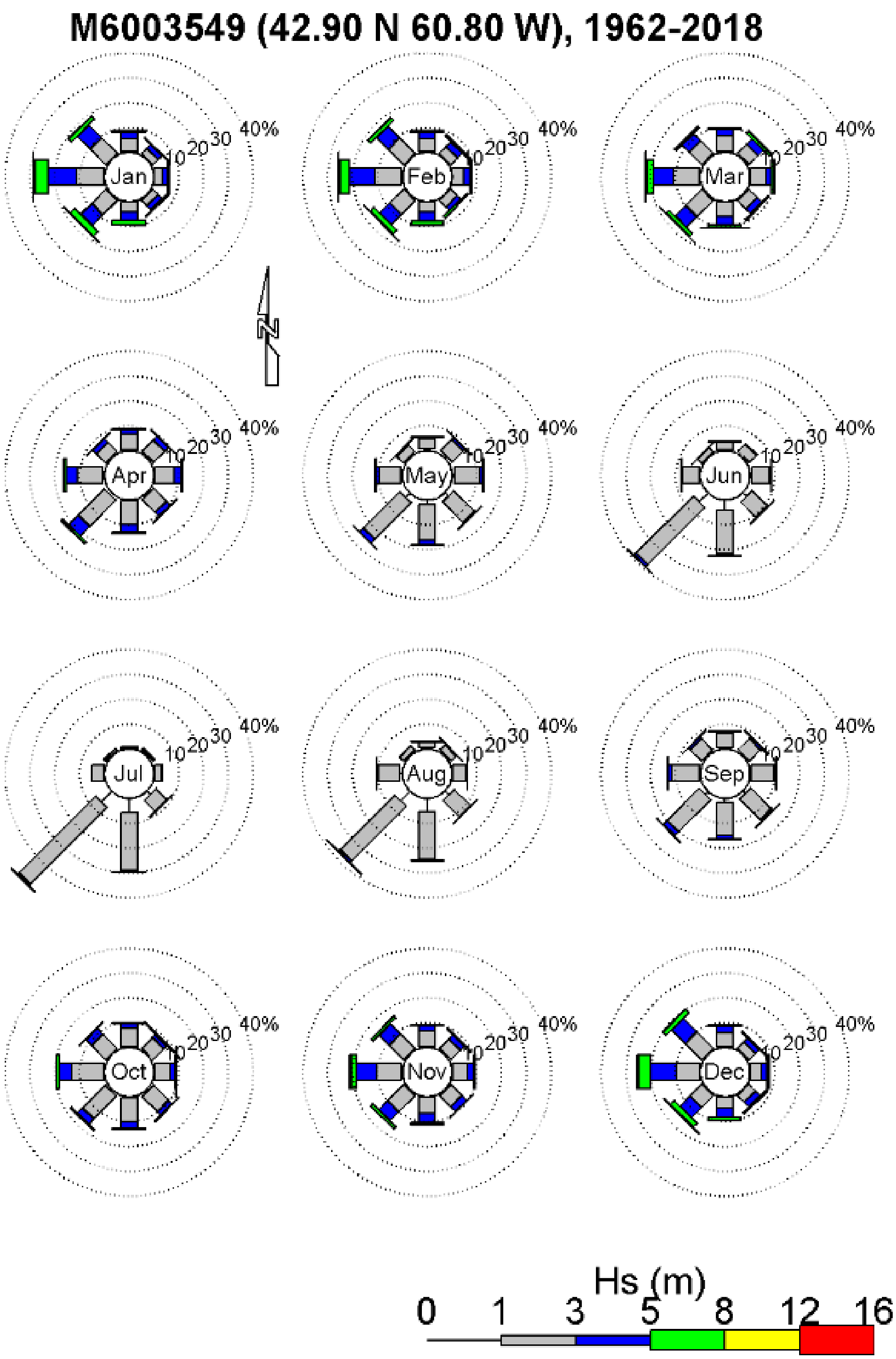


Figure 3-11: Monthly Wave Roses, MSC50 Node M6003549 (1962-2018)

Source: DFO 2021a

3.1.5.2 Ocean Currents

An offshore branch of the cold Labrador Current dominates the general circulation over the eastern Canada-Nova Scotia offshore area (Figure 3-1). This flows southwest-wards along the edge and slope of the Scotian Shelf, a continuation of the Labrador Current's flow past the east coast of Newfoundland and along the outer edge of the Grand Banks. An inshore Nova Scotia Current, emanating from Gulf of St. Lawrence waters flowing through the Cabot Strait, flows southwest-wards closer to the coast at speeds of about 5 to 10 cm/s. Farther to the south, outside the Study Area, the warm Gulf Stream flows from the south towards the east, ultimately branching into the northeastward-flowing North Atlantic Current.

For the purposes of this overview, current statistics for current meter data within the Study Area are reported. The primary data source is the Bedford Institute of Oceanography (BIO) ODI (Gregory 2004). To approximate the Study Area, a query was completed for the two rectangles 41°N to 43.5°N, 61°W to 63.5°W (west) and 42°N to 44.67°N, 58.5°W to 61.0°W (east), returning 3,940 monthly instrument-depth records from 1967 to 2008 (DFO 2021b). Results are presented here for all current meter records that have a record length of at least five days within a given month. Instrument depths range from 1 m to 3,368 m. A summary of these data by depth, noting the number of instrument records, data duration, and mean and maximum current speed and mean current direction is presented in Table 3-8. The mean and maximum of both the mean and maximum current speeds from all monthly records for a given instrument depth are reported.

Table 3-8: ODI Ocean Current Statistics Summary

Depth	Number of Instrument Records	Number of Data Months	Mean Current Speed (cm/s) (mean value)	Mean Current Speed (cm/s) (maximum value)	Mean Current Direction (°T) (to)	Maximum Current Speed (cm/s) (mean value)	Maximum Current Speed (cm/s) (maximum value)
0 to 100 m	2252	1784	7.6	46.0	195	53.7	222.1
100 to 200 m	522	451	9.4	35.3	196	45.0	130.9
200 to 500 m	664	573	6.6	32.7	200	34.9	105.4
500 to 1,000 m	224	188	4.8	17.8	232	22.4	73.0
1,000 to 2,000 m	184	155	4.2	13.9	237	20.4	58.7
2,000 to 3,000 m	66	60	2.0	9.2	221	14.1	29.9
> 3,000 m	28	26	3.9	7.7	261	21.4	29.3
Total	3940	3237	7.2	46.0	201	45.1	222.1

Source: DFO 2021b

These current measurements have average speeds that range from 2.0 to 9.4 cm/s over all depths. The mean of the monthly maximum current speeds range from 14.1 to 53.7 cm/s. Mean current directions over all depths are to the south-southwest through west-southwest.

The largest mean current speeds of 41 to 46 cm/s to the northeast were measured in September 2003 at depths of 40 to 72 m on the Scotian Slope 180 km southwest of Sable Island. Corresponding maximum monthly current speeds at the time were to 1.1 to 1.3 m/s.

The largest maximum current speeds of 2.2 m/s to the west were measured in August 2002 at an instrument depth of 12.4 m near the Sable Offshore Energy Project (SOEP), North Triumph site 22 km south of Sable Island. Corresponding average monthly mean current speeds at the time were 20 cm/s to the southwest. Maximum current speeds of 1.7 and 1.9 m/s were also measured at 15 m instrument depth during May and June 2002 at the nearby Onondaga B-84 exploration well.

Figure 3-12 shows the monthly mean and maximum current speeds and current direction vs. depth with maximum speeds at depths less than 200 m about two the three times larger than for greater depths.

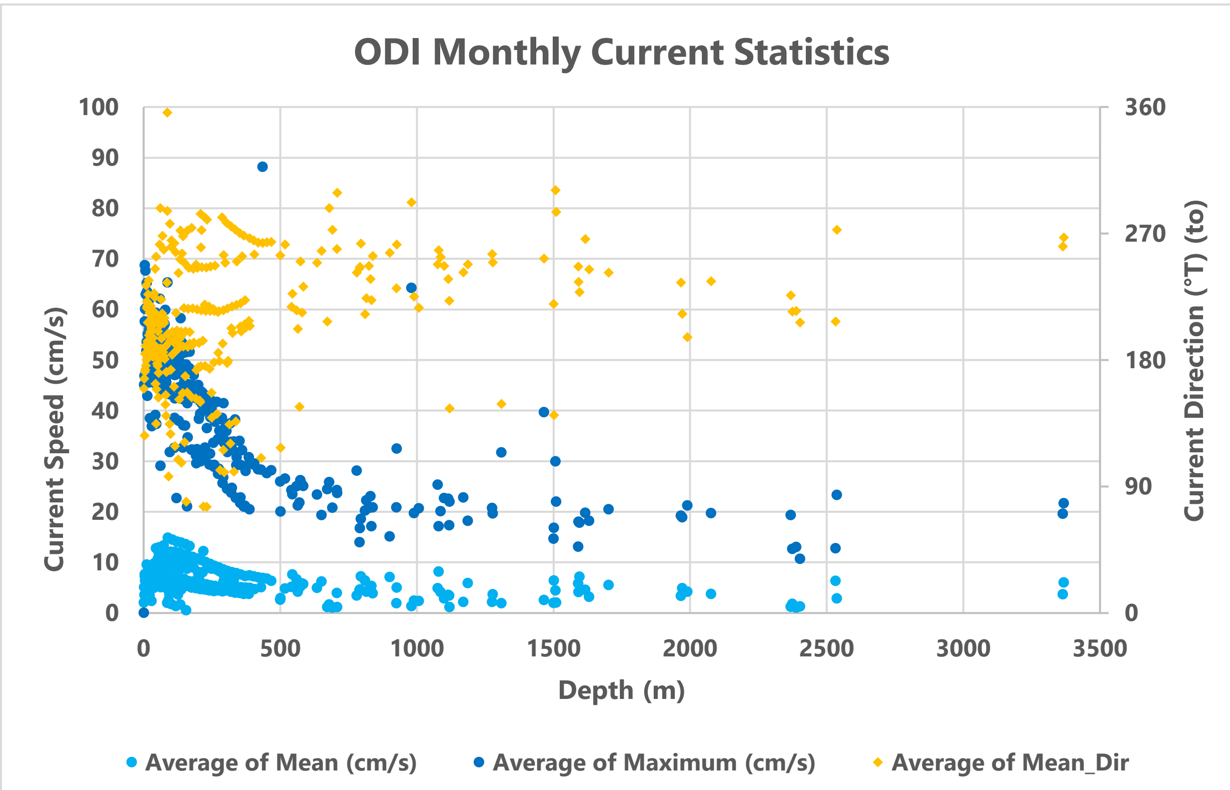


Figure 3-12: ODI Ocean Currents, Monthly Speed and Direction vs. Depth

Source: DFO 2021b

3.1.5.3 Seawater Properties (Temperature, Salinity)

Over the Study Area, the equatorward-flowing Deep Western Boundary Current (DWBC) flows along the Scotian Slope and brings water masses created in the subpolar North Atlantic, including Labrador Sea Water (LSW) and Denmark Strait Overflow Water (DSOW). The DWBC is a key component of the Atlantic portion of the ocean's Meridional Overturning Circulation (MOC). The MOC is sometimes referred to as the "global ocean conveyor belt" of the coupled atmosphere-ice-ocean climate system (DFO 2018a).

The distribution of the temperature and salinity profiles are presented in Figure 3-13 and Figure 3-14 which show potential temperature and salinity from the Atlantic Zone Off-Shelf Monitoring Program (AZOMP) along the extended Halifax Line from May 2007. The southeastern boundary of the Study Area is about 400 km from Halifax.

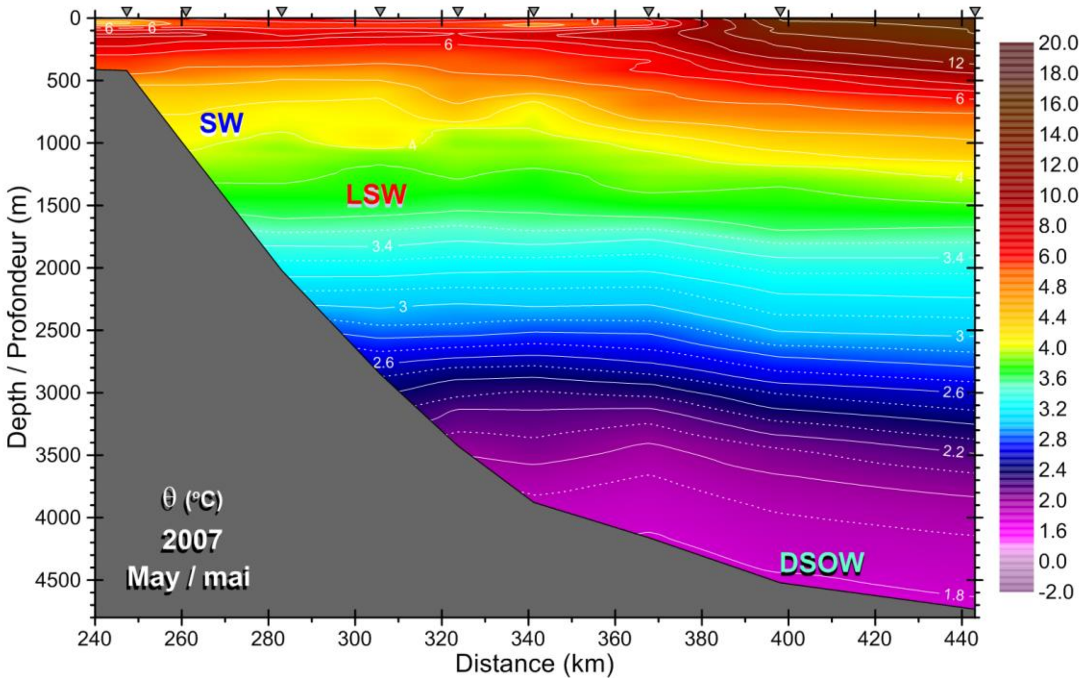


Figure 3-13: Distribution of Potential Temperature over the Scotian Slope and Rise from AZOMP profiles (May 2007)

Notes: LSW=Labrador Sea Water, DSOW=Denmark Strait Overflow Water

Source: DFO 2018a

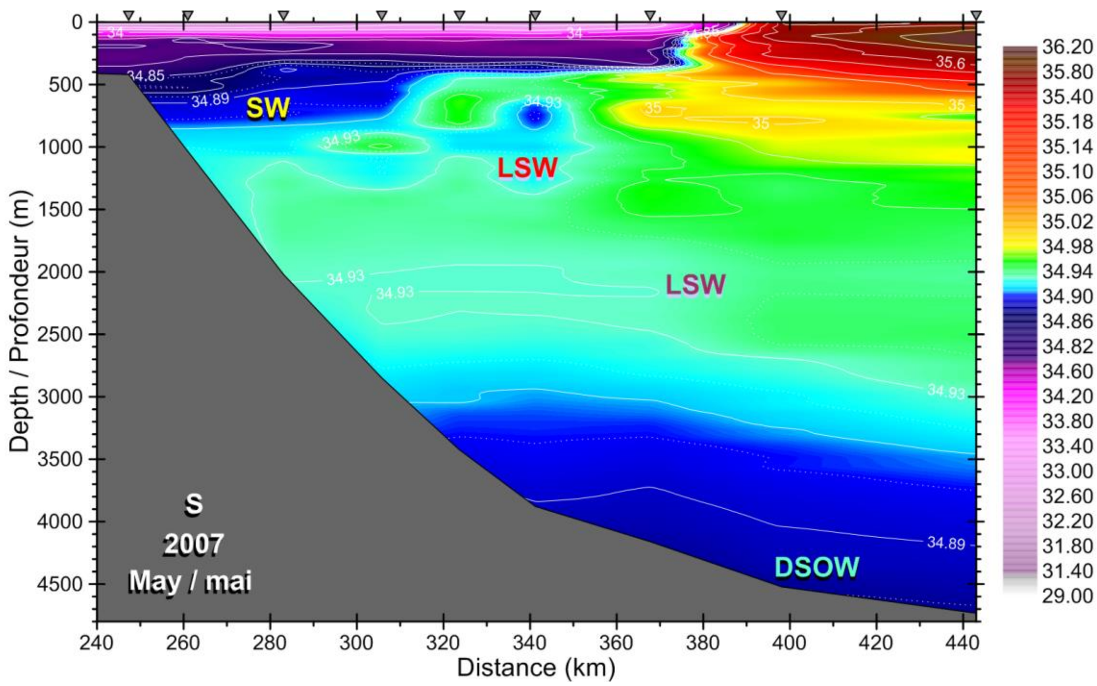


Figure 3-14: Distribution of Salinity over the Scotian Slope and Rise from AZOMP profiles (May 2007)

Notes: LSW=Labrador Sea Water, DSOW=Denmark Strait Overflow Water

Source: DFO 2018a

Statistical summaries of sea temperature and salinity were also derived from the Hydrographic Database of the ODI at BIO (DFO 2021c) based on a query of the rectangular area 41°N to 45°N, 58°W to 64°W (surrounding the Study Area) for the period 1991 to 2020 for depths down to 3,000 m. The location of the measurements is shown in Figure 3-15 where the AZOMP Halifax Line noted above is evident. Those observations within the Study Area were analysed to derive monthly temperature and salinity profiles.

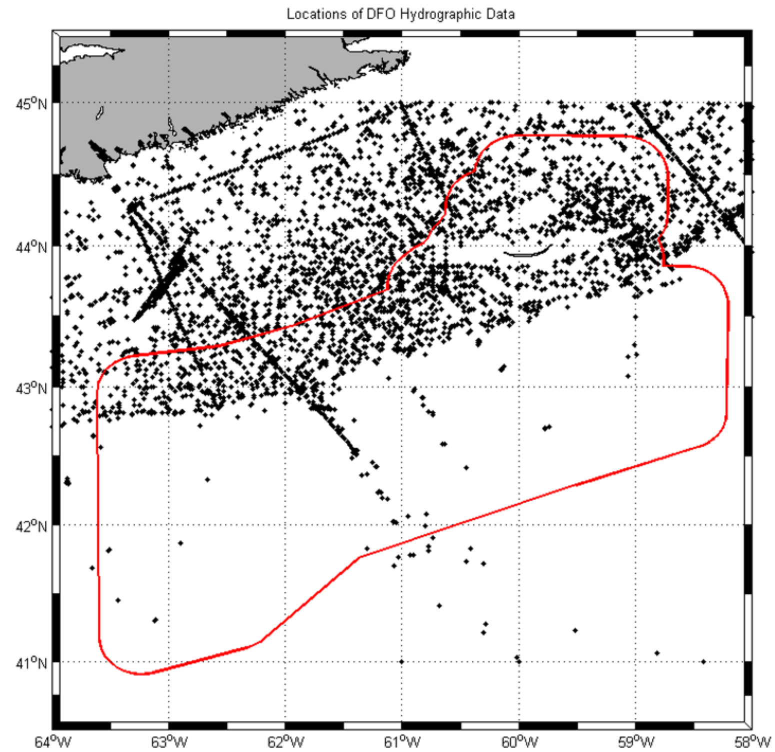


Figure 3-15: Location of ODI Hydrographic Database, Temperature and Salinity Measurements

Source: DFO 2021c

Figure 3-16 through Figure 3-18 present monthly contours of average, minimum and maximum sea temperature and monthly depth profiles of average sea temperature for the Study Area.

Average sea surface temperatures range from 1.5°C in February to 10.7°C in September. Minimum temperatures at the surface range from -1.1°C in March to 5.2°C in September (Figure 3-19). Maximum sea surface temperatures range from 3.6°C in February to 21.7°C in August. This seasonal temperature cycle is observed down to about 200 m, where temperatures are higher in the summer and fall than in the late winter. For depths greater than about 300 m, sea temperature decreases with depth and uniformly over the year with depth, averaging 5.0°C at 600 m down to 4.0°C at 1,200 m and 3.0°C at 2,600 m.

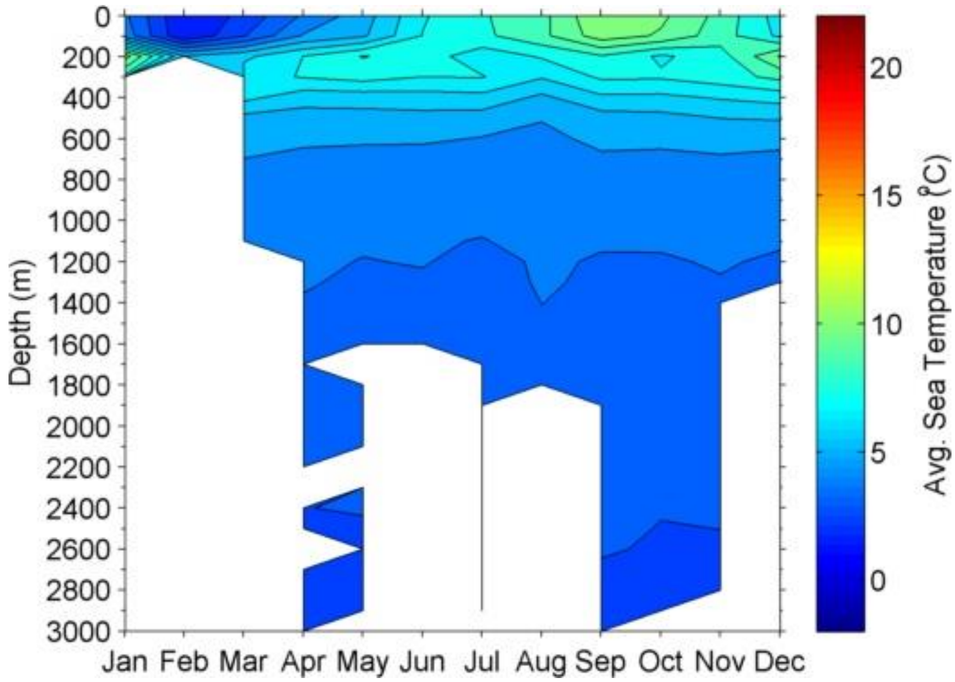


Figure 3-16: Monthly Average Sea Temperature

Source: DFO 2021c

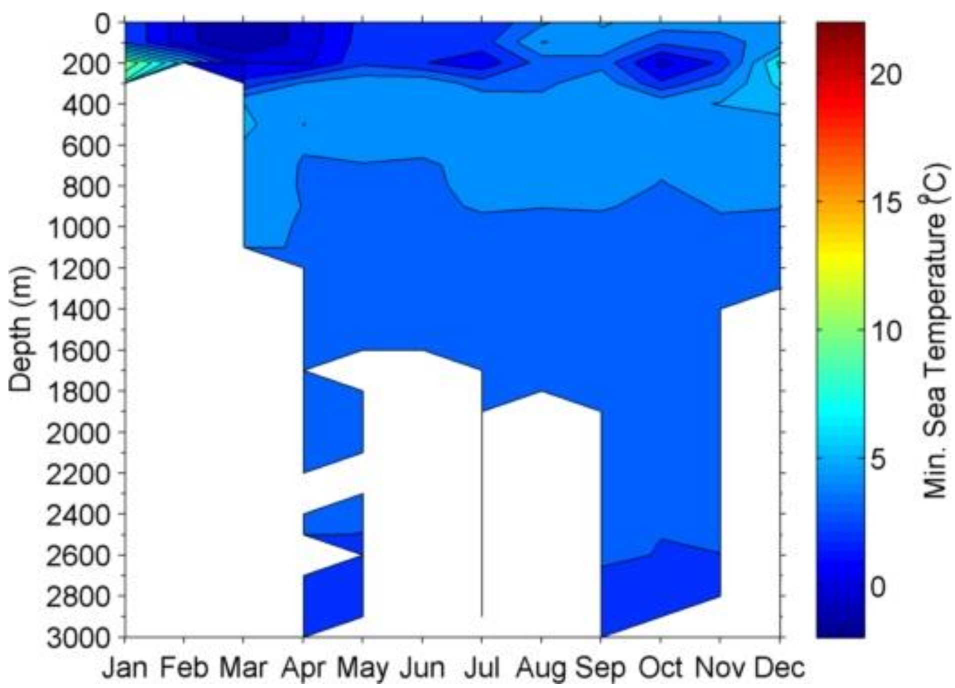


Figure 3-17: Monthly Minimum Sea Temperature

Source: DFO 2021c

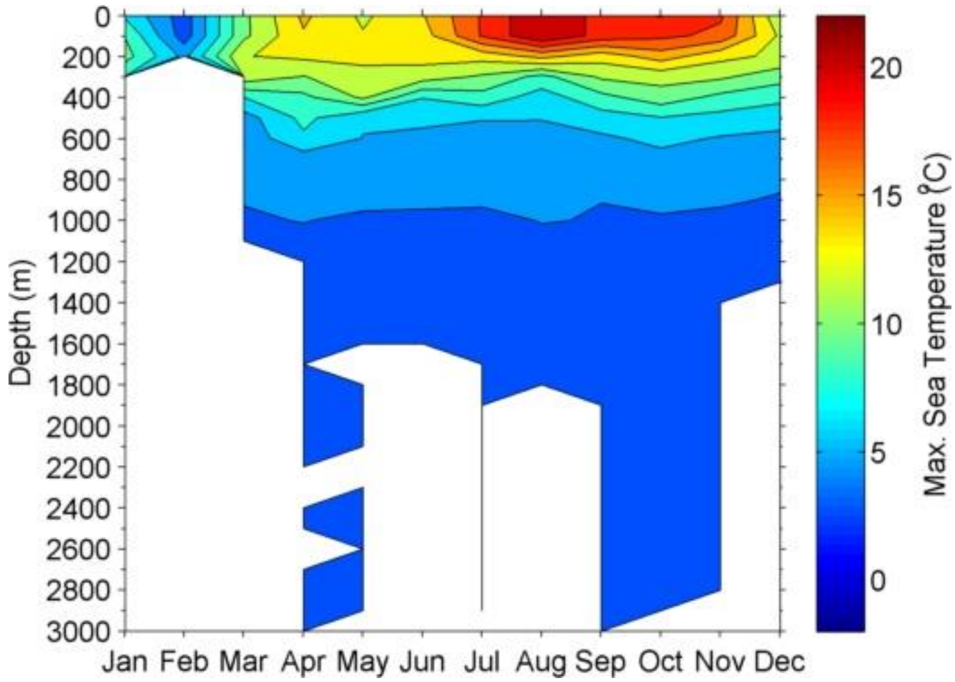


Figure 3-18: Monthly Maximum Sea Temperature

Source: DFO 2021c

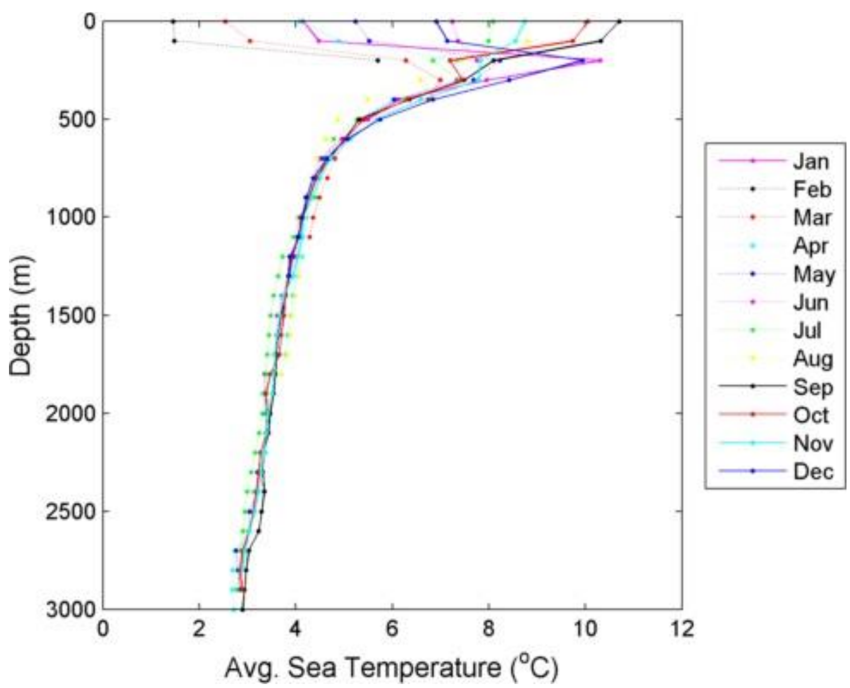


Figure 3-19: Depth Profile of Monthly Average Sea Temperature

Source: DFO 2021c

As a companion to the above sea temperature overview, Figure 3-20 to Figure 3-23 present monthly contours of average, minimum and maximum salinity and monthly depth profiles average salinity. Mean sea surface salinities are fairly uniform during the year ranging from a minimum of 32.1 The practical salinity unit (PSU) in February to a maximum of 32.9 PSU in April. At depths below about 200 m, salinity values are fairly uniform ranging from 34.7 to 35.1 PSU and averaging 34.9 PSU.

These temperature and salinity statistics represent conditions which might be encountered across the Study Area. Local seawater properties may exhibit some spatial variability (both across the Study Area and by depth) as well as temporal variability. In addition, not all months or depths are well-sampled over this large area. For example, the winter months are not well sampled below about 100 m, there are few, generally less than five samples per month for depths below 1,200 m, and summer months are better represented than winter months.

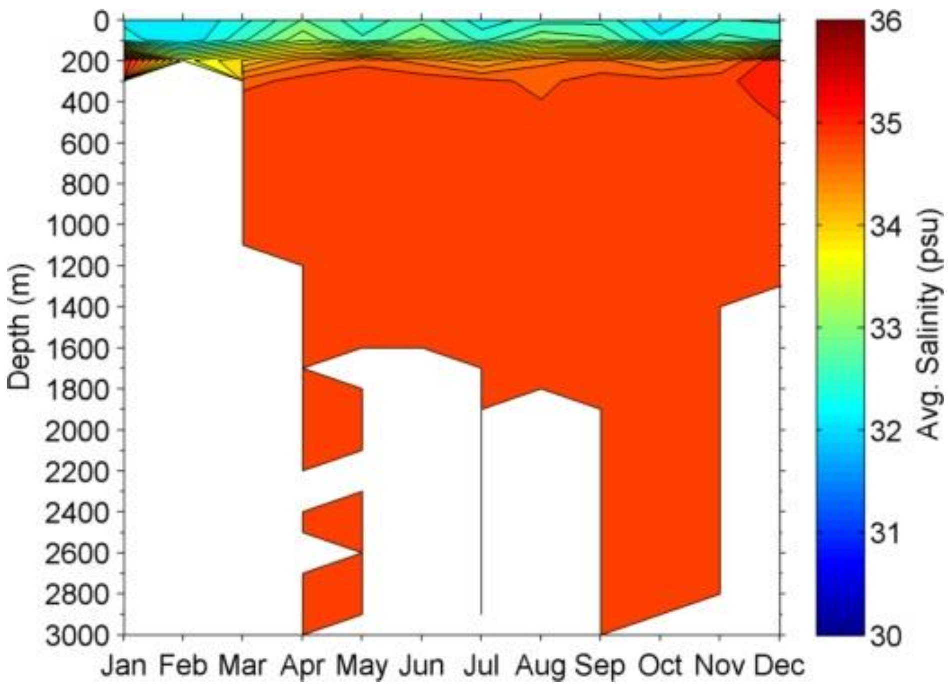


Figure 3-20: Monthly Average Salinity

Source: DFO 2021c

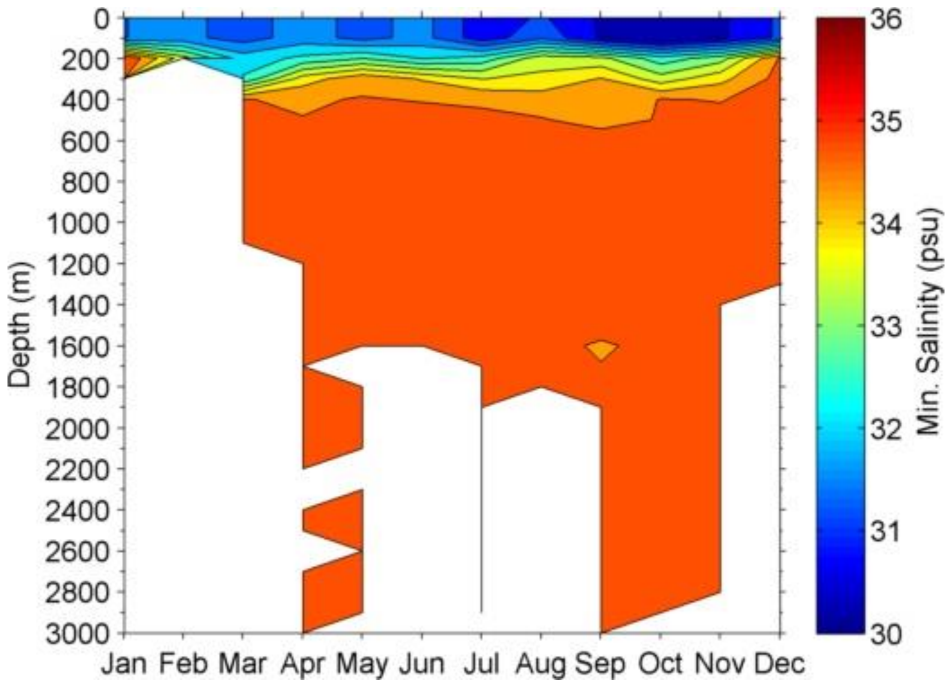


Figure 3-21: Monthly Minimum Salinity

Source: DFO 2021c

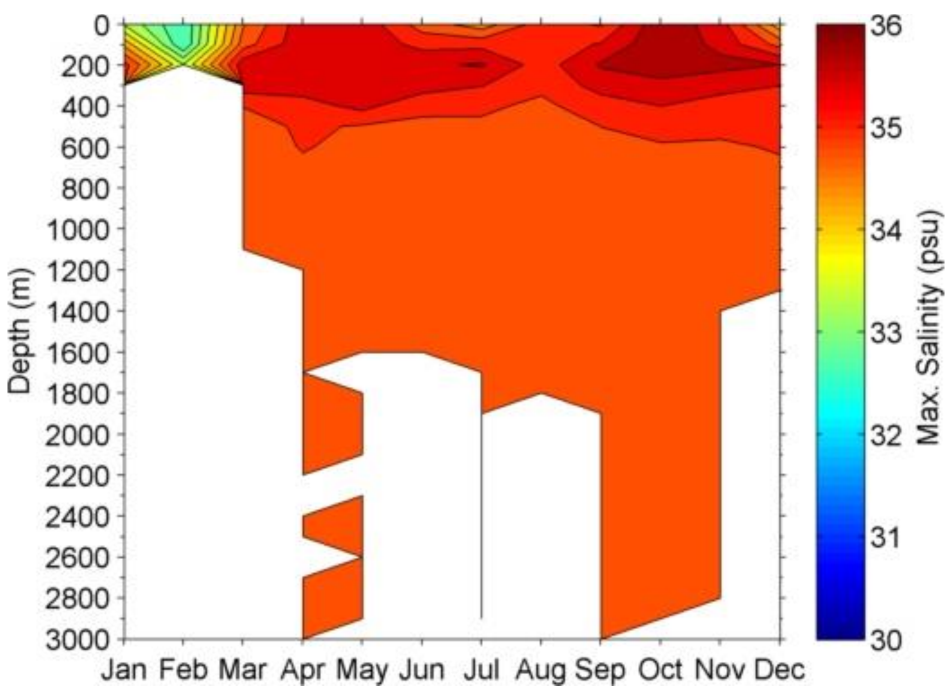


Figure 3-22: Monthly Maximum Salinity

Source: DFO 2021c

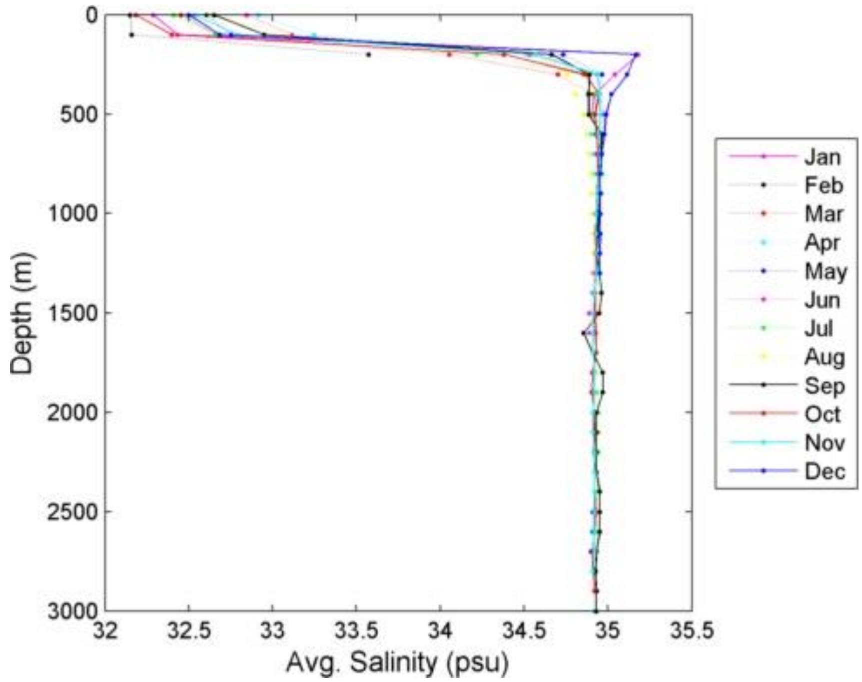


Figure 3-23: Depth Profile of Monthly Average Salinity

Source: DFO 2021c

3.1.5.4 Extreme Events

An illustration of extreme winds and waves over the Study Area is provided through extremal analysis of the full 1954 to 2018 MSC50 wind and wave hindcast record (Section 3.1.4). Estimates are derived from the Gumbel distribution.

Figure 3-24 shows 100-year return period maximum wind speeds on the order of 30 m/s over the Study Area. Maximum 100 year wave height is shown in Figure 3-25.

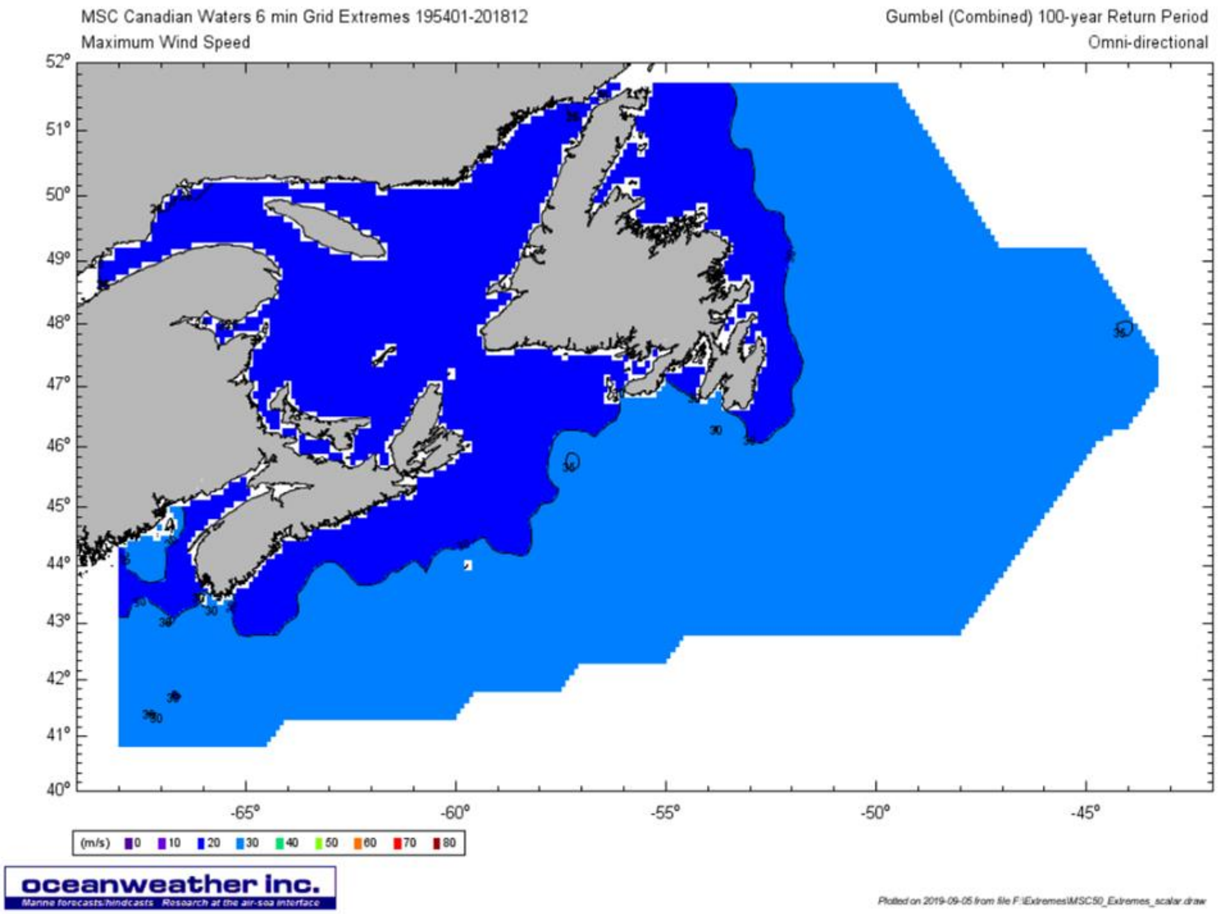


Figure 3-24: 100-Year Maximum Wind Speed

Source: Oceanweather, 2019

Figure 3-25 shows 100-year return period maximum wave height which range from about 20 to 26 m over the Study Area.

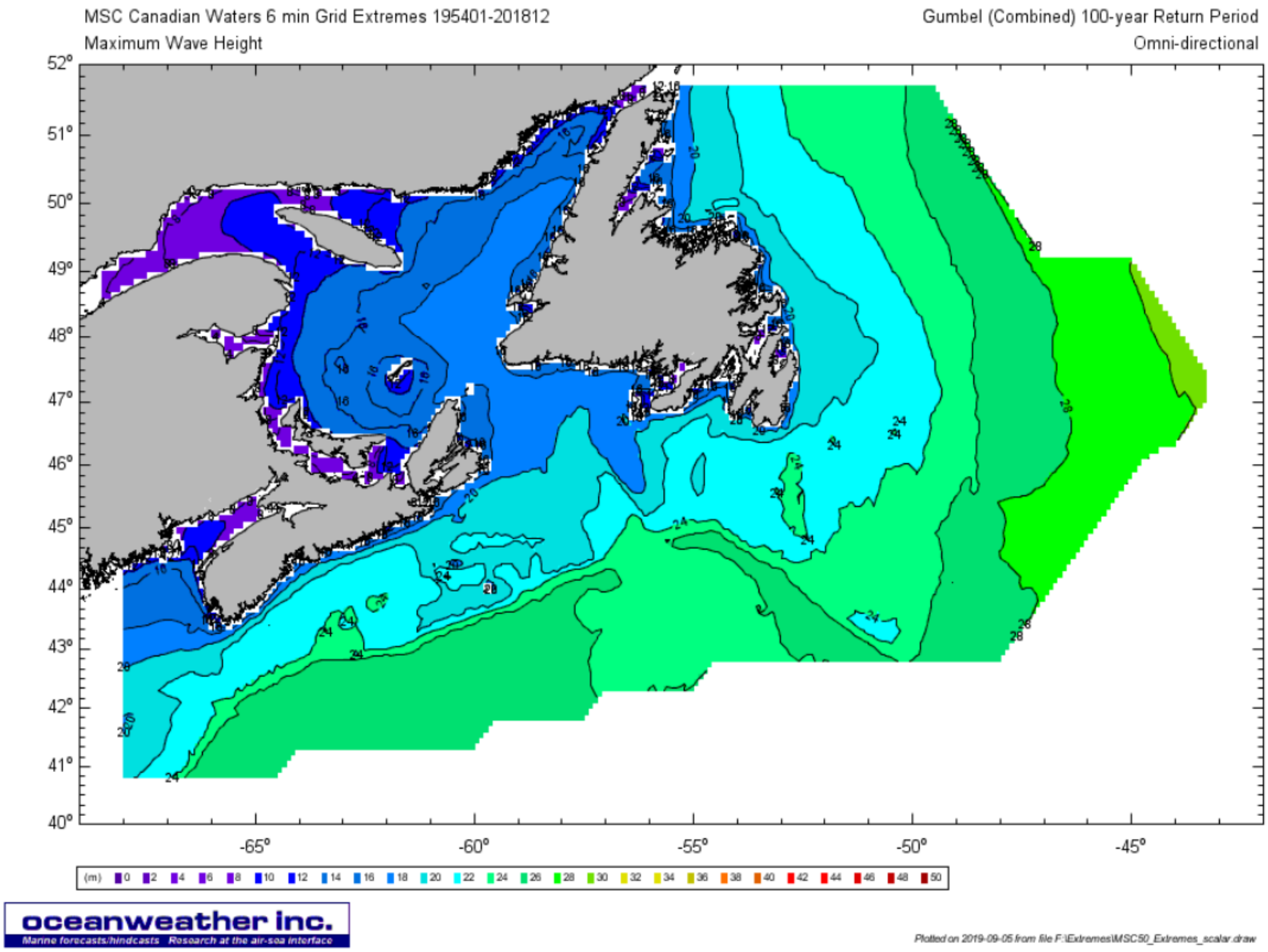


Figure 3-25: 100-Year Maximum Wave Height

Source: Oceanweather, 2019

Figure 3-26 shows 100-year return period peak wave period, Tp, associated with maximum wave height which range from about 14 to 18 s over the Study Area.

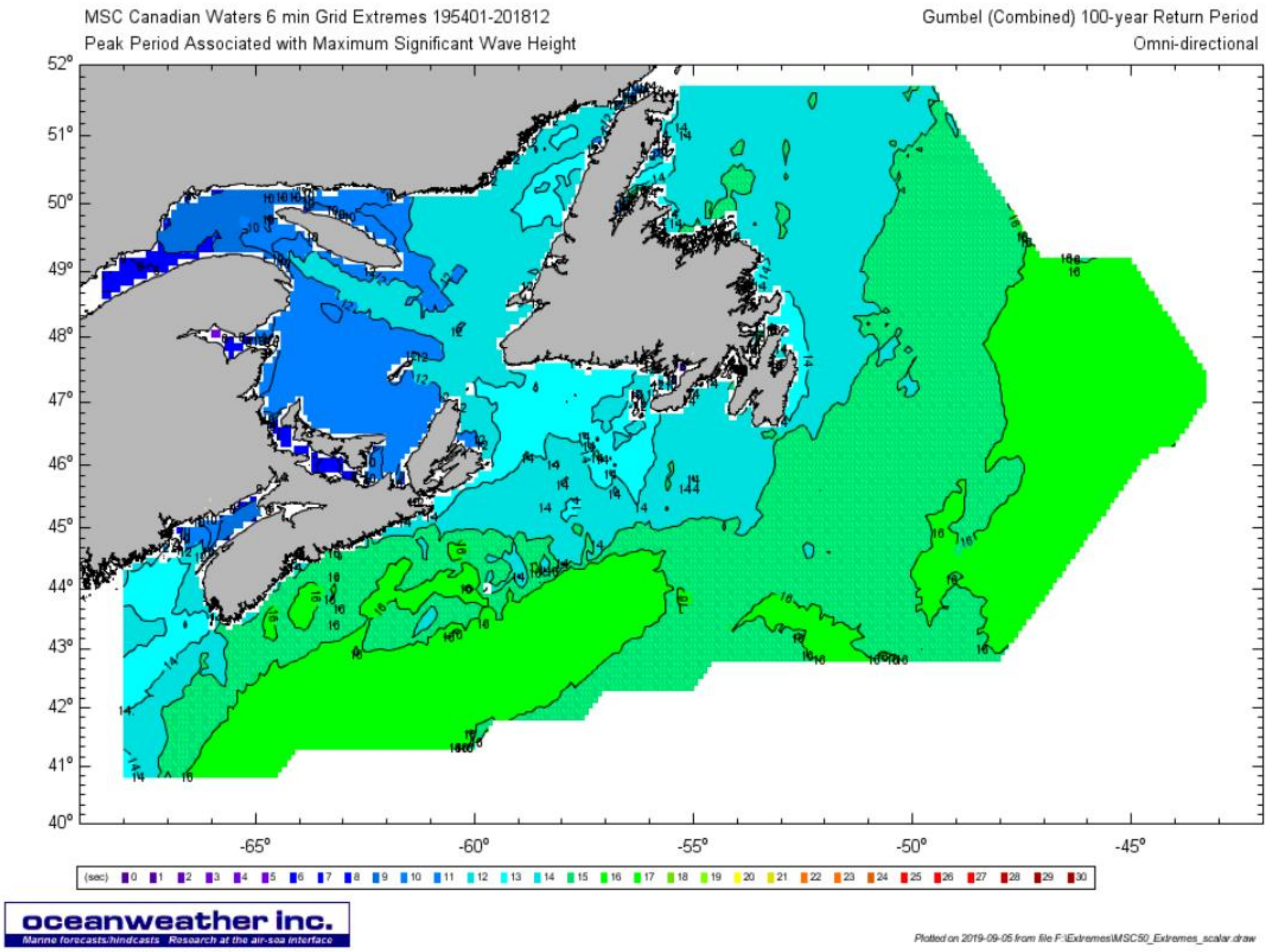


Figure 3-26: 100-Year Peak Wave Period associated with Maximum Significant Wave Height

Source: Oceanweather, 2019

3.1.6 Ice Conditions

Sea ice is produced when the surface layer of the ocean freezes, while icebergs occur when ice from glaciers that have extended to the coast break off and enter the ocean.

Knowledge and monitoring of sea ice and iceberg conditions is required for marine vessel navigation and ice management as part of offshore marine seismic survey activities and oil and gas exploration and development. Ice can pose a risk of damage to vessels as well as resulting in additional costs due to delays or downtime. Consideration of potential ice-structure interaction is an essential element of ship, drilling rig or platform design and selection. Several risks include bergy bits and growlers which may be difficult to detect, icebergs which due to their size or shape or the sea conditions at the time are difficult to tow or deflect, and hard, multi-year ice (expected to be less of a factor outside the northern regions of the Study Area).

3.1.6.1 Sea Ice

This section provides an illustration of the sea (or pack) ice conditions most likely to be encountered in Study Area. Information is drawn from the Sea Ice Climatic Atlas for the East Coast 1981-2010 (Canadian Ice Service, 2011). As noted in the Ice Atlas, variations in the extent of ice over East Coast waters are great due to both winds and temperatures being effective in changing the location of the ice edge. Large variability in sea ice conditions on the East Coast of Canada can therefore be experienced from year to year, and also in any given year on time scales of days to weeks and over comparatively small geographic scales of tens of kilometres.

The section that follows provides a summary overview of how frequent sea ice is present, its concentration when present, and its predominant ice type (and hence thickness) in the Study Area. The summary quantifies conditions over a typical ice season.

3.1.6.1.1 Frequency of Presence of Sea Ice

Frequency of Presence of Sea Ice charts show that historically sea ice encroaches on the Study Area from 1 to 15 percent of the time beginning the week of February 05 and lasts until the week of April 02 (CIS, 2011). The frequency of presence does not exceed 15 percent and only affects the northernmost portion of the Study Area (north of Sable Island). Figure 3-27 illustrates the frequency sea ice presence for the week of February 12, which historically has the greatest occurrence of sea ice.

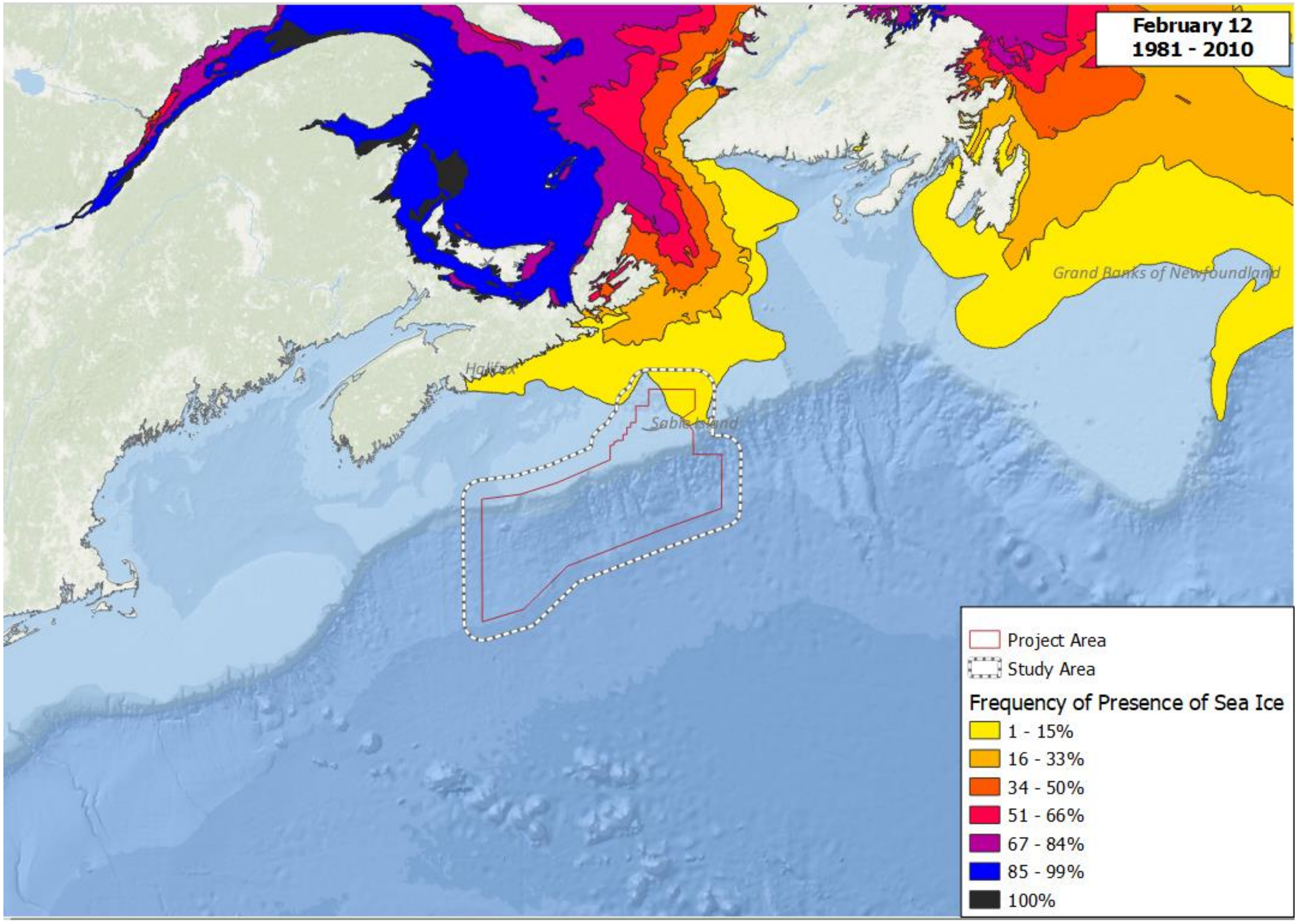


Figure 3-27: Frequency of Presence of Sea Ice (%), Week of Feb 12th 1981-2010

Source: CIS, 2011

3.1.6.1.2 Median Ice Concentration when Ice is Present

The median ice concentration when ice is present ranges from 1 to 3 tenths up to 9 to 9+ tenths, with concentrations of 1 to 3/10 and 4 to 6 tenths being the most common. A chart of median ice concentration for the period when the frequency of presence is greatest is provided in Figure 3-28.

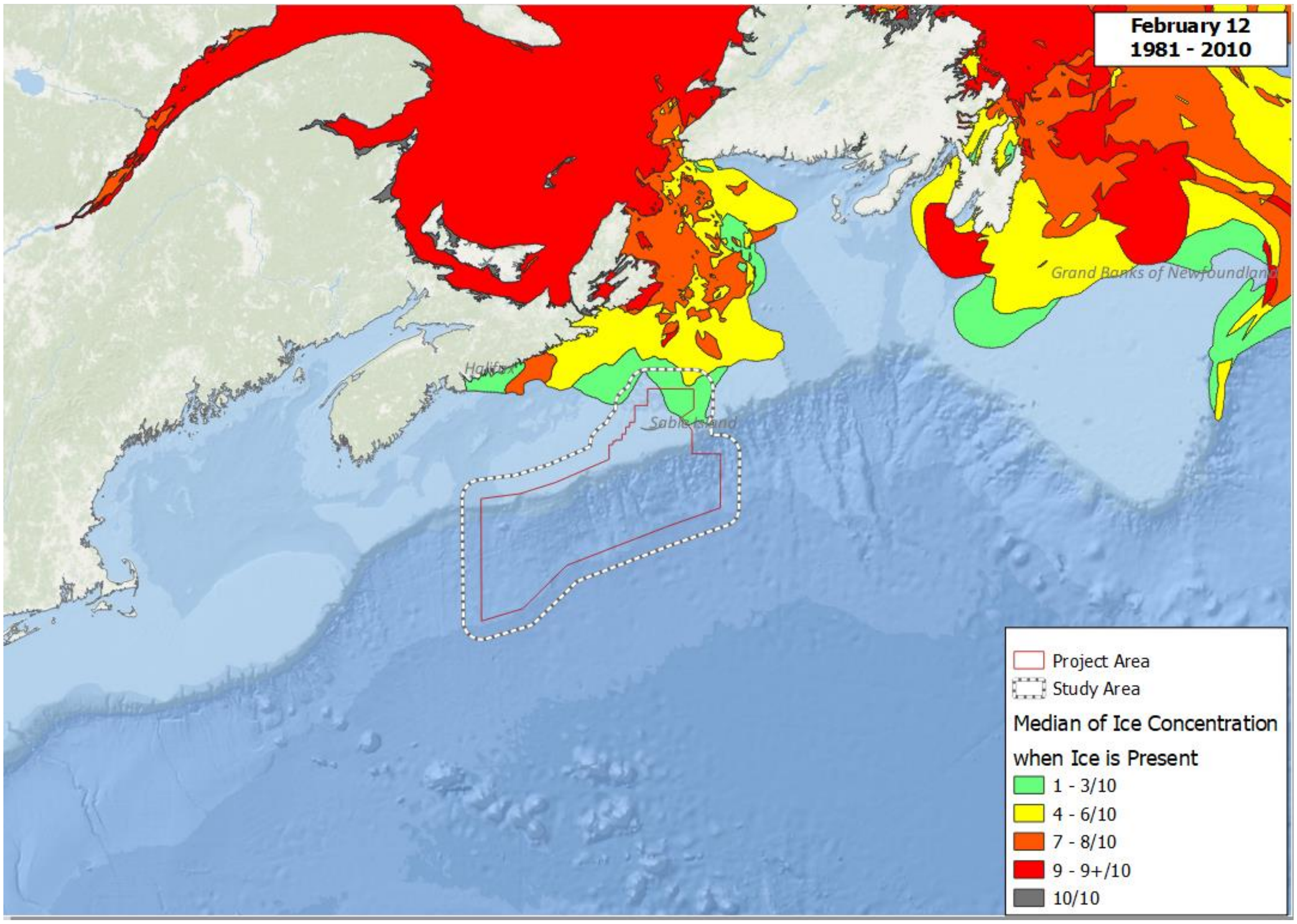


Figure 3-28: Median of Ice Concentration When Ice Is Present (Week of Feb 12th 1981-2010)

Source: CIS, 2011

3.1.6.2 Icebergs

The U.S Coast Guard IIP has monitored the number of icebergs north of 48°N since 1914 as part of its core purpose to promote safe navigation of the Northwest Atlantic Ocean when the danger of iceberg collision exists (International Ice Patrol, 1995). A subset of the Iceberg Sightings database from 1993 through 2019 was analyzed for this report and it was found that no iceberg sightings have been reported near the Study Area during this time. A map of all iceberg sightings within the IIP database from 1993 through 2019 is provided in Figure 3-29.

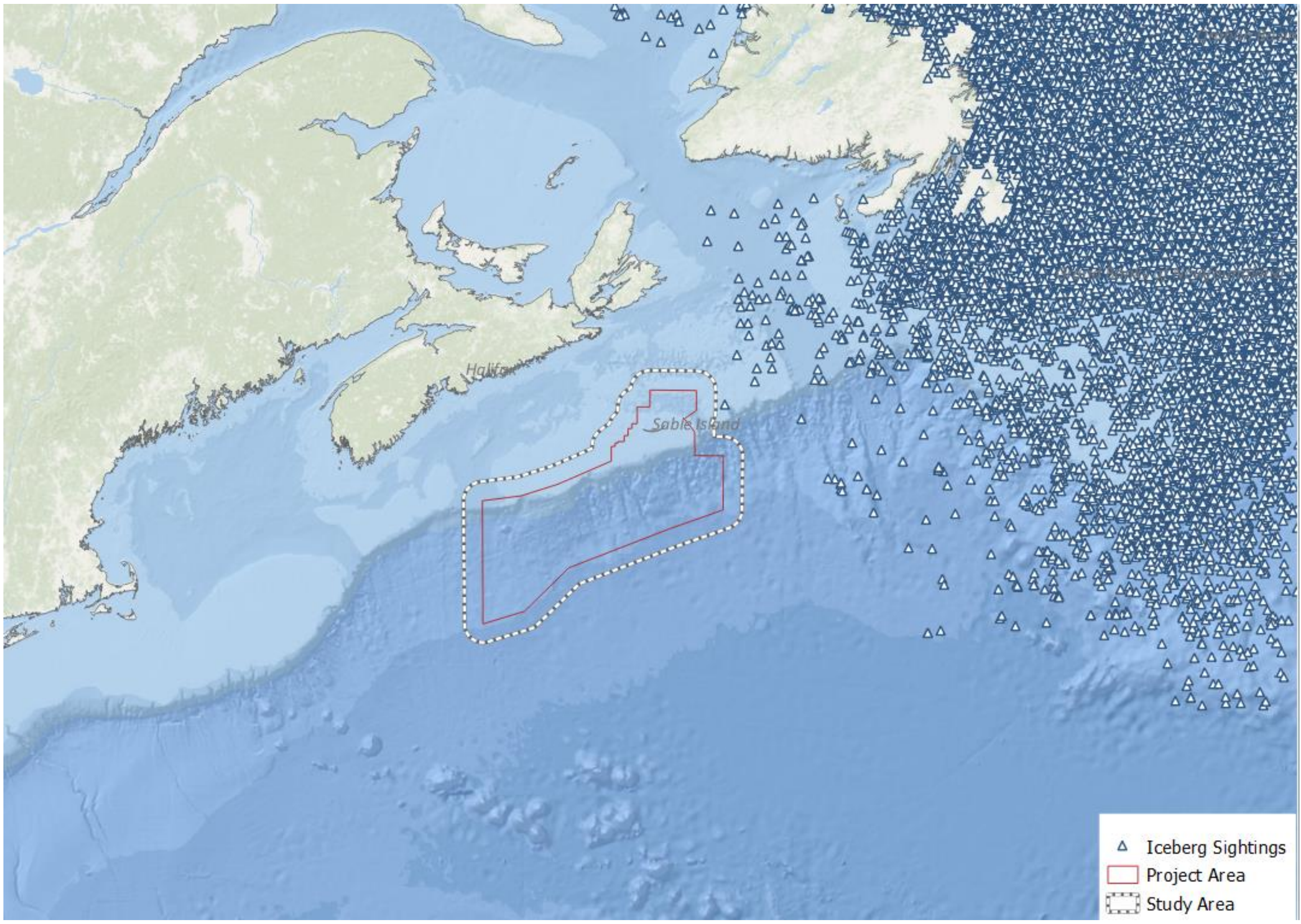


Figure 3-29: International Ice Patrol Iceberg Sightings Database (1993-2019)

Source: IIP, 1995 updated 2020

3.2 Biological Environment

The following sections present an overview of relevant aspects of the biological environment of the Study Area. Key elements of the Study Area's marine ecosystem range from primary producers such as phytoplankton to consumers such as zooplankton, benthic invertebrates and fish. The following subsections provide a discussion of relevant fish species, as well as plankton, algae, invertebrates, marine and migratory birds, marine mammals and sea turtles, and relevant components of their habitats. Special attention is paid to fish, marine invertebrates, marine / migratory birds, marine mammals and sea turtles because of their particular commercial and ecological importance. This section also includes a discussion of protected and special areas in the Study Area and the key species groups and habitats present in these areas.

All of the species groups discussed in this section interact to some degree, and many play key trophic roles in the ecosystem of the Study Area. Information on key species with Indigenous, fisheries and ecological importance is presented with focus on spatial distribution, geographic location, and timing of sensitive life history stages.

3.2.1 Key Information Sources

This section outlines existing and available datasets used to describe ecological and biological conditions in the Study Area. Availability of information for species of conservation concern and protected and special areas are discussed in Sections 8.1 and 8.2, respectively. Key information sources for the existing biological environment are presented in Table 3-9.

Table 3-9: Key Information Sources: Biological Environment

Topic	Sources
Ecosystem Overview	DFO World Wildlife Fund (WWF) Canada
Plankton	DFO Ocean Biogeographic Information System (OBIS)
Macroalgae and Plants	Research papers
Benthic Marine Invertebrates	DFO
Marine Fish	DFO Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
Marine and Migratory Birds	Atlas of Seabirds at Sea in Eastern Canada, 2006-2016 Atlantic Colonial Waterbird Database – Canadian Wildlife Service (CWS) Fifield et al. 2016 Birds Canada
Marine Mammals and Sea Turtles	OBIS DFO State of the World's Sea Turtle Project
Species of Conservation Concern	Federal Species-at-Risk Public Registry COSEWIC
Protected and Special Areas	Birds Canada CNSOPB COSEWIC ECCC CWS DFO Government of Canada Kenchington, et al. 2016 King, et al. 2016 Parks Canada SAR Public Registry

3.2.2 Ecosystem Overview

The offshore marine ecosystem is made up of species and habitats that are linked together through ecological relationships and processes (Zwanenburg et al. 2002, Bernier et al. 2018). In the Study Area, as with a majority of the continental shelf and open ocean, primary production is predominantly derived through phytoplankton. These tiny photosynthetic organisms form the base of the food chain, feeding energy to higher trophic levels (fish, marine mammals, and birds), through zooplankton, planktivorous fish and invertebrates (Boudreau 2013). Species which feed on dead organic material, (detritivores) then break down this material and permit nutrients from dead organisms to be recycled through the food web. Due to the interdependence of species and habitats, perturbations (such as overfishing, changing climatic conditions) can affect many elements of the ecosystem (Choi et al. 2005, Frank et al. 2007, Koen-Alonso et al. 2010, Bernier et al. 2018) through direct (direct mortality) and indirect (competition or changes in predation rates) means.

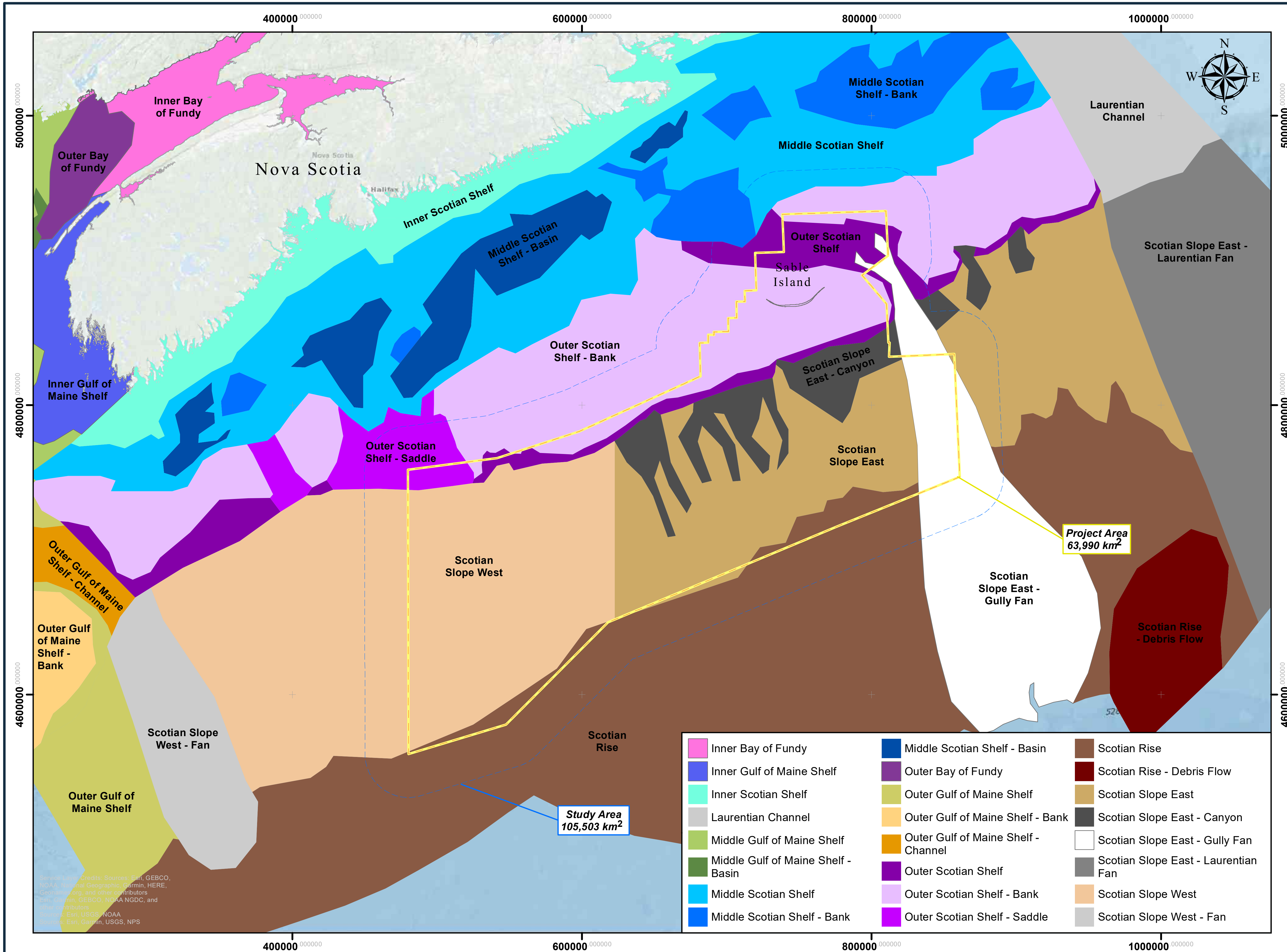
In the early 1990s, many of the east coast groundfish fisheries including that of the eastern, and to a lesser extent western, Scotian Shelf collapsed. This coincided with a shift to colder ocean waters beginning in the early 1980s (Zwanenburg et al. 2002). These changes caused a drastic ecosystem response that included increases in primary production and invertebrates (including shrimp and crab) and greatly reduced numbers of many long-lived groundfish species (Bundy 2005, Choi et al. 2005, Bernier et al. 2018). It was also associated with an increased abundance in cold-water fish species such as capelin and Greenland halibut (Zwanenburg et al. 2002). The collapse of groundfish stocks released some species such as shrimp from predation, further augmenting their abundance (Myers and Worm 2003). Benthic invertebrates such as shrimp, crab, and lobster are now key fisheries species. However, as water temperatures now rise across the region, cold-water species such as northern shrimp and snow crab are declining (Bernier et al. 2018). This ecosystem shift has had significant ecological, economic and social repercussions.

3.2.2.1 Marine Habitat

The Study Area encompasses marine areas from 100 to 4,300 m water depth and includes regions previously assessed for seabed features by WWF Canada and DFO. Main seabed features within the Study Area are depicted in Figure 3-30 and are characterized by shelf, slope, and canyon areas. The area is also a transition zone between subpolar waters from an extension of the Labrador Current and the warmer waters of the Gulf Stream (King et al. 2016, Bernier et al. 2018). Seabed features of the Outer Scotian Shelf region in northern portion of the Study Area include large banks covered in sand and gravel with lesser patches of shell beds and boulders. Sand ridges, waves, and ripples, formed by storms and currents occur in this area, with sand ridges recorded as high as 18 m (WWF Canada 2009, Eamer et al. 2021). Many invertebrate species inhabit this area with scallop, quahog, surf clams, and sand dollars mainly on fine sand substrate and mussels, brittlestars, lobster and toad crab on rocky substrates (WWF Canada 2009).

Along the slopes at greater than 200 m depth, water mixes promote conditions for abundant phytoplankton (WWF Canada 2009). This high productivity area therefore is an area of migration and aggregation for whales, porbeagles, Greenland sharks, swordfish, tuna, seabirds and leatherback turtles (WWF Canada 2009, King et al. 2016). From depths of 250-500 m on the slope, relict furrows and pits from previously grounded icebergs are wide spread and subject to erosion (Piper and Campbell 2002, WWF Canada 2009). This natural disturbance regime has been suggested to enhance biodiversity (WWF Canada 2009). A wide range of shallow-shelf to deepwater fish inhabit the slope including Atlantic halibut, cusk, redfish, white hake, thorny skate, longfin hake and Atlantic argentine (WWF Canada 2009, King et al. 2016). Narrow, deep and steep sided submarine canyons are distributed on the Scotian slope and act as channels for transport of sand (WWF Canada 2009). This includes the Logan, Bonnecamps, Dawson, and Verrill Canyons with heads and floors of the canyons covered in sand and walls comprised mainly of mudstone and sandstone with outcropping of boulders and cobbles (Stortini 2015). While less studied relative to other canyons in the region, it has been suggested that the area is important habitat for beaked whales and soft corals (Stortini 2015). As the physical characteristics (e.g., currents, sediment transport, substrate types) vary between canyons, the resulting benthic fauna may also differ among canyons in the region (Kenchington 2014). The diversity of habitat types in this area are home to a wide range of fish and invertebrate species (WWF Canada 2009). Deepwater squid that inhabit the canyons are an important food source for beaked whales, sperm whales, and northern bottlenose whales (WWF Canada 2009, Moors-Murphy 2014). Gorgonian corals are also typically found along deep areas of the canyon walls in areas of slow moving water (WWF Canada 2009). Beyond the slopes in southern parts of the Study Area is the Scotian Rise, with surficial substrates comprised mainly of deposited sand and mud from the continental shelf and slope (WWF Canada 2009). This area is characterised by high bacterial and feathery polychaete abundance, and presence of mud burrowing species such as bivalves and sea pens (WWF Canada 2009). Corals and sponges on the Scotian slope and rise are considered ecosystem engineers and providing structural complexity to areas (King et al. 2016, Bernier et al. 2018).

Within these marine habitats particular areas have been identified as special areas due to their ecological importance. These areas are further described in Section 3.2.10.



LEGEND:

Project Area

Study Area

KEYMAP

CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
SCOTIAN SHELF SEABED FEATURE CLASSES

PROJECT:
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 1	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 3-30

SCALE:
1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\TE211002_FIGURE_3_30_ScotianShelfSeabedFeatures.mxd User: candace.macdonald Date: 5/12/2022

3.2.3 Plankton

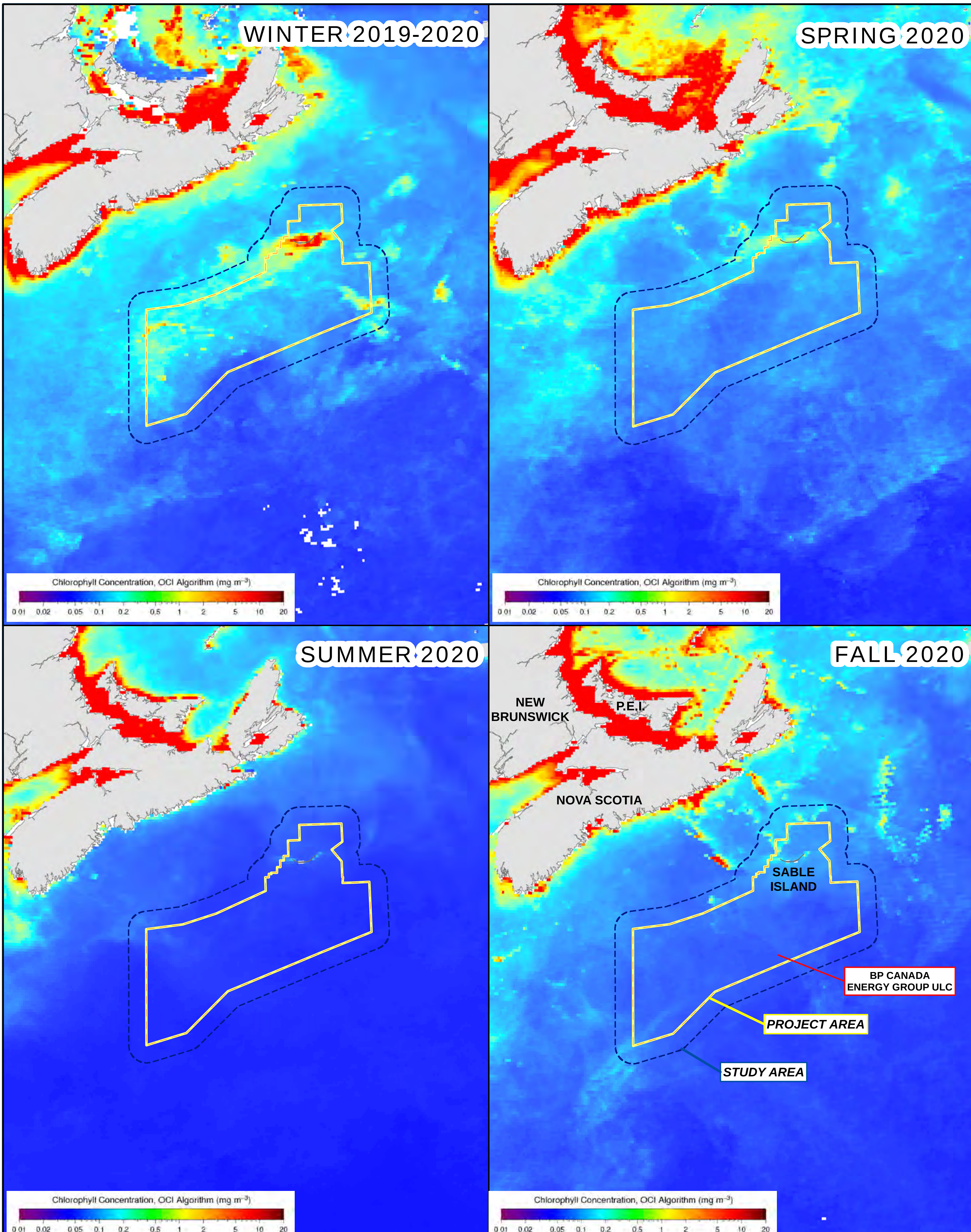
Plankton consists of small marine organisms that passively drift with ocean currents. Marine plankton play an important role in the environment as they serve as the base layers of most food webs (primary and secondary production). Plankton comprise the largest group of organisms in the ocean both in terms of diversity and biomass. Taxa in this group include microscopic marine plants (phytoplankton), invertebrates (zooplankton), vertebrate eggs and larvae (ichthyoplankton), bacteria, fungi, and even viruses.

3.2.3.1 Phytoplankton

Phytoplankton or microalgae consist of microscopic free-floating algae and cyanobacteria species. They are primary producers of oceanic ecosystems, using sunlight to produce energy (sugar) from carbon dioxide and water via photosynthesis. Their energy production forms the base of marine food webs as higher trophic levels depend on their production (Worcester and Parker 2010, Bernier et al. 2018). Phytoplankton are thought to be responsible for up to half of all global photosynthesis (Barsanti and Gualtieri 2006) and have a role in drawing carbon dioxide out of the atmosphere (Ross et al. 2017).

Types of phytoplankton occurring on the Scotian Shelf include diatoms, cyanobacteria, dinoflagellates and coccolithophores, euglenids and other single celled and colonial algae (Graham and Wilcox 2000). The distribution and abundance of phytoplankton in surface waters is strongly influenced by nutrient concentrations in the water column, sunlight availability, and physical oceanographic features of the shelf (Boudreau 2013, Stantec 2019). Annually, there is a distinctive cycle to phytoplankton abundance and extent responding to high concentration of nutrients, seasonal mixing patterns of marine waters, and sunlight in the water column resulting in widespread spring and fall blooms (Song et al. 2010, Boudreau 2013). Physical environmental changes from climate change may have implications on phytoplankton blooms and therefore have effects on the overall biological environment (Bernier et al. 2018). In general, the upwelling of the water column in spring, combined with increased sunlight availability is thought to cause a peak in phytoplankton production, known as the spring bloom. This creates an increased food supply mainly for herbivorous zooplankton, that are an important link between phytoplankton and larger organisms (Rivkin et al. 1996, Boudreau 2013, Bernier et al. 2018). Many fish and invertebrate species attempt to synchronize their annual reproductive cycles to take advantage of the increased biomass of phytoplankton (Platt et al. 1973, Cushing 1990). The spring bloom can persist for a few weeks until the key nutrients (nitrate, phosphate) are depleted in the surface waters. On the Scotian Shelf, blooms are typically dominated by diatoms, accounting for 95 percent of total phytoplankton abundance in 2019 surveys (Casault et al. 2020). Secondary producers (zooplankton) prey heavily on the phytoplankton, resulting in a mid-summer low in phytoplankton abundance. The development of thermally stratified water layers (thermocline) as summer progresses minimizes mixing of the water column, further reducing the nutrient supply to surface waters. After the bloom, large phytoplankton are reduced in abundance and the dominant zooplankton tend to be omnivores which prey on flagellates and ciliates (Rivkin et al. 1996). A smaller fall bloom often occurs with the advent of fall upwelling, though flagellates and dinoflagellates tend to dominate this later bloom. The magnitude, timing and duration of the blooms influence regional productivity variations of organisms dependent on lower trophic levels (Bernier et al. 2018).

Within the Scotian Shelf and Slope region the day of spring bloom initiation may vary by two months depending on location based on satellite-derived observations (Zhai et al. 2011). From January to April, the spring bloom was initiated first in the slope waters followed by the shelf and deeper waters approximately a month later (Zhai et al. 2011). Phytoplankton abundance, based on chlorophyll levels, had largely subsided by early May on the shelf, however it continued to increase in deeper waters (Zhai et al. 2011). Figure 3-31 shows the surficial chlorophyll levels by season in 2020 (NOAA 2020a). Over the last few decades, the spring blooms on the Scotian shelf have also occurred earlier with higher intensity (Worcester and Parker 2010, Boudreau 2013, Casault et al. 2020). Recent studies by (Ross et al. 2017) with electric gliders indicate that spring blooms on the Scotian Shelf may not be triggered by the re-stratification of the water column as there is a subsurface phytoplankton layer that persists throughout the summer. The phytoplankton layer is thinner (~15 m) and deeper (~30 m) during the summer months, and is relatively shallower (~10 m) and thicker (~40 m) during the late fall and winter (Ross et al. 2017). This research indicates that primary productivity of the area may be underestimated by the satellite-derived observations and subsurface observations are important for assessing changes to primary productivity (Ross et al. 2017). Recent trends observed for the Scotian Shelf based on the Atlantic Zone Monitoring Program (AZMP) indicate a decrease in nutrient levels that support phytoplankton abundance, combined with a community shift away from large phytoplankton cells towards smaller phytoplankton cells that may have implications for higher trophic levels (Casault et al. 2020).



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

SURFICIAL CHLOROPHYLL A LEVELS IN THE STUDY AREA

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:	FIGURE:
TE211002	**MAY 2022**	**FIGURE 3-31**
REV NO: **0**	DWN/CHK'D BY: **JA/JS**	SCALE: 1:6,000,000
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**	0 50 100 200 300 400 Kilometres

LEGEND:

Study Area

Project Area

3.2.3.2 Zooplankton

Zooplankton are small floating or swimming marine organisms that generally drift with the current. They are a key energy pathway between primary producers (phytoplankton) and species occupying higher trophic levels, such as fish, whales and seabirds (Breeze et al. 2002, Boudreau 2013). Changes to phytoplankton levels from environmental conditions (e.g., warm ocean temperatures from climate change) would have implications for zooplankton abundance (Bernier et al. 2018). Zooplankton communities includes holoplanktonic organisms which complete their life cycle within the plankton. Examples are amphipods, krill, ctenophores, larvaceans, some copepods, and salps. These are in contrast to meroplanktonic organisms, which spend only part of their lives as plankton. Examples include most larval forms of sea urchins, sea stars, crustaceans, marine worms, some marine snails, most fish, and some cnidarians. Zooplankton occur in a range of sizes. The microzooplankton (20-200 µm in length) includes ciliates and the eggs and larvae of larger taxa. Mesozooplankton are 0.2-2 mm in length and include copepods, Cladocerans; Ostracods; Chaetognaths, amphipods, larvaceans, pelagic molluscs, and larvae of benthic organisms such as echinoderms, molluscs, and crustaceans. The macrozooplankton are 2 mm to 20 cm long and include organisms such as krill, salps, and ctenophores. Finally, megaplankton are >20 cm long and include jellyfish, squid, and some salps (Stantec 2019). Many zooplankton species have been shown to migrate vertically on a daily basis, in order to minimize their predation risk. Individuals move to surface waters at night to feed on light-dependent phytoplankton and return to greater depths during the day to avoid visual predators (Dalley and Anderson 1998). This is the largest animal migration on the planet and plays an important role in global carbon cycling (Boyd et al. 2019).

The mesozooplankton community on the Scotian Shelf and Slope is dominated by copepods, with *Calanus finmarchicus* and *Pseudocalanus* spp. as two key species representing broad groups of similar life histories (Boudreau 2013, Bernier et al. 2018). *Calanus finmarchicus* is typically the dominant species in copepod communities and is an important and rich food source for pelagic fish due to their large energy reserves (Bernier et al. 2018). *Pseudocalanus* spp. is a smaller species with relatively lower energy reserves that is widely distributed in Atlantic areas and has a life history representative of smaller copepod species (Bernier et al. 2018). In general, zooplankton abundance is tied to phytoplankton abundance with higher abundances in April, and lowest concentrations from January to February (Casault et al. 2020). The life cycle of *C. finmarchicus* involves reproduction and development in surface waters in the spring and summer before overwintering in deeper waters (Sören Häfker et al. 2018, Krumhansl et al. 2018). On the Scotian Slope, this copepod species forms dense aggregations at depths of >400 m (Head and Pepin 2007).

Krill are the dominant macrozooplankton on the Scotian Shelf that are a key food source for fish, seabirds, and whales (Cochrane 2000, WWF Canada 2009, Boudreau 2013, Hawkes et al. 2019). This species is mainly distributed from 100-300 m and as with other zooplankton, play an important role in transferring energy from phytoplankton to higher trophic levels (Zwanenburg et al. 2006). Combined with *C. finmarchicus,* these species make up the largest proportion of zooplankton biomass (Boudreau 2013). Areas of high krill and copepod abundance have been considered in establishment of special areas in the region. See Section 3.2.10 for further details on protected and special areas.

Food abundance (e.g., phytoplankton) and environmental variables (e.g., temperature) are important variables that influence zooplankton abundance on the Scotian Shelf (Boudreau 2013). Zooplankton community composition may also be affected by large scale processes including shifts in water mass boundaries (Ruckdeschel et al. 2020, Casault et al. 2020). Trends since 2010 for the Scotian Shelf indicate a shift to from energy rich *C. finmarchicus* towards more small and warm-water copepods, and other zooplankton species (Boudreau 2013, Bernier et al. 2018, Casault et al. 2020).

3.2.3.3 Microbial Communities

Bacterial communities play critical roles in primary and secondary productivity, and regulating nutrient cycles (dissolved organic matter, nitrogen fixation, remineralisation) (Boudreau 2013, Zorz et al. 2019). Recent studies have shown that bacterioplankton play a larger role than was once thought; including in the seasonal progression of spring blooms (Bolaños et al. 2020). In addition, cells <20-µm diameter (i.e., micro-phytoplankton) were main contributors to phytoplankton biomass in some areas during non-bloom times in the western north Atlantic (Bolaños et al. 2020).

Bacteria may be categorized by their energy source. Photoautotrophic bacteria and photoheterotrophic bacteria use light as their primary or alternate energy sources, respectively (Stantec 2019). Other bacteria in the microbial community are heterotrophic or secondary producers that consume organic material such as phytoplankton as an energy source (Stantec 2019). While the direct contribution of microbial communities as a food source to higher trophic levels (e.g., adult fish) is small, they may function as food for zooplankton and ichthyoplankton (Mousseau et al. 1998, Boudreau 2013).

Sampling of microbial communities on the Scotian Shelf and Slope indicate different communities within specific areas of the water column (Zorz et al. 2019). Characteristic surface communities included Cyanobacteria (photoautotrophic) and bacteria associated with phytoplankton. Below the photic zone, Deltaproteobacteria (includes iron-reducing and sulphate-reducing), Acidobacteria (includes nitrogen fixers), and select Pelagibacteracea were observed (Zorz et al. 2019). Bacterial communities also differed seasonally among on-shelf and off-shelf waters with the highest species richness observed at the shelf break where slope and shelf water masses meet (Zorz et al. 2019).

3.2.3.4 Ichthyoplankton

Many marine fish species utilize a reproductive strategy known as broadcast spawning, in which the fish release their eggs and sperm into the water column to be fertilized (Chambers 1997, Scott and Scott 1988). The eggs then passively disperse in the water column as they develop and hatch into larvae. The larvae then generally drift in the current as they develop into juvenile fish. These floating fish eggs and larvae are referred to as ichthyoplankton and can have considerable importance to local fisheries, both as a source of new fish and as a food supply for larger organisms. On the Scotian Shelf, at least 147 species, representing 91 genera were reported in ichthyoplankton samples collected as part of the Scotian Shelf Ichthyoplankton Survey (SSIP) (Shackell and Frank 2000). The species within ichthyoplankton assemblages vary depending on season and location (Frank et al. 1992, Dalley and Anderson 1998, Bradbury et al. 2008), as well as hydrographic and physical oceanographic features (e.g., Frank and Leggett 1983, Cowen et al. 1993, Moser and Smith 1993). Research on larval fish production on Sable Island Bank indicate that ichthyoplankton can be partially supported by the microbial food web and may not be entirely dependent on spring and fall blooms. Both calanoid and cyclopoid copepods, which are important larval prey, are known to be able to prey on members of the microbial food web (Mousseau et al. 1998).

Shackell and Frank (2000), using data from the SSIP from 1978-82, described ichthyoplankton communities on the Scotian Shelf as dominated by redfish, hakes (longfin, silver, red, and white), witch flounder, sand lance, and fourbeard rockling. Other fish larvae that were regularly captured in tows included commercial species such as

Atlantic cod, American plaice, haddock, Atlantic herring, monkfish and Atlantic mackerel. SAR such as northern, striped, and spotted wolffish were also reported. Additional data on distribution of ichthyoplankton on the Scotian Shelf are available, however datasets for ichthyoplankton over the Scotian Slopes and Rise are limited (Stewart et al. 2003, Stewart and Branton 2004, Ocean Biodiversity Information System 2018). Of the records within the Study Area, main occurrences were for Atlantic cod, redfish, winter flounder, haddock, silver hake (Ocean Biodiversity Information System 2018). Table 3-10 provides details on early life history stages for species likely to occur in the Study Area and provides an indication of timing of sensitive life stages.

Table 3-10: Key Reproductive Times and Areas for Fish Species Likely to Occur in the Study Area

Common Name	Scientific Name	Phase	J	F	M	A	M	J	J	A	S	O	N	D	Key Areas
Species at Risk															
American eel	*Anguilla rostrata*	Eggs		P	P	P									Spawns in the Sargasso Sea, eggs and larvae may drift through Study Area
		Larvae	P	P	P	P	P	P	P	P	P	P	P	P	
American plaice	*Hippoglossoides platessoides*	Eggs				P	P	P							Banquereau Bank, Western Bank, and Browns Bank
		Larvae				P	P	P	P						
Atlantic bluefin tuna	*Thunnus thynnus*	Eggs					P	P							No spawning in Study Area. Spawns in the Gulf of Mexico or Mediterranean
		Larvae					P	P	P						
Atlantic cod	*Gadus morhua*	Eggs				P	P	P	P	P					Throughout Study Area, higher densities on Browns Bank and similar banks
		Larvae					P	P	P	P	P				
Atlantic salmon	*Salmo salar*	Eggs	B	B	B	B							B	B	Spawning, eggs, and larvae are in freshwater
		Larvae				P	P	P							
Atlantic wolffish	*Anarhichas lupus*	Eggs									B	B			Rocky inshore areas, little known about deeper water spawning
		Larvae											P	P	
Basking shark	*Cetorhinus maximus*	Eggs													Ovoviviparous. Details on reproduction are poorly known. Mating area within the Emerald Basin and the Scotian Gulf EBSA.
		Larvae								P	P				
Cusk	*Brosme*	Eggs					P	P	P	P					Spawns throughout the Study Area, may aggregate on slopes and banks, no distinct areas known
		Larvae					P	P	P	P	P				
Lumpfish	*Cyclopterus lumpus*	Eggs					B	B	B						Reproduces in inshore rocky areas, but may also in offshore areas
		Larvae						P	P	P	P				
Northern wolffish	*Anarhichas denticulatus*	Eggs	B	B										B	Spawning areas not known, but may occur in the Study Area
		Larvae	P	P	P	P									
Redfish (Acadian and deepwater)	*Sebastes fasciatus / S. mentella*	Eggs													Viviparous. Spawning occurs throughout Study Area
		Larvae					P	P	P	P	P				
Porbeagle	*Lamna nasus*	Eggs													Viviparous. Gulf of St Lawrence entrance, Georges Bank, pupping in Sargasso Sea.
		YOY							P	P	P				

Common Name	Scientific Name	Phase	J	F	M	A	M	J	J	A	S	O	N	D	Key Areas
															Potential nursery area in the Emerald Basin and the Scotian Gulf EBSA.
Roundnose grenadier	*Coryphaenoides rupestris*	Eggs	P	P	P	P	P	P	P	P	P	P	P	P	Potentially on Scotian Slope
		Larvae	P	P	P	P	P	P	P	P	P	P	P	P	
Shortfin mako	*Isurus oxyrinchus*	Eggs													Viviparous. Unlikely to spawn in Study Area
		Birth		P	P	P	P	P							
Smooth skate	*Malacoraja senta*	Eggs	B	B	B	B	B	B	B	B	B	B	B	B	Larval development in egg case. Throughout Study Area
		Larvae													
Spiny dogfish	*Squalus acanthias*	Eggs													Viviparous. Thought to spawn in deep, warm waters off continental shelf
		Birth	D	D	D										
Spotted wolffish	*Anarhichas minor*	Eggs						B	B	B					Spawning and egg laying areas not known
		Larvae							P	P	P				
Thorny skate	*Amblyraja radiata*	Eggs	B	B	B	B	B	B	B	B	B	B	B	B	Larval development in egg case. Throughout area, bank edges and slopes
		Larvae													
White hake	*Urophycis tenuis*	Eggs						P	P	P	P				Throughout Study Area on banks and shelf edge, including Sable Island Bank
		Larvae						P	P	P	P	P			
White shark	*Carcharodon carcharias*	YOY						P	P	P					Ovoviviparous. Spawning and pupping are outside Study Area, not well known
		Juven.	P	P				P	P	P	P	P	P	P	
Winter skate	*Leucoraja ocellata*	Eggs						B	B	B	B	B	B		Larval development in egg case. Likely on banks, potentially in Study Area
		Larvae													
Other finfish species															
Atlantic hagfish	*Myxine glutinosa*	Eggs	B	B	B	B	B	B	B	B	B	B	B	B	Likely direct development. Thought to spawn in deeper waters over mud
		Larvae													
Atlantic halibut	*Hippoglossus*	Eggs	P	P									P	P	Scotian Slope at depths around 800-1000m
		Larvae	P	P	P	P	P	P	P					P	
Atlantic herring	*Clupea harengus*	Eggs				B	B	B		B	B	B			Either spring or fall spawning populations, inshore areas and banks, Minas Basin
		Larvae	P	P			P	P	P	P	P	P	P	P	
Atlantic mackerel	*Scomber scombrus*	Eggs						P	P	P					Southern Gulf of St Lawrence, shallow portions of the Scotian Shelf (banks)
		Larvae						P	P	P	P	P	P		
Bigeye tuna	*Thunnus obesus*	Eggs				P	P	P	P	P	P				

Common Name	Scientific Name	Phase	J	F	M	A	M	J	J	A	S	O	N	D	Key Areas
		YOY				D	D	D	D	D	D	D	D		Not likely to spawn in Study Area, tropical or subtropical areas
Black dogfish	*Centroscyllium fabricii*	Eggs													Ovoviviparous. Thought to give birth year-round, little known about areas
		YOY	D	D	D	D	D	D	D	D	D	D	D	D	
Blue shark	*Prionace glauca*	Eggs													Viviparous. Unlikely to spawn or pup in Study Area
		Birth						P	P	P					
Capelin	*Mallotus villosus*	Eggs						B	B	B	B				Eastern Scotian Shelf, inshore or in shallow water
		Larvae						P	P	P	P	P			
Greenland halibut	*Reinhardtius hippoglossoides*	Eggs	P	P	P	P								P	No known spawning grounds on Scotian Shelf
		Larvae	P	P	P	P	P	P	P	P	P				
Haddock	*Melanogrammus aeglefinus*	Eggs		P	P	P	P								Offshore banks, typically from 50 to 150 m deep
		Larvae			P	P	P	P							
Monkfish	*Lophius americanus*	Eggs			P	P	P	P	P	P					Likely on banks and along shelf edge
		Larvae				P	P	P	P	P	P				
Northern Sand lance	*Ammodytes dubius*	Eggs	B	B									B	B	Spawn on sandy or fine gravel banks
		Larvae	P	P	P	P	P	P	P						
Pollock	*Pollachius virens*	Eggs	P	P									P	P	Spawn in inshore waters and on shallow banks
		Larvae	P	P	P	P								P	
Red hake	*Urophycis chuss*	Eggs					P	P	P	P					Likely spawn on shallow banks
		Larvae						P	P	P	P	P			
Roughhead grenadier	*Macrourus berglax*	Eggs	P	P	P	P	P	P	P	P	P	P	P	P	Likely in deep waters of Scotian Slope
		Larvae	P	P	P	P	P	P	P	P	P	P	P	P	
Silver hake	*Merluccius bilinearis*	Eggs						P	P	P	P				Banks and slopes throughout the Scotian Shelf, possibly shelf edge
		Larvae						P	P	P	P	P	P	P	
Swordfish	*Xiphias gladius*	Eggs	P	P	P	P	P	P	P	P	P	P			Not in Study Area, northwest Atlantic individuals may spawn in Sargasso Sea
		Larvae	P	P	P	P	P	P	P	P	P	P	P		
Witch flounder	*Glyptocephalus cynoglossus*	Eggs	P	P	P										Spawning is in deep waters or in channels, possibly in Study Area
		Larvae	P	P	P	P	P	P	P	P	P	P	P	P	
Yellowfin tuna	*Thunnus albacares*	Eggs					P	P	P	P	P				Not likely to spawn in Study Area, tropical or subtropical areas
		Larvae					P	P	P	P	P	P	P		
		Eggs						P	P	P					

Common Name	**Scientific Name**	**Phase**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Key Areas**
Yellowtail flounder	*Limanda ferruginea*	Larvae						P	P	P	P				Nearshore and on shallow banks, possibly in the Study Area
Notes: D – Demersal, B – Benthic, P – Pelagic															

Sources: Scott 1980, Methven 1983, Ware and Lambert 1985, Scott and Scott 1988, Frank et al. 1989, Hurley and Campana 1989, Bradford and Iles 1992, Frank et al. 1996, Rabe 1999, Rideout et al. 1999, Jakobsdóttir 2001, Rabe and Brown 2001, Reis et al. 2005, Grant 2006, COSEWIC 2008, COSEWIC 2009a, COSEWIC 2009b, COSEWIC 2010a, COSEWIC 2010b, COSEWIC 2010c, COSEWIC 2010d, COSEWIC 2011a, COSEWIC 2012a, COSEWIC 2012b, COSEWIC 2012c, COSEWIC 2012d, COSEWIC 2012e, COSEWIC 2012f, COSEWIC 2012g, Armsworthy et al. 2014, COSEWIC 2014a, Vandeperre et al. 2014, COSEWIC 2015, COSEWIC 2016, Garabana 2016, COSEWIC 2017, McBride et al. 2017, Coad and Reist 2018, Siemann et al. 2018, COSEWIC 2019a, Bastien et al. 2020, Froese and Pauly 2020, Mbaye et al. 2020

3.2.4 Macroalgae and Plants

Macroalgae (e.g., brown, green, red) and sea grasses function to enhance productivity and provide habitat and refuge areas to marine organisms in coastal waters (Teagle et al. 2017). Macroalgal community composition and density changes with depth. Macroalgal density and composition typically changes with depth, associated with changes in substrate, nutrients, salinity, temperature, and light levels (Teagle et al. 2017). Sunlight is a key factor on the growth and survival of macroalgae and seagrasses, therefore plant and algal distribution is generally limited to photic zones of <50 m (Amec 2014, Mathieson and Dawes 2020). However, macroalgae have been suggested to provide detrital subsidies to deeper waters, with dislodged and drifted algae observed up to 140 m depth on the Scotian Shelf (Filbee-Dexter and Scheibling 2016). Masses of *Sargassum*, a floating brown macroalgae, also occasionally occurs on the edge of the Scotian Shelf from the Gulf Stream (WWF Canada 2009). The Study Area ranges from 100 to 4,300 m and the majority of the area is generally too deep to support growth of macroalgae and sea grasses. Seaweed and macroalgae likely occur in waters surrounding Sable Island (Little 2017), the shallowest waters within the Study Area, with community composition likely similar to the coast of mainland Nova Scotia due to the proximity.

3.2.5 Benthic Marine Invertebrates

Marine invertebrates are comprised of a very diverse group of organisms, which live on or near the sea floor (benthic species) or may be pelagic and occur throughout the water column. Benthic species include those which live within the sea floor (infauna, e.g., worms and clams) and epifauna, or species which live on the sea floor (e.g., lobsters and whelks). Pelagic species include small zooplankton species, as well as larger more mobile species such as squid. Marine Invertebrates have key roles in ocean ecosystems including enhancing habitat complexity, influencing nutrient cycling and biochemical processes, and are a critical component of the benthic food web (Kenchington 2014, Beazley and Kenchington 2015, Murillo et al. 2016). As corals and sponges provide biogenic habitat and areas have been specifically delineated for protection of these species, they are described separately (See Section 3.2.5.1). Key taxa identified for the Scotian Shelf and Slope region include echinoderms (e.g., sand dollar, sea cucumber), crustaceans (e.g., snow crab, shrimp), cephalopods (e.g., squid) and bivalves (e.g., scallop) for their roles as ecosystem engineers, commercial species, or prey species (Tremblay et al. 2007, Kenchington 2014, Ward-Paige and Bundy 2016, DFO 2020r). Further information on the habitat and distribution and key reproductive times of these species is presented in Table 3-11 and Table 3-12.

Marine benthic invertebrate biodiversity hotspots have been assessed for the Scotian Shelf within the survey footprint for various DFO research trawls (Ford and Serdynska 2013, Ward-Paige and Bundy 2016, Bundy et al. 2017). Within the Study Area, areas around Sable Island and patchy areas along the shelf edge had high invertebrate biodiversity (Ford and Serdynska 2013, Ward-Paige and Bundy 2016). Bundy et al. (2017) identified areas of high biomass for fish and invertebrate functional groups. Small benthivores (e.g., northern shrimp, striped shrimp), medium benthivores (e.g., snow crab, American lobster), filter feeding invertebrates (e.g. sea scallop, Russian hat sponge) and detritivores (e.g., sea cucumber) had higher biomass in shelf areas around Sable Island (Bundy et al. 2017). Patchy areas of the shelf edge had higher biomass for medium benthivores and filter feeding invertebrates (Bundy et al. 2017).

Benthic invertebrate composition and densities may vary among canyons as due to the varied microhabitats from differing physical characteristics of each canyon (Kenchington 2014). However, information from surrounding canyons may provide an indication of species assemblages in the Study Area. Surveys of benthic invertebrates in The Gully Marine Protected Area (MPA) indicate sandy areas on adjacent banks from 50-300 m water depth are dominated by echinoderms (e.g., sand dollars, brittlestars) (Hargrave et al. 2004). Upper areas of The Gully (130-410 m) with glaciomarine deposits and bedrock microhabitats are dominated by anemones, sponges and soft corals (Hargrave et al. 2004). Benthic invertebrate diversity and biomass decreased with depth in areas greater than 500 m water depth. In areas of lower hard substrate, deep-water brittle stars, hard and soft coral, and sea anemone species were dominant species observed (Hargrave et al. 2004). Benthic seabed surveys were previously conducted at EL areas (EL 2381, EL 2382, EL 2384) at depths from 1,500-3,400 m and include areas of the Verrill and Dawson Canyons within the Study Area (Stantec 2016, 2018). Benthic invertebrates frequently observed included brittle stars and burrowing sea anemones (Stantec 2016). Other species observed included polychaetes, sea cucumbers, sea urchins, and large nudibranchs (Stantec 2016). Similar observations were made in pre-drilling surveys at approximately 2,800 m water depth for BP's Aspy D-11 well with brittle stars commonly observed, sea cucumbers and nudibranchs occasionally observed and shrimp uncommonly observed (Stantec 2018).

Marine invertebrates may have roles as ecosystem engineers or biogenic habitat in the Study Area and taxa such as sand dollars, brittle stars, and burrowing anemones are known bioturbators that rework surficial sediments in the Scotian Shelf region. Areas of high densities of sand dollars may occur around Sable Island and eastern shelf areas (Kenchington 2014, Beazley et al. 2017). Brittle stars can aggregate in areas of high density, with general peak abundance from 250-650 m. This species group are important prey for flatfishes (e.g., American plaice) and has an ecological role in bioturbation of surficial sediments (Kenchington 2014). Burrowing anemones may form dense aggregations, providing habitat complexity in fine substrate areas. In other regions, burrowing anemones have been suggested to provide refuge for juvenile redfish (Kenchington 2014).

Squid are important pelagic invertebrates in the region as they are primary prey for various whale species in the region (Wimmer and Whitehead 2004, Stortini 2015, DFO 2020w). Shortfin squid has been observed to be mainly associated with depths of 30-100 m in the transition from shelf waters to slope waters and at depths of 200-300 m at the lower boundary of slope water to depths of minimal oxygen levels (Arkhipkin and Fedulov 1986). Catches of shortfin squid are elevated in the slope and canyon regions within the Study Area (Stortini 2015). Deep-water squid (*Gonatus* sp.) have been noted as primary prey for the Endangered Scotian Shelf population of northern bottlenose whales (DFO 2020w). While this species likely occurs in canyons on the Scotian Shelf, little is known about the abundance and distribution of this species (WWF Canada 2009, DFO 2020w). Deep-water squid have been observed to be concentrated at depths of 300-600 m and potentially deeper during daylight and migrate closer to the surface (30-300 m) at night (Arkhipkin and Fedulov 1986). Aggregation of deepwater squid in canyons is potentially due to enhancement of food sources or formation of mating aggregations (Wimmer and Whitehead 2004).

Various invertebrates are of commercial importance to the region. See Section 3.3.2 for further information on fisheries. Areas of high benthic invertebrate density or abundance have been considered in establishment of special areas in the region. See Section 3.2.10 for further details on protected and special areas.

Table 3-11: Pelagic and Benthic Invertebrates of Ecological and Commercial Importance Likely to Occur in the Study Area

Group	Species	Key Importance	Time of Year Present	Habitat and Distribution
Echinoderm	Brittlestar species Ophiuroidea	Ecological (bioturbation, prey species)	Year-round	• Benthic epifaunal invertebrate • *Ophiura sarsii* is common on the Scotian Shelf region. Global distribution indicates peak abundances between 250-600 m but can occur at water depths up to 2,000 m.
	Sand dollar *Echinarachnius parma*	Ecological (bioturbation)	Year-round	• Benthic infaunal invertebrate, primarily in fine substrate areas of the Scotian Shelf. • Regionally high aggregation of sand dollars north of Sable Island.
	Green sea urchin *Strongylocentrotus droebachiensis*	Commercial	Year-round	• Benthic epifaunal invertebrate, distributed mainly on the eastern Scotian Shelf, inside of Sable Island Bank
	Orange Footed Sea cucumber *Cucumaria frondosa*	Commercial	Year-round	• Benthic epifaunal invertebrate, distributed on Sable Island Bank in Study Area • Primarily distributed in areas <6°C at water depths <150 m.
Cnidaria	Burrowing anemone species Ceriantharia	Ecological (biogenic habitat)	Year-round	• Benthic invertebrate. Various species distributed in canyon, slope, and rise areas (fine substrates)
Crustacean	American lobster *Homarus americanus*	Commercial	Year-round	• Benthic invertebrate • Primarily distributed in western Scotian Shelf, but has occurrences on the shelf edge within the Study Area.
	Snow crab *Chionoecetes opilio*	Commercial	Year-round	• Benthic invertebrate, primarily distributed in colder waters (1-4°C) on the eastern Scotian Shelf. • Distributed in eastern areas of the Study Area around Sable Island and Shelf Edge.
	Jonah Crab *Cancer borealis*	Commercial	Year-round	• Benthic invertebrate • Primarily distributed in western Scotian Shelf, • Distributed in eastern areas of the Study Area around Sable Island and Shelf Edge.

Group	Species	Key Importance	Time of Year Present	Habitat and Distribution
	Northern shrimp *Pandalus borealis*	Commercial	Year-round	• Pelagic invertebrate, distributed mainly on the eastern Scotian Shelf, inside of Sable Island Bank
Bivalve	Sea scallop *Placopecten magellanicus*	Commercial	Year-round	• Benthic epifaunal invertebrates, distributed on the Sable Island-Western Banks in the Study Area.
	Clam species Bivalvia	Commercial	Year-round	• Benthic infaunal invertebrate. • Ocean quahogs abundant on the Sable Island-Western Banks in the Study Area
Cephalopod	Shortfin squid *Illex illecebrosus*	Ecological (Prey species)	Year-round	• Pelagic invertebrate, primarily found at water depths of 30-100 m and 200-300 m. • Aggregated on the Scotian slope and canyons.
	Deepwater squid *Gonatus fabricii*	Ecological (Prey species)	Year-round	• Pelagic invertebrate, primarily found at water depths of >300 m during the day and 30-300 m at night. • Aggregated on the Scotian slope and canyons.

Source: Arkhipkin and Fedulov 1986, Kenchington 2014, Stortini 2015, Ward-Paige and Bundy 2016, Bundy et al. 2017

Table 3-12: Key Reproductive Times and Areas for Marine Invertebrate Species Likely to Occur in the Study Area

Common Name	Scientific Name	Phase	J	F	M	A	M	J	J	A	S	O	N	D	Key Areas
Brittlestar	*Ophiuroidea*	Eggs			P	P	P	P							Broadcast spawner. Spawns occurs throughout distribution.
		Larvae				P	P	P	P						
Sand dollar	*Echinarachnius parma*	Eggs						P	P	P					Broadcast spawner. Spawns occurs throughout distribution. Larvae preferentially settle in substrate conditioned by adults
		Larvae						P	P	P					
Green Sea Urchin	*Strongylocentrotus droebachiensis*	Eggs			P	P									Broadcast spawner. Spawns occurs throughout distribution.
		Larvae				P	P	P	P	P					
Orange Footed Sea cucumber	*Cucumaria frondosa*	Eggs				P	P	P	P	P					Broadcast spawner. Spawns occurs throughout distribution. Chemical cues from spawning adults may trigger spawning in adults inhabiting deeper regions.
		Larvae				B	B	B	B	B					
Burrowing anemone species	*Ceriantharia*	Eggs													Pelagic larvae, spawning details unknown for the region. Likely Spawns occurs throughout distribution.
		Larvae													
American lobster	*Homarus americanus*	Eggs	B	B	B	B	B	B	B	B	B	B	B	B	Females brood eggs. Spawning occurs in nearshore waters.
		Larvae					P	P	P	P	P	P	P		
Snow crab	*Chionoecetes opilio*	Eggs	B	B	B	B	B	B	B	B	B	B	B	B	Females brood eggs. Spawning occurs nearshore southwest Nova Scotia and from Bridgewater to Halifax.
		Larvae			P	P	P	P	P	P	P	P	P		
Jonah crab	*Cancer borealis*	Eggs	B	B	B	B	B	B					B	B	Females brood eggs. Spawning occurs in coastal to shelf waters.
		Larvae				P	P	P	P						
Northern shrimp	*Pandalus borealis*	Eggs	B	B	B							B	B	B	Females brood eggs. Spawning occurs in nearshore waters.
		Larvae	P	P	P	P	P	P	P	P	P	P	P	P	
Sea scallop	*Placopecten magellanicus*	Eggs								P	P	P	P	P	Broadcast spawner. Nearshore southwest NS, Georges Bank, Browns Bank, Western to Banquereau Banks
		Larvae								P	P	P	P	P	
Clam species	*Bivalvia*	Eggs						P	P	P					Broadcast spawner. Spawns occurs throughout distribution.
		Larvae						P	P	P					
Shortfin squid	*Illex illecebrosus*	Eggs	P	P	P								P	P	Female brood eggs. Not well known, potentially continental shelf south of Cape Hatteras and in the Gulf Stream
		Larvae	P	P	P								P	P	
Deepwater squid	*Gonatus fabricii*	Eggs													Eggs brooded in pelagic females. Key spawning areas and times not well known. Mating may potentially occur in canyons.
		Larvae													
Notes: D – Demersal, B – Benthic, P – Pelagic															

Source: (Shepard et al. 1986, Pearce and Scheibling 1990, Hamel and Mercier 1999, Balch and Scheibling 2000, Incze and Naimie 2000, DFO 2000, 2019, NOAA 2004, Wimmer and Whitehead 2004, Allen and Pechenik 2010, Arnberg et al. 2013, Gulf of Maine Research and University of Maine 2013, Shackell et al. 2013, DFO 2016a, Golikov et al. 2019, Genelt-Yanovskiy et al. 2021)

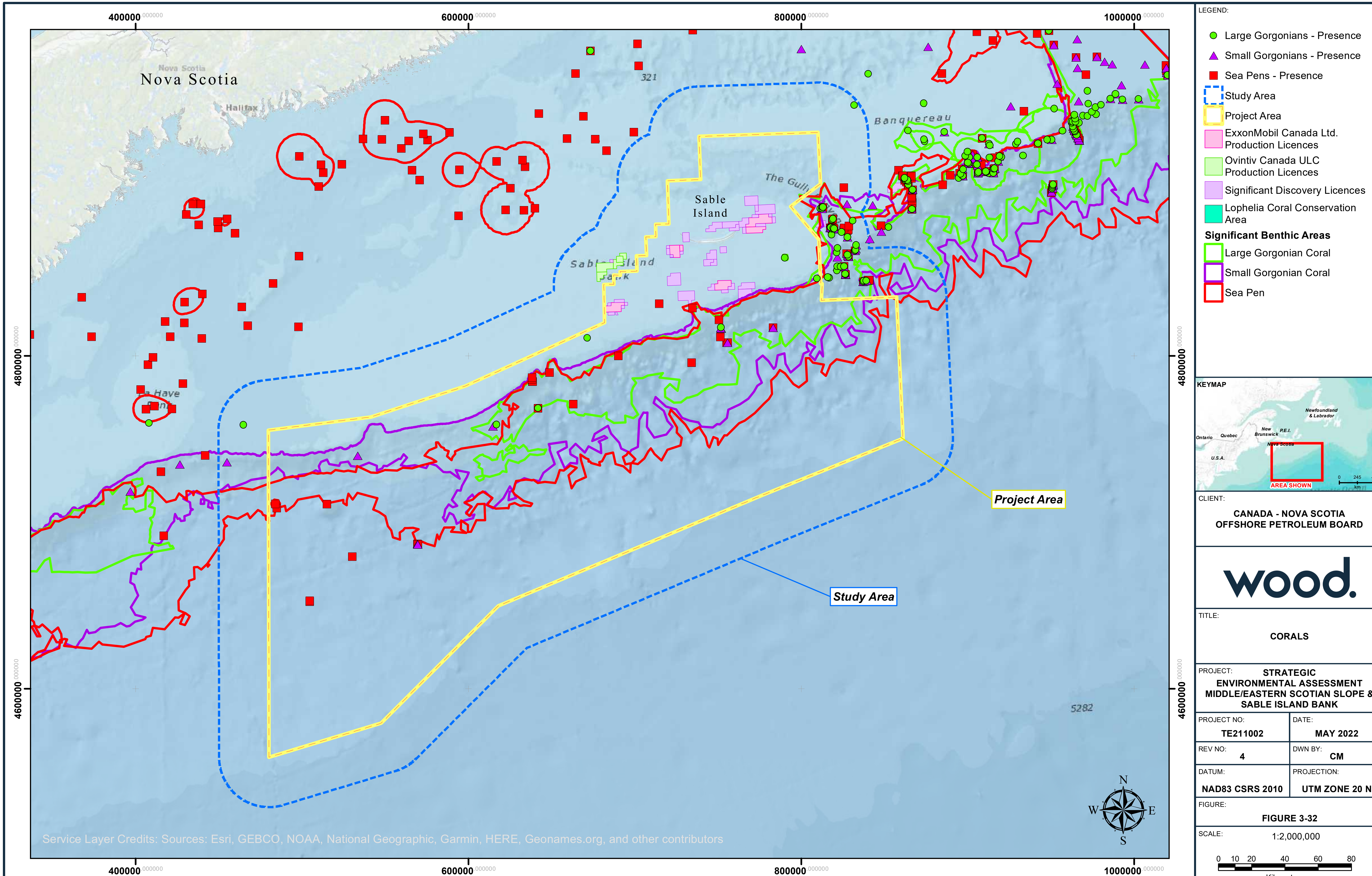
3.2.5.1 Corals and Sponges

Coldwater corals and sponges are generally filter feeding, sessile benthic invertebrates that are vulnerable to anthropogenic activities as they are slow growing and long lived (i.e., decades to centuries) (Sherwood and Edinger 2009). Deep-sea corals and sponges are important component to the ecology of the marine environment. Corals and sponges provide structural complexity on the seafloor, and therefore provide refuges, nursery areas, and foraging areas for many fish and invertebrates, including commercial species (Edinger et al. 2007, Watanabe et al. 2009, Baker et al. 2012, Baillon et al. 2012, 2014, Beazley et al. 2013, Kenchington et al. 2013, DFO 2015, Bernier et al. 2018, Hawkes et al. 2019, Neves et al. 2020). For example, a total of 114 associated species have been identified to date on specimens of *Paragorgia* and *Primnoa* in Atlantic Canada (Buhl-Mortensen and Mortensen 2005). Sea pens have also been identified as important refuge for supporting early life history stages of redfish, a commercial fish species and as substrate for small invertebrates (Baillon et al. 2012, 2014). Areas of Russian hat sponges on the Emerald Bank have been observed to have higher biodiversity and species abundance, likely due to a combination of presence of the sponges and attachment substrate (Hawkes et al. 2019). In areas of high numbers of sponges, distinct habitats are created by the spicules from deceased sponges that form dense mats on the seabed (Kenchington 2014).

Deep sea corals in Atlantic Canada have been classified into five functional groups: 1) Gorgonian corals (Alcyonacea), 2) black corals (Antipatharia), 3) cup corals (Scleractinia), 4) sea pens (Pennatulacea), and 5) soft corals (Alcyonacea). The first two groups are considered to be the most sensitive to disturbance because their carbonate skeletons cannot reattach to substrate if dislodged (Gilkinson and Edinger 2009). Most deep sea coral species occur in areas of hard substrates, such as cobble, boulder and consolidated sandstone, and in areas with high current speeds (MacIsaac et al. 2001, Buhl-Mortensen and Mortensen 2005). A notable exception is the sea pens, or Pennatulaceae, which anchor in soft or clay bottom habitats (Buhl-Mortensen and Mortensen 2005) and cup corals that lay on the seafloor. The Scotian Shelf and Slope, including the Study Area, support a high diversity of corals and sponges (Cogswell et al. 2009). In particular The Gully MPA is an important coral area with more than 30 coral species observed including black coral, gorgonian corals, sea pen and *Desmophyllum pertusum* based on ROV surveys (Cogswell et al. 2009, King et al. 2016). While less information is available on other submarine canyons in the area it is expected they would also contain habitats that support corals and sponges (King et al. 2016). Corals observed from Remotely Operated Platform for Ocean Sciences (ROPOS) surveys in the Verrill and Dawson Canyons included cup corals, soft corals, and sea pens (Stortini 2015). However, relative to more well studied eastern canyons in the region, high abundance of corals was not observed (Stortini 2015). Significant benthic areas (SiBAs),identified from species distribution modelling for small and large gorgonians and sea pens, and are presented in Figure 3-32 (Kenchington et al. 2016). In particular, the Scotian slope is an area for high potential occurrence of sea pens and gorgonian corals (Kenchington et al. 2016). Soft coral gardens may support juvenile Northern shrimp and snow crab, with potential for occurrences the shelf edge and slope (Kenchington 2014, Beazley et al. 2017). Cup corals are not considered to be habitat-forming species, however, areas of high diversity and density for this group have been identified on the Scotian Slope (Beazley et al. 2017).

In the Scotian Shelf and Slope region, Russian hats are a well-known species that is included in the ICES Journal of Marine Science 2009 list of habitat-forming sponge species. Russian hats are a large, barrel-shaped shelf species are considered to be a structure forming species supporting vulnerable marine ecosystems (ICES 2009). A dense patch of this species occurs in the Emerald Basin on the Scotian Shelf has been described as a globally significant and unique population (Fuller et al. 2008, DFO 2015). Within the Study Area, there are occurrences of this species in shelf and shelf edge with potential habitat on the slopes (Beazley et al. 2018). Significant areas in and near the Study Area are presented in Figure 3-33 (Kenchington et al. 2016).

Corals and sponges are often captured in DFO trawl surveys but many of these are not easily identified to species level while at sea. Many sponges also disintegrate when collected and brought to the surface in research trawls (Murillo et al. 2016). Therefore, much of the DFO data is presented at coarser levels of identification. Many surveys in the region are focused on protected areas that have high abundance, high biodiversity or unique species (Cogswell et al. 2009). Sampling efforts for corals and sponges are generally unevenly distributed with fewer surveys in deeper waters. Therefore, lack of coral or sponge records in an area may reflect limited survey efforts rather than absence of corals and sponges and should be considered for any marine spatial planning in the area (Cogswell et al. 2009).



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wood.

TITLE: CORALS

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 4	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-32

SCALE: 1:2,000,000

Kilometres

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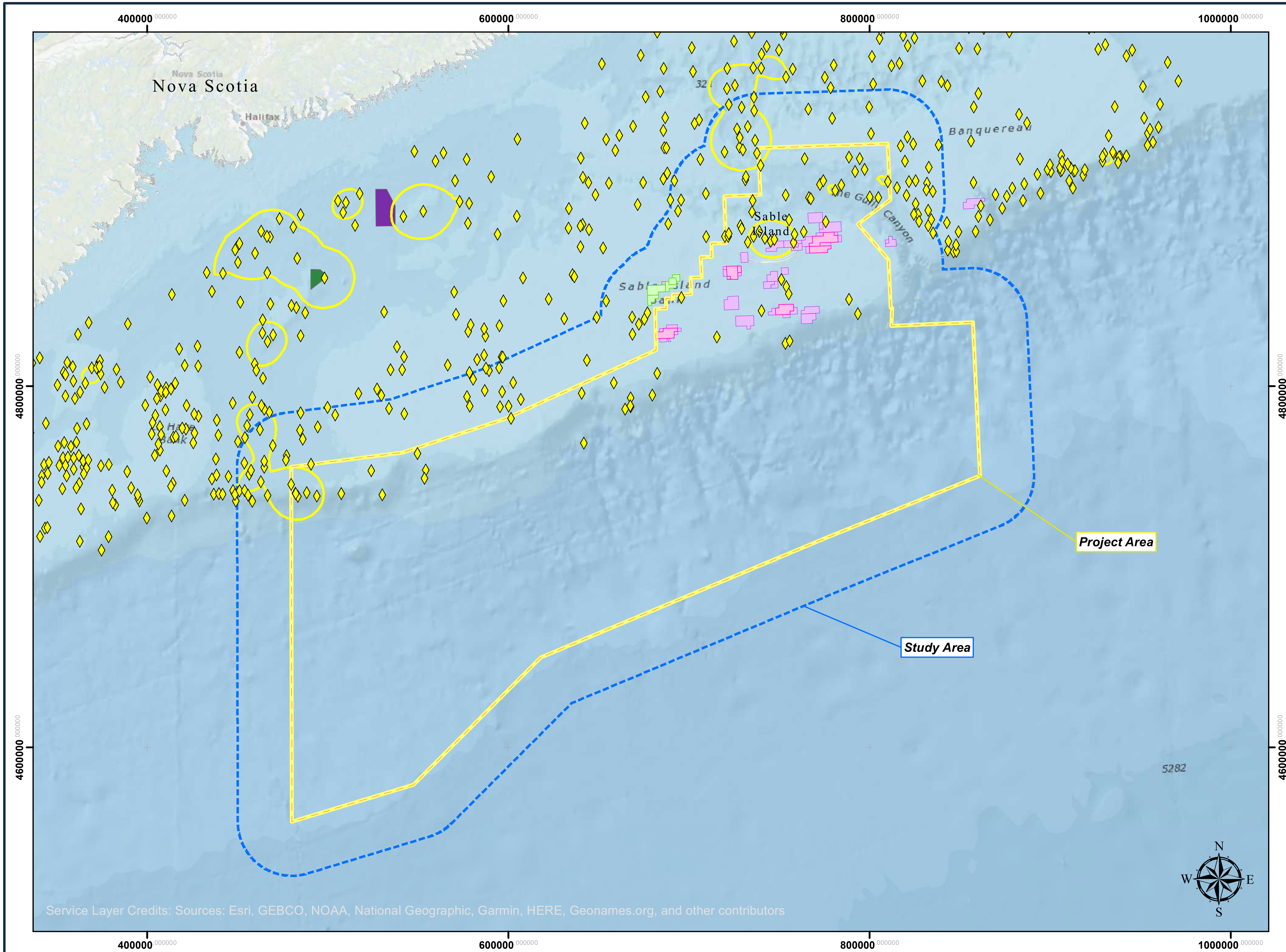

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

SPONGES

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 4	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-33**

SCALE: 1:2,000,000

0 10 20 40 60 80
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3.2.6 Marine Fish

Fish are an integral part of the ecosystem within the Study Area and range from small planktivorous fish such as herring to large predatory sharks. Marine fish have historically supported large commercial fisheries, and many species continue to support fisheries today. The fish species and/or species groups (assemblages) present within an area vary depending on factors such as habitat and season. Physical aspects of the marine environment which determine suitability of habitat for fish species include depth and temperature and, to a lesser extent, sediment type (Mahon and Smith 1989). In addition, larval and juvenile fish may utilize different habitats (nursery habitat) than adults (Zeller and Pauly 2001). Fish species may therefore use various habitats within the Study Area as spawning, nursery, rearing, and/or foraging habitats throughout the year. Ichthyoplankton are further described in Section 3.2.3. The distribution of groundfish on the Scotian Shelf is well documented (Horsman and Shackell 2009, Bundy et al. 2017, Bernier et al. 2018), with fewer studies on the shelf edge and slopes (Themelis and Halliday 2012, Halliday et al. 2012b, 2012a, Stortini 2015).

Bundy et al. (2017) identified areas of high biomass for fish and invertebrate functional groups based on annual DFO research trawls. Hotspots for small and medium benthic piscivores (e.g., silver hake, yellowtail flounder) in the Study Area were primarily located on the Sable Island Bank around Sable Island. Biomass hotspots for large benthic piscivores (e.g., Atlantic cod, spiny dogfish) were primarily outside the Study Area in the Bay of Fundy and Northeastern Shelf, with relatively lower levels in the Study Area (Bundy et al. 2017). Pelagic piscivores (e.g., moustache sculpin, boa dragonfish) had generally low biomass relative to other functional groups with a few patchy areas of relatively higher biomass along the shelf edge. Small and benthic benthivores biomass hotspots were primarily outside the Study Area but there were patchy hotspots north of Sable Island (Bundy et al. 2017). Medium (e.g., winter flounder, witch flounder) and large (e.g., haddock) benthic benthivores hotspots were distributed on Western and Sable Island Bank including portions of the Study Area. Planktivore (e.g., herring) biomass hotspots were distributed throughout the region with low levels throughout the Study Area. Benthic zoopiscivores (e.g. redfish species) had patchy biomass hotspots along the shelf edge and pelagic zoopiscivores (e.g., mackerel, capelin) had relatively lower biomass in the Study Area (Bundy et al. 2017). Based on a combination of diversity indices, Ward-Paige and Bundy (2016) identified patches of the Scotian Shelf edge as an area of high fish biodiversity.

The fish fauna distributions within the Scotian Shelf edge and Slope areas are mainly influenced by the cold northeastern Labrador slope waters (Halliday et al. 2012b, 2012a, 2015). On the Scotian Shelf edge (<600 m water depth), redfish are the most abundant fish in survey trawls. Redfish are known to associate with coral species and may be highly abundant in canyons (e.g., Logan, Dawson) for this reason (Stortini 2015). Other species commonly found at the shelf edge around canyons include Greenland halibut, Atlantic halibut, thorny skate, white hake, and witch flounder (Stortini 2015). In deeper surveys on the Scotian Slope (600-3000 m water depth), Greenland halibut and roundnose grenadier are the most abundant species captured (Stortini 2015). Roundnose grenadier and black dogfish were the most abundant species captured by weight in exploratory trawls of the Scotian Slope from 910-1830 m water depth (Halliday et al. 2012a). Fish species captured in deepwater (500-2,800 m) gillnets and baited traps in The Gully frequently included small-eyed rabbitfish, Portuguese dogfish, black dogfish, roughhead grenadier, blue hake, and Greenland halibut (Halliday et al. 2012b). Few fish species were observed in exploration drilling associated benthic seabed surveys within the Study Area with incidental observations of chimaera, gadoids and tripod fish (Stantec 2018). Reproductive times for key species that are likely to occur in the Study Area is presented in Table 3-10.

Pelagic fish species are those which spend most of their time in the pelagic zone and the upper layers of the water column above the sea floor. Fish species' presence varies considerably with depth. Common large pelagic species include tunas, swordfish, and sharks; well-known small species include Atlantic herring and Atlantic mackerel. The large pelagic species often tend to be apex predators, while small species are integral to the marine ecosystem due to their role in capturing energy from lower trophic levels (phytoplankton, zooplankton, and small planktivorous fish) and transferring it to higher level carnivores including mammals, birds, and numerous species of pelagic and demersal fish and marine invertebrates (Read and Brownstein 2003). Myctophid lanternfish, mostly comprised of *Benthosema glaciale* are a dominant taxa in mesopelagic fish surveys off the Scotian Shelf in the colder, Labrador slope water component of the water mass (Themelis and Halliday 2012, Halliday et al. 2012a, 2015). Lanternfish are planktivorous species that undergo diel vertical migrations and an important link between lower to higher trophic levels as a prey item for larger fish and birds. Other pelagic fish include American eel and Atlantic salmon, taxa that have previously been identified as species of importance to Indigenous peoples. Additional species of importance will be identified in future project-specific EAs through consultation, communications and engagement activities.

The Scotian Shelf region has been undergoing a warming trend in recent years with warm water fish species becoming increasingly prevalent relative to historical surveys. Many ecosystems are experiencing biological and physical changes due to climate change (Bernier et al. 2018). Fish species occurrences includes common warm water species in Georges Bank surveys that have now expanded to the Scotian Shelf (Bernier et al. 2018). Blackbelly rosefish which typically inhabits warmer areas of the Shelf are now distributed along the shelf edge (Bernier et al. 2018). While occurrences of these species remains a small proportion of the overall groundfish biomass, it indicates that other species may eventually become a regular part of the community composition on the shelf (Bernier et al. 2018).

3.2.6.1 Marine Fish Species in the Study Area

Information on the habitat and distribution of marine fish species likely to occur in the Study Area is presented in Table 3-13. This includes information on species at risk (SAR) under Schedule 1 of SARA and populations under consideration by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Species of conservation concern are discussed in Section 3.2.9.

Table 3-13: Summary of Pelagic and Demersal Fish Likely to Occur in the Study Area

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Hagfishes (Myxinidae)	**Atlantic hagfish**	NA	Year-round	Likely	• Benthopelagic, but frequently burrows in mud • Eggs are benthic, typically laid over mud or sandy bottom • Occupy waters from 200 m down to 1,200 m
Mackerel sharks (Lamnidae)	**Porbeagle**	Endangered (COSEWIC)	Year-round	Possible	• Pelagic predators, can dive down to 1,360 m • Typically winters offshore, and moves into shallow waters in summer • Spawns on Georges Bank and the Gulf of St Lawrence entrance, likely pups in the Sargasso Sea
	White shark	Endangered (COSEWIC / SARA)	Summer	Possible	• Pelagic predators that dive to approximately 1,200 m and occupies a range of temperatures (1.6 - 30.4ºC) • Can undergo large migrations to Canadian waters to feed. Recent telemetry studies indicate presence in Atlantic Canada from June to February. • Spawning and pupping are not well known, possibly in the Mid-Atlantic Bight • May spawn off Sable Island
	Shortfin mako	Endangered (COSEWIC)	Summer and fall	Possible	• Pelagic, from surface waters down to 750 m • Typically oceanic, but can move inshore to feed • Occurrence in Canadian waters is at the northern edge of their range • Spawning not well known, unlikely to spawn or pup in Study Area

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Requiem sharks (Carcharhinidae)	**Blue shark**	NA	Year-round	Possible	• Pelagic predator, can dive down to 1,000 m • Typically winters offshore, and moves into shallow waters in summer • Likely spawn inshore, and pup in their winter grounds
Basking Shark (Cetorhinidae)	**Basking shark**	Special Concern (COSEWIC)	More likely in summer months	Possible	• Pelagic, typically in shallow waters in the summer but can go as deep as 2,000 m • Can migrate long distances across the Atlantic, and to southern waters • Little known about spawning grounds or pupping
Dogfish sharks (Squalidae)	**Spiny dogfish**	Special Concern (COSEWIC)	Year-round	Likely	• Benthopelagic, found from the subtidal down to 1,460 m • Thought to spawn in deep waters off continental shelf, adults can undertake long migrations to inshore waters following preferred water temperatures (7-15°C)
Lantern sharks (Etmopteridae)	**Black dogfish**	NA	Year-round	Likely	• Bathydemersal, can be found pelagically, typically from 180 m down to 2,250 m • Typically found on the shelf edge and slope, temperatures around 3.5-4.5°C • Ovoviviparous, thought to spawn year-round but little is known
Skates (Rajidae)	**Smooth skate**	Special Concern (Laurentian-Scotian population; COSEWIC)	Year-round	Likely	• Demersal, from 46 to 914 m deep • Typically found on mud or clay bottoms, or over sand, shells, or gravel on offshore banks • Eggs typically laid on sand or mud, thought to be laid year-round
	Thorny skate	Special Concern (COSEWIC)	Year-round	Likely	• Demersal, from 5 to 1,540 m though usually at shallower end of range • Found over various bottoms, commonly caught on the eastern Scotian Shelf

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
					• Eggs are benthic, laid year-round on bank edges and slopes
	Winter skate	Endangered (COSEWIC)	Year-round	Likely	• Demersal, typically on sand or gravel bottoms from the subtidal to 120 m • Have a distinct spawning embrace, eggs laid on bottom with horns for attachment, and can take up to 22 months to hatch
Redfishes (Sebastidae)	**Acadian / deepwater redfish**	Threatened (COSEWIC)	Year-round	Likely	• Demersal, typically from 70 to 592 m, prefer rock reefs but are encountered over mud/silt • Acadian redfish are more common on the Scotian Shelf and at shallower depths, while deepwater redfish are only found to the northeast of Sable Island at slope depths • Viviparous, larvae are pelagic
Goosefishes (Lophiidae)	**Monkfish**	NA	Year-round	Likely	• Typically found in shelf waters in the summer and fall, and the deeper waters of the shelf edge in winter • Eggs and larvae pelagic, present in late spring and summer
Freshwater eels (Anguillidae)	**American eel**	Threatened (COSEWIC)	Migrate through area to spawn, or returning as eggs/larvae	Possible	• Inhabits freshwater streams or estuaries as adults, eggs and larvae develop at sea • Catadromous, spawns in the Sargasso sea, eggs and larvae are pelagic and drift north in currents before entering freshwater as elvers
Lumpsuckers (Cyclopteridae)	**Lumpfish**	Threatened (COSEWIC)	Year-round	Likely	• Benthopelagic, typically from near the surface down to 868 m • Solitary, associated with rocky bottoms • Migrate to inshore waters to spawn in the summer months, and to deeper waters in the winter • Eggs are benthic on rocky bottoms and guarded by the male, larvae pelagic

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Right-eye Flounders (Pleuronectidae)	**American plaice**	Threatened (COSEWIC)	Year-round	Likely	• Demersal, typically found from 90 to 250 m deep usually on soft bottoms • Will bury themselves in bottom substrate, and as such soft or gravel bottoms with larger fish able to bury in larger grain sized bottoms • Spawn on Banquereau Bank, Western Bank, and Browns Bank, with eggs and larvae pelagic
	Atlantic halibut	NA	Year-round	Likely	• Typically benthic, but occasionally pelagic • Migrate to shallow Shelf waters in the summer months, and to deeper waters off the Shelf in winter for spawning • Eggs and larvae pelagic, settle to bottom in summer
	Greenland halibut	NA	Summer months, some year-round	Possible	• Benthopelagic, typically from depths of 50-650 m • Capable of extensive migrations from feeding grounds to spawning areas in the north • Eggs and larvae pelagic throughout spring and summer
	Witch flounder	NA	Year-round	Likely	• Demersal, prefers soft bottoms usually from 45 to 366 m deep • Eggs and larvae are pelagic, with spawning typically in winter (though variable), and larvae remaining pelagic for up to a year
	Yellowtail flounder	NA	Year-round	Likely	• Demersal on sandy or muddy bottoms from 27 m down to 364 m • Spawning in summer, with eggs and larvae pelagic in summer to early fall

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Codfishes (Gadidae)	**Atlantic cod**	Endangered (COSEWIC)	Year-round	Likely	• Benthopelagic, can be found from the subtidal to 600 m, but usually from 150 to 200 m • Can migrate long distances, especially to inshore areas to feed on species such as capelin • Spawn throughout Study Area, typically on banks, eggs and larvae are pelagic
	Haddock	NA	Year-round	Likely	• Demersal, typically found from 80 to 200 m deep, over rock, sand, gravel, or shells • Occupy banks and shallower depths for spawning • Eggs and larvae pelagic in spring and summer
	Pollock	NA	Year-round	Likely	• Demersal, occasionally pelagic, ranging from 37 m to 364 m deep • Migrate to inshore waters in summer and deeper offshore waters in winter • Eggs and larvae pelagic, present in late fall to spring
Grenadiers (Macrouridae)	**Roundnose grenadier**	Endangered (COSEWIC)	Year-round	Likely	• Bathypelagic, usually from 400 to 1,200 m • Found on the Scotian Slope in areas of low current and temperatures of 3.5-4.5°C • Thought to spawn year-round, likely withing the Study Area, with eggs and larvae pelagic
	Roughhead grenadier	NA	Year-round	Likely	• Benthopelagic, typically from 400 to 1,200 m • Found throughout the Scotian Slope • May migrate to deeper waters to spawn, thought to occur year-round, with pelagic eggs and larvae
Lings (Lotidae)	**Cusk**	Endangered (COSEWIC)	Year-round	Likely	• Demersal, usually from 18 to 549 m • Prefer small shoals on rock, gravel, or pebble bottoms throughout the Scotian Shelf, though are more common further south

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
					• Eggs and larvae are pelagic, present in late-spring through to early fall
Salmonids (Salmonidae)	**Atlantic salmon**	Varies by population – Not at Risk to Endangered (COSEWIC / SARA)	May migrate through in spring and/or fall	Unlikely	• Atlantic salmon are anadromous, spawning in freshwater streams and migrating to the ocean as adults • Though not well known for all populations, most adults migrate to the eastern Grand Banks, Labrador Sea, or Greenland to feed • Return in the fall to freshwater when ready to spawn
Wolffishes (Anarhichadidae)	**Atlantic wolffish**	Special Concern (COSEWIC / SARA)	More likely in winter months	Likely	• Demersal, can be found from the subtidal down to 600 m, though typically at the shallower end of that range • Typically inhabit rocky bottoms • Benthic eggs are typically laid inshore and guarded by the male, larvae are pelagic
	Spotted wolffish	Threatened (COSEWIC / SARA)	Year-round	Possible	• Demersal, typically from 200 to 750 m • Scotian Shelf is at the southern end of their range, and they would likely inhabit deeper, colder waters • Eggs are likely benthic, and larvae are pelagic
	Northern wolffish	Threatened (COSEWIC / SARA)	Year-round	Possible	• Benthopelagic, typically found from 100 to 900 m deep • Found in a narrow temperature range on the Scotian Shelf (3-5°C), and this is near the southern end of their range • Eggs are likely benthic, and larvae pelagic
Herrings (Clupeidae)	**Atlantic herring**	NA	More likely in winter months	Likely	• Benthopelagic, with diel movements to surface waters to feed at night, and down to 364 m deep in the day • Migrate inshore to spawn, and to deeper waters to feed • Eggs are benthic in inshore areas or banks, and larvae are pelagic

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Tunas and Mackerels (Scombridae)	**Atlantic bluefin tuna**	Endangered (COSEWIC)	Summer months	Possible	• Pelagic, can dive to 985 m but more common near surface • Typically oceanic, but can move inshore to feed • Undertakes long migrations to spawning grounds in the Gulf of Mexico • Eggs and larvae are pelagic, not found in Study Area
	Atlantic mackerel	NA	More likely in winter	Likely	• Pelagic, from the surface down to 1,000 m • Typically diurnal, can form large schools near the surface • Migrate to inshore waters in the summer to spawn, and to deeper waters in the winter • Eggs and larvae are pelagic
	Bigeye tuna	NA	Summer months	Possible	• Pelagic, typically found from the surface down to 500 m, with adults typically remaining deeper than juveniles • Can form large schools, including with other tuna species, frequently associated with floating debris • Eggs and larvae are pelagic, not found in Study Area
	Yellowfin tuna	NA	Summer months	Possible	• Pelagic, typically in the top 100 m of the water column • Can form school with other tunas or porpoise species, frequently associated with floating debris • Eggs and larvae are pelagic, not found in Study Area
Swordfish (Xiphiidae)	**Swordfish**	NA	Summer months	Possible	• Pelagic, usually from the surface to 550 m • Can migrate long distances from feeding grounds in temperate areas to spawning grounds • Eggs and larvae pelagic, northwest Atlantic population thought to spawn in southern Sargasso Sea
Sand lances (Ammodytidae)	**Northern Sand lance**	NA	Year-round	Likely	• Semi-pelagic, with burial behaviour in sand and fine gravel • Typically found offshore at depths between 73 to 90 m

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
					• Eggs are laid in late fall and winter, are adhesive and benthic on sand or gravel • Larvae are pelagic, typically present in winter to July
Smelts (Osmeridae)	**Capelin**	NA	More likely in winter	Possible	• Pelagic, typically from surface waters down to 200 m • Migrate inshore in large schools to spawn in summer months • Scotian Shelf is near the southern edge of their range, less common overall • Eggs benthic on beaches or near-shore, larvae pelagic
Phycid hakes (Phycidae)	**Red hake**	NA	More likely in winter	Likely	• Found on muddy and sandy bottoms, from subtidal depths down to 550 m • Juveniles live inside scallops, with adults in deeper waters typically between 110-130 m • Eggs and larvae pelagic in late spring and summer
	White hake	Threatened (COSEWIC)	More likely in winter	Likely	• Demersal, typically from 100 m down to 247 m on muddy bottoms • Migrate inshore in summer and to deeper waters in winter • Eggs and larvae are pelagic, typically in summer and early fall
Merluccid hakes (Merlucciidae)	**Silver hake**	NA	More likely in winter	Likely	• Found from shallow waters down to 910 m • Migrate to shallow waters in the summer to spawn, and to deep waters in winter • Eggs and larvae are pelagic, present in summer and fall

3.2.7 Marine and Migratory Birds

The nutrient-rich waters of the Scotian Shelf support a diverse assemblage of migratory and marine birds, with an estimated 30 million seabirds using eastern Canadian waters each year (Fifield et al. 2009). Bird diversity on the Scotian Shelf and Slope peaks in the spring and summer due to the combination of northern hemisphere breeding birds and southern hemisphere migrants entering the region. However, significant numbers of over-wintering gulls, alcids (e.g., Dovekie, Atlantic Puffin, murres) and Northern Fulmars also use these waters during fall and winter (Fifield et al. 2009, Brown 1986). In addition to the productive waters of the Scotian Shelf, the Study Area contains Sable Island, a small, emergent portion of the Sable Bank that supports nesting Ipswich Sparrows, thousands of colonial-nesting seabirds and an unusually large number of vagrant landbirds (Birds Canada, no date).

As key components and indicators of ecosystem health, marine-associated birds are often considered to be of high intrinsic importance. Further, they hold significant socioeconomic (e.g., tourism, hunting) and cultural (i.e., Indigenous) importance in the Atlantic provinces. In addition to their intrinsic and socioeconomic value, birds have legal protections. The federal *Migratory Birds Convention Act* (MBCA) prohibits the disturbance or destruction of most migratory birds, as well as their nests and eggs. The legislation and regulations of the Act, which is administered by Environment and Climate Change Canada (ECCC), apply to all lands and waters in Canada. Species excluded from the MBCA (e.g., cormorants, hawks, owls and game birds such as grouse and pheasant) are protected under the Nova Scotia *Wildlife Act* and its regulations. The Canadian SARA and / or the *Nova Scotia Endangered Species Act* (NSESA) and regulations provide additional protections avian SAR and their habitats, including species occurring or potentially occurring in the Study Area.

For the purposes of this SEA, birds that may occur within the Study Area are divided into four groups:

- Seabirds (pelagic and neritic);
- Waterfowl and divers;
- Shorebirds; and
- Other marine-associated birds (including passerines).

The following subsections discuss the presence and abundance of these groups in the Study Area and surrounding Scotian Shelf.

3.2.7.1 Seabirds

Seabirds are long-lived species with low fecundity, delayed recruitment, and low rates of population growth, and are therefore particularly vulnerable to factors that affect adult survival. Aside from breeding on land, seabirds spend most of their life in the marine environment. At various times of year, numerous seabird species occur or potentially occur in the Study Area, including cormorants, gannets, phalaropes, gulls, terns, alcids, jaegers and skuas, fulmars, petrels and shearwaters. The Atlas of Seabirds at Sea in Eastern Canada (2006-2016) data were used to prepare seasonal distribution maps of seabirds occurring in and near the Study Area; these maps are presented in Figures 3-34 to 3-42. Mapped data includes density estimates of species within a given Eastern Canadian Seabirds at Sea (ECSAS) survey block, summarized over a four-month period: December to March, April to July, and August to November. These data were combined into guilds or taxonomic groups to provide information on the relative distribution and abundance of seabirds in and near the Study Area. It must be noted that survey effort was much lower on the Scotian Slope in winter months (i.e., December to March) and therefore the density maps are not spatially representative at this time. Consequently, information on seabird distribution and abundance in winter is discussed here at a broader geographic scale (i.e., entire Scotian Shelf and Slope). During all survey periods, effort was generally higher on than off the Scotian shelf (Bolduc et al. 2018).

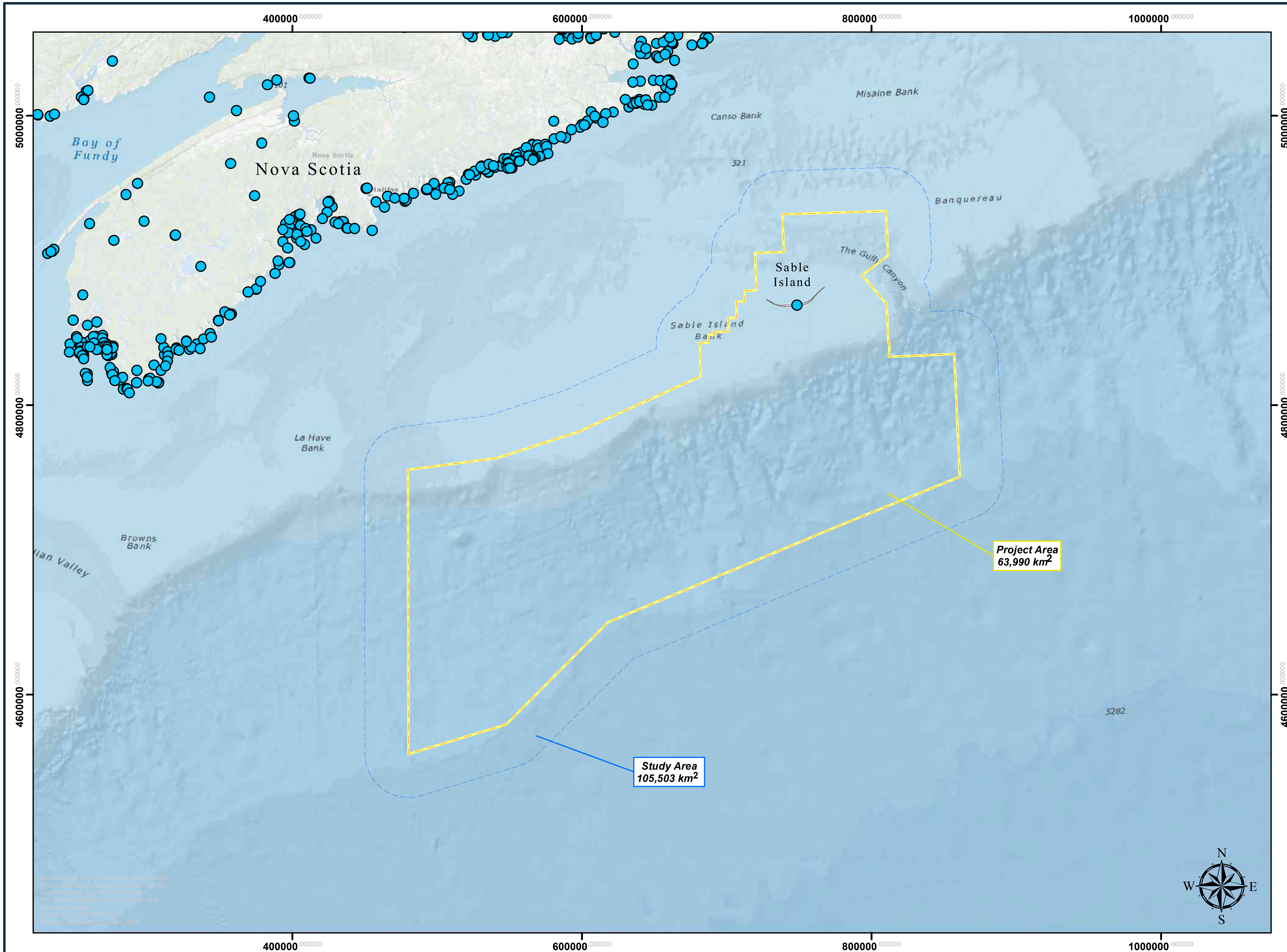
In general, seabirds are frequently encountered off the Scotian Shelf and Slope in the spring and summer months. In spring, gulls, murres and gannets are abundant in the area (Fifield et al. 2009; Bolduc et al. 2018). By the summer months, storm-petrels and shearwaters are also present in high numbers. During summer, seabird abundance is estimated to be lower on the Scotian Shelf and Slope than the Newfoundland and Labrador Shelves, but higher than the Gulf of St. Lawrence region (Fifield et al. 2009). The most abundant species include Great Shearwater, storm-petrels (Wilson's Storm-petrel and Leach's Storm-petrel), and Red Phalarope (arriving in late summer), with Great Black-backed Gull, Herring Gull and Sooty Shearwater also occurring in significant numbers. Seabird abundance declines in fall and winter, as many species migrate south. However, significant numbers of gulls, murres and other alcids are present throughout the winter months (i.e., November to February), and for some species (e.g., Great Black-backed Gull, Iceland Gull, Dovekie) abundance is higher in winter than other seasons (Fifield et al. 2009, Bolduc et al. 2018). There are several species that breed north of the Scotian Shelf and Slope but winter further south (i.e., Red-necked Phalarope, Red Phalarope, Pomarine Jaeger, Parasitic Jaeger, Long-tailed Jaeger); these species show two distinct peaks in abundance, corresponding to spring and fall migration periods (Fifield et al. 2009, Bolduc et al. 2018). Northern Fulmars are present throughout the year (Fifield et al. 2009). Based on survey data from Fifield et al. (2009), there are higher densities of birds overall along the Scotian Shelf than on the Slope. However, it must be noted that survey effort was greater along the Shelf than further offshore. Along the Scotian Shelf, birds are distributed widely; within the Study Area, the Sable Island Bank has slightly higher seabird densities than other areas (Bolduc et al. 2018). Throughout the year, the Study Area generally has lower abundance of seabirds than regions to the west, including Georges Bank and the Gulf of Maine (Bolduc et al. 2018).

Nesting sites for colonial seabirds and / or SAR constitute particularly important areas and habitats. The Study Area contains one such nesting site, Sable Island, which is the most isolated seabird colony site in eastern Canada (Ronconi et al. 2016). Breeding seabirds of Sable Island include dispersed colonies of Herring Gulls, solitary nests of Great Black-backed Gulls, and mixed colonies of Common and Arctic Terns (Wilhelm 2017). Recent seabird census data for Sable Island is presented in Table 3-14. Two seabird Species- at-Risk also breed on Sable Island, Leach's Storm-petrel and Roseate Tern. In the 1970s, more than 100 breeding pairs of Roseate terns were observed; however, numbers have significantly declined in recent years, with fewer than six pairs nesting on the Island since 1993 (Ronconi et al. 2016). No data exist on the estimated number of Leach's Storm-petrel breeding on Sable Island in recent years (D. Kehler and Z. Lucas, pers. comm.) Figure 3-34 presents the locations of known seabird colonies (all species) in and near the Study Area using data from 2006 to 2016, as provided in the Atlantic Colonial Waterbirds Database (ACWD) (Wilhelm 2017, BC 2012). Sable Island is also designated as an Important Bird Area (IBA) and Migratory Bird Sanctuary; these designations are discussed in Section 3.2.10.

Table 3-14: Population Estimates of Seabirds on Sable Island, 2009-2018.

Common Name	Survey Year	Number of Individuals[1]	Number of Colonies	Number of Breeding Pairs
Great Black-backed Gull	2013	978	NA	NA
	2017	659	NA	NA
	2018	581	NA	NA
Herring Gull	2012	1627	NA	951
	2013	1281	45	843
	2017	1517	46	NA
	2018	1130	42	NA
Common / Arctic Tern	2009	NA	11	4968
	2012	NA	4	6447
	2013	NA	3	4242
	2016	NA	7	4968
Roseate Tern	2009	NA	1	5
	2012	5	1	NA
	2013	NA	1	3

Note: NA indicates no available data.
[1]Estimate does not include loafers (i.e., failed breeders, deferring breeders, and subadult birds).
Sources: Data were obtained from Ronconi et al. (2016) and Parks Canada through a Data License Agreement.



LEGEND:

- Atlantic Canada Bird Colonies
- Project Area
- Study Area

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

ATLANTIC CANADA BIRD COLONIES

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 1	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

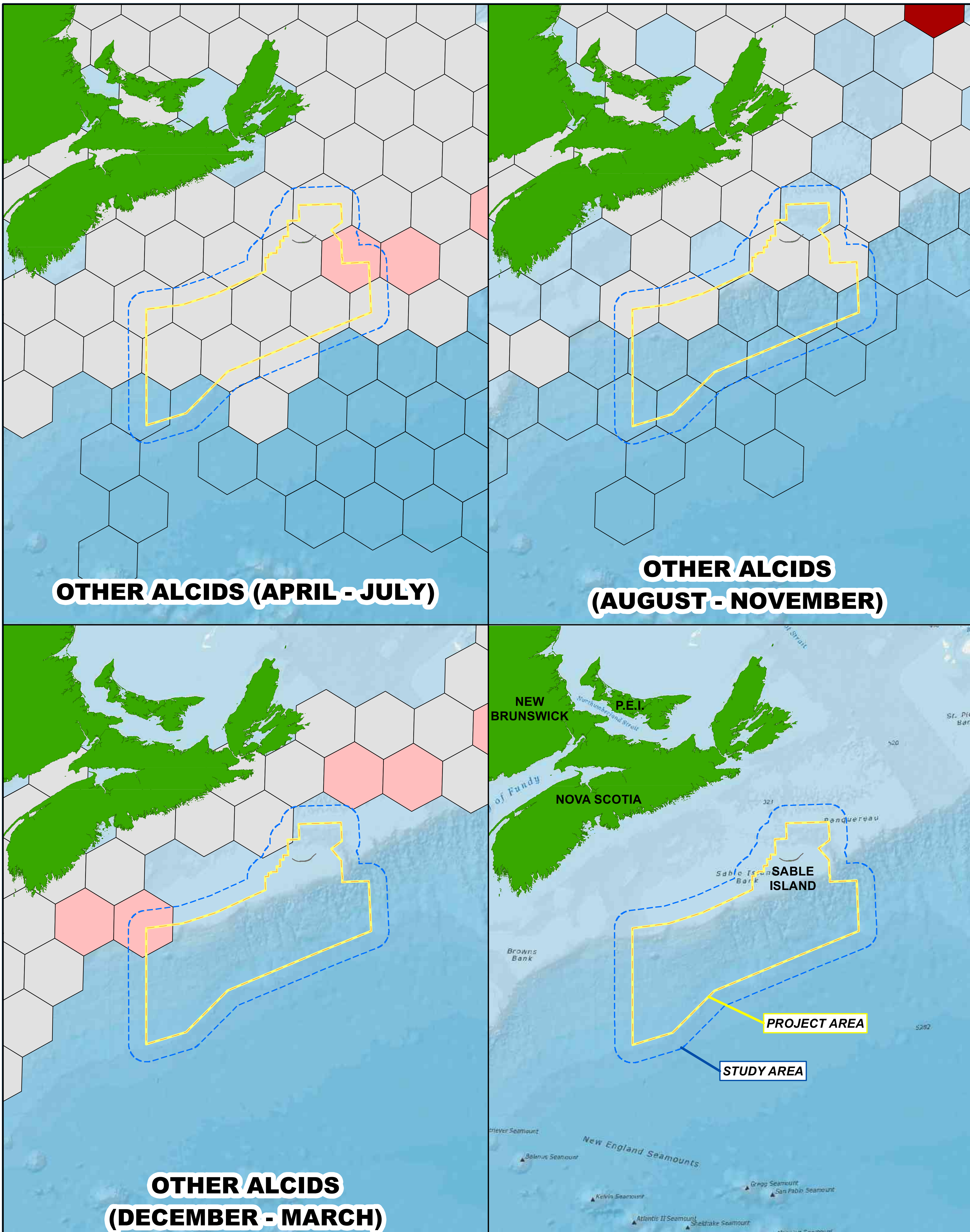
FIGURE: FIGURE 3-34

SCALE: 1:2,500,000

0 12.5 25 50 75 100

Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_BIRDS\TE211002_FIG_3_34_AtlanticCanadaBirdColonies.mxd User: candace.macdonald Date: 5/12/2022



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

TITLE:

MARINE BIRD DENSITY - OTHER ALCIDS

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:	FIGURE:
TE211002	MAY 2022	FIGURE 3-35
REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

LEGEND:
Study Area
Project Area

Density (birds/km^2)
0
> 0.0 - 17.0
> 17.0 - 38.2
> 38.2 - 79.4
> 79.4 - 175.2
100 km

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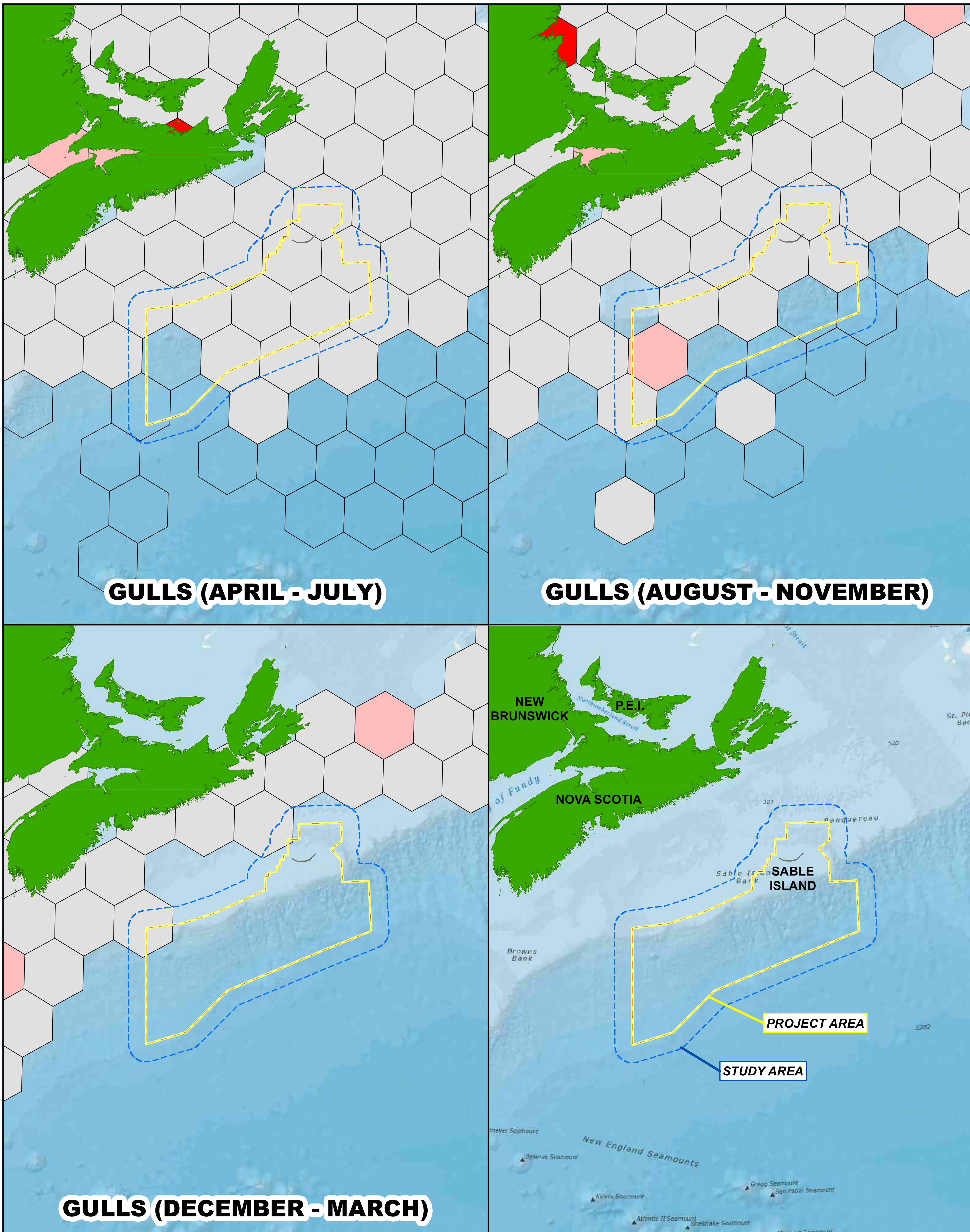

CLIENT:	TITLE:		
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	MARINE BIRD DENSITY - GULLS		
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK		
	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-36
	REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

LEGEND:
Study Area
Project Area

Density (birds/km^2)
- 0
- > 0.0 - 9.3
- > 9.3 - 16.4
- > 16.4 - 34.4
- > 34.4 - 62.8

100 km

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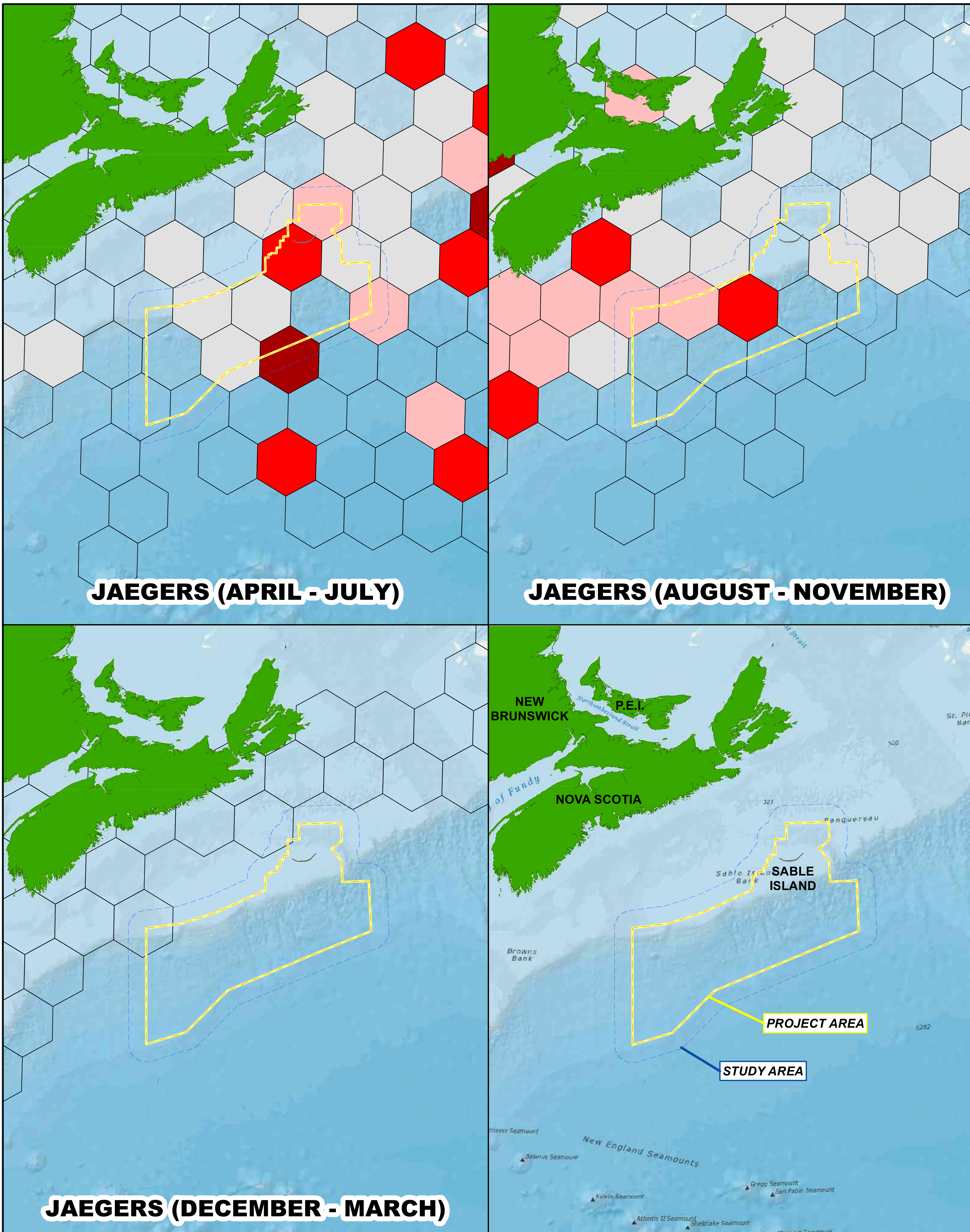

CLIENT:	TITLE:		
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	MARINE BIRD DENSITY - JAEGERS		
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK		
wood.	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-37
	REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

LEGEND:
- Study Area
- Project Area

Density (birds/km²)
- 0
- > 0.0 - 0.1
- > 0.1 - 0.2
- > 0.2 - 0.4
- > 0.4 - 5.5

100 km

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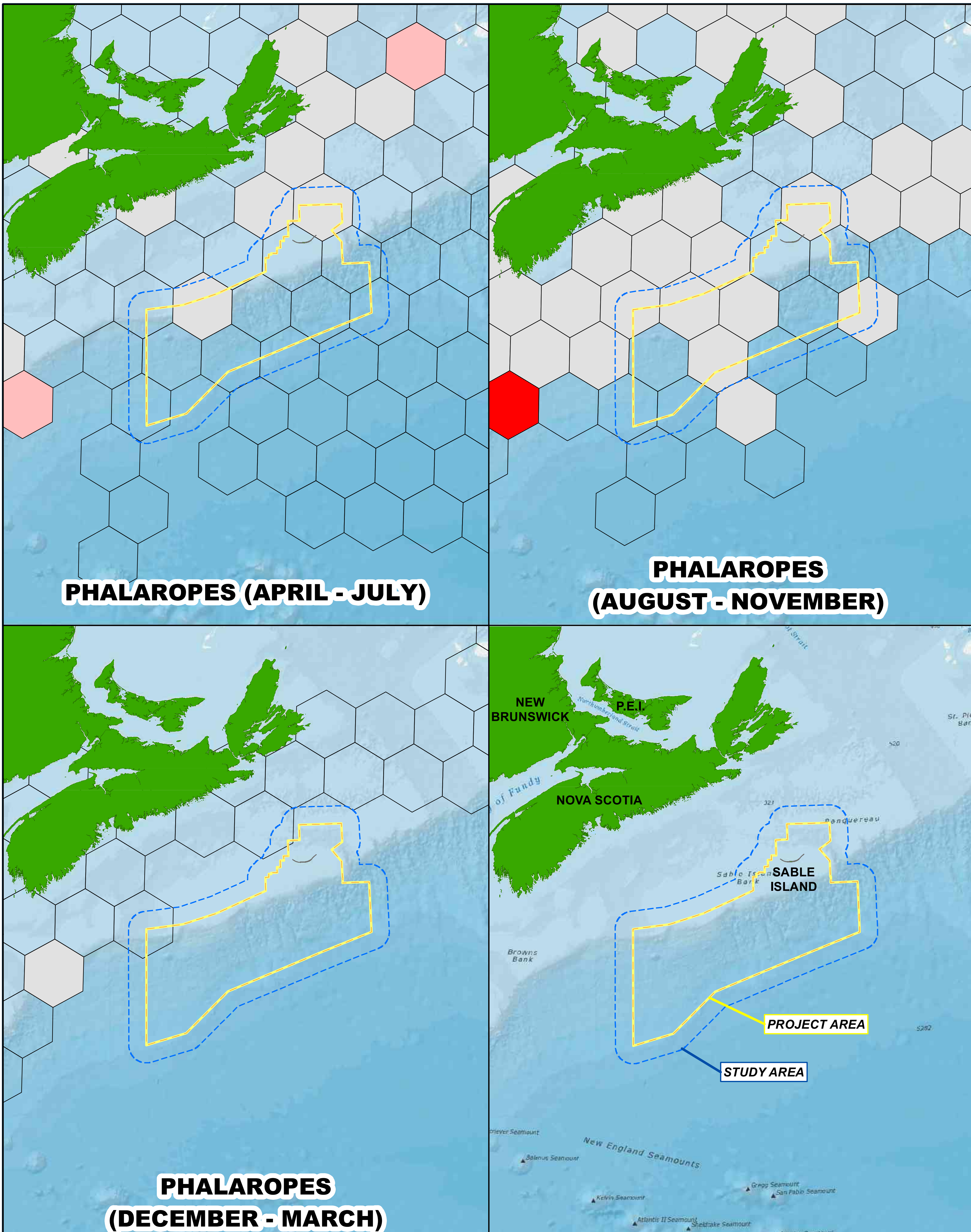

CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	TITLE: MARINE BIRD DENSITY - PHALAROPES		
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK		
wood.	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-38
	REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

LEGEND:
- Study Area
- Project Area

Density (birds/km²)
- 0
- > 0.0 - 3.9
- > 3.9 - 7.9
- > 7.9 - 15.7
- > 15.7 - 42.3

100 km

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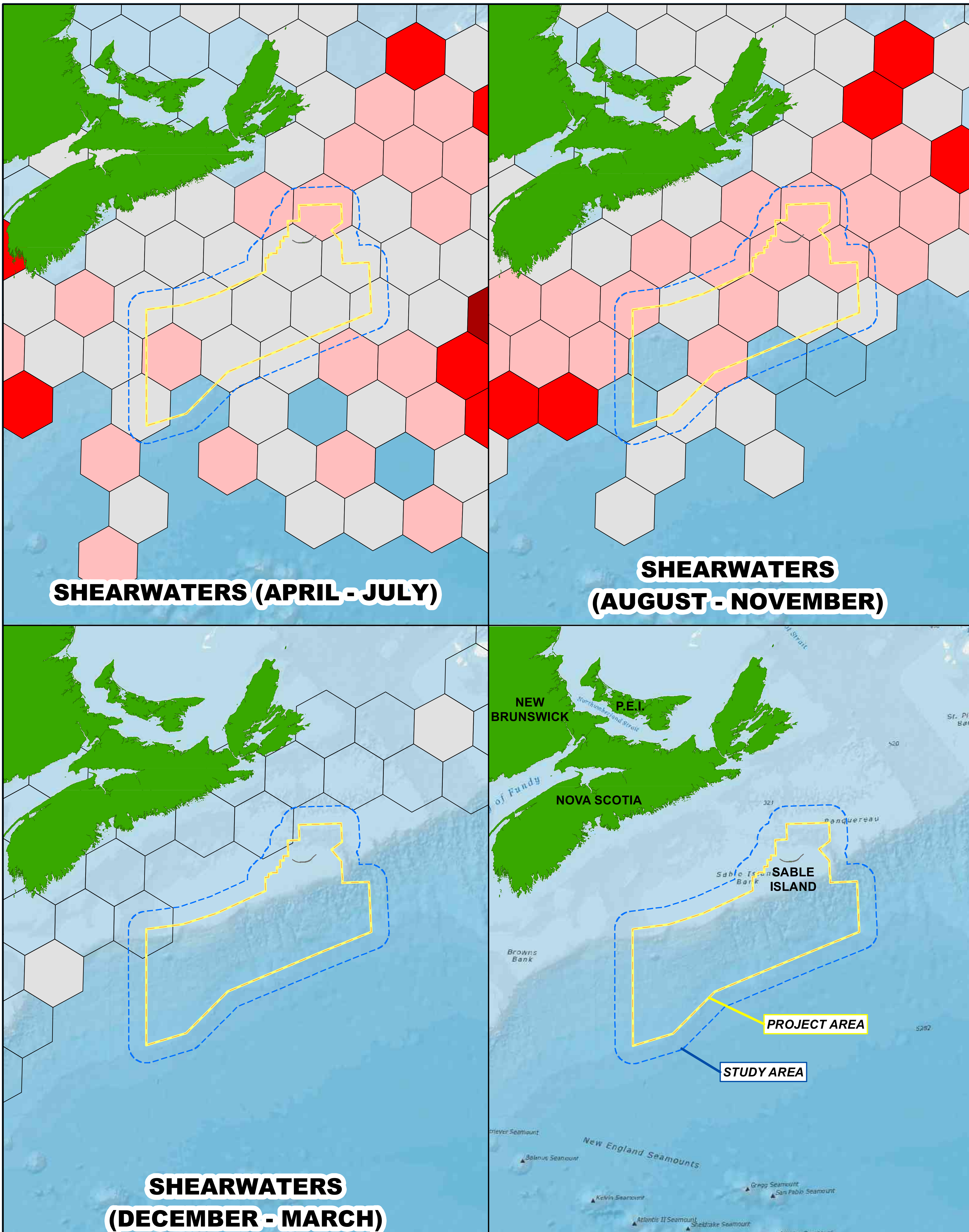
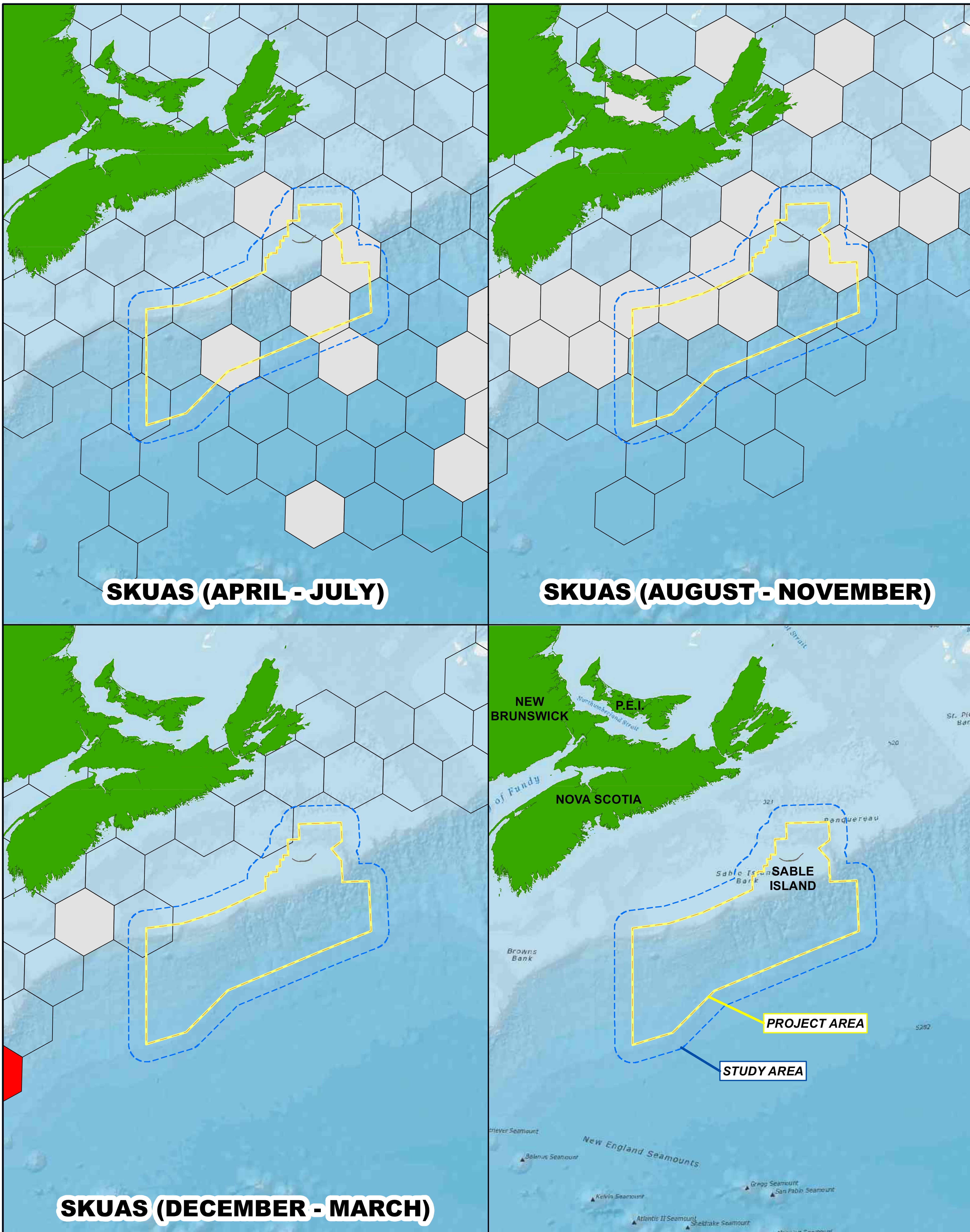


CLIENT:	TITLE:			LEGEND:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	MARINE BIRD DENSITY - SHEARWATERS			Study Area Project Area
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK			Density (birds/km^2) 0 > 0.0 - 2.9 > 2.9 - 12.5 > 12.5 - 25.2 > 25.2 - 74.4 100 km
wood.	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-39	
	REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000 0 50 100 200 300 400 Kilometres	
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N		

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_BIRDS\TE211002_FIGURE_3_39_MarineBirdDensity_SHEARWATERS.mxd User: candace.macdonald Date: 5/12/2022



CLIENT:	TITLE:		LEGEND:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	MARINE BIRD DENSITY - SKUAS		Study Area Project Area
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK		Density (birds/km^2) 0 > 0.0 - 0.4 > 0.4 - 0.7 > 0.7 - 1.1 > 1.1 - 9.6 100 km
wood.	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-40
	REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

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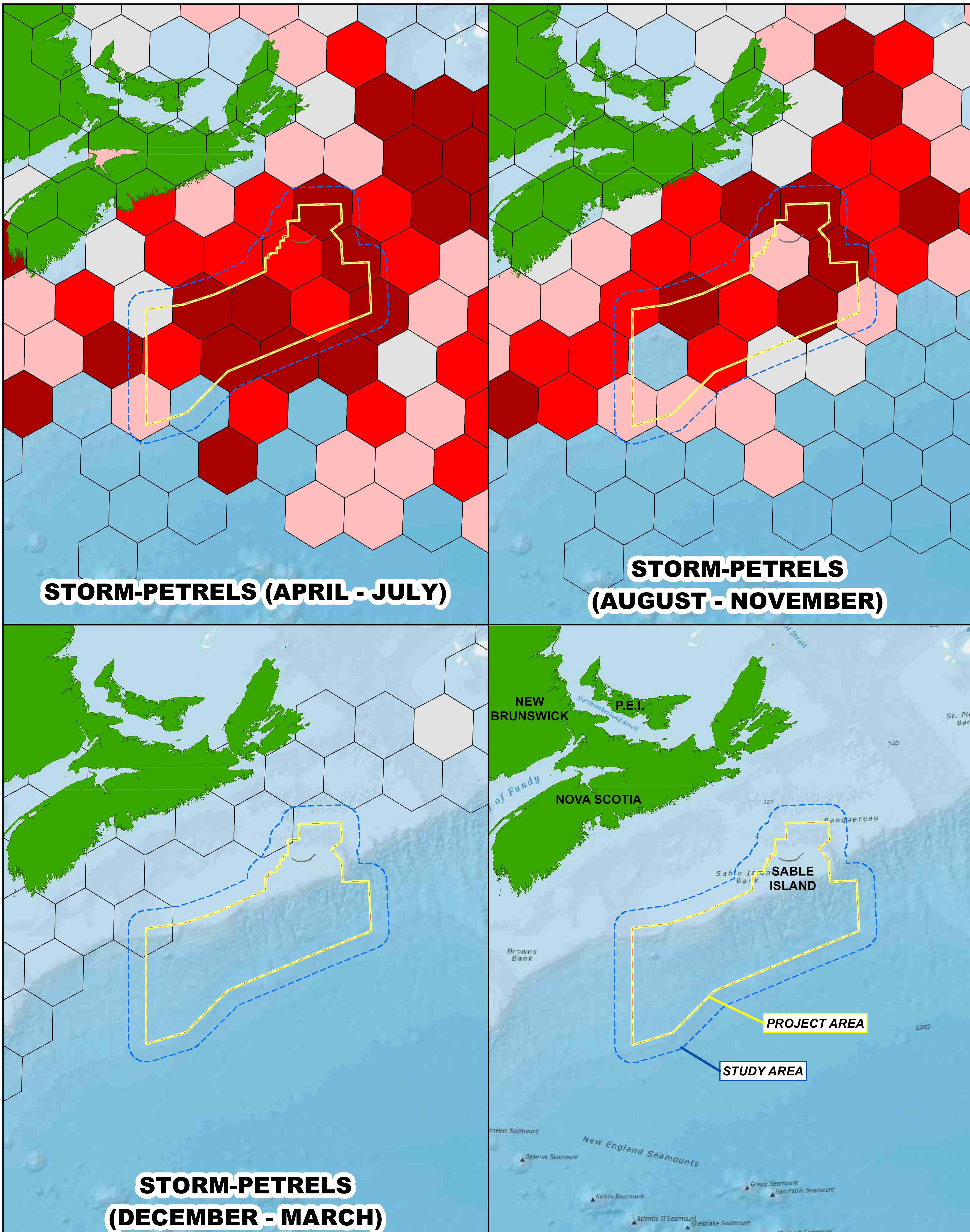


CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

TITLE:

MARINE BIRD DENSITY - STORM-PETRELS

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT
MIDDLE/EASTERN SCOTIAN SLOPE &
SABLE ISLAND BANK

LEGEND:

Study Area
Project Area

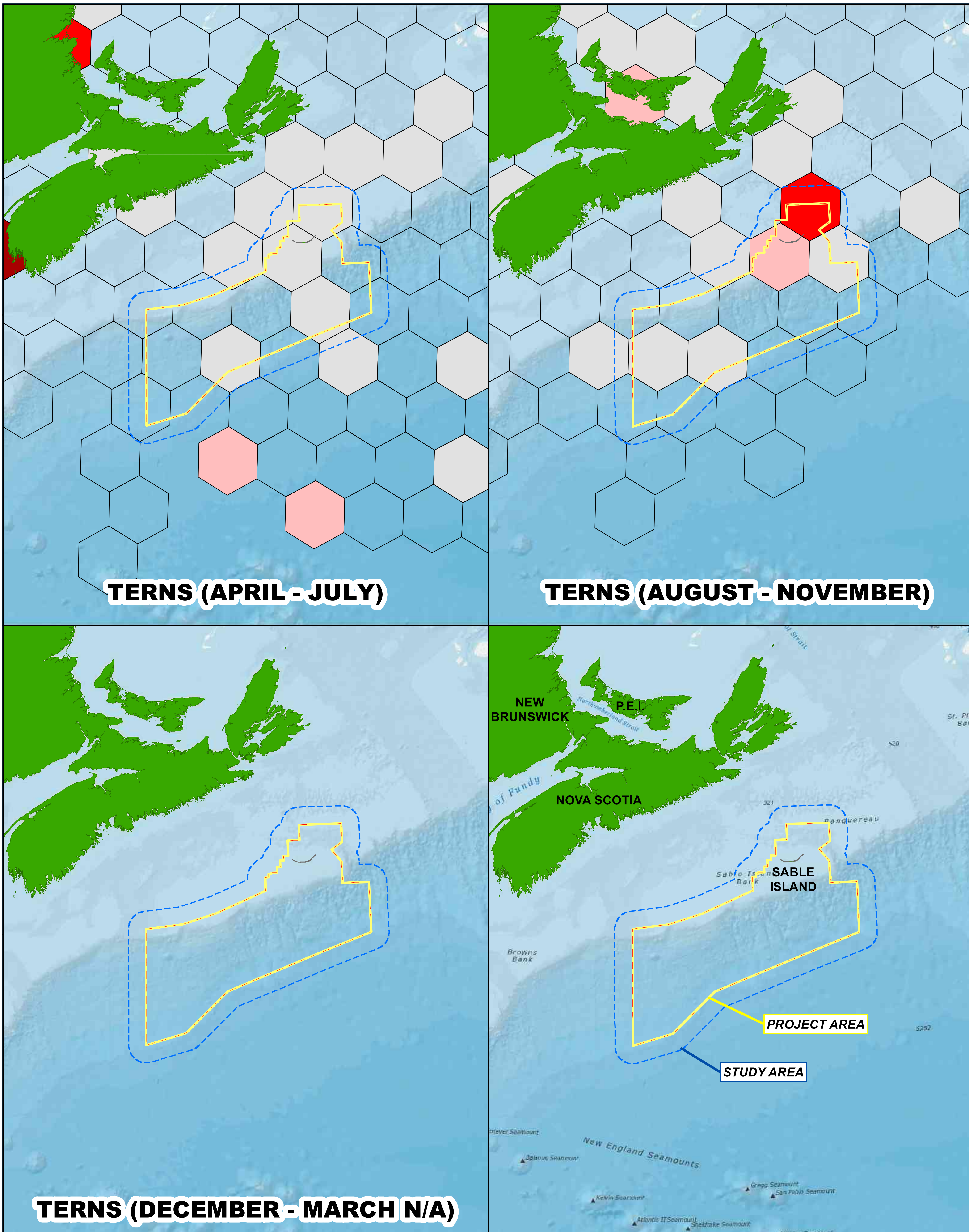
Density (birds/km^2)

- 0
- > 0.0 - 0.6
- > 0.6 - 2.4
- > 2.4 - 4.4
- > 4.4 - 102.8

100 km

PROJECT NO:	DATE:	FIGURE:
TE211002	MAY 2022	FIGURE 3-41
REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_BIRDS\TE211002_FIGURE_3_41_MarineBirdDensity_STORMPETRELS.mxd User: candace.macdonald Date: 5/12/2022



CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	TITLE: MARINE BIRD DENSITY - TERNS		
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK		
wood.	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-42
	REV NO: 1	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	0 50 100 200 300 400 Kilometres

LEGEND:
Study Area
Project Area

Density (birds/km^2)
- 0
- > 0.0 - 0.7
- > 0.7 - 1.7
- > 1.7 - 3.7
- > 3.7 - 8.5

100 km

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3.2.7.2 Shorebirds

Over 30 species of shorebirds occur on mainland Nova Scotia for at least part of the year and/or have been observed on Sable Island (ECCC 2017, LePage 2021). While not typically found offshore, shorebirds may pass through the Study Area and/or occur on Sable Island during migration. In Nova Scotia, shorebirds are most abundant during fall migration when many species feed in coastal areas on their southward journey from arctic breeding grounds. Of these feeding areas, the Bay of Fundy is of particular importance, supporting over 75 percent of the world's population of Semipalmated Sandpipers during migration. Some species may also breed in low numbers on Sable Island, including Semipalmated Plover and Least Sandpiper (Miller 1983).

Species that nest on mainland Nova Scotia include Willet, Spotted Sandpiper, Greater Yellowlegs, Piping Plover, Killdeer, Wilson's Snipe, and American Woodcock. During migration, Whimbrel, White-rumped Sandpiper, Greater Yellowlegs, Semipalmated Plover, Sanderling, American Golden-plover, Semipalmated Sandpiper and Black-bellied Plover are locally common in NS; other migrants include Dunlin, Hudsonian Godwit, Ruddy Turnstone, Least Sandpiper, Buff-breasted Sandpiper and Red Knot (rufa subspecies). Purple Sandpiper feeds in rocky coastal areas in the winter months.

As a guild, shorebirds are experiencing rapid, steep population declines, with an estimated 37 percent decline since 1970 (Rosenberg et al. 2019). Due to their reliance on high-quality coastal foraging habitat during migration, many shorebird species are susceptible to the effects of oil and gas production, particularly regarding possible oil spills affecting coastal Nova Scotia and Sable Island (Henkel et al. 2012). Although shorebirds are not expected to occur frequently within the Study Area, these broader potential impacts must be considered in project specific EAs.

3.2.7.3 Waterfowl

Waterfowl, along with loons and grebes, spend much of their time on the water's surface, and while most species nest in freshwater environments, many are found in the offshore environment during moult or to overwinter. Over 20 species of waterfowl occur in Nova Scotia during at least part of the year. Many species breed in NS, and Red-breasted Mergansers and American Black Ducks are known to breed on Sable Island (Birds Canada, no date). Most species nest on freshwater lakes and rivers, and some nest on estuaries. Many species migrate south in winter, while others such as scoters, mergansers, goldeneye and eiders overwinter in flocks on coastal and offshore waters of NS. Due to their preference for coastal environments (Fifield et al. 2009; Bolduc et al. 2018), waterfowl are not expected to occur frequently in the Study Area. It must be noted that data on waterfowl distribution and abundance on the Scotian Shelf and Slope are limited, particularly in winter months.

3.2.7.4 Other Marine-Associated Avifauna

Landbirds, including passerines (songbirds), raptors and other taxa, breed throughout the province and while most do not regularly occur in the marine environment, some species may migrate over the Study Area and/or occur as vagrants on Sable Island during migration. The Ipswich Sparrow is the only passerine species that breeds in significant numbers within the Study Area. Sable Island is identified as an Important Bird Area (IBA) due to the presence of breeding habitat critical to the species (Birds Canada, no date). In 1998, this species had an estimated island-wide breeding population at over 6000, though population size tends to fluctuate annually (Smith et al. 2003). The most recent estimates indicated a population size of 6671 and 5500 individuals in 2006 and 2013, respectively (Horn, 2007; Horn, 2013). Nocturnal migrants (including most passerines) are of particular concern, as they are attracted to artificial light sources at sea, particularly in foggy conditions. Sable Island is the only terrestrial habitat within the Study Area, the island is therefore expected to be an area of higher concentration for vagrant/migrant land birds compared to other marine areas (Birds Canada, no date). Other marine-associated birds that may infrequently occur in the Study Area include herons and egrets, though these species are mainly associated with coastal environments.

3.2.7.5 Marine and Migratory Bird Species in the Study Area

Table 3-15 lists bird species likely to be found in the Study Area, including their special status (i.e., special designations by SARA, COSEWIC and / or NSESA as applicable, habitat and distribution information, time of year present on Scotian Shelf and Slope, and probability of occurrence. Four avian SAR are likely to occur in the Study Area: Leach's Storm-petrel, Roseate Tern, Red-necked Phalarope and Ipswich Sparrow. Although not discussed here, a number of vagrant and/or non-breeding species may exist in low numbers within the Study Area; these species are most likely to occur on or near Sable Island (Birds Canada, no date). Species of conservation concern are discussed in Section 3.2.9.

Leach's Storm-petrels may be present throughout the breeding season; a recent tracking study recorded Leach's Storm-petrels travelling into the Study Area on foraging trips from colonies in Newfoundland, mainland NS, and New Brunswick during foraging trips (Hedd et al. 2018). Although Leach's Storm-petrels are widespread and relatively abundant, major breeding colonies in Canada have experienced an estimated 54 percent decline occurred over three generations (44 years) (COSEWIC 2020). This species is strongly attracted to artificial lighting from offshore oil and gas activities and may experience mortality due to collisions with or standings on platforms and vessels, incineration by flare stacks, and increased predation risk (Weiss et al. 2001). Project-specific EAs for petroleum exploration on the Scotian Shelf must consider Leach's Storm-petrels and their high susceptibility to disturbance. Similarly, projects in and near the Sable Island Banks must consider the small (<5 breeding pairs) population of Roseate Terns nesting on Sable Island, as the loss of even a single individual would have a significant impact on the population.

Table 3-15: Summary of Marine-Associated Birds Likely to Occur in the Study Area

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Pelagic Seabirds					
Gulls (Laridae)	**Black-legged Kittiwake**	-	**Year-round** (Peaks late fall to early spring)	**Likely**	• Much more pelagic than larger gulls. • Widespread and abundant, though more abundant on Newfoundland and Labrador Shelves than off coast of NS. Observed more frequently along Scotian Slope than Shelf. • NS is at the southern extent of the breeding range; mainly breeds at higher latitudes.
Fulmars, Shearwaters, and Petrels (Procellariidae)	**Northern Fulmar**	-	**Year-round** (Peaks in winter)	**Likely**	• Occurs primarily along continental shelf in temperate to cold waters. Present on Scotian Shelf and Slope year-round. • Breeds mainly in eastern Canadian Arctic in Summer. • Relatively common in Study Area, however abundance is highest along Newfoundland and Labrador Shelves.
	Great Shearwater	-	**Summer to fall** (May be present in low numbers in spring)	**Likely**	• In North Atlantic, occurs primarily along continental shelf in temperate to cold waters. • Breeds in South Atlantic in austral winter. Wide ranging and abundant in North Atlantic during non-breeding season. • Great Shearwater is the most abundant shearwater on the Scotian Shelf and Slope.
	Sooty Shearwater	-			

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Cory's Shearwater	-	**Fall**	**Likely**	• Breeds mainly in Northeast Atlantic. Migrates to Northwest Atlantic during non-breeding season. • In Northwest, occurs in areas of upwelling in temperate to cold waters. • Less common than Sooty and Great.
	Manx Shearwater	-	**Summer**	**Possible**	• Primarily occupies waters off continental shelf, with upwellings from Gulf Stream. • Uncommon but present along Scotian Shelf and Slope in summer months. • Breeds mainly in Northeast Atlantic. Few breeding pairs in Canada (<100).
	Audubon's Shearwater	-	**Summer**	**Likely**	• Breeds in the Caribbean. Winter range is not well understood. • Rarely observed in waters off southern NS.
	Barolo Shearwater	-	**Summer to Fall**	**Possible**	• Breeds in the Macaronesian Islands (Northeast Atlantic). • Rarely observed in waters off Maritime Canada.
	Scopoli's Shearwater	-	**Summer to Fall**	**Possible**	• Breeds in the Mediterranean. Overwinters in the Atlantic, predominantly in waters off the coast of West Africa and Eastern Brazil. • Infrequently observed in waters off eastern North America.

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Bermuda Petrel	-	**Spring to Fall**	**Likely**	• Breeds on small islands off southeastern Bermuda. Winter range is not well understood. • Known to travel 5,000 km or more in a foraging trip during the breeding season. • Few observations in waters off NS, though tracking data indicates some usage of the Bay of Fundy.
	Black-capped Petrel	-	**Spring to Fall**	**Likely**	• Breeds in the Caribbean. Found in offshore waters of the Caribbean and the Atlantic from northeast USA to northeast Brazil. • Highly pelagic year-round. • Infrequently observed in waters off NS.
	Fea's Petrel	-	**Spring to Fall**	**Possible**	• Breeds in the north Atlantic in the Cape Verde Islands and Madeira Islands. Disperses over tropical and subtropical waters of North Atlantic during the non-breeding season, with some birds remaining near the breeding sites year-round. • Rare vagrant to waters off NS.
	Zino's Petrel	-	**Spring to Fall**	**Possible**	• Breeds in the Madeira Islands. Disperses over east Atlantic during non-breeding period, though movements are not well understood. • Rare vagrant to waters off North America.
Storm-petrels (Hydrobatidae)	**Leach's Storm-petrel**	**Threatened** (COSEWIC)	**Spring to fall** (Peaks in summer)	**Likely**	• Highly pelagic, only returning to land to breed. Concentrated in areas with high zooplankton and crustacean densities. • Breeds mainly in Newfoundland, with a number of

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
					colonies along coastal Nova Scotia and one within the Study Area (Sable Island). Winters mainly in tropical Atlantic, concentrated near West Africa. • Within the breeding season, birds may travel hundreds of kilometers to forage offshore.
	Wilson's Storm-petrel	-	**Spring to fall** (Peaks in summer)	**Likely**	• Breeds in southern hemisphere during austral winter and spends summer months in the North Atlantic. • More common than Leach's on Scotian Shelf and Slope.
	Band-rumped Storm-petrel	-	**Spring to Fall**	**Possible**	• Breeds on small, remote islands of the Hawaiian archipelago, Galapagos, Japan, and off the coasts of Spain and Africa. Regular visitors to the east coast of North America from April to September. • Highly pelagic. Does not approach land except when blown in by storms.
	White-faced Storm-petrel	-	**Summer to Fall**	**Possible**	• Breeds on remote islands in northern and southern Atlantic Ocean, as well as New Zealand and Australia. • Infrequently observed off east coast of North America.
	European Storm-petrel	-	**Spring to Summer**	**Possible**	• Breeds in Northeast Atlantic. Winters in waters off South African coast. • Infrequently observed in small numbers off the coast of eastern North America.

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Alcids (Alcidae)	**Dovekie**	-	**Fall to spring** (Peaks in winter)	**Likely**	• Highly pelagic outside the breeding season. Spends a large proportion of their time on the water, rather than in flight. • Breed mainly in the high Arctic; not known to breed in NS. Core winter population is off Eastern Newfoundland, but also occurs off NS. • One of the most abundant seabirds along Scotian Shelf and Slope in winter.
	Atlantic Puffin	-	**Year-round** (Peaks in spring)	**Likely**	• Highly pelagic and widely dispersed outside the breeding season; sometimes found beyond continental shelves. • Breeds mainly in Newfoundland and high Arctic; small numbers breed near Bay of Fundy. • Relatively common on Scotian Shelf and Slope
	Common Murre	-	**Year-round** (Peaks in spring)	**Likely**	• Highly pelagic outside the breeding season. • Not abundant in winter aside from a "hotspot" northeast of Sable Island. • Common mainly breeds in Eastern Newfoundland and thick-billed mainly breeds in the high Arctic.
	Thick-billed Murre	-			
	Razorbill	-	**Year-round** (Peaks in spring)	**Possible**	• Relatively coastal year-round but have been observed during fall on the shelf edge near Sable Island and The Gully. • Winter mainly in the Bay of Fundy.

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Black Guillemot	-	**Year-round** (Peaks in spring)	**Unlikely**	• Largely coastal year-round. • Nesting sites are widespread along Bay of Fundy and coastal NS; mainly breeds north of Gulf of St. Lawrence.
Jaegers and Skuas (Stercorariidae)	**Pomarine Jaeger**	-	**Spring and fall**	**Possible**	• Breeds mainly in high Arctic tundra. • Pomarine is the most abundant Jaeger species observed on Scotian Shelf and slope. • May be present in low numbers within the Study Area during spring and fall migration.
	Parasitic Jaeger	-			
	Long-tailed Jaeger	-			
	Great Skua	-	**Fall to winter**	**Possible**	• Breeds in Europe and known to winter in the North Atlantic, mainly on the Grand Banks of Newfoundland. • May be present in low numbers within the Study Area during non-breeding season.
	South Polar Skua	-	**Spring to fall**	**Possible**	• Breeds along Antarctic coast in austral winter. May be present in low numbers within the Study Area during non-breeding season.
Gannets (Suliidae)	**Northern Gannet**	-	**Spring and fall** (May be present in low numbers year-round)	**Possible**	• Typically found along continental shelf. Flocks of up to 1000 may congregate over shoals of food fish. • Mainly breeds in eastern Newfoundland and Québec. Winter range extends from the Gulf of Maine to Mexico.

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
					• Arrive at colony in March. Juveniles migrate southward in September; adults and older immatures may migrate later.
Phalaropes[1] (Scolopacidae)	**Red Phalarope**	-	**Spring and fall** (Peaks in fall)	**Likely**	• Pelagic outside breeding season. Congregate near upwellings where densities of surface-dwelling prey are higher. • Breed in the low Arctic. Winter along offshore ocean fronts, mostly in tropical and sub-tropical regions.
	Red-necked Phalarope	**Special Concern** (SARA and COSEWIC)		**Likely** (In low numbers)	
Neritic Seabirds					
Gulls (Laridae)	**Herring Gull**	-	**Year-round** (Peaks late fall to early spring)	**Likely**	• Widespread and abundant; mainly coastal. • Outside the breeding season can be found in both coastal and offshore areas. • Breeds along Atlantic Coast, including numerous colonies in NS.
	Great Black-backed Gull	-			
	Ring-billed Gull	-	**Year-round** (Peaks late fall to early spring)	**Possible**	• Broadly distributed in winter; mainly coastal in NS. • Not confirmed to breed in NS. Atlantic Canadian population mainly breeds on in Newfoundland, with smaller colonies on Prince Edward Island and northern New Brunswick.
	Iceland Gull	-	**Fall to spring** (Peaks in spring)	**Unlikely**	• Breeds in the high Arctic. Winters in small numbers along Atlantic Coast and is infrequently observed on the Scotian Shelf.
	Glaucous gull	-			

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Ivory Gull	**Endangered** (SARA and COSEWIC)	**Winter vagrant**	**Unlikely**	• Breeds in the high Arctic. Winters near edges of pack ice in the North Atlantic. • Rarely observed along Nova Scotia coast and at Sable Island.
Terns (Sternidae)	**Arctic tern**	-	**Spring to fall**	**Likely**	• Relatively coastal during breeding season. Widely distributed with numerous colonies along the coast of eastern NS. • May occur in offshore waters of Study Area prior to and after migration. • Arctic Tern winters in Antarctica and Common Tern winters in Central and South America.
	Common Tern	-			
	Roseate Tern	**Endangered** (COSEWIC, SARA and NSESA)	**Spring and fall**	**Likely** (In low numbers)	• Canadian population breeds almost exclusively on a few coastal islands off the coast of NS, including a small colony within the Study Area (Sable Island). • Winters in South America. • May occur in offshore waters of Study Area prior to and after migration. • Terns nesting at Sable Island likely forage in the Study Area during the breeding season.
Cormorants (Phalacrocoracidae)	**Double Crested Cormorant**	-	**Spring to fall**	**Unlikely**	• Coastal; typically feed within a few kilometers of their nesting or roost location and rarely venture far offshore. • Both species breed along coastal Nova Scotia and migrate south in late fall.
	Great Cormorant	-	**Year-round** (Peaks in		

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
			spring and fall)		• Great Cormorants are partial migrants, with some individuals remain in the breeding range year-round.
Other Shorebirds[2]					
Plovers (Charadriidae)	**Piping Plover (Melodus subspecies)**	**Endangered** (COSEWIC, SARA and NSESA)	**Spring to fall**	**Unlikely**	• Found in low numbers on sandy or rocky beaches along the Atlantic Coast. • Not known to breed on Sable Island. Winter from the Southern Atlantic US coast to the Caribbean.
Other Sandpipers (Calidris)	**Red Knot (Rufa subspecies)**	**Endangered** (COSEWIC, SARA and NSESA)	**Late summer to early fall**	**Unlikely**	• Breeds in the Canadian Arctic and overwinters in northeast South America. • Stopover to feed along coastal Nova Scotia in late summer.
Waterfowl[2]					
	Harlequin Duck (Eastern Population)	**Endangered** (NSESA) **Special Concern** (COSEWIC and SARA)	**Fall to early spring**	**Unlikely**	• Mainly found in coastal marine environments; prefers rocky islands and shorelines for foraging. • Not known to breed in NS; mainly breeds in the Subarctic. Known to winter off the coast of NS.
	Barrow's Goldeneye	**Special concern** (COSEWIC and SARA)	**Fall to early spring**	**Unlikely**	• Diving duck with a range mainly restricted west of the Rocky Mountains; a small population breeds and winters in Eastern Canada. Not known to breed in NS.
Landbirds[2]					

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Passerines (Passeriformes)	**Savannah Sparrow** (Ipswich sparrow)	**Special Concern** (COSEWIC and SARA)	**Spring to fall**	**Likely**	• Coastal species; breeds almost exclusively on Sable Island. Winters on grassy dune beaches in the middle Atlantic states, with few individuals wintering in NS.

Notes:
1 Phalaropes are taxonomically shorebirds but are classified here as pelagic seabirds because they are highly pelagic outside the breeding season.
2 This is not a complete list of shorebird, waterfowl or landbird species. Other species could migrate through the Study Area and/or occur on Sable Island, however occurrences are expected to be infrequent, particularly on the Scotian Slope. The species listed in the Table above include SAR that should have special consideration in project specific EAs.

Sources: Ainley et al. 2020, Arnold et al. 2020, Baker et al. 2020, Bolduc et al. 2018, Brinkley and Sutherland 2020, Brown 1986, Butler et al. 2020, Carboneras et al. 2020a-e, Crysler et al. 2016, del Hoyo et al. 2020, Dorr et al. 2020, Drucker et al. 2020, Eadie et al. 2020, Farnsworth 2020, Fifield et al. 2009, Fjeldså et al. 2020, Furness et al. 2020a-b, Gaston and Hipfner 2020, Gochfeld et al. 2020, Good 2020, Hatch et al. 2020a-c, Hedd et al. 2018, Kirwan et al. 2020a-b, Lavers et al. 2020, Lee et al. 2020, Lowther et al. 2020, Mallory et al. 2020a-b, Montevecchi and Stenhouse 2020, Mowbray 2020, Pollet et al. 2020, Robertson and Goudie 2020, SARA 2020a-d, Slotterback 2021, Snell et al. 2020, Tracy et al. 2020, Weiser and Gilchrist 2020, Wheelwright and Rising 2020, Winkler et al. 2020.

3.2.8 Marine Mammals and Sea Turtles

Marine mammals and sea turtles are important long-lived megafauna on the Nova Scotian shelf. These animals are considered ecologically, economically and culturally valuable to several stakeholders and Indigenous groups (see Section 3.3). The combination of underwater topography and oceanographic conditions (see Section 3.1.3 and 3.1.5); form a productive ecosystem for various prey species (e.g., squid and fish) favoured by marine mammals and sea turtles (see Section 3.2.2). The Study Area has been identified as an area with high marine mammal species diversity from both visual and acoustic detections (Lawson and Gosselin 2009, Delarue et al. 2018). Specifically, the areas of Sable Island, the shelf edge, and the submarine canyons (e.g., The Gully) have been identified as important foraging, breeding, and migratory routes within the Study Area. There are 31 species of marine mammals and four species of sea turtles that may occur within the Study Area. Of these several are resident populations present year-round.

For the purposes of this SEA, marine mammals that may occur within the Study Area are divided into three groups:

- Mysticetes (baleen whales)
- Odontocetes (toothed whales and dolphins)
- Pinnipeds (earless seals)

Sea turtles that may occur within the Study Area are also discussed in this section. The following subsections discuss the presence and abundance of these groups in the Study Area and the surrounding areas.

Marine mammal and sea turtle occurrence within the Study Area is known from visual sightings, strandings and acoustic surveys. These maps may not depict a complete record of all marine mammal or sea turtle sightings within the Study Area. DFO and the Canadian Sea Turtle Network are actively tagging Leatherback sea turtles to investigate their migration patterns. The OBIS observation database is continually updated with new detections from various sources. Whales and sea turtles sightings maps provide an indication of presence only as absence in seasons or areas may be reflective of sampling effort rather than low presence. Table 3-16 lists the marine mammal and sea turtle species previously observed within the Study Area including conservation status (e.g., SARA or COSEWIC designations), time of year present, presence probability, and description of the habitat and distribution of each species. Appendix A provides a list of marine mammal and sea turtle common and scientific names for reference.

3.2.8.1 Mysticetes

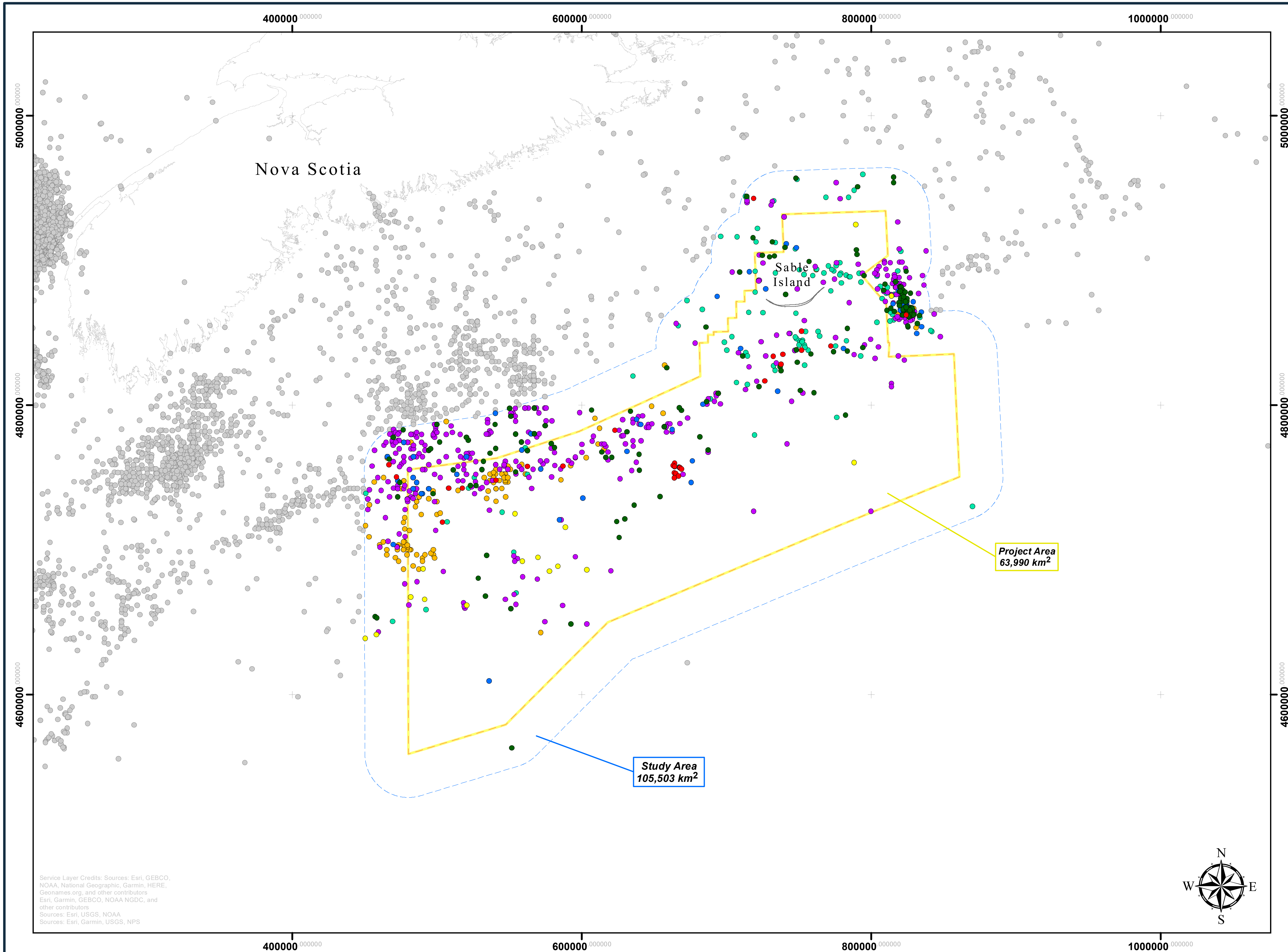
Six types of mysticete whales (blue, fin, right, humpback, sei, and minke whales), also known as baleen whales, are known to occur in the Study Area. These whales are differentiated from other whales by their relatively large size and sieve-like structures (baleen hair) instead of teeth that are used to filter out prey from the surrounding seawater. The main prey taxa for these species are copepods, krill and small schooling fish. Several areas within (e.g., The Gully) and near the Study Area have been designated important habitat for certain species (e.g., protected habitat for the North Atlantic right whale, see Section 3.2.10). The Study Area has been identified as important foraging grounds and migratory routes however, the full extent of how these animals use the area is still unknown. The entire shelf-slope break is considered Important Habitat for the Blue Whale as foraging habitat with evidence for year-round use (DFO 2018b).

Table 3-16 summarizes the current protection status, possibility of being observed in the Study Area, and habitat information for the six species. Figure 3-43 shows OBIS and DFO obtained detections data of these whales within the Study Area. While the sighting data has not been corrected for sampling effort, it does indicate that these species may occur within the Study Area. Observations of mysticetes from this dataset were mainly concentrated along the shelf edge and in The Gully, areas of high observations outside of the Study Area include the Scotian Shelf and the Bay of Fundy.

The Study Area is a region of ongoing marine mammal scientific investigations. In one 23-year study of visual observations found blue, fin, and humpback whales were frequently observed in the area and specifically The Gully (Whitehead 2013). Of the three canyons on the Scotian shelf (The Gully, Shortland, Haldimand), The Gully is the largest, and studies have observed whales and dolphins are more attracted to larger submarine canyons (Moors 2012). Acoustic surveys of Eastern Canada found that blue whales and fin whales do not seasonally migrate out of Canadian waters (Delarue et al., 2018). Blue whales have been acoustically detected within the Study Area on the Scotian shelf edge with high detections rates in the adjacent Laurentian Channel and southern edge of the Grand Banks of Newfoundland (Delarue et al., 2018). Species distribution modelling in the region based on ocean depth, seabed topography, sea surface temperature, and chlorophyll-a levels was used to identify priority research areas for various whale species (Gomez et al. 2020). Areas of the Scotian Shelf and slope within the Study Area were identified in the study, suggesting preferred habitat conditions in those areas by particular whale species (Gomez et al. 2020). Although deeper waters were not identified for high potential habitat use, this is likely an artifact of sampling effort rather than absence of whales in the area. Movement of tagged blue whales, visual survey sightings, and sparse acoustic detections could indicate that the Study Area is used as a migratory corridor to and from the Laurentian Channel (Lesage et al. 2017, Whitehead 2013, Delarue et al. 2018). As shelf break and slope areas are aggregation areas for krill, this area is also important feeding habitat for blue whales (DFO 2018b). Fin whales have also been detected within the Study Area year-round with most acoustic detections occurring between August and April (Delarue et al., 2018). As ice cover moves into its northern range, the ice-free Scotian shelf becomes a key area for this species in fall and winter (Delarue et al., 2018).

The North Atlantic right whale has been designated Endangered under SARA Schedule 1 (DFO 2020c) after it was over hunted from whaling. The Roseway Basin and Grand Manan Basin have been identified as critical habitat for this species in Canadian Waters (DFO 2014, 2020c). Recent passive acoustic monitoring studies using fixed stations and gliders indicated that North Atlantic right whales are present in Atlantic Canada year round with relatively higher detections from June to December (Durette-Morin 2021, NOAA 2021). Their slow movements and propensity to linger at the surface make them susceptible to ship strikes and entanglements with fishing gear (MacLean et al. 2013, Moore et al. 2021). Other potential threats that may limit recovery of this species include habitat degradation (i.e., from pollution, ocean dumping, and dredging), biotoxins, and acoustic disturbance (e.g., vessels and seismic activity) (COSEWIC 2013, DFO 2014). There are some protections in place in the adjacent shipping lanes in the Laurentian Channel adjacent to the Study Area (TC 2021). Within the Study Area, the right whale is commonly observed and utilizes the area for migration and foraging (Plourde et al. 2019). They have been observed to congregate in the Roseway Basin, critical habitat adjacent to the Study Area (DFO 2014). Their distribution is likely influenced by the presence of dense aggregations of their main prey species of copepods (e.g., *Calanus* sp., DFO 2019b, Plourde et al. 2019). In assessment of the historical copepod distribution and abundance, potential foraging habitats were identified in the Roseway Basin and areas adjacent to the Grand Manan Basin (Plourde et al. 2019). Other potential foraging habitats in the region included coastal waters off western Nova Scotia, central and eastern Scotian Shelf in the spring and east of Cape Breton in the summer to fall (Plourde et al. 2019).

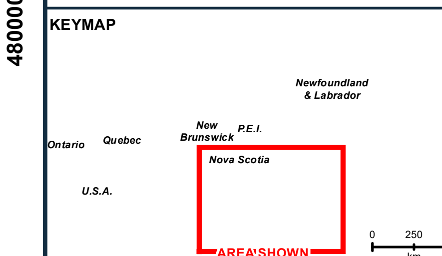
Other mysticetes observed in the area include the humpback, sei, and minke whales. Humpback whales have been visually detected in the Study Area (Whitehead 2013) and acoustically detected year-round on the Scotian shelf (Delarue et al., 2018). Sei whales were commonly detected in deep waters from the Flemish Pass to southern Labrador in the summer and fall months and off the Scotian shelf edge in late November to early December (Delarue et al., 2018). Minke whales, the smallest baleen whale observed in the region, may seasonally migrate through the area (Bernier et al. 2018). Aerial studies have noted that minke whales were the most abundant baleen whale on the Scotian shelf (Lawson and Gosselin 2009).



LEGEND:

- Baleen Whale (16)
- Blue Whale (72)
- Fin Whale (479)
- Humpback Whale (168)
- Minke Whale (116)
- Right Whale (30)
- Sei Whale (149)
- Observation Outside Study
- Project
- Study

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

MARINE MAMMALS MYSTICETES BALEEN WHALES

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 2	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-43**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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3.2.8.2 Odontocetes

Odontocetes, also known as toothed whales, includes several groups including sperm whales, beaked whales, and dolphins. These species are generally smaller than baleen whales and can travel in large groups known as pods. The main foraging taxa for these animals are fish and deep-sea squid. There are 20 species that have been observed on the Scotian shelf and may occur in the Study Area (Table 3-16). Within in the Study Area odontocetes have been observed along shelf edge and within The Gully but are also observed in adjacent areas (Figure 3-44 and 3-45).

There is a northern bottlenose whale population that is routinely present in The Gully Canyon (Gowans et al. 2000). The Scotian shelf population has been designated as Endangered under SARA Schedule 1 in 2006 (SARA 2021). The submarine canyons on the shelf edge have been designated as critical habitat for this species (DFO 2010a). Mainly found in deep waters offshore (Mead 1989), these whales use the submarine canyons for foraging for food (e.g., squid).

There are several species of beaked whales observed in Atlantic Canada and within the Study Area (Figure 3-44). Sowerby's beaked whale are designated Special Concern under SARA Schedule 1 (COSEWIC 2019b, SARA 2021) and have been visually observed in the Study Area (Whitehead 2013). Beaked whales and particularly Cuvier's and Sowerby's beaked whales have a year-round presence within the Study Area along the Scotian Shelf edge south west of Sable Island (Delarue et al. 2018). Sowerby's beaked whales prefer deep waters for foraging and are sighted more often in the Shortland and Haldimand canyons versus The Gully (Whitehead 2013). Acoustic detections of Mesoplodon species (possibly Gervais' or True's beaked whale) have also been detected along the Eastern Canadian Seaboard (Delarue et al. 2018). The presence of Gervais,' True's, and Blainville's beaked whale in Eastern Canadian waters is based on isolated strandings/sightings (Mead 1989) and Mesoplodon acoustic detections (attributed to Grevias' or True's beaked whales) (Delarue et al. 2018). Blainville's beaked whales have been sighted once in The Gully and stranded twice in Nova Scotia (Mead 1989).

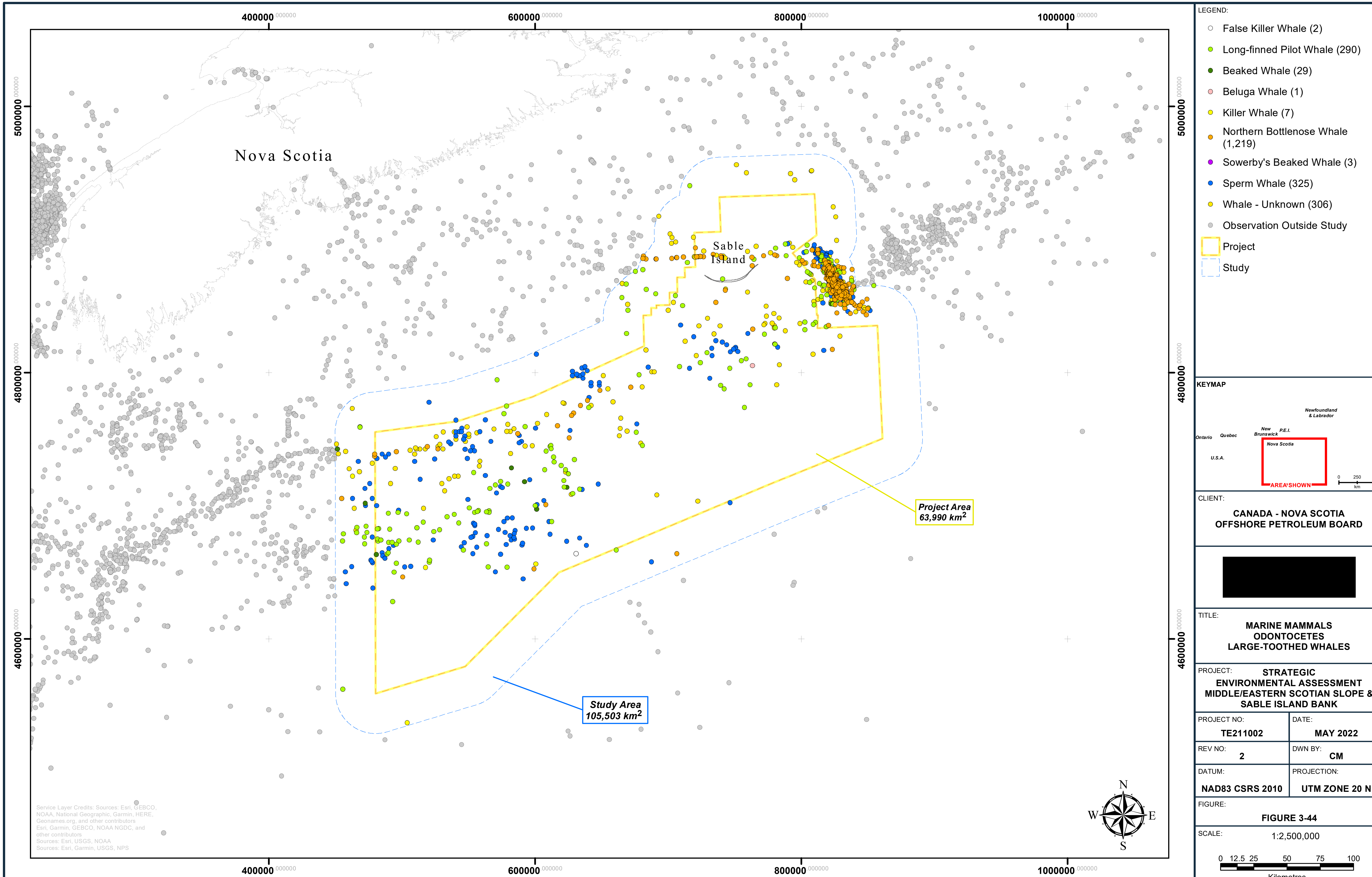
Sperm whale vocalizations have been detected year-round along the Scotian Shelf edge within the Study Area (Delarue et al., 2018). Eastern Canadian waters appear to be habitat for male sperm whales (Reeves and Whitehead 1997) while females reside year-round in lower latitudes. While sperm whales have been detected year-round in Canadian waters, this may account for some seasonal variations in observations. Delarue et al., (2018) detected vocalizations similar to harbour porpoise clicks and tentatively attributed it to dwarf or pygmy sperm whales.

Pilot whales are commonly observed off Eastern Canada (Lawson and Gosselin 2009, Whitehead 2013) and persist year-round off the Scotian Shelf (Delarue et al. 2018). Long-finned pilot whales are commonly detected in late summer along the continental slope and canyons (Whitehead 2013) which is the preferred habitat of their prey species the long-finned squid.

Several dolphin species have been observed in the Study Area (Figure 3-45). Scientific surveys have found dolphins to be some of the most abundant marine mammals observed on the shelf (Lawson and Gosselin 2009, Delarue et al. 2018). Small delphinidae species (e.g., dolphins) are present year-round within the Study Area (Delarue et al. 2018). The most commonly observed species were the white-beaked, white-sided, and common dolphins in the Scotian shelf region (Lawson and Gosselin 2011). A two-year acoustic survey of Eastern Canada found that delphinid acoustic signal distribution was concentrated along the Scotian Shelf edge during winter and spring months (Delarue et al. 2018). Killer whales have been visually (Lawson and Gosselin 2009) and acoustically detected within the Study Area close to Sable Island (mostly in the summer and fall) (Delarue et al.

2018). Unlike in other Canadian populations (Pacific Ocean), prey specialization by Killer whales in eastern Canada is unknown although there is evidence of this species foraging on marine mammals (Lawson and Stevens 2013).

Harbour porpoise acoustic detections had seasonal variations on the outer Scotian Shelf in the Study Area, being more pronounced in winter and early summer months (Delarue et al., 2018). While they have been observed in the deep water in The Gully Canyon (Whitehead 2013), they are more commonly detected in shallow coastal waters on the shelf (Lawson and Gosselin 2009, Lawson and Gosselin 2011).



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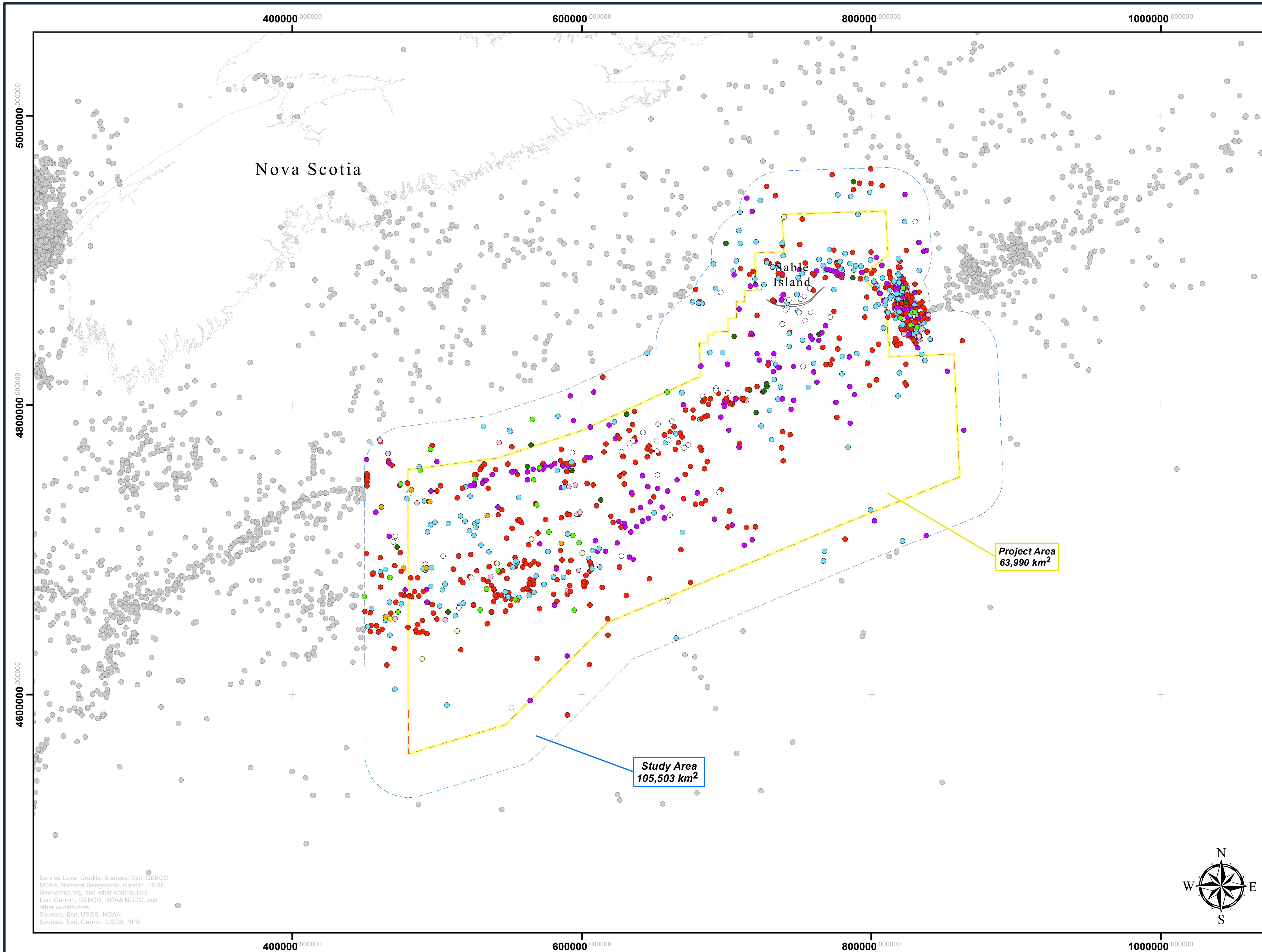
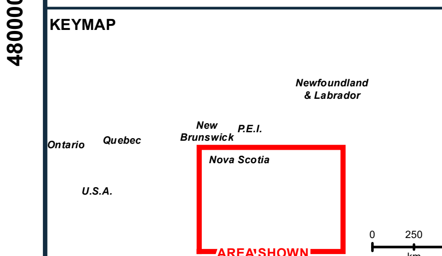


LEGEND:

- Spotted Dolphin (1)
- Dolphin - Unknown (702)
- Atlantic Bottlenose Dolphin (67)
- Common Dolphin (432)
- Rissos Dolphin (10)
- Striped Dolphin (72)
- White-beaked Dolphin (6)
- White-sided Dolphin (471)
- Harbour Porpoise (20)
- Cetacean - Unknown (27)
- Observation Outside Study
- Project Area
- Study Area

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

MARINE MAMMALS
ODONTOCETES
SMALL-TOOTHED WHALES

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 2	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

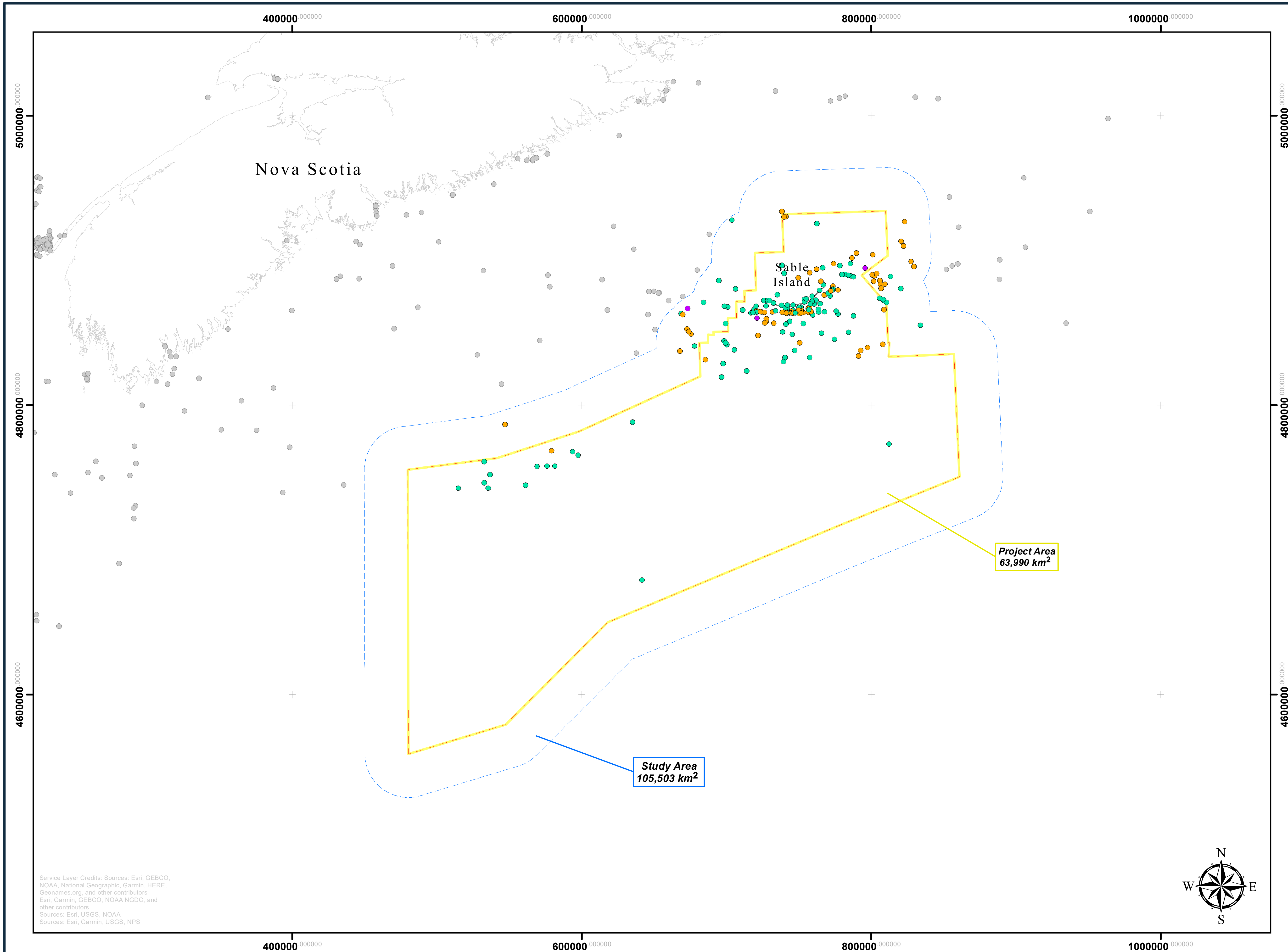
FIGURE: FIGURE 3-45

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

3.2.8.3 Pinnipeds

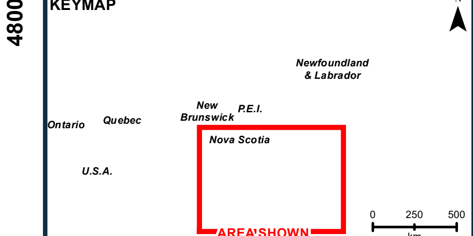
There are five pinniped (seal) species found within Atlantic Canada which include the grey seal, harbour seal, harp seal, ringed seal, and hooded seal (Figure 3-46). Of the species noted, ringed and hooded seals are least likely to occur within the Study Area. Hooded seals, an ice-breeding offshore species, have been noted on Sable Island in previous years (Lucas et al. 2003). The grey seal population is divided into three components in Atlantic Canada (DFO 2017). Based on arial surveys, the largest colony of grey seals is located on Sable Island within the Study Area (DFO 2017). Pupping season occurs from December to February and in 2016, 85 percent of pups were born to the Sable Island colony (DFO 2017). Similar to the grey seal, harbour seals in Atlantic Canada (*Phoca vitulina concolor*) have three distinct components of which one population is within the Study Area on Sable Island (Hammill et al. 2010). Harbour seals are associated with coastal areas and sandy beaches. Pupping occurs in the spring and summer months on the island. A resident herd of harp seals located in the Gulf of St. Lawrence have been occasionally observed within the Study Area (DFO 2010b). This species migrates north to the Davis Strait after April/May. Presence of this species within the Study Area is sporadic.



LEGEND:

- Grey Seal (98)
- Harbour Seal (3)
- Seal - Unknown (118)
- Observation Outside Study
- Project
- Study

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

MARINE MAMMALS SEALS

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 2	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-46

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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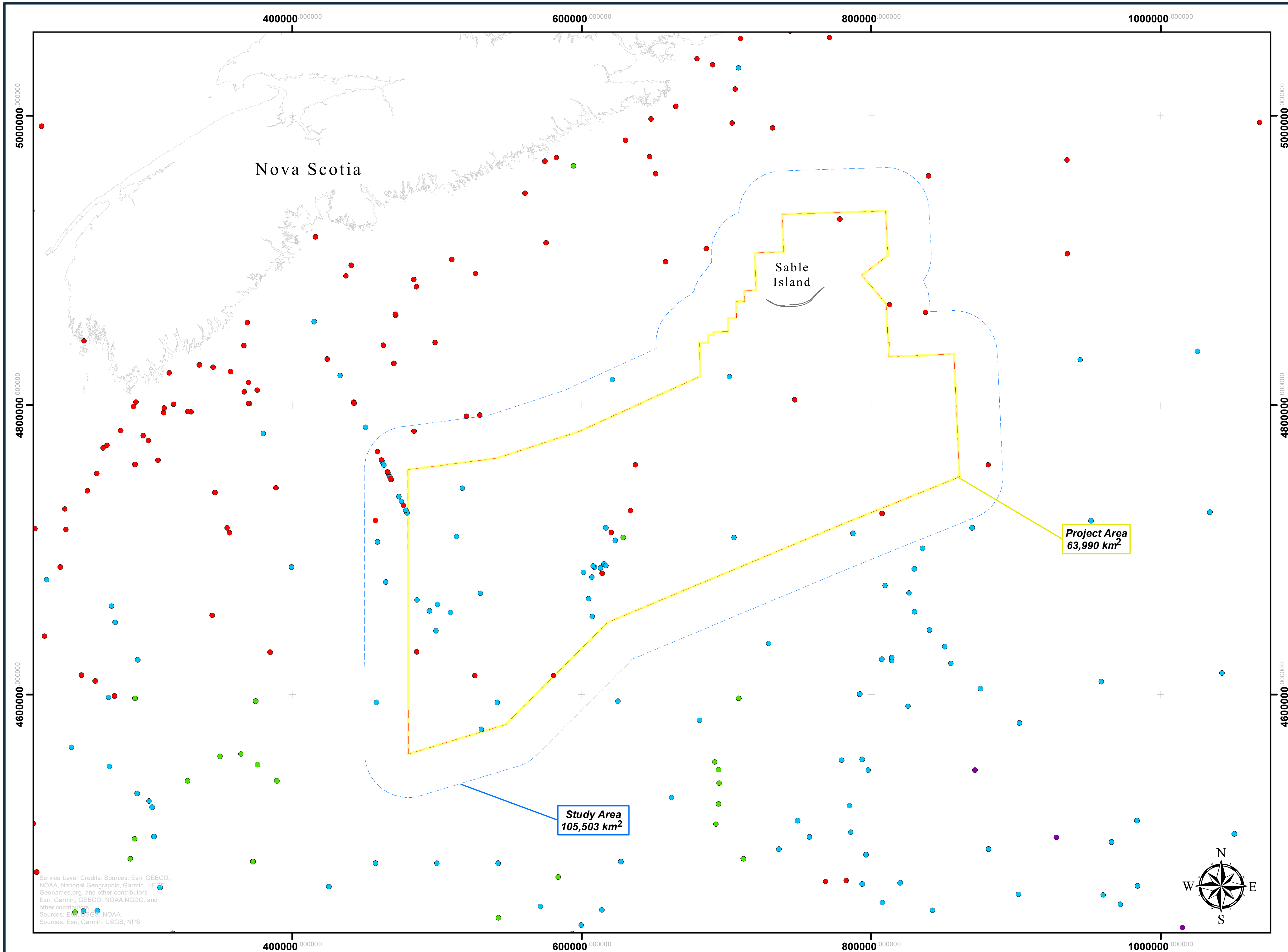
3.2.8.4 Sea Turtles

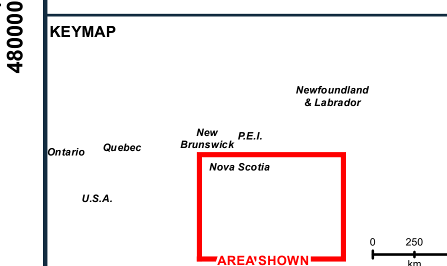
Of the four species of sea turtles that may occur in the Study Area, leatherback and loggerhead sea turtles are commonly observed (Figure 3-47). The main prey species for sea turtles are jellyfish, whereas prey for loggerheads consists of invertebrates (such as crustaceans and molluscs), fish and other zooplankton. Leatherback sea turtles are the largest sea turtle in the world and have a global distribution. In Canada, the leatherback is listed under Schedule 1 of SARA (SARA 2021). For the northwest Atlantic subpopulation, nesting areas are in low latitude areas in the Wider Caribbean Region up through to Florida, US (NALWG 2018). Within the Study Area, leatherbacks migrate to the area in the summer months and are found along the shelf edge and slope (Nordstrom et al. 2020, DFO 2020u). Leatherback turtles are particularly abundant on the Scotian Shelf in late June and July based on satellite telemetry studies (DFO 2020u). Two primary areas of important habitat for leatherback turtles are in areas outside the Study Area; the southeastern Gulf of St. Lawrence and east of Cape Breton Island, and waters south and east of the Burin Peninsula, Newfoundland (DFO 2020u). Changes in jellyfish distribution could signal changes in leatherback distribution. Loggerhead sea turtles are also listed under Schedule 1 of SARA and are declining globally (SARA 2021). Similarly, loggerheads migrate to Atlantic Canadian waters to forage and nest primarily on beaches in the tropics and subtropics. Locally they are found in the offshore in warmer waters such as the Gulf Stream (SARA 2021). Loggerhead sea turtle have been found to hybridize with Kemp's Ridley and green sea turtles (Karl et al. 1995, Barber et al. 2003, James et al. 2004). Green sea turtles and Kemp's Ridley sea turtles are less commonly observed in the Study Area. The green sea turtle has a broad range in the western Atlantic and is manly found in warm waters in the tropic and subtropics. Juveniles have been observed seasonally on the Scotian shelf and slope (Figure 3-47, James et al. 2004).



LEGEND:

- Leatherback Sea Turtle
- Green Sea Turtle
- Kemp's Ridley
- Loggerhead Sea Turtle
- Project Area
- Study Area

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

SEA TURTLES

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 1	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-47

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_MAMMALS\TE211002_FIGURE_3_47_SeaTurtles.mxd User: candace.macdonald Date: 5/12/2022

3.2.8.5 Marine Mammal and Sea Turtle Species in the Study Area

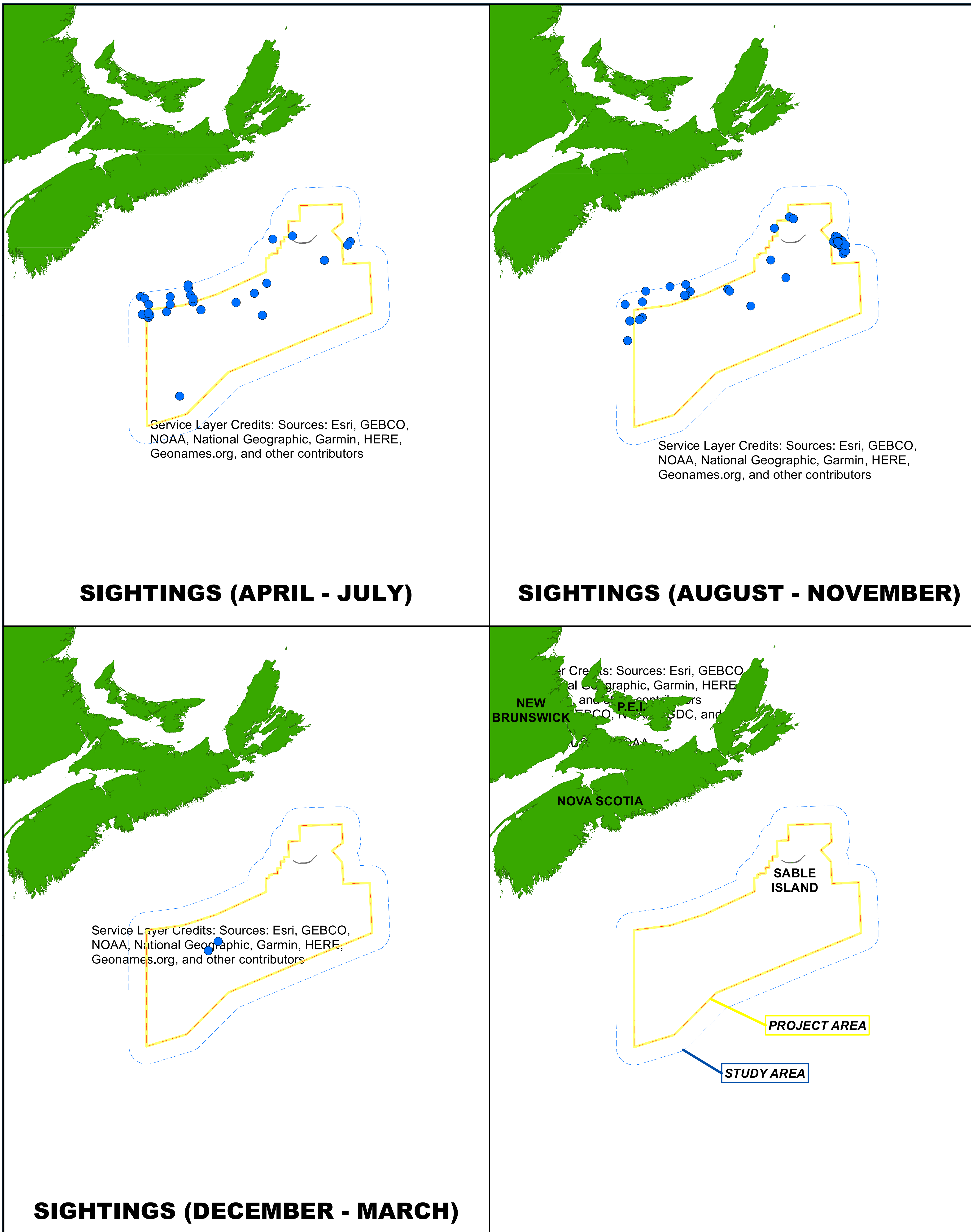
Information on the habitat and distribution of marine mammal and sea turtle species likely to occur in the Study Area is presented in Table 3-16. This includes information on SAR designated under SARA, identified by COSEWIC or through the International Union for Conservation of Nature (IUCN). Species of conservation concern are discussed in Section 3.2.9.

Of these species known or likely to occur in the Study Area, seven are listed under Schedule 1 of SARA: blue whale, fin whale, North Atlantic right whale, northern bottlenose whale, Sowerby's beaked whale, leatherback sea turtle and loggerhead sea turtle. The Beluga whale (designated under SARA) is unlikely to occur in the Study Area (SARA 2021). The Sei whale (designated by COSEWIC) is likely to occur in the Study Area. The Killer Whale and Harbour Porpoise (both designated by COSEWIC) possibly occur in the Study Area (COSEWIC 2006a). The sperm whale (COSEWIC) is likely to be observed in the Study Area year-round. Additionally, five species proposed as candidates for assessment consideration by COSEWIC (i.e., Cuvier's beaked whale, hooded seal, harp seal, green sea turtle and Kemp's Ridley sea turtle) may occur in the Study Area (COSEWIC 2021).

Several whale species are of particular concern due to important and critical habitat in the Maritimes Region. Within the Study Area, important or critical habitat (SARA) has been identified for two whale species: northern bottlenose whale (critical habitat) and North Atlantic right whale (critical habitat) (SARA 2021). The Scotian shelf and slope (including submarine canyons) has been identified as important habitat for blue whales (DFO 2018b). Adjacent areas in the Roseway Basin and Bay of Fundy are designated as critical habitat (SARA) for North Atlantic right whales (DFO 2014, SARA 2021). Recent passive acoustic monitoring studies have detected North Atlantic right whales in the Study Area primarily through fixed stations (DFO 2020v, Durette-Morin 2021, NOAA 2021). Detections for this species are relatively low in the Study Area compared to other areas of Atlantic Canada (DFO 2020v, Durette-Morin 2021, NOAA 2021). This is likely an artifact of fewer passive acoustic monitoring stations in the Study Area and not necessarily indicative of lower presence.

The Gully has been identified as important habitat for many of the species listed in Table 3-16, and specifically the northern bottlenose whale and Sowerby's beaked whale (SARA 2021). Seasonal distribution patterns of these four marine mammal species are presented in Figure 3-48 to Figure 3-51. Blue whales and Northern bottlenose whales (Scotian Shelf Population) are observed year-round, mainly along the shelf edge and in The Gully. While North Atlantic right whales and Sowerby's beaked whales were mainly observed in the spring and fall along the shelf edge and The Gully (SARA 2021) however, this may be an artifact of the OBIS dataset with lower historical sampling effort in winter. Passive acoustic monitoring studies suggests that North Atlantic right whales are present in Canadian waters year round, although with fewer detections in winter (DFO 2019b). These whale populations are threatened by vessel strikes and entanglements with fishing gear. While exact estimates of population for all species are unknown, their populations are considered low. The number of North Atlantic right whales at its most recent peak was approximately 500 individuals in 2010 with declines to approximately 400 individuals by 2018 (Pace et al. 2021). Therefore, the loss of small numbers of whales has wider population implications.

Both leatherback and loggerhead sea turtles are classified as endangered under SARA schedule 1. Their distribution patterns in the area are represented in Figure 3-47 and are migratory occurring mainly in summer and fall months. Leatherback sea turtle distribution is influenced by sea surface temperatures and important foraging habitat has been identified on the Scotian Shelf in the Study Area (SARA 2021).



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

SPECIES AT RISK - BLUE WHALE

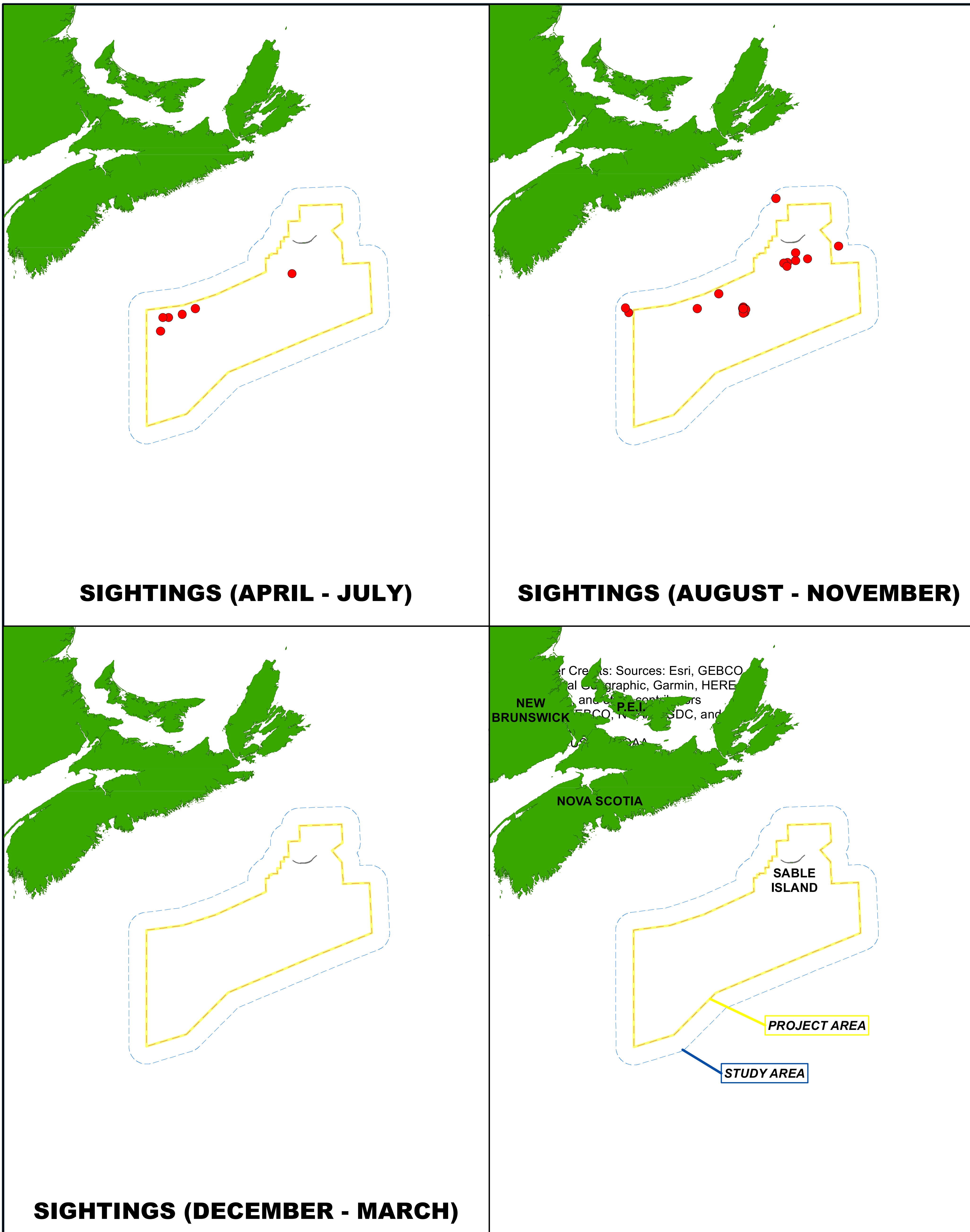
PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:	FIGURE:
TE211002	**MAY 2022**	**FIGURE 3-48**
REV NO: **1**	DWN/CHK'D BY: **CM / MA**	SCALE: 1:6,000,000
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**	0 50 100 200 300 400 Kilometres

LEGEND:
- Blue Whale Sighting
- Study Area
- Project Area

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_MAMMALS\TE211002_FIGURE_3_48_SAR_BlueWhale.mxd User: candace.macdonald Date: 5/12/2022



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

SPECIES AT RISK - NORTH ATLANTIC RIGHT WHALE

PROJECT:

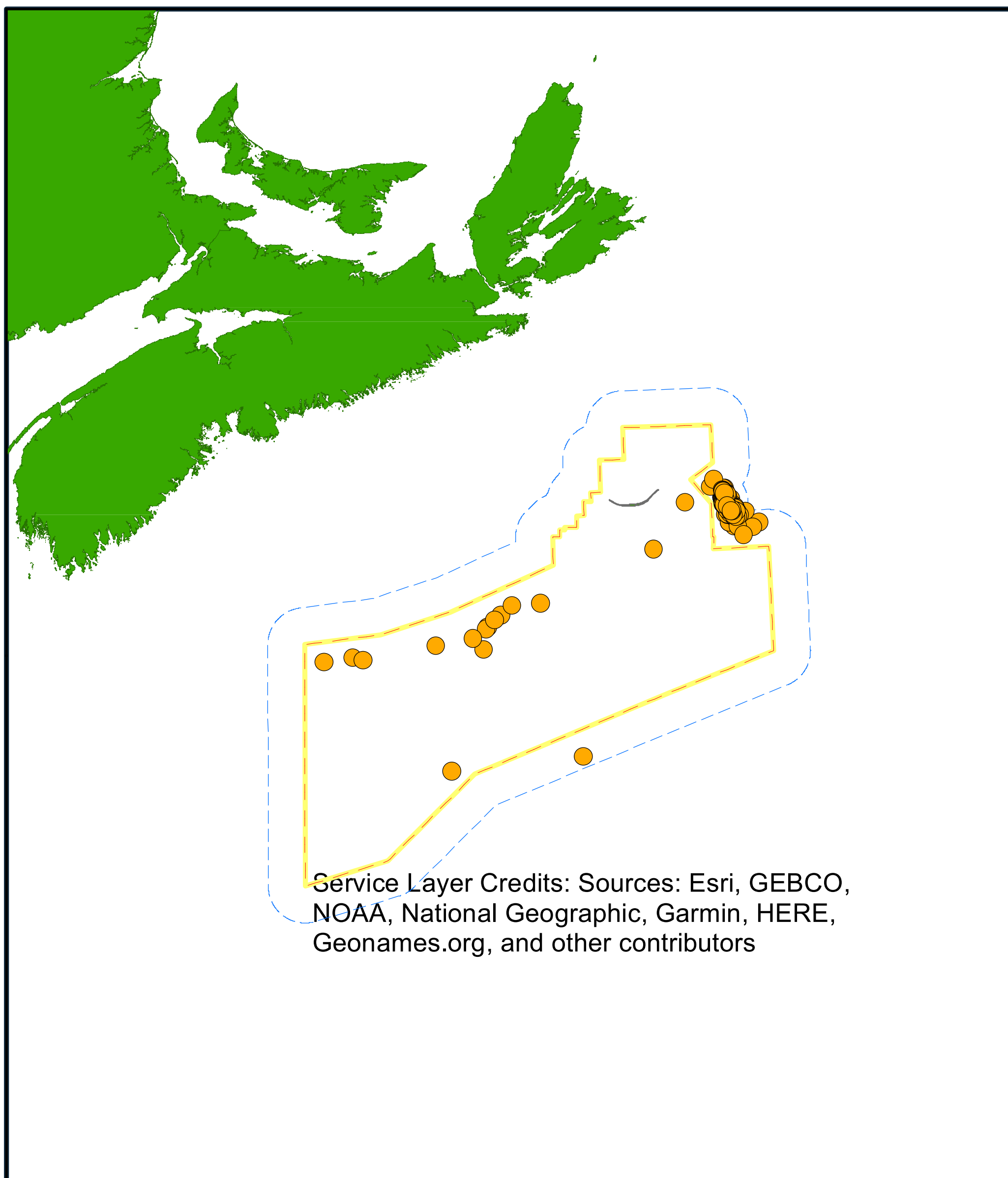
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: **TE211002**	DATE: **MAY 2022**	FIGURE: **FIGURE 3-49**
REV NO: **1**	DWN/CHK'D BY: **CM / MA**	SCALE: 1:6,000,000
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**	0 50 100 200 300 400 Kilometres

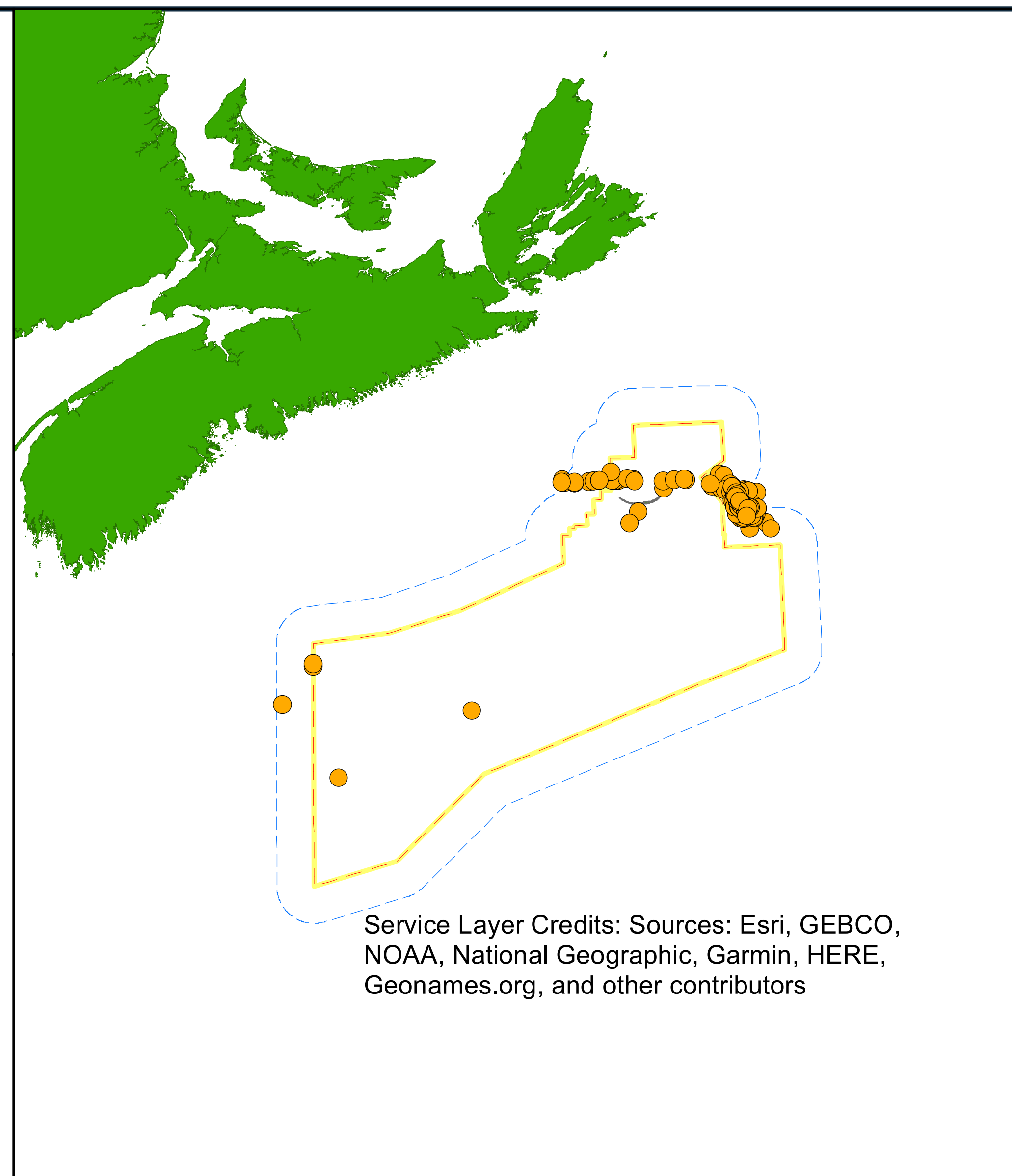
LEGEND:

- North Atlantic Right Whale Sighting
- Study Area
- Project Area

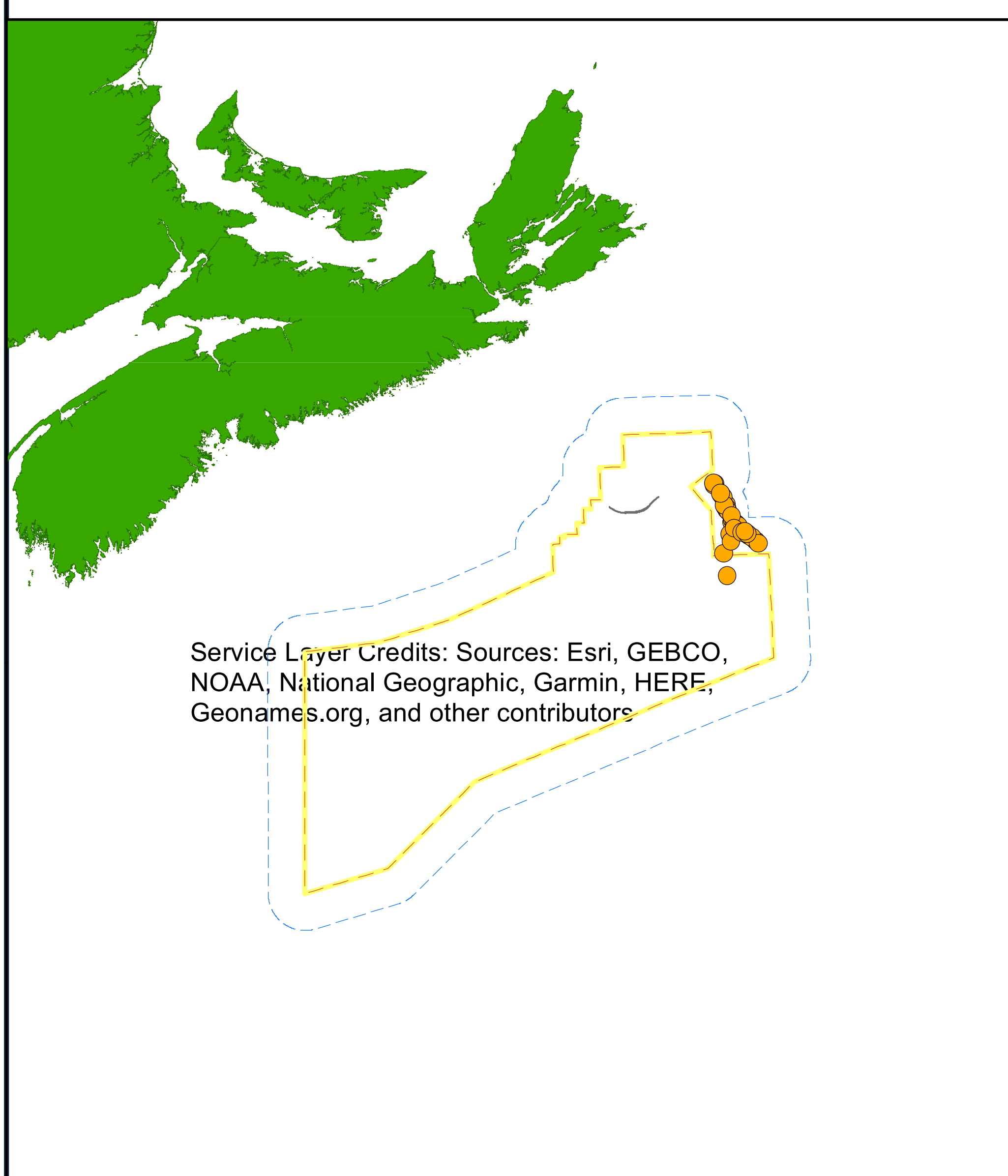
Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_MAMMALS\TE211002_FIGURE_3_49_SAR_NARightWhale.mxd User: candace.macdonald Date: 5/12/2022



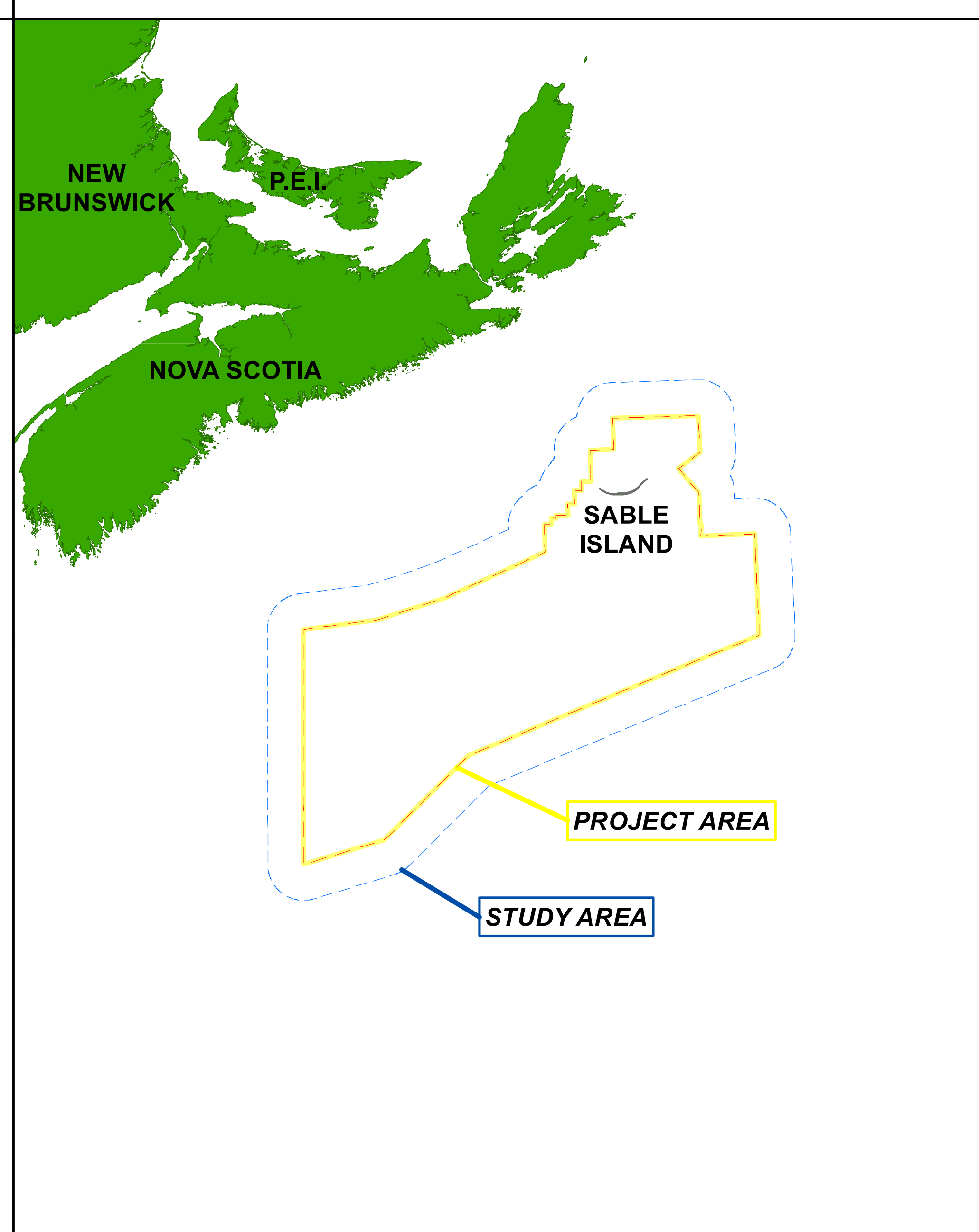
SIGHTINGS (APRIL - JULY)



SIGHTINGS (AUGUST - NOVEMBER)

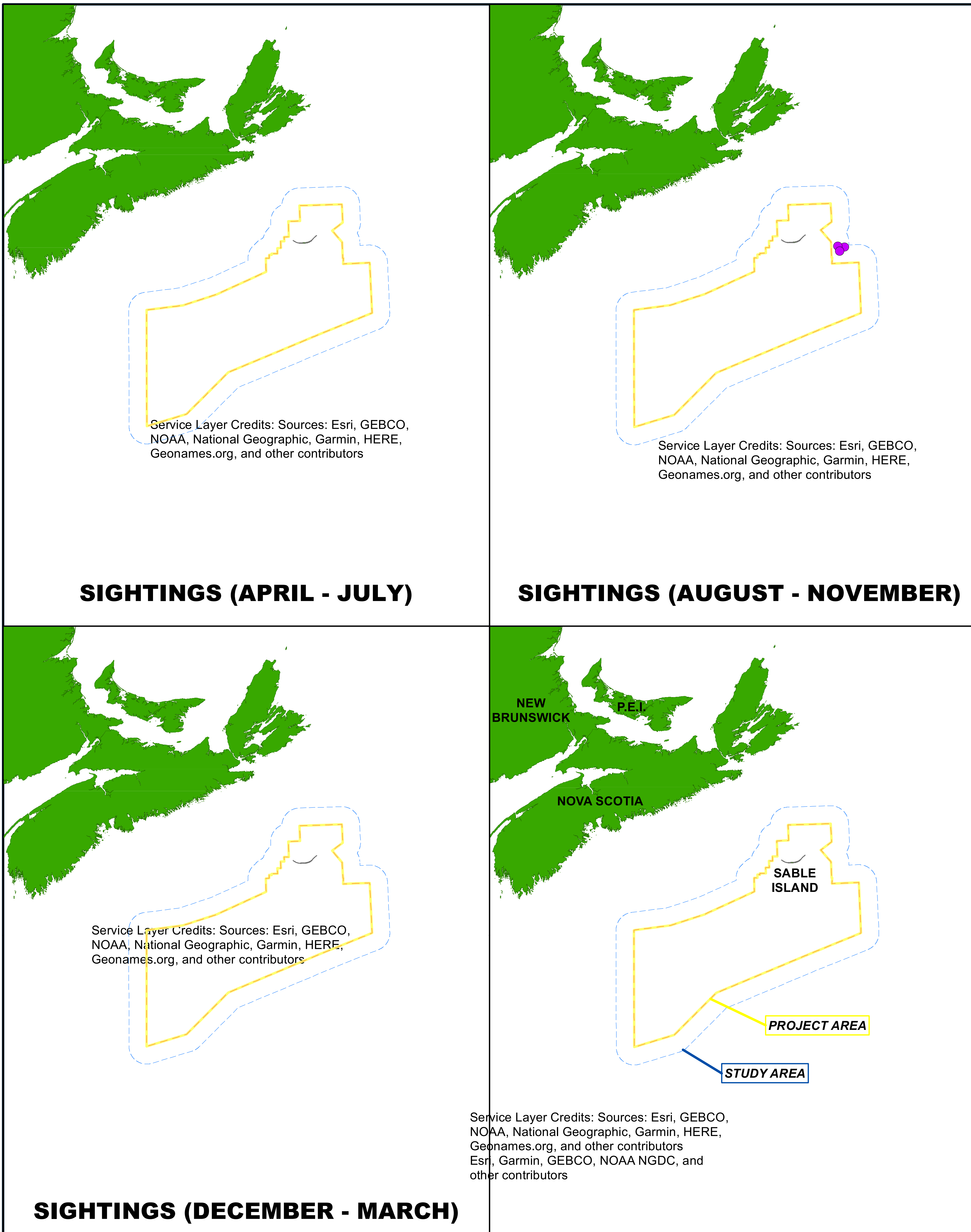


SIGHTINGS (DECEMBER - MARCH)



CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD	TITLE: SPECIES AT RISK - NORTHERN BOTTLENOSE WHALE		LEGEND: Northern Bottlenose Whale Sighting; Study Area; Project Area
	PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK		
[redacted]	PROJECT NO: TE211002	DATE: MAY 2022	FIGURE: FIGURE 3-50
	REV NO: 2	DWN/CHK'D BY: CM / MA	SCALE: 1:6,000,000 (0 50 100 200 300 400 Kilometres)
	DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N	

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_MAMMALS\TE211002_FIGURE_3_50_SAR_NorthernBottlenoseWhale.mxd User: candace.macdonald Date: 5/12/2022



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

SPECIES AT RISK - SOWERBY'S BEAKED WHALE

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:	FIGURE:
TE211002	**MAY 2022**	**FIGURE 3-51**
REV NO: **2**	DWN/CHK'D BY: **CM / MA**	SCALE: 1:6,000,000
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**	0 50 100 200 300 400 Kilometres

LEGEND:

- Sowerby's Beaked Whale Sighting
- Study Area
- Project Area

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\MARINE_MAMMALS\TE211002_FIGURE_3_51_SAR_SowerbysBeakedWhale.mxd User: candace.macdonald Date: 5/12/2022

Table 3-16: Summary of Marine Mammals and Sea Turtles Likely to Occur in the Study Area

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
Whales and Dolphins					
Mysticetes	**Blue Whale**	**Endangered (SARA)**	**Year Round (peak in spring, summer, and fall)**	**Likely**	• Coastal waters and open ocean: Eastern Scotian Shelf Canyons, particularly high sighting rates at The Gully/ The Emerald Basin • They are frequently observed in waters with high productivity of krill • Mating takes place in warmer southern waters in the fall and spring.
	Fin Whale	**Special Concern (SARA)**	**Year Round (peak in summer)**	**Likely**	• Deep water: particularly Middle Bank, the continental shelf, and deep canyons • Occurrence is associated with productive oceanic fronts and high densities of schooling fish and crustaceans (krill)
	North Atlantic Right Whale	**Endangered (SARA)**	**Year Round (peak in summer and fall)**	**Common**	• Mainly coastal waters: particularly in the Bay of Fundy and Roseway Basin EBSA • The adjacent Bay of Fundy (near Grand Manan Island) and Roseway Basin have been identified as critical habitat and there are significant aggregations observed in the southern Gulf of St. Lawrence • Recent studies suggest that North Atlantic right whales are going through a distribution shift, as such historical distribution may not be reflective of current and future distribution • There are transportation protections in place in the adjacent Laurentian Channel • They are a migratory species feeding on dense aggregations of copepod *Calanus finmarchicus*

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Minke Whale	**-**	**Seasonal (summer and fall)**	**Likely**	• Middle Bank • Feed on crustaceans (kill) and small schooling fish
	Sei Whale	**Endangered (COSEWIC)**	**Seasonal (peak in summer)**	**Possible**	• Pelagic waters, while this species makes seasonal migrations from low to high latitudes, some individuals are found in Atlantic Canada year-round. • Sightings coincide with high concentrations of zooplankton (copepods) and small schooling fish (capelin and herring) • Wintering and breeding ground are unknown
	Humpback Whale	**-**	**Seasonal (peak in summer)**	**Common**	• Coastal with some observations offshore • Movements regularly linked to prey availability such as, krill and small schooling fish
Odontocetes	**Northern Bottlenose Whale (Scotian Shelf Population)**	**Endangered (SARA)**	**Year Round (peak in spring and summer)**	**Likely**	• Deep waters: the three canyons on the eastern Scotian Shelf have been designated Critical Habitat: including The Gully, Shortland Canyon, and, particularly the Haldimand Canyon (see Section 3.2.10) Can remain submerged for over an hour foraging for squid and small schooling fish
	Sowerby's Beaked Whale	**Special Concern (SARA)**	**Year Round**	**Likely**	• Deep waters along the continental shelf edge and slope: particularly the Eastern Scotian Shelf Canyons. • High sighting rates in The Gully, and the Scotian Slope
	Sperm Whale	**Mid priority candidate (COSEWIC)**	**Year Round**	**Likely**	• Deep water: shelf edge and The Gully • Its main prey species is squid (all sizes)

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Pygmy Sperm Whale	-	**Seasonal**	**Rare**	• Deep water with its main prey species being squid and octopus
	Cuvier's Beaked Whale	**High priority candidate (COSEWIC)**	**Year Round**	**Unlikely**	• Deep waters: • Main prey species are squid and some fish
	Blainville's Beaked Whale	-	**Seasonal**	**Unlikely**	• Deep waters: There has been one sighting by DFO in The Gully
	True's Beaked Whale	-	**Seasonal**	**Unlikely**	• Temperate waters • There have been two strandings in the Gulf of St. Lawrence and southern Newfoundland
	Short-finned Pilot Whale	-	**Seasonal**	**Possible**	• Deep water preferable warmer tropical or temperate • Main prey species is squid
	Long-finned Pilot Whale	-	**Year-round**	**Common**	• Deep waters: The Gully • Travel in large groups foraging for squid
	Beluga Whale	**Endangered (SARA)**	**Seasonal (summer)**	**Unlikely**	• St. Lawrence River Estuary Population is the closest to the Study Area. • There have been occasional sightings within the Study Area, Scotian Shelf, and Newfoundland but these are rare.
	False Killer Whale	-	**Seasonal (summer)**	**Very Rare**	• Offshore tropical and subtropical deep waters (greater than 1,000 m) • There is a Gulf of Mexico population that may occasionally follow the Gulf Stream north foraging for fish and squid. Sightings in the Study Area are rare.

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Killer Whale	**Special Concern (COSEWIC)**	**Seasonal (summer)**	**Possible**	• Inshore waters, usually in mixed family groups • The specific habitat requirements for the NW Atlantic population are not well known.
	Short-beaked Common Dolphin	-	**Seasonal (summer and fall)**	**Common**	• Near shore to far offshore: The Gully • They are usually associated with warmer water temperatures • They are found in areas with concentrated schools of small fish and squid
	Atlantic Spotted Dolphin	-	**Seasonal (summer and fall)**	**Unlikely**	• Warm temperate waters • Fish and squid
	Striped Dolphin	-	**Seasonal (summer)**	**Unlikely**	• Offshore: in areas with concentrations of fish and squid, particularly The Gully
	Common Bottlenose Dolphin	-	**Seasonal**	**Possible**	• Coastal and over continental shelves in areas with concentrations of fish and squid.
	Risso's Dolphin	-	**Seasonal**	**Rare**	• Deep waters, continental shelf, and slope in areas with concentrations of squid
	White-beaked Dolphin	-	**Year Round**	**Common**	• Inshore, offshore, and along the continental shelf
	Atlantic White-sided Dolphins	-	**Year Round**	**Common**	• Outer continental shelf and slope: The Gully

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
	Harbour Porpoise	**Special Concern (COSEWIC)**	**Year Round**	**Possible**	• Shallow coastal waters and continental shelves. Occasionally in deeper waters. • The Study Area is adjacent to two sub-populations: Bay of Fundy-Gulf of Maine and Gulf of St. Lawrence.
Seals					
Pinnipeds	**Grey Seal**	**-**	**Year Round**	**Common**	• Shallow waters: Sable Island • Winter breeding ground is Sable Island
	Harbour Seal	**-**	**Year Round**	**Common**	• Breeding ground is Sable Island
	Ringed Seal	**Special Concern (COSEWIC)**	**Seasonal**	**Very Rare**	• Circumpolar distribution, with occasional vagrant sightings south of the seasonal ice zone • Its life cycle is closely linked to available sea ice
	Harp Seal	**-**	**Year Round**	**Possible**	• The Gulf herd are adjacent breeding grounds in the Magdalen Islands in the middle of the Gulf of St. Lawrence
	Hooded Seal	**Mid priority Candidate (COSEWIC)**	**Seasonal**	**Unlikely**	• Offshore, ice-breeding species • Previously documented on Sable Island
Sea Turtles					
Sea Turtles	**Leatherback (Atlantic Population)**	**Endangered (SARA)**	**Seasonal (June to December)**	**Likely**	• Scotian shelf is a high-use foraging area for with important prey species (Jellyfish and salps) concentrated are along the slope • The Scotian Slope is an important migratory route particularly the slope off Georges Bank and

Group	Species	Status	Time of Year Present	Potential Presence in Study Area	Habitat and Distribution
					southwest Scotian Slope • The nearby St. Ann's Bank and Laurentian Channel is also an important summer feeding habitat • Important Habitat in the region identified as the southeastern Gulf of St. Lawrence and waters south and east of the Burin Peninsula, Newfoundland
	Loggerhead	**Endangered (SARA)**	**Seasonal (June to December)**	**Likely**	• Offshore waters and along the shelf break: distribution is thermally limited by available warm sea surface temperatures (>18°C). • Individuals migrate between their southern nesting areas (U.S. and Mexico) to their northern foraging areas (Atlantic Canada). • Juveniles are caught as by-catch in the surface long-line fishery.
	Kemp's Ridley Sea Turtle	**Low priority candidate (COSEWIC)**	**Seasonal (summer months)**	**Possible**	• Considered the most endangered sea turtle species in the world and is only found in the Atlantic Ocean • Adults are usually found in the Gulf of Mexico while juveniles forage on algae off Nova Scotia in the summer months.
	Green Sea Turtle	**Low priority candidate (COSEWIC) Endangered (IUCN)**	**Seasonal (summer months)**	**Possible**	• Found in warm waters in the Atlantic, Pacific, and Indian Oceans • Adults are usually found in tropical latitudes and general forage in shallow near-shore waters.

Sources: Delarue et al. 2018, COSEWIC 2009c, COSEWIC 2010e, COSEWIC 2011b, COSEWIC 2012h, COSEWIC 2014b, COSEWIC 2019b, COSEWIC 2019c, COSEWIC 2019d, DFO 2010c, DFO 2016b, DFO 2020c, 2020d, 2020e, 2020f, SARA, Jefferson et al. 2009, IUCN, Mead 1989, NCC

3.2.9 Species of Conservation Concern

Several species of fish, birds, marine mammals and sea turtles at risk or of special conservation concern are known or likely to occur in the Study Area. This includes species that are formally designated by *SARA* and / or the NSESA, or those identified as otherwise being of conservation concern by either COSEWIC or the IUCN.

Species with formal protection in Canada under SARA are listed on Schedule 1, with the following designations:

- Extirpated: A species that no longer exists in the wild in Canada, but exists in the wild elsewhere
- Endangered: A species that is facing imminent extirpation or extinction
- Threatened: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction
- Special Concern: A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Designations under SARA are guided by the advice provided by COSEWIC. COSEWIC also has a Not at Risk designation for species that are not at risk of extinction given the current circumstances., and Data Deficient for species lacking sufficient information to resolve a species' eligibility for assessment or to permit an assessment of the species' risk of extinction. The summary information presented here is current as of the time of writing, but species status can be updated at any time, and so it is important to refer to the public SARA registry (Government of Canada 2021a) for the most current information.

The NSESA gives the following five categories of protection designation:

- Endangered: a species facing imminent extirpation or extinction
- Threatened: a species likely to become endangered if limiting factors are not reversed
- Vulnerable: a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events
- Extirpated: a species that no longer exists in the wild in the Province but exists in the wild outside the Province
- Extinct: a species that no longer exists

The IUCN is a not-for-profit, membership union composed of numerous organizations, scientists, and experts that voluntarily provide environmental data and recommendations for species from a global perspective. They maintain a Red List of threatened species (iucnredlist.org) and monitor global population trends and assign the following designations: Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct.

Summary information for each SAR can be found in the respective sections for marine fish and fish habitat (Sections 3.2.6), marine and migratory birds (Section 3.2.7), and marine mammals and sea turtles (Section 3.2.8). Critical and important habitat areas for species of conservation concern can be found in Section 3.2.10.

3.2.9.1 Marine Fish

The status of marine fish species that are known or likely to occur in the Study Area can be found in Table 3-17. Of these species, five are listed on Schedule 1 of SARA: the Atlantic, spotted, and northern wolffish, white sharks, and the inner Bay of Fundy population of Atlantic salmon. Critical habitat has been established for the spotted and northern wolffish, though it does not overlap with the Study Area. No marine finfish species are listed under the NSESA.

Table 3-17: Fish Species of Conservation Concern Known or Likely to Occur in the Study Area

Species		Status / Designation[1,2]			Relevant Population (Where Applicable)
Common Name	**Scientific Name**	**SARA**	**COSEWIC**	**IUCN**	
Acadian redfish	*Sebastes fasciatus*		T	E	Atlantic (COSEWIC); Global (IUCN)
American eel	*Anguilla rostrata*		T	E	Global (IUCN)
American plaice	*Hippoglossoides platessoides*		T		Maritime Population (COSEWIC)
Atlantic bluefin tuna	*Thunnus thynnus*		E	E	Global (IUCN)
Atlantic cod	*Gadus morhua*		E		Laurentian North
			E		Laurentian South
			E		Southern
				V	Global (IUCN)
Atlantic salmon	*Salmo salar*		T		South Newfoundland
			SC		Quebec Eastern North Shore
			SC		Quebec Western North Shore
			E		Anticosti Island
			SC		Inner St. Lawrence
			SC		Gaspe-Southern Gulf of St. Lawrence
			E		Eastern Cape Breton
			E		Nova Scotia Southern Upland
		E	E		Inner Bay of Fundy Population
			E		Outer Bay of Fundy Population
				LC	Global (IUCN)
Atlantic wolffish	*Anarhichas lupus*	SC	SC		
Basking shark	*Cetorhinus maximus*		SC	E	Atlantic (COSEWIC); Global (IUCN)
Cusk	*Brosme*		E		
Deepwater redfish	*Sebastes mentella*		E	LC	Gulf of St Lawrence – Laurentian Channel (COSEWIC); Global (IUCN)
Lumpfish	*Cyclopterus lumpus*		T		
Northern wolffish	*Anarhichas denticulatus*	T	T		
Porbeagle	*Lamna nasus*		E	V	Global (IUCN)
Roundnose grenadier	*Coryphaenoides rupestris*		E	CE	Global (IUCN)

Species		Status / Designation[1,2]			Relevant Population (Where Applicable)
Common Name	**Scientific Name**	**SARA**	**COSEWIC**	**IUCN**	
Shortfin mako	*Isurus oxyrinchus*		E	V	Atlantic (COSEWIC); Global (IUCN)
Smooth skate	*Malacoraja senta*		E		Funk Island Deep
			DD		Hopedale Chanel
			DD		Nose of the Grand Bank
			SC		Laurentian-Scotian
				V	Global (IUCN)
Spiny dogfish	*Squalus acanthias*		SC	V	Atlantic (COSEWIC); Global (IUCN)
Spotted wolffish	*Anarhichas minor*	T	T		
Thorny skate	*Amblyraja radiata*		SC	V	Global (IUCN)
White hake	*Urophycis tenuis*		T		Atlantic and Northern Gulf of St. Lawrence (COSEWIC)
White shark	*Carcharodon carcharias*	E	E	V	Atlantic (COSEWIC/SARA); Global (IUCN)
Winter skate	*Leucoraja ocellata*		E	E	Eastern Scotian Shelf – Newfoundland (COSEWIC); Global (IUCN)

[1] Not at Risk (NR), Data Deficient (DD), Least Concern (LC), Vulnerable (V), Near Threatened (NT), Special Concern (SC), Threatened (T), Endangered (E), Critically Endangered (CE) (blank cells indicate not assessed)
[2] Multiple designations refer to multiple populations or sub-populations.

3.2.9.2 Marine and Migratory Birds

The status of marine and migratory bird species that are known or likely to occur in the Study Area can be found in Table 3-18. Of these species, three are listed on Schedule 1 of SARA: the Ipswich Sparrow, Red-necked Phalarope and Roseate Tern. Leach's Storm-petrel was recently assessed as Threatened by COSEWIC and is currently under consideration for listing on Schedule 1 of SARA (COSEWIC 2020). Roseate Tern is the only species listed under the NSESA and is designated as Endangered. Sable Island is important breeding habitat for Leach's Storm-petrel and is critical breeding habitat for Roseate Tern and Ipswich Sparrow.

Table 3-18: Bird Species of Conservation Concern Known or Likely to Occur in the Study Area

Species		Status / Designation[1]			Relevant Population (Where Applicable)
Common Name	**Scientific Name**	**SARA**	**COSEWIC**	**IUCN**	
Atlantic Puffin	*Fratercula artica*			V	Global (IUCN)
Bermuda Petrel	*Pterodroma cahow*			EN	Global (IUCN)
Black-capped Petrel	*Pterodroma hasitata*			EN	Global (IUCN)
Black-legged Kittiwake	*Rissa triactyla*			V	Global (IUCN)
Fea's Petrel	*Pterodroma feae*			NT	Global (IUCN)
Leach's Storm-petrel	*Oceanodrama leucorhoa*		T	V	Global (IUCN)
Razorbill	*Alca torda*			NT	Global (IUCN)
Red-necked Phalarope	*Phalaropus lobatus*	SC	SC	LC	Global (IUCN)
Roseate Tern	*Sterna dougallii*	E	E	LC	Global (IUCN)
Savannah Sparrow (Ipswich Sparrow)	*Passerculus sandwichensis* (*princeps* subspecies)	SC	SC	LC[2]	*Princeps* subspecies (COSEWIC, SARA); Global (IUCN)
Sooty Shearwater	*Puffinus griseus*			NT	Global
White-faced Storm-petrel	*Pelagodroma marina*			EN	Europe (IUCN)
Zino's Petrel	*Pterodroma madeira*			EN	Global (IUCN)

[1] Not at Risk (NR), Data Deficient (DD), Least Concern (LC), Vulnerable (V), Near Threatened (NT), Special Concern (SC), Threatened (T), Endangered (E), Critically Endangered (CE) (blank cells indicate not assessed)
[2] Designation applies to *Passerculus sandwichensis* as a species and is not specific to *P. sandwichensis princeps* subspecies.

3.2.9.3 Marine Mammals and Sea Turtles

The status of marine mammal and sea turtle species that are known or likely to occur in the Study Area can be found in Table 3-19. Of these species, seven are listed under Schedule 1 of SARA: blue whale, fin whale, North Atlantic right whale, northern bottlenose whale, Sowerby's beaked whale, leatherback sea turtle and loggerhead sea turtle. Three whale species designated by COSEWIC may occur in the Study Area: Sei whale is likely to occur; killer whale and harbour porpoise possibly occur. Five species are proposed as candidates for assessment consideration by COSEWIC: Cuvier's beaked whale, hooded seal, harp seal, Kemp's Ridley sea turtle and green sea turtle. The Gully, within the Study Area, is important habitat for all species listed, and specifically the northern bottlenose whale and Sowerby's beaked whale.

Table 3-19: Mammal and Sea Turtle Species of Conservation Concern Known or Likely to Occur in the Study Area

Species		Status / Designation[1]			Relevant Population (Where Applicable)
Common Name	**Scientific Name**	**SARA**	**COSEWIC**	**IUCN**	
Blue Whale	*Balaenoptera musculus*	E	E	E	Atlantic (COSEWIC/SARA), Global (IUCN)
Fin Whale	*Balaenoptera physalus*	SC	SC	V	Atlantic (COSEWIC/SARA), Global (IUCN)
North Atlantic Right Whale	*Eubalaena glacialis*	E	E	CE	Global (IUCN)
Sei Whale	*Balaenoptera borealis*		E	E	Atlantic (COSEWIC), Global (IUCN)
Northern Bottlenose Whale	*Hyperoodon ampullatus*	E	E	DD	Scotian Shelf (COSEWIC/SARA), Global (IUCN)
Sowerby's Beaked Whale	*Mesoplodon bidens*	SC	SC	LC	Global (IUCN)
Killer Whale	*Orcinus orca*		SC	DD	Northwest Atlantic (COSEWIC), Global (IUCN)
Harbour Porpoise	*Phocoena*		SC	LC	Global (IUCN)
Leatherback Sea Turtle	*Dermochelys coriacea*	E	E	V	Atlantic (COSEWIC/SARA), Global (IUCN)
Loggerhead Sea Turtle	*Caretta*	E	E	V	Global (IUCN)
[1] Not at Risk (NR), Data Deficient (DD), Least Concern (LC), Vulnerable (V), Near Threatened (NT), Special Concern (SC), Threatened (T), Endangered (E), Critically Endangered (CE) (blank cells indicate not assessed)					

3.2.10 Protected and Special Areas

In Canada, various areas may be designated as protected through federal, territorial or provincial legislation, sometimes also protected and / or managed by municipal or Indigenous governments and / or identified as rare or sensitive by other agencies. These special areas may be identified for sensitive species and habitats, as especially sensitive to possible environmental disturbances and / or as representative natural areas. Special areas may also be identified for cultural or historical reasons and / or for human use and enjoyment.

This section describes various existing and proposed protected and special areas. There are no provincial sites in the Study Area and the only international site is an IBA. Various types of federal special areas overlap partially or wholly with the Study Area. These include protected areas: an MPA, a marine refuge, critical habitat for three species of conservation concern, a migratory bird sanctuary (MBS), a national park reserve and fisheries conservation areas. In addition, six Ecologically and Biologically Significant Areas (EBSAs) and four types of SiBAs overlap the Study Area. Note that Sable Island and its environs are protected as an MBS and National Park Reserve and also identified as an EBSA and IBA.

3.2.10.1 Marine Protected Areas

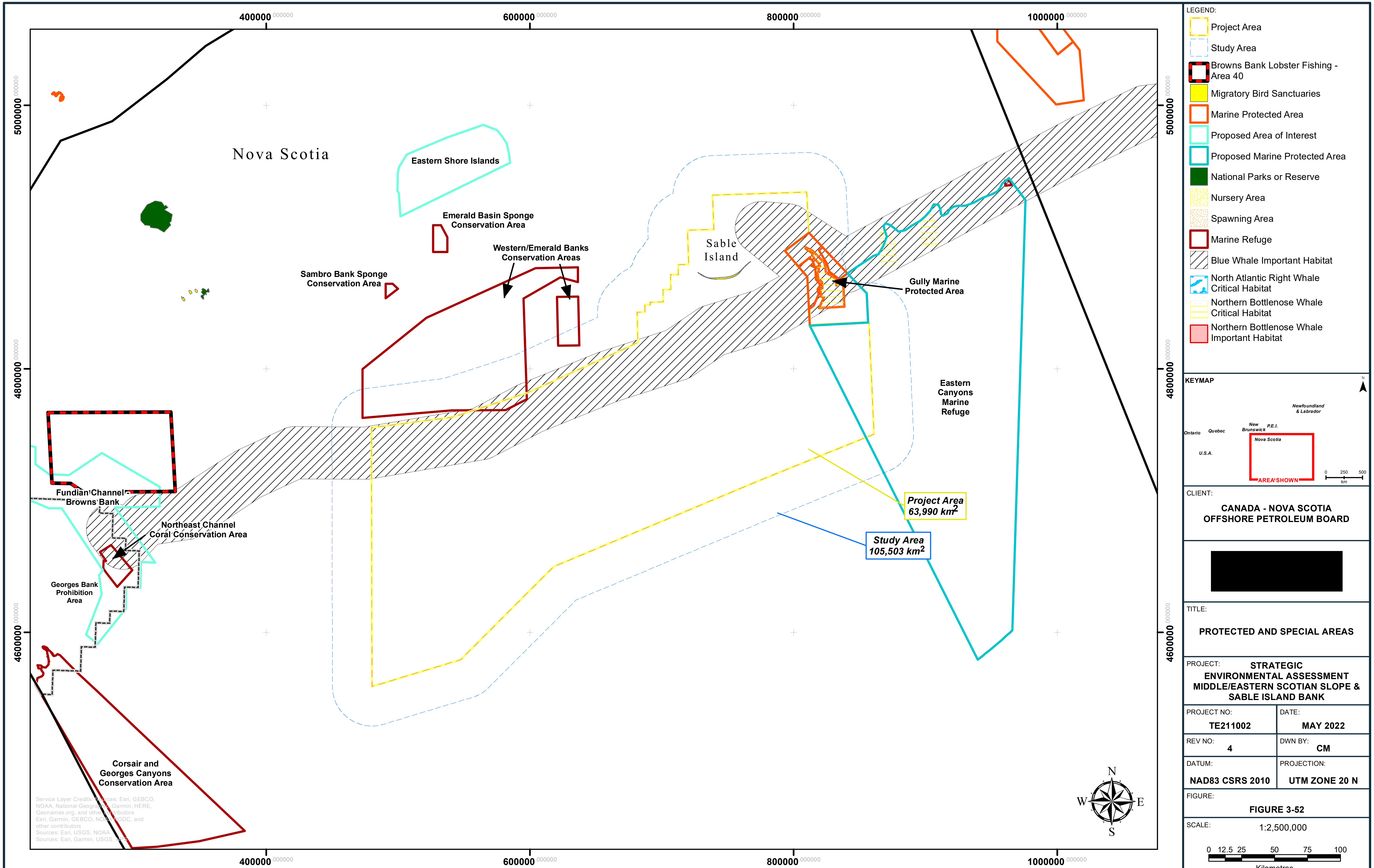
DFO has undertaken a process to develop an MPA network in the coastal and offshore waters of the Scotian Shelf Bioregion, which includes the Scotian Shelf, the Bay of Fundy and the Canadian portion of the Gulf of Maine and Georges Bank. The Gully MPA, which is east of Sable Island (Figure 3-52) is within the Study Area (Table 3-20).

Table 3-20: Marine Protected Areas Within the Study Area

Marine Protected Area	Summary Description
The Gully	Designated as an MPA under the *Oceans Act* in 2004. Habitat of the endangered Northern bottlenose whale, Scotian Shelf population and 15 other species of whales and dolphins along with other marine species such as fish, shellfish, invertebrates (including approximately 30 species of cold-water corals) and birds. Area: approximately 2,363 km^2.

Source: DFO 2020g

The *Oceans Act* protects MPAs (including special or sensitive features, habitats and species) from the impacts of fishing and other human enterprises. *The Gully Marine Protected Area Regulations* prohibit any activities that disturb, damage, destroy or remove living marine organisms or any part of their habitat or the seabed (including the subsoil to a depth of 15 m). Prohibitions include any activity (e.g., depositing, discharging or dumping any substance, or causing any substance to be deposited, discharged or dumped), in The Gully MPA or vicinity, which is likely to result in disturbance, damage, destruction or removal of living marine organisms or any part of their habitat or the seabed. The Gully MPA has three management zones. Zone 1 (a deep canyon environment that includes important habitat for cold-water corals, dolphins and whales) has the highest level of protection. Zone 2 (the canyon head and sides featuring a high diversity of marine life, feeder canyons and continental slope) has a limited number of permitted activities. Zone 3 (sand banks adjacent to the canyon prone to regular natural disturbance) has some flexibility to permit activities that do not damage or destroy species assemblages or their habitats. Exceptions include licensed commercial fishing in Zones 2 and 3 (Government of Canada 2021b).



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3.2.10.2 Marine Refuges

DFO has designated marine refuges in the Scotian Shelf Bioregion (Figure 3-52). Two portions of a Marine Refuge intersect the Study Area (Table 3-21).

Table 3-21: Marine Refuges Within the Study Area

Marine Refuges	Summary Description
Western / Emerald Banks Conservation Areas (restricted fisheries zone)	Designated as a marine refuge under the *Fisheries Act* in 2017. High adult and larval fish (e.g., herring, halibut, silver hake, American plaice, redfish, and yellowtail flounder) and invertebrate diversity compared to other Eastern Scotian Shelf banks. Supports productivity of important groundfish including a nursery ground for haddock. Important habitat for depleted species (e.g., Atlantic cod, American plaice, winter skate) assessed as at-risk by COSEWIC. All commercial and recreational fisheries using bottom-contact gear and gear that interacts with groundfish are prohibited in most of the protected area. Area: approximately 10,234 km^2.

Source: DFO 2020g

Marine Refuges are protected through the *Fisheries Act*. Conservation objectives for the Western / Emerald Banks Conservation Areas (restricted fisheries zone) include productivity of groundfish for commercial fishing and management of disturbance to benthic habitat that is important for haddock and other groundfish species some of which are considered depleted or at-risk. Commercial and recreational fisheries using bottom-contact gear and / or gear known to interact with groundfish is prohibited. Likewise, no human activities incompatible with conservation objectives may occur (DFO 2020g). Oil and gas exploration is not explicitly prohibited in Marine Refuges.

Eastern Canyons is a proposed marine refuge and is located approximately 60 km east of Sable Island, off Banquereau, and is approximately 36,000 km^2. The dense corals found in the canyons and along the shelf edge warrant protection under DFO's Policy for Managing the Impact of Fishing on Sensitive Benthic Areas. This site is extended into the deep-water to foster connectivity among the shelf, slope, and abyssal plain, as deep-sea ecosystems are known to be vulnerable to disturbance (DFO 2018j).

3.2.10.3 Species at Risk Act Critical and Important Habitat

Habitats of SAR such as Atlantic wolffish, spotted wolffish, blue whale, fin whale, northern bottlenose whale, Sowerby's beaked whale, leatherback sea turtle and loggerhead sea turtle have been identified in offshore Nova Scotia. Several areas of the Scotian Shelf are protected as critical habitat for aquatic SAR (Table 3-22). Important Habitats for SAR have also been identified in the Study Area (Figure 3-52).

Table 3-22: Critical and Important Habitats for Species at Risk Within the Study Area

Species at Risk	Summary Description
Leatherback Sea Turtle (Atlantic Population)	Concentrations have been identified in the Atlantic coast of Nova Scotia (including the Scotian Shelf, the Cabot Strait and Laurentian Channel), the southeastern Gulf of St. Lawrence and waters south and east of the Burin

Species at Risk	Summary Description
	Peninsula, Newfoundland Proposed critical habitat has been identified and will be confirmed in an upcoming recovery strategy.
Blue Whale (Northwest Atlantic Population)	The continental shelf edge is considered Important Habitat for the Blue Whale as foraging habitat with evidence for year-round use. Foraging areas have been identified in the Scotian Shelf, the Gulf of St. Lawrence and off southern and eastern Newfoundland.
Northern Bottlenose Whale (Scotian Shelf Population)	The 2016 recovery strategy identifies SAR critical habitat in three canyons (i.e., The Gully MPA Zone 1, Haldimand Canyon and Shortland Canyon) on the Scotian Shelf. Ongoing studies include identifying other potential critical habitat such as shelf-break areas between The Gully, Shortland and Haldimand Canyons (possible transit corridors and feeding grounds) and the Logan, Dawson and Verill canyons southwest of The Gully.

Source: DFO 2016c, DFO 2020d, DFO 2020e

Section 58 of SARA prohibits destruction of any part of identified critical habitat necessary for the survival or recovery of a listed wildlife species identified as such in the recovery strategy or action plan for the species. The Critical habitat for the Northern Bottlenose Whale is legally protected under SARA:

- *Critical Habitat of the Northern Bottlenose Whale (Hyperoodon ampullatus) Scotian Shelf Population Order (SOR/2018-157)* (SARA 2021).

Any oil and gas activity that has the potential to affect a SAR as prohibited by SARA requires a review by DFO (CNSOPB 2021b).

3.2.10.4 Migratory Bird Sanctuaries

Nova Scotia has five MBS – most of which are associated with freshwater ecosystems (Figure 3-52). Sable Island MBS is within the Study Area (Table 3-23).

Table 3-23: Migratory Bird Sanctuaries Within the Study Area

Migratory Bird Sanctuary	Summary Description
Sable Island	Designated as an MBS under the *Migratory Birds Convention Act* in 1977. Important habitat of Ipswich sparrow (SARA Special Concern), a subspecies of the savannah sparrow. Important nesting area for seabirds: more than 2,500 pairs of terns (mainly Arctic Terns), over 500 pairs of great black-backed gulls and 2,000 pairs of herring gulls. A few sandpipers and semipalmated plovers nest on the island. American black ducks and red-breasted mergansers are known to breed in freshwater ponds between the sand dunes. An unusual abundance of over 200 species of migrating birds and many exotic strays have been spotted. The only mammals living on the island itself are the wild horses whose population varies between 150 to 400 individuals. In the waters surrounding the island however, both harbour

Migratory Bird Sanctuary	Summary Description
	seals and grey seals occur in concentrations larger than in any other place in the western North Atlantic. Area: 3,100 km^2.

Source: ECCC 2020

The *Migratory Bird Sanctuary Regulations (C.R.C., c. 1035)* prohibit hunting, disturbing, destroying or taking nests of migratory birds, or having possession of a live migratory bird or a carcass, skin, nest or egg of a migratory bird in an MBS. Some activities may be permitted if not harmful to migratory birds and their habitats (Government of Canada 2021c).

3.2.10.5 National Parks and Reserves

Nova Scotia has two national parks and one national park reserve (Figure 3-52). Sable Island National Park Reserve is within the Study Area (Table 3-24).

Table 3-24: National Parks and Reserves Within the Study Area

National Park or Reserve	Summary Description
Sable Island National Park Reserve	Designated as a National Park Reserve under the *Canada National Parks Act* in 2013. A narrow crescent shaped island of sand with features of natural and human history. One of Canada's furthest offshore islands. Among Eastern Canada's largest sand dunes. Freshwater ponds exist between dunes. A free roaming wild horse population. The world's largest breeding colony of grey seals. Rare and sometimes unique plants, birds and insects. Four centuries of human history including more than 350 shipwrecked vessels. Canada's first life-saving station was established here in 1801.

Source: Parks Canada 2020c

General regulations under the *Canada National Parks Act* address matters including protection of flora, fauna, soil, waters, fossils, natural features, air quality, and cultural, historical and archaeological resources in national parks (Government of Canada 2021d). The *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act (S.C. 1988, c. 28*) defines the physical limits of Sable Island where oil exploration drilling is prohibited on or within approximately 1.85 km (i.e., 1 nautical mile) of the National Park Reserve. Surface access is permitted for low-impact activities, including seismic, aeromagnetic and aerogravity surveys, and geological or geophysical programs (CNSOPB 2021b).

3.2.10.6 Other Conservation Areas

Various areas of the Scotian Shelf are closed seasonally or annually to protect spawning or nursery habitat areas for species that have been subject to damage from fishing gear (Figure 3-52). One such area intersects the Study Area (Table 3-25). While fisheries closures may not have prohibitions for oil and gas activities, these areas are known to be sensitive to human activities in the offshore.

Table 3-25: Other Conservation Areas Within the Study Area

Conservation Area	Summary Description
Haddock Nursery Area	Nursery area for juvenile haddock. Closed to support greater growth potential of recruiting year classes and allow a larger portion of individuals to reach maturity.

Sources: DFO 2018c; Bishop and Brodie 1997

The area was closed year-round to bottom fishing using mobile gear through the *Fisheries Act* in 1987. It was subsequently closed to all bottom fishing gear types in 1993 (DFO 2018c).

3.2.10.7 Ecologically and Biologically Significant Areas

DFO has identified EBSAs by ranking candidate areas using criteria of fitness consequences, aggregations, uniqueness, naturalness and resilience. These EBSAs cover large areas of the Scotian Shelf (Figure 3-53). Six EBSAs are located entirely or partially within the Study Area (Table 3-26). EBSAs have no legal or regulatory status but a conservative approach is advised in the management of activities in or near EBSAs due to the ecological services that EBSAs provide in healthy ecosystem functioning.

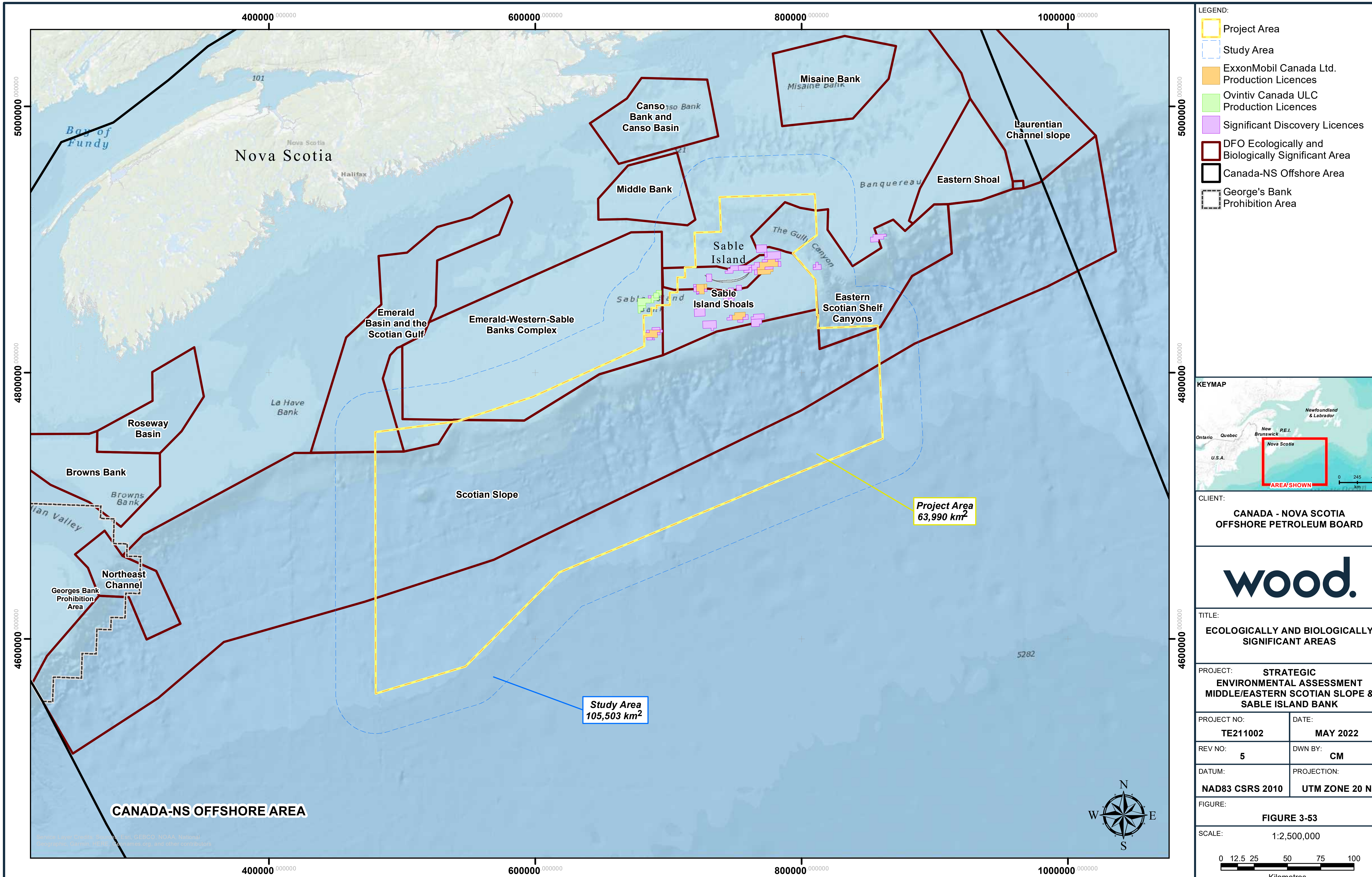
Table 3-26: Ecologically and Biologically Significant Areas Within the Study Area

EBSA	Summary Description
Emerald Basin and the Scotian Gulf	Globally unique concentrations of the Hexactinellid sponge *Vazella pourtalesii* (Russian hat sponge), which are long lived, slow growing and sensitive to disturbance. Dense patches provide habitat for other species. Large depressions in the Emerald Basin also provide relief on the flat seabed. Overwintering area for the copepod *Calanus finmarchicus*. Highest biomass of the euphausiid *Meganyctiphanes norvegica* on the shelf. Contains large populations of *C. finmarchicus* and *M. norvegica* below 200 m year-round. High fish and invertebrate biomass and high species richness for small fish and invertebrates. High concentrations of zooplankton create an important food source for juvenile silver hake (spring to fall) and other young fishes. Summer habitat for tuna and swordfish. Overwintering and mating area for basking sharks. Potential nursery for porbeagle sharks. Probable feeding area for cetaceans, including at-risk species (e.g., blue whale). Important habitat for white hake, sand lance, northern shortfin squid and seabirds. Area: 8,513 km^2.
Emerald-Western-Sable Island Bank Complex	Important habitat, including spawning and nursery areas, for haddock and Atlantic cod (endangered COSEWIC). Fall spawning area for Atlantic herring. Concentration area for eggs and larvae of haddock, mackerel, pollock, silver hake and yellowtail. High retention levels of pelagic larvae and their food and high diversity of zooplankton species. Western and Sable Island Bank are areas of high larval fish diversity. High levels of species richness and abundance in all seasons as well as high adult fish diversity. Important

EBSA	Summary Description
	habitat for silver hake, winter skate, yellowtail flounder. Important habitat for seabirds. Area of high invertebrate species richness, evenness and biodiversity. Greater species richness attributed to greater habitat heterogeneity. Area: 17,900 km^2.
Sable Island Shoals	Important seal habitat with key prey species: sand lance and groundfish. World's largest breeding colony of grey seals (81% of grey seal pups born here). Small population of harbour seals. High fish and invertebrate species evenness and diversity. High concentrations of juvenile fish, particularly haddock, silver hake, Atlantic cod (endangered COSEWIC) and yellowtail flounder. Important seabird habitat (plunge diving piscivores, shallow diving piscivores, shallow pursuit generalists). Significant breeding populations of terns (common, arctic, and roseate) (endangered SARA) and gulls (great black backed and herring). Tern foraging (sand lance and small groundfish) within close proximately (~10km) of nesting locations. Area: 1,297 km^2.
Eastern Scotian Shelf Canyons	Includes The Gully, which is the largest submarine canyon off Eastern North America, and the Shortland and Haldimand canyons resulting in unique environments and ecology. The deeper waters of the three canyons are designated as Critical Habitat (SARA) for Northern bottlenose whales (endangered SARA) though sighting rates are highest in The Gully. The slope edge between the canyons is also defined as important habitat for this species. The Gully is an important habitat for marine mammals, with 16 species of whales and dolphins observed. The Gully has consistent sightings of blue whales and high sighting rates of Sowerby's beaked whales (special concern SARA) and other cetacean species occur within the canyons. The Gully has a wide variety of benthic and pelagic habitats and the Shortland and Haldimand Canyons are expected to have significant habitat diversity. Area of high fish species richness, evenness, biomass and diversity with evidence of higher levels of diversity for finfish, cetaceans and invertebrates. Important habitat for cod (endangered COSEWIC), white hake (threatened COSEWIC), smooth skate (special concern COSEWIC) and redfish (threatened COSEWIC) in summer, fall and spring. Area of high invertebrate biomass with high species richness, evenness and diversity. Approximately 30 different species of coral have been identified in The Gully, the highest coral diversity in Atlantic Canada. Several vulnerable and/or rare taxa, including Alcyonacea (e.g., *Keratoisis grayi*, *Paragorgia arborea*), Pennatulacea (sea pens) and Scleractinia (*Flabellum* spp.) Shortland and Haldimand Canyons also have significant corals populations, including concentrations of gorgonians (Alcyonacea) and sea pens (Pennatulacea). High densities of *Flabellum alabastrum* (cup coral) have been observed in

EBSA	Summary Description
	Shortland Canyon. Important seabird habitat. Area: approximately 7,434 km^2.
Middle Bank	Important habitat (e.g., spawning and nursery for Atlantic cod (endangered COSEWIC) in summer and fall. High small fish species richness. High larval fish genus richness. Historically high fish biomass. Abundant American plaice (threatened COSEWIC), redfish (threatened COSEWIC), silver hake, yellowtail flounder, and witch flounder larvae and possible spawning and/or nursery area for these species. High invertebrate biomass and species evenness and diversity. High primary productivity. Fin whales (special concern SARA) and minke whales in summer and fall. Important seabird habitat. Area: 2,748 km^2.
Scotian Slope	High diversity of finfish (e.g., demersal, mesopelagic and large pelagic fishes). High fish species evenness and diversity. High species richness for small fishes. Overwintering area for shelf fishes (e.g., halibut, mackerel). Important habitat for many demersal fish species in summer, fall and spring, including cusk (endangered COSEWIC), redfish (threatened COSEWIC), white hake (threatened COSEWIC), thorny skate (special concern COSEWIC), Atlantic halibut, longfin hake and Atlantic argentine. Area of high invertebrate species richness / evenness and high species richness for small invertebrates. Important habitat for many invertebrates, including red crab, northern shortfin squid, northern stone crab, American lobster and sea stars. Overwintering area for shelf invertebrates (e.g., lobster along SW slope). A variety of coldwater coral species along the slope, with highest concentrations of some species in submarine canyons. Dense concentrations of coral forests and large sea pen fields add to the structural complexity of the seafloor and serve as habitat for fishes and other invertebrates. Many rare species in Canadian waters have been identified in the slope areas off the Scotian Shelf. Migratory route for cetaceans and large pelagic fishes (e.g., sharks, swordfish, tuna). Appears to be an important area for leatherback turtles (endangered SARA), part of a migratory route and important prey (e.g., jellyfish and salps) concentrate along the slope. Habitat for Sowerby's beaked whale (special concern SARA). Important habitat for seabirds. Area: 72,800 km^2.

Source: King et al. 2016



CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

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TITLE:
ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREAS

PROJECT:
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 5	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 3-53

SCALE: 1:2,500,000

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Kilometres

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3.2.10.8 Significant Benthic Areas

DFO has used Kernel Density Estimation (KDE) and Species Distribution Modelling (SDM) from research vessel trawl survey data and in situ observations to identify Significant Benthic Areas (SiBAs) for sponges, sea pens and gorgonian corals in the Scotian Shelf (Figure 3-54). Four types of SiBAs have been identified within the Study Area (Table 3-27).

Table 3-27: Significant Benthic Areas Within the Study Area

Significant Benthic Area Type	Summary Description
Large Gorgonian Corals	Significant concentrations and predicted presence probability for each species, based on research vessel (RV) trawl survey data and in situ observations, using kernel density analysis and species distribution models.
Small Gorgonian Corals	
Sea Pens	
Sponges	

Source: Kenchington et al. 2016

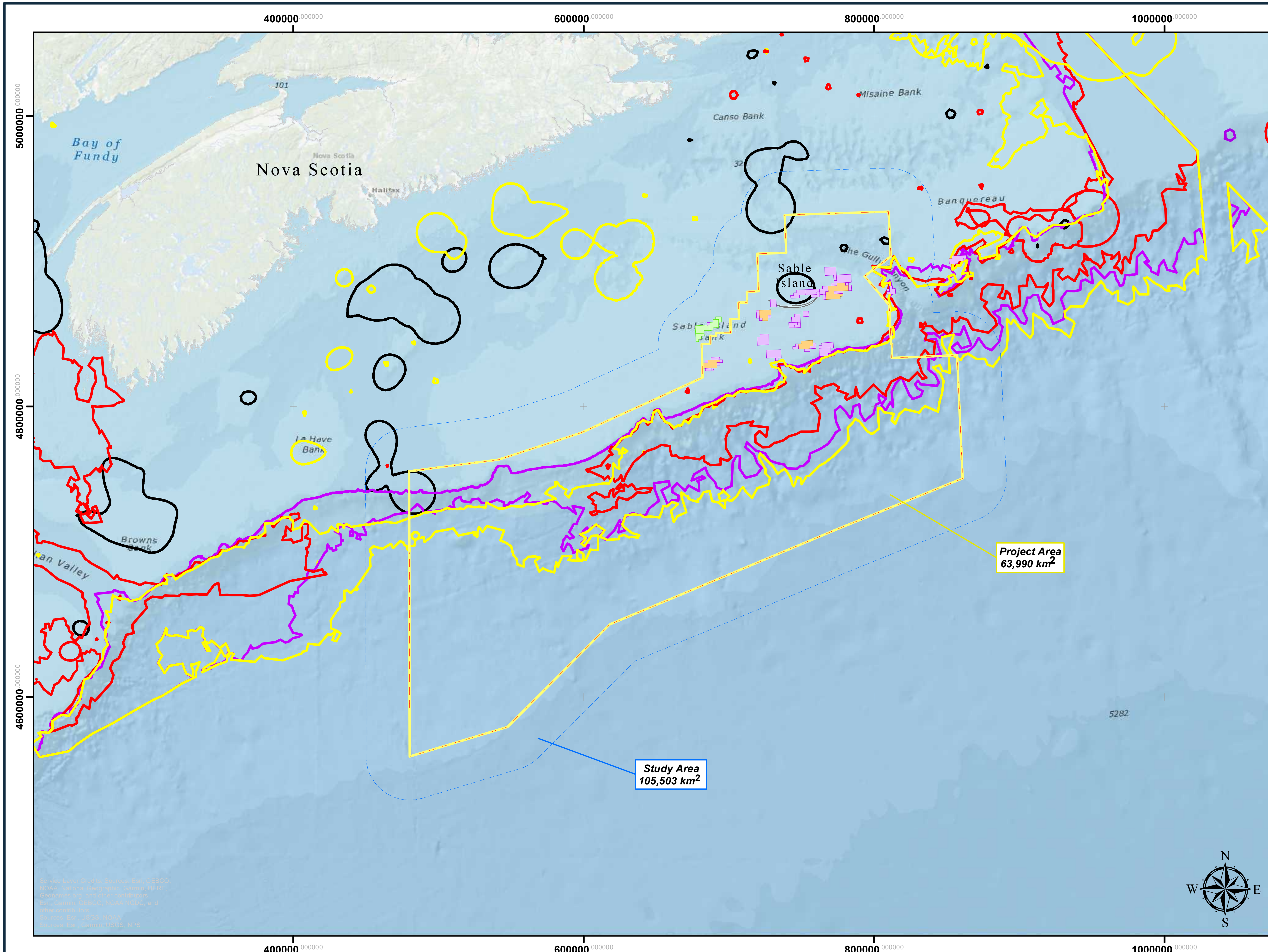
3.2.10.9 Important Bird Areas

Important Bird Areas (IBAs) support specific groups of birds: threatened, large populations, and those restricted by range or habitat. Canada's IBAs support the design of conservation areas and sometimes overlap with protected areas. Sable Island, Nova Scotia IBA, which is also an MBS and a National Park Reserve (Figure 3-52) is within the Study Area (Table 3-28).

Table 3-28: Important Bird Areas Within the Study Area

Important Bird Areas	Summary Description
Sable Island, Nova Scotia	Provides habitat for nearly the entire population of Ipswich Savannah sparrow (listed as Nationally Vulnerable and Schedule 1 Special Concern under SARA) as well as large numbers of nesting colonial waterbirds and a population of nesting terns.

Source: Birds Canada No Date



LEGEND:

- Project Area
- Study Area
- ExxonMobil Canada Ltd. Production Licences
- Ovintiv Canada ULC Production Licences
- Significant Discovery Licences

Significant Benthic Areas

- Sponge
- Sea Pens
- Small Gorgonian Coral
- Large Gorgonian Coral

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

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TITLE:

SIGNIFICANT BENTHIC AREAS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 4	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-54**

SCALE: 1:2,500,000

0 12.5 25 50 75 100

Kilometres

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3.3 Socioeconomic Environment

This section describes key aspects of the existing human environment likely to occur in the Study Area. Commercial fisheries (Section 3.3.2) are the most intensive of such activities described in this chapter, active year-round and valued for economic and for social / cultural reasons. This section characterizes the fisheries both descriptively (e.g., harvest timing and methods) and quantitatively (catch tonnage and values), focusing on key species harvested in and near the Study Area based on their importance in terms of the quantity and / or value of the harvest. The information presented in this section collectively includes all commercial fisheries licensed through DFO (e.g., individual harvesters, corporate license holders and commercial communal licenses). Indigenous groups involved in commercial communal fisheries and Indigenous fishing licenses in the Study Area are both described in Section 3.3.5.

3.3.1 Key Information Sources

Key information sources for the socioeconomic environment sections are included in Table 3-29. DFO is the most important source of information for these as well as other aspects of the existing environment.

Table 3-29: Key Information Sources: Socioeconomic Environment

Topic	Sources
Commercial Fisheries	DFO Digital datasets provided directly to the authors: quantity and value for tables and graphs and geospatial for fisheries mapping and graphs) Datasets available through Canada's Open Government Portal Published research documents and atlases Online data sources: fisheries landings, quota reports and licensing Published documents and data from Nova Scotia Department of Fisheries and Aquaculture and Statistics Canada Personal communications with, and information supplied by, DFO personnel, fishing industry representatives and other key persons
Indigenous Fisheries and Other Harvesting	DFO Supreme Court of Canada (SCC)
Other Marine Activities and Ocean Uses	CNSOPB DFO Canadian Hydrographic Services Research institute / government agency web sites

3.3.2 Commercial Fisheries

3.3.2.1 Fisheries Jurisdiction and Management

DFO is responsible for marine fisheries management under the authority of the federal *Fisheries Act (2019)* and regulations. Jurisdiction under the Act includes "Canadian fisheries waters", and "with respect to a sedentary species, any portion of the continental shelf of Canada that is beyond the limits of Canadian fisheries waters". In 1977, Canada extended its fisheries jurisdiction beyond 12 nautical miles (NMi) or 22 km from shore by declaring authority over a 200 NMi (370 km) Exclusive Economic Zone (formalized through the United Nations Convention on the Law of the Sea (UNCLOS) in 1982), which placed its management authority beyond the Scotian Shelf and slope.

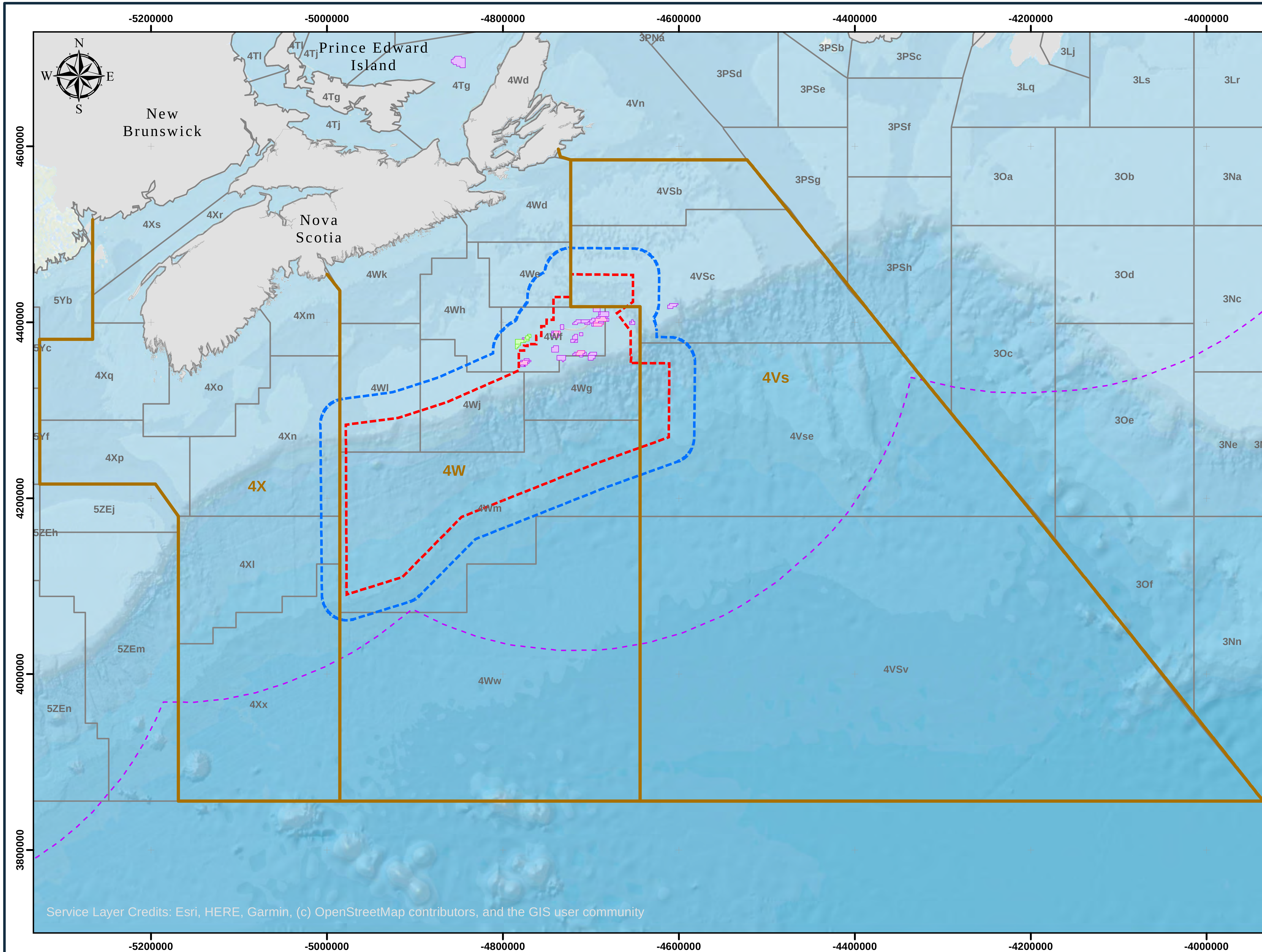
Other key legislation defining and supporting DFO's mandate includes the *Ocean's Act (2019)* and SARA. The Department's core responsibilities include Fisheries, Aquatic Ecosystems, Marine Navigation, Marine Operations and Response. In addition, the Department's purview includes the Canadian Coast Guard, small craft harbours and the CHS (DFO 2019c, DFO 2019d).

For administrative and management purposes, DFO operates from six Regions across Canada with National Headquarters in Ottawa. The Study Area is in the Maritimes Region, which includes the Scotian Shelf and slope, extending from southern New Brunswick and the Bay of Fundy in the west to the Cabot Strait in northeast Nova Scotia, with licensed harvesters based in both provinces. DFO Maritimes Region manages most fisheries in the Study Area, though large pelagic species – notably, swordfish and bigeye and bluefin tunas - are managed through the International Commission for the Conservation of Atlantic Tuna (ICCAT).

Management measures vary with species and locations and may include establishing total allowable catch (TAC) and / or quotas, minimum retainable fish sizes, gear restrictions, limited harvesting seasons, fleet (vessel size) restrictions, trip limits and area closures. Several fisheries are highly monitored (dockside or on-board). These measures and requirements are set out in Integrated Fisheries Management Plans (IFMPs) for many species, in Conservation Harvesting Plans (CHPs), policies, license conditions and / or fisheries notices and variation orders.

Most fisheries are managed by measures tied to certain geographic areas, and many of these employ boundaries (e.g., for quota setting or harvester access) defined by the Northwest Atlantic Fisheries Organization (NAFO), a regional fisheries management organization established by international convention (NAFO 2020). The NAFO Convention Area is divided into Subareas designated by number (0-6, north to south), and further subdivided into Divisions (and Subdivisions in the case of 4VS) for data collection and fisheries management purposes. The Divisions are further divided into Unit Areas (UAs) (Figure 3-55). Thus, UA 4Wg is in NAFO Subarea "4", Division "W", UA "g". Much of the fisheries descriptions in this section of the SEA (including DFO management plans) are based on the location of activities at the Division and / or UA level. Most of the Study Area is within Division 4W, and primarily within UAs 4Wl, 4Wj, 4Wf, 4Wg and 4Wm, the Study Area UAs, as described above.

Other marine boundaries have been defined by DFO for the management of species, such as Lobster Fishing Areas (LFAs) and Crab Fishing Area (CFAs); these are described and illustrated in the sections below for the relevant species. Since the 2010s, management measures and decisions are typically made in communication and coordination with the participants and organizations in the various harvesting sectors / fleets to which they apply, though the DFO Minister has the ultimate authority. All such measures may affect harvest timing, the gear sectors involved, and the overall geographic concentration and range of fishing effort.

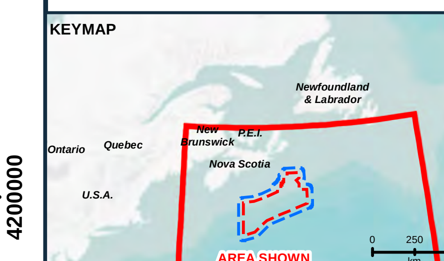


LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING BOUNDARIES

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO: **TE211002**	DATE: **MAY 2022**
REV NO: **0**	DWN BY: **JA**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE: **FIGURE 3-55**

SCALE: 1:4,112,529

0 20 40 80 120 160

Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_General_M1_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022

3.3.2.2 Overview and Context

Fishing has been pursued around Nova Scotia for thousands of years, originally by Indigenous peoples and since the 1500s by Europeans (e.g., English, French, Spanish and Portuguese). The fisheries became a major attraction for seasonal European visitors and later for settlers to the region, and salted fish products from what were to become the Atlantic Provinces served as an important food source in European countries. Originally focused on groundfish (demersal species, mainly cod), the commercial fisheries gradually pursued other species of value, including several pelagic and shellfish species, with lobster canneries appearing in communities around Nova Scotia by the early to mid-1800s. The types of fishing gear also expanded and developed in effectiveness, progressing from labour-intensive hooks and lines to seines, traps and other nets, demersal and pelagic longlines, and - by the early 1900s – to mobile bottom-trawlers (also called draggers), which expanded further in capacity during the 1950s and 1960s. With greater harvesting efficiency and expanding species fisheries, catch numbers and economic returns increased, with peak landings of 750,000 t being recorded in 1973. As the landings increased, more fish processing plants were established in coastal communities creating - along with the sale of fishing gear and shipbuilding - additional adjunct employment and economic returns (CCPFH 2015; Gough and James-abra 2015; MacLean et al. 2013). Given their long history and being a foundational industry in some communities, the fisheries also have a strong social and cultural significance for the people of the region.

The industry has experienced downturns in some longstanding fisheries, expansion of others and exploration and development of new harvesting opportunities. Beginning in the late 1980s, declines in biomass of several Atlantic groundfish stocks led to Canadian government closures of directed harvesting for key species. For Division 4W, this began in 1993. These restrictions continue in many areas to the present, including within the Study Area for several groundfish species, including Atlantic cod, haddock, skates and white hake. After these moratoria came into effect, DFO oversaw a process of reducing the harvesting capacity of the Atlantic Canadian industry through license buy-outs and other measures, such as restrictions on vessel replacements (DFO 2018d; Gough 2007). As a result, groundfish, which made up 42 percent of the landed value of all commercial fisheries in 1991, constituted just 7 percent of the regional total in 2015 (DFO 2018d). While overall Maritimes Region groundfish quantities plummeted with the closures (from 214,017 t in 1990, to 68,676 t in 2000 and 43,292 t in 2015), high-value shellfish landings increased (from 104,781 t in 1990, to 149,471 t in 2000 and 157,984 t in 2015), particularly with landings of shrimp, snow crab and lobster. Figure 3-56 shows groundfish values and quantities. During this time key large pelagic species fisheries, for swordfish, remained stable, though with substantial annual fluctuations (e.g., 909 t in 1990, 740 t in 2000, in 1,579 t 2015 and 996 t in 2019 (DFO 2020h).

In 2018, approximately 12,500 persons in the Maritimes Region were employed in commercial fish harvesting, operating with 3,110 active vessels, for a total landed value of approximately $1.4 billion that year. Of that total value, 66 percent was derived from three shellfish species: lobster ($818 million), snow crab ($70 million) and scallop ($40 million) (DFO 2019d). There are no aquaculture operations within the Study Area and the nearest location in coastal Nova Scotia is Area on the Canso Peninsula 120 km from the closest point to the Study Area.

Fisheries organizations throughout Nova Scotia support the interests of commercial license holders and industry sectors, based on fishing areas, species, vessels and / or gear. These organizations are accredited under Nova Scotia's *Fish Harvester Organization Support Act (2011)*. In addition, the Atlantic Groundfish Council, the Nova Swordfishermen's Association, the Atlantic Halibut Council and the Canadian Association of Prawn Producers and several other groups represent their members interests to DFO for different species. The Seafood Producers Association of Nova Scotia represents fish processors in the province. Several of these organizations collaborate with DFO in marine research.

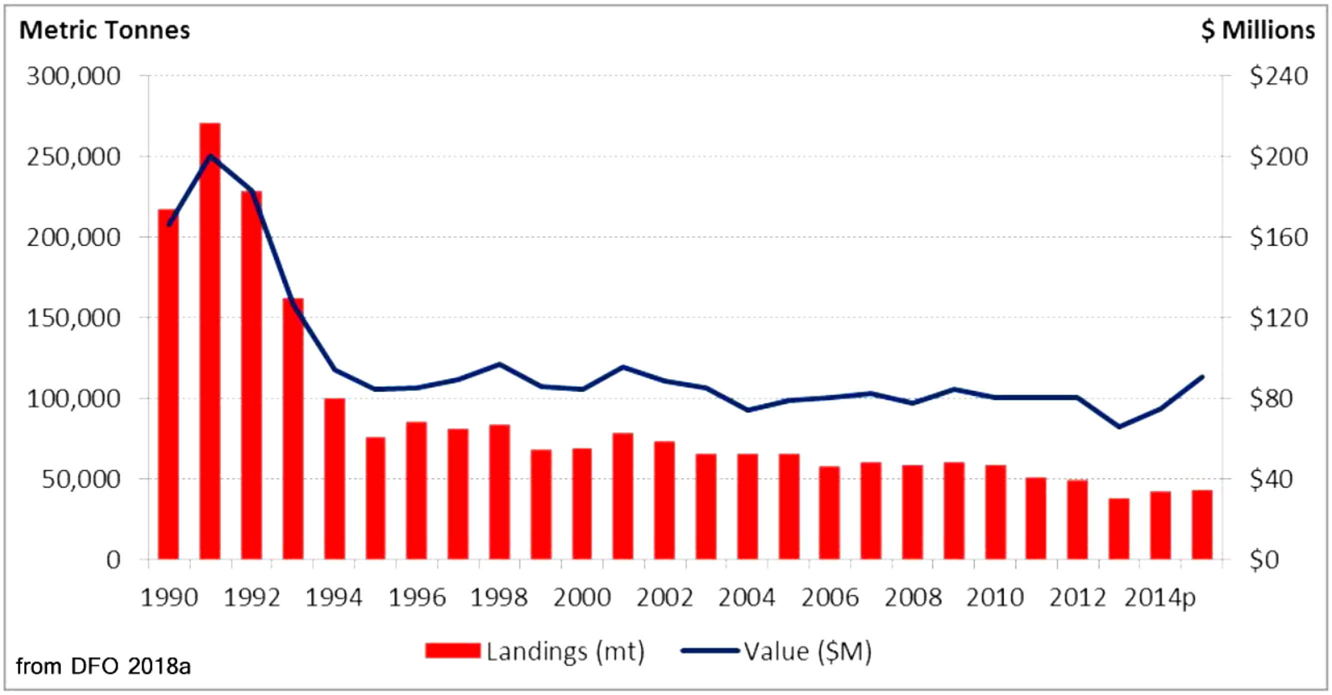


Figure 3-56: Maritimes Region Groundfish Landed Quantities and Values (1990-2015)

3.3.2.3 Harvesting Participants and Licenses

As of 2018, DFO Maritimes Region had a total of 6,086 licensed commercial harvesters (core, independent core and non-core), based either Nova Scotia or New Brunswick (Table 3-30). This does not include crew members working with a licensed harvester who must possess a valid Personal Fisher Registration. Collectively, licensed harvesters held nearly 15,500 individual species licenses in 2018, though not all licenses are fished each year.[1]. Bait harvesting licenses (e.g., for mackerel) are available to all who are licensed to pursue a bait-dependent fishery. Depending on the fishery, license conditions and / or other management plans may restrict the licensee to a particular geographical area, gear type, vessel size or require other measures (DFO 2020i). Table 3-31 lists 2020 commercial licenses by key species (discussed in Section 3.3.2.7), indicating those with landings, and total landings that year.

Table 3-30: Commercial Licenses, Maritimes Region

Province	Core / Independent Core	Non-Core	Other	Total
Maritimes Region – Nova Scotia	2,666	2,528	0	5,194
Maritimes Region – New Brunswick	311	581	0	892
Total	2,977	3,109	0	6,086

[1] These include commercial communal licenses issued to Indigenous groups. Commercial communal fishing data (e.g., licenses, quotas, management plans, landings) are collectively included in this section as part of the overall commercial fisheries data. Available information on commercial communal licenses and landings are described and discussed further in Section 3.3.4.

Province	Core / Independent Core	Non-Core	Other	Total
A License Holder is categorized as core when they meet the following criteria for inshore vessel-based fishing licenses: is head of the enterprise or fishing unit, holds key licenses, has an attachment to the fishery, and is dependent upon the fishery. The Independent Core category is an eligibility criteria for the receipt of new or replacement inshore vessel-based licenses. A non-core harvester does not meet those criteria.				

Source: DFO 2018e

Table 3-31 shows the number of commercial licenses, the number with landings and total landings. All quantities provided are in metric tonnes live weight, and values are in relevant year (unadjusted) Canadian dollars. Some totals do not match exactly due to rounding. The highest landings (weight) are reported for scallop, lobster, crab, groundfish, shrimp, large pelagic species and mackerel (largest to smallest) in the Maritimes Region. The number of licenses for hagfish was below threshold for federal government protection of privacy requirements. Note that DFO datasets have been redacted for some fisheries and / or areas. For those with few participants, all data may have been suppressed, while others are fully disclosed due to having many participants.

Table 3-31: Commercial Species Licenses and Landings, Maritimes Region (2020 Preliminary)

Fishery	Licenses (#)	Licenses with Landings (#)	Total Landings (tonnes)
Crab	CFA[3] 23 – 62 CFA 24E - 53 CFA 24W - 9	CFA 23/24E - 51 CFA 24W - *	Total landings for all areas: 8,026
Groundfish (All gear / all groundfish)	Total licenses for all areas (some licenses may fish multiple areas): 869 4W - 869 4VS - 869	Total licenses with landings for all areas (some licenses may have landings from multiple areas): 282 W - 251 4VS - 104	Total landings for all areas: 7,306 4W – 4,055 4VS – 3,251
Hagfish	Total licenses for all areas (some licenses may fish multiple areas): 5 4W - 5 4VS - 2	Total licenses with landings for all areas (some licenses may have landings from multiple areas): * 4W - * 4VS - *	Total Landings for all areas: * 4W - * 4VS - *
Large Pelagic Species (Licenses that are valid to fish DFO Maritimes Region.)	Total licenses for all areas (some licenses may fish multiple areas) - all large pelagic species - 845	Total licenses with landings for all areas (some licenses may have landings from multiple areas): Shark - 5 Swordfish Total - 42 4W - 42 4VS - 16 Tuna (bluefin) Total - 90 4W - 90	Total Landings for all areas: Shark - * Swordfish Total - 705 4W - 486 4VS - 219 Tuna (Bluefin) Total: 157 Other large pelagic species total: 31 4W - 26 4VS - 5

Fishery	Licenses (#)	Licenses with Landings (#)	Total Landings (tonnes)
		4VS - 7 Other large pelagic species total - (albacore, bigeye, yellowfin tunas, blue marlin, white marlin, mahi mahi): 34 4W - 31 4VS - 14	
Lobster (Inshore and Offshore)	LFA 41 - 8 LFA 30 - 20 LFA 31A - 71 LFA 31B - 70 LFA 32 - 157 LFA 33 - 680	LFA 41 - * LFA 30 - 19 LFA 31A - 55 LFA 31B - 67 LFA 32 - 132 LFA 33 - 555	LFA 41 - * LFA 30 - * LFA 31A - 825 LFA 31B – 1,074 LFA 32 - 945 LFA 33 – 5,584
Mackerel (Vessel-based licenses that are valid to fish DFO Maritimes Region)	Total licenses for all areas (some licenses may fish multiple areas): 1,963	Total licenses with landings for all areas (some licenses may have landings from multiple areas): 20 4W - 20 4VS - 0	Total landings for all areas: 34 4W - 34 4VS - 0
Scallop (Licenses that are valid to fish DFO Maritimes Region)	Total licenses for all areas (some licenses may fish multiple areas): (Offshore) 6 SFA 25 - 6 SFA 26 - 6 SFA 27 - 6	Total licenses with landings for all areas (some licenses may have landings from multiple areas): * SFA 25 - * SFA 26 - 6 FA 27 - 6	Total landings for all offshore areas (SFA 25,26,27): 46,999
Shrimp	Total licenses for all areas (some licenses may fish multiple areas): 29 SFA 14 - 28 SFA 15 - 29	Total licenses with landings for all areas (some licenses may have landings from multiple areas): 16 SFA 14 - 7 SFA 15 - 11	Total landings for all areas: 1,028 SFA 14 - 713 FA 15 - 315

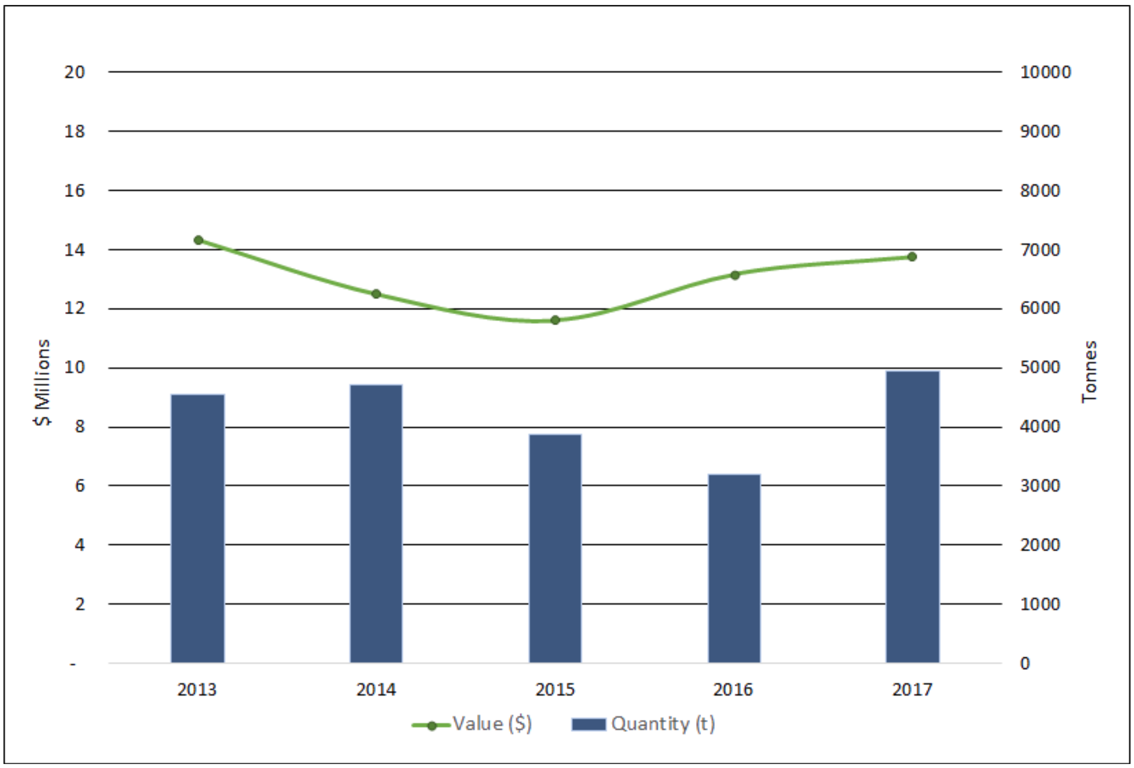
Source: DFO 2021d

3.3.2.4 Species Landings by Quantity and Value

Data in DFO datasets have been aggregated by relatively large geographic units. For quantity and value data, the smallest geographic aggregation provided by DFO is at the NAFO UA level for relevant quantities and values of commercial fisheries. The UAs that provide the most accurate representation of commercial harvesting in the Study Area are UAs 4Wl, 4Wj, 4Wf, 4Wg and 4Wm (Figure 3-55). In this report, these are referred to as the Study

Area UAs and together encompass approximately 90 percent of the Project Area's geographic extent and 75 percent of the Study Area. The rest of the Study Area is covered by small proportions of other UAs which, if included, would distort the data attributed to the Study Area.

Figure 3-57 graphs the quantities and values of the harvest from the Study Area UAs for 2013-2017, and Table 3-32 shows the breakdown of these landings by species in terms of quantities and values reported in the available DFO datasets. Figure 3-57 indicates that, overall, quantities and values of landings from this area were stable over the period. The lower numbers in 2016 are primarily the result of lower than average groundfish landings that year, as indicated in the dataset. Table 3-32 presents the average catch over the period, and the catch in 2017 for comparison[2]. The Table also indicates the percent that each of those landings represents of the total quantities and values for the period. While most of these species are caught in directed fisheries (e.g., silver hake, swordfish), some are permitted only as bycatch in other fisheries (e.g., white hake, sharks). Together, the species named in the Table made up 98.5 percent of the area's harvest by quantity and 99.2 percent by value during those years, based on the DFO data.



Source: DFO 2020h

Figure 3-57: Study Area UAs Landed Quantities and Values (2013-2017)

[2] As described above, protection of privacy redaction from the data provided by DFO has reduced the reported totals for most species in some areas. For example, sea scallop harvesting is recorded in the Study Area UAs in the 2017 geospatial dataset but is not reported within the received quantity and value data for 2017.

Table 3-32: Quantities and Values of Harvest from Study Area UAs (2013-2017 Average and 2017)

Species	Average Quantity (t)	Average Value ($)	% of Average Quantity	% of Average Value	2017 Quantity (t)	2017 Value ($)	% of 2017 Quantity	% of 2017 Value
Hake, Silver*	2,481.1	1,976,918	58.3	15.1	3,286.3	2,660,772	66.8	19.4
Swordfish	483.6	4,349,195	11.4	33.3	317.9	3,503,45	6.5	25.6
Redfish*	320.1	278,494	7.5	2.1	365.9	338,217	7.4	2.5
Halibut, Atlantic*	250.6	3,709,436	5.9	28.4	275.9	4,124,05	5.6	30.1
Hake, Red*	171.6	207,897	4.0	1.6	255.8	140,694	5.2	1.0
Crab, Queen/Snow	128.3	793,944	3.0	6.1	113.2	1,155,04	2.3	8.4
Scallop, Sea	100.7	275,066	2.4	2.1	-	-	0.0	0.0
Tuna, Bigeye	81.2	789,524	1.9	6.0	97.8	799,794	2.0	5.8
Hake, White*	50.3	60,536	1.2	0.5	54.0	69,696	1.1	0.5
Pollock*	27.0	33,645	0.6	0.3	7.3	8,247	0.1	0.1
Shark, Mako	24.9	82,285	0.6	0.6	33.8	124,278	0.7	0.9
Greysole/Witch*	21.1	23,430	0.5	0.2	15.2	19,548	0.3	0.1
Tuna, Bluefin	20.8	259,117	0.5	2.0	22.7	407,802	0.5	3.0
Cusk*	14.5	13,236	0.3	0.1	10.9	9,289	0.2	0.1
Tuna, Yellowfin	13.9	108,726	0.3	0.8	30.5	262,045	0.6	1.9
Haddock	11.6	16,662	0.1	0.1	9.7	13,460	0.2	0.1
All Other Species	52.1	81,866	1.2	0.6	22.5	73,462	0.5	0.5
Totals	4,253.5	13,059,977	100.0	100.0	4,919.4	13,709,857	100.0	100.0
* Classified as groundfish by DFO								

Source: DFO 2020h

As these data indicate, groundfish species constitute the major part of the harvest by quantity, making up more than 78 percent of the average catch though less than half of the average landed value of the harvest (48%). This is owing to the relatively higher prices paid for swordfish and other large pelagic species, and for shellfish. Details about the Study Area UA key species are provided in Section 3.3.2.7.

3.3.2.5 Harvesting Locations and Seasonality

The Study Area present a diverse ecosystem and highly variable ocean depths, ranging from relatively shallow areas on the shelf (e.g., less than 25 m near Sable Island) to depths exceeding 4,000 m beyond the shelf (Section 3.1.3). The Shelf itself is punctuated with deep holes, some 300 m deep (several just north of the Study Area) where shrimp and snow crab are pursued. These varying features facilitate or limit different fishing activities and the fishing gear that can be used. In the deep southern regions of the Study Area, harvesting is limited to near-surface/floating gear, mainly tuna and swordfish longlines, while the waters near the shelf edge between roughly

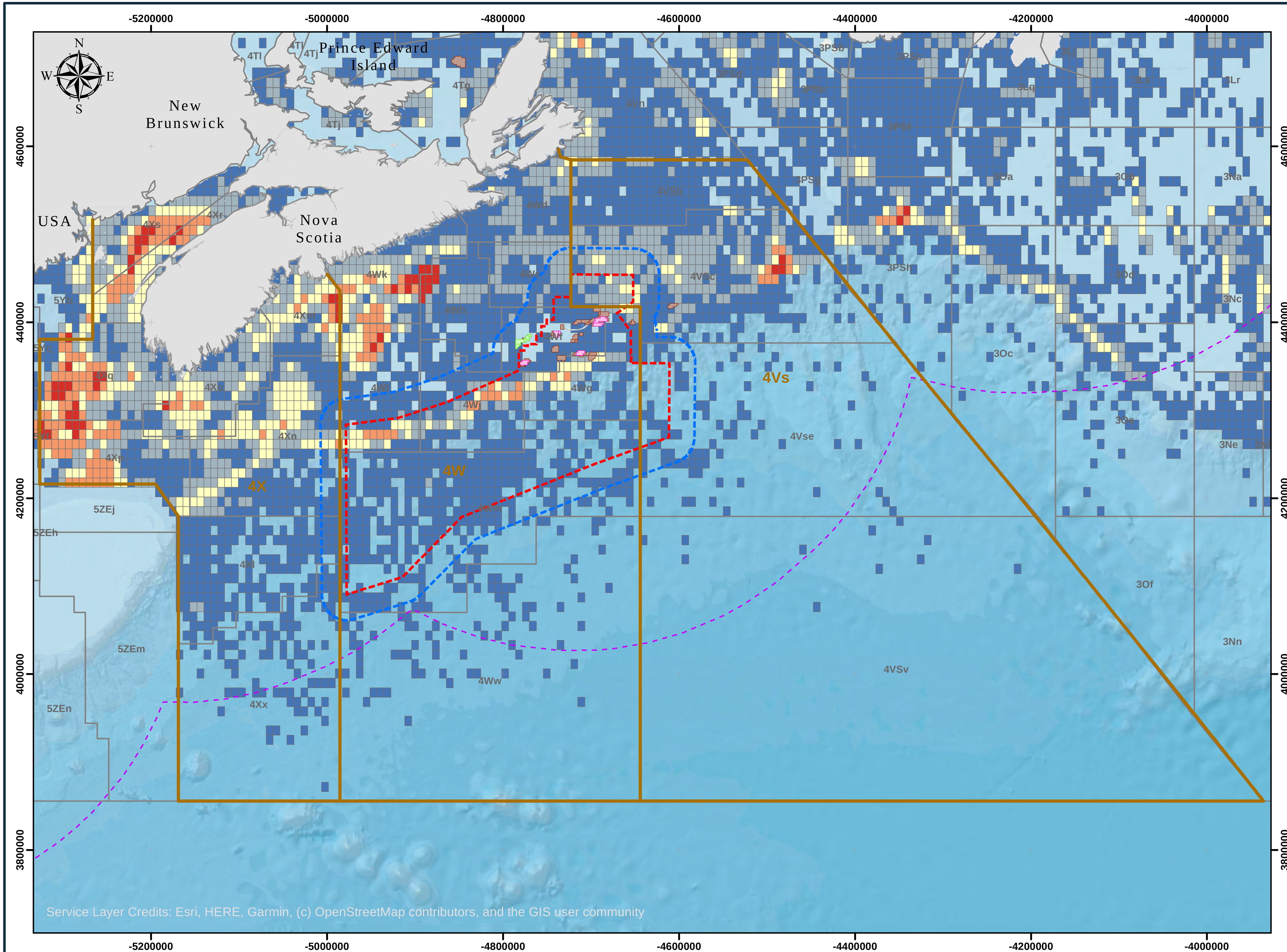
100 m and 1000 m are fished extensively for many species using several different gear types, both bottom-tending and surface.

Both where fish are harvested and when they are fished in those locations are determined by several other factors as well. The fish must be taken where they aggregate at the times that they are present in sufficient quantities for the harvesting to be economically feasible. Apart from factors associated with the biology and behaviour of the species, management regulations often define the season when harvesting is permitted, and many species licenses also set boundaries on where the license can be fished (e.g., snow crab). Harvesting times and locations can also be affected by the presence of ice and other weather factors, the types of vessels used, and business plans of a fishing enterprise (e.g., fishing one species first, then rigging up to fish another). The following maps indicate the locations of all species, aggregated, in relation to the Study Area, based on the latest available DFO data (DFO 2021a). For most species' fisheries – unless there are changes in management regimes – locations and timing are quite consistent year to year, and so are a good predictor for future planning purposes.

Figure 3-58 presents a five-year aggregated view of all harvesting locations provided, in the Study Area, and other features to indicate the extent of the Shelf and adjacent waters that are fished. Figure 3-59 shows the same, but for 2018 only, to show what a typical year of activity looks like. In these figures and others based on the DFO geospatial datasets (DFO 2020a), the cells are colour-coded to provide an indication of relative fishing intensity based on the number of harvesting records at each cell location: blues represent areas with relatively lower numbers of records and yellow to red indicates where more fishing activity reports occurred (see map legends).

As the maps illustrate, the Scotian Shelf and slope areas are widely used by the fishing industry, the exceptions being defined primarily by the location of protected areas with fisheries closures or other harvesting restrictions (see Section 3.2.10). Within the Study Area, much of the fishing is focused on the band approximately 30-40 km wide along the slope edge where fish are attracted by upwelling nutrients and other favourable environmental conditions. The shelf-edge fisheries are largely for groundfish species (using fixed and mobile gears) and large pelagic longlining, though several other types are taken there in smaller quantities. In the outer waters of the shelf slope, the harvest is primarily large pelagic species – swordfish and tunas, with some sharks as bycatch. Shellfish harvesting, relative to the Study Area, occurs primarily in the northernmost part of the Study Area (snow crab), north of Sable Island and in The Gully trough area, with a relatively smaller amount of red crab being taken along the shelf margin. Other shellfish indicated as being harvested within the Study Area are shrimp, clams, and scallops, all in the general vicinity of Sable Island.

Figure 3-58 to Figure 3-71 show the same data presented by month to illustrate how fishing patterns change within and near the Study Area over the year. The grid size is approximately 4 x 6 nautical miles (rectangular pixels) which represent the number of hits for each designated grid area. The intensity value indicated in the legend represents the number of logbook records. Section 3.3.2.7 provides additional locational and temporal information for key species identified.



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity - All Species (2014 - 2018)

- 1 - 24
- 25 - 74
- 75 - 173
- 174 - 340
- 341 - 1068

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
FISHING INTENSITY - ALL SPECIES - ALL YEARS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-58**

SCALE: 1:4,112,529

0 20 40 80 120 160 Kilometres

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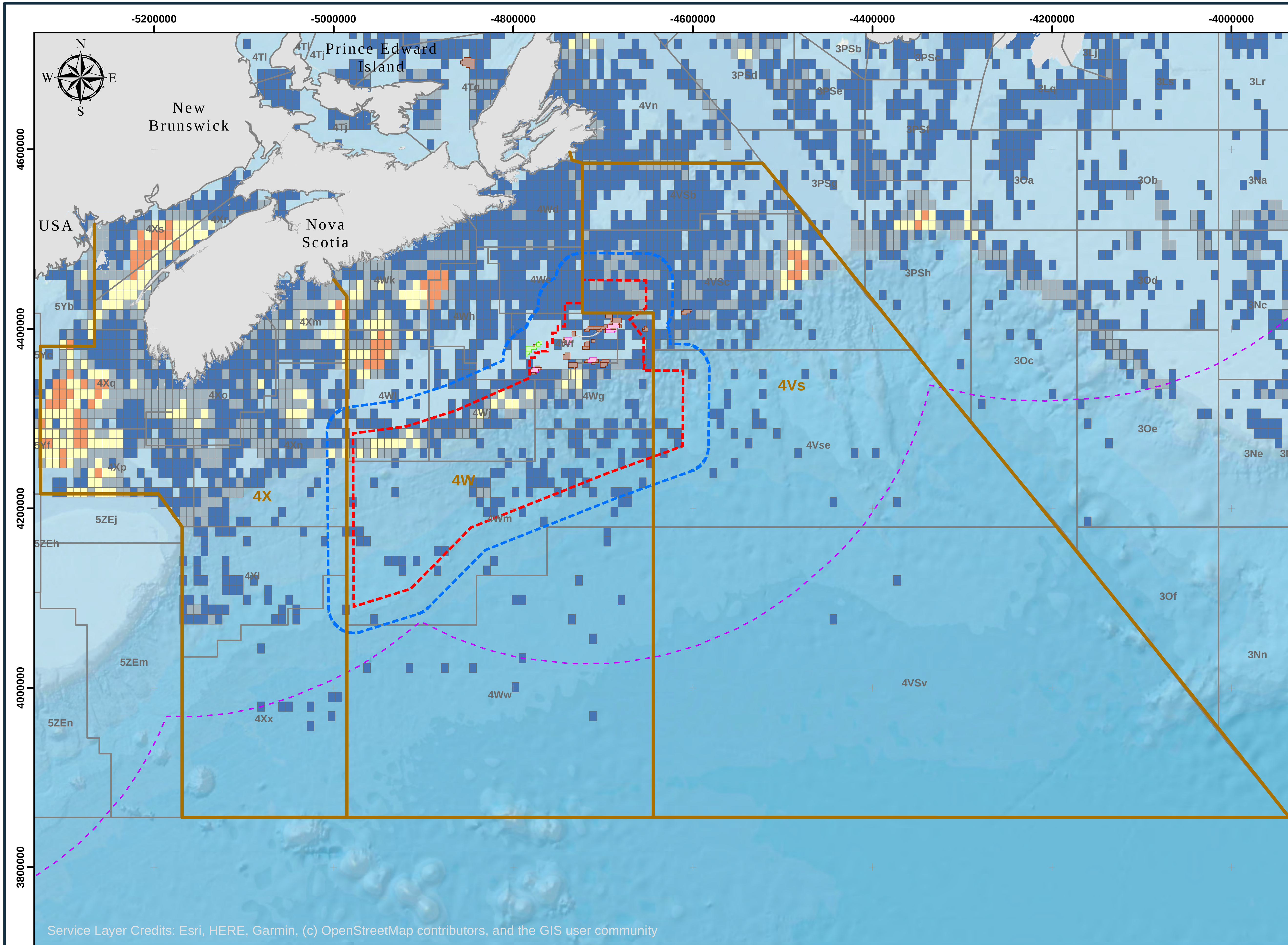

LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity - All Species (2018)

- 1 - 10
- 11 - 31
- 32 - 70
- 71 - 139
- 140 - 2119

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY - ALL SPECIES - 2018

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-59**

SCALE: 1:4,112,529

0 20 40 80 120 160

Kilometres

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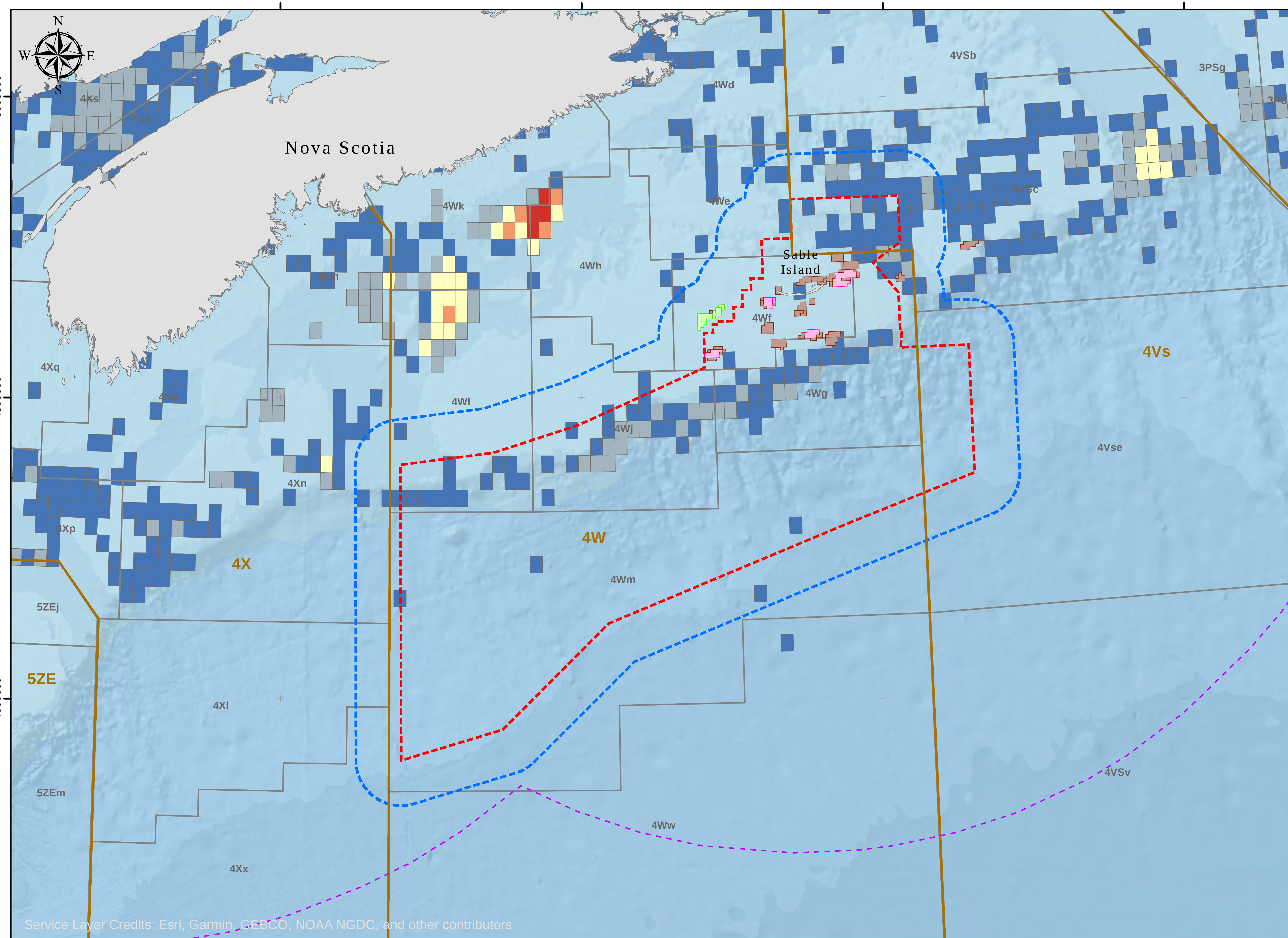

LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species January (2014 - 2018)

- 1 - 7
- 8 - 23
- 24 - 46
- 47 - 70
- 71 - 139

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY MONTH

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO: **TE211002**	DATE: **MAY 2022**
REV NO: **0**	DWN BY: **JA**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE: **FIGURE 3-60**

SCALE: 1:2,500,000

0 12.5 25 50 75 100 Kilometres

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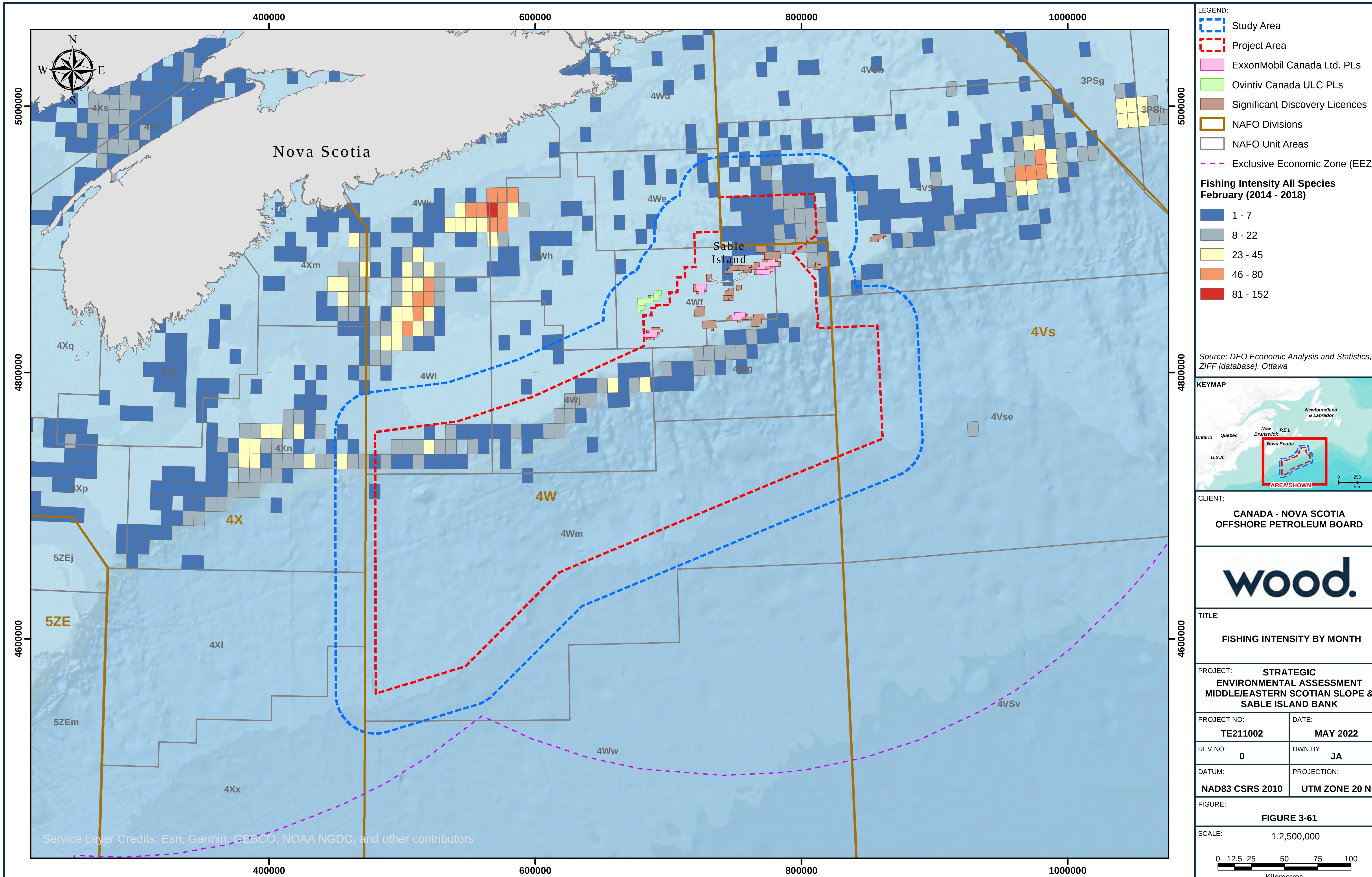

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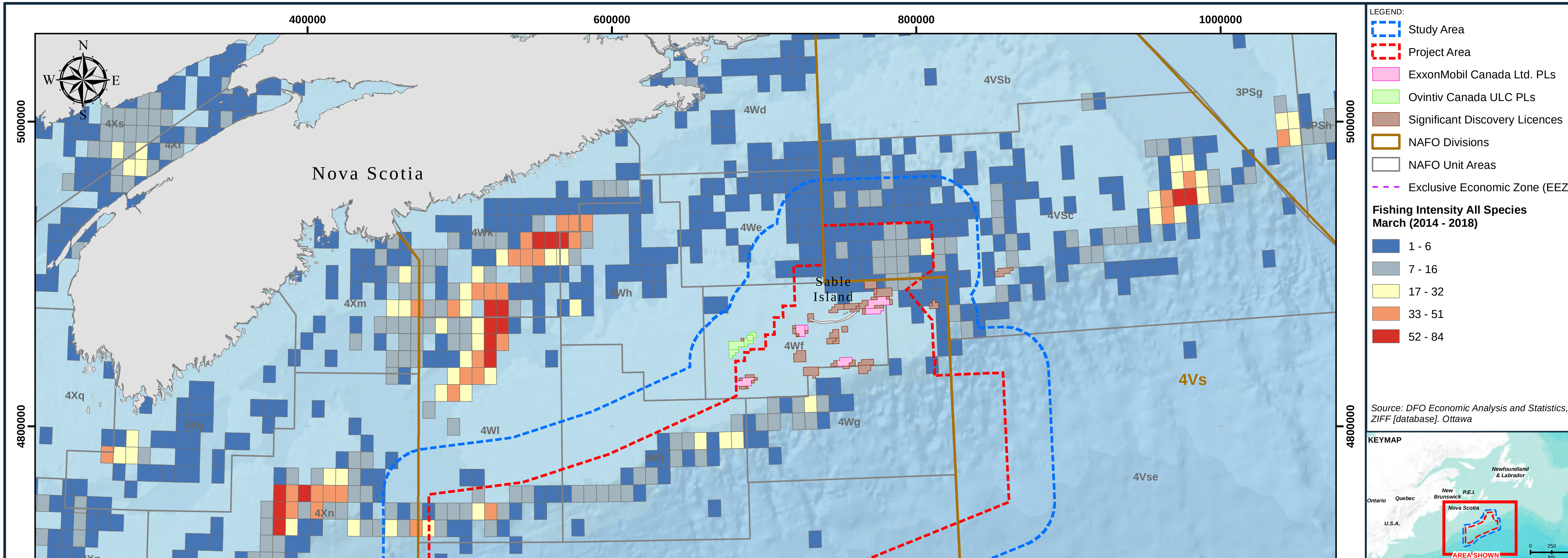

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY MONTH

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-62

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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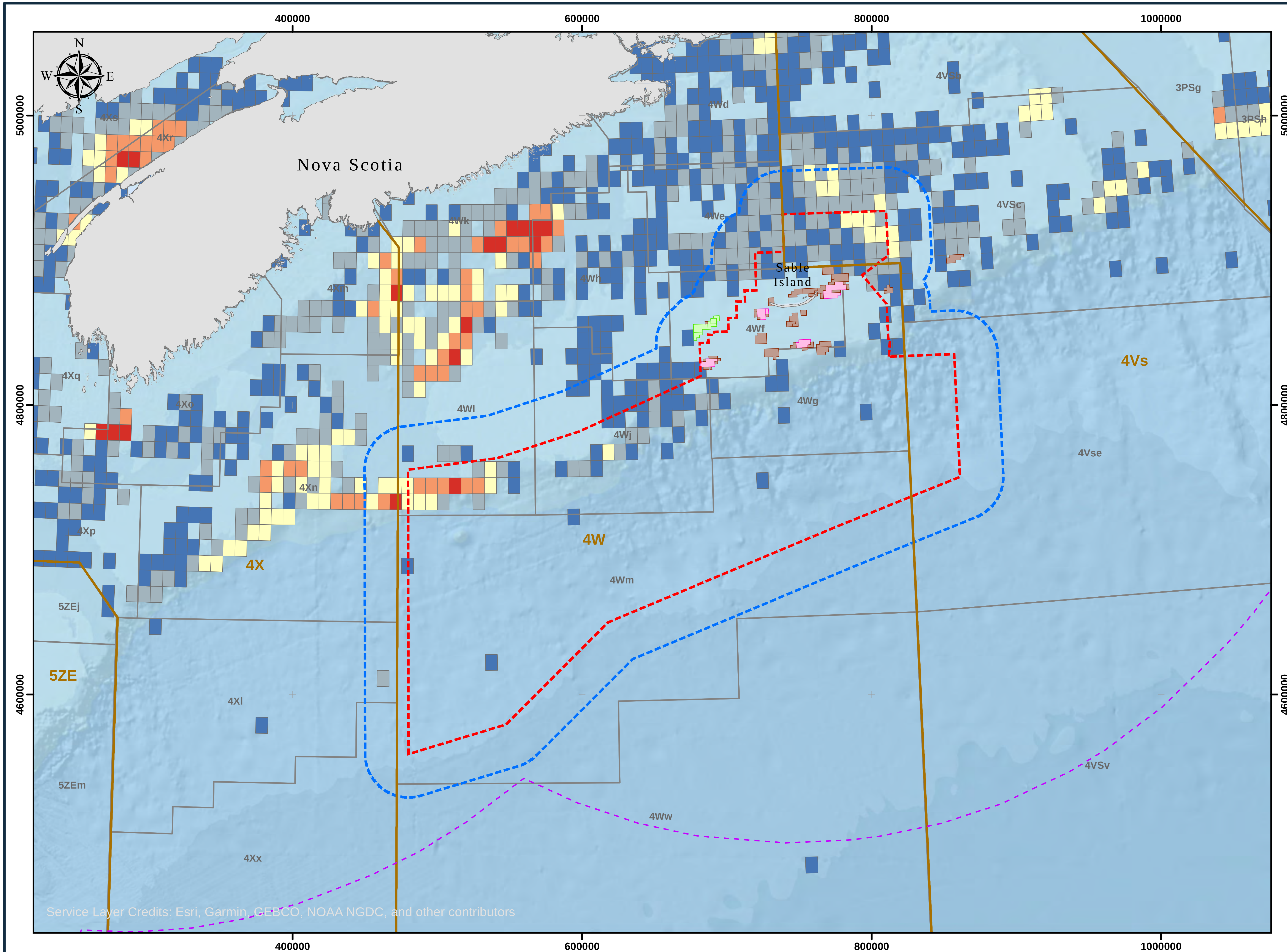

LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species April (2014 - 2018)

- 1 - 4
- 5 - 13
- 14 - 29
- 30 - 53
- 54 - 91

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY MONTH

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-63

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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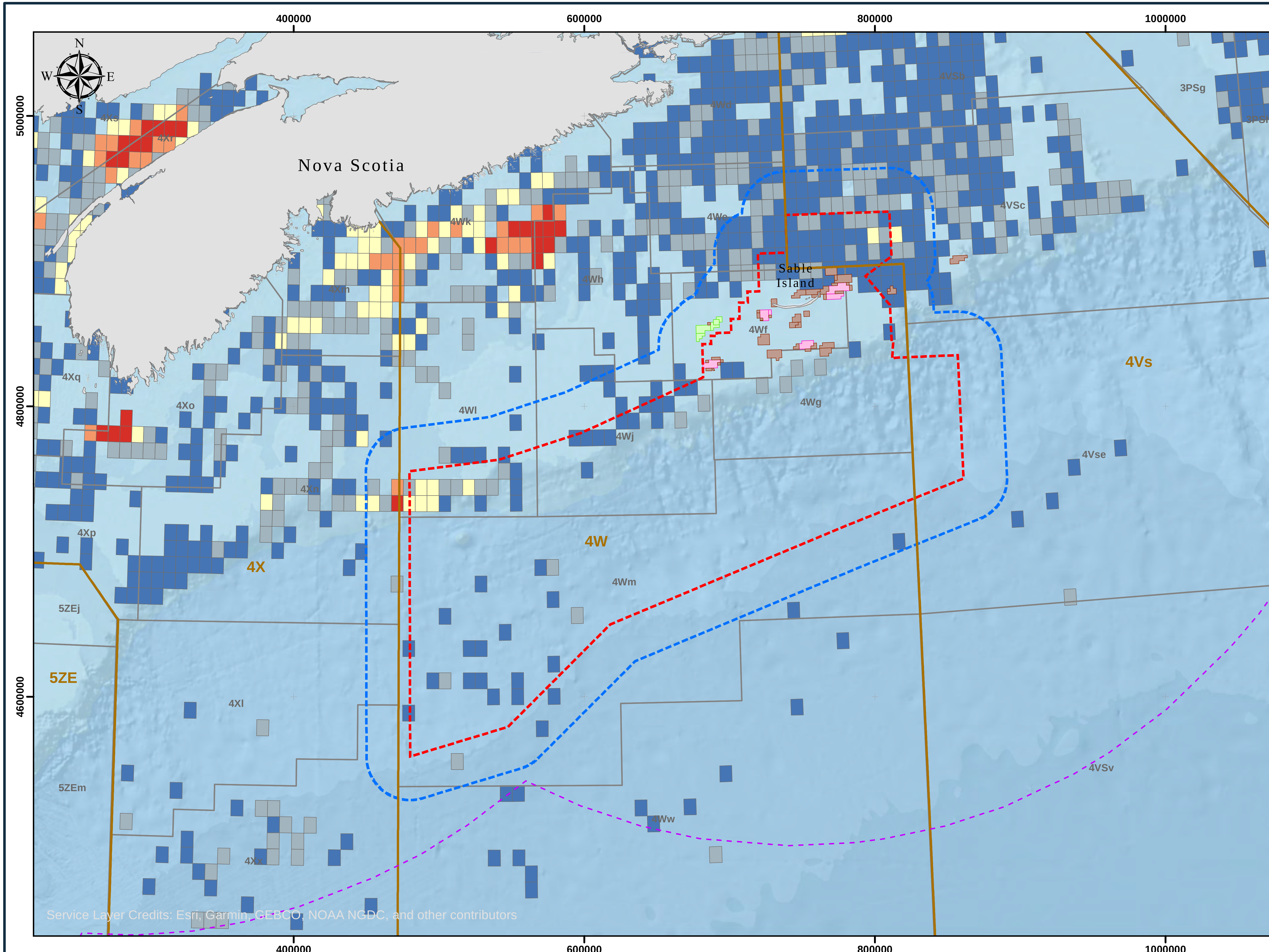


LEGEND:

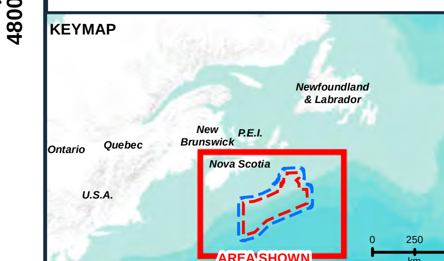
- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species May (2014 - 2018)

- 1 - 5
- 6 - 14
- 15 - 32
- 33 - 62
- 63 - 116

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY MONTH

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-64

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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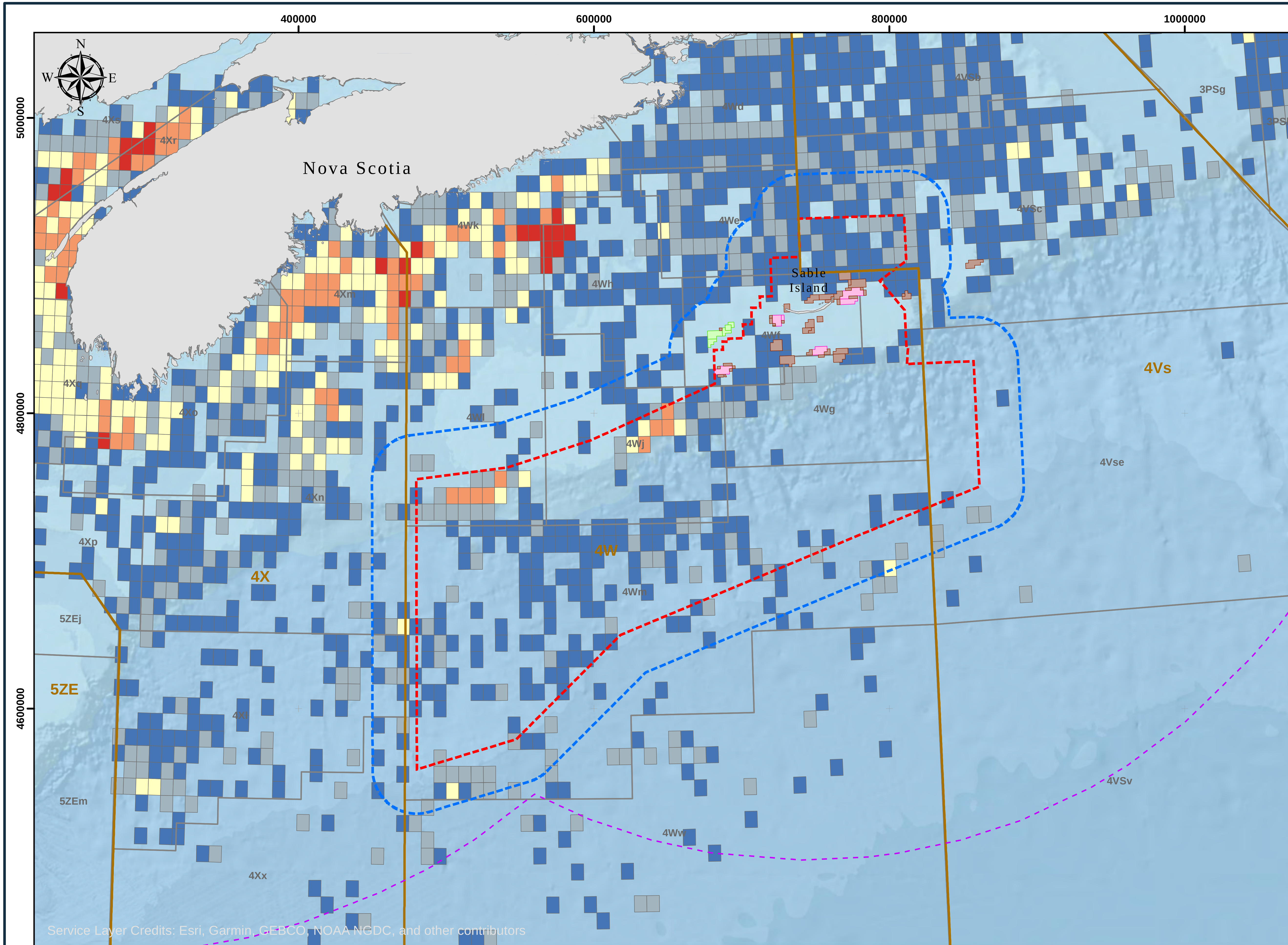


LEGEND:

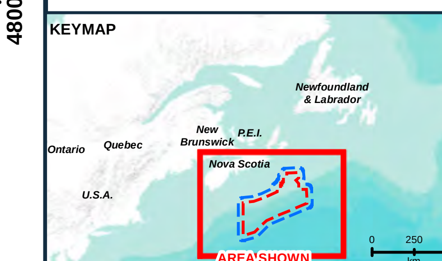
- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species June (2014 - 2018)

- 1 - 5
- 6 - 13
- 14 - 28
- 29 - 52
- 53 - 104

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

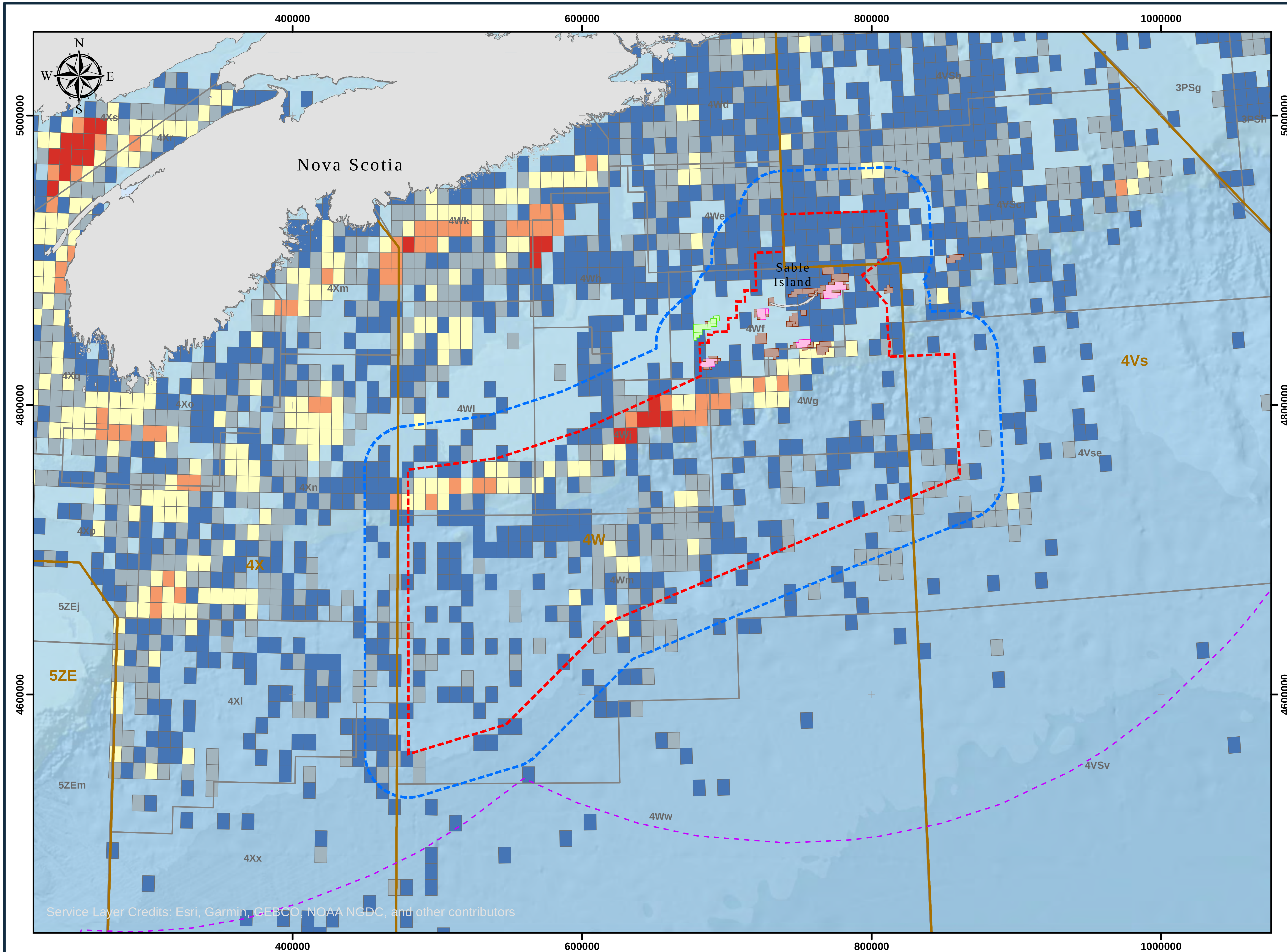
KEYMAP



CLIENT:	CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD
	wood.
TITLE:	FISHING INTENSITY BY MONTH
PROJECT:	STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK
PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N
FIGURE:	FIGURE 3-65
SCALE:	1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

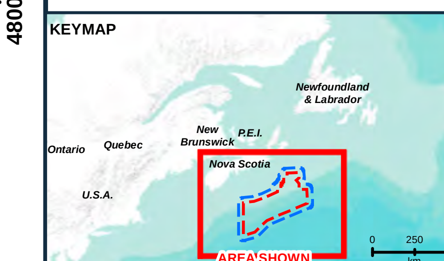
- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species
July (2014 - 2018)

- 1 - 5
- 6 - 13
- 14 - 28
- 29 - 52
- 53 - 96

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP



CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

TITLE:
FISHING INTENSITY BY MONTH

PROJECT:
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

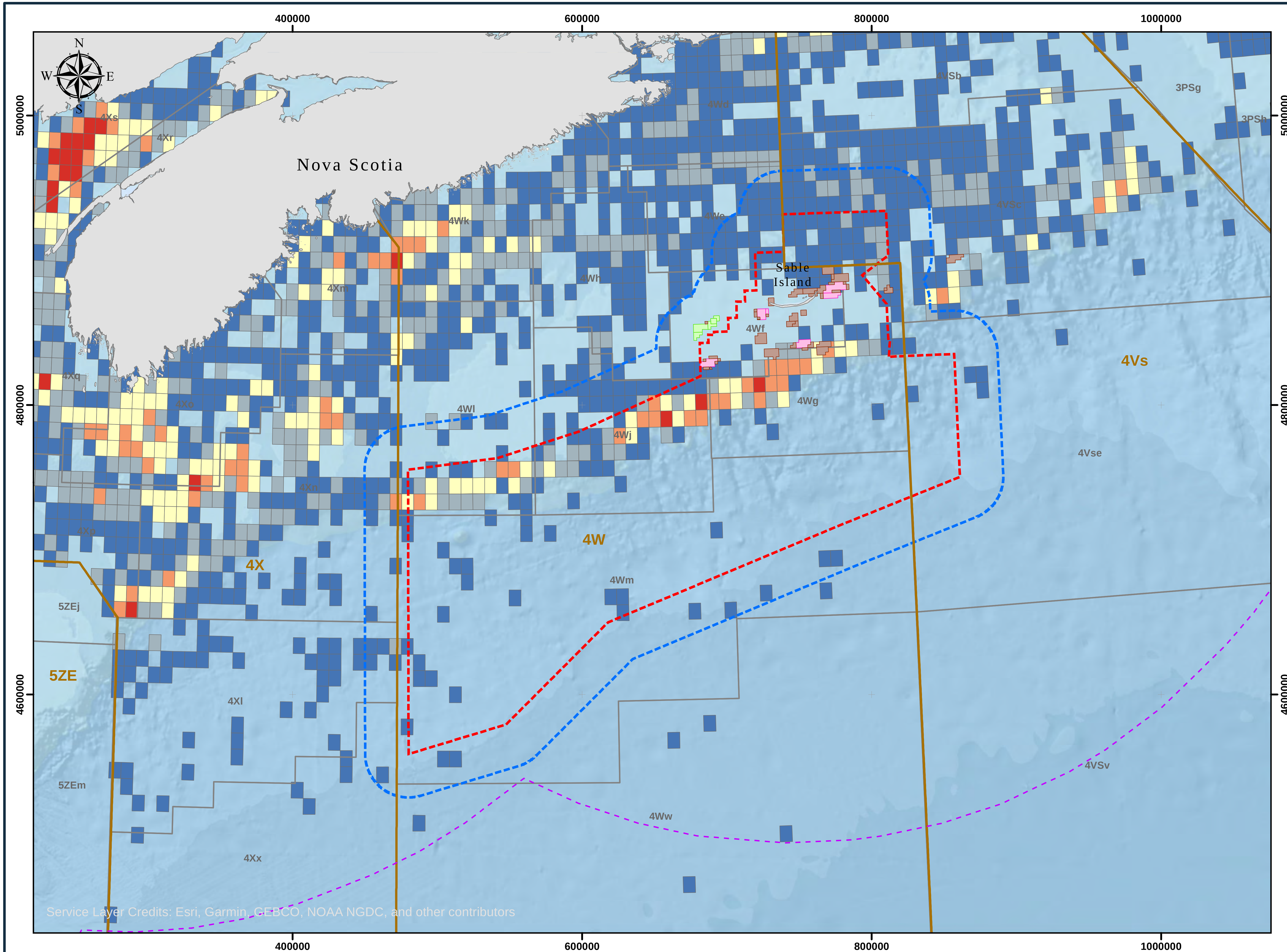
PROJECT NO: **TE211002**	DATE: **MAY 2022**
REV NO: **0**	DWN BY: **JA**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE:
FIGURE 3-66

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species August (2014 - 2018)

- 1 - 6
- 7 - 15
- 16 - 28
- 29 - 52
- 53 - 98

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

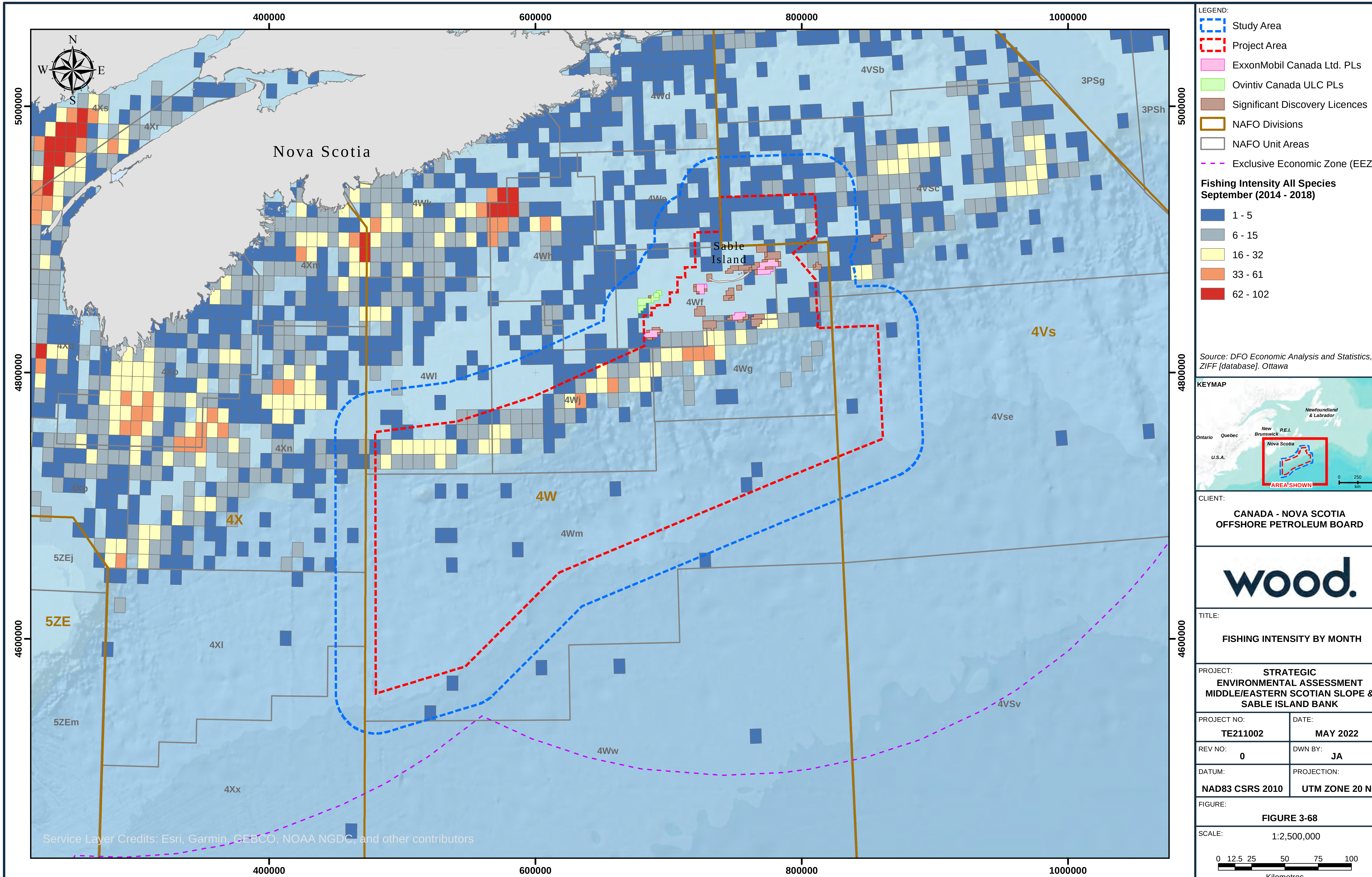
FISHING INTENSITY BY MONTH

PROJECT:	STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK
PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N
FIGURE:	FIGURE 3-67
SCALE:	1:2,500,000

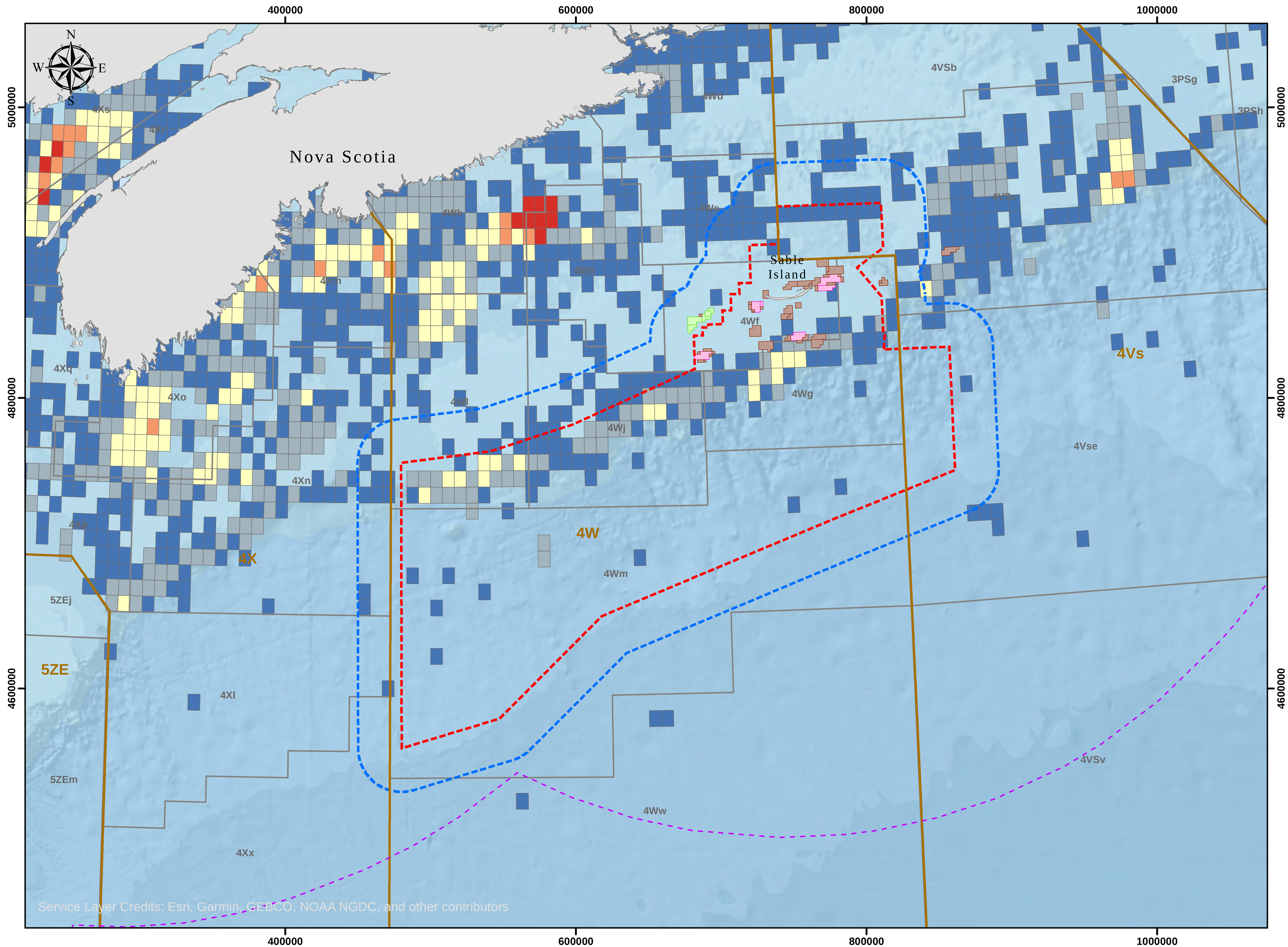
0 12.5 25 50 75 100

Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species October (2014 - 2018)

- 1 - 6
- 7 - 19
- 20 - 40
- 41 - 69
- 70 - 108

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE: FISHING INTENSITY BY MONTH

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

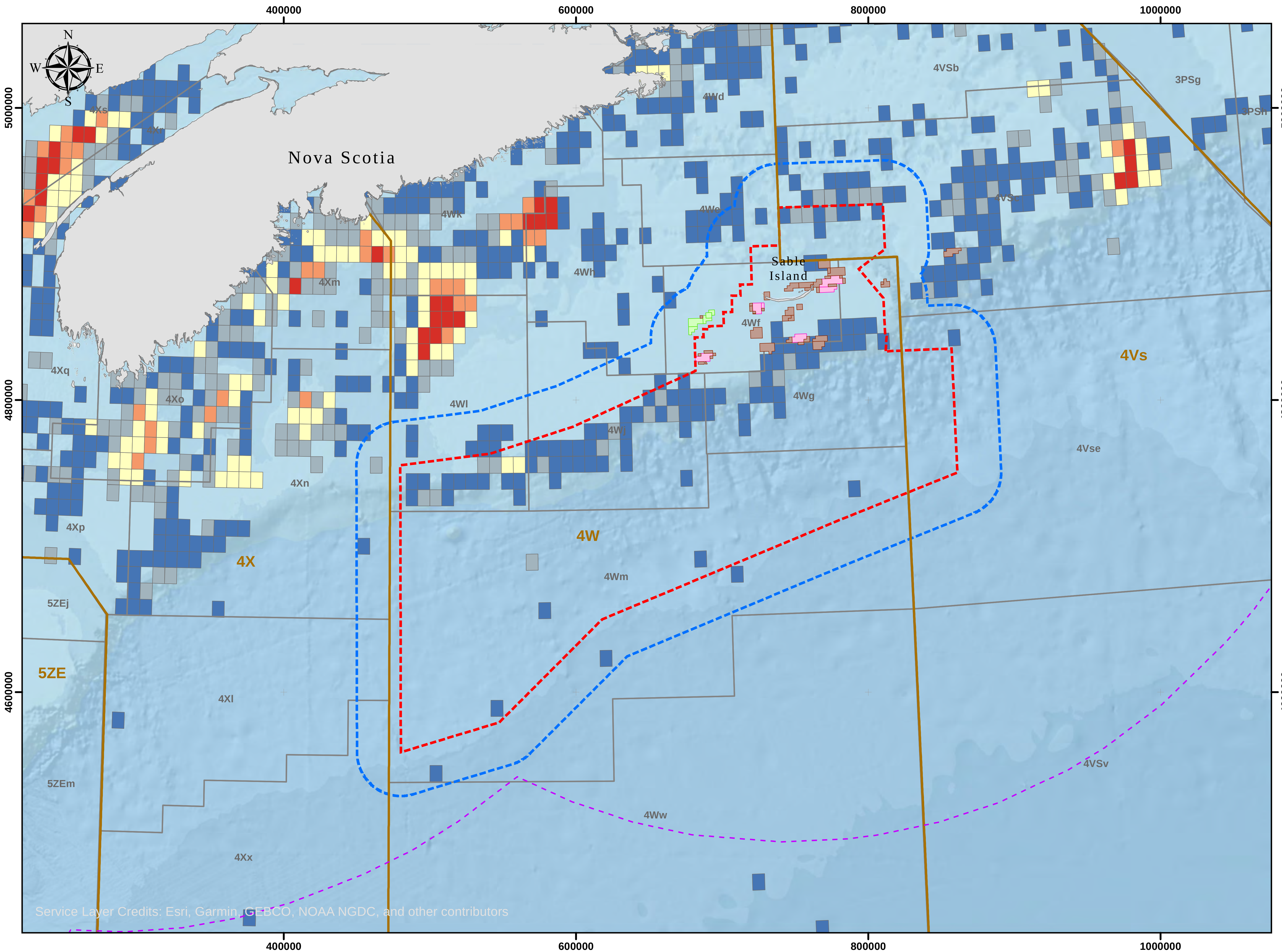
PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-69

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

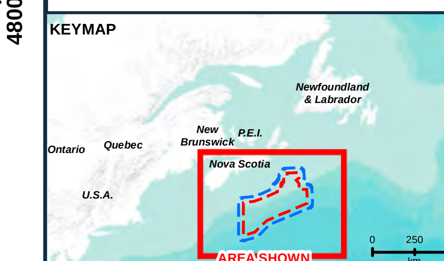
- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species November (2014 - 2018)

- 1 - 4
- 5 - 12
- 13 - 26
- 27 - 42
- 43 - 82

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP



CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
FISHING INTENSITY BY MONTH

PROJECT:
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

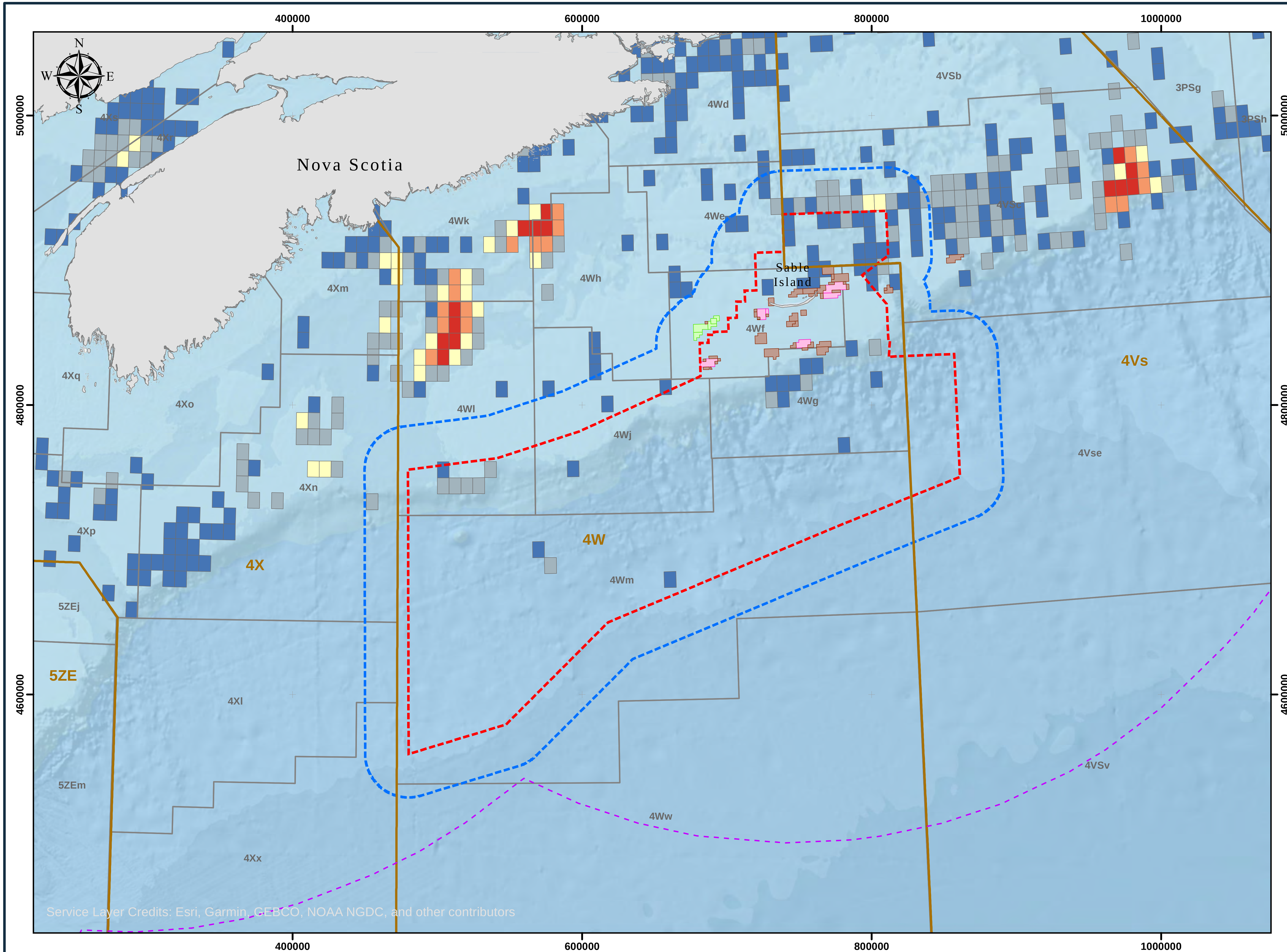
PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 3-70

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

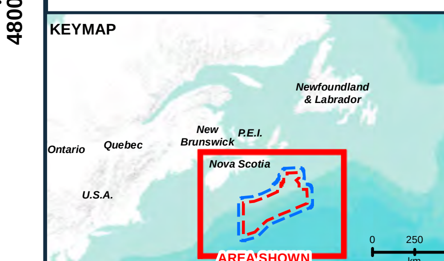
- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity All Species December (2014 - 2018)

- 1 - 4
- 5 - 12
- 13 - 26
- 27 - 49
- 50 - 85

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP



CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
FISHING INTENSITY BY MONTH

PROJECT:
STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 3-71

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022

3.3.2.6 Fishing Gear

Several types of fishing gear are used in and near the Study Area. While some species are caught with one gear type, such as pots for snow crab, others are harvested with more than one gear, such as bottom trawls and bottom longlines for some groundfish. Another gear distinction is whether it is fixed (or set) gear - like pots and longlines - or mobile gear, like otter trawls. For obvious reasons mobile and fixed gear harvesting are often not compatible and have a high potential for gear conflict if fishing in the same area at the same time; for example, bottom otter trawls and bottom longlines or nets, or shrimp trawls and snow crab pots.

Gear conflicts are important when considering potential interactions with other types of vessel operations, particularly marine seismic surveys where the towed hydrophone streamers might snag surface buoys marking bottom fixed gear or tangle with near-surface longlines. These implications are discussed further in Section 5.3.

Table 3-33 indicates the average quantities and value of the harvest that each gear type represents for the Study Area UAs in the datasets available from DFO, and Table 3-34 lists the principal species harvested in the area by each of the gears. Other DFO data sources indicate some hagfish harvesting in the Study Area using pots (Butler et al. 2019).

Table 3-33: Quantities and Values of Harvest by Fishing Gear from Study Area UAs (2013-2017)

Fishing Gear	Average Quantity (t)	Average Value ($)	% of Total Quantity	% of Total Value
Bottom otter trawl (stern)	3,077.0	2,595,378	72.3	19.9
Longlines*	922.5	9,162,844	21.7	70.2
Pots*	128.3	793,944	3.0	6.1
Dredge (boat)	100.7	275,066	2.4	2.1
Harpoon and spear	25.0	232,745	0.6	1.8
Totals	4,253.5	13,059,977	100.0	100.0
* Classified as fixed gear by DFO				

Source: DFO 2020h

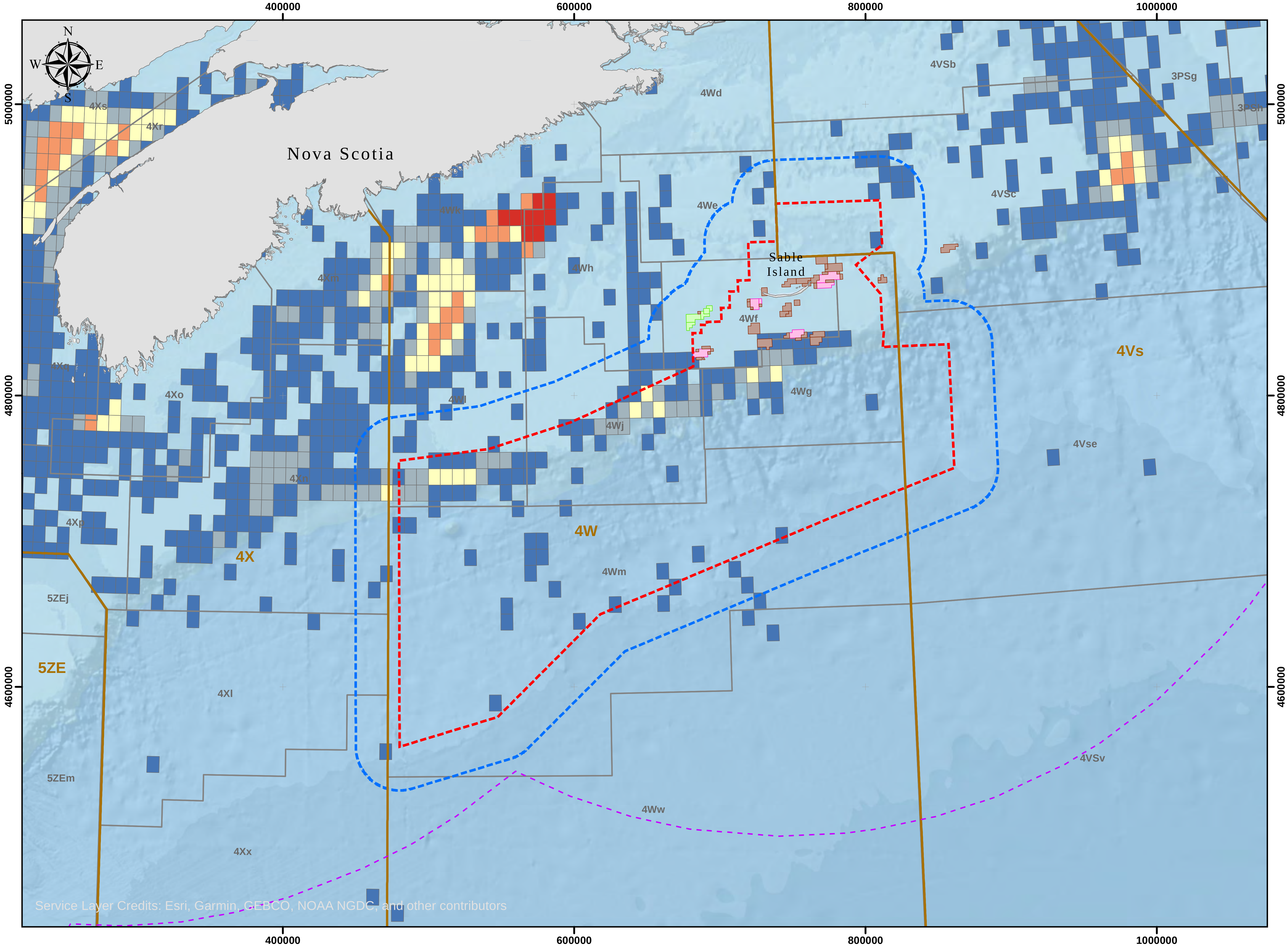
Various gear types are used in Study Area UAs (Table 3-34). These may be present at the water surface, in the water column or at subsea surface depending on the species.

Table 3-34: Fishing Gear and Principal Species Harvested, Study Area UAs (2013-2017)

Fishing Gear	**Principal Species Harvested**
Bottom otter trawl (stern)	Groundfish, mainly silver hake, redfish, red hake
Bottom longlines	Groundfish, mainly Atlantic Halibut, cusk
Near-surface longlines	Large pelagic species, mainly swordfish, tunas, sharks
Pots	Snow Crab, Red crab (also hagfish, but data redacted)
Dredge (boat)	Sea scallops
Harpoon and spear	Swordfish (also used for some tunas)

Source: DFO 2020h

The maps that follow (Figures 3-72 to 3-77) indicate the locations where each of these gear types has been used, based on the available datasets. Two maps are provided for longlines, one for bottom longlines (groundfish) and one for near-surface gear (pelagic species). For the pelagic longlines, especially, the “point” data presented is misleading about the actual gear locations in the water (near the surface) since these may reach lengths of 65 km to 100 km (40 to 60+ miles) set out as a single mainline, as described in Section 3.3.2.7.2; Figure 3-86 is a more realistic representation of pelagic longline locations when fishing. The grid size is approximately 4 x 6 nautical miles (rectangular pixels) which represent the number of hits for each designated grid area. The intensity value indicated in the legend represents the number of logbook records.



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity Gear Type - Bottom otter trawl (stern) (2014 - 2018)

- 1 - 39
- 40 - 130
- 131 - 258
- 259 - 468
- 469 - 1053

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE: FISHING INTENSITY BY GEAR TYPE

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-72

SCALE: 1:2,500,000

0 12.5 25 50 75 100 Kilometres

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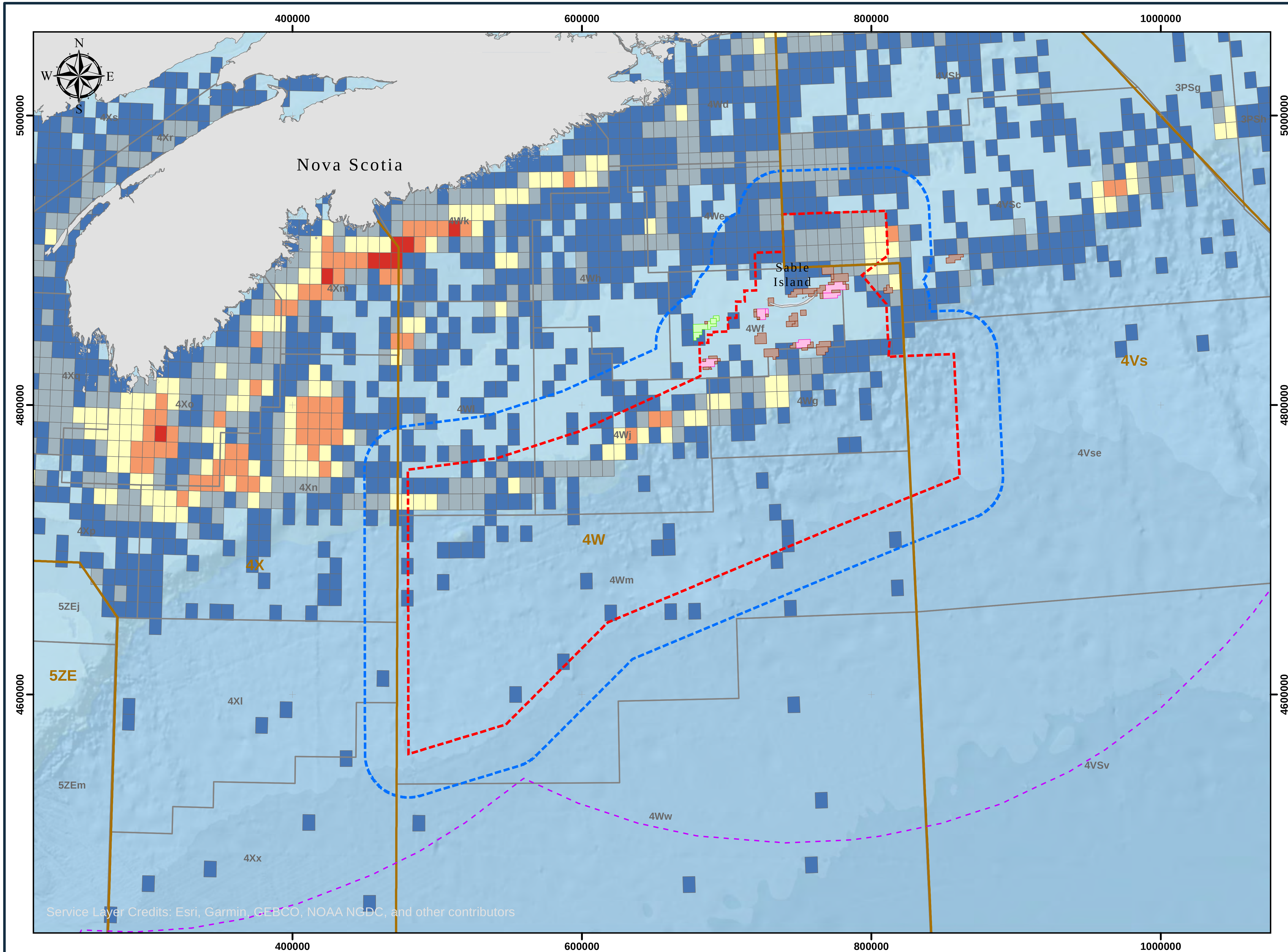


LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity Gear Type - Longlines (Bottom) (2014 - 2018)

- 1 - 15
- 16 - 45
- 46 - 92
- 93 - 180
- 181 - 398

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT: **CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD**

wood.

TITLE: **FISHING INTENSITY BY GEAR TYPE**

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

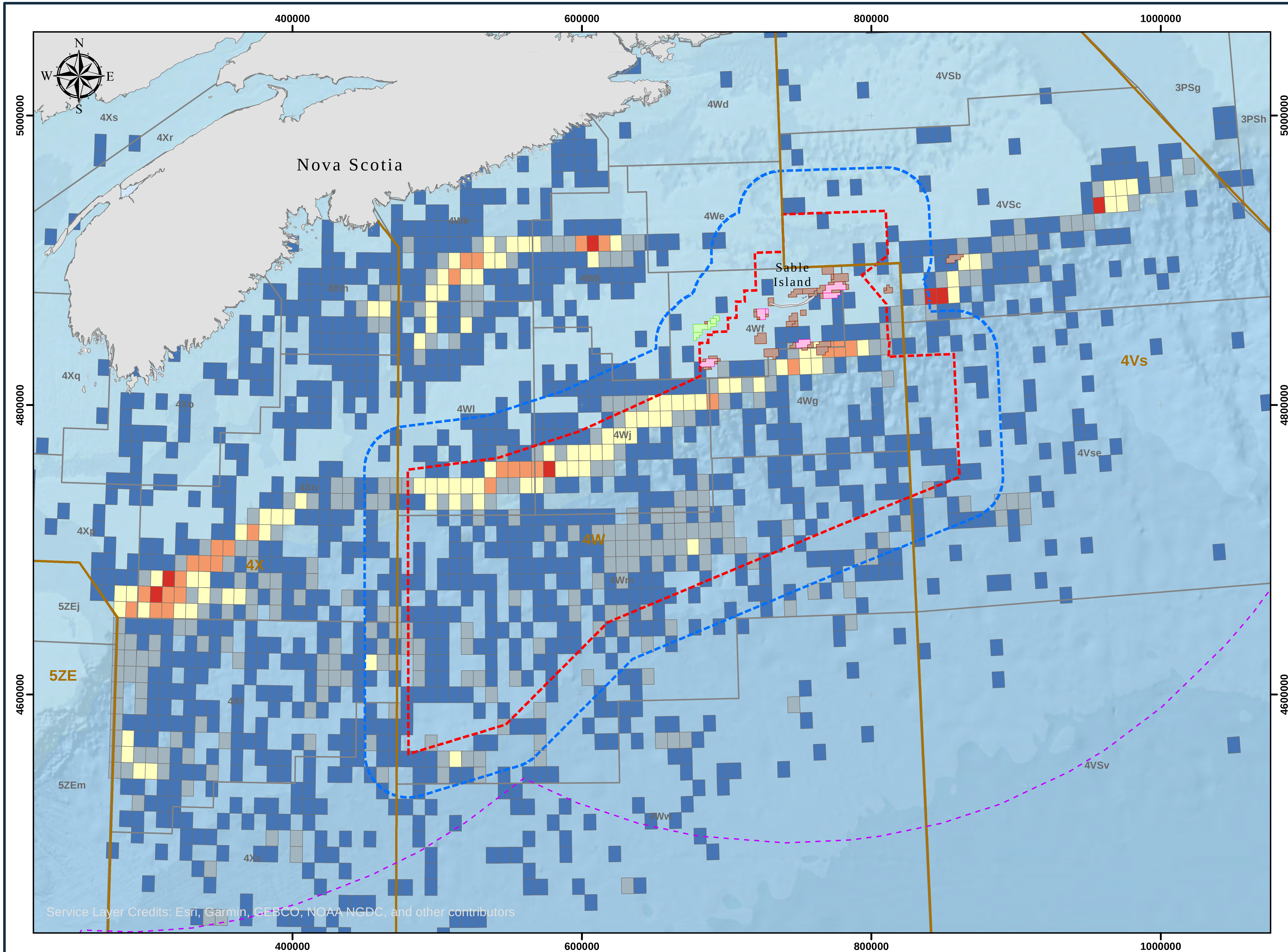
PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-73**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity Gear Type - Longlines (Surface) (2014 - 2018)

- 1 - 8
- 9 - 21
- 22 - 40
- 41 - 64
- 65 - 98

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY GEAR TYPE

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

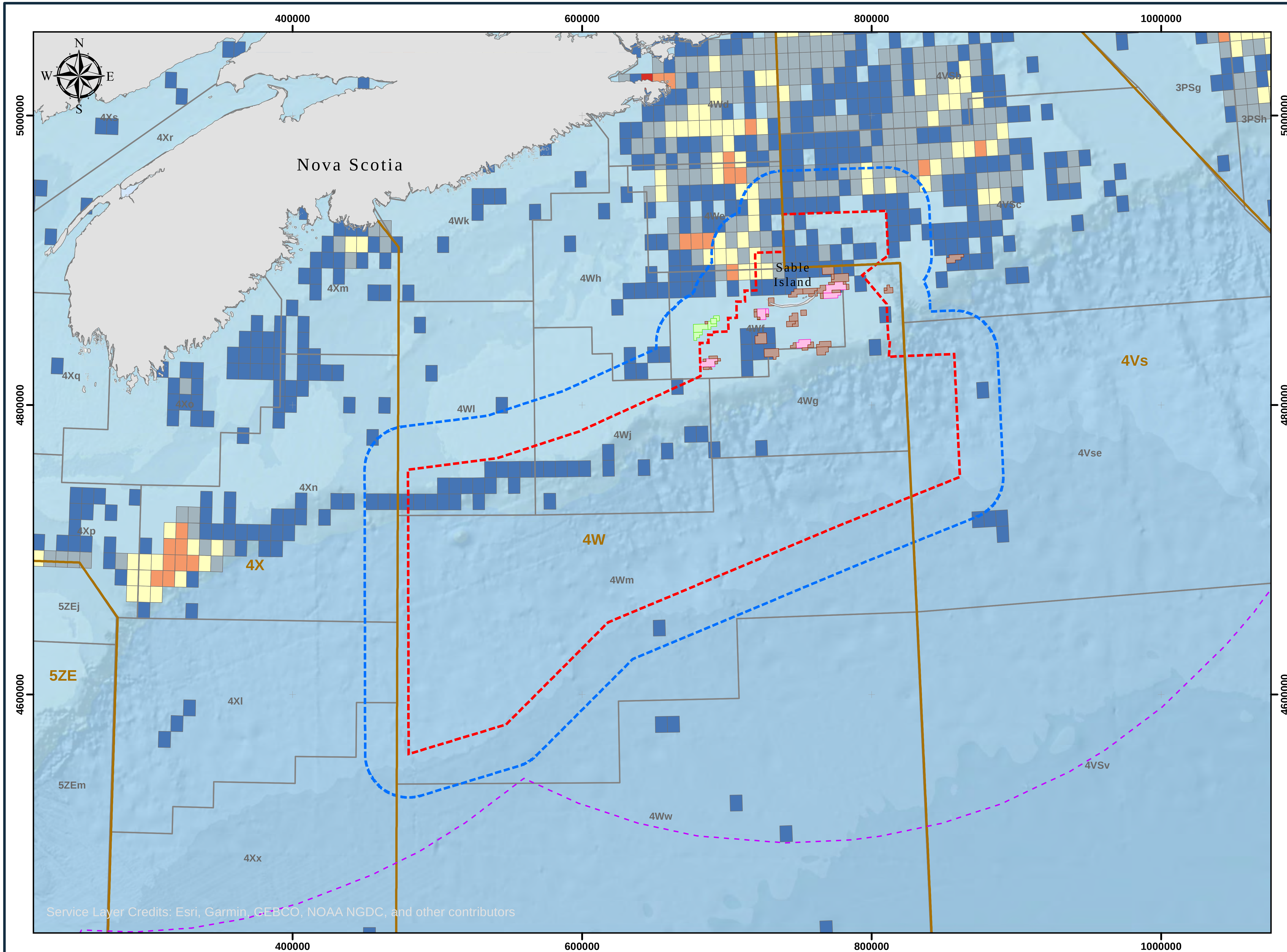
FIGURE: FIGURE 3-74

SCALE: 1:2,500,000

0 12.5 25 50 75 100

Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity Gear Type - Pots (2014 - 2018)

- 1 - 5
- 6 - 14
- 15 - 25
- 26 - 44
- 45 - 82

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE: FISHING INTENSITY BY GEAR TYPE

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-75

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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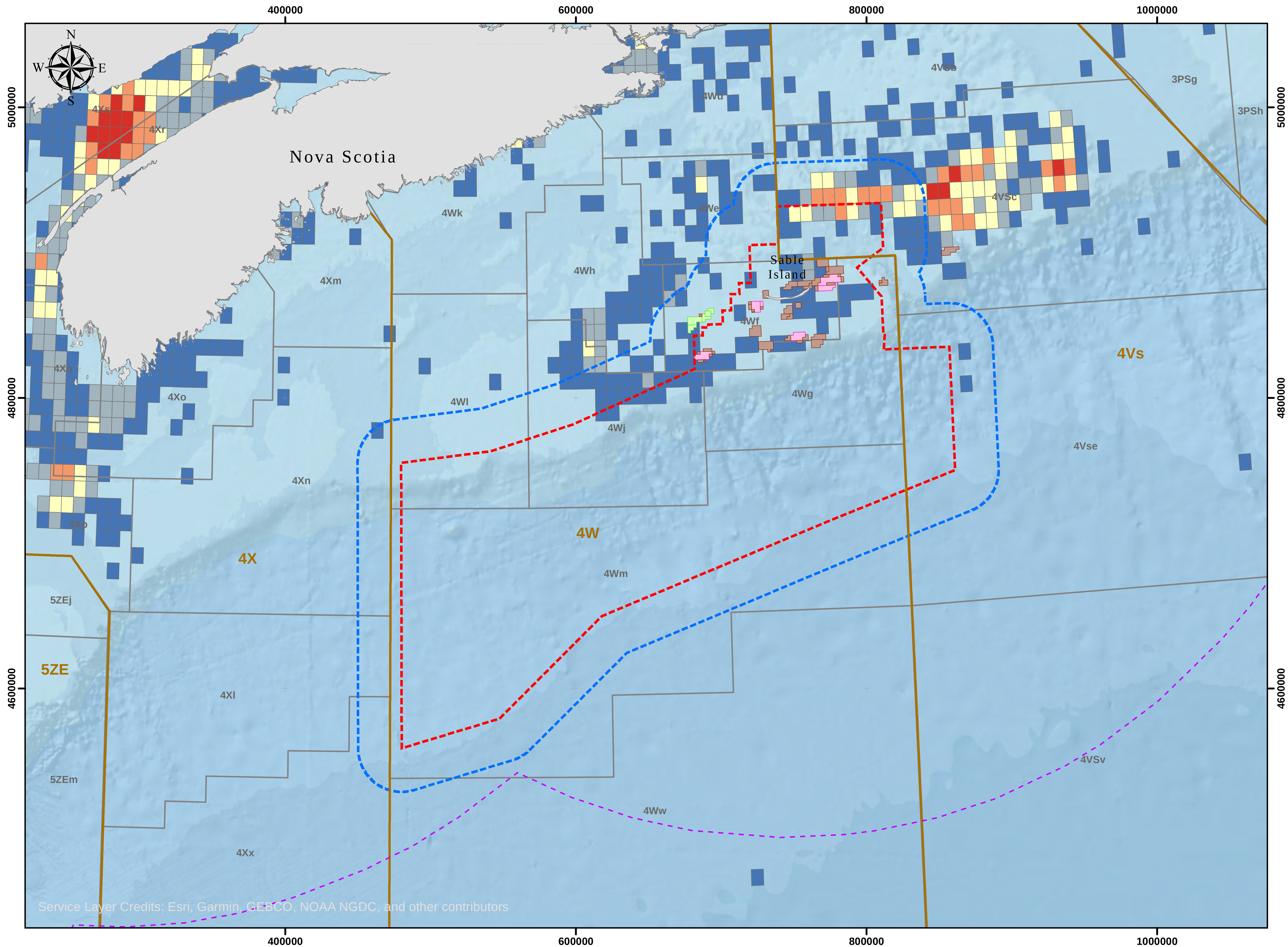


LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity Gear Type - Dredge (Boat) (2014 - 2018)

- 1 - 9
- 10 - 25
- 26 - 47
- 48 - 77
- 78 - 125

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY GEAR TYPE

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

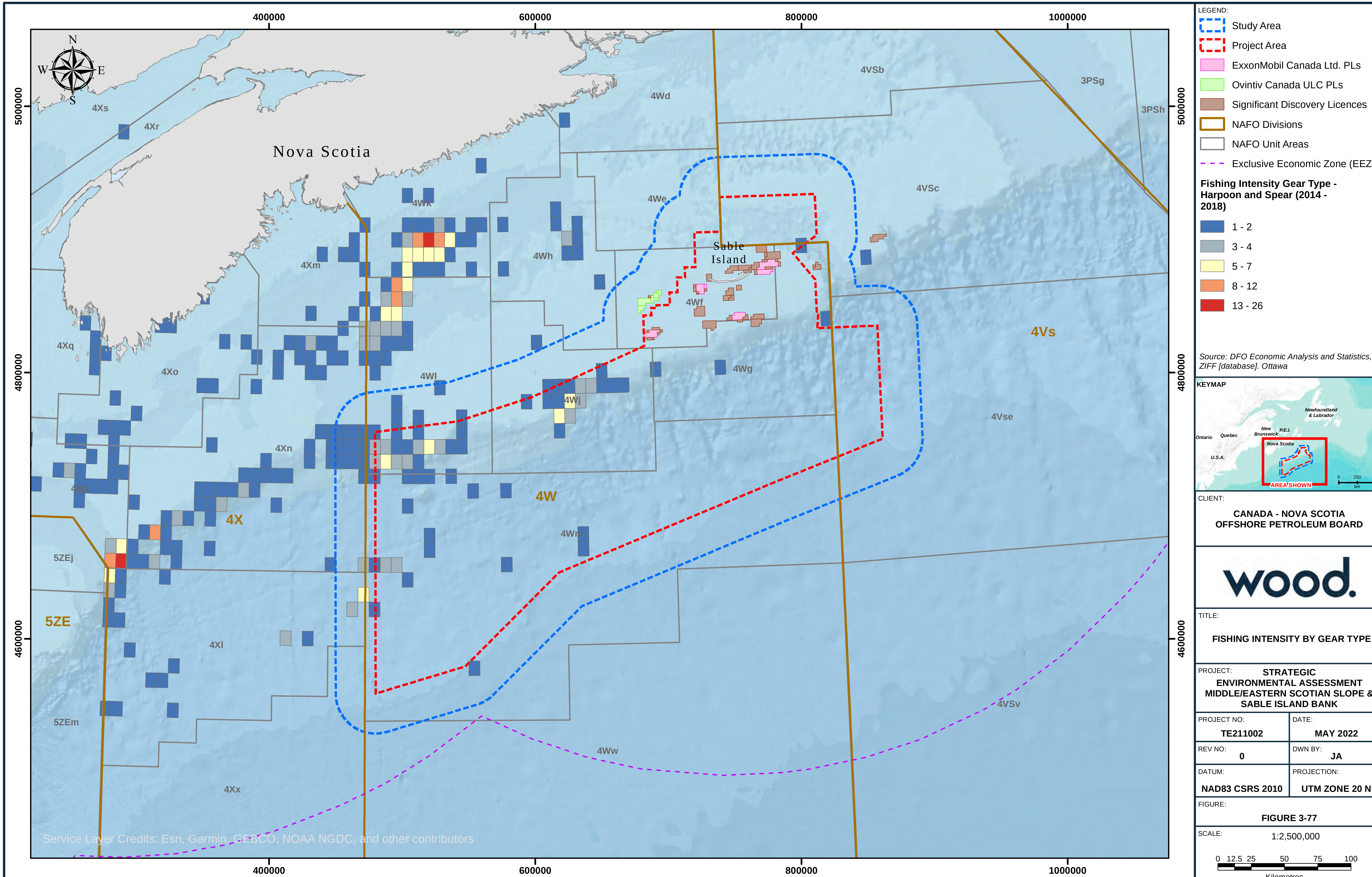
PROJECT NO: **TE211002**	DATE: **MAY 2022**
REV NO: **0**	DWN BY: **JA**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE: **FIGURE 3-76**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022

3.3.2.7 Key Species Fisheries

This section presents additional information about the key species identified, including harvesting locations, management, gear use and seasonality. Additional information about species biology, habitat and stock status is contained in Section 3.2.6.

3.3.2.7.1 Groundfish

As discussed above, groundfish constitute, by quantity, the largest part of the Study Area UA harvest, though they are collectively lower in value than the large pelagic species fisheries, such as swordfish. A notable exception is Atlantic halibut, which has a much higher landed value per kg than the other groundfish species discussed here (nearly $15 landed value per kg, vs silver hake at less than a dollar per kg in 2017).

Except for Atlantic halibut and some white hake, most of the groundfish species harvested in the Study Area are almost exclusively taken in bottom stern otter trawlers, often together. While otter trawls are mobile gear towed by fishing vessels, halibut longlines are set over several kilometres on the sea floor with baited hooks extending from a main line which is usually buoyed at the surface at either end so that the gear can be retrieved and hauled. The longline may also catch other bycatch species, such as white hake.

Table 3-35 provides other key information for the key groundfish species. Groundfish harvesting in Divisions 4VWX and Subarea 5 operate year-round, from 1 April to 31 March (DFO 2020j). The bar graphs in this section illustrate the typical timing of the fishing effort based on the number of records per month in the 2014-2018 geospatial dataset (DFO 2020a) indicated within the Study Area UAs. The maps that follow show the locations recorded in the 2014-2018 digital dataset used in Rozalska and Coffen-Smout 2020 except as noted.[3]

Table 3-35: Groundfish Species Summaries

Species	TAC	Status / Relevant Areas	Notes
Silver hake	2019-20: 15,000 t 2020-21: 15,000 t Harvesting restricted to areas deeper than 190 m. The fishery uses trawls equipped with grates to help reduce bycatch.	Directed fishery / Divisions 4VWX	The highest level of landings by quantity in the Study Area. Caught mainly along the shelf edge within the area, and near The Gully, 100% using bottom otter trawl, based on DFO 2020h. Also captures bycatch species.
Red hake	-	Landed opportunistically; nearly all from Divisions 4VW	Most a bycatch in the silver hake directed fishery; geospatial database indicates close co-location of catches. Difficult to separate from white hake because of similar appearance.

[3]As with DFO 2020a, these data have been privacy screened as well; see corresponding maps in Rozalska and Coffen-Smout 2020 for locations where data are not available for this reason.

Species	TAC	Status / Relevant Areas	Notes
White hake	-	Bycatch only with limits / Divisions 4VWX + Subarea 5	Caught with other groundfish along the shelf break in the Study Area, including on halibut longlines, which accounted for 75% of the white hake catch in the DFO 2020h dataset.
Atlantic halibut	2019-20: 4,789 2020-21: 5,507 t For 2020-2021, 100 t set aside for the US and France, and a maximum 185 t set aside for "use of fish" (i.e., for financing scientific or fisheries management activities)	Directed fishery / Divisions 3NOPs4VWX5Z	The highest value groundfish in Atlantic Canada, 99% were harvested with longlines in the Study Area, 2013-2017, based on DFO 2020h.
Redfish species	Unit II: 2019-20: 8,500 t 2020-21: 8,500 t Unit III: 2019-20: 9,000 t 2020-21: 9,000 t	Unit II (portions of Divisions 4W and 4V); Directed fishery / Unit III (portions of Divisions 4WX and 5Y)	There are three species of redfish (perch) in Atlantic Canada: Deepwater redfish (*Sebastes mentella*), Acadian redfish (*S. fasciatus*) and Golden Redfish (*S. marinus*), with Acadian redfish the predominant species in Unit III. Dataset indicates nearly 100% captured with bottom otter trawls.
Pollock	2019-20: 900 t 2020-21: 660 t	Directed fishery / Divisions 4VW	DFO dataset indicates more than 90% harvested with bottom otter trawls and the rest with longlines.
Greysole (Witch) flounder	-	Bycatch only / all areas	Data indicates all are taken in bottom otter trawls.
Cusk	-	Bycatch only / Divisions 4VWX + Subarea 5	Based on the dataset statistics, nearly all of this species is captured using longlines.
Haddock	2019-20: 9,000 t 2020-21: 6,877 t (in directed areas)	Directed / Divisions 4X5Y + 5Ze but under moratorium in 4TV,	The largest (by quantity) groundfish fishery in Maritimes Region as a whole, but a small proportion of the catch indicated in the DFO dataset (Table 3-33) since it is under moratorium in most of

Species	TAC	Status / Relevant Areas	Notes
		with capped bycatch limits in that area.	the Study Area. Predominantly harvested in bottom otter trawls, with a small amount on longlines in other fisheries.
Hagfish	-	Divisions 4VWX5Z	A small fishery involving six participants in the Region at present; the fishery is conducted using barrel-like bottom traps (450 per harvester) between mid-April and mid-October. It occurs within the Study Area along the shelf break at depths of approximately 100 m to 200 m. See mapping in Rozalska and Coffen-Smout 2020.
Other groundfish species	Various	Directed (e.g., haddock) or bycatch (e.g., Atlantic cod) / Within 4W	Several other groundfish species with small or zero quantities indicated, possibly because of data confidentiality redaction: e.g., skates, Atlantic cod, and turbot/Greenland halibut. Harvesting locations and gear within the Study Area would be similar to other groundfish species described above. See Rozalska and Coffen-Smout 2020 for additional species mapping.

Sources: den Heyer et al. 2015; DFO 2018d, DFO 2018f, DFO 2019c, DFO 2020a, DFO 2020j; Rozalska and Coffen-Smout 2020

Other general management measures for some or all participants include returning non-groundfish bycatch to the water, hail-in and hail-out requirements, logbooks, dockside catch monitoring, at-sea observers, vessel size restrictions and vessel monitoring system (VMS) tracking for most of the fleets in the area. Within the Study Area, there are several fisheries closures / conservation areas. These include The Gully MPA where fishing is excluded or restricted and the Western / Emerald Banks Conservation Areas (restricted fisheries zone) Marine Refuge, which is closed to all groundfish harvesting (Section 3.2.10). Other areas may be temporarily closed if the incidence of non-directed or small-size fish is too high.

Figure 3-78 illustrates the monthly pattern of groundfish harvesting for 2014 to 2018 within the Study Area UAs; Figure 3-79 shows the same for Atlantic Halibut. Geospatial record counts are averaged in both. Figures 3-80 and 3-81 map the locations for these species for the same period.

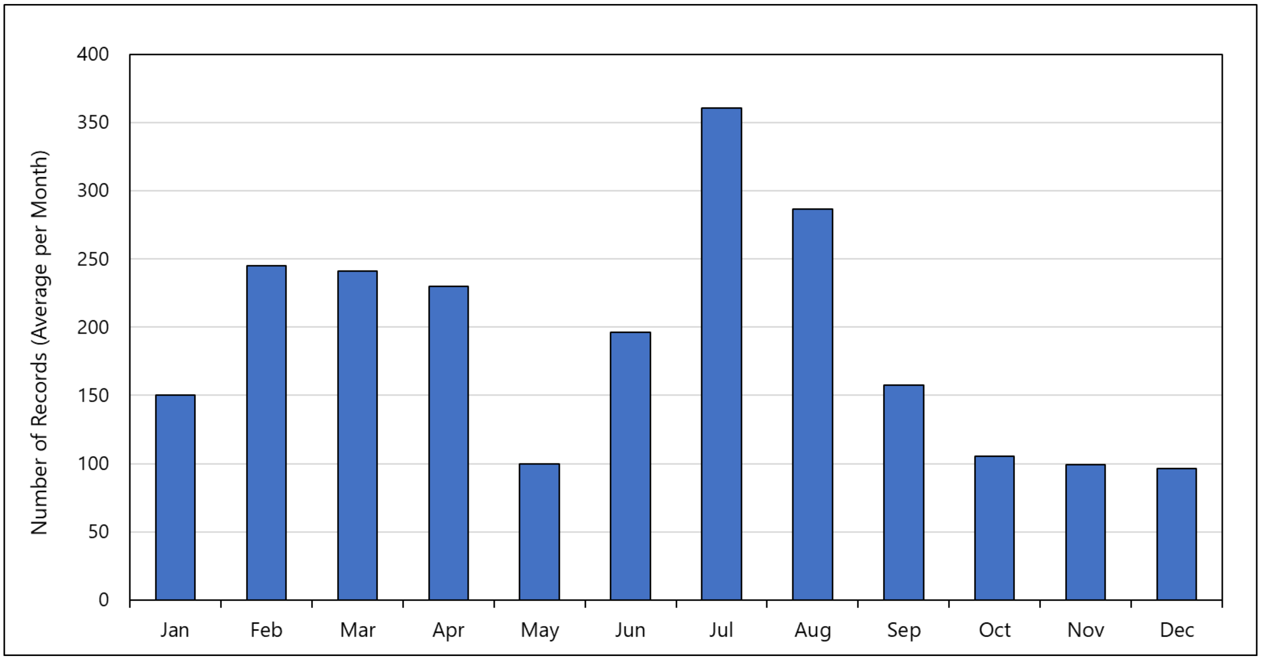


Figure 3-78: All Groundfish Harvesting (2014-2018)

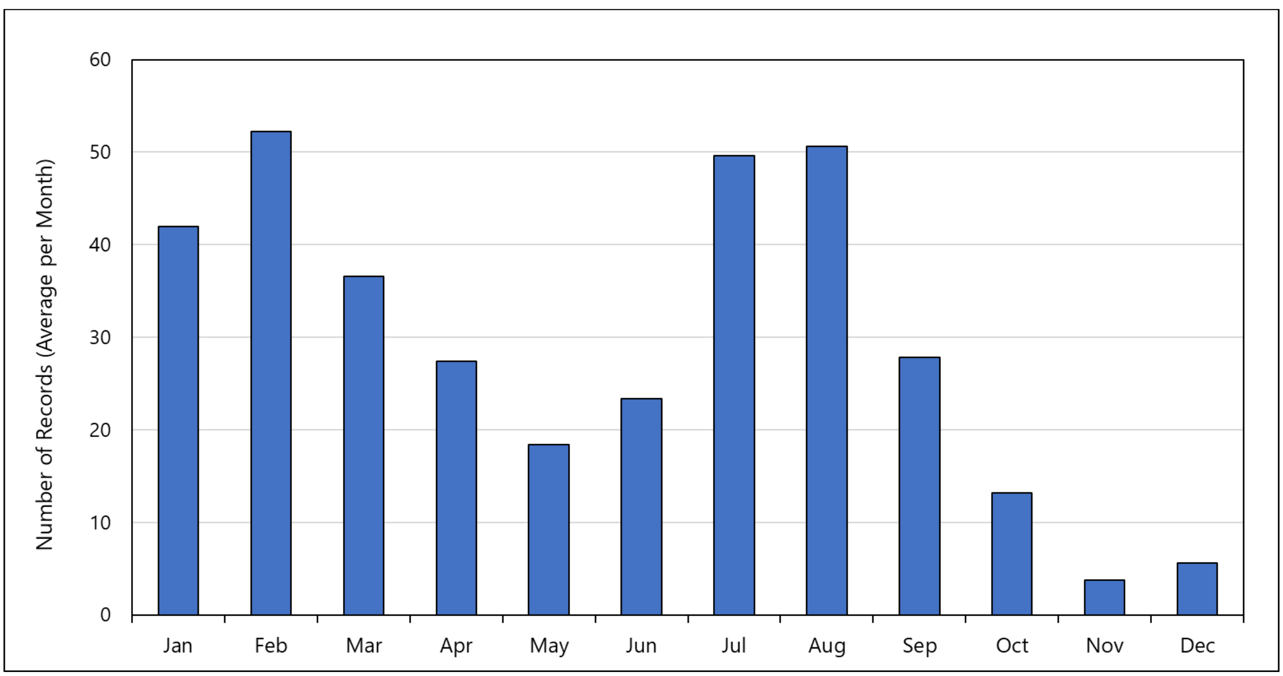
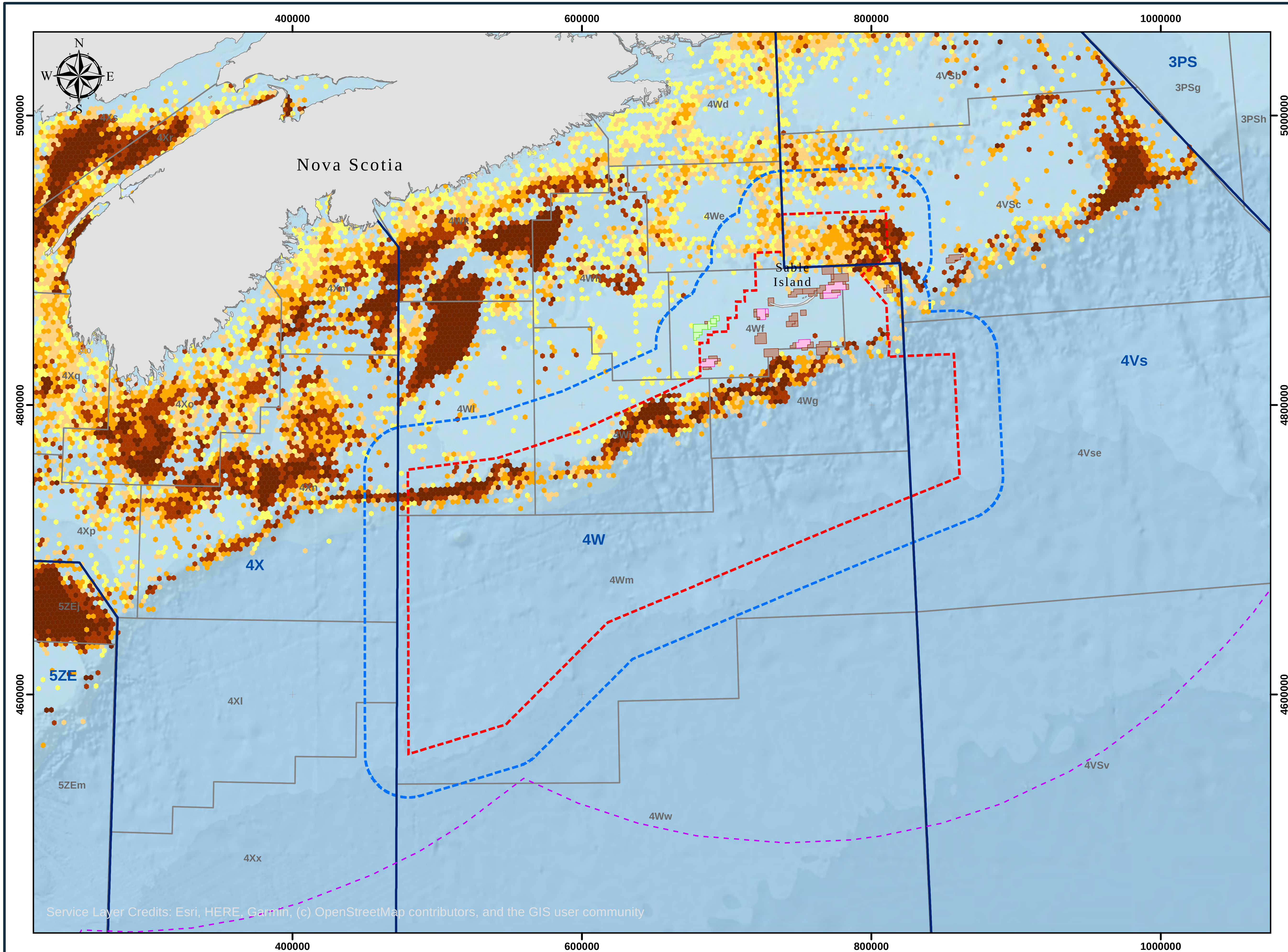


Figure 3-79: Atlantic Halibut Harvesting (2014-2018)



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Groundfish 2014 - 2018 screened (Round Weight/KG)

- 1 - 418
- 419 - 1,334
- 1,335 - 3,574
- 3,575 - 13,212
- 13,213 - 1,433,298

Source: Rozalska and Coffen-Smout 2020

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

COMPOSITE LANDINGS (KG) PER 10KM^2 HEXAGON (MARITIMES, GULF, QC AND NL REGIONS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

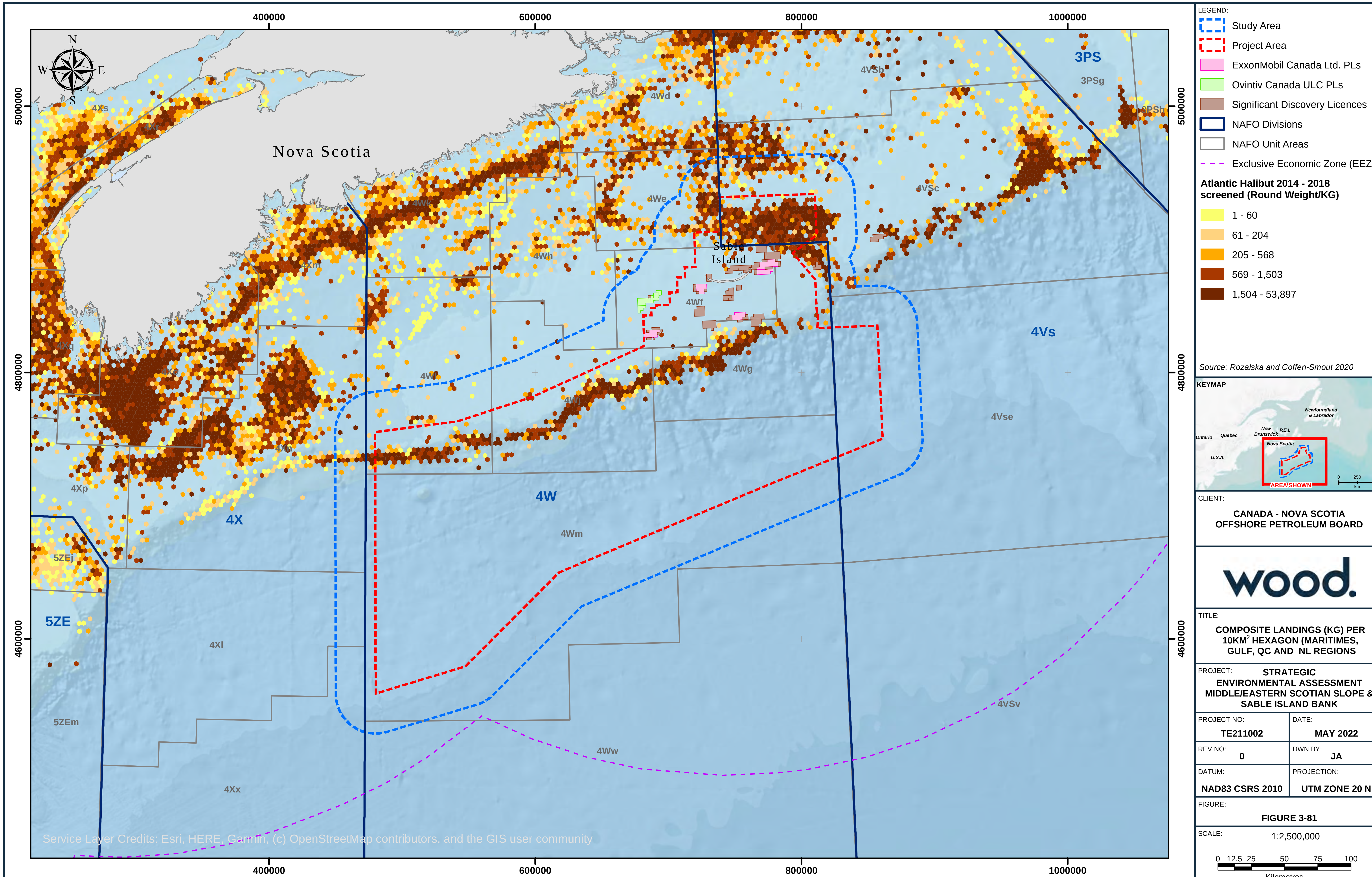
PROJECT NO: **TE211002**	DATE: **MAY 2022**
REV NO: **0**	DWN BY: **JA**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE: **FIGURE 3-80**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_SpeciesOnly_Feb2021.mxd User: juanita.abbott Date: 5/18/2022



Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_SpeciesOnly_Feb2021.mxd User: juanita.abbott Date: 5/18/2022

3.3.2.7.2 Large Pelagic Species

These key fisheries within the Study Area UAs are all for high-value, large pelagic species – primarily (by quantities in the area) swordfish, bigeye tuna and yellowfin (directed fishery), and bluefin tuna (longline bycatch in the Study Area; directed in other areas). Sharks (mainly mako) are large pelagic species typically captured as bycatch. As discussed in Section 3.3.2.1, ICCAT manages these fisheries, with input from contracting parties. Most of these highly migratory fish are taken using pelagic longlines, with a smaller quantity using harpoons. The pelagic longline fishery typically captures all these species together. Swordfish longline license holders have licenses for directed tuna harvesting as well and swordfish bycatch may occur in the directed tuna fishery and vice versa. Longlining is most focused along and near the shelf break and slope throughout the Study Area and to the east and west, but also occurs over much deeper waters to the south, over the shelf slope and rise as the following maps indicate. Bluefin tuna are caught in these areas (bycatch) but also in other areas on the shelf, and close to shore in the directed bluefin fishery using other gear types (DFO 2017, DFO 2018g, DFO 2020h).

As of 2021, Atlantic Canada had approximately 77 longlining licenses (swordfish and other tunas) most based in Nova Scotia (Maritimes Region) with 40 to 45 usually active annually. Most boats are less than 65' and the rest up to 100', with one over 100' (single offshore license holder). These boats are all VMS monitored. The directed bluefin tuna fishery has separate license from swordfish / other tunas and are more concentrated in the Gulf Region, with 66 participants based out of Nova Scotia ports (DFO 2013a; DFO 2017; T. Atkinson pers com 2021).

The swordfish fleet is active from April to December, with harpooning focused from June to late August, mainly along the edge of Georges and Browns Banks. Bluefin tuna are harvested primarily from July to late November. Typically, the longline fleet moves from western fishing grounds to the east over the course of the season, along the Scotian Shelf edge and slope to the Grand Banks (DFO 2017; Rozalska and Coffen-Smout 2020). Figure 3-82 illustrates harvest timing for these species collectively. Geospatial record counts are averaged.

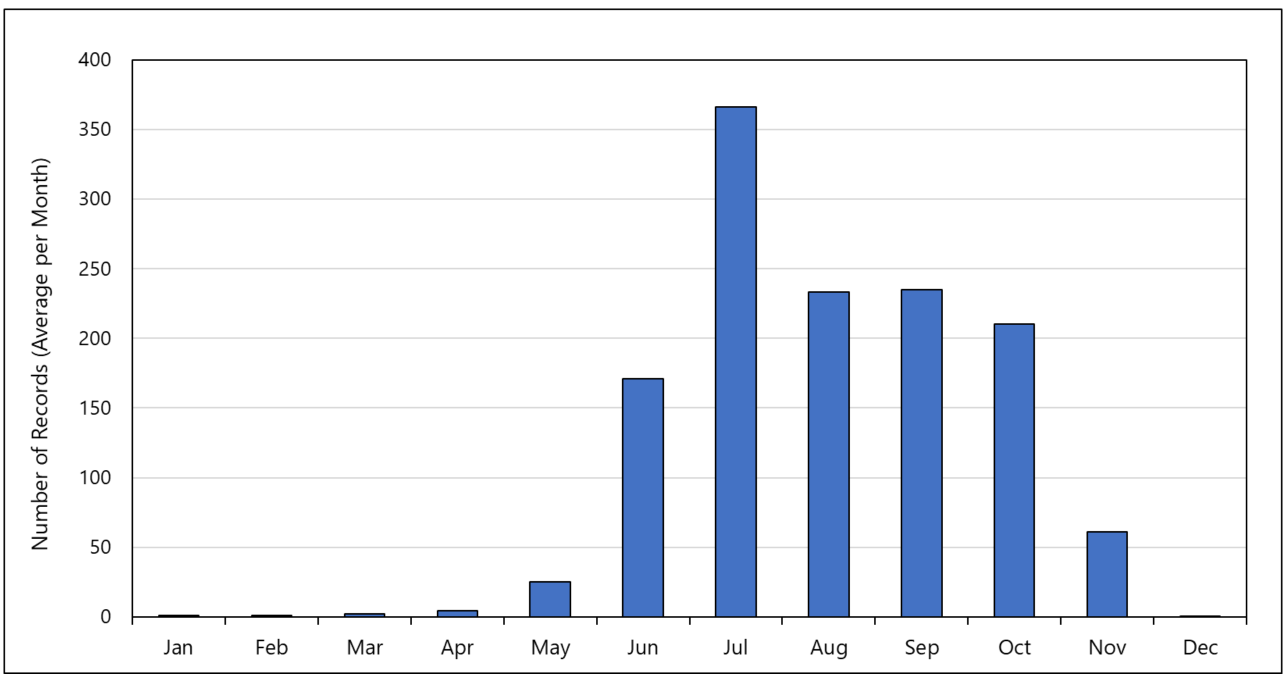


Figure 3-82: Large Pelagic Species Harvesting (2014-2018)

The longline fishing gear consists of a long floating mainline – often 65 to 100 km long near the sea surface – paid out by the fishing boat. The mainlines have shorter lines suspended from them (gangions) with baited hooks, 600–1,100 per set, at intervals. Swordfish longlines are typically set out for a day or less and then pulled back up for the catch. The preferred "soak" time is at night when fish are most active. Lines are also buoyed at intervals and equipped with AIS transmitters so they can be found easily. This also allows other vessels to see their locations on their own AIS receivers (Rozalska and Coffen-Smout 2020; T. Atkinson pers com 2021).

The harpoon fishery has approximately 1,200 licenses in two categories. Group B licenses may only be used opportunistically during other directed licensed fisheries. Group A licenses (about 180) can pursue large pelagic species as directed fisheries; all longline swordfish / shark licenses also have category A licenses. (DFO 2013a; T. Atkinson, pers. comm. 2021). Total allowable catch (TAC) / quota allocations are shown in Table 3-36.

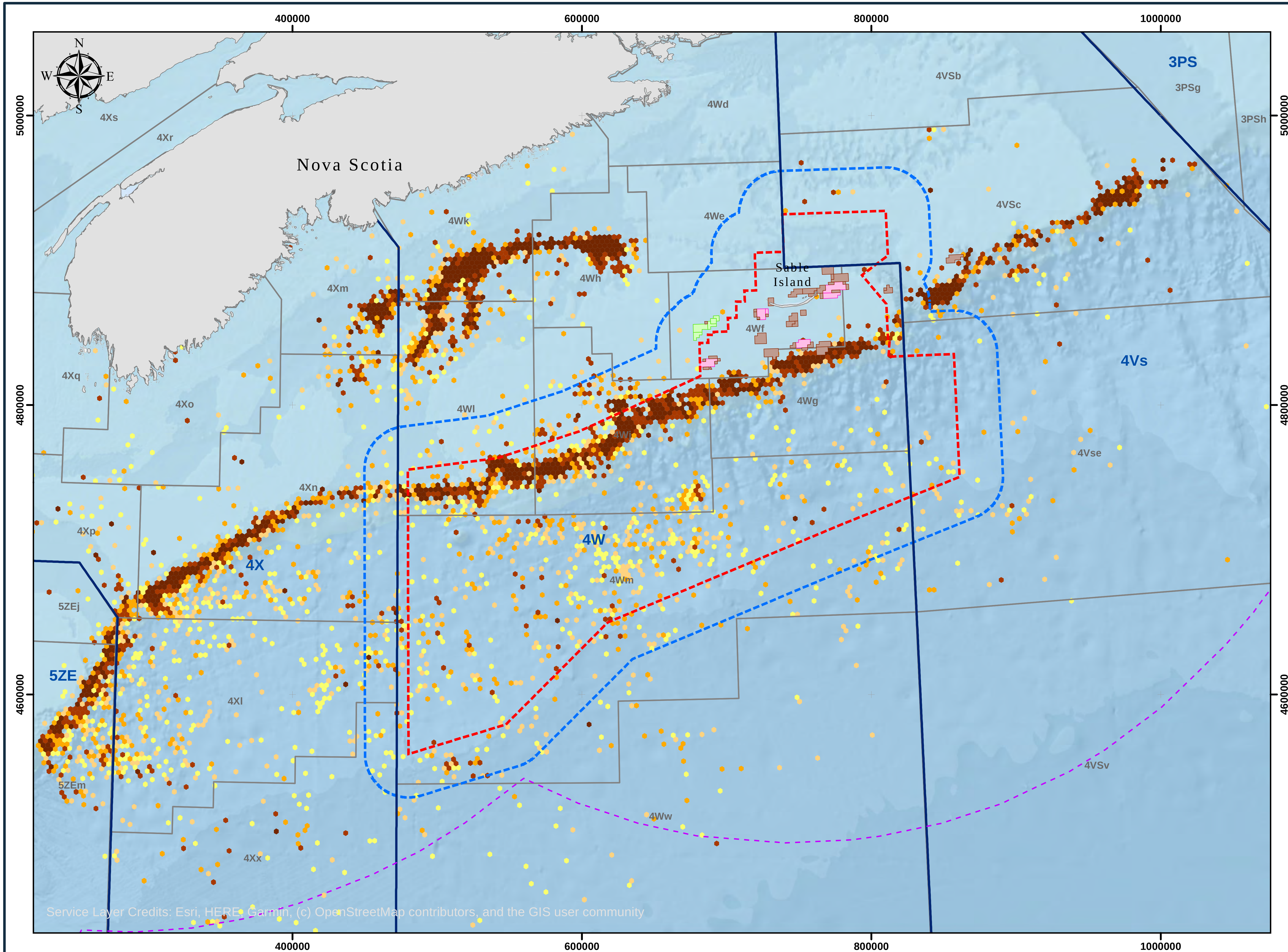
Figure 3-83 to Figure 3-85 map the locations of swordfish, other tuna and bluefin harvesting based on DFO 2020a. As noted in Section 3.3.2.6, the location data in other mapping (e.g., Figure. 3-29) does not represent the actual presence of the longlines in the ocean. Figure 3-86 presents a more realistic depiction of longline locations since it plots the continuous VMS "pings" of pelagic longline vessels while fishing the gear. See Butler et al. 2019 for a description of the data source and methodology.

Table 3-36: Large Pelagic Species Quotas / TACs

Species	Area	2019 and 2020 Quota / TAC	Notes
Swordfish	Atlantic Canada	1,348 t	Individual transferable quota (ITQ) system for longline fleet; competitive for harpooners, though some with individual quotas. Harpoon fishers are allocated 10% of the Canadian quota. The longline fleet also harvests with harpoons - 5% - 10% of their quota annually. The annual quota available to be fished is often increased through annual quota transfers from other ICCAT entities; for instance, in 2020 it was 1845.2 t after transfers.
Other Tunas	Atlantic Canada	Albacore: 200 t (with a 25% carry-over allowed to the next year if not caught Bigeye: No set quota but see note. Yellowfin: No set quota but see note.	Albacore, bigeye and yellowfin are harvested under this license. Quotas have been constant lately, but Albacore quotas are planned to increase to 242 t for 2021. For bigeye, ICCAT encourages countries with recent average catches of less than 1,000 t to maintain catch and effort at recent levels. Canada has taken about 200-250 t per year since 2014. Yellowfin catches have been variable, ranging between 15 t and nearly 200 t since 2014. ICCAT advises entities not to increase levels of effort for the species.

Species	Area	2019 and 2020 Quota / TAC	Notes
Bluefin Tuna	Atlantic Canada: Divisions 3KLNOP, 4RSTVWX and 5YZ	530.59 t	The Nova Scotia International Tuna Tournament receives an allocation of up to ten fish annually from the Canadian quota. Swordfish/other tunas license holders can retain 33.76 t and the offshore license 20 t as bycatch. Some areas (outside the Study Area) have timing/spatial restrictions for bluefin.
Sharks	No directed fishery in the region	Bycatch only	Main species harvested prior to 2020 was shortfin mako shark and a smaller quantity of porbeagle shark. In 2020, DFO prohibited landing of shortfin mako sharks. Since 2016 only porbeagle sharks dead at haul back may be retained. The license holder is prohibited from retaining the following species: white shark (carcharodon carcharias), bigeye thresher sharks (alopias superciliosus), hammerhead sharks (sphyrna lewini and sphyrna zygaena), oceanic whitetip sharks (carcharhinus longimanus), silky sharks (carcharhinus falciformis), basking sharks (cetorhinus maximus), and shortfin mako sharks (isurus oxyrinchus). Although no commercial directed fishery, there is an active (catch and release) recreational fishery for blue sharks and some retention of blue sharks recreationally via shark tournaments.

Sources: DFO 2013; DFO 2015b; DFO 2017; DFO 2020k; C. MacDonald pers. comm. 2021, ICCAT Database



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Swordfish 2014 - 2018 screened (Round Weight/KG)

- 1 - 145
- 146 - 326
- 327 - 752
- 753 - 2,041
- 2,042 - 38,774

Source: Rozalska and Coffen-Smout 2020

KEYMAP

CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
COMPOSITE LANDINGS (KG) PER 10KM^2 HEXAGON (MARITIMES, GULF, QC AND NL REGIONS

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-83

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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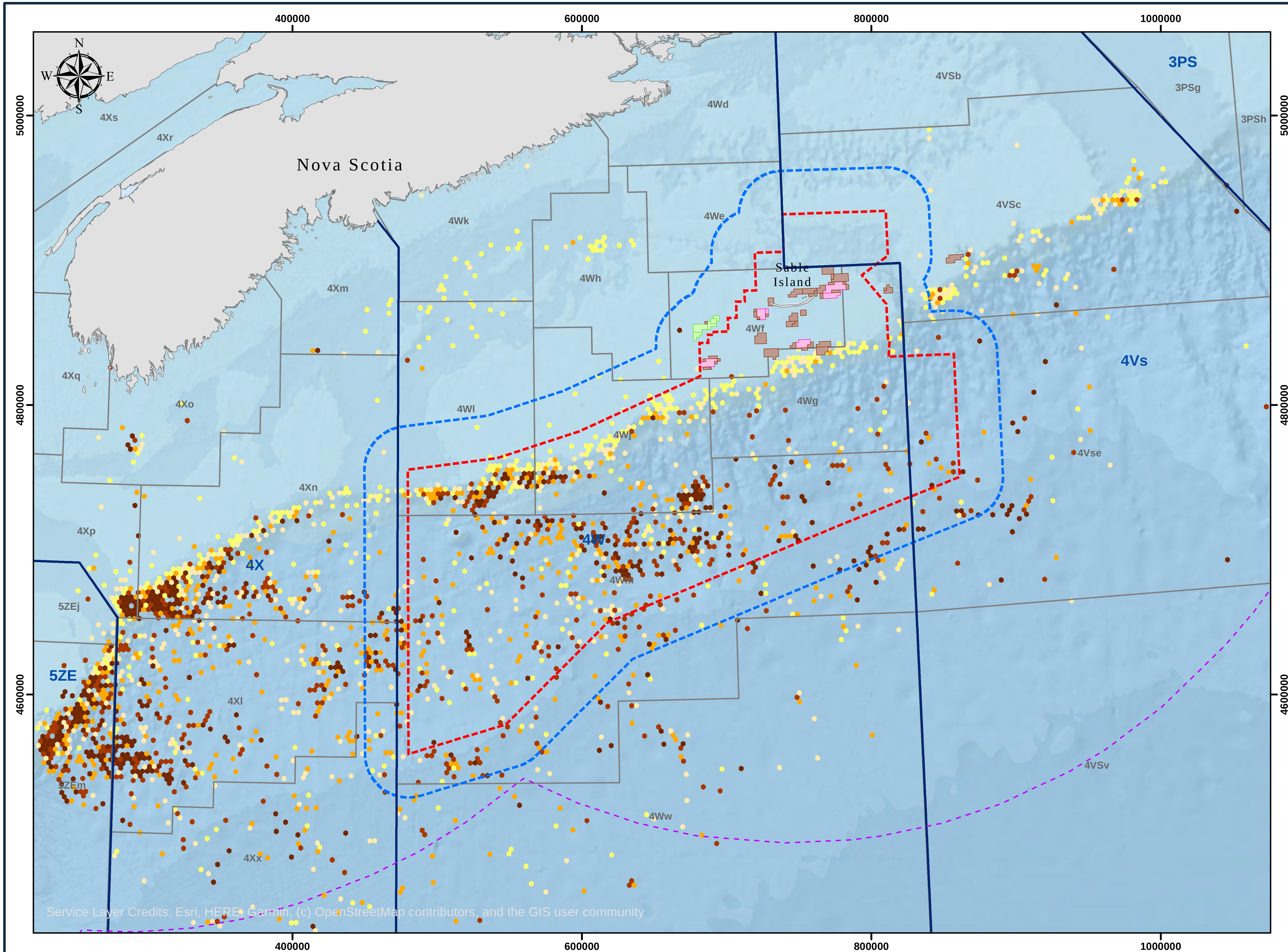


LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Other Tuna 2014 - 2018 screened (Round Weight/KG)

- 1 - 75
- 76 - 219
- 220 - 443
- 444 - 930
- 931 - 30,068

Source: Rozalska and Coffen-Smout 2020

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

COMPOSITE LANDINGS (KG) PER 10KM^2 HEXAGON (MARITIMES, GULF, QC AND NL REGIONS

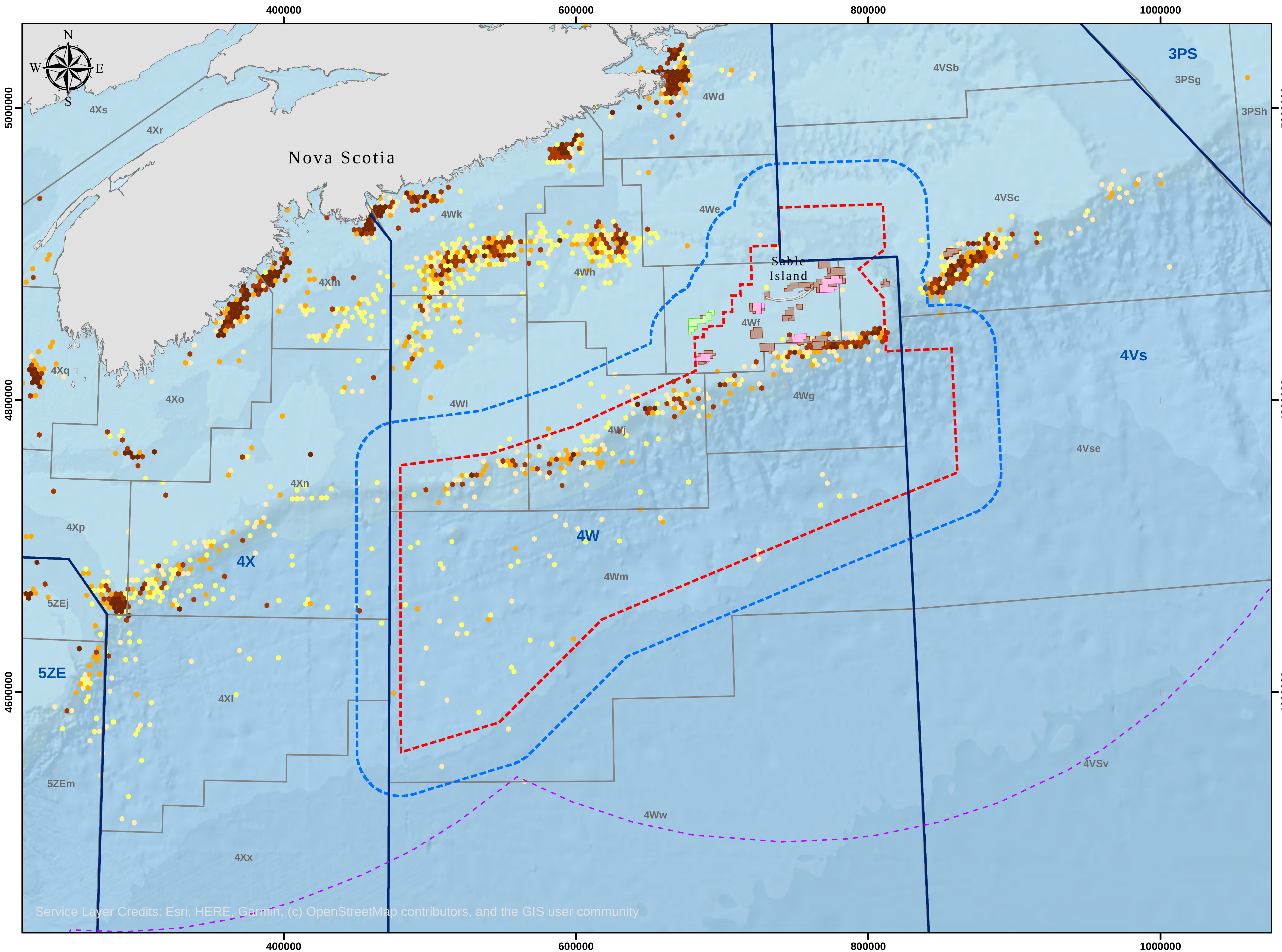
PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-84**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Bluefin Tuna 2014 - 2018 screened (Round Weight/KG)

- 53 - 172
- 173 - 251
- 252 - 382
- 383 - 808
- 809 - 44,845

Source: Rozalska and Coffen-Smout 2020

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

COMPOSITE LANDINGS (KG) PER 10KM^2 HEXAGON (MARITIMES, GULF, QC AND NL REGIONS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM:	PROJECTION:
NAD83 CSRS 2010	UTM ZONE 20 N

FIGURE:

FIGURE 3-85

SCALE: 1:2,500,000

0 12.5 25 50 75 100

Kilometres

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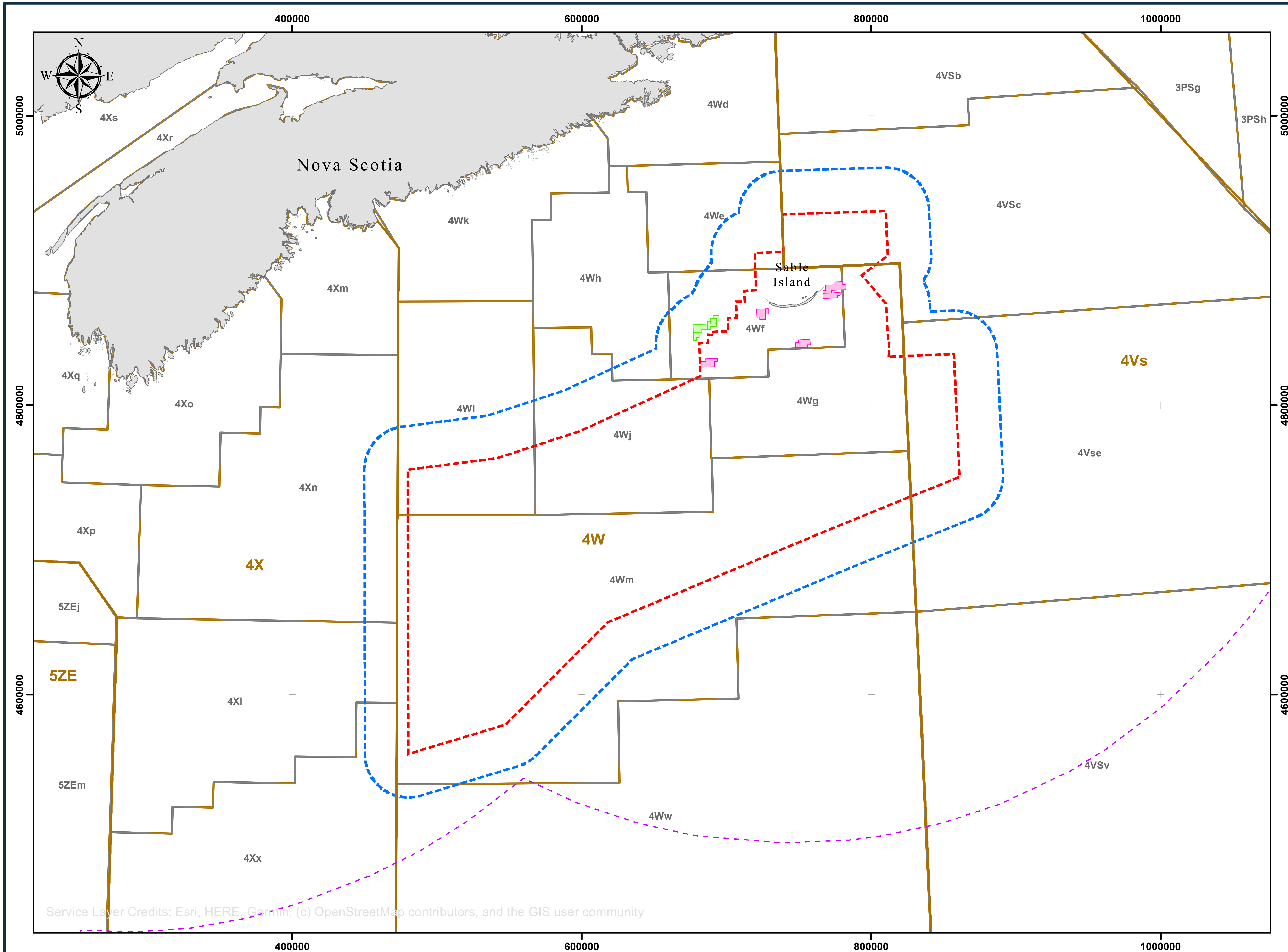

LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Pelagic Longline VMS (2003 - 2018)

Vessel Minutes per km^2

High : 4.65929

Low : -0.292281

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

[redacted]

TITLE:

PELAGIC LONGLINE HARVESTING LOCATIONS BASED ON VMS DATA 2003 - 2018

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 2	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:

FIGURE 3-86

SCALE: 1:2,500,000

0 12.5 25 50 75 100

Kilometres

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3.3.2.7.3 Shellfish Species

Snow crab and offshore scallop harvesting are the only shellfish fisheries that register quantities and values in Table 3-33[4]. However, northern shrimp, clams and red crab are indicated within the Study Area based on the geospatial datasets (DFO 2020a) - the majority focused north and northeast of Sable Island. The associated data are assumed to have been redacted by DFO in accord with privacy protection requirements, described in Section 3.1.1.1. Table 3-37 summarizes key information about these species or species groups. These are also relatively high value species (compared to most groundfish) and are directed commercial fisheries, though some species are captured in other fisheries with gear that has limited selectivity, such as bottom trawls. Figures 3-87 to 3-90 illustrate the locations based on DFO 2020a and indicate relevant fisheries management areas. The grid size is approximately 4 x 6 nautical miles (rectangular pixels) which represent the number of hits for each designated grid area. The intensity value indicated in the legend represents the number of logbook records. The Study Area is located within the offshore lobster fishing area, LFA 41, though the available data indicate that this fishery takes place well to the west of the Study Area. A small portion of the Study Area in the north crosses the outermost extent of inshore LFAs 30 and 31a (85 km – 100 km from shore), approximately 23 km from the Project Area at the closest point.

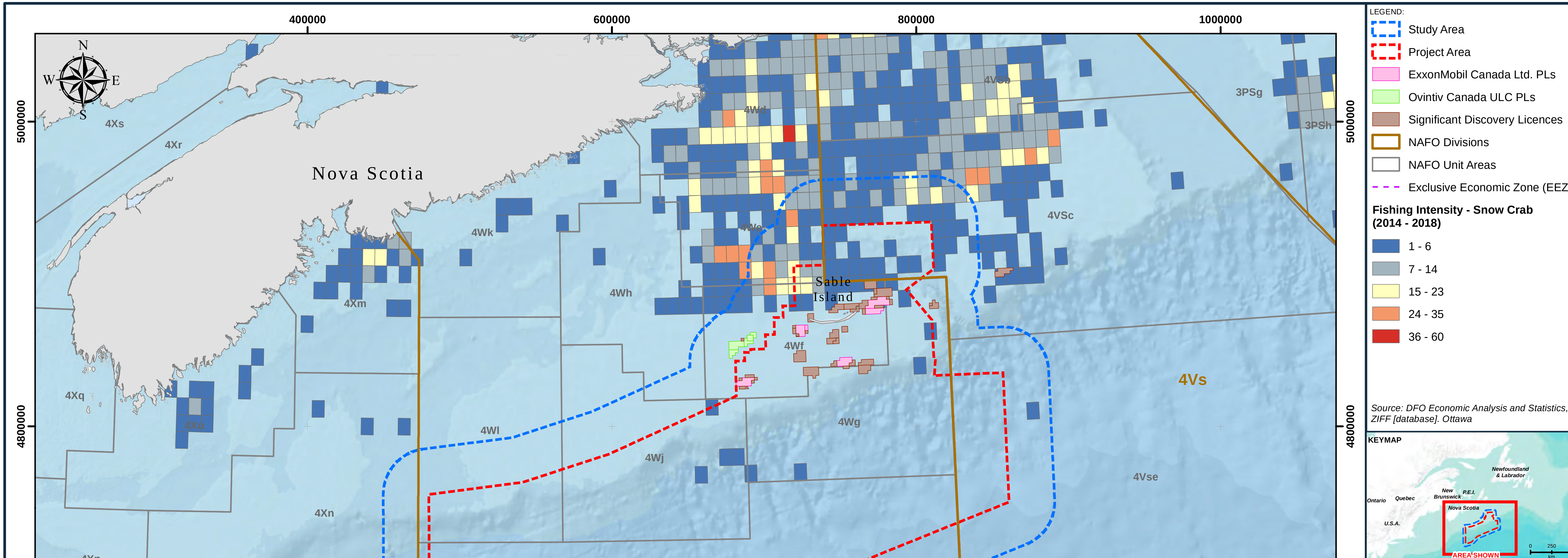
Table 3-37: Shellfish Harvesting Associated with the Study Area

Species / Species groups	Timing	TACs / Quotas	Principal Gear	Notes
Snow crab	April 1 to August 31, 2020	For 2020 CFA 23: 4,414.4 t CFA 24E: 3,746.8 t (includes a portion for use of fish)	Bottom-weighted crab pots or traps	Snow crab fishing, is focused almost entirely north of Sable Island, overlapping with the north-easternmost part of the Study Area. This overlaps parts of CFA 23 and 24E (part of 24 in Division 4W), also designated S-ENS. In 2019, there were 116 licenses in the relevant areas. Vessels are less than 20 m length. A concern in the fishery at certain times is high incidence of soft-shelled (newly moulted) crab, which may affect harvesting patterns.
Red crab	Year-round	For 2019 Divisions 4WX5Z: 300 t	Bottom-weighted crab pots or traps	Deep-sea red crabs are harvested along / near the shelf edge, with most concentrated in the western part of the Study Area. Some are also taken in the offshore lobster which occurs west of the Study Area.
Sea scallops	Year-round	For 2020 SFA 25 (Offshore) Banquereau Bank TAC: 30 t	Scallop dredges / drags	Harvesting is focused northeast of Sable Island, most in the area just outside the Study Area, and on the Western / Sable Island Bank within the Study Area. In 2016 there were vessels harvesting offshore scallops in Atlantic Canada,

[4] Some of the harvesting, mainly for snow crab, takes place in UA 4VSc, northeast of Sable just outside the Study Area UAs – see Section 3.3.1.

Species / Species groups	Timing	TACs / Quotas	Principal Gear	Notes
		Rest of Eastern Scotian Shelf TAC: 25 t		5 freezer vessels and 7 vessels without freezing capabilities. All are over 27 m in length. A high value species ($24 / kg of meat in 2015)
Clams	Year-round	For 2021 Banquereau Bank TAC 20,943 t	Hydraulic dredges	One major entity harvests clams in the eastern Scotian shelf. The fishery targets Arctic (Stimpsons) surf slams but may take several other species, such as propeller clams and ocean quahaugs. The fishery occurs in the vicinity of Banquereau bank and on the eastern Grand Banks. Within and near the Study Area, it is focused near Sable Island and The Gully trough.
Northern Shrimp	Year-round	For 2020 (mobile fleet) SFA 13 – 15 TAC: 2,392 t	Shrimp trawls	Although permitted year-round, most harvesting takes place from early spring to early summer, concentrated on deeper areas or holes on the eastern Shelf. The trawl fleet had 15 active licenses as of 2020, in two sectors: midshore (vessels 65–100' based in the Gulf Region) and inshore (vessels mainly <65' based in the Maritimes Region). Trawlers use a separator grate in the trawl gear to limit bycatch. There had been substantial decreases in TAC since 2016 owing to concerns about the stock, but most recent DFO analysis notes a more favorable outlook currently.
Ocean Quahaugs	Year-round	Sable Island Bank TAC: 11,587 t	Hydraulic dredges	In the last several years, the license holder has made dedicated trips to Sable Island bank to evaluate the fishery in that area.

Sources: DFO 2013b, DFO 2013c, DFO 2016d, DFO 2018h, DFO 2019e, DFO 2019f, DFO 2020a, DFO 2020l, DFO 2020m, DFO 2020n, DFO 2020o, DFO 2020p, DFO 2020q, DFO 2020x, DFO 2021a



CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE: FISHING INTENSITY BY SPECIES - SNOW CRAB

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-87

SCALE: 1:2,500,000

0 12.5 25 50 75 100 Kilometres

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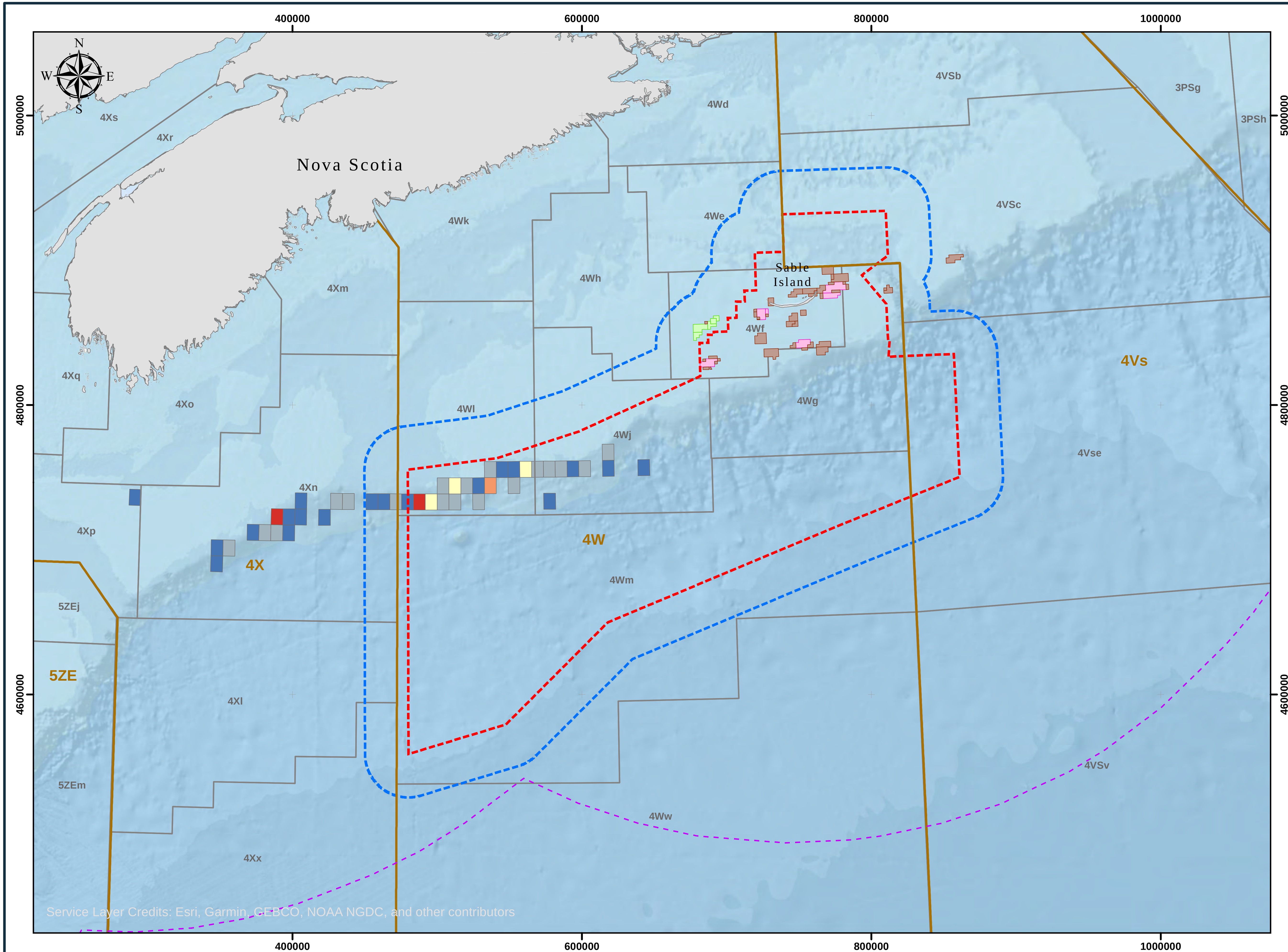


LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)

Fishing Intensity - Red Crab (2014 - 2018)

- 1
- 2
- 3
- 4
- 5

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY SPECIES - RED CRAB

PROJECT:

STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:

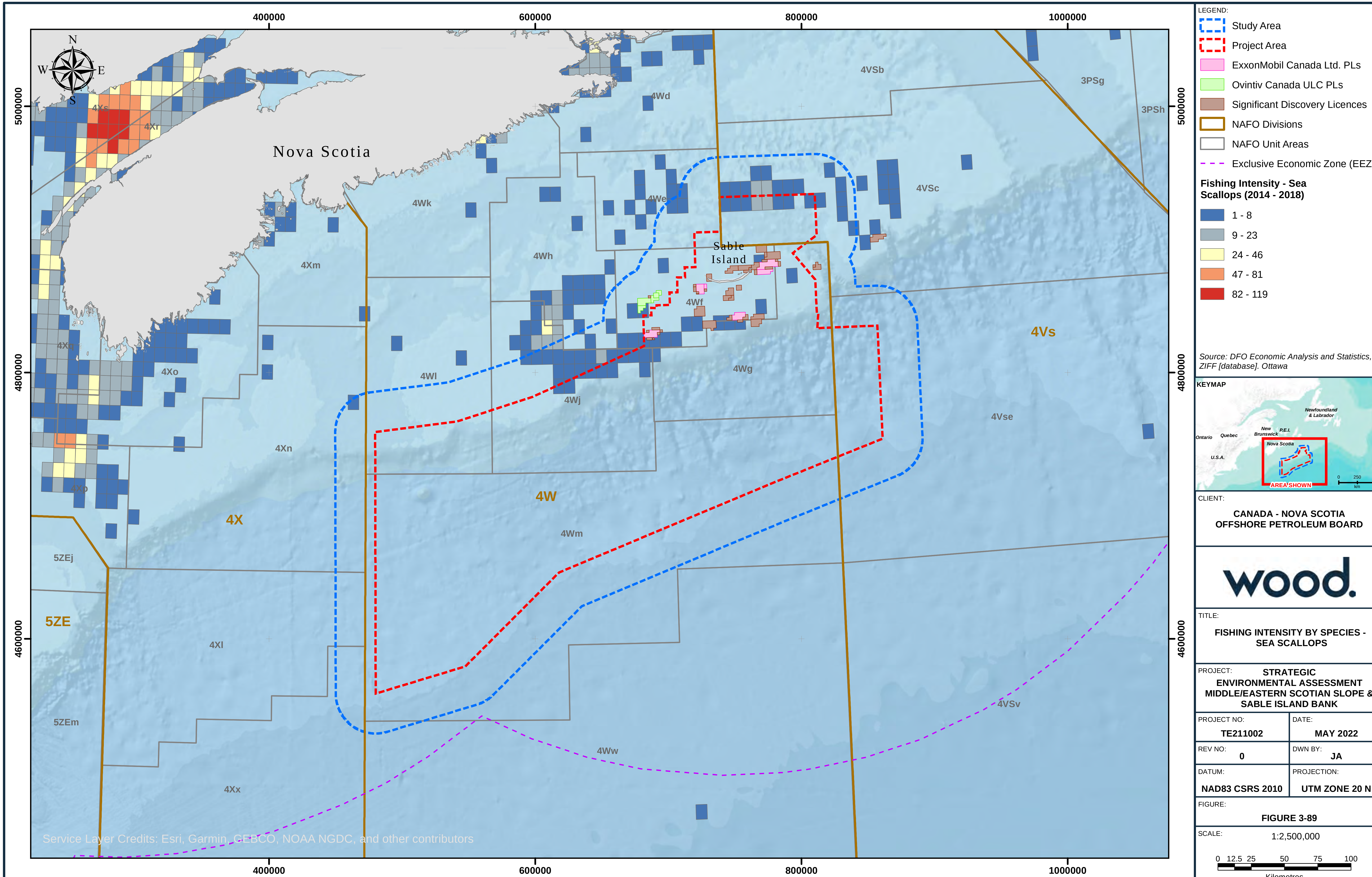
FIGURE 3-88

SCALE: 1:2,500,000

0 12.5 25 50 75 100

Kilometres

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022



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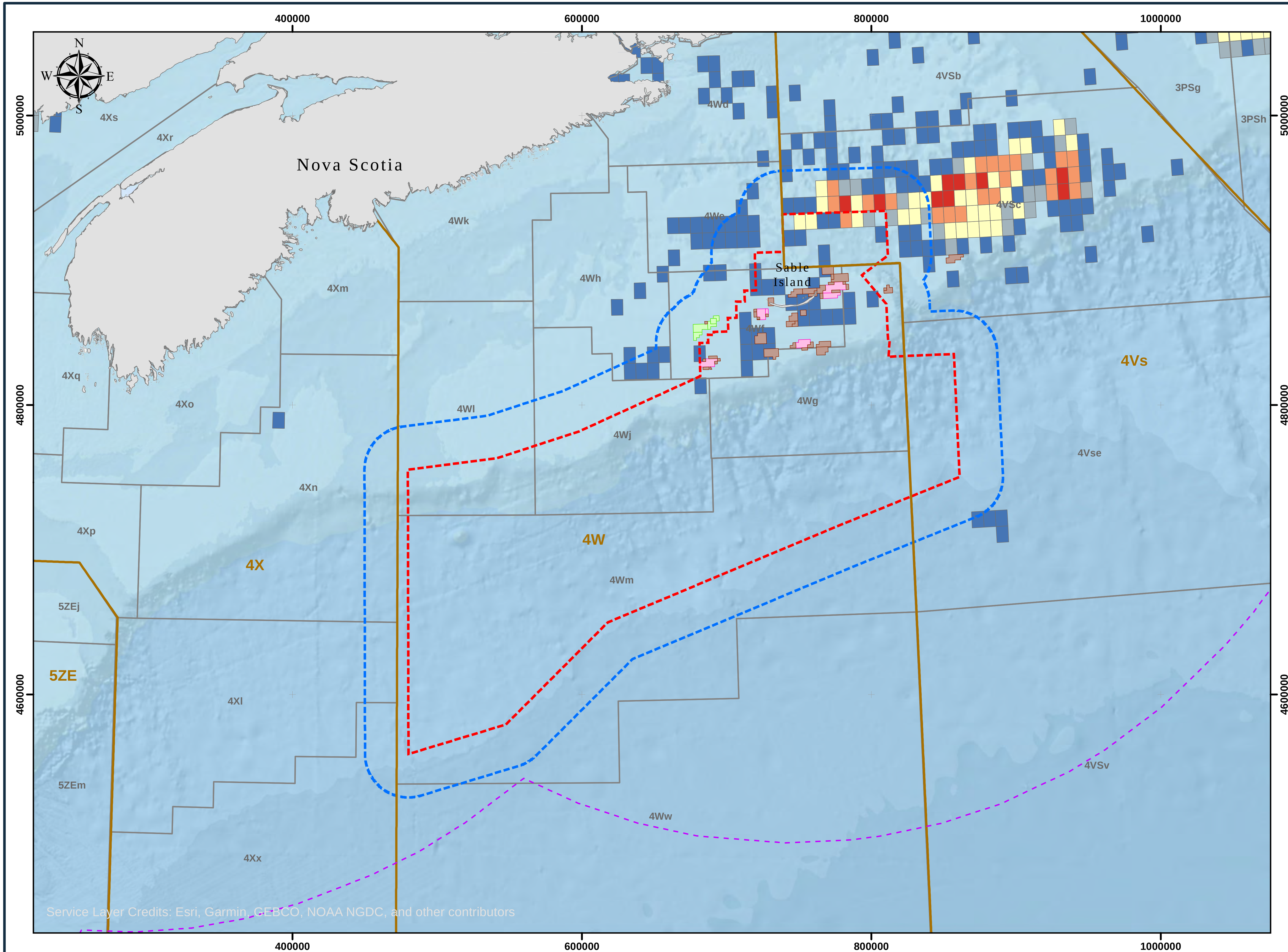
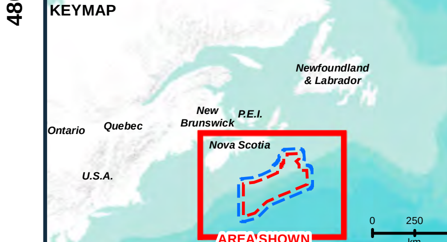


KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

FISHING INTENSITY BY SPECIES - CLAMS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-90**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

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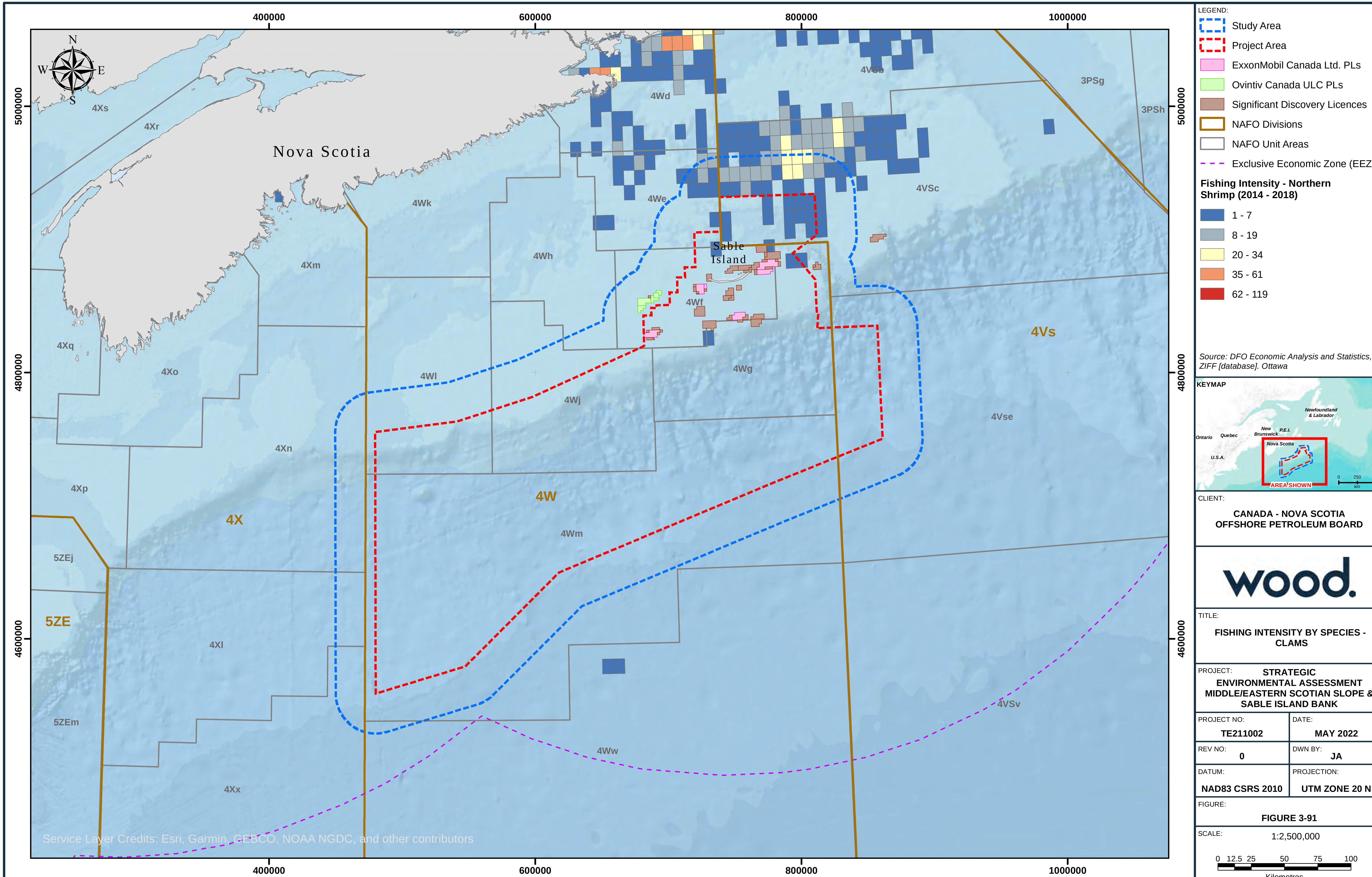


CLIENT: CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE: FISHING INTENSITY BY SPECIES - CLAMS

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-91

SCALE: 1:2,500,000

Path: F:\TE211002\Project_Figures\MXD\Fisheries\TE211002_CF_Monthly_Feb2021v2.mxd User: juanita.abbott Date: 5/18/2022

3.3.2.8 Commercial Fisheries Surveys

Regular fisheries science surveys are conducted across the Scotian Shelf by DFO and / or in collaboration with fish harvesting groups and individual fish harvesters. The Nova Scotia based Fishermen and Scientists Research Society also undertakes research that brings together scientists, harvesters and harvester organizations to work together on a variety of projects. These surveys are important to the fishing industry and fisheries managers as they collect information used to understand fish stocks and inform a fishery's management regime. Much of the research is conducted by fishing, using standard commercial fishing gear or modified versions. Petroleum-related activities have a potential to affect survey results or interact with fixed gear as they might with commercial fish harvesting.

Most surveys follow a typical annual plan, though other studies may be conducted from time to time, depending on the research interests and objectives. Descriptions and locations of annual surveys that are likely to occur within the Study Area are provided below.

3.3.2.8.1 Snow Crab Collaborative Trawl Survey

The DFO-industry collaborative survey is undertaken annually at approximately 400 sampling sites on the Scotian Shelf using a commercial fishing boat and a type of otter trawl. The survey takes place after the commercial fishing season and extends to areas beyond usual fishing grounds to identify the spatial bounds of snow crab habitat. Within the Study Area, the survey includes areas north of Sable Island and near the 100 m depth contour along the Shelf edge from near The Gully to Dawson Canyon, based on past survey locations (Figure 3-92). Specific locations are chosen randomly each year from within a consistent predefined grid (Zisserson et al. 2019; C. Mussells pers. comm. 2021).

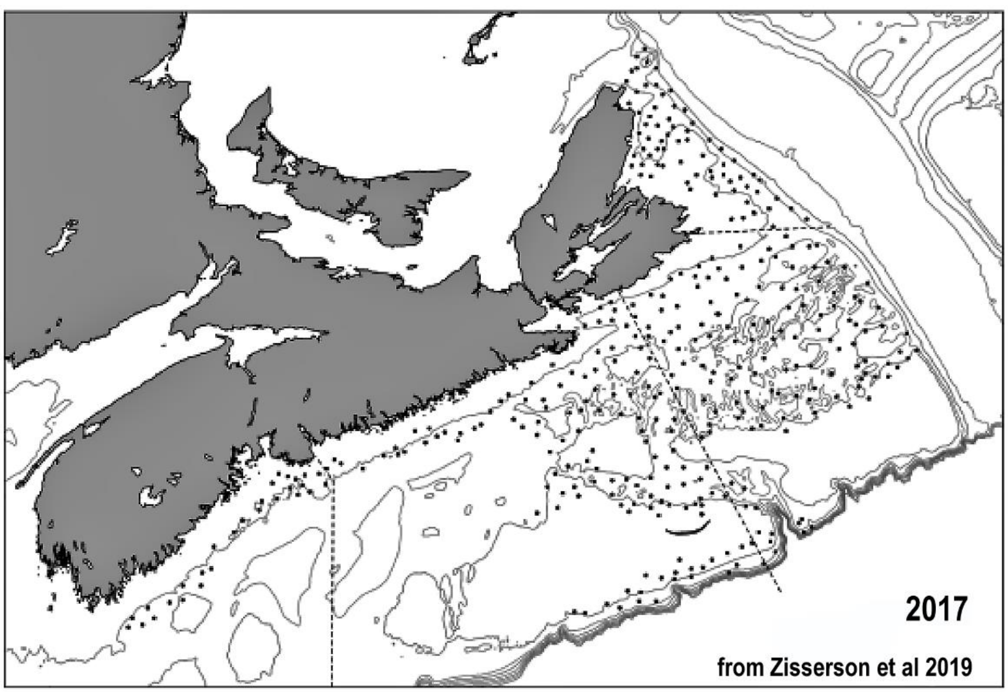


Figure 3-92: Snow Crab Survey Trawl Locations (2017)

3.3.2.8.2 Atlantic Halibut Longline Collaborative Survey

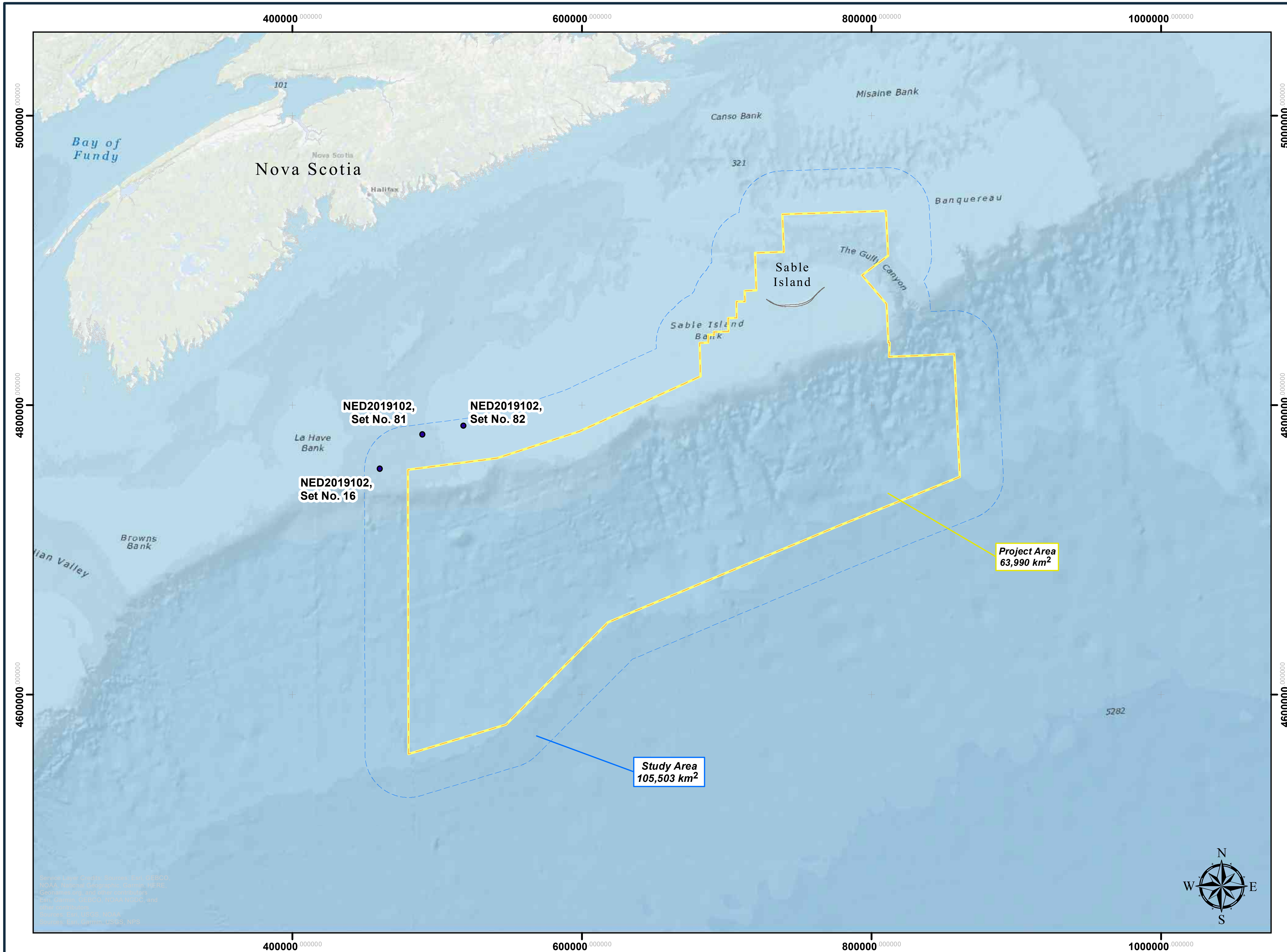
A survey of Atlantic halibut resources is conducted annually across the Scotian shelf and east to the southern Grand Banks of Newfoundland (Divisions 5Zc to 3N). It usually takes place from May to July as a collaborative effort with harvesters in adjacent provinces. It usually involves approximately 250 locations; 100 of these are at fixed locations where they are fished every year, and the rest are chosen randomly each year. Alternative locations are also provided in case some of the chosen locations cannot be fished for some reason. The stations are fished by commercial harvesters using halibut bottom longlines, approximately 5-km long on the sea floor, which must be set between 0400 and 1200 local time. After the gear is set, the harvester remains nearby while it soaks for six to twelve hours. The locations of the 2020 fixed and random stations are mapped in Figure 3-93 (Spring) and Figure 3-94 (Summer). (D. Harper pers comm. 2021).

3.3.2.8.3 Offshore Scallop Mobile Collaborative Survey

Joint industry / DFO offshore scallop surveys conducted in SFA 25 may overlap with the Study Area. A stratified trawl survey is carried out in the Sable Bank area during May each year, as is a fixed-station survey on the Middle Bank. A fixed station survey also occurs on Banquereau Bank, typically once every several years (F. Keyser pers. comm. 2021).

3.3.2.8.4 DFO Research Vessel (RV) Trawl Surveys

Annual surveys of fish and habitat characteristics are conducted throughout Atlantic Canada's oceans by DFO research vessels, to collect biomass and abundance data for species in the various DFO Regions and are a critical part of DFO's stock assessments. The Maritimes Region surveys occur throughout Divisions 4VWX and the Canadian portions of 5YZ targeting groundfish and invertebrate species. These random stratified surveys occur in two phases: the first (Winter/Spring) survey is usually conducted from early February to late March and the second (Summer Survey) during July and August. They follow a generally consistent time frame and geographic plan in each area, employing a modified small-mesh stern otter trawl to gather samples along planned transects, usually 3 km – 3.5 km in length. The survey vessels used have been the CCGS Teleost and CCGS Alfred Needler in recent years with a new ship, the CCGS Capt. Jacques Cartier, expected to join in 2021. Figure 3-95 shows the locations of 2020 DFO trawl survey locations (start locations) in relation to the Study Area (DFO 2020q, DFO 2020r; C. Mussells pers. comm. 2021).



LEGEND:
- Spring Trawl Locations (centroid)
- Project
- Study Area

KEYMAP

CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
SPRING TRAWL LOCATIONS

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

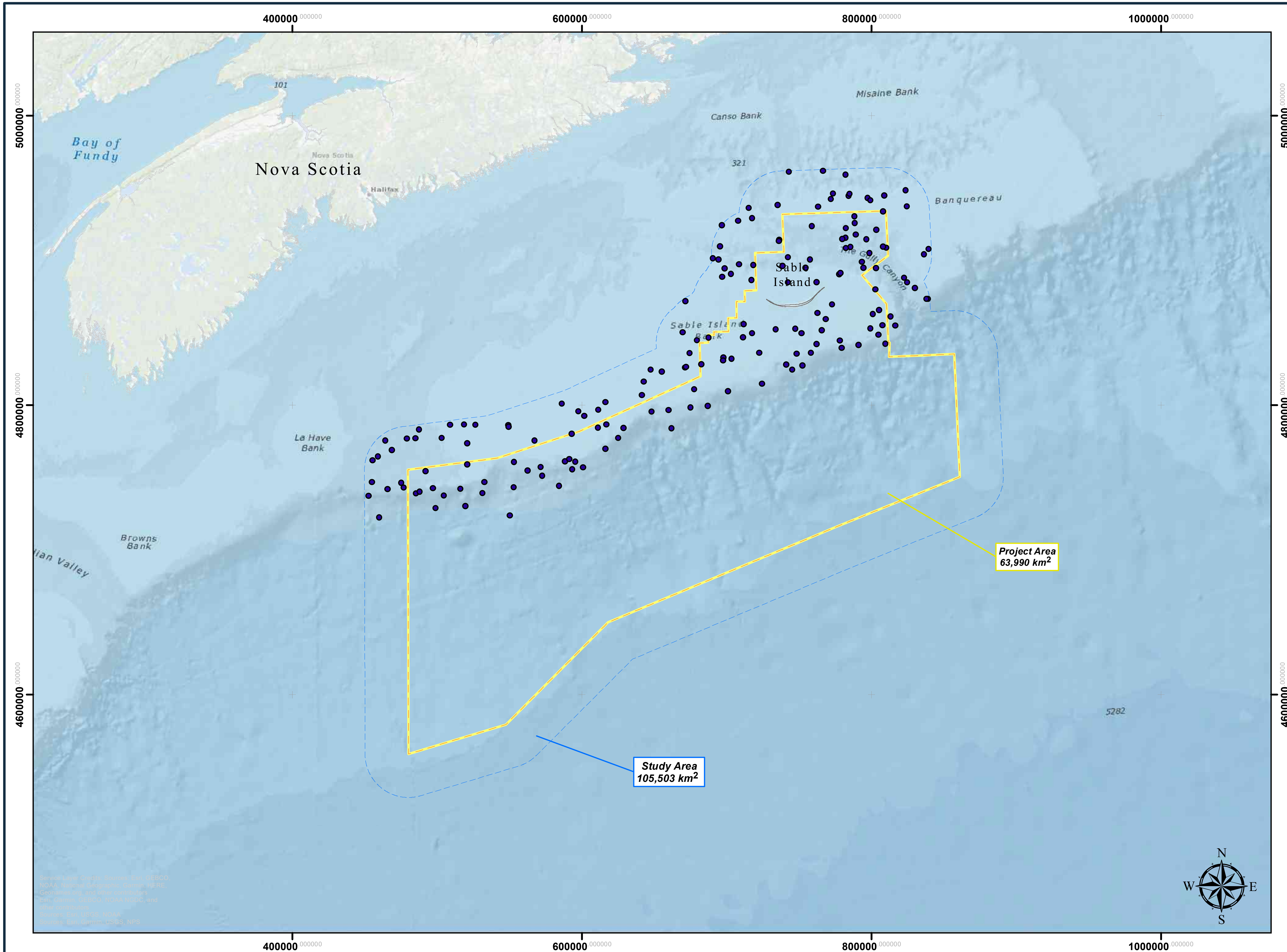
PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 1	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 3-93

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\RV_TRAWLS\TE211002_FIGURE_3_93_RV_Spring_Trawls.mxd User: candace.macdonald Date: 5/12/2022



LEGEND:

- Summer Trawl Locations (centroid)
- Project
- Study

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

TITLE:

SUMMER TRAWL LOCATIONS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

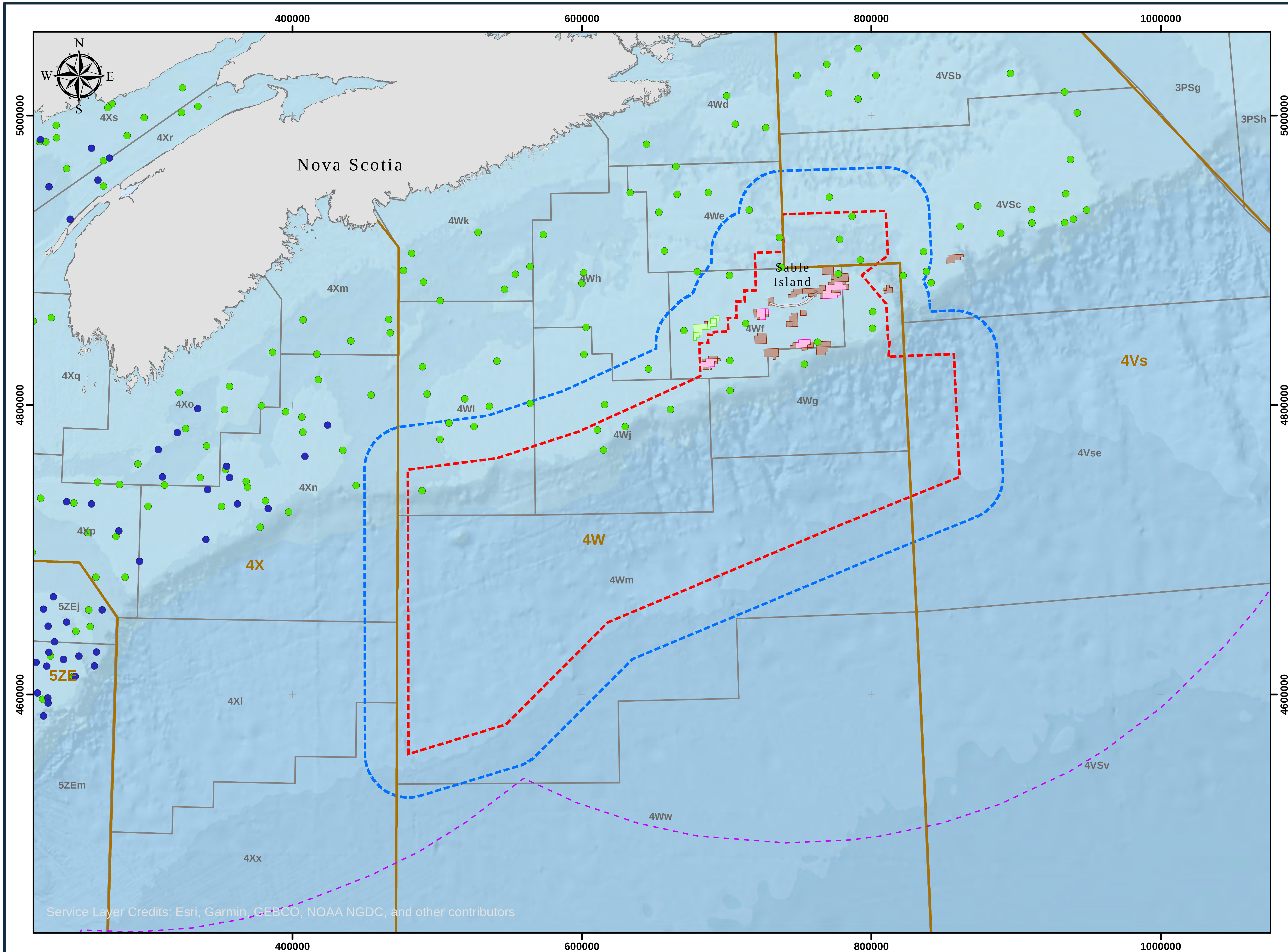
PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 1	DWN BY: CM
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-94**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: G:\5290 PROJECTS\2021\TE211002 CNSOPB_SEA\GIS\MXD\RV_TRAWLS\TE211002_FIGURE_3_94_RV_Summer_Trawls.mxd User: candace.macdonald Date: 5/12/2022



LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- NAFO Divisions
- NAFO Unit Areas
- Exclusive Economic Zone (EEZ)
- 2020 RV data (Spring)
- 2020 RV data (Summer)

Source: DFO Economic Analysis and Statistics, ZIFF [database]. Ottawa

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

DFO RV LOCATIONS (2020)

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO: **TE211002**	DATE: **MAY 2022**
REV NO: **0**	DWN BY: **JA**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE: **FIGURE 3-95**

SCALE: 1:2,500,000

0 12.5 25 50 75 100
Kilometres

Path: F:\TE211002\Project_Figures\MXD\MFFH\TE211002_RVDATA_May2022.mxd User: juanita.abbott Date: 5/20/2022

3.3.3 Other Ocean Uses

Human activities other than fisheries occur in and near the Study Area, and some have a potential to interact with future petroleum exploration operations. This section provides an overview of other principal uses of the Study Area, which include vessels transiting, conducting operations, and anthropogenic installations and artifacts (Table 3-38). These are illustrated in Figure 3-96 to 3-100. Marine tourism (e.g., seabird and whale watching) and recreational fishing (including tuna tournaments and a recreational shark fishery) also take place in Scotian Shelf waters - mostly outside of the winter months - though few activities occur as far from shore as the Study Area. However, visits / tours are possible to Sable Island National Park Reserve and The Gully MPA with permission. Fly-in and ship-based visits to the Sable Island National Park Reserve occurs regularly between May to October.

Table 3-38: Other Ocean Uses

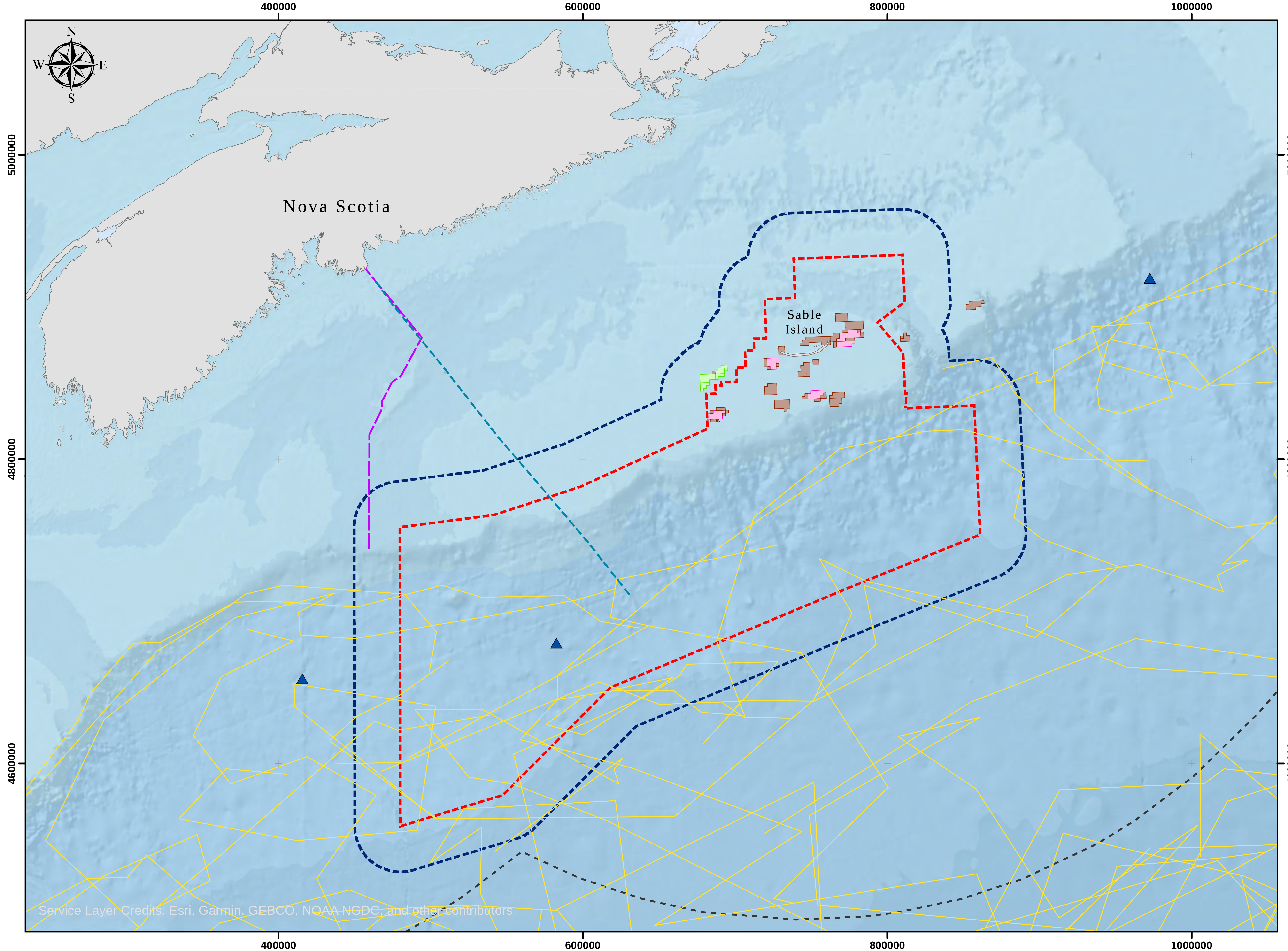
Activities / Artifacts	Description
Other Marine Research and Observation Activities **(Figure 3-96)**	Marine research programs not focused on commercial fisheries may occur at different times as research opportunities, needs and funding arise. These may be undertaken by other government agencies, educational institutions, NGOs, industry, or international research interests throughout the Scotian Shelf and adjacent areas. These include, or might include in the future, the following groups or interests: • Environmental monitoring at prospective, producing, decommissioning or decommissioned petroleum development sites. The CNSOPB is involved (summer 2021) in post-abandonment monitoring of recent project decommissioning (see below) to confirm the integrity of the work and confirm that there are no remaining seabed hazards for other commercial ocean users. • Seismic and other surveys by the Geological Survey of Canada, and by the petroleum industry (see below) which are an initial stage in identifying leases interests and production prospects. • Other petroleum related research including projects through the Centre for Offshore Oil, Gas and Energy Research (COOGER) and the Environmental Studies Research Fund (ESRF). • Marine archaeology investigations, e.g., of shipwrecks (see below). • Research related to the Sable Island Institute. • Research conducted by or on behalf of Parks Canada. • Marine mammal research associated with the Whitehead Research Lab, Dalhousie University, and other groups. • The AZMP and the AZOMP collects data from the Scotian Slope and rise along the Halifax Line (extended) which terminates in the Study Area.

Activities / Artifacts	**Description**
	• Environment and Climate Change Canada (ECCC) operates Ocean Data Acquisition System (ODAS) fixed buoys in the Region acquiring weather and oceanographic parameters. One is located within the Study Area approximately 80 km south of the Shelf. EC also deploys drifting data collectors. ARGO Canada and other ARGO oceanographic drifting buoys may be encountered within the Study Area, as may Seaexplore gliders deployed by the DFO Coastal Ocean Glider Group. • The Ocean Tracking Network (OTN) and the Coastal Environmental Observation Technology and Research (CEOTR) group deploy sub-sea marine tracking and observation equipment, some of which is in the Study Area. Several other agencies may fund or assist marine research of various kinds, such as the Natural Sciences and Engineering Research Council (NSERC), Marine Environmental Observation, Prediction and Response Network (MEOPAR), and the Ocean Frontier Institute. Nova Scotia's Offshore Energy Research Association (OERA) assists and works collaboratively with researchers investigating energy issues. Sources: CEOTR 2020; ECC 2014; DFO 2018i, DFO 2019g, DFO 2020s; OERA 2021; OTN 2021
Petroleum Industry **(Figure 3-97)**	The Study Area has been the site of several offshore petroleum production platforms in an area south and southwest of Sable Island. • Canada's first offshore development was the Cohasset-Panuke Project (oil, 14 production wells), which operated from 1992 until decommissioning in 1999. • The SOEP (natural gas) commenced production in 1999 from five fields each with a production platform; 21 production wells were drilled. Decommissioning began in 2017 and concluded at the last site in 2020. A post-abandonment monitoring program was conducted in 2021 to re-confirm the integrity of the well plugging and abandonment program, and to confirm that there is nothing on the seabed that could pose a potential hazard to other commercial ocean users. Based on the results of this program, in 2022 ExxonMobil will be conducting additional monitoring of the Alma 2 well to further investigate a well condition observed. • The Deep Panuke Offshore Project (natural gas) began production in 2013 and operated seasonally (2015 – 2018) with four production wells until decommissioning began in 2018; completed in 2020. A post-abandonment monitoring program was completed in 2021 to re-confirm the integrity of the well plugging and abandonment program, and to confirm that there is nothing on the seabed that could pose a potential hazard to other

Activities / Artifacts	Description
	commercial ocean users. The CNSOPB was satisfied that the post-abandonment monitoring requirements were met, concluded future monitoring was not required and revoked the authorization for Deep Panuke thereby officially closing out the project. Project infrastructure included inter-field pipelines (SOEP and Deep Panuke) and a gas pipeline to shore at Country Harbour, Nova Scotia. This subsea infrastructure remains in place in most areas. There have also been many seismic exploration programs in the Nova Scotia offshore. Since the first exploration well was drilled on the Scotian Shelf in 1967, more than 200 were drilled to 2017. Seismic and well data may be accessed through the CNSOPB's Data Management Centre. The CNSOPB has a Nominations and Call for Bids process for new lease acquisitions in the region. Future activities may include 2D, 3D and four-dimensional (4D) geophysical (seismic) surveys using compressed air arrays or other developing technologies, as well as geotechnical surveys; exploration drilling; production; decommissioning; and abandonment. When exploration drilling and/or production operations are active, associated vessel traffic (construction, servicing) is also frequent between those locations and land bases. Sources: CNSOPB 2018, DFO 2021c, DFO 2021d, DFO 2021e
Military and Coast Guard **(Figure 3-98)**	Both the Royal Canadian Navy and Air Force (Department of National Defence) conduct training exercises and coastal surveillance in Nova Scotia's offshore areas, sometimes in cooperation with other North Atlantic Treaty Organization (NATO) allies. • Activities may involve ships, submarines, and aircraft, possibly within the Study Area. Submarines may be on the surfaced, partially submerged or fully submerged, with or without surface ships nearby. • Exercises in areas west of the Study Area may include firing and bombing practices: at sea, air to air and air to sea. Northern portions of the Study Area are within military exercise Sea Area J, which is designated as sub-surface military operations area, and the western Study Area overlaps with sub-surface operations and firing practice areas (Sea Areas G3, G4, H3 M1, M2, N1, N2 and HOTBOX 2). • Past military operations have also resulted in the deposition of Unexploded Ordnance (UXO) in several marine locations. Specific location data can be requested during project level EA.

Activities / Artifacts	Description
	• The Canadian Coast Guard (CCG) also has responsibility to conduct fishery patrols and law enforcement in Canadian waters, and to respond to search and rescue emergencies, sometimes with support from naval vessels. • Canada's Maritime Forces Atlantic (MARLANT) is based in Halifax. Sources: Breeze and Horsman 2005; CCG NotMAR Annual 2021
Other Marine Traffic **(Figure 3-99)**	Other marine vessel transits (apart from fishing, marine research, military exercises and petroleum industry activities) are frequent through the Study Area. These include diverse domestic and international cargo and tanker traffic (petroleum products and chemicals) operating year-round: • Domestic-bound or -originating traffic. Cargo, cruise ship and other traffic commonly travels to and from ports in the Maritimes Region (particularly Saint John, Halifax, Strait of Canso, and Sydney/North Sydney), and to other Canadian Ports via the Cabot Strait to the Gulf of Saint Lawrence and the Saint Lawrence Seaway to Quebec, Montreal and the Great Lakes, or eastward to Newfoundland and Labrador ports. • International traffic passing by the area. The Scotian Shelf is near common commercial marine routes between Europe and North America, most following the "Great Circle Route". Cruise ships and private pleasure craft may also pass through the area. CCG issues timely NAVWARNs, formerly Notices to Shipping) to alert domestic and international vessels of hazards or certain operations in Canadian waters. Its annually published Notices to Mariners contains information about permanent or regular features or activities, and the *Collision Regulations* under the *Canadian Shipping Act* set out operational and safety requirements in Canadian navigable waters. Sources: Breeze and Horsman 2005; Government of Canada 2021e; OTN 2021
Subsea Infrastructure, Shipwrecks and UXO **(Figure 3-100)**	Anthropogenic sub-sea features in the region (other than petroleum-industry related) include: • Submarine telecommunications cables, some active but most abandoned. Of the active cables, three pass through the western/southwestern quadrant of the Study Area, connecting into the Halifax area, passing primarily through deep water. • Shipwrecks, including many around Sable Island, which has been called the "Graveyard of the Atlantic" for the 350 known shipwrecks that occurred there. • Lost, deliberately dumped or shipwrecked UXO, including explosive, chemical or biological materials, may be in nearby offshore areas. There is a

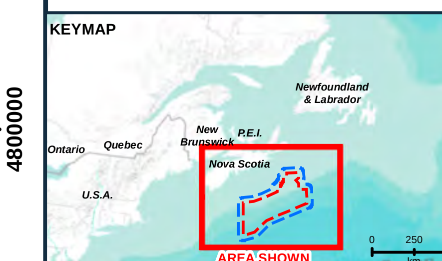
Activities / Artifacts	Description
	known military UXO site beyond the shelf edge in approximately 3,000 m of water. Specific location data can be requested during project level EA. Sources: Breeze and Horsman 2005; DND 2021; Museum of the Atlantic 2021.



LEGEND:

- Study Area
- Project Area
- ODAS environmental bouys
- ARGO Drifter Tracklines (Feb 2021)
- Halifax Line AZMP + AZOMP Extension
- OTN Sensors
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- Exclusive Economic Zone (EEZ)

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

OTHER MARINE RESEARCH AND MONITORING LOCATIONS

PROJECT: **STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK**

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: **FIGURE 3-96**

SCALE: 1:2,405,187

0 12.5 25 50 75 100
Kilometres

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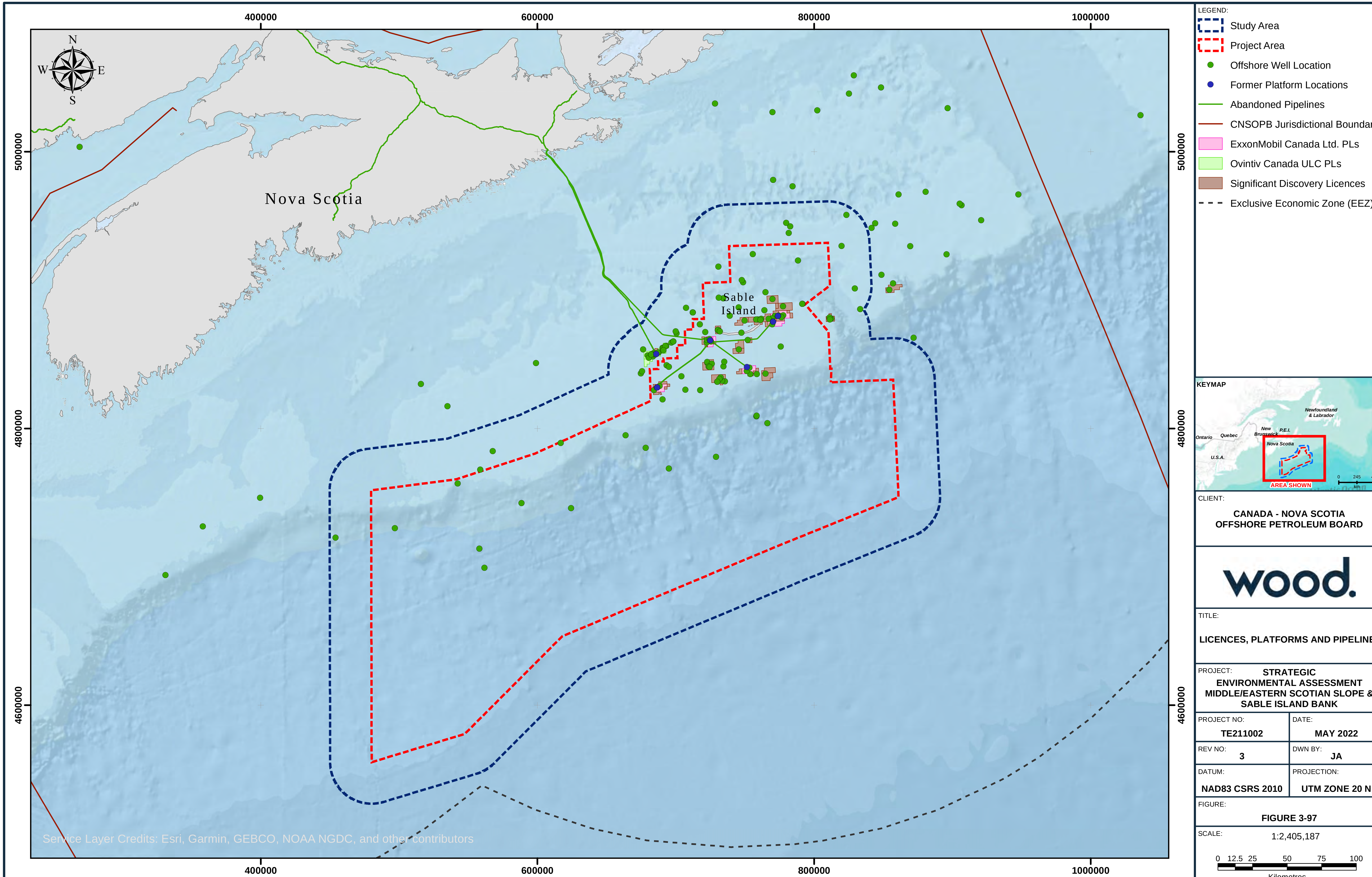

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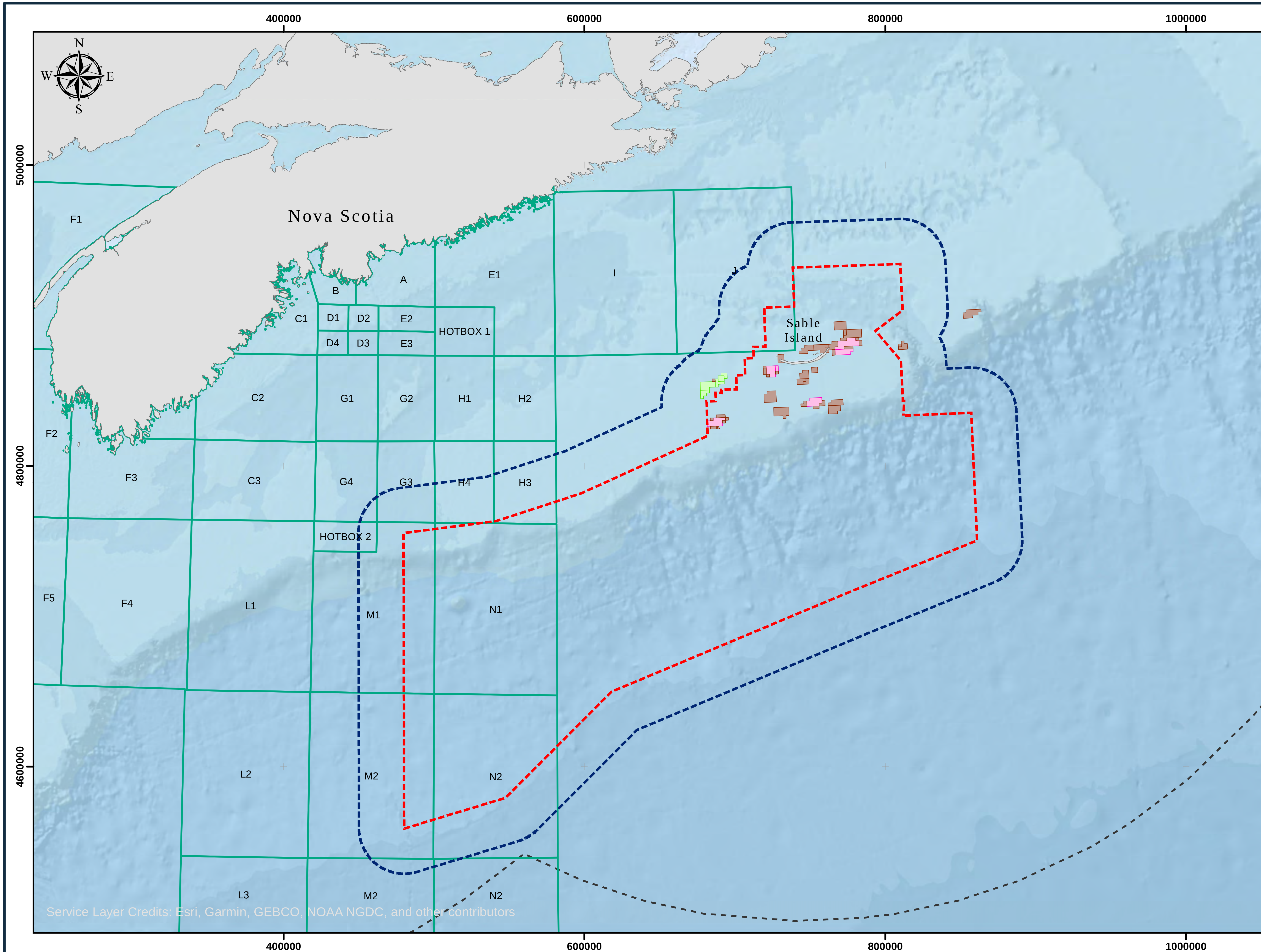
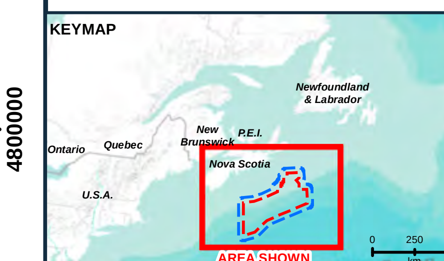


LEGEND:

- Study Area
- Project Area
- Military Exercise Areas
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- Exclusive Economic Zone (EEZ)

KEYMAP



CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

TITLE:

DESIGNATED MILITARY EXERCISE AREAS

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE: FIGURE 3-98

SCALE: 1:2,405,187

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Kilometres

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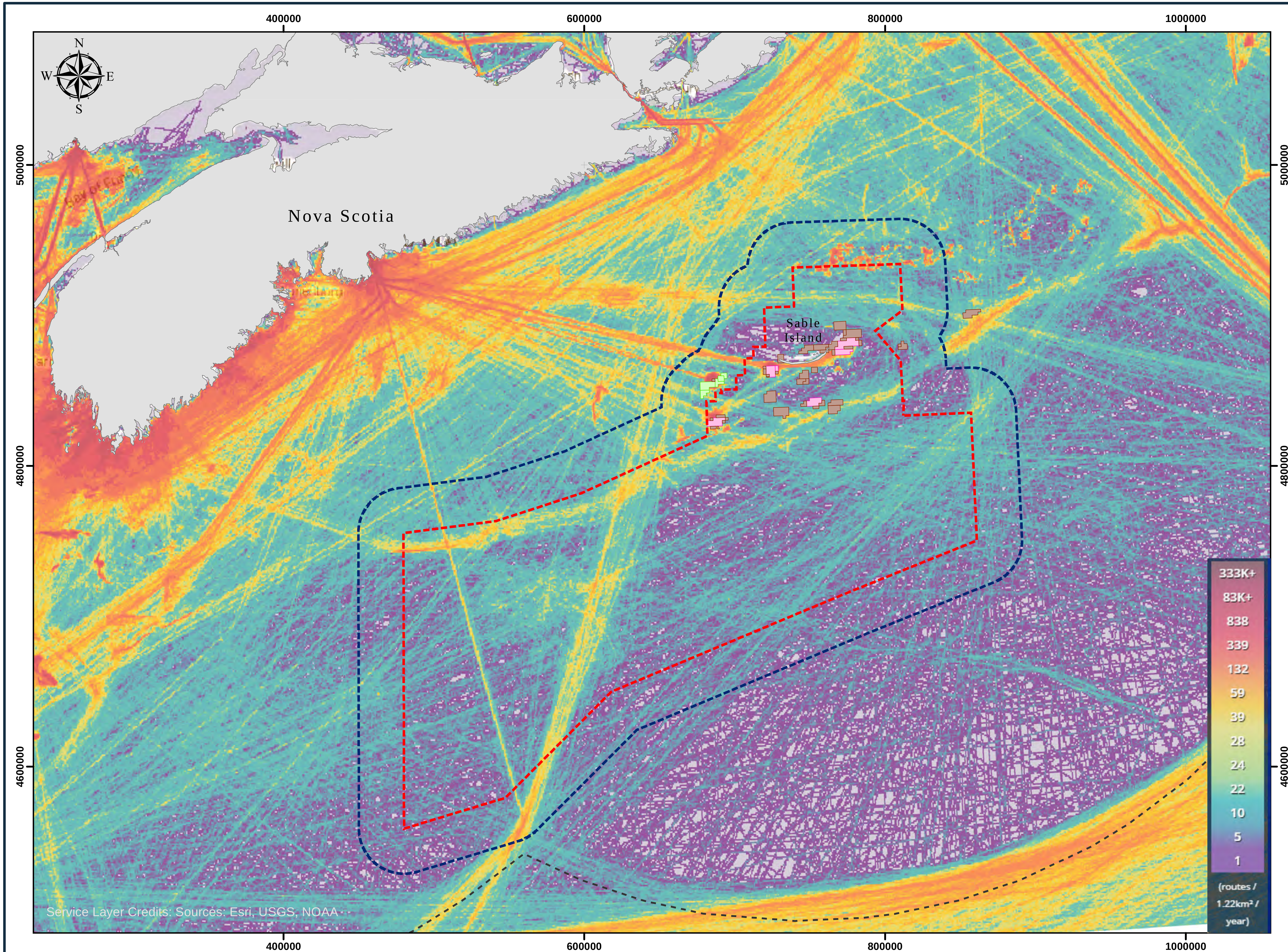

LEGEND:

- Study Area
- Project Area
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- Exclusive Economic Zone (EEZ)

KEYMAP

CLIENT:

CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:

MARINE TRAFFIC

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO:	DATE:
TE211002	MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:

FIGURE 3-99

SCALE: 1:2,405,187

0 12.5 25 50 75 100

Kilometres

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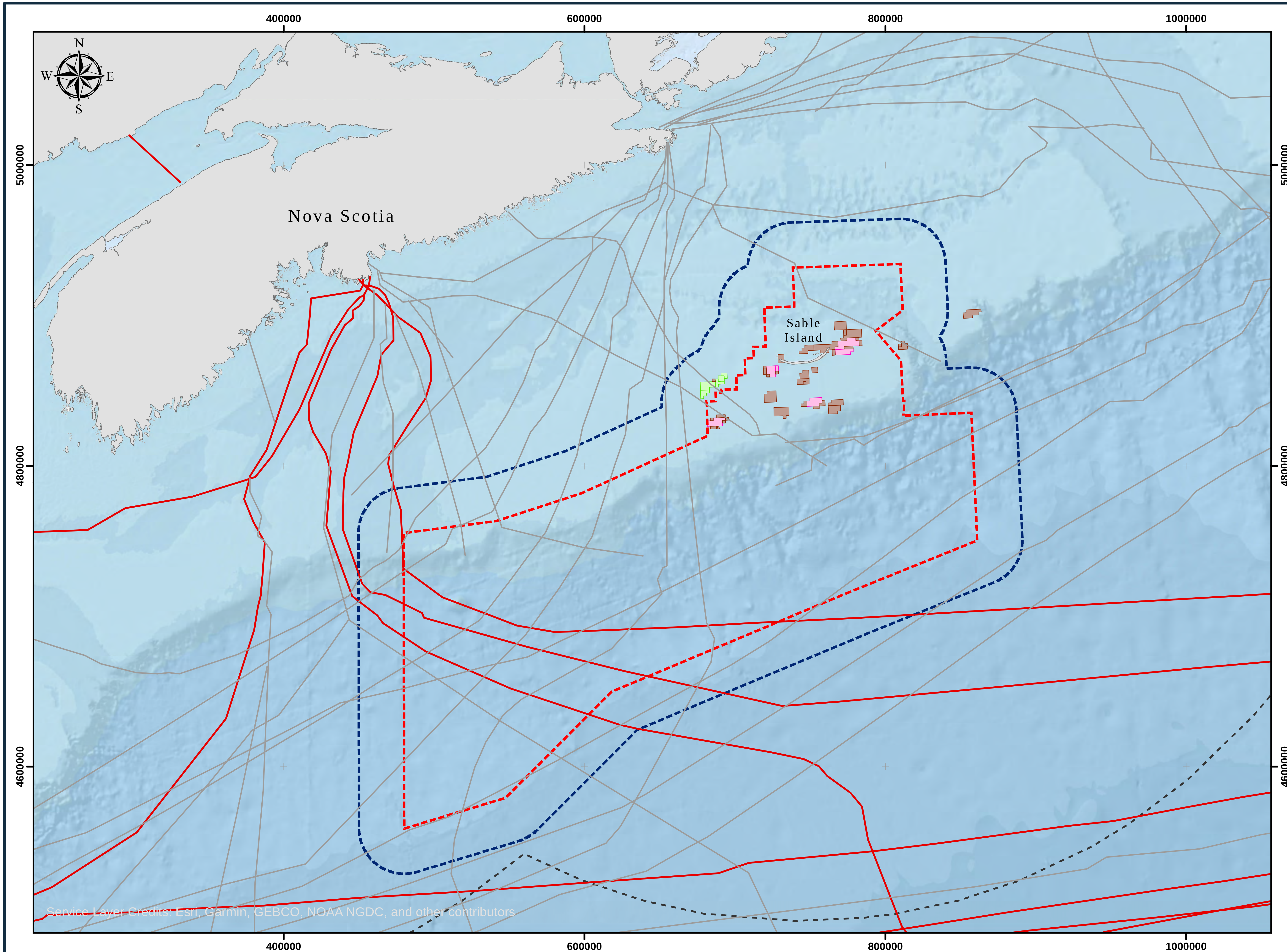


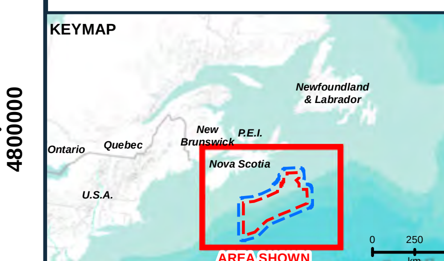
LEGEND:

- Study Area
- Project Area

Marine Cables

- Active
- Inactive
- ExxonMobil Canada Ltd. PLs
- Ovintiv Canada ULC PLs
- Significant Discovery Licences
- Exclusive Economic Zone (EEZ)

KEYMAP



CLIENT:
CANADA - NOVA SCOTIA OFFSHORE PETROLEUM BOARD

wood.

TITLE:
MARINE CABLES

PROJECT: STRATEGIC ENVIRONMENTAL ASSESSMENT MIDDLE/EASTERN SCOTIAN SLOPE & SABLE ISLAND BANK

PROJECT NO: TE211002	DATE: MAY 2022
REV NO: 0	DWN BY: JA
DATUM: NAD83 CSRS 2010	PROJECTION: UTM ZONE 20 N

FIGURE:
FIGURE 3-100

SCALE: 1:2,405,187

0 12.5 25 50 75 100
Kilometres

3.3.4 Indigenous Fisheries

Harvesting, food preparation and sharing with community members are important components of Indigenous culture and often the focus of social and ceremonial activities. Wildlife, fish, birds and plants including those found in the marine environment have been traditionally used for sustenance, medicine, spiritual and cultural practices, and for trade. Indigenous peoples in Atlantic Canada continue to engage in traditional land and resource use practices though location, species and / or harvesting methods may have evolved.

Canada's Indigenous peoples hold Aboriginal and treaty rights to harvest various species for food, social and ceremonial (FSC) purposes and / or to earn a moderate livelihood from harvesting. These Aboriginal and treaty rights are protected by section 35 of the *Canadian Constitution Act, 1982* (Section 35 rights). Section 35 rights have been affirmed in SCC decisions, such as the Sparrow decision in 1990 and the Marshall decision in 1999 (SCC 2021). DFO issues FSC harvesting licenses to Indigenous communities rather than individuals but these licenses do not encompass all traditional land and resource use practices. FSC harvesting occurs near Indigenous communities and is thus unlikely to interact with offshore oil and gas exploration activities. Thus, the remaining discussion on Indigenous harvesting is focussed on commercial communal fisheries.

Indigenous peoples in Atlantic Canada hold commercial communal licenses for various fisheries, meaning licenses (issued by DFO) are held by the Indigenous group rather than an individual. Commercial communal fisheries are an economically significant resource for Indigenous people and revenue from such activities is used to support community programs and services including those that address health, wellness, education and economic development needs as well as employment opportunities.

Currently, DFO has issued 605 commercial communal harvesting licenses in the Scotia-Fundy region (Table 3-39). These are held by 22 Indigenous groups or related organizations in Nova Scotia (14), New Brunswick (7) and Newfoundland and Labrador (1). This information shows the number of licenses many of which are for inshore areas or other locations (e.g., Bay of Fundy to Cape Breton) as opposed to the Study Area. Information is not available to describe fishing participation or harvesting results for each Indigenous group or organization. However, with as many as 104 commercial communal licenses in the Scotia-Fundy Region, these Indigenous organizations are, or have the potential to be, important players in the regional fishing industry.

Table 3-39: Indigenous Commercial Communal Fishing Licenses in Scotia-Fundy Region (2021)

First Nation or Group, Province	Licensed Species or Group	Licenses (#)
Acadia First Nation, Nova Scotia (83 licenses)	Alewives / gaspereau	1
	Clams, unspecified	11
	Green Crab	2
	Jonah Crab	1
	Snow Crab	4
	Eel	1
	Groundfish, unspecified	2
	Herring	5
	Herring / Mackerel (bait)	11
	Lobster	25
	Mackerel	5

First Nation or Group, Province	Licensed Species or Group	Licenses (#)
	Marine worm	3
	Ocean quahaug	1
	Sea scallop	8
	Swordfish	1
	Tuna	2
Afton First Nation, Nova Scotia (1 license)	Sea urchins	1
Annapolis Valley First Nation, Nova Scotia (24 licenses)	Alewives / gaspereau	1
	Green crab	5
	Groundfish, unspecified	2
	Herring	2
	Herring / Mackerel (bait)	1
	Lobster	8
	Marine worm	1
	Sea scallop	3
	Sea urchins	1
Apaqtukewag Fishermans Co-Op, Nova Scotia (6 licenses)	Snow Crab	2
	Lobster	1
	Mackerel	1
	Sea urchins	1
	Squid, Unspecified	1
Bear River First Nation, Nova Scotia (7 licenses)	Clams, unspecified	4
	Lobster	2
	Tuna	1
Chapel Island Band Council, Nova Scotia (15 licenses)	Alewives / gaspereau	2
	Snow Crab	4
	Eel	1
	Groundfish, Unspecified	1
	Herring / Mackerel (bait)	1
	Lobster	3
	Sea urchins	1
	Shrimp, *Pandalus borealis*	2
Miawpukek First Nation, Newfoundland and Labrador (2 licenses)	Swordfish	1
	Tuna	1
Eskasoni First Nation, Nova Scotia (48 licenses)	Alewives / gaspereau	1
	Snow Crab	28
	Eel	1
	Herring / Mackerel (bait)	1
	Lobster	6

First Nation or Group, Province	Licensed Species or Group	Licenses (#)
	Shrimp, *Pandalus borealis*	11
Fort Folly First Nation, New Brunswick (11 licenses)	Alewives / gaspereau (bait)	1
	Eel	1
	Groundfish, Unspecified	1
	Herring / Mackerel (Bait)	1
	Lobster	2
	Sea scallop	1
	Swordfish	2
	Tuna	2
Glooscap First Nation, Nova Scotia (29 licenses)	Alewives / gaspereau (bait)	2
	Clams, unspecified	2
	Green crab	10
	Groundfish, Unspecified	3
	Herring / Mackerel (bait)	2
	Lobster	3
	Mackerel	2
	Marine worm	2
	Swordfish	0
	Tuna	2
Kingsclear First Nation, NB (19 licenses)	Rock crab	1
	Groundfish, Unspecified	2
	Herring	3
	Lobster	5
	Sea scallop	2
	Sea urchins	6
Membertou Band, Nova Scotia (32 licenses)	Alewives / gaspereau	2
	Rock crab	1
	Snow crab	6
	Eel	1
	Groundfish, unspecified	2
	Herring	1
	Herring / mackerel (bait)	1
	Lobster	6
	Mackerel	1
	Sea scallop	4
	Sea urchins	2
	Shrimp, *Pandalus borealis*	1
	Squid, unspecified	2

First Nation or Group, Province	Licensed Species or Group	Licenses (#)
	Tuna	1
Millbrook First Nation, Nova Scotia (35 licenses)	Alewives / gaspereau	1
	Clams, unspecified	1
	Jonah Crab	1
	Snow Crab	8
	Eel	2
	Groundfish, Unspecified	1
	Hagfish (Slime Eel)	1
	Herring	1
	Herring / mackerel (bait)	1
	Lobster	11
	Mackerel	1
	Sea urchins	2
	Seal (harp, ragged jacket)	1
	Swordfish	0
	Tuna	2
Mime 'J Seafoods Ltd., Nova Scotia (104 licenses)	Alewives / gaspereau	12
	Hard shell clams	1
	Clams, unspecified	16
	Green crab	5
	Jonah crab	2
	Snow crab	8
	Eel	2
	Groundfish, unspecified	7
	Herring	5
	Herring / mackerel (bait)	9
	Lobster	13
	Mackerel	12
	Marine worm	3
	Sea scallop	1
	Shad	1
	Squid, Unspecified	2
	Swordfish	4
	Tuna	1
NB Aboriginal Peoples Council, New Brunswick (8 licenses)	Clams, unspecified	1
	Eel	1
	Herring	1
	Lobster	3

First Nation or Group, Province	Licensed Species or Group	Licenses (#)
	Mackerel	1
	Sea scallop	1
Oromocto First Nation, New Brunswick (16 licenses)	Alewives / gaspereau	2
	Groundfish, unspecified	1
	Herring	1
	Herring / mackerel (bait)	1
	Lobster	4
	Sea scallop	3
	Sea urchins	1
	Shad	2
	Smelts	1
Shubenacadie Band, Nova Scotia (37 licenses)	Alewives / gaspereau	1
	Clams, unspecified	4
	Snow crab	2
	Groundfish, unspecified	1
	Herring / mackerel (bait)	9
	Lobster	15
	Sea scallop	1
	Sea urchins	2
	Swordfish	1
	Tuna	1
St. Mary's First Nation, New Brunswick (22 licenses)	Alewives / gaspereau	1
	Herring	2
	Lobster	7
	Sea scallop	3
	Sea urchins	3
	Shad	3
	Shrimp, *Pandalus borealis*	1
	Swordfish	1
	Tuna	1
Tobique First Nation, New Brunswick (42 licenses)	Jonah Crab	1
	Groundfish, Unspecified	4
	Herring	4
	Lobster	19
	Mackerel	1
	Ocean quahaug	1
	Sea scallop	16
	Sea urchins	3

First Nation or Group, Province	Licensed Species or Group	Licenses (#)
Wagmatcook First Nation, Nova Scotia (27 licenses)	Alewives / gaspereau (bait)	1
	Snow Crab	8
	Eel	2
	Groundfish, Unspecified	3
	Herring /mackerel (bait)	1
	Lobster	5
	Mackerel	3
	Sea urchins	1
	Seal (harp / ragged jacket)	1
	Squid, unspecified	1
	Swordfish	1
Waycobah First Nation, Nova Scotia (20 licenses)	Snow Crab	6
	Eel	1
	Groundfish, Unspecified	2
	Herring	1
	Herring / mackerel (bait)	1
	Lobster	2
	Mackerel	1
	Sea urchins	2
	Seal (harp / ragged jacket)	1
	Shrimp, *Pandalus borealis*	2
	Swordfish	1
Woodstock First Nation, New Brunswick (17 licenses)	Groundfish, Unspecified	2
	Herring	1
	Herring / mackerel (bait)	2
	Lobster	5
	Sea scallop	2
	Sea urchins	3
	Swordfish	1
	Tuna	1
Total		605

Source: DFO 2020i (Regional Licencing Maritimes Region)

Of the commercial communal fishing licenses held by First Nations groups / organizations in the Scotia-Fundy Region, 138 (~23%) intersect the Study Area (Table 3-40). This does not mean that these fisheries occur in the Study Area as some fisheries management areas are large in geographic range. These licenses are mainly for crab, groundfish, hagfish, lobster, mackerel, shrimp and large pelagic species such as tunas, and swordfish. These fishing licenses may or may not be currently active. For instance, though licenses were held for hagfish and mackerel in 2020, no landings were reported. Fewer than five harvesters were active in fisheries for groundfish, lobster, large pelagic species and shrimp. Crab is the only species for which active harvesters numbered more than five in the Study Area.

Table 3-40: Indigenous Commercial Communal Fishing in the Study Area (2020 Preliminary)

Fishery	Licenses (#)	Licenses with Landings (#)	Total Landings (tonnes)
Crab	CFA 23 - 21 CFA 24E - 14 CFA 24W - 3	CFA 23/24E - 16 CFA 24W - *	Total landings for all areas: 2,290
Groundfish (All gear / all groundfish)	Total licenses for all areas (some may fish multiple areas): 14 4W - 14 4VS - 14	Total licenses with landings for all areas (some licenses may have landings from multiple areas): * 4W - * 4VS - *	Total landings for all areas: * 4W - * 4VS - *
Hagfish	Total licenses for all areas: 1 4W - 1 4VS - 1	Total licenses with landings for all areas: 0	Total landings for all areas: 0
Large Pelagic Species (Licenses valid for DFO Maritimes Region.)	Total licenses for all areas - All large pelagic species - 12	Total licenses with landings for all areas: Shark - * Swordfish Total - * 4W - * 4VS - * Tuna (Bluefin) Total - 5 4W - 5 Other large pelagic species total- * 4W - * 4VS - *	Total landings for all areas: Shark - * Swordfish Total - * 4W - * 4VS - * Tuna (Bluefin) Total landings for all areas = * Other large pelagic species total - * 4W - * 4VS - *
Lobster (Inshore and Offshore)	LFA 32 - 6 LFA 33 - 20	LFA 32 - * LFA 33 - 13	LFA 32 - * LFA 33 - *
Mackerel	Total licenses for all areas: 30	Total licenses with landings for all areas: 0	Total landings for all areas: 0

Fishery	Licenses (#)	Licenses with Landings (#)	Total Landings (tonnes)
(Vessel-based licenses valid for DFO Maritimes Region)			
Shrimp	Total licenses for all areas: 15 SFA 14 - 14 SFA 15 - 15	Total licenses with landings for all areas: * SFA 14 - * SFA 15 - *	Total landings for all areas: * SFA 14 - * SFA 15 - *
Notes: Data for 2020 is preliminary and may be incomplete and / or subject to change without notice. In instances where fewer than five license holders have been actively fishing, total landings are denoted by an asterisk (*) to protect confidentiality.			

Source: DFO 2020h

4 STRATEGIC ENVIRONMENTAL ASSESSMENT SCOPE AND APPROACH

This Chapter defines the scope of the SEA analysis, including the spatial and temporal boundaries of the assessment and a summary of public, Indigenous and stakeholder communications that have been or will be undertaken as part of the SEA process. It describes the rationale for selection of valued components (VCs) upon which the SEA is focussed and those components that are outside the scope of the SEA. This Chapter concludes with an overview of the approach and methods used to conduct the SEA and its associated analyses.

4.1 SEA Scoping Document and the Associated "Strategic Decision"

Preparation of the SEA report has been informed and guided by a Scoping Document, which outlines the factors to be considered, the scope of those factors and other guidelines for preparing the SEA Report. The SEA Scoping Document was prepared and released by the CNSOPB on January 29, 2021. Review and input by various advisory agencies and organizations guided planning and completion of the SEA report. The Scoping Document sets out the key purpose and objectives of the SEA, which is to:

- Provide a description of typical offshore oil and gas exploration activities, including accidental events;
- Provide an overview of the existing environment;
- Identify the appropriate Study Area surrounding the SEA Project Area;
- Identify species-at-risk and special areas that may interact with exploration activities including marine and migratory birds;
- Describe and evaluate potential environmental effects, including cumulative effects, associated with offshore oil and gas exploration;
- Identify and describe commercial, recreational and Indigenous fisheries in the Study Area, the potential environmental effects on the fishing industry, and potential effects on established Aboriginal and Treaty rights;
- Make recommendations for general mitigation measures to be employed during offshore petroleum exploration activities;
- Identify, where appropriate, activities / areas requiring enhanced levels of mitigation; identify, if feasible, the level of enhanced mitigation required;
- Identify knowledge and data gaps that may affect the outcome of the SEA;
- Identify follow-up measures (i.e., environmental effects monitoring), as appropriate, that may be required to verify EA predictions related to future offshore petroleum exploration activities; and
- Assist the CNSOPB in its determination with respect to the issuance of future exploration rights within the SEA Project Area.

The SEA Scoping Document also specifies that the SEA will describe and consider all potential and reasonably foreseeable offshore oil and gas exploration activities that may occur in the Study Area if one or more ELs are eventually issued. It also states that the focus of the SEA will be on offshore exploration activities (and their potential interactions with the environment), which fall under the jurisdiction of the CNSOPB.

The specific "strategic decision" that the SEA is intended to inform is whether further exploration rights should be issued in whole, in part, or at all in the Middle and Eastern Scotian Slope and Sable Island Bank Areas, and if so, to identify any environmental components and issues that should be considered in taking these future decisions and actions.

4.2 Spatial and Temporal Boundaries

The spatial boundaries of the SEA Project Area include waters within the Canada-Nova Scotia offshore area that could be included in any potential future Call for Bids or resulting ELs in Middle and Eastern Scotian Slope and Sable Island Bank Area. The spatial boundaries of the SEA and associated analysis also reflect consideration of the nature and scale of any offshore oil and gas exploration activities that may occur, as well as the potential environmental zones of influence of such activities and their associated disturbances in the marine environment.

As described in Chapter 2, some offshore oil and gas (particularly, exploration) activities (e.g., seismic surveys) may be relatively widespread in nature, and often extend beyond the boundaries of individual ELs. It is also recognized that ecological and anthropogenic components and systems rarely correspond to (and often extend well beyond) such administrative boundaries, due to oceanographic conditions and the extensive ranges and mobile nature of some marine species and activities. These characteristics and processes can also influence and extend the potential influence of any environmental disturbances and effects that may be associated with oil and gas activities in the Project Area.

The geographic scope of the SEA considers the nature, key characteristics, and spatial distribution (including movements) of the various environmental components under consideration (Chapter 3). This includes associated life histories, ranges, habitat preferences, movement patterns and other activities of key species known or likely to be present either year-round or seasonally. It also considers the overall location, size, and extent of any protected or special areas that overlap in whole or part with the Project Area, and the overall geographic extent and distribution of key human activities (e.g., fishing, shipping) within and adjacent to the Project Area.

Therefore, although the SEA has a primary focus on the Middle and Eastern Scotian Slope and Sable Island Bank Areas themselves (approximately 63,990 km^2), the analysis has not been confined to the Project Area. Rather, the assessment also considers a 30 km buffer around the Project Area to recognize the potential zone of influence of environmental and socioeconomic effects from activities that could occur within the Project Area.

The temporal boundaries of the SEA will focus upon a timeframe of approximately 10 years, which would generally correspond to the duration of ELs that could be issued in the area following the SEA. In conducting the assessment, particular consideration has been given to the overall timing and seasonality of the presence of marine wildlife and relevant marine activities within the Study Area, including any particularly important or sensitive time periods. As has been CNSOPB practice in completing SEAs, this assessment will be reviewed within a five-year period, or earlier if warranted, to determine whether an update is required.

4.3 Communication Activities and Initiatives

The CNSOPB approach to planning and conducting SEAs is inherently open and consultative, incorporating various mechanisms to allow relevant organizations and individuals to receive and review information, as well as to provide information and perspectives relevant to the SEA and its scope. These comment periods are opportunities to identify questions, concerns, and issues that require consideration in the SEA and may be relevant to associated licensing decisions by the CNSOPB. There was a 30-day public comment period on the Scoping Document in late January through February 2021. The draft version of the SEA report was available for Indigenous, stakeholder and public comment during the review period of November 16 to December 17, 2021. The CNSOPB understands that engagement activities often identify issues and ideas from stakeholder and Indigenous groups and the public that can enhance understanding. To this end, the CNSOPB tracked the comments received and incorporated them into the revised final SEA Report, as appropriate. A summary of the comments is included in Appendix B in this final SEA Report.

4.4 Identification of Valued Components

The communication activities and initiatives described in Section 4.3 helped to identify Valued Components (VCs) of the environment, issues and interactions that may be relevant to possible future oil and gas activity in the Project Area and which require consideration in the SEA. These include preparation of the Scoping Document and receipt of information and updates through the CNSOPB's website and other means. In addition to these past, ongoing and planned communications activities, the scoping exercise for the SEA has also included consideration of the nature of past and potential future oil and gas activities in the Middle and Eastern Scotian Slope and Sable Island Bank Areas, and the existing biophysical and socioeconomic environments of the Study Area (Chapter 3) to identify key potential environmental interactions and issues. Other SEAs undertaken in relation to offshore petroleum exploration and development in Nova Scotia were also reviewed and considered, as well as project specific EAs conducted for individual seismic surveys, exploration drilling programs and production projects. The results of these previous assessments and studies were considered as part of the scoping exercise, as appropriate.

Based on the results of the scoping exercise, and as specified in the SEA Scoping Document, the following VCs are considered in this assessment:

- Species of Conservation Concern
- Protected and Special Areas
- Fisheries and Other Ocean Uses; and
- Indigenous Fisheries.

A definition of these VCs and the rationale for the selection is provided in Table 4-1 below.

Table 4-1: Valued Components

Environmental Component	Rationale / Scoping Considerations
Species of Conservation Concern	Various marine fish, bird, mammal and reptile species that are known or likely to occur in the SEA Project Area have been designated as (1) being at risk with varying degrees of formal protection under the federal SARA, (2) species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC), (3) migratory birds protected by *the Migratory Birds Convention Act, 1994* and other legislation. This includes species of marine and anadromous fish, marine and land birds, whales, and sea turtles. See Section 3.2.9.
Protected and Special Areas	Various locations within or adjacent to the SEA Project Area have been protected under federal legislation or identified as special through Canadian organizations or other mandates, due to their biological, historical and / or sociocultural characteristics (Section 3.2.10). Other locations, including some that are important ecologically and / or for human activities, have been identified as especially sensitive to possible

Environmental Component	Rationale / Scoping Considerations
	environmental disturbances. Various protected and special areas are within the Study Area. DFO has designated The Gully MPA under the *Oceans Act* and the Western / Emerald Banks Conservation Areas (restricted fisheries zone) under the *Fisheries Act*. Important or Critical Habitat for aquatic SAR such as Leatherback Sea Turtle (Atlantic Population), Blue Whale (Northwest Atlantic Population) and Northern Bottlenose Whale (Scotian Shelf Population) have been identified. Sable Island is protected as an MBS under the *Migratory Birds Convention Act*, as a National Park Reserve under the *Canada National Parks Act* and identified as an IBA. DFO has defined EBSAs in the Scotian Shelf Bioregion, which overlap with the Study Area including Sable Island Shoals, Scotian Shelf, Emerald-Western Sable Bank Complex, Emerald Basin and the Scotia Gulf, Eastern Scotian Shelf Canyons and Middle Bank. SiBAs are defined as areas of significant concentrations of sponges, sea pens, large gorgonian corals and small gorgonian corals some of which overlap the Study Area in the Scotian Shelf. A Haddock Nursery that is closed to all bottom fishing types also intersects the Study Area.
Fisheries and Other Ocean Uses	Fisheries are an important and integral component of the socioeconomic environment of Nova Scotia and most of Atlantic Canada. Commercial harvesting, which is conducted throughout the Study Area involves fishers from Nova Scotia and other provinces harvesting a wide range of commercial species (groundfish, shellfish and large pelagic species) using a variety of gear types (fixed and mobile), year-round. Commercial fisheries and fisheries research have the potential to be affected both directly (through possible interactions between offshore oil and gas activities and fishing activity and gear) and indirectly (behavioural changes or market perceptions) because of offshore petroleum activities. Other human activities and components also occur within the marine environment, and therefore have the potential to interact with, and be affected by, any future offshore oil and gas activities, including installations and vessel movements. These include commercial shipping, submarine cables, shipwrecks and legacy sites, military activities, other scientific observations and data collection.
Indigenous Fisheries	Canada's Indigenous peoples hold Aboriginal and Treaty rights to harvest various species for FSC purposes as well as commercial communal fishing licenses. Indigenous Groups in Atlantic Canada hold commercial communal fishing licenses that may intersect the Study Area (Section 3.3.4). The potential interactions with Indigenous commercial communal fisheries are generally consistent with commercial fishing as both activities may overlap spatially and temporally with the oil and gas industry.

These four VCs represent the main environmental components assessed in this SEA. This assessment therefore focuses on those environmental components and potential interactions which are of primary concern, and thus, which have the most relevance to strategic planning and decision-making related to possible future oil and gas activities in the Middle and Eastern Scotian Slope and Sable Island Bank Areas.

4.5 SEA Analysis: Approach and Methods

The following sections describe the approach and methods used in conducting the environmental effects analysis for each of the VCs under consideration.

4.5.1 Environmental Setting

The SEA initially provided a description of the environmental setting of the SEA Project Area (Chapter 3), including the relevant components of its physical, biological and socioeconomic environments based on existing and available information and datasets. This is used as a basis for identifying potential environmental issues and interactions, required mitigations and associated planning considerations to attempt to avoid or reduce potential adverse environmental effects (Chapter 5).

This description of the existing environment does not focus exclusively upon the identified VCs, but also includes other aspects of the physical, biological and socioeconomic environments relevant for the SEA. It is intended that the SEA Report will be viewed as a source of environmental information on the Middle and Eastern Scotian Slope and Sable Island Bank Areas and used in the planning and EAs of potential future projects in the area.

4.5.2 Potential Environmental Interactions and Effects

This SEA includes identification of general environmental issues and effects that may be associated with offshore oil and gas activities in the Middle and Eastern Scotian Slope and Sable Island Bank Areas. The analysis for each of the identified VCs includes consideration of components and activities typically associated with offshore oil and gas exploration (Chapter 2) and the region's existing environment (Chapter 3), to identify potential interactions between them. This analysis has been generally informed by available scientific literature and other existing information on the interactions of offshore oil and gas activities and the environment and their associated environmental effects on VCs. The sections of the SEA on potential interactions include a general identification and overview of known and likely environmental issues and interactions associated with petroleum exploration activities, as background and context for identifying key issues and environmental planning considerations.

4.5.3 Environmental Mitigation Measures and Planning Considerations

The sections on environmental mitigation measures provide a summary overview of typical / standard mitigation measures often implemented during offshore oil and gas exploration activities in the Canada-Nova Scotia offshore area and elsewhere to avoid or reduce potential environmental effects. They also discuss environmental monitoring and follow-up programs that are typically required and implemented in the offshore.

Based on the overview of the existing environmental setting and the potential environmental interactions and typical mitigations identified through the above, the SEA also identifies key environmental considerations to help guide future planning and decision-making. This involves identification of key planning and management considerations that may help inform future licensing decisions and discussion of other activity, issue, site or time-specific measures that may help to avoid or reduce potential environmental effects.

4.5.4 Cumulative Environmental Effects

Cumulative effects that may result from future offshore oil and gas activities in the Middle and Eastern Scotian Slope and Sable Island Bank Areas are also assessed as part of the analyses, to the degree possible given that their specific number, characteristics, locations, and timing is not known at this stage.

The SEA also considers the potential cumulative effects of offshore oil and gas activities in the Project Area in combination with other projects and activities in the region (e.g., general marine vessel traffic, fisheries). The overall objective is to identify and evaluate potential issues regarding cumulative effects for consideration in licensing decisions, and for planning and assessing future oil and gas projects to minimize cumulative effects.

4.5.5 Information Availability, Requirements and Opportunities

The SEA also discusses the overall nature and adequacy of existing and available environmental information in the Project Area and identifies important data gaps and information requirements that may be relevant to planning and decision-making. It also considers opportunities to add to the knowledge base of the region through future information collection or collaboration initiatives.

5 POTENTIAL ENVIRONMENTAL / SOCIOECONOMIC INTERACTIONS, MITIGATION, RESIDUAL EFFECTS AND PLANNING CONSIDERATIONS

This Chapter presents an analysis of potential environmental effects, mitigation measures and planning considerations related to possible future offshore oil and gas activities in the Middle and Eastern Scotian Slope and Sable Island Bank Areas. The discussion is focused on the four VCs that have been identified for this SEA:

- Species of Conservation Concern;
- Protected and Special Areas;
- Commercial Fisheries and Other Ocean Uses; and
- Indigenous Fisheries.

A list of typical mitigations is included for each VC to provide understanding of legislative requirements and best practices available to avoid, reduce or compensate for potential effects from oil and gas exploration activities in the marine environment. This is followed by a discussion of key environmental planning considerations that may help inform future licensing decisions and identification of other activity-, issue-, site- or time-specific measures that may help to avoid or reduce potential environmental effects.

5.1 Species of Conservation Concern

Various fauna known or likely to occur in the Study Area have been designated as being at risk with varying degrees of formal protection under the federal SARA, species assessed as endangered, threatened, or of special concern by COSEWIC, migratory birds protected by the *Migratory Birds Convention Act, 1994* and other legislation. This includes several species of marine and anadromous fish, as well as species of marine, coastal and land birds and various whale and sea turtle species.

5.1.1 Potential Environmental Interactions

The main activities and associated environmental disturbances that may be associated with possible offshore petroleum exploration activities in the Study Area include:

- The presence and movement of drill rigs / platforms or survey vessels and other supporting ships;
- Underwater sound generated by the exploration activities (such as during seismic surveying, seabed sampling, offshore drilling) including its introduction to and transmission through the marine environment;
- Other oil and gas activity related noise (vessels, aircraft) and air emissions (engine exhausts);
- Seabed sampling activity associated with the collection of core, grab and samples or other in water activities and their associated sea bottom footprints;
- Drill wastes and the discharge and deposition of drill cuttings;
- Lighting on drilling platforms, seismic or support vessels and on-board equipment;
- Flaring on drilling platforms;
- The generation of solid and liquid waste materials and their management; and
- Potential accidental spills or the loss of material / equipment into the marine environment.

Potential effects of offshore oil and gas exploration on Species of Conservation Concern (SOCC) are discussed in the Section 5.1.3.

5.1.2 Environmental Mitigation Measures

This section provides an overview of some of the standard and typical mitigation measures that are often required and/or otherwise implemented during offshore oil and gas activities to reduce or eliminate adverse environmental effects on marine fish, birds, mammals and sea turtles, including any associated species of conservation concern.

The CNSOPB has published a number of guidelines that include various requirements and other measures related to environmental planning, mitigation, monitoring and reporting which are intended to help reduce or eliminate the potential effects of offshore exploration activities. These include the following, which are available through the CNSOPB's website:

- Geophysical and Geological Programs in the Canada-Nova Scotia Offshore Area - Guidelines for Work Programs, Authorizations and Reports (January 2015)
- Drilling and Production Guidelines (August 2017)
- Environmental Protection Plan Guidelines (March 2011)
- Offshore Physical Environmental Guidelines (September 2008)
- Offshore Waste Treatment Guidelines (December 2010)
- Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands April (2009)
- Safety Plan Guidelines (March 2011)
- Incident Reporting and Investigation Guidelines (April 2018)

A summary of standard mitigation measures which are often applied to offshore oil and gas activities in the Canada-NS offshore area is provided in Table 5-1 below, which also includes an indication of the type(s) of exploration activities to which these would typically apply.

Table 5-1: Summary of Standard Mitigation Measures – Species of Conservation Concern

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Adherence to the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*	•	*•		
Avoidance of known SAR and / or sensitive species and areas and / or times where possible in the planning and conduct of oil and gas activities	•	•	•	
Reduction of airgun source levels in design and implementation of offshore seismic programs to the minimum level practical for the survey, including the amount and	•	•		

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
frequency of energy used and its likely horizontal propagation				
Use of a gradual "ramp-up" procedure over a minimum 20-minute period to allow mobile marine animals to move away from the area if they are disturbed by underwater sound levels associated with a seismic survey	•	•		
Establishment of a safety zone (with a radius of at least 500 m) around the seismic air source array, which is monitored by a qualified Marine Wildlife Observer (or through Passive Acoustic Monitoring in low visibility conditions). Specific protocols regarding observation requirements and times. Shutdown, as required	•	•		
Shutdown of seismic sound source(s) during line changes and maintenance activities with associated monitoring and ramp-up provisions	•			
Minimizing the amount of associated vessel and aircraft traffic. Use of existing and common travel routes where possible. Avoidance of low-level aircraft operations wherever possible	•	•	•	
Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards	•	•	•	
Installation and use of oily water separators to treat contained deck drainage, with collected oil stored and disposed of properly	•	•	•	•
Selection of non-toxic drilling fluids, including the use of WBMs wherever possible and technically feasible		•		

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Treatment of operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids, other waste) prior to release in compliance with the OWTG for Drilling and Production Activities on Frontier Lands and other applicable regulations and standards	•	•	•	
Minimizing use of artificial lighting on offshore vessels and installations, where possible with due regard to safety and associated operational requirements	•	•	•	
Search protocols and procedures for collection and release of marine and migratory birds that become stranded on offshore vessels and installations, using the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC, 2017) and *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms* (ECCC, 2021) as guidance.	•	•	•	•
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. 2012)	•			
Inspections of ship hulls, drilling rigs and equipment for alien invasive species and associated follow-up maintenance. Maximizing use of local vessels, drill rigs and equipment to reduce spread of alien invasive species	•	•	•	
All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and Management Regulations* of the	•	•	•	

Mitigation Measures	Applicability			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Canada Shipping Act (2001) during ballasting and de-ballasting activities.				
Adherence to *ECCC's Guidelines to Avoid Disturbance to Seabird and Waterbird Colonies in Canada*, including maintaining a distance of at least 300 m (or 1 km for highly disruptive activities such as drilling) from active seabird breeding colonies between March and September	•	•	•	•
Avoiding or minimizing flaring, particularly during periods of migratory bird vulnerability. Use of high efficiency burners		•		
Appropriate handling, storage, transportation and onshore disposal of solid and hazardous wastes	•	•	•	•
Hydrocarbon contaminated water generated during flow testing (within certain tolerances), can be atomized in the flare (using high efficiency burners) or shipped onshore for disposal		•		
Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands*	•	•	•	•
Use of mechanical procedures during well completion and abandonment activities where possible, including proactive design of well structures to facilitate this		•		•
Should blasting be required (e.g., in well abandonment), appropriate scheduling of these activities to avoid sensitive times. Setting of charges below the sediment surface. Minimizing the amount of explosives utilized. Use of high velocity explosives. Staggering of individual blasts.		•		

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Pre-drilling seabed surveys to assess potential presence of sensitive benthic habitats (e.g., corals and sponges)		•		
Use of turtle guards to minimize potential for turtle entanglement	•			
Spill prevention plans and procedures, with established and effective spill preparedness and response plans				•

* *Related to components that apply to VSP*

The above list provides examples of typical environmental protection measures which may be implemented to avoid or reduce adverse effects on species of conservation concern, as well as referencing a number of relevant compliance standards which may apply to such activities. Additional measures may be required for particular projects, depending on their specific characteristics, location, timing, environmental settings, and possible effects.

Required mitigation measures are therefore determined on a project-specific basis, through the individual regulatory reviews of proposed exploration programs in the Canada-Nova Scotia offshore area. The use of additional/enhanced mitigation measures beyond the current Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2007) is likely required when conducting seismic operations in waters where cetacean SAR occur.

As a result of the "project-specific" nature of individual offshore programs and their environmental emissions and effects, the regulatory reviews of proposed drilling programs, for example, typically must include an analysis of possible spill types and probabilities, as well as detailed modelling of drill cutting deposition on the seafloor and the likely fate and behaviour of hypothetical oil spills based on project and site specific factors such as hydrocarbon types and properties, water depths and characteristics, currents and other oceanographic conditions. Environmental compliance monitoring (including audits, inspections and reporting on waste discharges, emissions, and treatment systems) is also required to verify adherence to applicable legislation and regulations and any conditions of regulatory approval.

5.1.3 Potential Residual Environmental Effects

Following the implementation of mitigation measures, potential residual environmental effects of offshore oil and gas activities on SOCC and their habitats may be both direct and indirect in nature, and can include the following:

- Though not well understood, possible injury or mortality to fish / invertebrates (particularly immobile species), mammals and turtles due to exposure to underwater sounds such as seismic sound at very close range;
- Possible injury or mortality from interaction between vessels and gear with wildlife (e.g., vessel strikes, entanglement).

- Possible avoidance of locations that would otherwise be used by marine wildlife, due to underwater noise or other disturbances (such as ensonified areas during seismic surveys, drilling activity, vessel traffic), which may affect the presence and abundance of marine animals as well as impact their movements / migration, feeding, communication, reproduction, rearing, nursery or other important activities or areas;
- Attraction of marine wildlife to rigs or vessels and their lighting / flares or other environmental discharges, with increased potential for injury, mortality, contamination or other interactions;
- Interference with (and the masking of) sounds within the marine environment that originate from or are used by marine animals, such as in communication, the identification and detection of prey and other activities;
- Possible contamination of marine wildlife and their habitats or feed sources as a result of environmental discharges due to planned project activities and/or accidental events (such as drill wastes, deck drainage, large spills);
- Possible alteration of benthic habitats due to the discharge and deposition of drill cuttings, placement of other infrastructure or equipment or other activities, as well as possible accidental spills;
- Changes in the availability, distribution or quality of food sources for marine wildlife resulting from offshore petroleum activities and their environmental emissions; and
- Changes in presence, abundance, distribution and/or health of marine species resulting from exposure to accidental spills from offshore exploration or production installations or vessels (through physical exposure, ingestion, effects on prey and habitats, etc.).

Potential effects on marine fish, birds, marine mammals, and sea turtles are discussed in the following subsections.

5.1.3.1 Marine Fish

Table 5-2 identifies, for each potential effect, the project activities that might interact with marine fish and fish habitat and result in the identified environmental effect. These interactions are indicated by a dot and are discussed in detail in Sections 5.1.2.1.1 through 5.1.2.1.4, in the context of effects pathways, standard and project-specific mitigation/enhancement, and residual effects. Marine fish SOCC are detailed in Section 3.2.9. While this current section is focused on species of conservation concern, the assessment and associated mitigation measures would apply to other fish and invertebrate species not of conservation concern (see Section 3.2.6).

Table 5-2: Potential Project Effects on Marine Fish Species of Conservation Concern

Activity	Potential Environmental Effect			
	Change in Risk of Mortality or Injury	Change in Wildlife Presence and Abundance	Change in Habitat Quality or Use	Change in Food Availability or Use
Seismic / Seabed Surveys	●	●	●	●
Drilling / Well Abandonment	●	●	●	●

Vessel / Helicopter Traffic		●		●
Accidental Spills	●	●	●	●

5.1.3.1.1 Seismic and Seabed Surveys

Seismic surveys can be 2D, 3D, or 4D type surveys (used for exploration surveys) or VSP (done to verify a drilled well depth), while seabed surveys are generally done with an ROV or autonomous underwater vehicle (AUV). Seismic surveys make use of airguns to send an echo through the water column. The extent of sound surveys varies significantly based on the topography of a given site, but behavioural effects can extend out to 50 km from the sound source. Other types of surveys such as sidescan sonar (SSS) or multi-beam echosounder (MBES) can cause temporary and minor behavioural effects to fish. As seismic represents a much higher energy sound source, it is the focus of this discussion. This can have effects on fish presence and abundance, habitat quality, food availability and use, and have changes to fish mortality or health.

There are two main components of underwater sound: sound pressure, and particle motion. Sound pressure is measured as pressure fluctuations in the medium above and below the local hydrostatic pressure, and particle motion refers to the back-and-forth motion of the medium. Sound pressure is detected by fish that have air filled spaces, while particle motion is able to be detected by most fishes (lateral line) and all invertebrates (mechanoreceptors) and can be used for directional hearing. For impulsive sounds such as seismic surveys, the use of the sound exposure limit (SEL) and peak levels, as well as cumulative exposure (SEL_{cum}), are commonly used by researchers (e.g., Popper and Hawkins 2016). The majority of fish and invertebrates studied to date appear to be more sensitive to low-frequency sound (<1 kHz) (Popper et al. 2014), though those with swim bladders connected to the inner ear are also sensitive to higher frequencies. Many studies using fish and invertebrates are done in a laboratory setting, where individuals cannot avoid the sound source, though many recent studies have shifted to monitoring of behavioural effects especially as it relates to catch rates of fish.

Popper et al. (2014) provide relative risk criteria ratings based on behavioural effects thresholds for fishes at three qualitative distances from the seismic sound source: (1) near (tens of metres); (2) intermediate (hundreds of metres); and (3) far (thousands of metres). The criterion rating for all fishes at the 'near' distance from the sound source was high relative risk. At intermediate distances from the sound source, the relative risk for fishes without swim bladders and fishes with swim bladders not involved in hearing was moderate, while for fishes with a swim bladder involved in hearing, the rating remained high. At far distances from the sound source, the relative risk for fishes without swim bladders and fishes with swim bladders not involved in hearing was low, while for fishes with a swim bladder involved in hearing, the rating was moderate.

Studies on behavioural effects of fishes exposed to seismic sounds generally show short-term alterations to behaviour that return to baseline after the sound source is removed. Løkkeborg et al. (2012) found that Greenland halibut and redfish were caught more often during and after the removal of sound compared to before exposure possibly due to increased swimming behaviour. Little change was noted for catches of haddock, though pollock catches decreased and were found to have partly left the area after the survey. Pearson et al. (1992) studied the behaviour of capture rockfish exposed to seismic sound and found various degrees of startle and alarm responses. Some species responded by tightening schools, retreating downward in the water column, or with random movements and orientation. Similar results of downward distribution changes and decreased catch rates have been noted for rockfish and Atlantic cod, respectively (Skalski et al. 1992, Løkkeborg and Soldal

1993). Studies of seismic sound on snow crab and shrimp species have found limited behavioural changes overall (Christian et al. 2003, Morris et al. 2018).

The effects on sound on fish health fall into three categories: physiological, non-lethal, and lethal effects. Physiological effects have been shown in many studies and include effects such as increased cortisol (a hormone associated with stress). Sierra-Flores (2015) exposed Atlantic cod to a range of sound pressures, and found rapid increases in cortisol levels, that returned to baseline after 20 to 40 minutes. This study also analyzed the effect of sound on cod eggs, and found increased cortisol levels, and decreased fertilization rate and viable egg productivity. Similar studies on snow crab looking at stress indicators in their haemolymph found no substantial difference in those exposed to various sound pressures (Christian et al. 2003, 2004). Non-lethal effects from fish exposed to sound are typically damage to the inner ear. McCauley et al. (2000a, 2000b, 2003) exposed pink snapper to over 600 seismic air source discharges and found damage to the sensory epithelium of the inner ear in some fish. This damage was still present up to 58 days post-exposure. Similar studies conducted on lobsters found no major effects in either the short or long term (Payne et al. 2015).

Lethal effects from sound are observed within small distances from the sound source, and recent research suggests that eggs and larvae are the most vulnerable stage. Christian et al. (2003) found increased mortality rates and lower development rates in fertilized snow crab eggs exposed to seismic air source sound. McCauley et al. (2017) suggested that mortality was two to three times higher in zooplankton exposed to seismic air source sound, and that effects on zooplankton were observed out to 1.2 km from the sound source. Other similar studies found that mortality of zooplankton was limited to within 25 m of the sound source, and that zooplankton potentially have avoidance behaviour to seismic sound (Richardson et al. 2017, Fields et al. 2019).

The particle motion component of sound is thought to be the major cause of effects, as it essentially equates to shaking an animal (Oak 2020). Particle motion can be carried either through the water or through the substrate, with benthic animals potentially being exposed to both. Sediment-borne particle motion has received little attention, though low frequency waves can travel long distances in this medium (Roberts et al. 2016). In general, these effects would be minimal compared to higher energy seismic sound near the sound source itself, though more research in needed in this area (Oak 2020).

Seabed surveys carried out with ROV or AUV can have direct impacts to the seafloor or release sound for SSS or MBES surveys. The sound energy levels associated with these surveys is much lower than that used in seismic air guns (Oak 2020). ROV surveys can directly contact the seafloor, either through the umbilical, core sampling, or direct grab samples. These can directly damage vulnerable organisms or stir up sediment leading to clogging of gills or filter-feeding organs or smothering of animals (Oak 2020). These effects are localized to the survey area, and minor overall compared to seismic surveys, drilling, or seafloor construction activities.

Overall, changes to fish mortality or injury are limited to fish located near the sound source, with those with swim bladders attached to the inner ear at greater risk out to further distances from the sound source. Changes in fish presence and abundance, and food availability and use may be present multiple kilometers away from the sound source. The effects on most fish species are negligible, or mitigated by avoidance behaviour, as well as the mitigations set out in the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2007).

5.1.3.1.2 Drilling and Well Abandonment

Components associated with drilling exploration and delineation wells that interact with the marine fish and fish habitat for SOCC include the presence of the drilling unit, associated emissions (e.g., sound, light) and routine discharges (e.g., black and grey water, drill cuttings), and seabed interactions (e.g., seabed disturbance, turbidity, sedimentation). Potential changes in risk of mortality or injury, fish presence and abundance, habitat quality or use, and food availability or use may result from presence and operation of a drilling unit.

The presence of a drilling unit in marine waters will often result in a "reef effect" and attract some fish and invertebrate species due to a combination of the physical structure, the safety zone, and light attraction (Picken and McIntyre 1989, Cordes et al. 2016). The safety zone around the drilling unit would be avoided by marine traffic including commercial fishers and therefore provide a refuge area for marine fish (Franks 2000, Keenan et al. 2007, Macreadie et al. 2011, Cordes et al. 2016). Food availability may be affected by attraction of phototaxic phytoplankton species to drilling unit lighting and resulting in attraction of planktivorous species. The addition of lighting may also provide increased foraging opportunities for various species and better lighting for predation (Franks 2000, Cordes et al. 2016). Large piscivorous pelagic species have been observed to be attracted to marine structures including oil platforms and other offshore structures (Franks 2000, Hazin et al. 2005, Hoolihan et al. 2014). Higher abundances of cod, pollock, and mackerel have been observed around offshore platforms in the North Sea (Valdemarsen 1979, Soldal 2002). However, some species such as lanternfish, a forage fish species in the Study Area, may avoid artificial lighting with migration to deeper waters or to areas away from the drilling unit (Peña 2019). Any potential positive effects (e.g., refuge, foraging opportunities) would last for the duration of the presence of the drilling unit and safety zone. Underwater sound emissions from a drilling unit would be continuous from drilling operations and dynamic positioning of the vessel if used. While continuous underwater sound has been observed to result in temporary threshold shifts in fish under laboratory conditions, mobile fish would likely move away from the sound source and potentially reduce exposure levels (Popper et al. 2014). The majority of studies on effects of underwater sound are focused on the sound pressure component that some fishes and no invertebrates are able to detect. Organisms near the seafloor may be sensitive to the particle motion component of sound that all fishes and invertebrates can detect (Oak 2020). Further research is required to assess potential thresholds and extent of particle motion effects from marine activities.

Routine discharges from the drilling installation may include sewage, deck drainage, bilge/cooling water, wash fluids drill cuttings, and other waste. Routine waste discharges are managed in accordance with the OWTG and Offshore Chemical Selection Guidelines (OCSG) that detail acceptable concentrations and treatment for discharge of wastes and a framework for chemical selection to minimize potential environmental impacts (NEB et al. 2009, 2010). Drill cuttings discharge from exploration drilling represents the primary potential adverse effect on marine environments and includes discharge of WBM cuttings near the seafloor and treated SBM cuttings near the water surface. Turbidity effects from near-surface discharges are generally temporary with rapid dilution and dispersal of the drill cuttings with low potential for effect on plankton and other pelagic organisms (Koh and Teh 2011, IOGP 2016). WBM and SBM fluids have low direct toxicity to marine organisms, however, potential injury and mortality effects, reduction of habitat and associated change in food availability may occur for benthic communities from burial, sediment alteration, and creation of anoxic conditions from organic component degradation (Kjeilen-Eilertsen et al. 2004, Smit et al. 2008a, Neff 2010, Ellis et al. 2012, Bakke et al. 2013, DeBlois et al. 2014, Tait et al. 2016, DFO 2019h, Oak 2020). Direct mortality may result from smothering and burial from drill cuttings discharge with benthic organisms unable to penetrate through the deposited layer from underneath. Species living on or near drill cuttings may have lower growth rates from suboptimal conditions (i.e., lower nutrient levels in cuttings deposition areas relative to native sediment) and reduced filter feed from exposure to suspended sediments (e.g., corals, and sponges) (Kjeilen-Eilertsen et al. 2004, DFO 2019h, Oak 2020). Settlement of marine invertebrates may also be reduced through alterations in sediment stability and changes to physical and chemical cues (Pearce and Scheibling 1990, Kjeilen-Eilertsen et al. 2004). Therefore, drill cuttings deposition may result in change in species community composition within the deposition footprint from a combination of these potential effects (Kjeilen-Eilertsen et al. 2004, Bakke et al. 2013, Cordes et al. 2016, IOGP 2016). The extent of drill cuttings deposition is dependent on the volume of cuttings discharged, type of drilling fluid, particle size distribution, oceanographic processes, discharge water depth and flocculant formation (Cordes et al. 2016, Gates et al. 2017). In general, monitoring of regional and global drilling programs indicate the deposition from drill cuttings deposition may be limited to 100s of metres to a kilometre (Cordes et al. 2016, Gates et al. 2017, Stantec 2017, Stantec 2019b, DFO 2020t, Wood 2021). As the drill cuttings discharge is localized, potential population level effects on marine species (e.g., wolffish) may be limited (DFO 2020t).

Direct interactions with the seafloor and placement of subsea infrastructure (e.g., anchors) may result in direct injury and mortality of organisms and short-term turbidity and suspended sediment effects (Heery et al. 2017). Addition of structures may change local community composition with change in local habitat complexity (Bomkamp et al. 2004, Macreadie et al. 2011, Lacey and Hayes 2019). For the duration of subsea infrastructure presence there may be a localized shift from soft bottom communities to communities associated with hard substrates (Cordes et al. 2016). Well abandonment may result in infrastructure remaining on the sea floor (e.g., well head left in place) and result in addition of hard substrate that may result in local faunal community changes as described above. While this results in a change in habitat, the effects would be highly localized in nature. Well abandonment activities would be conducted with ROVs with effects similar to seabed surveys described above.

5.1.3.1.3 Vessel and Helicopter Traffic

Vessel presence directly interacts with the marine environment and therefore may have effects on marine fish and fish habitat. Helicopter traffic is not predicted to interact with marine fish and fish habitat due to the transient nature of flights and distances above the water surface. Two main pathways exist for vessels to affect marine fish and fish habitat: light emissions, and underwater sound. Light emissions can cause avoidance behaviour or attraction in fish and invertebrate species, which leads to a change in their presence or abundance in the area, as well as a change in their potential food availability or use. Similarly, underwater sound can lead to attraction or avoidance behaviours depending on the type of hearing or mechanoreception of a species.

Reaction to light from vessels or helicopters is species-specific and can vary based on competing priorities, and can range from avoidance, no reaction, or attraction to the light source. Lighting may attract phototaxic phytoplankton species and provide increased opportunities for predation by fish and other species (Cordes et al. 2016). Many species that forage at night rely on darkness as camouflage and for predator avoidance and would likely move away from the light source. Lanternfish use photophores to imitate ambient light to reduce visibility to predators and would likely react to light with horizontal or vertical avoidance depending on other environmental effects (Peña 2019). Measurements of acoustic backscatter in the Barents Sea found that, when vessel lights were turned on, species showed avoidance behaviours down to 200 m depth (Berge et al. 2020). Species that undergo diel migrations can be confused by artificial light sources and may forego vertical migrations or foraging. Due to the avoidance or attraction behaviours, food availability may be temporarily altered in the vicinity of the light source, however no change would be noted relative to baseline conditions as prey would relocate and would return after the light source departs. For vessels and helicopters, this source of light is temporary, unlikely to cover a large area, and unlikely to penetrate deep into the water column. Additionally, these effects would only be pronounced at night. These effects are also reversible once the vessel or helicopter leaves the area.

The effects of sound on fish species can vary with the species, life stage, sound frequency, received sound, and type of sound (impulsive vs. continuous). Response to continuous sound from vessel dynamic positioning has shown both attraction (Røstad et al. 2006) and avoidance (Peña 2019) behaviours from different fish species. Attraction to continuous noise has been shown with species such as whiting, herring, and sprat in Norwegian experiments, while startle responses were noted when the vessel shifted positions as this sound can be quite abrupt (Røstad et al. 2006). Other species, such as lanternfish, avoid continuous dynamic positioning noise from vessels, though this effect may be partially from vessel light as well (Peña 2019). These changes in behaviour in potential prey species may affect food availability, but only in the short-term. Long-term exposure to sound can cause damage to fish, but the timescales involved (12 to 24 hours; Popper et al. 2014) are unlikely to be experienced from a vessel source. Overall, sound emissions from vessels would be short term and localized and unlikely to have any long-term non-reversible effects.

5.1.3.1.4 Accidental Spills

Spill effects on marine fish and invertebrates depend on a variety of factors, including: the volume and type of oil, environmental conditions, species and life history characteristics, habitat distribution, behavioural and avoidance responses and time of year. Accidental spill events may have effects on pelagic and benthic species with early life history stages generally considered more sensitive to hydrocarbon exposure (Lee et al. 2015, Sørensen et al. 2017, Laurel et al. 2019). Potential environmental effects on marine fish from accidental spills may include changes in fish injury and mortality from lethal and sublethal effects from hydrocarbon exposures. Oiling of the water column, benthic habitats and nearshore habitats would potentially degrade habitats and change its quality and use. The combination of these effects pathways may further change fish presence and abundance (e.g., avoidance) and food availability and use.

Planktonic species (e.g., phytoplankton, zooplankton) may be affected by direct exposure to hydrocarbons on the water surface and water column and indirectly through reduction of air-water gas exchange and light penetration (Almeda et al. 2013). As tolerances and responses to hydrocarbon exposure may vary by species, accidental releases typically result in a shift in plankton community composition (Jiang et al. 2010). Potential adverse effects on lower trophic levels may influence higher trophic levels. Zooplankton may accumulate oil through ingestion of hydrocarbon contaminated phytoplankton or crude oil droplets with potential mortality, and sublethal effects on growth, development, feeding, and reproduction (Almeda et al. 2014, 2016, Utne 2017, Toxværd et al. 2018). However, zooplankton contain oil-degrading bacteria in their gut that aids in detoxification through fecal pellet extraction (Toxværd et al. 2018). Microbial communities adapted to background levels of hydrocarbons and bacteria that are capable of metabolizing hydrocarbons are able to proliferate quickly in the presence of an oil spill (ASM 2011). Hydrocarbons are degraded into marine "snow" and shuttled to benthic environments where it will continue to degrade (Passow et al. 2012, Daly et al. 2016, Passow 2016). Oil spills would be eventually cleaned up through the combination of physical processes (e.g., evaporation, dissolution, dispersion, and photo-oxidation), and bacterial consumption of hydrocarbon compounds that are biodegradable, typically resulting in end products (under aerobic conditions) of carbon dioxide and water (ASM 2011). Remaining partially degraded hydrocarbons may be toxic to marine organisms but with potential adverse effects less than the original oil components (ASM 2011).

Finfish may be affected through direct physical effects (e.g., coating of gills and suffocation) or more subtle physiological effects (e.g., abnormal gill function, decreased growth, altered enzymatic activity, reduced immune defenses, increased susceptibility to parasite loading, and increased physiological stress, and reproductive alterations) (Khan 1990, Barron 2012, Klinger et al. 2015, Stieglitz et al. 2016, Bayha et al. 2017, Suzuki et al. 2018). Nearshore species and species that spawn nearshore may be at higher risk of repeated exposure where oil is stranded on shorelines (Yender et al. 2002). Oil exposure in coastal environments may potentially have effects on nursery and rearing habitats for fish and invertebrates as well. Early life history stages are generally considered to be at higher risk for potential effects as they have limited avoidance capabilities (Yender et al. 2002). In fish species such as Atlantic cod, haddock, polar cod, Atlantic herring and capelin, increased mortalities, developmental issues, and reduced growth have been observed from exposure to PAHs and dispersed oil to larval stages (Paine et al. 1992, Ingvarsdóttir et al. 2012, Sørensen et al. 2017, Laurel et al. 2019). In southern bluefin and yellowfin tuna eggs and larvae, PAHs exposure (1-15 µg/L total PAH) has been observed to result in reduced growth rates, and various developmental impairments under laboratory conditions (Incardona et al. 2014). Reproductive cycles in Polar cod were altered when fed experimentally contaminated Calanus sp. copepods (0.57 µg crude oil/g fish/d), resulting in lower sperm motility relative to control fish (Bender et al. 2016). Of the concentrations tested (0.11, 0.57, 1.14 µg crude oil/g fish/d) none had effects on gonad and liver health indices or sex steroid levels (Bender et al. 2016). Experimental studies on northern wolffish, a SAR in the region, exposed to crude oil and dispersed (e.g., chemically, mechanically) oil resulted in low mortality rates and lower growth rates relative to control fish five weeks after exposure (Sandrini-Neto et al. 2016). Apex predators such as white shark may be vulnerable to bioaccumulation as sharks frequenting oil shipping routes off South Africa have been observed to have elevated PAH levels (Marsili et al. 2016). Similar trends for toxin bioaccumulation have been observed with white sharks in the Fundy-Gulf of Maine Area, that had higher polychlorinated biphenyls (PCBs) and chlorinated hydrocarbon pesticides relative to other fish (Zitko et al. 1972, COSEWIC 2006b). The health impacts of toxins are not well understood for sharks, and the accumulation of contaminants have been suggested lead to hormone-disrupting effects (Marsili et al. 2016). However, the presence of high concentrations of metals in white sharks off South Africa with no observed negative effects on health suggest that they may have protective mechanisms against heavy metal exposure (Merly et al. 2019). Preliminary work on contaminant and PAH exposure to adult tuna species may cause in reproductive alterations, however, highly mobile adult pelagic species that are capable of long-distance travel may be able to avoid prolonged exposure and reduce potential effects (Fossi et al. 2007, Hazen et al. 2016). Some salmon species have shown some capability for detection and avoidance of contaminated waters (Barnett and Toews 1978, Weber et al. 1981, Alvarez Piñeiro et al. 1996, Stagg et al. 1998).

Oil spill chemical dispersants are designed to break down oil into small droplets, creating a larger surface area for accelerated microbial degradation of spilled oil (ASM 2011, Lee et al. 2013, AORST-JIP 2014, Coelho et al. 2017). Dispersant use on oil spills increases the concentration of more toxic components of oil and increases exposure to species in the water column (e.g., plankton, pelagic fish and invertebrates) and the seabed (e.g., demersal and benthic fish and invertebrates) (Pace et al. 1995, Ramachandran et al. 2004). Oil spill dispersants can impair physiological function of fish (Milinkovitch et al. 2013). Relative to laboratory exposures to undispersed oil and dispersant alone, chemically dispersed oil exposures resulted in lower sperm fertilizing activity in capelin (Beirão et al. 2018). The adverse effects of chemically dispersed oil is also more pronounced in early life stages of fish and invertebrates such as eggs and larvae (Cordes et al. 2016). Greer et al. (2012) observed increased deformities and mortalities for Atlantic herring eggs experimentally exposed to dispersed oil (1 mg/L total hydrocarbons; up to 14-day exposure). Effects from dispersed oil may be species specific with higher adherence of mechanically and chemically dispersed oil to haddock eggs relative to Atlantic cod eggs (Hansen et al. 2018).

5.1.3.2 Marine and Migratory Birds

Table 5-3 identifies the physical activities that may interact with marine and migratory bird SOCC to result in the potential environmental effect, as specified. Interactions are identified in Table 5-3 and are discussed in the following subsections in the context of effects pathways, mitigation and residual effects of each activity on marine and migratory birds.

Table 5-3: Potential Project Effects on Marine and Migratory Bird Species of Conservation Concern

Activity	Potential Environmental Effect			
	Change in Risk of Mortality or Injury	Change in Wildlife Presence and Abundance	Change in Habitat Quality or Use	Change in Food Availability or Use
Seismic / Seabed Surveys				●
Drilling / Well Abandonment	●	●	●	●
Vessel / Helicopter Traffic	●	●	●	●
Accidental Spills	●	●	●	●

5.1.3.2.1 Seismic and Seabed Surveys

Limited information exists on the effects of seismic and seabed surveys and VSP on seabirds in the Northwest Atlantic; however, underwater sound emissions produced by seismic surveys have the highest potential to produce adverse effects. These sound emissions can affect food availability and use (see Section 5.1.1.1.1), and to a lesser extent affect risk of injury and bird presence and abundance.

Available sources indicate there is no evidence that seismic sound significantly influences marine bird behaviour or mortality risk (Davis et al. 1998, MMS 2004, Lacroix et al. 2003). For instance, molting Long-tailed Ducks showed no change in movement or diving behaviour in response to seismic surveys in the Beaufort Sea, although authors noted that the study design did not permit detection of smaller-scale behavioural changes (Lacroix et al. 2003). A study of three species found in the Study Area (Northern Fulmar, Thick-billed Murre, and Black-legged Kittiwake) found no evidence of marine bird mortality or changes in distributions due to seismic surveys in the Davis Strait (Stemp 1985). However, it should be noted that beyond these studies, very limited data exists on interactions between seismic sound and marine birds. Additional studies are necessary to determine the occurrence and magnitude of potential effects. Non-diving birds are unlikely to be affected by underwater sound disturbance. Air guns used in seismic exploration produce a sound that is muffled in air and reduced to a level that does not cause injury or mortality to birds above water. Deep-diving birds (e.g., murres, dovekies, razorbill and Atlantic Puffin) may be at somewhat higher risk of injury or disruption from sound emissions than shallow-diving birds (e.g., Northern Fulmar, shearwaters), as deep-divers spend more time underwater and thus have heighted exposure to potential underwater sound. These species dive from a resting position on the water to forage on fish and invertebrates, reaching depths of up to 180 m and spending up to 40 s underwater at a time (Winkler et al. 2020b). Diving birds typically place their heads under the water suddenly in pursuit of prey and could therefore potentially be exposed to unpredictably high noise levels without the benefit of a steady gradient or associated ramp up procedures.

There are currently no data indicating the underwater sound levels that cause injury to marine birds, although temporary hearing impairment can occur in terrestrial birds exposed to sound in air (Saunders and Dooling 1974). Available evidence suggests that avian hearing underwater is poorer than in air, given that the avian middle ear constricts under the increased pressure associated with diving (Dooling and Therrien 2012). Unlike some other marine mammals, seabirds are not known to communicate vocally underwater and thus heighted auditory sensitivity in water is unlikely to have evolved. An identified exception is the Great Cormorant, a species that responds to underwater sounds and may have special adaptations for hearing underwater (Johnansen et al. 2016, Anderson Hansen et al. 2016, Anderson Hensen et al. 2017). Overall, current evidence suggests negligible effects of seismic sound on marine bird mortality / injury risk and presence and abundance.

Birds are not known to use sound to communicate with each other underwater, so communication masking is not expected to be of concern. Underwater noise may indirectly affect surface-feeding and diving birds through potential changes in the presence, abundance and concentration of prey species (e.g., small fish, invertebrates) that are temporarily displaced during seismic exploration; see Section 5.1.1.1. for details on displacement of marine fish. Due to the transient, short-term nature of seismic surveys, overall effects on migratory and marine birds are expected to be minimal.

5.1.3.2.2 Drilling and Well Abandonment

Components associated with drilling exploration and delineation wells that interact with marine and migratory bird SOCC include the presence of the drilling unit and associated emissions (e.g., lighting and gas flares) and routine discharges (e.g., organic waste, sheens of crude oil). Potential changes in risk of mortality or injury, bird presence and abundance, habitat quality or use, and food availability or use may result from presence and operation of a drilling unit.

Habitat use may be altered by the physical presence of the drilling unit, as birds may be attracted to the structure for roosting (e.g., gulls) and resting (e.g., migrant landbirds). Marine and migratory birds are also known to be attracted drilling units by artificial light sources (e.g., nocturnal lighting, gas flares), though the underlying mechanisms and degree of associated injury and mortality are poorly understood. It has been suggested that artificial lights may be mistaken for celestial cues by seabirds and nocturnally-migrating passerines that rely heavily on visual cues when navigating (Montevecchi 2006, Rebke et al. 2019, Wiese et al. 2001). Another hypothesis is that nocturnally foraging seabirds (e.g., storm-petrels, shearwaters) may mistake reflections of lights on the sea as bioluminescent prey (Montevecchi 2006). Attraction of nocturnal migrants and night-flying seabirds can result in mortality or injury through collisions with facility infrastructure, incineration by gas flares, and predation. Collisions may cause marine birds to become stranded on platforms and die from exhaustion, starvation or hypothermia (Ronconi et al. 2015, Hope Jones 1980, Montevecchi 2006). Direct mortalities from incineration appear to be rare (Hope Jones 1980, Wallis 1981), although birds may be incinerated and not recovered due to scavenging or loss at sea (Ballie et al. 2005, Ellis et al. 2013). Large congregations of smaller birds near drilling units may attract aerial predators (e.g., Great Black-backed Gull), increasing risk of predation. Artificial light often causes birds to become disoriented and circle light sources for extended periods, which can deplete energy reserves, increase predation risk and interfere with migration or foraging activities (Wiese et al. 2001). These risks are heightened in inclement weather conditions (e.g., fog, rain) that reduce visibility and prompt vessel lighting, further increasing disorientation of birds near the platform. The effects of lighting on marine birds may vary greatly by species, life stage, lunar phase, time of year and location of exploratory drilling operations (Montevecchi 2006).

Night-flying birds such as storm-petrels are particularly attracted to lighting and thus have a heightened risk of mortality, injury and/or standing. A recent study summarizing stranded bird encounters identified Leach's Storm-petrel as the most common species found stranded at coastal and offshore industrial sites in Atlantic Canada, with the majority of strandings occurring offshore Newfoundland (Gjerdrum et al. 2021). The higher rates of strandings offshore Newfoundland may be explained by generally brighter light regimes than those onshore and offshore NS, partially due to flaring activities (Gjerdrum et al. 2021). Most individuals were found alive and were subsequently released. Similarly, Leach's Storm Petrels comprised 97% of all recovered birds in an earlier study conducted on offshore installations and vessels in Newfoundland (Ballie et al 2005). Attraction of marine birds to artificial lighting has been observed year-round but occurs most frequently at the end of the nesting season when inexperienced young fledge and adults depart nesting colonies. A recent study onshore in Newfoundland and Labrador found that juvenile Puffins and Leach's Storm Petrels were more likely to strand than adults (Wilhelm et al. 2021). Additionally, strandings were less likely to occur around the full moon (Wilhelm et al. 2021; Gjerdrum et al. 2021). Proponents should conduct searches and have protocols for the collection, release, and reporting of marine birds that become stranded on offshore installations. Searches and protocols should be addressed in project-specific EAs and use the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC 2017) and ECCC's *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms* (ECCC 2021) as guidance.

Routine discharges from drilling units can produce sheens of crude oil, which may have adverse effects on pelagic seabirds by altering feather weight and microstructure (Morandin and O'Hara 2016); see Section 5.1.1.2.4. for details on effects of oiling. Food and sanitary discharges may attract marine birds directly or through attraction of prey sources. As described in Section 5.1.1.1.2, drilling units can have a "reef" effect in which fish and invertebrates are attracted the structure for refuge (Franks 2000, Keenan et al. 2007, Macreadie et al. 2011, Cordes et al. 2016). In turn, the presence and abundance of marine birds may increase due to heightened prey availability. Any energetic benefits associated with increased prey availability will likely be offset by the risks associated with collisions, incineration, and predation around platforms.

Overall, the effects of drilling operations on most migratory birds are expected to be short-term and localized in nature. However, due to their life history characteristics and documented interactions with platforms, seabirds are of comparatively higher risk to adverse effects of drilling activities than other migratory birds. These potentially adverse effects are expected to be minimized by the implementation of stringent mitigation measures and monitoring, including daily systematic surveys as described above. With such implementation, it is not anticipated that these effects will persist after drilling units and associated vessels have vacated the Study Area.

5.1.3.2.3 Vessel and Helicopter Traffic

Components associated with vessel and helicopter traffic that interact with marine and migratory bird SOCC include the presence of vessels/helicopters and associated emissions (e.g., artificial light, sound) and routine discharges (e.g., organic waste, sheens of crude oil). Potential changes in risk of mortality or injury, bird presence and abundance, and food availability or use may result from presence of vessels and helicopters.

Increased vessel presence in the Study Area will increase instances and levels of artificial light, which may attract marine and migratory birds and lead to direct mortality or injury through collision and/or stranding on vessels (see Section 5.1.1.2.2.). In Atlantic Canada, Leach's Storm-petrel is the most found species stranded on vessels (Baillie et al. 2005), though in many cases birds survive if promptly rescued. One study reported that 74 percent of birds stranded on vessels and offshore oil platforms were released, with 3 percent mortality and unreported fates for the remainder (Baillie et al. 2005). To reduce instances of mortality, proponents should conduct searches and have protocols for the collection, release, and reporting of marine birds that become stranded on offshore geophysical and supply vessels. Searches and protocols should be addressed in project-specific EAs and use the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC 2017) and ECCC's *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms* (ECCC 2021) as guidance.

Organic (i.e., food and sanitary) wastes discharged from vessels may attract gulls and other predators, increasing risk of collision, stranding, exposure to contaminants and predation risk for small SOCC such as Red-necked Phalarope and Leach's Storm-petrel. Although attraction is common, some species may be deterred by vessel traffic, causing temporary displacement, loss of available habitat and potentially lost foraging opportunities (Bramford et al. 1990). Vessels may also cause some degree of sound disturbance that may deter birds at sea. However, considering the transitory nature of vessels and existing marine traffic in the region, effects of deterrence and sound disturbance are expected to be minimal.

Possible effects of helicopters and other aircraft on birds include temporary loss of useable habitat, increased energy expenditure due to escape reactions, and lower food intake due to interruptions (Ellis et al. 1991, Komenda-Zehnder et al. 2003). These effects would persist for the entirety of the aircraft's overwater flight path. Additionally, helicopters and vessels may cause sound disturbance to birds at nesting colonies, potentially leading to nest abandonment or exposure of eggs and young to predation (Carney and Sydeman 1999, Bolduc and Guillemette 2003). Sable Island is a nesting location for bird SAR (i.e., Leach's Storm-petrel, Roseate Tern, Ipswich Sparrow) and thus is a high-risk area for such effects. However, buffer requirements for active breeding colonies and other mitigation measures relating to helicopter and vessel use should significantly reduce potential for disturbance (See Section 5.1.3). Due to the anticipated infrequency of helicopter presence and anticipated mitigation measures, adverse effects on marine and migratory birds are expected to be minimal.

5.1.3.2.4 Accidental Spills

Marine Birds have a high risk of oiling and are extremely vulnerable to the effects of oil spills and blowouts. Potential changes in risk of mortality or injury, bird presence and abundance, and food availability or use may result from an accidental spill, though the degree of these effects would vary greatly by species, environmental conditions, time of year and the location, volume and type of spill. High-risk species include those that spend a considerable time resting or foraging on the water surface (Wiese and Robertson 2004, Boertmann and Mosbech 2011) and feed on organisms from high-risk areas (e.g., water surface, benthos) (Engelhardt 1983). Depending upon project and area specific factors, coastal birds inhabiting beaches and intertidal zones may also be at risk.

Oil easily absorbs into feathers, which can decrease the ability of birds to thermoregulate and maintain buoyancy (Morandin and O'Hara 2016). Oiling of feathers can cause physiological changes such as increased metabolic rate to compensate for heat loss (i.e., increased energy expenditure), and behavioural changes such as excessive preening at the expense of foraging opportunities or attending to nests/young. Ultimately, these changes can lead to death by exhaustion, hypothermia, drowning and starvation, and/or reduce reproductive output, both of which could have population-level effects for SOCC. Petroleum products may be ingested from preening of contaminated feathers, or consumption of contaminated prey items. Ingestion can have lethal and sublethal effects (McEwan and Whitehead 1980); including damage to the liver (Khan and Ryan 1991), pneumonia (Hartung and Hunt 1966), brain damage (Lawler et al. 1978) and immunotoxic effects (Barron 2012). In addition to direct contamination of prey, accidental spills may have indirect effects on birds through changes in habitat quality and in the presence, distribution, and abundance of prey items, especially those that are surface-dwelling (see Section 5.1.1.1.4)

Vessels produce chronic, small scale oil discharges that can be a source of seabird mortality through cumulative effects (Wiese and Robertson 2004). An estimated 74 marine oil discharge events were likely responsible for the oiling of the 2343 seabird corpses recovered on Sable Island between 1996-2005, indicating that oil discharges from vessels can increase bird mortality risk in the Study Area (Lucas and MacGregor 2006). Of the recovered corpses, most oiled birds were alcids (e.g., Thick-billed Murre, Common Murre, Dovekie).

Sable Island has been monitored sporadically for oiled birds since 1970, when corpses were reported following the grounding of a coastal tanker Arrow that released bunker-C into Chedabucto Bay, NS (Brown et al. 1973, Lucas et al. 2012). More intensive studies were conducted from 1993-2009 as part of the Environmental Effects Monitoring Programs for oil and gas activities in the region (Lucas and MacGregor 2006, Lucas et al. 2012 Wilhelm et al. 2009). These studies found higher incidents of oiling in winter than summer, and in alcids (e.g., Thick-billed Murre, Common Murre, Dovekie) compared to other marine birds. In recent years, there has been a decline in oiling rates of marine birds on Sable Island (Lucas et al. 2012), possibly due to strengthening of laws, enforcement and regulations regarding waste management practices, illegal dumping and oil spill prevention at sea (Lucas et al. 2012).

Within the Study Area, large numbers of birds may congregate at certain times of year (e.g., prior to migration) or around productive areas (e.g., upwellings of Scotian Shelf). A spill near an area of congregation could have significant, long-term effects on a population. Due to the highly mobile nature of marine birds, effects of oiled areas may also be transferred great distances from the spill site (Henkel et al. 2012).

5.1.3.3 Marine Mammals and Sea Turtles

Table 5-4 identifies the potential interactions that may occur between specific activities and marine mammal and sea turtle species of conservation concern. Interactions are indicated by dots and are discussed in the following subsections in the context of effects pathways, mitigation, and residual effects of each activity on these species.

Table 5-4: Potential Project Effects on Marine Mammal and Sea Turtle Species of Conservation Concern

Activity	**Potential Environmental Effect**			
	Change in Risk of Mortality or Injury	**Change in Wildlife Presence and Abundance**	**Change in Habitat Quality or Use**	**Change in Food Availability or Use**
Seismic / Seabed Surveys	●	●	●	●
Drilling / Well Abandonment	●	●	●	●
Vessel / Helicopter Traffic	●		●	
Accidental Spills	●	●	●	●

5.1.3.3.1 Seismic and Seabed Surveys

There are several aspects to seismic and seabed surveys and VSP that could have an impact on the marine environment including increased vessel traffic, towed equipment, and introduced noise. Seismic and seabed surveys, and to a lesser extent VSP, introduce changes to the underwater acoustic environment that could impact marine species. Introduced noise levels in the marine environment can disrupt or alter how marine animals use their habitat and could cause physical harm (Weilgart 2007). Marine mammals rely on echolocation for navigation and communication. Ship noise and seismic arrays can overlap with the sound frequency range of many marine mammal species, masking these calls and inhibiting individual's ability to forage, navigate, or communicate with each other (Lawson and Lesage 2013). Increases in environmental noise levels may cause direct and indirect affects in marine mammals which include avoidance response, a temporary threshold shift, change in vocalization patterns, generalized stress (Southall et al. 2007, Wright et al. 2007, Lawson and Lesage 2013). In the presence of increased noise, North Atlantic right whales will change their short-term calling behaviour by increasing the amplitude of their calls (Parks et al. 2011). During seismic surveys, blue whales have been noted to emit more feeding and social calls during survey days (Di Iorio and Clark 2010). Indirect effects from seismic surveys on marine mammals include impacting the local food web. Animals within close proximity to an active sound source have the potential to be physically injured. McCauley et al. (2017) observed increased mortality in adult and larval zooplankton (krill) following air gun signal exposure. The effects of seismic surveys on sea turtles is largely unknown with few research studies on this taxa regarding the impacts from anthropogenic underwater sound (Nelms et al. 2016, Williams et al. 2015). Vessel traffic during surveys have the potential to impact sea turtles (see Section 5.1.1.3.3).

Seismic surveys conducted in ice-free waters in Canada must adhere to protocols outlined in the SOCP. The SOCP outlines specific monitoring and mitigation procedures for all activities during a survey including before the survey starts, during the survey, during maintenance and testing of the sound source, and if any biological shutdowns are required. Mitigations during seismic surveys include but are not limited to, establishment of a safety zone around the sound source, monitoring of the safety zone by qualified marine mammal observers (visually and acoustically), shut-down protocols, using the minimal power to achieve project goals. Current seismic mitigations in Canada pertain to all SARA Schedule 1 species, which include whales (i.e., blue, fin, North Atlantic right, northern bottlenose (Scotian Shelf Population), Sowerby's beaked) and sea turtles (i.e., leatherback and loggerhead).

5.1.3.3.2 Drilling and Well Abandonment

As with other activities, drilling and well abandonment could impact marine mammals and sea turtles. During drilling and well abandonment impacts associated with increased vessel traffic, acoustic disturbance, and accidental releases could occur. Environmental effects associated with drilling wells includes disturbance from vessel and aircraft activities, potential collisions with vessels, pollution from trash and debris, oil and gas leaks, and artificial reef effects. Drilling operations require vessel and helicopter traffic which can adversely affect marine species from vessel strikes (van der Hoop et al. 2013, see Section 5.1.1.3.3). Well abandonment involves the permanent capping of the well. Oil and gas spills or leaks are possible during abandonment operations. These accidental releases could adversely affect marine species such as whales and sea turtles (NOAA 2020b, see Section 5.1.1.3.4). If seismic surveys are required or if the level of sound produced during well abandonment requires species monitoring, operators will implement the procedures outlined in the SOCP (Section 5.1.1.3.1).

5.1.3.3.3 Vessel and Helicopter Traffic

Vessel traffic is of concern due to possible interactions with marine species. Slow moving animals and wildlife that frequently linger at the sea surface (e.g., whales and sea turtles) are at risk of being struck by vessels. Vessel strikes are one of the leading causes of mortality for several endangered whales in the region including the North Atlantic right whale (COSEWIC 2013, van der Hoop et al. 2013). Injuries from vessel strikes may include lethal blunt force trauma, severe lacerations, broken bones, and internal bleeding (Kraus et al. 2005, Fujiwara et al. 2001). However, Kelley et al. (2021) indicates that blunt force trauma mortality to whales cannot be attributed to any single condition. While more severe injuries occur with strikes from larger vessels (>20 m), collisions with smaller vessels (<20 m) can still lead to serious injuries (Kelley et al. 2020). The mortality of even a few individuals can impede the recovery of these populations (Moor et al. 2004, Campbell-Malone et al. 2008). Sea turtles also have increased risk of mortality when impacted by a vessel. Vessel strikes cause lacerations and blunt force trauma (Foley et al. 2019). A strike can cause buoyancy disorders such as large air bubbles in the carapace that prevents the turtle from diving and foraging for food (Jacobson 1998). Reductions in vessel speed can reduce the likelihood of a marine mammal / sea turtle-vessel interaction. Vessel speed reductions have been shown to reduce vessel-strike mortality for many large whale species in other parts of their ranges (van der Hoop et al. 2012, van der Hoop et al. 2015). However, biophysical models of vessel strikes on whales suggest that even reduced vessel speeds of 10 knots may result in lethal injuries to whales (Kelley et al. 2021).In 2021, Transport Canada has enacted measures in the Gulf of St. Lawrence to reduce the risk of vessel strikes (TC 2021). There are currently no restrictions issued for the Study Area, however all vessel strikes with marine mammals and sea turtles must be reported to DFO within the required timeframe. Additionally, local authorities encourage reporting any marine mammal sightings to applications (e.g., WhaleMap) to alert other mariners of their presence and to avoid them if possible (Johnson 2018).

5.1.3.3.4 Accidental Spills

Marine mammals and sea turtles can be affected by accidental spills of hydrocarbons or other chemicals. An accidental spill can occur at any point during the lifetime of a well (e.g., initial drilling, operation, and abandonment). Impact to the environment from a spill depends on the amount spilled, how far contaminants spread, the time of year, and duration the oil is in the water. Exposure can cause direct and indirect affects including increased risk of injury, disease, and mortality in marine species (NOAA 2020). Food sources can become effected as well. Spills such as the Deepwater Horizon have afforded stakeholders the opportunity to examine these impacts on marine mammals and sea turtles (NOAA 2020). Spilled contaminants can build up on animal's bodies restricting their movements and enter the body when accidentally inhaled or ingested (Takeshita et al. 2017, NOAA 2020). Within the Study Area, the main concern for marine mammals and sea turtles are accidental inhalation of toxins and possible ingestion (Takeshita et al. 2017). Long-term effects (e.g., impaired health, population impacts) have been observed in marine mammals 20 years following the Exxon Valdez spill in 1989 (Helm et al. 2015) and in loggerhead sea turtles following the Deepwater Horizon spill (Lauritsen et al. 2017). Risk-based conceptual frameworks for assessing oil spill impacts to marine mammals are in development for other regions of Canada (Rosenberger et al. 2017).

5.1.4 Environmental Planning Considerations

Several SOCC, including marine and land birds, marine and diadromous fish, marine mammals and sea turtles may occur seasonally or year-round in the Study Area. Planning considerations for each of these groups are discussed in the following subsections.

5.1.4.1 Marine Fish

Marine fish are present in the Study Area throughout the year, with many species moving in and out of the area at different times according to their life histories, habitat preferences and seasonal activities. An overview of the distribution and seasonal occurrence of key marine fish species in the region is presented in Section 3.2.6.

Various fish species designated as being at risk (and which are formally protected) under SARA are known or likely to occur in the Study Area, including several species of wolffish as well as the white shark and the inner Bay of Fundy salmon (see Table-13).

Three wolffish species that occur in Atlantic waters are designated as being at risk. These include northern (SARA: Threatened), spotted (SARA: Threatened), and Atlantic (SARA: Special Concern) wolffish (COSEWIC 2012a, 2012b, 2012c). The SARA designations are currently under consideration for status change. These species have undergone steep declines in abundance and range since the 1980's, largely due to by-catch mortality with a small upward trend since the 1990's. These species are typically slow-growing and long-lived which are characteristics that limit potential recovery from anthropogenic stressors such as by-catch mortality and habitat disturbance (COSEWIC 2012a, 2012b, 2012c). Egg clusters are laid by Atlantic and spotted wolffish on the seafloor and are guarded by adults. The pelagic larvae are typically concentrated over continental slopes and are thought to consume zooplankton (COSEWIC 2012a, 2012b). Northern wolffish likely have a similar life history, although, this is less well known (Kulka et al. 2004). Atlantic and spotted wolffish primarily feed upon benthic invertebrates, whereas northern wolffish that generally occupy the water column feeds mainly on pelagic fish and invertebrates. Atlantic wolffish generally inhabits >100 m water depths with peak abundance at >250 m and spotted wolffish inhabits water depths of 200-750 m (COSEWIC 2012a, 2012b). Northern wolffish are a more pelagic species with a wider water depth range (38-1,504 m) (COSEWIC 2012c). The wolffish recovery strategy and management plan outlines potential threats to wolffish species including offshore oil and gas exploration and production. While there may be potential adverse environmental effects from operational discharges, the potential effects are suggested to be localized and minor at the population level (DFO 2020t). The potential effects of seismic activity on larval wolffish is suggested to be minimal, however potential disturbance and behavioural effects are largely unknown (DFO 2020t). Critical habitat has been established for Northern and Spotted wolffish in the Newfoundland and Labrador Offshore region and Laurentian Channel with no critical habitat established in the Study Area (DFO 2020t). No critical habitat has been established for the Atlantic wolffish. Within research trawl areas in the Study Area, (primarily Scotian Shelf) wolffish abundance for all three species is low (Ward-Paige and Bundy 2016).

White shark abundance has been estimated to have steeply declined in the North Atlantic and have been designated as "endangered" (SARA; COSEWIC 2006b). White sharks are seasonal migrants to Canadian waters, primarily from June to February (Bastien et al. 2020). Recent research has indicated high site fidelity with multiple sharks returning to the Maritime region over multiple years (Bastien et al. 2020). Increased detection of these species to Canadian waters, including the Study Area may be due to increased tracking efforts, population recovery, range expansion from warmer waters, or due to increasing prey abundance (e.g., seals) (Lucas and Natanson 2010, Bastien et al. 2020). Bycatch mortality from pelagic long-line fisheries remains a main threat to this species (COSEWIC 2006b, Bastien et al. 2020). Information on potential environmental effects from oil and gas activities on white sharks is generally limited, however as apex predators are able to bioaccumulate high levels of contaminants (Zitko et al. 1972, COSEWIC 2006b, Marsili et al. 2016, Bastien et al. 2020).

The inner Bay of Fundy (iBOF) Atlantic salmon population is listed as Endangered under COSEWIC and SARA. Atlantic salmon are anadromous species that spawn in freshwaters and migrate to marine waters for feeding and growth as they age. In marine waters, Atlantic salmon live a primarily pelagic life style. After a few years at sea, adults return to their natal rivers to spawn (COSEWIC 2010c). While the declines in iBOF salmon abundance and current low recovery are not well understood, it may be due to a combination of historical effects on freshwater habitats and low marine survival (DFO 2019i). Changes in regional productivity on the Scotian Shelf may also have had effects fish condition and community structure and therefore limit recovery potential (COSEWIC 2010c). The iBOF salmon are thought to overwinter in the Bay of Fundy / Gulf of Maine suggesting they are unlikely travel through the Study Area.

Several other species in the Study Area have also been evaluated and designated by COSEWIC, but are not currently protected under SARA. In many cases, these species occur in expected habitat zones during some seasons and/or have somewhat predictable migrations. For example, American eel adults migrate directly on the continental shelf and then open ocean towards the Sargasso Sea for spawning (Béguer-Pon et al. 2015). Various other COSEWIC-listed species aggregate for migration and spawning (e.g., Atlantic cod) or are restricted to limited areas).

The ecosystem of the eastern Scotian Shelf has changed and continues to do so. Fishing activity over many years has caused a trophic shift over the last 30 years that may not yet be stabilized, and consequently, the ecosystem may have somewhat less of a buffering capacity to potential stressors (Bernier et al. n.d., Choi et al. 2005). Climate change also has a compounding effect on marine fish communities, with climate-driven shifts in the presence, abundance and distribution of marine fish species throughout the general region (Bernier et al. 2020, Benoit and Swain 2008).

A wide range of marine species occur within the Study Area, occupying different habitats at various times throughout the year. Various areas of the Scotian Shelf have been identified as EBSAs for their significance to marine life. EBSAs in the Study Area are discussed in further detail in Section 3.2.10.

Five EBSAs within the Study Area are described as of importance to SOCC (King et al. 2016). Several of these areas were identified wholly or partly due to their significance to marine fish and other species, including SAR (Table 3-26).

5.1.4.2 Marine and Migratory Birds

Marine birds are present in the Study Area throughout the year, with many species moving in and out of the area at different times according to their characteristics, habitat preferences and seasonal activities. Existing and available information on the presence and geographic and seasonal occurrence of marine-associated avifauna in and near the region is presented in Section 3.2.7. One EBSA within the Study Area is described as of importance to a bird SOCC (Table 5-5).

Various bird species designated as being at risk (and are formally protected) under SARA and/or the NSESA are known or likely to occur in the Study Area. These include the Ipswich Sparrow, Leach's Storm Petrel, Red-necked Phalarope, and Roseate Tern. There are an additional four species that are not listed on SARA or NSESA but are designated as "Threatened" by the IUCN, including Atlantic Puffin, Bermuda Petrel, Black-capped Petrel, Black-legged Kittiwake, Razorbill, Sooty Shearwater, White-faced Petrel, and Zino's Petrel. An additional two species are designated as "Near Threatened" by the IUCN, including Fea's Petrel and Sooty Shearwater. These species have the potential for negative interactions with projects in the Study Area for at least some part of the year. Refer to Table 3-15 for information on the timing, distribution, and abundance of marine bird SOCC in and near the Study Area. Project components with the greatest potential to produce negative effects include artificial lighting (including gas flares), potential accidental spills, and discharges of oil and organic wastes from drilling units and vessels.

Vagrant and rare SAR identified in Table 3-15 that do not inhabit the offshore environment or only migrate over the ocean in the daytime (and are therefore unlikely to be affected by attraction to artificial marine lighting), are considered unlikely to be affected by petroleum exploration and so were not assessed. Other SAR or SOCC that may occur infrequently in the Study Area but are not considered here include the Barrow's Goldeneye, Harlequin Duck, Ivory Gull, Piping Plover and Red Knot.

A key area for marine bird species of special status within the Study Area is Sable Island, which is designated as an Important Bird Area (IBA #NS025) and a Migratory Bird Sanctuary. The island constitutes important nesting habitat for Leach's Storm Petrel and critical nesting habitat for Ipswich Sparrow and Leach's Storm-petrel. These species breed on the island from April to October. The Ipswich Sparrow does not occur offshore except during its non-stop migratory flight to and from mainland Nova Scotia. Roseate tern and Leach's Storm-petrel are likely present in offshore waters of the Study Area on foraging trips during the breeding season, as well as prior to and after migration from southern wintering areas. Red-necked Phalarope breed in the low Arctic and winter in tropical and subtropical areas, occurring in the Study Area only during migration. This species is present offshore from April to June and August to October, with higher likelihood of occurrence during fall migration. Project activities occurring in winter would be of lower risk to marine and migratory bird SOCC than other seasons, as these species are unlikely to be present in the Study Area during this time.

5.1.4.3 Marine Mammals and Sea Turtles

The Study Area is a key area for resident (e.g., present year-round) and migratory marine mammals and sea turtle species. Existing available information on the occurrence, distribution, and habitat use of these species is presented in Section 3.2.8. The Gully MPA and three EBSAs within the Study Area are described as of importance to marine mammal and sea turtle SOCC (Table 5-5).

Seven marine mammal and sea turtle species designated at risk under SARA, and three marine mammal species designated under COSEWIC are associated with the Study Area. Species designated under SARA include blue whale, North Atlantic right whale, fin whale, northern bottlenose whale (Scotian Shelf Population), Sowerby's beaked whale, leatherback sea turtle and loggerhead sea turtle. Locations within the Study Area has been identified as important habitat for several of the SARA species and could be affected by project related activities. Refer to Table 3-16 for species occurrence, distribution, and time of year presence. Within the Study Area, The Gully MPA is a key area for marine mammals and sea turtles. The area is important for foraging and there are resident populations of SARA species. Project activities with the greatest potential to produce negative effects include vessel traffic, introduced sound (e.g., seismic surveys), potential accidental spills or waste discharges (oil and organic), and debris from drilling units and support vessels.

Other resident or migratory marine mammal and sea turtle SOCC are not considered in this effects assessment. The species, designated as "endangered" or "special concern" under COSEWIC, are the sei whale, killer whale, and harbour porpoise. The occurrence of these species in the Study Area is considered seasonal or rare. However, potential effects discussed for SARA species (Section 5.1.1.3) are also of concern for these species. Implementation of mitigation that reduces or eliminates environmental effects on SOCC would also mitigate effects on these species.

Project activities that occur in the late spring to late fall have the highest likelihood of impacting marine mammals and sea turtles. This time of year has the highest occurrence of detections for all marine mammal and sea turtle species that may occur in the Study Area. Project activities that occur in the winter and early spring have the lowest risk associated with these species.

5.2 Protected and Special Areas

Various marine and coastal areas of Nova Scotia have been identified as protected and special areas (Section 3.2.10). Some of these areas are formally protected under provincial or federal legislation or designated through other processes due to their ecological, biological and / or socio-cultural characteristics. Others have been identified as sensitive to certain types of activities (e.g., bottom fishing) but do not have formal protection. Protected and special areas in the Study Area are identified, illustrated and described (to the extent that information is available) in Section 3.2.10.

The focus of this VC is those protected and special areas in the Study Area (Table 5-5) and the potential for interactions and effects from oil and gas exploration activities. These areas have been identified based on sensitive species including marine fish, marine and migratory birds and marine mammals and sea turtles and their habitats.

Table 5-5: Summary of Protected and Special Areas in the Study Area

Protected or Special Area	Species Group and / or Habitat Type
The Gully MPA	Marine mammals Marine fish and invertebrates Benthic habitat Marine and migratory birds
Western / Emerald Banks Conservation Areas (restricted fisheries zone) Marine Refuge	Marine fish and invertebrates Benthic habitat
SARA Critical Habitat: Critical Habitat for Northern Bottlenose Whale (Scotian Shelf Population) Important Habitat for Blue Whale (Northwest Atlantic Population) Important Habitat for Leatherback Sea Turtle (Atlantic Population) Critical Habitat for Ipswich Sparrow Critical Habitat for Roseate Tern	Marine mammals and sea turtles Marine and migratory birds
Sable Island MBS	Marine and migratory birds
Sable Island National Park Reserve	Marine mammals Marine migratory birds Terrestrial mammals Coastal and intertidal species Human history
Haddock Nursery Area	Marine fish Benthic habitat
EBSAs: Emerald Basin and the Scotian Gulf	Marine fish and invertebrates Benthic habitat

Protected or Special Area	**Species Group and / or Habitat Type**
Emerald Western-Sable Island Bank Complex Sable Island Shoals Eastern Scotian Shelf Canyons Middle Bank Scotian Slope	Marine mammals Marine and migratory birds
SiBAs: Sponges Sea Pens Large Gorgonian Corals Small Gorgonian Corals	Benthic species and habitat
Sable Island, Nova Scotia Important Bird Area	Marine and migratory birds

5.2.1 Potential Environmental Interactions

Environmental interactions between offshore oil and gas exploration activities and protected and special areas may be direct or indirect. The conduct of oil and gas exploration activities directly within or near such areas may have adverse implications for these locations and the important and sensitive characteristics for which they have been identified and / or protected. These interactions may occur through presence of oil and gas exploration or production equipment, personnel and activities in the area, as well as associated routine emissions and resulting disturbances that may occur in nearby environments.

The main activities and associated environmental disturbances for protected and special areas that may be associated with potential offshore petroleum exploration activities in the Study Area include:

- Presence and movement of drill rigs / platforms or survey vessels and other supporting ships;
- Underwater sound generated by exploration activities (e.g., during seismic surveying, seabed sampling, offshore drilling) including its introduction to and transmission through the marine environment;
- Direct interaction with the seabed from surveys, sampling, drilling and well abandonment;
- Drill wastes and discharge and deposition of drill cuttings;
- Lighting on drilling platforms, seismic or support vessels and on-board equipment;
- Generation of solid and liquid waste materials and their management; and
- Other oil and gas activity related noise (vessels, aircraft) and air emissions (engine exhausts);
- Potential accidental spills or the loss of material / equipment into the marine environment.

5.2.2 Environmental Mitigation Measures

This section provides an overview of standard and typical mitigation measures that are often required and / or otherwise implemented during offshore oil and gas activities to reduce or eliminate adverse environmental effects on marine fish, birds, mammals and sea turtles that may be present in protected and special areas. The CNSOPB has published guidelines that include various requirements and other measures related to environmental planning, mitigation, monitoring and reporting intended to help reduce or eliminate potential effects of offshore exploration activities. These include the following (available through the CNSOPB's website):

- Geophysical and Geological Programs in the Canada-Nova Scotia Offshore Area - Guidelines for Work Programs, Authorizations and Reports (January 2015)
- Drilling and Production Guidelines (August 2017)
- Environmental Protection Plan Guidelines (March 2011)
- Offshore Physical Environmental Guidelines (September 2008)
- Offshore Waste Treatment Guidelines (December 2010)
- Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands April (2009)
- Safety Plan Guidelines (March 2011)
- Incident Reporting and Investigation Guidelines (April 2018)

A summary of standard mitigation measures often applied to offshore oil and gas activities in the Canada-Nova Scotia offshore area is provided in Table 5-6 below, which also includes an indication of the type(s) of exploration activities to which these would typically apply.

Table 5-6: Summary of Standard Mitigation Measures – Protected and Special Areas

Mitigation Measures	Applicability			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Adherence to the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*	•	* •		
Avoidance of known SAR and / or sensitive species and areas and / or times where possible in the planning and conduct of oil and gas activities	•	•	•	
Reduction of airgun source levels in design and implementation of offshore seismic programs to the minimum level practical for the survey, including the amount and frequency of energy used and its likely horizontal propagation	•			
Use of a gradual "ramp-up" procedure over a minimum 20-minute period to allow mobile marine animals to move away from the area if they are disturbed by underwater sound levels associated with a seismic survey	•			

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Establishment of a safety zone (with a radius of at least 500 m) around the seismic air source array, which is monitored by a qualified Marine Mammal Observer (or through Passive Acoustic Monitoring in low visibility conditions). Specific protocols regarding observation requirements and times. Shutdown, as required	•			
Shutdown of seismic sound source(s) during line changes and maintenance activities with associated monitoring and ramp-up provisions	•			
Minimizing the amount of associated vessel and aircraft traffic. Use of existing and common travel routes where possible. Avoidance of low-level aircraft operations wherever possible	•	•	•	
Minimizing environmental discharges and emissions from planned operations and activities, including compliance with relevant regulations and standards	•	•	•	•
Installation and use of oil water separators to treat contained deck drainage, with collected oil stored and disposed of properly	•	•	•	•
Selection of non-toxic drilling fluids, including the use of WBMs wherever possible and technically feasible		•		
Treatment of operational discharges (such as sewage, deck drainage, bilge / cooling water, wash fluids, other waste) prior to release in compliance with the OWTG and other applicable regulations and standards	•	•	•	
Minimizing use of artificial lighting on offshore vessels and installations, where possible with due regard to safety and associated operational requirements	•	•	•	

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Search protocols and procedures for collection and release of marine and migratory birds that become stranded on offshore vessels and installations, using the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC, 2017) and *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms* (ECCC, 2021) as guidance	•	•	•	•
Inspections of ship hulls, drilling rigs and equipment for alien invasive species and associated follow-up maintenance. Maximizing use of local vessels, drill rigs and equipment to reduce spread of alien invasive species	•	•	•	
All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act* (2001) during ballasting and de-ballasting activities.	•	•	•	
Adherence to *ECCC's Guidelines to Avoid Disturbance to Seabird and Waterbird Colonies in Canada*, including maintaining a distance of at least 300 m (or 1 km for highly disruptive activities such as drilling) from active seabird breeding colonies between March and September	•	•	•	•
Avoiding or minimizing flaring, particularly during periods of migratory bird vulnerability.. Use of high efficiency burners		•		
Appropriate handling, storage, transportation and onshore disposal of solid and hazardous wastes	•	•	•	•

Mitigation Measures	**Applicability**			
	Seismic / Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Hydrocarbon contaminated water generated during flow testing (within certain tolerances), can be atomized in the flare (using high efficiency burners) or shipped onshore for disposal		•		
Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands*	•	•	•	•
Use of mechanical procedures during well completion and abandonment activities where possible, including proactive design of well structures to facilitate this		•		•
Should blasting be required (e.g., in well abandonment), appropriate scheduling of these activities to avoid sensitive times. Setting of charges below the sediment surface. Minimizing the amount of explosives utilized. Use of high velocity explosives. Staggering of individual blasts		•		
Pre-drilling seabed surveys to assess potential presence of sensitive benthic habitats (e.g., corals and sponges)		•		
Use of turtle guards to minimize potential for turtle entanglement	•			
Spill prevention plans and procedures, with established and effective spill preparedness and response plans				•

* *Related to components that apply to VSP*

5.2.3 Potential Residual Environmental Effects

Protected and special areas have been identified for the presence of sensitive species and habitats. Thus, the effects assessment is focussed on potential effects of offshore oil and gas activities on marine species and habitats, such as those found in protected and special areas in the Study Area (Table 5-7). To a much lesser extent protected and special areas in the Study Area are identified for human use (e.g., conservation of historical aspects or protection from fishing activities). Exploration activities are not anticipated to affect socio-cultural aspects of protected and special areas in the Study Area (other human uses of the marine environment are discussed in Section 5.3.2). Potential effects on protected and special areas include:

- Exposure to underwater sounds such as seismic sound at close range (particularly for immobile species);
- Disturbance to marine species due to underwater noise or activities that may affect their movements / migration, feeding, communication, reproduction, rearing, nursery or other important activities or areas;
- Interference with (and the masking of) sounds that originate from or are used by marine animals, such as in communication, identification and detection of prey and other activities;
- Attraction of marine species to rigs or vessels and their lighting / flares or other environmental discharges, with increased potential for injury, mortality or contamination;
- Possible contamination of marine wildlife and their habitats or feed sources resulting from discharges (e.g., deck drainage);
- Possible injury or mortality of benthic species or alteration of benthic habitats due to seabed surveys, discharge and deposition of drill cuttings, drilling, placement of other infrastructure or equipment or other activities; and
- Changes in presence, abundance, distribution and / or health of marine species resulting from exposure to accidental spills from offshore exploration or production installations or vessels.

Table 5-7: Potential Project Environmental Effects on Protected and Special Areas

Activity	**Potential Environmental Effect**
	Changes in Environmental Features and / or Processes
Seismic / Seabed Surveys	•
Drilling / Well Abandonment	•
Vessel / Helicopter Traffic	•
Accidental Spills	•

5.2.3.1 Seismic and Seabed Surveys

The potential effects of seismic and seabed surveys on protected and special areas mainly relate to potential disturbance and injury effects on mobile marine fish species, benthic habitats, marine and migratory birds and marine mammals and sea turtles (Table 5-6). Thus, the effects of seismic and seabed surveys on protected and special areas are similar to those on species of conservation concern. As discussed in Sections 5.1.1.1, 5.1.1.2. and 5.1.1.3, mitigations set out in the SOCP may include establishment of a safety zone around the sound source, visual and acoustic monitoring of the safety zone, shut-down protocols, and using the minimal power to achieve project goals. Seabed surveys that interact with the seafloor (e.g., coring, sediment sampling) are typically highly localized in nature. However, recovery rates would be slow for individual coral and sponges injured from seabed interactions (Cordes et al. 2016). Given the anticipated mitigations and due to the transient, short-term nature of seismic and seabed surveys, any residual effects on protected and special areas are expected to be minimal.

5.2.3.2 Drilling and Well Abandonment

For protected and special areas, the potential effects of drilling and well abandonment mainly relate to effects on marine species. Effects on marine fish, benthic habitats, marine and migratory birds and marine mammals and sea turtles are discussed in Sections 5.1.1.1, 5.1.1.2. and 5.1.1.3. In summary, these sections indicate that the potential effects on marine fish, marine and migratory birds and marine mammals and sea turtles can be addressed through compliance with legislation and adherence to best practices. However, the presence of sensitive benthic species (not at risk) in protected and special areas in the Study Area warrants additional consideration in this section.

Drilling and well abandonment have the potential to directly interact with the seabed including possibly with sensitive benthic habitats. Coral and sponge communities, which provide important biogenic habitat, are vulnerable to drilling that may cause injury or mortality. Additionally, release of drill cuttings and discharges may result in suspended sediments that can clog filter feeding organs, or smother organisms, in addition to potential toxicity of drilling mud. While corals and sponges are exposed to natural turbidity and suspended sediments, and have mechanisms for tolerating burial, prolonged use of these mechanisms can be costly and result in reduced growth or other sublethal effects on individuals (Bell et al. 2015, Edge et al. 2016). This reallocation of energy to recovery can cause impaired reproduction and decrease predation defense (Henry and Hart 2005). Other effects from sediment exposure can include changes in the microbial community structure, as noted for the sponge *Vazella pourtalesii* in areas closed to trawl fishing on the Scotian Shelf (Busch et al. 2020).

The ability to deal with suspended sediments is highly species specific, and dependent on exposure amounts and oceanographic conditions. Liefmann et al. (2018) found decreased food intake in *Duva florida*, a soft coral species, exposed to mine tailings, while *Primnoa resedaeformis*, a gorgonian coral, increased food intake. A common species of sponge in the northwest Atlantic (*Geodia barretti*) reduces filter feeding when exposed to suspended sediment to decrease sediment intake (Tjensvoll et al. 2013, Kutti et al. 2015). *Desmophyllum pertusum*, a commonly studied reef-building coral, has increased mucous production and ciliary movement to avoid burial by sedimentation (Zetsche et al. 2016). The effects of burial are also life-stage dependent, with Järnegren et al. (2017) finding earlier larval stages were more susceptible to lower concentrations of drill cuttings. Many studies have set thresholds above which effects on sensitive species such as corals and sponges are noted. Studies have used 6.5 mm based on average species burial tolerance that is unlikely to cause adverse effects (Smit et al. 2006, 2008b), with thresholds for sensitive species set as low as 1.5 mm (Kjeilen-Eilertsen et al. 2004). These effects are typically limited to within a kilometre of a drilled well, though this is highly variable (Oak 2020). Studies on direct toxicity of drill cuttings components (barite, bentonite, various metals) typically found they are not readily bioaccumulated, though *Desmophyllum pertusum* has been shown to incorporate barite particles from up to 600 m away from a drill site (IOGP 2016, Ragnarsson et al. 2017).

Due to the small footprints of components such as drilled wells and deposition of drill cutting discharges, as well as mitigations such as pre-drilling surveys to identify and avoid benthic species and habitats, the effects on these habitats are expected to be highly localized. Given the anticipated mitigations, the potential residual effects of well abandonment activities on benthic habitats are considered to be short term in duration with any residual effects from the abandoned wellheads themselves being highly localized. Thus, the effects on protected and special areas are expected to be minimal.

5.2.3.3 Vessel and Helicopter Traffic

The potential effects of vessel and helicopter traffic on protected and special areas mainly relate to effects on marine fish species, marine and migratory birds and marine mammals and sea turtles (Table 5-6). Thus, the effects on protected and special areas are similar to those on species of conservation concern. As discussed in Sections 5.1.1.1, 5.1.1.2. and 5.1.1.3, sound emissions from vessels would be short term and localized and unlikely to have any long-term non-reversible effects on marine fish. Mitigation measures relating to helicopter and vessel use should significantly reduce potential for disturbance to bird species. Mitigations such as reductions in vessel speed can reduce the likelihood of vessel strikes on marine mammal and sea turtles and the likelihood of mortality for many large whale species. Mariners are required to report all vessel strikes with marine mammals and sea turtles to DFO and encouraged to report any marine mammal sightings to alert other mariners of presence and to improve avoidance. Due to anticipated mitigation measures and the infrequency of helicopter presence, any residual adverse effects on protected and special areas are expected to be minimal.

5.2.3.4 Accidental Spills

For protected and special areas, the potential effects of accidental spills mainly relate to effects on marine species (Table 5-6). Effects on marine fish, marine and migratory birds and marine mammals and sea turtles are discussed in Sections 5.1.1.1, 5.1.1.2. and 5.1.1.3. In summary, these sections indicate that the potential effects of hydrocarbon, and other chemical, spills could have significant, long-term effects on a population of marine and migratory birds if a spill occurred at sensitive time of year (e.g., in a congregation area prior to migration) in an important habitat (potentially a protected or special area). The main concern effects of spills on marine mammals and sea turtles is accidental inhalation of toxins and possible ingestion with potential long-term effects (e.g., impaired health, population impacts).

No benthic SOCC have been identified for protected and special areas in the Study Area. Thus, the effects of accidental spills on benthic species were not discussed in depth in Section 5.1.1.1. During an accidental release of hydrocarbons, the major direct exposure pathways are typically to species in the upper water column with less direct interaction with sensitive benthic species such as corals and sponges. However, blowouts at the sea floor, use of dispersants, or long-term deposition by marine snow can expose corals and sponges to hydrocarbons. After the Deepwater Horizon (DWH) spill in the Gulf of Mexico, a variety of responses were noted for coral species including retracted polyps, damaged tissues, excessive mucus production, coverage of brown flocculant, and death (Buskey et al. 2016, Prouty et al. 2016, Ragnarsson et al. 2017). Several follow up studies noted signs of coral deterioration up to 22 km away, especially in those covered with flocculant (Hsing et al. 2013, Fisher et al. 2014). While some recovery was noted after 16 months post-spill, visible signs of impact (e.g., hydroid growth on dead coral tissue) were still present (Fisher et al. 2014). Recovery time for corals impacted from this spill was predicted to be a decade for the majority of affected corals, and up to three decades for heavily impacted corals (Girard et al. 2018). While these studies provide indications of coral and sponge responses and recovery to hydrocarbon exposure, recovery times would likely be relatively longer for cold-water deep sea species in the Study Area.

Exposure to PAHs have been shown to also have sub-lethal effects on early life stages of corals. Overmans et al. (2018) noted decreased metamorphosis success, phototoxic effects and larvae mortality when exposed to the PAH anthracene. As corals are slow growing and long-lived, effects on these early life stages can slow recruitment and recovery in areas affected by hydrocarbons. Similar to effects from burial, reallocation of energy to recover from a spill can result in decreased growth, impaired reproduction, and decreased predator defense

(Henry and Hart 2005). In the Gulf of Mexico, adult sea pens were found to have bioaccumulated PAHs in their tissues, likely from exposure to contaminated particulate organic matter which could result in lethal or sublethal effects (Lawson et al. 2021). Dispersants themselves can have sub-lethal and lethal effects on corals, potentially being even more toxic than untreated oil, and were widely used following the DWH spill (DeLeo et al. 2016, Bytingsvik et al. 2020).

Sponges have been shown to readily accumulate PAHs in their tissues, though they can also later expel PAHs after exposure to clean water (Pedrete et al. 2017). As they can alter their feeding behaviour with exposure to contaminants, accumulation can also be highly variable (Kutti et al. 2015). Though less data is available on sponges after the DWH spill event, a decrease in diversity and abundance of sponges in the path of the subsea plume was noted (Valentine and Benfield 2013). As sediment can be later resuspended, contaminated sediments in the deep-sea may also delay sponge recovery as they feed on suspended matter (Vad et al. 2018).

Adherence to regulations and various mitigations will avoid or reduce effects on protected and special areas. However, the potential effects of accidental spills on protected and special areas identified for benthic species and marine and migratory birds could be long term. This depends upon the location, size, duration and management of such spills.

5.2.4 Environmental Planning Considerations

Various protected and special areas intersect the Study Area in whole or in part. These are listed in Table 5-8. Several of these areas are protected with associated restrictions that must be considered in future decisions regarding petroleum exploration activities in the Middle and Eastern Scotian Slope and Sable Island Bank Areas. Relevant legislations that may result in prohibition of activities such as oil and gas are summarized in Table 5-9. More detailed information is included in Section 3.2.10.

Table 5-8: Protected Areas Legislation

Protected Area	Legislation Summary
The Gully MPA	Protected through the *Oceans Act*. Regulations prohibit any activities that disturb, damage, destroy or remove living marine organisms or any part of their habitat or the seabed. Prohibitions include any activity in the MPA, or vicinity, likely to result in disturbance, damage, destruction or removal of living marine organisms or any part of their habitat or the seabed. The Gully MPA has three management zones. Zone 1 has the highest level of protection. Zone 2 has a limited number of permitted activities. Zone 3 has some flexibility to permit activities that do not damage or destroy species assemblages or their habitats.
Western / Emerald Banks Conservation Areas (restricted fisheries zone) Marine Refuge	Protected through the *Fisheries Act*. Conservation objectives include productivity of groundfish for commercial fishing and management of disturbance to benthic habitat important for haddock and other groundfish species some of which are considered depleted or at-risk. Commercial and recreational fisheries using bottom-contact gear and / or gear known to interact with groundfish is prohibited. Likewise, no human activities incompatible with conservation objectives may occur.

Protected Area	Legislation Summary
Critical Habitat of Northern Bottlenose Whale (Scotian Shelf Population)	Protected under SARA. Any oil and gas activity with potential to affect a SAR as prohibited by SARA requires a review by DFO. Important Habitat for blue whale (Northwest Atlantic Population) and leatherback sea turtle (Atlantic Population) may be designated as critical habitat under SARA.
Sable Island MBS	Protected under the *Migratory Bird Sanctuary Regulations (C.R.C., c. 1035)*. Some activities may be permitted if not harmful to migratory birds and their habitats.
Sable Island National Park Reserve	Protected under the *National Parks Act*. The *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act (S.C. 1988, c. 28)* defines the physical limits of Sable Island where oil exploration drilling is prohibited on or within approximately 1.85 km of the National Park Reserve. Surface access is permitted for low-impact activities, including seismic, aeromagnetic and aerogravity surveys, and geological or geophysical programs.

Canada provides legislative protection to 13.81 percent (approximately 793,906 km^2) of its marine and coastal areas. These protected areas include MPAs, MBS and National Parks such as those found in the Study Area. Conservation areas also include other effective area-based conservation measures (OECM) including fisheries area closures such as marine refuges (DFO 2020g).

Marine refuges such as the Western / Emerald Banks Conservation Areas (restricted fisheries zone) have been established through the *Fisheries Act* to provide protection to species and their habitats from the impacts of fishing. Some activities may be permitted within marine refuges if they are consistent with conservation objectives of the protected area. The Eastern Canyons is a proposed marine refuge and is located approximately 60 km east of Sable Island, off Banquereau, and is approximately 36,000 km2. The dense corals found in the canyons and along the shelf edge warrant protection under DFO's Policy for Managing the Impact of Fishing on Sensitive Benthic Areas. This site is extended into the deep-water to foster connectivity among the shelf, slope, and abyssal plain, as deep-sea ecosystems are known to be vulnerable to disturbance (DFO 2018j).

Proponents of activities in marine refuges are required to work with DFO and the CCG to ensure that any risks to the area have been avoided or effectively mitigated. Conduct of exploration activities in marine refuges does not affect marine conservation targets, but where oil and gas extraction occurs the affected area will no longer be included in conservation targets. (DFO 2019j).

Oil and gas activities may be permitted, with restrictions implemented by the CNSOPB and possibly other regulators, in areas that are protected from other activities. This includes the Haddock Nursery Area, which is closed to bottom fishing under the *Fisheries Act*. In addition, various special areas such as EBSAs, SiBAs and IBAs have been identified for their sensitive species or habitats. Though not legally protected under regulations that prevent oil and gas activities, these areas should be considered in environmental planning efforts that aim to prevent harm to marine animals and their habitats especially those special areas identified for the presence of benthic species and habitats (e.g., sponges, corals) and marine and migratory birds.

5.3 Commercial Fisheries and Other Ocean Uses

Fisheries are an important and integral component of the socioeconomic environment within Atlantic Canada. Commercial harvesting is conducted throughout much of the Study Area involving large factory trawlers and smaller vessels, using both fixed and mobile gear to harvest groundfish, shellfish and several high-value large pelagic species. Activities occur year-round, particularly along the shelf break and have a potential to interact both directly and indirectly with petroleum industry activities. Science surveys to support the commercial fisheries also occur in the area each year, largely by employing fishing methods, and having similar potentials for interaction.

Other human activities and infrastructure also occur within the marine environment and have a potential to interact with, and be affected by, future offshore oil and gas activities. These include general vessel traffic through the area, possible military exercises, and other research studies and monitoring equipment. Marine artifacts (shipwrecks, possible UXO) and subsea Infrastructure (telecommunications cables) also pass through the SEA area of interest.

5.3.1 Potential Interactions

Because commercial harvesting, other marine activities and oil and gas operations may occupy the same marine areas at the same time, there is a potential for interaction between them. Petroleum exploration activities that may interact with commercial fisheries, commercial fisheries science surveys, and other ocean uses within the Study Area include the following:

- The presence and movement of drill rigs / platforms (including associated Safety Zones), underwater surveys or sampling, or geophysical survey vessels and other supporting ships might occupy preferred harvesting location and displace fishing effort while equipment and activities are present. Other marine traffic might need to deviate course around / away from equipment or installations.
- Towed equipment – particularly seismic hydrophone streamers – have a potential to snag / tangle fixed fishing gear (e.g., crab pot buoys, pelagic longlines), resulting in lost equipment, lost fish, and lost opportunities if the gear cannot be replaced quickly. Seismic surveys employing multiple streamers and/or multiple hydrophone ships (3D and wide azimuth (WAZ) surveys) increase the potential for interactions because of the physical footprint of the towed equipment. There is a similar potential for interaction with fisheries science gear and surface observation / data collection buoys.
- Underwater sound generated by the exploration activities (e.g., seismic surveying, seabed sampling, offshore drilling) might cause the movement (scaring) of mobile species from their usual grounds and diminish harvesting success in those areas; there is a similar potential for fisheries science surveys, affecting results.
- Seabed sampling activity associated with the collection of core or grab samples, or other in-water activities disturb a portion of fishing grounds. Damage to subsea infrastructure or artifacts such as communication cables or shipwrecks might occur; risks to operators in case of a UXO encounter.
- Drill wastes and the discharge and deposition of drill cuttings might smother benthic organisms or affect fish quality or market perceptions and catch values.
- The accidental loss of material / equipment into the marine environment could harm subsea infrastructure or be snagged by bottom fishing gear, especially mobile trawls, damaging gear and potentially affecting ship safety.
- Accidental spills could result in the closure of marine areas to fishing and other vessels and activities; fish

harvests might be tainted or perceived to be tainted and affect catch values.

Each of these possible interactions has potential economic consequences, through replacement costs of fishing gear, lost or diminished catch, decreased catch prices and/or increased expenses. For science surveys of all types, there might be loss of data collection opportunities, impairment of data quality and – depending on the type of survey – loss of gear or equipment. For other ocean uses, diminished efficiencies, lost opportunities and increased expenses might be consequences of interactions or the avoidance of interactions. These potential effects are discussed in more detail in the following subsections.

5.3.2 Mitigation Measures

5.3.2.1 Commercial Fisheries

Many procedures and mitigative measures have been developed and employed in the Atlantic Canada offshore and elsewhere to avoid or reduce possible negative interactions between offshore oil and gas activities and marine commercial fisheries. The CNSOPB's Geophysical, Geological, Environmental and Geotechnical Program Guidelines (CNSOPB 2015) contain advice and expected measures related to environmental planning, mitigation, monitoring and reporting which are intended to mitigate interactions with fisheries and other ocean operators, including scheduling to avoid fishing areas, operational planning, communications, gear and vessel damage compensation, and incident documentation and reporting. The Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017) describe the mechanisms available to potential claimants for actual loss or damages in the event of an oil spill.

These and additional best practices often employed by the petroleum industry operating in the Canadian offshore are summarized in Table 5-9 and discussed further below. The mitigation measures to avoid or reduce the potential biophysical and behavioural effects of offshore oil and gas activities on marine fish are described in Section 5.1.1.1 and also address potential indirect effects on commercial fisheries. These and other mitigation measures, if required, would be evaluated and applied as appropriate on a project-specific basis, through the individual regulatory reviews of a proposed exploration project.

Table 5-9: Summary of Standard Mitigation Measures – Commercial Fisheries

Mitigation Measures	Applicability			
	Seismic and Seabed Surveys	Drilling / Well Abandonment	Vessel / Helicopter Traffic	Accidental Spills
Planning oil and gas activities to avoid key fishing areas / harvesting times to the extent possible.	•	•	•	
On-going communications, information gathering, analysis and coordination with harvesting interests, and continued monitoring of fishing plans and activity.	•	•	•	•
Use of Fisheries Liaison Officers (FLOs).	•			

Mitigation Measures	**Applicability**			
	Seismic and Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Use of a scout or guard boat for seismic surveys, to provide advance observation, at-sea communications, and to help prevent equipment / ship interactions.	•			
Timely issuance of NAVWARNs and Notices to Mariners (NOTMARs) and other notifications, including direct industry communications about planned activities and unplanned incidents.	•	•	•	•
Project ships monitoring and communicating with other vessels in areas of operations (radar, AIS, direct at-sea radio communications), including using AIS to be aware of marked fishing gear.	•	•	•	•
Reporting of any fishing gear contacts by oil and gas activities as per the C-NLOPB / CNSOPB Incident Reporting and Investigation Guideline; compensation to fish harvesters in case of gear and/or vessel damage or loss resulting from a contact.	•	•	•	
Communication with DFO scientists to reduce overlap of seismic operations with research survey areas, and to allow an adequate temporal and spatial buffer between seismic survey operations and DFO research activities, and to inform DFO of any incidents.	•	•		•
Project vessels following established shipping lanes where they are able.			•	
Establishing and communicating the locations of safety zones or any other closed areas (e.g., in case of a spill); communication of hailing protocols and other measures.	•	•	•	•

Mitigation Measures	**Applicability**			
	Seismic and Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
Employing a sequential approach to drilling multiple wells in an area to limit the area occupied at any one time.		•	•	
Communicating the locations of any subsea infrastructure left in place to appropriate authorities for inclusion on nautical charts for the information of harvesters, as applicable.		•		
Closure of marine fishing areas affected by hydrocarbon in the case of a spill, to prevent tainted product from reaching markets.				•
Compensation for losses as required under the *Accord Acts* in case of an oil spill or loss of debris.		•		•

Early and ongoing engagement and communication between offshore oil and gas operators, government departments and agencies and the fishing industry while planning and implementing offshore seismic surveys and drilling programs are highly effective mechanisms for avoiding conflicts and adverse socio-economic impacts. NAVWARNS and other communications are used to inform fishers and others of current activities and emerging situations. Fisheries Liaison Officer (FLO) positions have also been established by oil and gas operators to serve as an essential link for at-sea communication with harvesters during offshore program components. FLOs are typically experienced fishers who are hired and placed on-board seismic vessels whose responsibilities include communicating with fishing vessels, as well as proposing advice to help avoid interference. The FLO should be familiar with the fisheries in the intended operational area.

The use of established and common marine traffic routes by support and supply vessels where possible can also reduce disturbances to and effects on harvesting. Oil and gas related vessels are typically made aware of likely fishing activity and locations in the region through start-up briefings, FLO discussions, and documents such as the project-specific EA, so that areas of potential conflict, including fishing gear damage, can be avoided. At sea, seismic, service and supply vessels will monitor radio, radar and AIS (which can detect some fishing gear, e.g., pelagic longlines) and can communicate with nearby fishing boats at sea by VHS, directly or via the FLO.

Prior communications with DFO scientists and direct contact with RVs at sea reduce the potential for overlap of seismic surveys with research survey areas to ensure an adequate spatial and temporal buffer between operations and DFO research location.

Ensuring the safety of offshore personnel and equipment working in both the fishing and oil and gas industries is a primary concern and objective of industry and regulators. The establishment of safety zones around offshore oil and gas installations (from arrival of the unit through abandonment) helps to eliminate the potential for physical interactions between drill-site activities and fishing. Typically, these zones are approximately 500 m in radius around a unit, but this will depend on the nature and location of the installation and activity. If a series of wells are to be drilled in an area, a sequential approach to drilling may be used for logistical reasons (such as rig availability and mobilization), which helps to minimize the area affected through loss of access to fishing grounds at any one time.

An important concern of harvesters is the effect on their industry resulting from a large oil spill. The prevention of spills has been and is a priority for the industry and the CNSOPB, and offshore drilling operators are required to develop plans which outline procedures for preventing and effectively responding to such spills. The regulatory reviews of proposed offshore drilling programs include an analysis of possible types and probabilities for oil spill, as well as detailed modelling of the likely behaviour and fate of hypothetical spills (how much, where it is most likely to go, and how long it persists), based on project- and site-specific factors, including hydrocarbon types and properties, water depths and characteristics, currents and other oceanographic conditions and patterns. This information and analysis are then used in assessing and evaluating the potential for, and likely nature and magnitude of, interactions between accidental spills and fishing activities, for use in project planning and associated regulatory decisions around whether and how a proposed drilling program may proceed. As part of the regulatory review and approval processes that apply to offshore drilling activities in the Canada - Nova Scotia offshore area, operators are also expected to demonstrate that they can undertake such activities in a safe and environmentally responsible manner. This includes the development and implementation of systematic and comprehensive oil spill prevention plans and procedures, as well as ensuring the ability to respond to a spill event in an effective and timely manner, should one occur.

Before they receive an authorization, operators must also demonstrate that they have the financial ability to pay compensation if an accidental spill were to occur (see CNSOPB et al. 2017). Under the *Accord Acts*, operators are liable in any circumstance for damages up to $1 billion, and for an unlimited amount if the operator was liable for the spill. If preventative measures failed and a spill occurred affecting fisheries, the compensation processes described in the Compensation Guidelines would apply for any actual loss or damages. As stated in the *Accord Acts*, claims can be made for losses associated with petroleum exploration, development, decommissioning and abandonment activities.

5.3.2.2 Other Ocean Uses

Many of the mitigations described above help to avoid or reduce potential effects on other marine operators, installations or artifacts. These and other measures are listed in Table 5-10 as they apply to other marine uses.

Table 5-10: Summary of Standard Mitigation Measures – Other Ocean Uses

Mitigation Measures	Applicability			
	Seismic and Seabed Surveys	Drilling / Well Abandonment	Vessel / Helicopter Traffic	Accidental Spills
Planning oil and gas activities to avoid known activity areas to the extent possible.	•	•	•	
Timely issuance of NAVWARNs and NOTMARs and other notifications / direct	•	•	•	•

Mitigation Measures	Applicability			
	Seismic and Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
communications about planned activities and unplanned incidents.				
Project ships monitoring and communicating with other vessels in any area of operations (radar, AIS, direct at-sea radio communications).	•	•	•	•
Use of a scout or guard boat for seismic surveys allows advance observation and at-sea communications with other operations in the area.	•			
Project vessels following established shipping lanes where they are able.			•	
Project site surveys will also detect unknown subsea infrastructure or artifacts before drilling.	•	•		
Employing a sequential approach to drilling multiple wells in an area to limit the area occupied at any one time		•	•	
Establishing and communicating the locations of safety zones, or any other closed areas (e.g., in case of a spill); communication of hailing protocols and other measures.	•	•	•	•
Contacting DND to determine if any UXOs may be present in a drilling or other subsea activity area; treatment of suspected UXO according to Notices to Mariners Annual Edition, Section 37, and reporting to DND.	•	•		
Contacting DND to determine if any military exercises are planned during the program timeline; establishing an operator-specific point of contact for MARLANT queries and concerns.	•	•	•	•
Communicating the locations of any subsea infrastructure left in place to appropriate authorities for inclusion on nautical charts for		•		

Mitigation Measures	**Applicability**			
	Seismic and Seabed Surveys	**Drilling / Well Abandonment**	**Vessel / Helicopter Traffic**	**Accidental Spills**
the information of other marine interests, as applicable.				

As noted, the environmental planning process for operators in the Nova Scotia offshore area requires a project-specific EA, project-specific environmental management plans and other components, as part of the regulatory authorization process. Planning for a proposed project includes communications programs and establishes compliance and monitoring regimes to ensure commitments and regulatory requirements are met. The identification of project-specific mitigation measures for commercial fisheries and other ocean uses would be part of that process.

5.3.3 Potential Residual Effects

5.3.3.1 Commercial Fisheries

Commercial fisheries have the potential to be affected both directly and indirectly by petroleum industry activities. Direct effects can be experienced through direct spatial interactions between offshore oil and gas operations and fishing operations in which fish harvesting is displaced or impeded, gear is damaged, or fish are scared away to other areas. Longer-term or indirect effects can occur through ecosystem changes caused by activities that result in adverse changes in the size, distribution and health of fish populations or fish habitat, or because of changes in market conditions, including decreased prices paid for fish or loss of buyers in the case of a hydrocarbon spill.

Much of the available information and insight regarding potential interactions between marine fisheries and the offshore oil and gas industry has been gathered through experience conducting exploration activities, communications with fishers and other individuals and organizations that have been involved in the fishing industry during many EA processes in Atlantic Canada, as well as the relevant literature. Communications for this SEA are discussed in Section 4.3, where oil spills have been noted as a particular issue of concern.

Issues identified include effects that might have the following economic consequences if not mitigated:

- loss of profit due to direct costs of replacing or repairing damaged fishing gear (e.g., a seismic streamer snagging a pelagic longline);
- lost income because of physical interference with fishing activities and the need to change location to alternative grounds, or change the timing of fishing, resulting in reduced harvests and increased expenses (e.g., if a preferred fishing area is occupied by a Safety Zone);
- lost income because of the displacement/movement of commercial species from usual harvesting areas because of petroleum-related activities (e.g., the sound from seismic surveys; closed areas because of a spill);
- reduced fishing income because of reduction of market prices because of changes in fish health or quality or market perceptions, such as actual or perceived tainting (e.g., from a spill).

While most of these effects would be short-term (i.e., only during the presence of the activity or for a relatively short time afterwards) a spill could have longer-term impacts on harvesting success and incomes in areas beyond the Project and Study Areas, depending on the extent of the spill (see Section 5.1.1.1.4).

Damage to fishing gear or vessels can result from physical contact with seismic vessel streamers, drill rigs and service vessels. Establishment of safety zones around operations should prevent physical interactions with fishing vessels. Helicopter transits do not have a potential for interaction with fisheries.

Seismic hydrophone streamers are a risk to fixed-gear fisheries, especially where the gear (pelagic and bottom longlines, pots) is deployed and remains for some time before recovery. Swordfish longlines (up to 100 km long) would be particularly susceptible to damage if crossed by a seismic boat with its streamers (e.g., set at 10 m depths). In addition to the direct costs of fixing or replacing any damaged fishing vessels or gear, further economic loss might also result from any associated reduction in fishing times and reduced catches (particularly in competitive fisheries) or increased operating costs in less favourable weather.

The sound from a seismic survey array can result in changes in the presence, abundance and distribution (spatial and temporal) of commercial species. Scaring swimming fish from the vicinity of operations to other areas for several days might reduce catch in exploration areas and possibly increase it in others. Longer-term temporary displacement of fish might occur because of sounds from drilling and other industrial activities. The nature, spatial extent, duration and implications of fish displacement will depend on the location of activities in relation to commercial species, the types of fisheries that are active, and the species in the area of influence (e.g., mobile vs. sedentary species). See Section 5.1.1.1.1 for the potential effects of sound on fish behaviour.

The need to travel to and fish on alternative grounds if oil and gas activities are occurring in preferred areas can have implications for fishing success, whether the displacement is by the choice of the harvester to avoid noise or vessel traffic, or because of the presence of a regulatory safety zone. These zones around offshore drilling operations are usually small (e.g., 500 m radius from a rig's anchor pattern) but fisheries that use drifting/floating longline gear would likely need to avoid a larger area. Increased travel times and associated expenses might occur, and alternative areas might not be as productive. The nature, spatial extent, duration and implications of any such deviations or restrictions depend on the type, location, timing and other characteristics of the offshore oil and gas project or activity occurring, as well as the nature and scale of any other concurrent fishing activity in the area.

Project-related discharges into the marine environment (e.g., materials lost from vessels or drill rigs) can also damage fishing gear, including mobile trawls and dredges. In addition to the direct costs of fixing or replacing damaged fishing vessels or gear, further economic loss might result from any associated reduction in fishing times and reduced catches (particularly in competitive fisheries).

Small spills can damage or foul fishing gear, including mobile trawls and dredges. If a large spill were to occur, any affected areas (e.g., subject to surface hydrocarbons) might be closed by regulators to prevent tainted product from reaching markets. Offshore oil and gas activities might affect fishing incomes if there is a change in the health (toxicity and bioaccumulation), condition (taint), and habitat (smothering of benthic habitats) of fish species. Any such biophysical effects on fish and fish habitat could result in a subsequent loss of fish catch or catch value. Even where there is a low potential for, or occurrence of, such effects, consumer perceived effects (lower quality, taint) can lower market prices and economic returns, though this is only likely to happen in a large oil spill, rather than as a result of routine offshore activities. In the event of a spill, loss of confidence in product quality might close markets for a time even if catches are determined to be fit (ITOPF 2014; IPIECA 2016; Cariglia 2017).

Table 5-11 provides a matrix identifying which types of petroleum exploration components and/or activities might cause the identified interactions with commercial harvesting and fisheries science surveys.

Table 5-11: Potential Project Environmental Effects on Commercial Fisheries

Components / Activities	Potential Effects				
	Gear and/or Vessel Damage	Loss of Access to Fishing Areas	Displacement of Commercial Species / Decreased Abundance	Decreased Quality and Market Value of Harvest	Interference with Fisheries Surveys and Research Results
Seismic / Seabed Surveys	•	•	•		•
Drilling / Well Abandonment and associated Safety Zones	•	•	•	•	•
Vessel / Helicopter Traffic	•				
Accidental Spills	•	•	•	•	•

5.3.3.2 Other Ocean Uses

Some of the potential interactions between offshore oil and gas related exploration activities and other anthropogenic features and activities in the marine environment are similar to those described for commercial fisheries and are associated with the same activities / pathways. These include:

- damage to vessels, equipment or subsea infrastructure / as a result of direct interactions with oil and gas related equipment, activities and/or environmental debris or discharges (e.g., snagging a stationary or drifting ocean sensor; damage from oiling), with associated costs and data loss; potential Interaction with UXO also poses safety concerns;
- loss of access to preferred use areas and most efficient travel routes during petroleum exploration activities, possible resulting in lost or delayed opportunities or increased costs affecting the economic, safety or social value or quality of these activities;
- Damage to, or diminution of, experience of areas (e.g., Sable Island, shorelines) and non-fisheries species (see Sections 5.1.1.2 and 5.1.1.3 of social, cultural and tourism value, in the event of a large oil spill.

Table 5-12 provides a matrix identifying which types of petroleum exploration components and/or activities might cause the identified interactions. (Helicopter transits do not have a potential for interaction with other known ocean uses in the area.)

Table 5-12: Potential Project Environmental Effects on Other Ocean Uses

Components / Activities	Potential Effects		
	Damage to Vessels, Equipment or Infrastructure	Loss of Access to Preferred Areas or Transit Routes	Decreased in Availability, Quality or Value of Activities and Experiences
Seismic / Seabed Surveys	•	•	
Drilling / Well Abandonment	•	•	
Vessel / Helicopter Traffic	•		
Accidental Spills	•	•	•

5.3.4 Planning Considerations

This section summarizes some considerations to help inform potential operators as they plan exploration programs in light of expected fishing and other marine activity locations and times. Most of the considerations below apply primarily to minimize effects during seismic surveys since a drilling program would have little flexibility in choosing a location. For drilling programs, principal considerations for commercial harvesting would be the overall importance of the area to the fisheries during the proposed timeframe, minimizing the footprint and duration of activities to the extent possible while maintaining safety, and the availability of alternative fishing grounds. Effective communication of a drilling unit's location and safety zone protocols would be important for harvesters and any other marine operators in the vicinity.

5.3.4.1.1 Commercial Fisheries

As discussed, and illustrated in Section 3.3, many diverse commercial fisheries occur in much of the Study Area year-round, characterized by complex spatial and temporal patterns of activity. This, along with the dynamic nature of the fishery over the seasonal cycle may make it difficult to be certain about activities in a particular location at a particular time to plan avoidance.

Based on the information presented in Section 3.3, the following general observations should be considered during exploration planning, understanding that the operator's project-specific EA will contain more up-to-date and project-area-specific intelligence, based on the latest available fisheries information, and consultations with DFO, harvesting representatives (fleet or area) identified during the project's EA process, and/or the CNSOPB's Fisheries Advisory Committee. Communications and information sharing before and throughout the program are important, as is the advice of an experienced FLO during operations. For any species, contacts through buyers may be an option; see for example, Nova Scotia Business (2016).

Groundfish: Harvesting of these species in the Study Area is primarily by large mobile trawlers towing bottom gear, with most activity focused along the shelf edge area. These operators should be identifiable easily at sea on AIS, and direct radio or email contact should be made if in proximity. Halibut bottom longline harvesting (shelf edge and The Gully trough area) may be more challenging to locate, and the FLO, communications with harvesters and other contacts can assist in identifying active areas and local risks. As the data indicate, groundfish fisheries are year-round but with high points in July and August. For the small hagfish pot fishery (6-7 individuals) along the shelf break, contacts via DFO managers are advised.

Large Pelagic Species: Large pelagic species harvesting in the Study Area occurs near or off the edge of the Shelf, some in very deep waters. The physical extent of floating longlines poses a higher than usual risk of entanglement with towed hydrophone streamers or other equipment (harmful to both industries' gear), though the use of AIS on this fishing gear is helpful for seismic ships and other project vessels. AIS monitoring and at-sea radio communications are essential if working near those areas. Operations usually take place in most months except winter, so at the same time as seismic surveys. Monitoring the seasonal movement of the fleet (typically west to east) is useful; contacts can be assisted through the Nova Scotia Swordfishermen's Association.

Shellfish: Harvesting is conducted in the Study Area by both large and smaller vessels, depending on the species. Harvesting time is set annually by DFO but has occurred from 1 April to 31 August in recent years in CFAs 24 and 23. The fixed-gear pots (60-70 per license) are fished by smaller boats, and pots may be left in the water unattended for many days at a time depending on weather and other factors. Use pre-operations communications and at-sea contacts, and the advice of the FLO if there might be spatial/temporal overlap. The red crab fixed-gear (pot) fishery that is indicated along the shelf edge within the Study Area is smaller but poses similar challenges to snow crab. Mobile-gear scallop draggers that might be in the area at any time (near and north of Sable Island, and Western Bank/Sable Island Bank) are larger vessels and may be contacted at sea. Mobile-gear shrimp trawling is possible year-round but is usually active in spring and summer. Sea clam harvesting is undertaken by a large semi-stationary vessel and on-shore and at-sea contacts are advised.

Fisheries Science Surveys: Contact with relevant DFO managers should be made during planning stages and maintained during operations to prevent temporal / spatial overlap.

5.3.4.1.2 Other Ocean Uses

Many of the other marine activities that occur or might occur in the Study Area are unpredictable (e.g., marine shipping transits, other science investigations, the locations of drifting sensors or submarine gliders), but advance communications (e.g., with DND/MARLANT), at-sea contacts where possible, and following standard marine safety and avoidance measures (e.g., the *Collision Regulations* under the *Canada Shipping Act*) are valuable for safely avoiding interference. Up-to-date charting/plotting of known, fixed infrastructure (such as fixed ODAS buoys and explosive dumpsites) is also important, as is making the best use of on-board technology, including AIS. Consistent filing of up-to-date NAVWARNs (through the CCG Atlantic Region Sydney MCTS Centre) is also important to maintain for project locations and activities NAVWARNs should be monitored for other operator activities. As with the fisheries, operators should understand the specific other uses that might occur in their planned operating area, based on the information contained in the project-specific EA and other contacts.

5.4 Indigenous Fisheries

Various First Nations groups / communities, Indigenous fishing companies or cooperatives hold commercial communal licenses for harvesting areas that overlap the Study Area. These licenses, which are mainly for groundfish, herring, mackerel, swordfish, lobster and snow crab, may or may not be currently active. If / when Indigenous commercial communal fisheries occurs within the Study Area, potential interactions would be generally consistent with commercial fishing as both activities may overlap spatially and temporally with the oil and gas industry.

5.4.1 Potential Interactions

Because commercial communal fisheries and oil and gas exploration may spatially overlap, there is potential for interaction. Petroleum exploration activities that may interact with commercial communal fisheries within the Study Area include:

- Presence and movement of drill rigs / platforms (including associated Safety Zones), underwater surveys or sampling, or geophysical survey vessels and other supporting ships that might occupy preferred harvesting locations and displace fishing effort while equipment and activities are present.
- Towed equipment – particularly seismic hydrophone streamers – has the potential to snag / tangle fixed fishing gear (e.g., crab pot buoys, pelagic longlines), resulting in lost equipment, lost fish, and lost opportunities if the gear cannot be replaced quickly. Seismic surveys employing multiple streamers and/or multiple hydrophone ships (3D and wide azimuth (WAZ) surveys) increase the potential for interactions because of the physical footprint of the towed equipment.
- Underwater sound generated by exploration activities (e.g., seismic surveying, seabed sampling, offshore drilling) could cause movement (scaring) of mobile species from their usual grounds and diminish harvesting success in those areas.
- Seabed sampling activity associated with collection of core or grab samples, or other in-water activities could disturb a portion of fishing grounds.
- Drill wastes and discharge / deposition of drill cuttings might smother benthic organisms or affect fish quality or market perceptions and catch values.
- Accidental loss of material / equipment into the marine environment could be snagged by bottom fishing gear, especially mobile trawls, damaging gear and potentially affecting ship safety.
- Accidental spills could result in the closure of marine areas to fishing and other vessels and activities; fish harvests might be tainted or perceived to be tainted and affect catch values.

Each of these possible interactions has potential economic consequences, through replacement costs of fishing gear, lost or diminished catch, decreased catch prices and / or increased expenses. These potential effects are discussed in more detail in the following subsections.

5.4.2 Mitigation Measures

Many mitigative measures have been developed and employed in the Atlantic Canada offshore and elsewhere to avoid or reduce possible adverse interactions between offshore oil and gas activities and marine commercial fisheries that apply to Indigenous fisheries. The CNSOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (CNSOPB 2015) contain advice and expected measures related to environmental planning, mitigation, monitoring and reporting intended to mitigate interactions with fisheries, including scheduling to avoid fishing areas, operational planning, communications, gear and vessel damage compensation, and incident documentation and reporting. The *Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity* (C-NLOPB and CNSOPB 2017) describe mechanisms available to potential claimants for actual loss or damages in the event of an oil spill. The *Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador* (IAAC 2020) and the Ministerial Regulation *Regulations Respecting Excluded Physical Activities (Newfoundland and Labrador Offshore Exploratory Wells)* (ECCC 2020b) contain information on mitigation, follow-up programs, and planning considerations for oil and gas drilling, much of which is also relevant to petroleum exploration in the Study Area. These and additional best practices are often employed by the petroleum industry operating in the Canadian offshore are summarized in the Table 5-13.

Mitigation measures to avoid or reduce potential biophysical and behavioural effects of offshore oil and gas activities on fish SOCC are described in Section 5.2.2 also address potential indirect effects on Indigenous fisheries. These and other mitigation measures would be evaluated and applied as appropriate on a project-specific basis, through the individual regulatory reviews of a proposed exploration project.

Table 5-13: Summary of Standard Mitigation Measures – Indigenous Fisheries

Mitigation Measures	Applicability			
	Seismic and Seabed Surveys	Drilling / Well Abandonment	Vessel / Helicopter Traffic	Accidental Spills
Planning oil and gas activities to avoid key fishing areas / harvesting times to the extent possible.	•	•	•	
On-going communications, information gathering, analysis and coordination with harvesting interests, and continued monitoring of fishing plans and activity.	•	•	•	•
Use of Fisheries Liaison Officers (FLOs).	•			
Use of a scout or guard boat for seismic surveys, to provide advance observation, at-sea communications, and to help prevent equipment / ship interactions.	•			
Timely issuance of NAVWARNs and NOTMARs and other notifications, including direct industry communications about planned activities and unplanned incidents.	•	•	•	•
Project ships monitoring and communicating with other vessels in areas of operations (radar, AIS, direct at-sea radio communications), including using AIS to be aware of marked fishing gear.	•	•	•	•
Reporting of any fishing gear contacts by oil and gas activities as per the C-NLOPB / CNSOPB Incident Reporting and Investigation Guideline; compensation to fish harvesters in case of gear and/or vessel damage or loss resulting from a contact.	•	•	•	

Mitigation Measures	Applicability			
	Seismic and Seabed Surveys	Drilling / Well Abandonment	Vessel / Helicopter Traffic	Accidental Spills
Communication with DFO scientists to reduce overlap of seismic operations with research survey areas, and to allow an adequate temporal and spatial buffer between seismic survey operations and DFO research activities, and to inform DFO of any incidents.	•	•		•
Project vessels following established shipping lanes where they are able.			•	
Establishing and communicating the locations of safety zones or any other closed areas (e.g., in case of a spill); communication of hailing protocols and other measures.	•	•	•	•
Employing a sequential approach to drilling multiple wells in an area to limit the area occupied at any one time.		•	•	
Communicating the locations of any subsea infrastructure left in place to appropriate authorities for inclusion on nautical charts for the information of harvesters, as applicable.		•		
Closure of marine fishing areas affected by hydrocarbon in the case of a spill, to prevent tainted product from reaching markets.				•
Compensation for losses as required under the *Accord Acts* in case of an oil spill or loss of debris.		•		•

Early and ongoing engagement and communication between offshore oil and gas operators, government departments and agencies, the fishing industry and Indigenous groups while planning and implementing offshore seismic surveys and drilling programs are highly effective mechanisms for avoiding conflicts and adverse socio-economic impacts. Communications including NAVWARNs are used to inform fishers and others of current activities and emerging situations. Fisheries Liaison Officer (FLO) positions, established by oil and gas operators, serve as an essential link for at-sea communication with harvesters during offshore program components. FLOs are typically experienced fishers who are placed on-board seismic vessels to communicate with fishing vessel operators, as well as proposing advice to help avoid interference. The FLO should be familiar with the fisheries in the intended operation location.

The use of established and common marine traffic routes by support and supply vessels, where possible, can reduce disturbances to and effects on harvesting. Oil and gas related vessels are typically made aware of likely fishing activity and locations in the region through start-up briefings, FLO discussions, and documents such as the project-specific EA, so that areas of potential conflict, including fishing gear damage, can be avoided. At sea, seismic, service and supply vessels will monitor radio, radar and AIS (which can detect some fishing gear, e.g., pelagic longlines) and can communicate with nearby fishing boats at sea by VHS, directly or via the FLO.

Prior communications with DFO scientists and direct contact with RVs at sea reduce the potential for overlap of seismic surveys with research survey areas to ensure an adequate spatial and temporal buffer between operations and DFO research location.

Ensuring the safety of offshore personnel and equipment working in both the fishing and oil and gas industries is a primary objective of industry and regulators. The establishment of safety zones around offshore oil and gas installations (from arrival of the unit through abandonment) helps to eliminate the potential for physical interactions between drill-site activities and fishing. Typically, these zones are approximately 500 m in radius around a unit, but this will depend on the nature of the installation and activity. If a series of wells are to be drilled in an area, a sequential approach to drilling may be used for logistical reasons (e.g., rig availability and mobilization), which helps to minimize areas of loss to access to fishing grounds at any one time.

An important concern of harvesters is the effect on their industry resulting from a large oil spill. The prevention of spills has been and is a priority for the industry and the CNSOPB, and offshore drilling operators are required to develop plans that outline procedures for preventing and effectively responding to such spills. Regulatory reviews of proposed offshore drilling programs include analyses of possible types and probabilities for oil spill, as well as detailed modelling of the likely behaviour and fate of hypothetical spills, based on project- and site-specific factors, including hydrocarbon types and properties, water depths and characteristics, currents and other oceanographic conditions and patterns such as those described in Section 3.1. As part of the regulatory review and approval processes that apply to offshore drilling activities in the Canada-Nova Scotia offshore area, operators are also expected to demonstrate the ability to undertake exploration activities in a safe and environmentally responsible manner. This includes development and implementation of systematic and comprehensive oil spill prevention plans and procedures, as well as ensuring the ability to respond to a spill event in an effective and timely manner, should one occur.

Before an authorization to proceed, operators must also demonstrate that the have the financial ability to pay compensation if an accidental spill were to occur (see CNSOPB et al. 2017). Under the *Accord Acts*, operators are liable in any circumstance for damages up to $1 billion, and for an unlimited amount if the operator was liable for the spill. If preventative measures failed and a spill occurred affecting Indigenous fisheries, the compensation processes described in the *Compensation Guidelines* would apply for any actual loss or damages. As stated in the *Accord Acts*, claims can be made for losses associated with petroleum exploration, development, decommissioning and abandonment activities. This includes "income, including future income, and, with respect to any Aboriginal peoples of Canada, loss of hunting, fishing and gathering opportunities."

5.4.3 Potential Residual Effects

Commercial communal fisheries have the potential to be affected directly and indirectly by petroleum exploration activities. Direct effects can be experienced through spatial interactions between offshore oil and gas operations and fishing activity where fish harvesting is displaced or impeded, gear is damaged or fish avoid active areas. Longer-term or indirect effects can occur through ecosystem changes caused by activities that result in adverse changes in the size, distribution and health of fish populations or fish habitat, or due to changes in market conditions, including decreased market prices or loss of buyers due to a hydrocarbon spill.

Much of the available information and insight regarding interactions between marine fisheries and the offshore oil and gas industry has been gathered through relevant literature and experience conducting exploration activities, communications with fishers, Indigenous groups and other individuals and organizations involved in the fishing industry during many EA processes in Atlantic Canada. Oil spills are typically noted as a particular concern. Communications for this SEA is discussed in Section 4.3.

The fishing industry has identified potential issues that may have the following economic consequences if not mitigated:

- loss of profit due to direct costs of replacing or repairing damaged fishing gear (e.g., a seismic streamer snagging a pelagic longline);
- lost income due to physical interference with fishing activities and the need to change location to alternative grounds, or change the timing of fishing, resulting in reduced harvests and increased expenses (e.g., if a preferred fishing area is occupied by a Safety Zone);
- lost income due to displacement / movement of commercial species from usual harvesting areas because of petroleum-related activities (e.g., sound from seismic surveys; closed areas because of a spill);
- reduced fishing income due to reduction of market prices because of changes in fish health or quality or market perceptions, such as actual or perceived tainting (e.g., from an accidental spill).

While most of these effects would be short-term (i.e., only during the presence of the activity or for a relatively short time afterwards) a spill could have longer-term impacts on harvesting success and incomes in areas beyond the Project and Study Areas, depending on the extent of the spill.

Damage to fishing gear or vessels can result from physical contact with seismic vessel streamers, drill rigs, or dropped or lost equipment, or vessels supporting oil and gas exploration, though the establishment of safety zones around drilling units should prevent physical interactions. Seismic hydrophone streamers are a risk to fixed-gear fisheries, particularly where gear (e.g., pelagic and bottom longlines, pots) is deployed and remains for some time before recovery. Swordfish longlines (up to 100 km long and set at 10 m depths) would be particularly susceptible to damage if crossed by a seismic boat with its streamers. Project-related discharges into the marine environment, such as small spills and materials lost from vessels or drill rigs can also damage or foul fishing gear, including mobile trawls and dredges. In addition to the direct costs of fixing or replacing any damaged fishing vessels or gear, further economic loss might also result from any associated reduction in fishing times and reduced catches (particularly in competitive fisheries) or increased operating costs in less favourable weather.

The need to travel to and fish on alternative grounds if activities are occurring in preferred areas can also have implications for fishing success, whether displacement is by the choice of the harvester to avoid noise or vessel traffic, or because of the presence of a regulatory safety zone. These zones around offshore drilling operations are usually small (e.g., 500 m radius from a rig's anchor pattern) but fisheries that use drifting / floating longline gear would likely need to avoid a larger area. Increased travel times and associated expenses might occur, and alternative areas might not be as productive. The nature, spatial extent, duration and implications of any such deviations or restrictions depend on the type, location, timing and other characteristics of the offshore oil and gas project or activity occurring, as well as the nature and scale of any other concurrent fishing activity in the area. If a large spill were to occur, any affected areas (e.g., subject to surface hydrocarbons) might be closed by regulators to prevent tainted product from reaching markets.

Sound from a seismic survey array can result in changes in the presence, abundance and distribution (spatial and temporal) of fish species. If mobile fishes avoid an area of operations for several days, this might reduce catch in exploration areas and possibly increase it in others. Longer-term temporary displacement of fish might occur because of sounds from drilling and other industrial activities. The nature, spatial extent, duration and implications of fish displacement depend on the location of activities in relation to fished species, the types of active fisheries, and species in the area of influence (e.g., mobile or sedentary species).

Offshore oil and gas activities might also affect fishing incomes if there is a change in the health (e.g., due to toxicity and bioaccumulation), condition (e.g., taint), and habitat (e.g., smothering of benthic habitats) of fish species. Any such biophysical effects on fish and fish habitat could result in a subsequent loss of fish catch or catch value. Even where there is a low potential for, or occurrence of, such effects, consumer perceived effects (e.g., lower quality, taint) can lower market prices and economic returns, though this is only likely to happen in a large oil spill, rather than from routine offshore activities. In the event of a spill, loss of confidence in product quality might close markets for a time even if catches are determined to be fit (ITOPF 2014; IPIECA 2016; Cariglia 2017).

Table 5-14 provides a matrix identifying types of petroleum exploration components and / or activities that might affect commercial communal harvesting. Note that helicopter transits do not have a potential for interaction with fisheries.

Table 5-14: Potential Project Environmental Effects on Indigenous Fisheries

Components / Activities	Potential Effects			
	Gear and/or Vessel Damage	Loss of Access to Fishing Areas	Displacement of Fished Species / Decreased Abundance	Decreased Quality and Market Value of Harvest
Seismic / Seabed Surveys	•	•	•	
Drilling / Well Abandonment and associated Safety Zones	•	•	•	•
Vessel / Helicopter Traffic	•			
Accidental Spills	•	•	•	•

5.4.4 Planning Considerations

This section summarizes some considerations to help inform potential operators as they plan exploration programs where fishing activities are anticipated to overlap in location and schedule. Most of the considerations below apply primarily to minimize effects during seismic surveys since a drilling program would have limited flexibility in choosing a location. For drilling programs, principal considerations for commercial communal harvesting would be the overall importance of the area to the fisheries during the proposed project timeframe, minimizing the footprint and duration of activities to the extent possible while maintaining safety, and the availability of alternative fishing grounds. Effective communication of a drilling unit's location and safety zone protocols would be important for harvesters and any other marine operators in the vicinity.

As discussed and illustrated in Section 3.3, many diverse commercial fisheries occur in much of the Study Area and Study Area year-round, and these include Indigenous fisheries. This, along with the dynamic nature of the fishery over the seasonal cycle may make it difficult to be certain about activities in a particular location at a particular time to plan for avoidance.

Based on the information presented in Section 3.3, the following general observations should be considered during exploration planning, understanding that the operator's project-specific EA will contain more up-to-date and project-area-specific intelligence, based on the latest available fisheries information, and consultations with DFO, harvesting representatives (fleet or area) identified during the project's EA process, and / or the CNSOPB's Fisheries Advisory Committee. Communications and information sharing before and throughout the program are important, as is the advice of an experienced FLO during operations.

Groundfish: Harvesting of these species in the Study Area is primarily by large mobile trawlers towing bottom gear, with most activity focused along the shelf edge area. These operators should be identifiable easily at sea on AIS, and direct radio or email contact should be made if in proximity. Halibut bottom longline harvesting (shelf edge and The Gully trough area) may be more challenging to locate, and the FLO, communications with harvesters and other contacts can assist in identifying active areas and local risks. As the data indicate, ground fisheries are year-round but with high points in July and August. For the small hagfish pot fishery (6-7 individuals) along the shelf break, contacts via DFO managers are advised.

Large Pelagic Species: Large pelagic species harvesting in the Study Area occurs near or off the edge of the Shelf, some in very deep waters. The physical extent of floating longlines poses a higher than usual risk of entanglement with towed hydrophone streamers or other equipment (harmful to both industries' gear), though the use of AIS on this fishing gear is helpful for seismic ships and other project vessels. AIS monitoring and at-sea radio communications are essential if working near those areas. Operations usually take place in most months except winter, so at the same time as seismic surveys. Monitoring the seasonal movement of the fleet (typically west to east) is useful; contacts can be assisted through the Nova Scotia Swordfishermen's Association.

Shellfish: Harvesting is conducted in the Study Area by both large and smaller vessels, depending on the species. In recent years, harvesting has occurred from 1 April to 31 August in CFAs 24 and 23. The fixed-gear pots (60-70 per license) are fished by smaller boats, and pots may be left in the water unattended for many days at a time depending on weather and other factors. Use pre-operations communications and at-sea contacts, and the advice of the FLO if there might be spatial/temporal overlap. The red crab fixed-gear (pot) fishery that is indicated along the shelf edge within the Study Area is smaller but poses similar challenges to snow crab. Mobile-gear scallop draggers that might be in the area at any time (near and north of Sable Island, and Western Bank / Sable Island Bank) are larger vessels and may be contacted at sea. Mobile-gear shrimp trawling is possible year-round but is usually active in spring and summer. Sea clam harvesting is undertaken by a large semi-stationary vessel and on-shore and at-sea contacts are advised.

6 POTENTIAL EFFECTS OF THE ENVIRONMENT ON OFFSHORE EXPLORATION ACTIVITIES

The physical environmental setting, socio-economic conditions and the potential for adverse effects are essential considerations in the planning, review and conduct of oil and gas exploration and development activities. These efforts help ensure that human health and safety, equipment and infrastructure, and the environment are appropriately protected.

Knowledge of the bathymetry, wind, wave, current and any ice conditions likely to be encountered is required for selection of the type and size of seismic, drilling and supply vessels and other equipment required. Planning and safe operations for activities may also be affected by vessel or platform icing, visibility, and to a lesser extent air and sea temperatures. Time of year will be a key factor in determining the level of risk, or effect, which may be encountered for any of these environmental parameters.

A regional overview of the physical environment of the Study Area is presented in Section 3.1.

6.1 Potential Effects

Wind and waves have the potential to increase stress on surfaces and vessels and disrupt scheduling, operations and, for seismic surveys, affect survey data quality. Vessels and equipment must be able to withstand the range of conditions expected, or forecast, to be encountered. Seismic survey operations may typically be limited by wind or sea conditions.

For the Study Area gale force winds (17.2-24.4m/s, 34-47 knots) in the spring and summer and storm force winds (24.5-32.6m/s, 48-63 knots) in the fall and winter can be expected. Wave conditions within the Study Area are most severe during the winter months with maximum significant wave heights near 13 metres. Wave conditions may contribute to incidents of potential safety and environmental concern. In March 2016, the crew of the Stena IceMAX (drilling the Cheshire L-97 exploratory well in the Canada – Nova Scotia offshore area) lost a riser in heavy seas. Though prevention measures were in place, the system was unable to compensate for the difference between rise and fall of the riser and heave of the vessel causing the Lower Marine Riser Package to be released to the ocean floor (CNSOPB 2016). Additionally, due to the presence of tropical systems passing through the area from June through November, large seas and hurricane force winds may be experienced during any season.

Currents may be a factor depending on equipment or operations potentially affected. Current magnitudes will vary depending on depth, time of year and location, but may be expected to be on the order of 0.02 to 0.10 m/s on average with maximum speeds generally from about 0.14 m/s to 0.54 m/s.

Any vessels and materials used must be rated to function and adhere to the appropriate standards and codes for expected conditions. Sea surface temperatures will seldom be less than about -1°C (March). The combination of low air and sea temperature, strong winds, and high waves can lead to vessel icing. The vessel itself is also a critical factor for icing potential: the vessel size, hull design which affects amount of spray produced during sailing, and amount of vessel rigging which can act as a 'trap' for spray accumulation, are considerations. The risk of vessel or platform icing is greatest in the northern portion of the Study Area.

While the summer to early fall generally favours calmer seas, ceiling and visibility restrictions may be a factor for shipping or flying activities, particularly in summer. Annually, poor or very poor visibility less than the 2 km can be expected from 10.8 percent of the time with July have the highest occurrence of poor visibility (23.5% of the time).

Sea ice can be expected to encroach on the northern most sections (north of Sable Island) of the Study Area 1-15 percent of the time (Canadian Ice Service, 2011). The remainder of the Study Area is expected to remain ice free. Due to warming and the subsequent melting of sea ice in the Arctic, the frequency of presence of sea ice is expected to deteriorate within the Study Area. The same warming of the Arctic however may have an opposite effect on the presence of icebergs. While icebergs have not been recorded within the Study Area during the study period, an increase in the number of icebergs due to an increase in calving of the Greenland glaciers may result in an increase in the number of icebergs affecting the Study Area.

Depending on the nature, location and timing and duration of specific offshore activities, the potential effects of the biological environment may also be a consideration in planning and undertaking such programs. Potential effects may include biofouling (or colonization of offshore structures by epibenthic communities), plankton blooms and possible interference during visual inspections of structures.

6.2 Essential Preparation

To mitigate the effects of the physical environment on any offshore activities there must be careful and adequate planning, design and operations procedures that consider the expected normal and extreme conditions that may be encountered. In concert with this, adequate monitoring and forecasting of conditions are required.

6.2.1 Bathymetric Conditions

Bathymetric configuration, atmospheric forcing conditions and resulting ocean circulation patterns are of critical importance for operational planning, navigation and emergency response or oil spill response operations. Climatological trends are important to consider for strategic, long-term planning but real-time observations and forecasts of ocean currents, wind and wave conditions should be considered for operational purposes.

The Study Area is rich with physical oceanographic features, highly variable spatial distributions of air and sea temperatures, salinity, currents and waves that change on a seasonal, as well as interannual basis. Therefore, it is important that project-specific EAs investigate and incorporate a more detailed representation of the environmental conditions that may differ from those of the broader Study Area.

6.2.2 Ice Conditions

Based on the CIS Ice Charts from 1980 – 2010, ice incursion is limited to the northernmost section of the Study Area. Also, the International Ice Patrol database has not recorded any iceberg sightings within the Study Area over the period of 1993 through 2019. Since icebergs along the East Coast of Canada are mainly formed from the deterioration of the Greenland glaciers, there is potential for an increase in the number and size of icebergs due to climate change.

According to Peng et al. (2020), sea ice conditions in the Arctic will continue to deteriorate with the Arctic becoming ice-free by 2054 under the RCP4.5 climate scenario, and by 2042 under the RCP8.5 scenario, with the decline of sea ice following a near-linear trend. It can be assumed, therefore, that the frequency of presence of sea ice within the Study Area will also lessen in the future.

The potential for icing of superstructures in the Study Area is significant, with a combination of near-freezing surface water temperatures in winter and seasonal wind conditions favourable to icing. Icing can pose a safety hazard to crews and vessels operating offshore and mitigative measures should be considered during operational planning.

Monitoring, forecasting and reporting of atmospheric, oceanographic and ice parameters are required for operators of oil and gas drilling exploration programs and offshore drilling installations to support the safe and prudent conduct of operations, emergency response and spill countermeasures and to comply with the Offshore Physical Environment Guidelines (NEB et al. 2008). For marine seismic activities, weather forecasting and observation programs are prudent measures to ensure safe and efficient planning and operations of activities and to mitigate weather and sea related effects.

Monitoring and forecasting of weather conditions enable planning of work scopes within appropriate weather windows. They also support safe supply and crew change operations via helicopter and supply vessels. Through monitoring and forecasting, project activities can be adjusted to maintain a safe working environment, and subsequent reporting establishes a sound and reliable environmental database. This in turn assists in the implementation of environmental effects monitoring programs and assessing future operational needs. It also enables regulators to perform their duties related to EA, review of design and operating criteria and to review and approval of applications and contingency plans.

Eastern Canada has a history of oil and gas exploration and a depth of experience to apply to any future projects. Given the resources and expertise available to potential proponents, together with the support and oversight of regulatory agencies, the highest standard of careful planning and preparation to avoid any significant effects are anticipated.

7 CUMULATIVE ENVIRONMENTAL EFFECTS

An integral component of environmental assessment is a cumulative effects assessment. The Canadian Council of Ministers of the Environment (CCME) has defined the operational concepts and processes that explain the importance of Cumulative Effects Assessment (CEA). These principles form the foundation upon which provincial, territorial and federal agencies have advanced cumulative effects assessment.

7.1 Natural and Anthropogenic Sources of Environmental Change

Not all impacts or effects of a new development are apparent at the onset, and it is understood that multiple natural and human activities can result in significant cumulative effects on the environment. Cumulative effects are changes to the environment caused by new activities in combination with other past, present and future human actions. Cumulative effects occur when there are new or additional interactions between activities, new or additional interactions between activities and the environment, and / or new or additional interactions between components of the environment. The incremental effects of new activities may be significant even though the effects of each individual activity are considered insignificant when assessed independently.

7.2 Cumulative Environmental Effects Analysis

Cumulative environmental effects (CEE) that may result from offshore exploration programs in the Study Area are assessed for each VC, to the degree possible. CEE assessment at the SEA level is constrained by the fact that the specific activities, and the spatial and temporal boundaries of these activities, are not known at this stage. However, the potential environmental effects for oil and gas activities assessed in this SEA can be summarized as follows:

- Possible injury or mortality due to exposure to underwater sounds such as seismic sound at very close range (particularly so for immobile species);
- Possible injury or mortality from interaction between vessels and gear with wildlife (e.g., vessel strikes, entanglement).
- Possible avoidance of locations that would otherwise be used by marine wildlife, due to underwater noise or other disturbances (such as ensonified areas during seismic surveys, drilling activity, vessel traffic), which may affect the presence and abundance of marine animals as well as impact their movements / migration, feeding, communication, reproduction, rearing, nursery or other important activities or areas;
- Attraction of marine wildlife to rigs or vessels and their lighting / flares or other environmental discharges, with increased potential for injury, mortality, contamination or other interactions;
- Interference with (and the masking of) sounds within the marine environment that originate from or are used by marine animals, such as in communication, the identification and detection of prey and other activities;
- Possible contamination of marine wildlife and their habitats or feed sources as a result of environmental discharges due to planned Project activities and/or accidental events (such as drill wastes, deck drainage, large spills);
- Possible alteration of benthic habitats due to the discharge and deposition of drill cuttings, placement of other infrastructure or equipment or other activities, as well as possible accidental spills;
- Changes in the availability, distribution or quality of feed sources for marine wildlife resulting from offshore petroleum activities and their environmental emissions; and

- Changes in presence, abundance, distribution and/or health of marine species resulting from exposure to accidental spills from offshore exploration or production installations or vessels (through physical exposure, ingestion, effects on prey and habitats, etc.).

7.2.1 Species of Conservation Concern

Cumulative effects on marine species of conservation concern can result from the combined effects of offshore oil and gas exploration activities, general marine traffic and other human activities and associated disturbances. For instance, each of these may result in direct or indirect effects on species of conservation concern, their food sources, and / or their breeding, rearing, foraging, or spawning habitats. These effects may interact with effects from other unrelated threats to marine ecosystems, such as climate change, sea level rise, marine traffic, fishing or marine pollution, to create a greater effect than would be expected from these factors on their own. Observed natural and / or anthropogenic changes in the environment of the SEA Study Area (e.g., water temperature changes and associated differences in the presence, location and timing of fish species and populations in the region) may also have effects on the occurrence and distribution of species of conservation concern. These species tend to be less resilient to environmental changes than species with more secure populations, thus cumulative effects may be greater on species of conservation concern.

There are currently no active exploration licences and no seismic surveys, seabed surveys, offshore drilling or production projects occurring in the Study Area, nor are any planned. The SOEP and Deep Panuke projects are decommissioned and abandoned. Post-abandonment monitoring of the Ovintiv Deep Panuke Project is completed. ExxonMobil has completed its post-abandonment monitoring survey, with follow-up monitoring occurring in 2022 in one well area.

7.2.2 Protected and Special Areas

The potential environmental effects of future exploration programs in the SEA Study Area may interact with each other and / or with other projects and activities in the region to result in cumulative environmental effects. Existing (and any future) protected areas in the Study Area and elsewhere will not be subject to direct effects by such activities within their boundaries due to regulatory restrictions (see Section 3.2.10). However, they could be affected by offshore oil and gas activities that may occur in adjacent areas, by way of associated visual, noise or other disturbances. These disturbances could result in hydrocarbon contamination, loss of protective and foraging habitat, and an increase in predation of sensitive species and habitats in these areas. Other special areas have no protection except in some cases where fishing activities are restricted. Protected and special areas may also be subject to natural stressors, both on-going and potential.

Consideration of potential cumulative environmental effects resulting from multiple stressors affecting protected and special areas would be part of planning and decision-making regarding any future offshore oil and gas activities in the region. The CNSOPB has the authority to approve offshore activities and can therefore limit the potential for overlap and interaction between individual exploration programs and their potential effects, as well as the effects of these activities in combination with those of other unrelated projects and activities in the region.

7.2.3 Commercial Fisheries and Other Ocean Uses

Cumulative effects on marine commercial fisheries can occur as a result of the combined effects of offshore oil and gas exploration and/or production activities, general marine traffic and other human activities and associated disturbances within the marine environment. Each of these may result in, for example, direct spatial conflict with fishing activity, damage to fishing equipment, ecosystem effects on fish resources and/or other effects on fisheries in the Study Area. Overlapping uses of marine space can result in potential cumulative environmental effects. Observed natural and/or anthropogenic changes in the environment of the Study Area, such as water temperature changes and associated differences in the presence, location and timing of fish species and populations in the region, could have an effect upon the nature and distribution of fishing activity. These effects can be more pronounced as increased development and activity place greater demands on marine spaces.

The establishment of safety zones around drill sites can prevent potential direct spatial conflicts, but this does not mitigate the wider cumulative effects if other marine use activities are increasing in adjacent areas. Any potential for cumulative effects will, however, depend on the eventual intensity and spatial and temporal nature of these activities. Avoiding or reducing such overlap can be addressed through proper planning and review of individual projects and activities as they are defined and proposed (e.g. scheduling and distributing a seismic program to begin only after a long line fleet has left that area).

The potential for interference with fishing activity by drill rigs, seismic surveying or supply vessels as well as general marine traffic to and through the Study Area can be mitigated through proper marine spatial planning, and good communication between the various marine activities (such as Notices to Mariners, participation in Fisheries Advisory meetings, etc.). Wherever possible, seismic surveys should be planned to coordinate program activities with the fishing industry to reduce potential conflict with commercial fishing activity during peak fishing times. In addition, routing supply vessel traffic to avoid the more active fishing aggregations in a region is a practice generally used for activities in the marine environment, with common routes used where possible.

Cumulative effects on other marine components, activities and ocean users can occur as a result of the combined effects of offshore oil and gas exploration activities, general marine traffic and human activities associated with other industrial operations, commercial shipping and transportation, military activities, tourism and recreation as well as the presence of subsea components such as communications cables and unexploded explosive ordnances. Any of these activities, and other uses of the marine environment including the fishery, may result in direct disturbances of one another’s operations and convenient use of marine resources both in terms of geographic area and time of year.

Certain human uses of the marine environment occur year-round and these include commercial and industrial activities and related marine shipping. General marine shipping and transportation of people and goods occur year-round, and military training exercises are conducted throughout the year. Transportation to and from Atlantic Canadian ports can also occur at any time of year. Tourism and recreation activities generally occur from May to October and often in coastal areas. Unexploded explosive ordnances and submarine cables exist on an ongoing basis, are generally not affected by activities that are limited to the ocean’s surface but require special consideration for subsea activities.

Mitigating the effects of offshore oil and gas exploration activities on other marine components, activities and ocean users requires a process of consultation and communications to avoid any unwanted interactions, avoid damage to infrastructure and equipment, limit inconvenience to other users, ensure the safety of the general public and other commercial and industrial users and to enable other sectors (and the communities that rely upon them) to conduct their usual activities and business operations. There are currently no seismic surveys, seabed surveys, offshore drilling or production projects occurring in the Study Area, nor are any planned, thus limiting potential for interaction between the effects of these activities and commercial fisheries.

In addition, new resource development projects along the coast may increase marine transportation. Mitigation of potential cumulative effects will require active communication to ensure these projects can proceed in a manner that is constructive and can avoid potential cumulative effects.

7.2.4 Indigenous Fisheries

Cumulative effects on Indigenous fisheries align with those for commercial fisheries in general. These effects can result from the combined effects of offshore oil and gas exploration activities, general marine traffic and other human activities and associated disturbances within the marine environment. For example, each of these may result in direct spatial conflict with fishing activity, damage to fishing equipment, ecosystem effects on fish resources and / or other effects on fisheries in the Study Area. Overlapping uses of marine space can result in adverse cumulative environmental effects. Observed natural and / or anthropogenic changes in the environment of the Study Area, such as water temperature changes and associated differences in the presence, location and timing of fish species and populations, could affect the nature and distribution of fishing activity. These effects can be more pronounced as increased development and activity place greater demands on marine spaces.

The establishment of safety zones around drill sites is an important mitigation measure to prevent potential direct spatial conflicts, but this does not mitigate the wider cumulative effects if other marine use activities increase in adjacent areas. Any potential for cumulative effects will depend on the eventual intensity and spatial and temporal nature of these activities. Avoiding or reducing such overlap can be addressed through planning and management of proposed projects and activities.

The potential for interference with fishing activity by drill rigs, seismic surveying or supply vessels as well as general marine traffic to and through the Study Area can be mitigated through proper marine spatial planning, good communication between the various marine activities (such as Notices to Mariners, participation in Fisheries Advisory meetings, etc.). Wherever possible, seismic surveys should be planned to coordinate program activities with the fishing industry to reduce potential conflict with commercial communal fishing during peak fishing times. In addition, practices such as routing supply vessel traffic to avoid more active fishing areas is a practice generally used to reduce conflict in the marine environment.

In addition, new resource development projects along the coast may increase marine transportation. Mitigation of potential cumulative effects will require active communication to ensure these projects can proceed in a manner that is constructive and can avoid potential cumulative effects.

7.3 Summary

The environment of the Middle and Eastern Scotian Slope and Sable Island Bank offshore area – including fish and fish habitat, marine birds, marine mammals and sea turtles, sensitive and special areas, fisheries and other components – has been influenced by a variety of natural and anthropogenic factors. These include past and on-going fishing activity, oil and gas exploration and development projects, vessel traffic and other human activities, as well as effects of climate change and other biophysical processes, all of which are reflected in the existing (baseline) environmental setting of the region as described in Section 3. These previous, on-going, and future activities and processes will continue to affect the environmental conditions and characteristics of the region, in combination with each other and with possible future oil and gas exploration and development projects in the area. While there are not currently any oil and gas exploration projects planned for the Study Area, fishing activity and other marine vessel traffic is active and will continue.

The nature, magnitude and spatial and temporal distribution of any environmental effects from any potential future offshore oil and gas projects would have to be assessed and evaluated through project-specific analyses as part of individual EA reviews. Cumulative effects assessments that are undertaken as part of such EAs typically utilize approaches and methods that allow for an analysis and consideration of the effects of past, present and reasonably foreseeable future projects and activities, as well as whether and how the effects of these will interact or otherwise accumulate with those of the project in question. Avoiding or reducing such overlap between offshore oil and gas exploration and development projects and/or with other unrelated activities in the region (and therefore, any resulting cumulative effects) can and should be considered in planning and reviewing any individual projects and activities as they are defined and proposed.

8 INFORMATION AVAILABILITY, REQUIREMENTS AND OPPORTUNITIES

This SEA provides an overview of the VCs in the Study Area and is based on available information. The following sections identify important data gaps and information requirements recognized during the preparation of this report that may be relevant to strategic planning and decision-making at project (licensing) levels.

8.1 Species of Conservation Concern

Several SOCC are known to or have potential to occur in the Study Area either on a seasonal or year-round basis. For some species, including some marine mammals and sea turtles known to be at-risk, the available information is general in nature and only available for broad geographic regions. Detailed information on the occurrence, abundance and distribution of at-risk fish, birds, marine mammals and sea turtles is not available for all locations or times throughout the Study Area. Surveys for fish species are mainly limited to the Scotian Shelf and upper slope with less distribution information for fauna in deeper waters of the Study Area. Species occurrence and habitat use for the canyons in the Study Area are also not fully understood. For marine birds, this information is unavailable in most of the Study Area for winter, though it is generally available for the broader region (i.e., entire Scotian Shelf and Slope).

A lack of specific and essential information and knowledge about biological behaviour for many marine mammal, fish, turtle and bird species on the Scotian Shelf and Slope is recognized as challenging for decision-making. For instance, because marine birds are highly mobile, and much of the available survey data are not collected systematically (i.e., from vessels of opportunity), these data do not provide a complete representation of fine-scale distribution and abundance. Consequently, the assessment of marine and migratory birds has inherent gaps and biases. This lack of information, along with an incomplete understanding of the specific effects of some oil and gas exploration activities (such as seismic surveying) on marine animals is recognized as a data gap for this SEA, as it has been for previous SEAs in eastern Canada.

8.2 Protected and Special Areas

Protected and special areas are identified or designated by a variety of agencies with differing mandates and resources. For the most part, those portions of the Study Area (e.g., MPAs, Marine Refuges, SAR Critical Habitat, MBSs, National Parks and Reserves) formally protected through legislation for biological and ecological conservation purposes have been fairly well studied and information regarding their location, size, and important ecological / biological and / or socioeconomic features and value is publicly available. In addition, those areas identified as EBSAs have been subject to considerable analysis and ongoing refinement, and the subject of various published reports. The Government of Canada's Open Data portal provides spatial data for many of the protected and special areas discussed in this report. These data and information sources will be useful during planning, assessing and implementation stages of any future oil and gas activities in the region.

As discussed in Section 3.2.10, other areas have also been identified as being of interest or sensitive, though not formally protected. Information is available on the types and locations of SiBAs (i.e., significant concentration and predicted presence probability of corals and sponges) though detailed descriptions of these areas are not publicly available. Information on many IBAs is descriptive and often linked to MBS or provincial protected areas information where these intersect but detailed field surveys are not regularly conducted at IBAs. Thus, information on protected and special areas is inconsistent. In addition, scientific literature includes extensive publications on the effects of oil and gas exploration activities (and other human activities and natural phenomena) on marine species, which allows for robust analysis and predictions in EAs and monitoring.

However, literature regarding the potential effects on protected and special areas is limited and where available focused on marine species.

8.3 Commercial Fisheries and Other Ocean Uses

Much of the commercial fisheries data, including commercial communal fisheries data and other information is available through DFO. This includes DFO Maritimes Region and DFO national headquarters for the latest available digital datasets (e.g., geospatial, quantity and value tables). Other relevant GIS datasets are available through the Open Canada initiative (e.g., past RV survey transect locations, data from regional fisheries atlases). Published DFO documents, most available online, include Integrated Fisheries Management Plans (valuable, but sometimes dated) and publications through the Canadian Science Advisory Secretariat (CSAS): Research Documents, Science Advisory Reports, Science Responses and Proceedings. For most major commercial species, science updates are frequent, many annually, reflecting the preceding years' research. Current information on quotas, fisheries openings and closures are available for many (but not all) species of interest through DFO's Fisheries Management Decisions (Atlantic, Quebec and the Arctic). Information for large pelagic species (e.g., catch data, species status and quotas) are available through ICCAT. As noted throughout this SEA, consultations with individual DFO managers, scientists (e.g., for upcoming science surveys), fishing industry participants and associations and other agencies are important for accessing the most up-to-date information.

As discussed in Section 3.3.1, data gaps for harvesting locations, patterns and intensity in the Study Area are related to privacy screening, geographic resolution and currency of area-specific DFO datasets. Both geospatial datasets (DFO 2020a) and quantity / value tabular datasets (DFO 2020h) available to external planners are redacted based on protection of privacy policies. This redaction can – for some species in some areas – underrepresent the level of activity or suggest there is none. For the tabular datasets, data are only resolved to the UA level, and the geospatial data are aggregated into 11 x 7.5 km blocks. The availability of both datasets is typically three or more years behind the present year. Nevertheless, harvesting locations and patterns that can be evaluated (supplemented by the DFO literature and recent atlases like Rozalska and Coffen-Smout 2020) allow an understanding of Study Area fisheries dynamics, particularly since patterns are quite consistent year-to-year, unless there is a change in management measures (e.g., open season) or the introduction of a new fishery.

Several sources are available for documenting other ocean uses within the Study Area, but a full accounting of activity is not realistic, given the diversity of marine traffic (e.g., container ships, bulk cargo, barges, hydrocarbon and chemical tankers, cruise ships, private craft, other oil and gas exploration vessels) and the unpredictability of drifting sensors. Awareness of general human activities and use of the best available marine technology (e.g., radar, AIS, at-sea radio and satellite communications, and visual observation) can offset this gap. Simultaneous operation planning with any nearby concurrent oil and gas exploration operation is common within the industry. Contacts through DND/MARLANT are essential for current military awareness. Information for plotting the locations of fixed scientific stations and other known subsea infrastructure / artifacts is valuable, depending on project activities. Potential unknown UXO locations are clearly a data gap that should only be of concern in the case of seafloor interaction. Reporting anything discovered by operators helps to close the gap.

8.4 Indigenous Fisheries

Commercial communal fisheries information is provided by DFO for commercially harvestable species in the form of IFMPs, CHPs, annual management decisions and notices for each species in each commercial fishing area or NAFO Regulatory Area. This information is presented alongside commercial fisheries data and is subject to the same management decisions. As with any commercial fishing licenses, it is difficult to identify license activity without direct input from the associated groups. Therefore, proponents should seek input directly from Indigenous Groups to assist in the prediction of potential effects on Indigenous commercial communal fishing and Aboriginal and Treaty rights.

Commercial communal harvesting data and other information is integrated within the commercial fisheries sources (Section 8.3), subject to the same management regimes and included within the data, discussions and analysis presented in Section 3.3.2. Consequently, pathways, potential effects and mitigative measures would be similar to those for other commercial fisheries.

9 SUMMARY AND CONCLUSIONS

9.1 Summary of Mitigation Measures

Sections 9.1.1 to 9.1.4 provide a summary of mitigation measures often required by legislation or implemented as best practices during offshore oil and gas exploration activities, to avoid or reduce potential environmental effects in the SEA study area.

9.1.1 Seismic and Seabed Surveys and Vertical Seismic Profiling

These surveys include 2-D and 3-D seismic surveys (including wide-azimuth configurations), seabed surveys, electromagnetic, and gravity and magnetic surveys, and VSP. For practicality and summation purposes, seismic and seabed surveys and VSP activities have been addressed together, as the mitigation measures are similar for these activities. In addition, CNSOPB requires that surveys for potential future exploration programs in the Study Area must be completed in compliance with the *Geophysical, Geological, Geotechnical and Environmental Program Guidelines* (CNSOPB 2015).

The key mitigation measures to be taken into consideration when planning and designing a seismic survey program in the Study Area include:

- Spatial and temporal avoidance of known SAR and / or sensitive species and areas and / or times where possible in the planning and conduct of oil and gas activities;
- At a minimum, adherence to the Canadian Statement of Practice with respect to the Mitigation of Seismic Sound in the Marine Environment;
- Reduction of airgun source levels of offshore seismic programs to the minimum level practical for the survey;
- Use of a gradual "ramp-up" procedures during seismic programs;
- Establishment of a safety zone around the seismic air source array, which is monitored by a qualified Marine Mammal Observer;
- Shut-down of seismic sound source(s) during line changes and maintenance activities;
- Minimizing the amount of associated vessel and aircraft traffic and the avoidance of low-level aircraft operations wherever possible;
- Minimizing environmental discharges and emissions from planned operations and activities;
- Installation and use of oil / water separators to treat contained deck drainage;
- Treatment of operational discharges prior to release in compliance with the OWTG and other applicable regulations and standards;
- Minimizing use of artificial lighting on offshore vessels, where possible;
- Search protocols and procedures for collection and release of marine and migratory birds that become stranded on vessels, using the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC, 2017) and *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms (ECCC, 2021)* as guidance ;
- Inspections of ship hulls and equipment for invasive species and associated follow-up maintenance;
- Maximizing use of local vessels and equipment to reduce the spread of invasive species;
- All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and*

Management Regulations of the *Canada Shipping Act (2001)* ;

- Adherence to ECCC's Guidelines to Avoid Disturbance to Seabird and Waterbird Colonies in Canada;
- Appropriate handling, storage, transportation and onshore disposal of solid and hazardous wastes;
- Selection and screening of chemicals under the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands;
- Use of turtle guards to minimize potential for turtle entanglement;
- Mitigations for SOCC may apply to protected and special areas;
- Adherence to legislation related to conservation of protected areas;
- Planning oil and gas activities to avoid key fishing areas / harvesting times to the extent possible;
- On-going communications, information gathering, analysis and coordination with harvesting interests, and continued monitoring of fishing plans and activities;
- Use of a scout or guard boat for seismic surveys;
- Timely issuance of NAVWARNs and NOTMARs and other notifications;
- Project ships monitoring and communicating (through radar, AIS, direct at-sea radio communications), with other vessels in areas of operations including using AIS to be aware of marked fishing gear;
- Reporting of any fishing gear contacts by oil and gas activities as per the C-NLOPB / CNSOPB Incident Reporting and Investigation Guideline; compensation in case of gear and / or vessel damage;
- Communication with DFO scientists to reduce overlap of seismic operations with research survey areas;
- Establishing and communicating locations of safety zones or any other closed areas;
- Project site surveys will also detect unknown subsea infrastructure or artifacts before drilling;
- Contacting DND to determine if any UXOs may be present in a drilling or other subsea activity area; and
- Contacting DND to determine if any military exercises are planned during the program timeline.

9.1.2 Exploration Drilling and Well Abandonment

The CNSOPB regulates offshore drilling activities through the *Nova Scotia Offshore Drilling and Production Regulations (2009)*. The associated guidelines detail the approvals, authorizations and conditions required for drilling in offshore Nova Scotia of which the primary approvals are an Operations Authorization and a Well Approval. Future EPPs and project-specific EAs should address, at a minimum, mitigation measures identified below. It is reasserted that these measures are general in nature and will be required to be re-visited to reflect project-specific details.

- Avoidance of known SAR and / or sensitive species and areas and / or times where possible in the planning and conduct of oil and gas activities;
- Reduction of airgun source levels of offshore seismic programs (including VSP) to the minimum level practical for the survey;
- Use of a gradual "ramp-up" procedures during seismic (including VSP) programs;
- Establishment of a safety zone around a seismic air source array, if it is in the water column, which may require monitoring by a qualified MMO;
- Minimizing the amount of associated vessel and aircraft traffic and the avoidance of low-level aircraft

operations wherever possible;

- Minimizing environmental discharges and emissions from planned operations and activities;
- Installation and use of oily / water separators to treat contained deck drainage;
- Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands;*
- Treatment of operational discharges prior to release in compliance with the OWTG and other applicable regulations and standards;
- Minimizing use of artificial lighting on offshore vessels and platforms, where possible;
- Search protocols and procedures for collection and release of marine and migratory birds that become stranded on offshore vessels and installations, using the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC, 2017) and *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms* (ECCC, 2021) as guidance;
- Inspections of ship hulls and equipment for invasive species and associated follow-up maintenance;
- All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act (2001);*
- Adherence to ECCC's *Guidelines to Avoid Disturbance to Seabird and Waterbird Colonies in Canada;*
- Avoiding or minimizing flaring, and use of high efficiency burners when flaring is necessary;
- Appropriate handling, storage, transportation and onshore disposal of solid and hazardous wastes;
- Appropriate treatment or disposal of water contaminated with hydrocarbons generated during flow testing;
- Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands;*
- Use of mechanical procedures during well completion and abandonment activities where possible;
- Where blasting is required in well abandonment, appropriate design of such programs;
- Pre-drilling surveys of the seabed to assess the potential presence of sensitive benthic habitats. If sensitive benthic habitat is identified, the drill site may be re-located or cuttings re-directed such that it is not affected;
- Use of mitigations for SOCC as applicable to protected and special areas;
- Adherence to legislation related to conservation of protected areas;
- Planning oil and gas activities to avoid key fishing areas / harvesting times to the extent possible;
- On-going communications, information gathering, analysis and coordination with harvesting interests, and continued monitoring of fishing plans and activities;
- Timely issuance of NAVWARNs and NOTMARs and other notifications;
- Project ships monitoring and communicating (through radar, AIS, direct at-sea radio communications), with other vessels in areas of operations including using AIS to be aware of marked fishing gear;
- Reporting of any fishing gear contacts by oil and gas activities as per the C-NLOPB / CNSOPB Incident Reporting and Investigation Guideline; compensation in case of gear and / or vessel damage;
- Establishing and communicating locations of safety zones or any other closed areas;

- Employing a sequential approach to drilling multiple wells to limit the area occupied at any one time;
- Communicating locations of any subsea infrastructure left in place to appropriate authorities for inclusion on nautical charts for the information of harvesters, as applicable;
- Project site surveys will also detect unknown subsea infrastructure or artifacts before drilling;
- Contacting DND to determine if any UXOs may be present in a drilling or other subsea activity area; and
- Contacting DND to determine if any military exercises are planned during the program timeline.

9.1.3 Vessel and Helicopter Traffic

Supply vessels and helicopters that are used to transport personnel, equipment and materials to and from drilling rigs during offshore drilling programs, seismic vessels, and stand-by vessels all have the potential to effect VCs. The CNSOPB's Geophysical, Geological, Environmental and Geotechnical Program Guidelines include various requirements and mitigation measures which are intended to avoid or reduce the potential for interactions with marine species and habitats, commercial / Indigenous fisheries and other ocean users. The key mitigation measures to be taken into consideration when planning oil and gas exploration activities in the Study Area include:

- Avoidance of known SAR and / or sensitive species and areas and / or times where possible in the planning and conduct of oil and gas activities (spatial and temporal restrictions);
- Minimizing the amount of associated vessel and aircraft traffic and the avoidance of low-level aircraft operations wherever possible;
- Minimizing environmental discharges and emissions from planned operations and activities;
- Installation and use of oily / water separators to treat contained deck drainage;
- Treatment of operational discharges prior to release in compliance with the OWTG and other applicable regulations and standards;
- Minimizing use of artificial lighting on offshore vessels, where possible;
- Search protocols and procedures for collection and release of marine and migratory birds that become stranded on offshore vessels, using the most recent versions of ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Offshore Atlantic Canada* (ECCC, 2017) and *Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms* (ECCC, 2021) as guidance;
- Inspections of ship hulls and equipment for invasive species and associated follow-up maintenance
- All foreign vessels operating in Canadian jurisdiction to comply with the *Ballast Water Control and Management Regulations* of the *Canada Shipping Act (2001);*
- Adherence to ECCC's *Guidelines to Avoid Disturbance to Seabird and Waterbird Colonies in Canada;*
- Appropriate handling, storage, transportation and onshore disposal of solid and hazardous wastes;
- Selection and screening of chemicals under the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands;*
- Planning oil and gas activities to avoid key fishing areas / harvesting times to the extent possible;
- On-going communications, information gathering, analysis and coordination with harvesting interests, and continued monitoring of fishing plans and activities;
- Timely issuance of NAVWARNs and NOTMARs and other notifications;

- Project ships monitoring and communicating (through radar, AIS, direct at-sea radio communications), with other vessels in areas of operations including using AIS to be aware of marked fishing gear;
- Reporting of any fishing gear contacts by oil and gas activities as per the C-NLOPB / CNSOPB Incident Reporting and Investigation Guideline; compensation in case of gear and / or vessel damage;
- Project vessels following established shipping lanes as much as possible;
- Employing a sequential approach to drilling multiple wells to limit the area occupied at any one time;
- Establishing and communicating locations of safety zones or any other closed areas; and
- Contacting DND to determine if any UXOs or exercises may be in a drilling or other subsea activity area.

9.1.4 Accidental Spills

Inherent in the nature of oil and gas activities is the risk of releases of hydrocarbons to the surrounding environment. Given the reliance of many Nova Scotian coastal communities on the marine environment for livelihood (fisheries), recreation and tourism, accidental oil spills take on a special significance.

Drilling technology continues to advance and operators are expected to make use of best available technology appropriate for their operation. Before any operator can carry out activity in the Canada-Nova Scotia offshore area, they must submit an application to the CNSOPB that demonstrates that they can meet all of the stringent safety and environmental regulatory requirements during their program, and that any potential risks have been mitigated to be as low as reasonably practicable. This includes drilling of deep-water wells. The specifics of well depth and associated risks and mitigation required must be assessed in detail in a project-specific IAs. This includes spill modelling, which considers well design and the surrounding environment, including depth and any other pertinent topographical features. The CNSOPB requires preparation and submission of Environmental Protection Plans (EPP) for offshore drilling activities; an EPP includes identification of potential environmental emergencies and hazards and appropriate emergency response plan and spill response plan that would be implemented in such situations.

Additionally, to address the potential effects on the economy should a significant spill occur, the CNSOPB has implemented a guideline to identify compensation sources, *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (November 2017). Specifically, the guidelines are intended to describe mechanisms available to potential claimants for actual loss or damage related to spills associated with petroleum exploration activities and outline the CNSOPB's regulatory and administrative roles respecting compensation payments for actual loss or damage directly attributable to accidental spills from offshore operations.

9.2 Conclusions

In Nova Scotia, the environmental planning process, which includes EA, project specific environmental management plans, regulatory permitting, and compliance programs, can be used to develop detailed guidance on measures to prevent or minimize adverse effects on the environment. Consultation and communications, inspections and audits, and compliance and monitoring regimes are developed and implemented to enforce regulatory requirements. Through planning, consultation, communications and issues management, most adverse aspects of oil and gas exploration activities can be avoided, mitigated or influenced for the good of the environment and other resource users, as well as oil and gas exploration activities themselves. Summaries of specific planning considerations for each of the VCs are provided in Sections 9.2.1 to 9.2.4.

9.2.1 Species of Conservation Concern

9.2.1.1 Marine Fish

Various fish species designated as being at risk (and formally protected) under the SARA and/or the NSESA are known or likely to occur in the Study Area, including Atlantic salmon, white shark and several species of wolffish.

Several other species known or likely to occur in the Study Area have also been evaluated and designated by COSEWIC but are not currently protected under SARA. In many cases, these species occur in expected habitat zones during some seasons and / or have somewhat predictable migrations. For example, significant aggregations of a given Atlantic salmon population can occur near natal estuaries when smolt leave rivers for marine migrations (spring) and as adults return for spawning migrations (summer). Various other COSEWIC-listed species aggregate for migration and spawning (e.g., Atlantic cod) or are restricted to limited areas.

9.2.1.2 Marine and Migratory Birds

Various seabird and land bird species designated as being at risk (and formally protected) under the SARA and / or the NSESA are known or likely to occur in the Study Area. Of these species, Roseate Tern and Ipswich Sparrow are known to breed on Sable Island.

Several other bird species known or likely to occur in the Study Area have also been evaluated and designated by COSEWIC and / or IUCN but are not currently protected under SARA. This includes Leach's Storm-petrel, a species that breeds on Sable Island and was recently assessed as Threatened by COSEWIC. In many cases, these species occur in expected habitat zones during some seasons and / or have somewhat predictable migrations. For example, Leach's Storm-petrel are migratory and are only expected to be present in the Study Area from spring to fall.

9.2.1.3 Marine Mammals and Sea Turtles

Five marine mammal species (i.e., blue whale, fin whale, North Atlantic right whale, northern bottlenose whale, Sowerby's beaked whale) and two sea turtle species (i.e., leatherback and loggerhead) designated as being at risk (and formally protected) under the SARA Schedule 1 are known or likely to occur in the Study Area. Sea turtles use the waters within the Study Area as foraging and migratory habitat (James et al. 2005, DFO 2020r). The marine mammals are primarily baleen whales and large toothed whales. These species can occur in the Study Area year-round and particularly at the Gully submarine canyon. One other species (harbour porpoise) are listed under SARA but are not listed under Schedule 1. Two other species, sei whale and killer whale, known or likely to occur in the Study Area have also been evaluated and designated by COSEWIC, but the Northeast Atlantic populations are not currently protected under SARA. In many cases, these marine mammal species and the protected sea turtle species are likely to have higher occurrences in the area during feeding and migration seasons.

9.2.2 Protected and Special Areas

Various protected and special areas are present within or adjacent to the Study Area, these include an MPA, a marine refuge, critical and important habitat of species registered under SARA, an MBS, a national park reserve, fisheries closure areas, EBSAs, SiBAs and an IBA. Note that the Sable Island area is protected as an MBS and national park reserve and also identified as an IBA and an EBSA.

In Nova Scotia, operators of oil and gas activities are required to meet regulatory requirements such as legislation, regulations, guidelines and policies including those that protect special and sensitive habitats.

9.2.3 Commercial Fisheries and Other Ocean Uses

Based on the available information regarding commercial marine fisheries likely to occur in the Study Area, particular consideration should be given to intensively fished areas and times to help avoid or reduce potential interactions between the oil and gas and fishing sectors within the Study Area. A variety of commercial fisheries occur within and throughout the Study Area and adjacent regions, several year-round, and the region is characterized by a complex spatial and temporal pattern of fishing activity. The overall fishing effort is widely distributed throughout the Study Area, and varies depending on the season, the targeted species and the types of gear employed. Each of the commercial fisheries contributes significantly to employment and income throughout the region's fishing communities.

On-going communication between offshore oil and gas operators and the fishing industry has been and remains the most effective means to ensure such activities are carried out in a manner to avoid or reduce adverse interactions between the oil and gas and fishing sectors. NAVWARNs and other communications, use of FLOs, the CNSOPB's Fisheries Advisory Committee have been particularly useful in creating and maintaining open and ongoing dialogue between the two industries, for strategic decision-making and to foster a proactive and cooperative approach to identifying and addressing issues or concerns.

Aside from the fishing industry, various human activities and infrastructure exist within the marine environment of the Study Area. These include shipping and transportation transits and military exercises that may interact with seismic surveys and other vessel movements. Both drifting and moored, subsea and surface scientific sensors are deployed in parts of the Study Area, which also includes unexploded explosive ordnances and marine communications cables that may require special attention, particularly when planning exploratory drilling programs. Other petroleum industry operations (exploration and production) have been active in the area in the past and some subsea artifacts remain, such as portions of pipelines.

If new oil and gas opportunities arise, full consideration must be given to minimizing potential negative effects and optimizing the benefits of exploration activities. As a result, attention must be given to a variety of mitigation measures, many of which are well established and proven effective in offshore Nova Scotia and in other jurisdictions. Due to the longstanding involvement of local industries in the marine environment and the recognized ecological significance of some of the marine environments in the Study Area, consideration should be given to enhanced mitigation measures as identified through the project-specific EA process. These could include buffer zones around designated sensitive use areas and fishing grounds, and introduction of greater seasonal flexibility for exploration activities to minimize temporal conflicts. It is understood that local engagement will be required to facilitate mitigation, and to enhance mutual benefits from any new project.

9.2.4 Indigenous Fisheries

Commercial communal fisheries data (e.g., quantities and values) are included within general DFO fisheries data. A variety of commercial communal fisheries may occur within the Study Area and adjacent regions throughout the year. The general fishing effort is widely distributed throughout the Study Area and high value commercial fisheries contribute significantly to employment and income for fishing communities. For Indigenous groups, commercial communal fisheries also provide revenue for services and infrastructure for community members.

Based on the available information regarding marine fisheries in the Study Area and adjacent regions, consideration should be given to selected fishing activities, areas and times to help avoid or reduce potential interactions between oil and gas exploration activities and Indigenous fisheries within the Study Area. Mitigations that have been legislated or identified for the fishing industry are also applicable to Indigenous fisheries.

Ongoing communication between offshore oil and gas operators and the fishing industry (including Indigenous groups and fishing organizations) has been and remains the most effective means to ensure activities are planned to avoid or reduce adverse interactions between the oil and gas and fishing sectors. NAVWARNs and other communications, use of FLOs, the CNSOPB's Fisheries Advisory Committee have been particularly useful in creating and maintaining open and ongoing dialogue between the two industries, and in fostering a proactive and cooperative approach to identifying and addressing any issues or concerns.

10 REFERENCES

10.1 Personal Communications

Atkinson, T. Nova Scotia Swordfishermen's Association, 2021 (Swordfish fisheries)

Campbell, A. Fisheries and Oceans Canada Maritimes Region Commercial Data Division, 2021 (Licensing)

Coffen-Smout, S. Fisheries and Oceans Canada Maritimes Region, 2021 (Fisheries mapping)

Harper, D. Fisheries and Oceans Canada Maritimes Region, 2021 (Fisheries science surveys)

Keyser, F. DFO Maritimes Region, 2021 (Fisheries science surveys)

MacDonald, C. Fisheries and Oceans Canada Maritimes Region, 2021 (Large pelagics fisheries)

Mussells, C. Fisheries and Oceans Canada Maritimes Region, 2021 (Fisheries science surveys)

10.2 Citations

AAPG (American Association of Petroleum Geologists). 2008. Available at: https://www.AAPG.org/.

Ainley, D. G., D. N. Nettleship, H. R. Carter, and A. E. Storey. 2020. Common Murre (*Uria aalge*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.commur.01

Allen, J. D., and J. A. Pechenik. 2010. Understanding the Effects of Low Salinity on Fertilization Success and Early Development in the Sand Dollar *Echinarachnius parma*. The Biological Bulletin 218:189–199.

Almeda R., Z. Wambaugh, Z. Wang, C. Hyatt, Z. Liu, and E.J. Buskey. 2013. Interactions between Zooplankton and Crude Oil: Toxic Effects and Bioaccumulation of Polycyclic Aromatic Hydrocarbons. PLoS ONE, 8(6): e67212.

Almeda, R., S. Baca, C. Hyatt, and E. J. Buskey. 2014. Ingestion and sublethal effects of physically and chemically dispersed crude oil on marine planktonic copepods. Ecotoxicology 23:988–1003.

Almeda, R., T. L. Connelly, and E. J. Buskey. 2016. How much crude oil can zooplankton ingest? Estimating the quantity of dispersed crude oil defecated by planktonic copepods. Environmental pollution 208:645–654.

Alvarez Piñeiro, M., M. Lage, S. Carril González-Barros, and J. Simal Lozano. 1996. Aliphatic hydrocarbon levels in turbot and salmon farmed close to the site of the Aegean Sea oil spill. Bulletin of environmental contamination and toxicology 57:811–815.

Amec. 2014. Eastern Newfoundland Strategic Environmental Assessment. Prepared for Canada-Newfoundland and Labrador Offshore Petroleum Board.

Amos, C. and A. Miller. 1990. The Quaternary stratigraphy of southwest Sable Island Bank, eastern Canada. Geological Society of America Bulletin. 102. 915-934.

Amos, C. L., Li, M. Z., Chiocci, F. L., La Monica, G. B., Cappucci, S., King, E.L., Corbani, F. 2003. Origin of shore-normal channels from the shoreface of Sable Island, Canada. Journal of Geophysical Research 108(C3), 3094.

Anderson Hansen, K., O.N. Larsen, M. Wahlberg and U. Siebert. 2016. Underwater hearing in the great cormorant (Phalacrocorax carbo sinensis): Methodological considerations. Proceedings of Meetings on Acoustics, 27: 010015.

Anderson Hansen, K., A. Maxwell, U. Siebert, O.N. Larsen and M. Wahlberg. 2017. Great cormorants (Phalacrocorax carbo) can detect auditory cues while diving. The Science of Nature, 104: 45.

Angus, W.D. and G. Mitchell. 2010. Facts Do Not Justify Banning Canada's Current Offshore Drilling Operations: A Senate Review in the Wake of BP's Deepwater Horizon Incident. Eighth report of the Standing Senate Committee on Energy, the Environment and Natural Resources. August 2010. Available at: https://sencanada.ca/Content/SEN/Committee/403/enrg/rep/rep08aug10-e.pdf

AORST-JIP (Arctic Oil Spill Response Technology – Joint Industry Programme). 2014. Environmental impacts of Arctic oil spills and Arctic spill response technologies: literature review and recommendations. Page 205.

Arkhipkin, A. I. and P. P. Fedulov. 1986. Diel Movements of Juvenile *Illex illecebrosus* and Other Cephalopods in the Shelf Water-Slope Water Frontal Zone off the Scotian Shelf in Spring. Journal of Northwest Atlantic Fishery Science 7:15–24.

Armsworthy, S.L., M.K. Trzcinski, and S.E. Campana. 2014. Movements, environmental associations, and presumed spawning locations of Atlantic halibut (*Hippoglossus hippoglossus*) in the northwest Atlantic determined using archival satellite pop-up tags. Mar. Biol., 161:645-656.

Arnberg, M., P. Calosi, J. I. Spicer, A. H. S. Tandberg, M. Nilsen, S. Westerlund, and R. K. Bechmann. 2013. Elevated temperature elicits greater effects than decreased pH on the development, feeding and metabolism of northern shrimp (*Pandalus borealis*) larvae. Marine Biology 160:2037–2048.

Arnold, J. M., S. A. Oswald, I. C. T. Nisbet, P. Pyle, and M. A. Patten. 2020. Common Tern (*Sterna hirundo*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.comter.01

ASM (American Society for Microbiology). 2011. A report from the American Academy of Microbiology: Microbes and Oil Spills FAQ. Page 16. ASM FAQ.

Baillie, S.M., G.J. Robertson, F.K. Wiese, and U.P. Williams. 2005. Seabird data collected by the Grand Banks offshore hydrocarbon industry 1999-2002: results limitation and suggestions for improvement. Canadian Wildlife Service Technical Report Series 434. V + 47 pp.

Baillon, S., J.-F. Hamel, V. E. Wareham, and A. Mercier. 2012. Deep cold-water corals as nurseries for fish larvae. Frontiers in Ecology and the Environment 10:351–356.

Baillon, S., J.-F. Hamel, and A. Mercier. 2014. Diversity, distribution and nature of faunal associations with deep-sea pennatulacean corals in the northwest Atlantic. PLoS ONE 9:14–16.

Baker, K. D., V. E. Wareham, P. V. R. Snelgrove, R. L. Haedrich, D. A. Fifield, E. N. Edinger, and K. D. Gilkinson. 2012. Distributional patterns of deep-sea coral assemblages in three submarine canyons off Newfoundland, Canada. Marine Ecology Progress Series 445:235–249.

Baker, A., P. Gonzalez, R. I. G. Morrison, and B. A. Harrington (2020). Red Knot (Calidris canutus), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.redkno.01

Bakke, T., J. Klungsøyr, and S. Sanni. 2013. Environmental impacts of produced water and drilling waste discharges from the Norwegian offshore petroleum industry. Marine Environmental Research 92:154–169.

Balch, T., and R. Scheibling. 2000. Temporal and spatial variability in settlement and recruitment of echinoderms in kelp beds and barrens in Nova Scotia. Marine Ecology Progress Series 205:139–154.

Barber, R.C., C.T. Fontaine, J.P. Flanagan, and E.E. Louis, Jr. 2003. Natural hybridization between a Kemp's Ridley (*Lepidochelys kempii*) and loggerhead sea turtle (*Caretta caretta*) confirmed by molecular analysis. Chelonian Conservation and Biology 4:701–704.,

Barnett, J., and D. Toews. 1978. The effects of crude oil and the dispersant, Oilsperse 43, on respiration and coughing rates in Atlantic salmon (*Salmo salar*). Canadian Journal of Zoology 56:307–310.

Barron, M.G. 2012. Ecological impacts of the Deepwater Horizon oil spill: implications for immunotoxicity. Toxicologic pathology 40:315–320.

Bastien, G., A. Barkley, J. Chappus, V. Heath, S. Popov, R. Smith, T. Tran, S. Currier, D. C. Fernandez, P. Okpara, V. Owen, B. Franks, R. Hueter, D. J. Madigan, C. Fischer, B. McBride, and N. E. Hussey. 2020. Inconspicuous, recovering, or northward shift: status and management of the white shark (*Carcharodon carcharias*) in Atlantic Canada. Canadian Journal of Fisheries and Aquatic Sciences.

Bayha, K. M., N. Ortell, C. N. Ryan, K.J. Griffitt, M. Krasnec, J. Sena, T. Ramaraj, R. Takeshita, G.D. Mayer, F. Schilkey, and others. 2017. Crude oil impairs immune function and increases susceptibility to pathogenic bacteria in southern flounder. PloS one 12:e0176559.

Beazley, L. I. and E. L. Kenchington. 2015. Epibenthic Megafauna of the Flemish Pass and Sackville Spur (Northwest Atlantic) Identified from In Situ Benthic Image Transects. Canadian Technical Report of Fisheries and Aquatic Sciences 3127:v + 496p.

Beazley, L. I., E. L. R. Kenchington, F. J. Murillo, and M. Sacau. 2013. Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the Northwest Atlantic. ICES Journal of Marine Science 70:1471–1490.

Beazley, L., E. Kenchington, and C. Lirette. 2017. Species distribution modelling and kernel density analysis of benthic ecologically and biologically significant areas (EBSAs) and other benthic fauna in the Maritimes Region. Canadian Technical Report of Fisheries and Aquatic Sciences 3204.

Beazley, L., Z. Wang, E. Kenchington, I. Yashayaev, H. T. Rapp, J. R. Xavier, F. J. Murillo, D. Fenton, and S. Fuller. 2018. Predicted distribution of the glass sponge *Vazella pourtalesi* on the Scotian Shelf and its persistence in the face of climatic variability. PLOS ONE 13:e0205505.

Béguer-Pon, M., M. Castonguay, S. Shan, J. Benchetrit, and J. J. Dodson. 2015. Direct observations of American eels migrating across the continental shelf to the Sargasso Sea. Nature Communications 6:8705.

Beirão, J., M. A. Litt, and C. F. Purchase. 2018. Chemically-dispersed crude oil and dispersant affects sperm fertilizing ability, but not sperm swimming behaviour in capelin (*Mallotus villosus*). Environmental Pollution 241:521–528.

Bell, J. J., E. McGrath, A. Biggerstaff, T. Bates, H. Bennett, J. Marlow, and M. Shaffer. 2015. Sediment impacts on marine sponges. Marine Pollution Bulletin 94:5–13.

Bell, J. S. and R.D. Howie. 1990. Paleozoic geology, Chapter 4 in Geology of the Continental Margin of Eastern Canada. M. J. Keen and G. L. Williams (Eds.). Geological Survey of Canada, Geology of Canada.

Bender, M. L., M. Frantzen, I. Vieweg, I.-B. Falk-Petersen, H. K. Johnsen, G. Rudolfsen, K. E. Tollefsen, P. Dubourg, and J. Nahrgang. 2016. Effects of chronic dietary petroleum exposure on reproductive development in polar cod (*Boreogadus saida*). Aquatic Toxicology 180:196–208.

Benoit, H. P. and D. P. Swain. 2008. Impacts of environmental change and direct and indirect harvesting effects on the dynamics of a marine fish community. Canadian Journal of Fisheries and Aquatic Sciences 65:2088–2104.

Berge, J., M. Geoffroy, M. Daase, F. Cottier, P. Priou, J.H. Cohen, G. Johnsen, D. McKee, I. Kostakis, P.E. Renaud, D. Vogedes, P. Anderson, K.S. Last, and S. Gauthier. 2020. Artificial light during the polar night disrupts Arctic fish and zooplankton behaviour down to 200 m depth. Communications Biology, 3(1), 1-8.

Bernier, R.Y., R.E. Jamieson, and A.M. Moore (eds.). 2018. State of the Atlantic Ocean Synthesis Report. Canadian Technical Report of Fisheries and Aquatic Sciences 3167: iii + 149 p.

Birds Canada. Important Bird and Biodiversity Areas in Canada. Available at: https://www.ibacanada.com/ Accessed March 3, 2021.

Birds Canada (BC), Environment Canada - Canadian Wildlife Service, New Brunswick Department of Natural Resources, Nova Scotia Department of Natural Resources, Prince Edward Island Department of Agriculture and Forestry. (2012). Maritimes Breeding Bird Atlas Database. Data accessed from the Maritimes Breeding Bird Atlas website and/or NatureCounts, a node of the Avian Knowledge Network, Birds Canada. Available: http://www.naturecounts.ca/.

Bishop, C.A. and W.B. Brodie. Evaluation of offshore closed areas as a fisheries management tool, with emphasis on two case studies. Research Document 97/32. Available at: https://www.nafo.int/Portals/0/PDFs/sc/1997/scr-97-032.pdf

Boertmann, D. and A. Mosbech (eds.). 2011. The western Greenland Sea, a strategic environmental impact assessment of hydrocarbon activities. Aarhus University, DCE – Danish Centre for Environment and Energy, 268 pp. - Scientific Report from DCE – Danish Centre For Environment and Energy no. 22.

Bolaños, L. M., L. Karp-Boss, C. J. Choi, A. Z. Worden, J. R. Graff, N. Haëntjens, A. P. Chase, A. Della Penna, P. Gaube, F. Morison, and others. 2020. Small phytoplankton dominate western North Atlantic biomass. The ISME journal 14:1663–1674.

Bolduc, F., and M. Guillemette. 2003. Human disturbance and nesting success of Common Eiders: interaction between visitors and Gulls. Biological Conservation 110:77-83.

Bolduc, F., F. Rosseu, C. Gjerdrum, D. Fifield, and S. Christin. 2018. Atlas of Seabirds at Sea in Eastern Canada 2006 - 2016. Environment and Climate Change Canada, Canadian Wildlife Service. https://open.canada.ca/data/en/dataset/f612e2b4-5c67-46dc-9a84-1154c649ab4e

Bomkamp, R. E., H. M. Page, and J. E. Dugan. 2004. Role of food subsidies and habitat structure in influencing benthic communities of shell mounds at sites of existing and former offshore oil platforms. Marine Biology 146:201–211.

Boudreau, S. A. 2013. State of the Scotian Shelf Report: Primary and Secondary Producers. Canadian Technical Report of Fisheries and Aquatic Sciences 3074.

Bower, P. 2003. Hurricane Juan Storm Summary. October 29, 2003. https://www.ec.gc.ca/ouragans-hurricanes/default.asp?lang=en&n=B1A7B85A-1

Boyd, P. W., H. Claustre, M. Levy, D. A. Siegel, and T. Weber. 2019. Multi-faceted particle pumps drive carbon sequestration in the ocean. Nature 568:327–335.

Bradford, R.G. and T.D. Iles. 1992. Unique biological characteristics of spring-spawning herring (*Clupea harengus* L.) in Minas Basin, Nova Scotia, a tidally dynamic environment. Can. J. Zool., 70:641-648.

Bramford, A. R., S. J. J. F. Davies, and R. Van Delft. 1990. The effects of model power boats on waterbirds at Herdsman lake, Perth, Western Australia. Emu, 90: 260-265.

Breeze, H. and T. Horsman (eds.). 2005. The Scotian Shelf: An Atlas of Human Activities. https://www.dfo-mpo.gc.ca/oceans/publications/scotian-atlas-ecossais/page01-eng.html

Breeze, H., D. Fenton, R. Rutherford, and M. Silva. 2002. The Scotian Shelf: An ecological overview for ocean planning. Canadian Technical Report of Fisheries and Aquatic Sciences:269.

Brinkley, E. S. and K. Sutherland. 2020. Bermuda Petrel (Pterodroma cahow), version 2.0. In Birds of the World (T. S. Schulenberg, B. K. Keeney, and S. M. Billerman, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.berpet.02

Brown, R.G.B. 1986. Revised atlas of eastern Canadian seabirds: I. Shipboard surveys. Environment and Climate Change Canada, Canadian Wildlife Service, Ottawa, ON, Canada.

Brown, R.G.B., Gillespie, D.I., Lock, A.R., Pearce, P.A., Watson, G.H. 1973. Bird mortality from oil slicks off Eastern Canada, February– April 1970. Canadian Field-Naturalist 87, 225–234.

Brown, M.W., D. Fenton, K. Smedbol, C. Merriman, K. Robichaud-Leblanc, and J.D. Conway. 2009. Recovery strategy for the North Atlantic right whale (*Eubalaena glacialis*) in Atlantic Canadian waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. Vi +66 p.

Buhl-Mortensen, L., and P. B. Mortensen. 2005. Distribution and diversity of species associated with deep-sea gorgonian corals off Atlantic Canada. Pages 849–879 Cold-water corals and ecosystems. Springer.

Bundy, A. 2005. Structure and functioning of the eastern Scotian Shelf ecosystem before and after the collapse of groundfish stocks in the early 1990s. Canadian Journal of Fisheries and Aquatic Sciences 62:1453–1473.

Bundy, A., E. Will, A. Serdynska, A. Cook, and C. Ward-Paige. 2017. Defining and mapping functional groups for fishes and invertebrates in the Scotian Shelf Bioregion.

Busch, K., L. Beazley, E. Kenchington, F. Whoriskey, B.M. Slaby, and U. Hentschel. 2020. Microbial diversity of the glass sponge *Vazella pourtalesii* in response to anthropogenic activities. Conservation Genetics, 21:1001-1010.

Buskey, E.J., H.K. White, and A.J. Esbaugh. 2016. Impact of oil spills on marine life in the Gulf of Mexico: effects on plankton, nekton, and deep-sea benthos. Oceanography, 29(3): 174-181.

Butler, S., D. Ibarra and S. Coffen-Smout. 2019. Maritimes Region Longline and Trap Fisheries Footprint Mapping for Marine Spatial Planning and Risk Assessment. Can. Tech. Rep. Fish. Aquat. Sci. 3293.

Butler, R. G., D. E. Buckley, D. N. Nettleship, P. F. D. Boesman, and E. F. J. Garcia. 2020. Black Guillemot (Cepphus grylle), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.blkgui.01

Byrne, M.-L., B. Freedman, and D. Colville. 2014. The geology of Sable Island and the Evolution of the Sable Island Bank. Chapter 2 in An Ecological and Biodiversity Assessment of Sable Island. Freedman, B. (ed.). Parks Canada.

Bytingsvik, J., T.F. Parkerton, J. Guyomarch, L. Tassara, S. LeFloch, W.R. Arnold, S.M. Brander, A. Volety, and L. Camus. The sensitivity of the deepsea species northern shrimp (*Pandalus borealis*) and the cold-water coral (*Lophelia pertusa*) to oil-associated aromatic compounds, dispersant, and Alaskan North Slope crude oil. Marine Pollution Bulletin, 156:111202.

Caires, A., A. Sterl, A. Bidlot, N. Graham, and V.R. Swail. 2004. Intercomparison of different wind-wave reanalyses. Journal of Climate. 17(10):1893-1913.

Cameron GDM, King EL, Campbell DC. 2008. Surficial geology and sun-illuminated seafloor topography, The Gully, Scotian Shelf, offshore eastern Canada. Geological Survey of Canada Map 2123A, scale 1:100 000.

Campbell, D.C., Piper, D.J.W., Mosher, D.C., Jenner, K.A. 2008a. Surficial geology and sun-illuminated seafloor topography, Mohican channel, Scotian Slope, offshore Nova Scotia. Geological Survey of Canada, "A" Series Map 2127A, 2008, 1 sheet, https://doi.org/10.4095/225383

Campbell, D.C., Piper, D.J.W., Mosher, D.C., Jenner, K.A. 2008b. Surficial geology and sun-illuminated seafloor topography, Verrill Canyon, Scotian Slope, offshore Nova Scotia. Geological Survey of Canada, "A" Series Map 2128A, 2008, 1 sheet, https://doi.org/10.4095/225384

Campbell, D.C., Piper, D.J.W., Mosher, D.C., Jenner, K.A. 2008c. Surficial geology and sun-illuminated seafloor topography, Logan Canyon, Scotian Slope, offshore Nova Scotia. Geological Survey of Canada, "A" Series Map 2129A, 2008, 1 sheet, https://doi.org/10.4095/225385

Campbell-Malone, R., S.G. Barco, P.-Y. Daoust, A.R. Knowlton, W.A. McLellan, D.S. Rotstein, and M.J. Moore. 2008. Gross and histologic evidence of sharp and blunt trauma in North Atlantic right whales (*Eubalaena glacialis*) killed by vessels. J Zoo Wildlife Med. 39(1).

Canadian Ice Service. 2011. Sea Ice Climatic Atlas, East Coast, 1981-2010. Environment and Climate Change Canada.

Carboneras, C., F. Jutglar, and G. M. Kirwan. 2020a. Great Shearwater (*Ardenna gravis*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.greshe.01

Carboneras, C., F. Jutglar, and G. M. Kirwan. 2020b. Sooty Shearwater (*Ardenna grisea*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.sooshe.01

Carboneras, C., F. Jutglar, and G. M. Kirwan. 2020c. White-faced Storm-Petrel (*Pelagodroma marina*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.wfspet.01

Carboneras, C., F. Jutglar, and G. M. Kirwan 2020d. European Storm-Petrel (*Hydrobates pelagicus*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bripet.01

Carboneras, C., F. Jutglar, and G. M. Kirwan. 2020e. Zino's Petrel (*Pterodroma madeira*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.madpet.01

Cariglia, N. 2017. Implementation of oil spill impact mitigation measures in fisheries and mariculture. May 2017 International Oil Spill Conference Proceedings 2017(1):3011-30299. https://www.researchgate.net/publication/320052126_Implementation_of_oil_spill_impact_mitigation_measures_in_fisheries_and_mariculture

Carney, K. M., and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68-79.

Casault, B., C. Johnson, E. Devred, E. Head, A. Cogswell, and J. Spry. 2020. Optical, Chemical, and Biological Oceanographic Conditions on the Scotian Shelf and in the Eastern Gulf of Maine during 2019.

CCG (Canadian Coast Guard), 2021. Notices to Mariners 1 to 46 Annual Edition 2021. https://www.notmar.gc.ca/publications/annual-annuel/annual-notices-to-mariners-eng.pdf

CCPFH (Canadian Council of Professional Fish Harvesters). 2015. History of Fishing in Canada. http://www.fishharvesterspecheurs.ca/fishing-industry/history

CEOTR (Coastal Environmental Observation Technology and Research). 2020. We Support Oceanographic & Geophysical Research in Atlantic Canada. http://ceotr.ocean.dal.ca/

Choi, J., K. Frank, B. Petrie, and W. Leggett. 2005. Integrated assessment of a large marine ecosystem: a case study of the devolution of the Eastern Scotian Shelf, Canada. Oceanography and Marine Biology: An Annual Review, 43: 47-67.

Christian, J.R., A. Mathieu, D.H. Thompson, D. White, and R.A. Buchanan. 2003. Effect of Seismic Energy on Snow Crab (*Chionoecetes opilio*). Environmental Funds Project No. 144. Fisheries and Oceans Canada. Calgary, AB, 106 pp.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board) and CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2017. Compensation Guidelines with Respect to Damages Relating to Offshore Petroleum Activity. https://www.cnsopb.ns.ca/sites/default/files/resource/compensation_guidelines-final-november_7_2017_-_includes_isbn.pdf

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board) and CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2018. Incident Reporting and Investigation Guideline. https://www.cnsopb.ns.ca/sites/default/files/resource/incident_reporting_and_investigation_guidelinesen g.pdf

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2016. Review Report Summary. Dropped Riser Incident. Cheshire L-97 Exploration Well. Shell Canada’s Shelburne Venture Exploration Drilling Project. March 2016. June 22, 2016. https://www.cnsopb.ns.ca/sites/default/files/resource/droppedriserreportsummary.pdf

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board), C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board), and NEB (National Energy Board). 2017. Guidelines Respecting Financial Requirements August 2017 (amended). https://www.cnsopb.ns.ca/sites/default/files/resource/financial_requirements_fr_guidelines_-_amended.pdf

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2015. Geophysical, Geological, Environmental and Geotechnical Program Guidelines. https://www.cnsopb.ns.ca/sites/default/files/resource/cnsopb_gg_program_guidelines_final_2015.pdf

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2018. Exploration & Production History of the Nova Scotia offshore area offshore area-December 2018. https://www.cnsopb.ns.ca/sites/default/files/resource/exploration_production_history_of_ns_offshore_-_december_2018.pdf

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2021a. Health, Safety & Environmental Performance (1990-2021). Available at: https://www.cnsopb.ns.ca/offshore-activity/health-safety-environmental-performance

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2021b. Special Designated Areas. Available at: https://www.cnsopb.ns.ca/what-we-do/environmental-protection/special-designated-areas

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2021c. Current Activity. https://www.cnsopb.ns.ca/offshore-activity/current-activity

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2021d. Cohasset Panuke. https://www.cnsopb.ns.ca/offshore-activity//legacy-production-projects/cohasset-panuke

CNSOPB (Canada-Nova Scotia Offshore Petroleum Board). 2021e. CNSOPB Directory of Wells Nova Scotia offshore area offshore area. https://www.cnsopb.ns.ca/sites/default/files/resource/dow.pdf

Coad, B.W. and J.D. Reist. 2018. Marine Fishes of Arctic Canada. University of Toronto Press, Toronto, Canada. Xiii + 618 pp.

Cochrane, N. 2000. Scotian Shelf euphausiid and silver hake population changes during 1984–1996 measured by multi-frequency acoustics. ICES Journal of Marine Science 57:122–132.

Coelho, G. M., A. G. Slaughter, and J. C. Staves. 2017. Spill Impact Mitigation Assessment in Support of Statoil Canada Ltd Drilling Program in the Flemish Pass. Page v + 71 pp. Sponson Group Inc., Mansfield, TX. Sponson Group Technical Report.

Cogswell, A. T., E. L. R. Kenchington, C. G. Lirette, K. MacIsaac, M. M. Best, L. I. Beazley, and J. Vickers. 2009. The Current State of Knowledge Concerning The Distribution of Coral in The Maritime Distribution of Coral in The Maritime Distribution of. Canadian Technical Report of Fisheries and Aquatic Sciences 2855:v + 66p.

Cordes, E.E., D.O.B. Jones, T.A. Schlacher, D.J. Amon, A.F. Bernardino, S. Brooke, R. Carney, D.M. DeLeo, K.M. Dunlop, E.G. Escobar-Briones, A.R. Gates, L. Génio, J. Gobin, L.-A. Henry, S. Herrera, S. Hoyt, M. Joye, S. Kark, N.C. Mestre, A. Metaxas, S. Pfeifer, K. Sink, A.K. Sweetman, and U. Witte. 2016. Environmental Impacts of the Deep-Water Oil and Gas Industry: A Review to Guide Management Strategies. Frontiers in Environmental Science 4:1–54.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006a. COSEWIC assessment and update status report on the harbour porpoise *Phocoena* (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 32 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2006b. COSEWIC assessment and status report on the White Shark *Carcharodon carcharias* (Atlantic and Pacific populations) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. vii + 31 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2008. COSEWIC assessment and status report on the Roundnose Grenadier *Coryphaenoides rupestris* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 42 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009a. COSEWIC assessment and status report on the American Plaice *Hippoglossoides platessoides*, Maritime population, Newfoundland and Labrador population and Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 74 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009b. COSEWIC assessment and status report on the Basking Shark *Cetorhinus maximus*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 56 pp.

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

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010a. COSEWIC assessment and status report on the Deepwater Redfish/Acadian Redfish complex *Sebastes mentella* and *Sebastes fasciatus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 80 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010b. COSEWIC assessment and status report on the Spiny Dogfish *Squalus acanthias*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 50 pp.

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

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2010d. COSEWIC assessment and status report on the Atlantic cod *Gadus morhua* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiii + 105 pp.

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

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011a. COSEWIC assessment and status report on the Atlantic Bluefin Tuna *Thunnus thynnus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 30 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2011b. COSEWIC Assessment and Status Report on the Northern Bottlenose Whale *Hyperoodon ampullatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xii + 31 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012a. COSEWIC Assessment and Status Report on the Atlantic Wolffish *Anarhichas lupus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 56 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012b. COSEWIC assessment and status report on the Spotted Wolffish *Anarhichas minor* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 44 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012c. COSEWIC assessment and status report on the Northern Wolffish *Anarhichas denticulatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 41 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012d. COSEWIC assessment and status report on the Smooth Skate *Malacoraja senta* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xix + 77 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012e. COSEWIC assessment and status report on the Thorny Skate *Amblyraja radiata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 75 pp.

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

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012g. COSEWIC assessment and status report on the Cusk *Brosme* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 85 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012h. COSEWIC assessment and status report on the leatherback sea turtle *Dermochelys coriacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xv + 58 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. COSEWIC assessment and status report on the North Atlantic Right Whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xi + 58 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014a. COSEWIC assessment and status report on the Porbeagle *Lamna nasus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 40 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2014b. COSEWIC assessment and status report on the Beluga Whale *Delphinapterus leucas*, St. Lawrence Estuary population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. xii + 64 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2015. COSEWIC assessment and status report on the Winter Skate *Leucoraja ocellata*, Gulf of St. Lawrence population, Eastern Scotian Shelf - Newfoundland population and Western Scotian Shelf - Georges Bank population in Canada. Ottawa. xviii + 46 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2017. COSEWIC assessment and status report on the Lumpfish *Cyclopterus lumpus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 78 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2019a. COSEWIC assessment and status report on the Shortfin Mako *Isurus oxyrinchus*, Atlantic Population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 38 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2019b. COSEWIC assessment and status report on the Sowerby's Beaked Whale *Mesoplodon bidens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 41 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2019c. COSEWIC assessment and status report on the Sei Whale *Balaenoptera borealis*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 48 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2019d. COSEWIC assessment and update status report on the fin whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. Ix + 37 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2020. COSEWIC wildlife species assessments (detailed version), November 2020. Available from: https://cosewic.ca/index.php/en-ca/assessment-process/detailed-version-november-2020. Accessed 23 Feb 2021.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2021. COSEWIC candidate wildlife species list, updated February 16, 2021. Accessed at https://www.cosewic.ca

Crysler Z.J., Ronconi R.A., Taylor, P.D. 2016. Differential fall migratory routes of adult and juvenile Ipswich Sparrows *(Passerculus sandwichensis princeps*). Movement Ecology. 4:3.

Cushing, D. 1990. Plankton production and year-class strength in fish populations: an update of the match/mismatch hypothesis. Advances in Marine Biology 26:249–293.

Dalley, E.L., and J.T. Anderson. 1998. Plankton and Nekton of the Northeast Newfoundland Shelf and Grand Banks in 1997. Canadian Stock Assessment Secretariat Research Document 98/121:30.

Daly, K.L., U. Passow, J. Chanton, and D. Hollander. 2016. Assessing the impacts of oil-associated marine snow formation and sedimentation during and after the Deepwater Horizon oil spill. Anthropocene 13:18–33.

Davis, R.A., D.H. Thomson and C.I. Malme. 1998. Environmental assessment of seismic exploration on the Scotian Shelf. Prepared for Mobil Oil Canada Properties Ltd., Shell Canada Ltd., and Imperial Oil Ltd. for the Canada-Nova Scotia Offshore Petroleum Board, Halifax.

DeBlois, E.M., M.D. Paine, B.W. Kilgour, E. Tracy, R.D. Crowley, U.P. Williams, and G.G. Janes. 2014. Alterations in bottom sediment physical and chemical characteristics at the Terra Nova offshore oil development over ten years of drilling on the grand banks of Newfoundland, Canada. Deep Sea Research Part II: Topical Studies in Oceanography 110:13–25.

del Hoyo, J., C. Carboneras, F. Jutglar, N. Collar, and G. M. Kirwan. 2020. Cory's Shearwater (*Calonectris diomedea*), version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY,USA. https://doi.org/10.2173/bow.corshe.01

Delarue, J., Kowarski, K. A., Maxner, E. E., MacDonnell, J. T., Martin, S. B. 2018. Acoustic monitoring along Canada's East Coast: August 2015 to July 2017. Document Number 01279. Environmental Studies Research Funds Report Number 215 v.1.0. Technical report by JASCO Applied Sciences for Environmental Studies Research Fund. Dartmouth, NS, Canada. +120pp.

DeLeo, D.M., D.V. Ruiz-Ramos, I.B. Baums, and E.E. Cordes. 2016. Response of deep-water corals to oil and chemical dispersant exposure. Deep Sea Research Part II: Topical Studies in Oceanography, 129: 137-147.

den Heyer, C.E., Hubley, B., Themelis, D., Smith, S.C., Wilson, S., and Wilson, G. 2015. Atlantic Halibut on the Scotian Shelf and Southern Grand Banks: Data Review and Assessment Model Update. DFO Can. Sci. Advis. Sec. Res. Doc.2015/051. https://waves-vagues.dfo-mpo.gc.ca/Library/362062.pdf

DFO (Fisheries and Oceans Canada). 2000. Scotian Shelf (LFA 33) Jonah Crab (*Cancer borealis*). DFO Science Stock Status Report C3-09:7.

DFO (Fisheries and Oceans Canada). 2007. Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment. Background Paper. Available at: http://waves-vagues.dfompo.gc.ca/Library/363838.pdf

DFO (Fisheries and Oceans Canada). 2010a. Northern bottlenose whale (*Hyperoodon ampullatus*), Scotian Shelf: recovery strategy 2010. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa.

DFO (Fisheries and Oceans Canada). 2010b. Current Status of northwest Atlantic harp seals (*Pagophilus groenlandicus*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/074.

DFO (Fisheries and Oceans Canada). 2010c. Stock assessment of Northwest Atlantic grey seals (*Halichoerus grypus*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/091.

DFO (Fisheries and Oceans Canada). 2013a. Integrated Fisheries Management Plan: Canadian Atlantic swordfish and other tunas. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/swordfish-espadon/NEW-swordfish-2013-espado-eng.html

DFO (Fisheries and Oceans Canada). 2013b. https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/snow-crab-neiges2013-eng.html

DFO (Fisheries and Oceans Canada). 2013c. Integrated Fisheries Management Plan: Shrimp (*Pandalus borealis*) - Scotian Shelf - As of 2013. https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/shrimp-crevette/shrimp-crevette-2013-eng.html

DFO (Fisheries and Oceans Canada). 2014. Recovery strategy for the North Atlantic Right Whale (*Eubalaena glacialis*) in Atlantic Canadian waters. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. vii + 68 pp.

DFO (Fisheries and Oceans Canada). 2015a. Coral and Sponge Conservation Strategy for Eastern Canada 2015:70.

DFO (Fisheries and Oceans Canada). 2015b. Swordfish. https://www.dfo-mpo.gc.ca/fisheries-peches/sustainable-durable/fisheries-peches/swordfish-espadon-eng.html

DFO (Fisheries and Oceans Canada). 2016a. Snow Crab. https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/snow-crab-crabe-neiges-atl-eng.html.

DFO (Fisheries and Oceans Canada). 2016b. Recovery Strategy for the Northern Bottlenose Whale, (*Hyperoodan ampullatus*), Scotian Shelf population, in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. vii + 70 pp. Available at: https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/RecoveryStrategy-NorthernBottlenoseWhale-v00-2016Jun07-Amended-Eng.pdf

DFO (Fisheries and Oceans Canada). 2016c. Offshore Ecologically or Biologically Significant Areas in the Scotian Shelf Bioregion. Research Document 2016/007. Available at: https://waves-vagues.dfo-mpo.gc.ca/Library/363946.pdf

DFO (Fisheries and Oceans Canada). 2016d. Red Crab. https://dfo-mpo.gc.ca/species-especes/profiles-profils/red-crab-crabe-rouge-eng.html

DFO (Fisheries and Oceans Canada). 2017. Integrated Fisheries Management Plan: Canadian Atlantic Bluefin Tuna (*Thunnus thynnus*)- NAFO Fishing Areas 3KLNOP, 4RSTVWX and 5YZ – 2017. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/bluefin-tuna-thon-rouge/bluefin-tuna-thonrouge2017-eng.html

DFO (Fisheries and Oceans Canada). 2018a. Scotian Slope/Rise Monitoring Program. Available at https://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/slope-pente/scotian-ecossais-en.php Accessed March 2021.

DFO (Fisheries and Oceans Canada). 2018b. Identification of habitat important to the blue whale in the western North Atlantic. Can. Sci. Advis. Sec. Sci. Advis. Rep. 2018/003.

DFO (Fisheries and Oceans Canada). 2018c. The Scotian Shelf: an atlas of human activities. Available at: https://www.dfo-mpo.gc.ca/oceans/publications/scotian-atlas-ecossais/page05-eng.html.

DFO (Fisheries and Oceans Canada). 2018d. Integrated Fisheries Management Plan: 4VWX5 groundfish - Maritimes Region. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/groundfish-poisson-fond/groundfish-poisson-fond-4vwx5-eng.html

DFO (Fisheries and Oceans Canada). 2018e. Number of Licence Holders, by Province and Region, 2018. https://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/fishers-pecheurs/xls/fp18_e.xls?

DFO (Fisheries and Oceans Canada). 2018f. Status of the Hagfish (*Myxine glutinosa*) Fishery in the Maritimes Region. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/048. https://waves-vagues.dfo-mpo.gc.ca/Library/40739612.pdf

DFO (Fisheries and Oceans Canada). 2018g. Bluefin Tuna. https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/bluefin-tuna-thon-rouge-eng.html

DFO (Fisheries and Oceans Canada). 2018h. Integrated Fisheries Management Plan: Offshore Scallop - Maritimes Region. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/scallop-petoncle/2018/index-eng.html

DFO (Fisheries and Oceans Canada). 2018i. Atlantic Zone Off-Shelf Monitoring Program (AZOMP). https://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/azomp-pmzao-en.php

DFO (Fisheries and Oceans Canada).2018j. Three new potential marine conservation measures announced off the coast of Nova Scotia. https://www.canada.ca/en/fisheries-oceans/news/2018/03/three-new-potential-marine-conservation-measures-announced-off-the-coast-of-nova-scotia.html

DFO (Fisheries and Oceans Canada). 2019a. An assessment of northern shrimp (*Pandalus borealis*) in shrimp fishing areas 4–6 and of striped shrimp (*Pandalus montagui*) in shrimp fishing area 4 in 2018. Canadian Science Advisory Secretariat Science Advisory Report 2019/027.

DFO (Fisheries and Oceans Canada). 2019b. Review of North Atlantic Right Whale occurrence and risk of entanglements in fishing gear and vessel strikes in Canadian waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/028

DFO (Fisheries and Oceans Canada). 2019c. Departmental Plan 2019-20. Cat. No. Fs1-82E-PDF. https://waves-vagues.dfo-mpo.gc.ca/Library/40776542.pdf

DFO (Fisheries and Oceans Canada). 2019d. Ministerial Transition Binders 2019. https://www.dfo-mpo.gc.ca/transparency-transparence/mtb-ctm/2019/index-eng.htm

DFO (Fisheries and Oceans Canada). 2019e. Integrated Fisheries Management Plan: Offshore lobster and Jonah crab - Maritimes Region. https://dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/lobster-crab-homard/2019/index-eng.html

DFO (Fisheries and Oceans Canada). 2019f. 2019 Red crab fishery - NAFO divisions 4WX and 5Z. https://dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2019-gp/atl-27-eng.html

DFO (Fisheries and Oceans Canada). 2019g. Canadian Tracked Float Data & Information. https://isdm.gc.ca/isdm-gdsi/argo/canada/cd-dc-eng.asp

DFO (Fisheries and Oceans Canada). 2019h. Assessment of the Effectiveness of Mitigation Measures in Reducing the Potential Impacts of Oil and Gas Exploration and Production on Areas with Defined Benthic Conservation Objectives. Canadian Science Advisory Secretariat Science Advisory Report 2019/025:23.

DFO (Fisheries and Oceans Canada). 2019i. Action Plan for the Atlantic Salmon (*Salmo salar*), inner Bay of Fundy population in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. vii + 59pp.

DFO (Fisheries and Oceans Canada). 2019j. Protection Standards to better conserve our oceans. Available at: https://www.dfo-mpo.gc.ca/oceans/mpa-zpm/standards-normes-eng.html

DFO (Fisheries and Oceans Canada). 2020a. Geospatial dataset. Fisheries and Oceans Canada, Economic Analysis and Statistics, Zonal Interchange Formatted File [database]. Ottawa. (Accessed various years to 23-10-2020.)

DFO (Fisheries and Oceans Canada). 2020b. Assessment of the distribution, movements, and habitat use of northern bottlenose whales on the Scotian Shelf to support the identification of important habitat. Canadian Science Advisory Secretariat Science Advisory Report 2020/008.

DFO (Fisheries and Oceans Canada). 2020c. Action Plan for the North Atlantic Right Whale (*Eubalaena glacialis*) in Canada [Proposed]. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa. v+40 pp.

DFO (Fisheries and Oceans Canada). 2020d. Action Plan for the Blue Whale (*Balaenoptera musculus*) in Canada. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa. iv+23 pp.

DFO (Fisheries and Oceans Canada). 2020e. Action Plan for the Leatherback Sea Turtle (*Dermochelys coriacea*), Atlantic population, in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 28 p. Available at: https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/Ap-TortueLuthAtlLeatherback-v00-2020Mar-Eng.pdf

DFO (Fisheries and Oceans Canada). 2020f. Action Plan for the Blue Whale (*Balaenoptera musculus*), Northwest Atlantic Population, in Canada. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 23 pp. Available at: https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/Ap-BlueWhaleNwRorqualBleu-v00-2020Juil-Eng.pdf

DFO (Fisheries and Oceans Canada). 2020g. Canada's marine protected and conserved areas. Available at: https://www.dfo-mpo.gc.ca/oceans/conservation/areas-zones/index-eng.html

DFO (Fisheries and Oceans Canada). 2020h. Quantity and value tabular datasets. Fisheries and Oceans Canada Integrated Catch and Effort System [database]. Ottawa. (Accessed various years to 2-11-2020.)

DFO (Fisheries and Oceans Canada). 2020i. Scotia-Fundy Region Commercial Communal Fishing Data. Provided by Regional Licensing Maritimes Region.

DFO (Fisheries and Oceans Canada). 2020j. 2020-21 groundfish 4VWX5 (Maritimes Region). https://www.dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2020-gp/atl-24-eng.html

DFO (Fisheries and Oceans Canada). 2020k. Shark fisheries. https://www.dfo-mpo.gc.ca/species-especes/sharks/info/fisheries-eng.html

DFO (Fisheries and Oceans Canada). 2020l. 2020 offshore scallop fishery in the Maritimes Region – Scallop Fishing Areas 10-12, 25-27. https://dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2020-gp/atl-05-eng.html

DFO (Fisheries and Oceans Canada). 2020m. 2020 Scotian Shelf shrimp (Shrimp Fishing Areas 13, 14, 15 and 16) Maritimes Region. https://dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2020-gp/atl-02-eng.html

DFO (Fisheries and Oceans Canada). 2020n. 2019 Stock Status Update of Eastern Scotian Shelf Northern Shrimp (SFAs 13–15). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/012. https://waves-vagues.dfo-mpo.gc.ca/Library/40883826.pdf

DFO (Fisheries and Oceans Canada). 2020o. 2020 snow crab - Southeastern Nova Scotia (Crab Fishing Areas 23 and 24E). https://dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2020-gp/atl-36-eng.html

DFO (Fisheries and Oceans Canada). 2020p. Assessment of Scotian Shelf Snow Crab. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/042. https://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2020/2020_042-eng.pdf

DFO (Fisheries and Oceans Canada). 2020q. Maritimes Winter Research Vessel Survey Trends on Georges Bank. DFO Can. Sci. Advis. Sec. Sci. Resp. 2020/048. http://publications.gc.ca/collections/collection_2020/mpo-dfo/fs70-7/Fs70-7-2020-048-eng.pdf

DFO (Fisheries and Oceans Canada). 2020r. Maritimes Research Vessel Survey Trends on the Scotian Shelf and Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Resp. 2020/019. https://waves-vagues.dfo-mpo.gc.ca/Library/40912504.pdf

DFO (Fisheries and Oceans Canada). 2020s. Atlantic Zone Monitoring Program (AZMP). https://www.dfo-mpo.gc.ca/science/data-donnees/azmp-pmza/index-eng.html

DFO (Fisheries and Oceans Canada). 2020t. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada. Page vii + 81 p. Fisheries and Oceans Canada, Ottawa.

DFO (Fisheries and Oceans Canada). 2020u. Using Satellite Tracking Data to Define Important Habitat for Leatherback Turtles in Atlantic Canada: 2019 Update. DFO Can. Sci. Advis. Sec. Sci. Resp. 2020/041.

DFO (Fisheries and Oceans Canada). 2020v. Updated information on the distribution of North Atlantic Right Whale in Canadian waters. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/037.

DFO (Fisheries and Oceans Canada). 2020w. Assessment of the Distribution, Movements, and Habitat Use of Northern Bottlenose Whales on the Scotian Shelf to Support the Identification of Important Habitat. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/008.

DFO (Fisheries and Oceans Canada). 2020x. Offshore clam - Maritimes and Newfoundland and Labrador regions. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/clams-palourdes/2020/offshore-hauturieres-eng.html

DFO (Fisheries and Oceans Canada). 2021a. MSC50 Wind and Wave Climate Hindcast. Available at http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/waves-vagues/MSC50-eng.html . Accessed February 2021.

DFO (Fisheries and Oceans Canada). 2021b. ODI: database inventory of moored current meters, thermographs and tide gauges from the East Coast of Canada, 1960 to present. Department of Fisheries and Oceans, Canada. Available at: http://www.bio.gc.ca/science/data-donnees/base/data-donnees/odi-en.php. Accessed February 2021.

DFO (Fisheries and Oceans Canada). 2021c. ODI: Hydrographic Climate Database. Department of Fisheries and Oceans, Canada. Available at: http://www.bio.gc.ca/science/data-donnees/base/data-donnees/odi-en.php. Accessed March 2021.

DFO (Fisheries and Oceans Canada). 2021d. 2021 offshore Arctic surfclam fishery (Maritimes Region) – Banquereau and Grand Bank. https://dfo-mpo.gc.ca/fisheries-peches/decisions/fm-2021-gp/atl-05-eng.html

Di Iorio, L. and C.W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters. 6

DND (Department of National Defence Canada) 2021. Unexploded Explosive Ordnance (UXO). https://www.canada.ca/en/department-national-defence/services/uxo/unexploded-explosive-ordnance.html

Dooling, R.R. and S.C. Therrien. 2012. Hearing in Birds: What Changes From Air to Water. Chapter in: The Effects of Noise on Aquatic Life. Popper, A.N. and A. Hawkins, eds. Advances in Experimental Medicine and Biology, Springer, New York. pp. 77-82.

Dorr, B. S., J. J. Hatch, and D. V. Weseloh. 2020. Double-crested Cormorant (*Phalacrocorax auritus*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.doccor.01

Drucker, J., C. Carboneras, F. Jutglar, and G. M. Kirwan. 2020. Wilson's Storm-Petrel (*Oceanites oceanicus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.wispet.01

Eadie, J. M., J.-P. L. Savard, and M. L. Mallory. 2020. Barrow's Goldeneye (*Bucephala islandica*), version 1.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bargol.01

Eamer, J.B.R., Didier, D., Kehler, D., Manning, I., Colville, D., Manson, G.K., Jagot, A., and Kostylev, V. 2021. Multi-decadal coastal evolution of a North Atlantic shelf-edge vegetated sand island – Sable Island, Canada. Canadian Journal of Earth Sciences. http://dx.doi.org/10.1139/cjes-2020-0194

Eamer, J.B.R., Shaw, J., King, E.L., MacKillop, K., 2020. Seabed conditions on the inner shelves of Atlantic Canada. Geological Survey of Canada Open File 8731, 162p. https://doi.org/10.4095/326514.

Earthquake Canada, GSC, Earthquake search (On-line Bulletin). Available at: http://earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bulletin-en.php, Nat. Res. Can., Accessed Feb 25, 2021.

ECCC (Environment and Climate Change Canada). 2014. Marine buoy observations. https://www.canada.ca/en/environment-climate-change/services/general-marine-weather-information/observations/buoy.html

ECCC (Environment and Climate Change Canada). 2017. Procedures for handling and documenting stranded birds encountered on infrastructure offshore Atlantic Canada. Environment and Climate Change Canada. 17 pp.

ECCC (Environment and Climate Change Canada). 2017. Atlantic Canada Shorebird Survey. https://www.canada.ca/en/environment-climate-change/services/bird-surveys/shorebird/atlantic.html

ECCC (Environment and Climate Change Canada). 2020a. Migratory bird sanctuaries across Canada. Available at: https://www.canada.ca/en/environment-climate-change/services/migratory-bird-sanctuaries/locations.html#ns

ECCC (Environment and Climate Change Canada). 2020b. Regulations respecting excluded physical activities (Newfoundland and Labrador offshore exploratory wells). Available at: https://www.canada.ca/en/impact-assessment-agency/corporate/acts-regulations/legislation-regulations/regulations-respecting-excluded-physical-activities.html

ECCC (Environment and Climate Change Canada) 2021a. Guidelines for Wildlife Response Plans. 37pp.

ECCC (Environment and Climate Change Canada). 2021b. Guidance for Developing Systematic Stranded Bird Survey Protocols for Vessels and Platforms. 3pp.

Edge, K. J., E. L. Johnston, K. A. Dafforn, S. L. Simpson, T. Kutti, and R. J. Bannister. 2016. Sub-lethal effects of water-based drilling muds on the deep-water sponge *Geodia barretti*. Environmental Pollution 212:525–534.

Edinger, E. N., K. D. Baker, R. Devillers, and V. Wareham. 2007. Coldwater Corals off Newfoundland and Labrador: Distribution and Fisheries Impacts:49.

Ellis, J.I., G. Fraser, and J. Russell. 2012. Discharged drilling waste from oil and gas platforms and its effects on benthic communities. Marine Ecology Progress Series 456:285–302.

Ellis, J.I., Wilhelm, S.I., Hedd, A., Fraser, G.S., Robertson, G.J., Rail, J.F., Fowler, M., Morgan, K.H. 2013. Mortality of migratory birds from marine commercial fisheries and offshore oil and gas production in Canada. Avian Conserv. Ecol. 8.

Engelhardt, F.R. 1983. Petroleum effects on marine mammals. Aquatic Toxicology. 4:199-217.

Fader, G. B. 1991. Gas-related sedimentary features from the eastern Canadian continental shelf. Continental Shelf Research. 11.

Farnsworth, A. 2020. Black-capped Petrel (*Pterodroma hasitata*), version 1.0. In Birds of the World (T. S. Schulenberg, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi-org.proxy1.lib.trentu.ca/10.2173/bow.bkcpet.01

Fields, D.M., N.O. Handegard, J. Dalen, C. Eichner, K. Malde, Ø. Karlsen, A.B. Skiftesvik, C.M.F. Durif, and H.I. Browman. 2019. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod Calanus finmarchicus. ICES Journal of Marine Science, 76(7), 2033-2044.

Fifield, D. A., Lewis, K.P., Gjerdrum C., Robertson, G. J., Wells R. 2009. Offshore Seabird Monitoring Program. Environment Studies Research Funds Report No. 183. St. John’s. 68 p.

Filbee-Dexter, K., and R. E. Scheibling. 2016. Spatial Patterns and Predictors of Drift Algal Subsidy in Deep Subtidal Environments. Estuaries and Coasts 39:1724–1734.

Fish Harvester Organizations Support Act. 2011. Chapter 36 of the Acts 2011 (Nova Scotia). https://nslegislature.ca/sites/default/files/legc/statutes/fish%20harvester%20organizations%20support.pdf

Fisher, C.R., P.-Y. Hsing, C.L. Kaiser, D.R. Yoerger, H.H. Roberts, W.W. Shedd, and J.M. Brooks. 2014. Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proceedings of the National Academy of Sciences, 111(32): 11744–11749.

Fisheries Act. 2019. R.S.C., 1985, c. F-14; as amended to 2019. https://laws.justice.gc.ca/PDF/F-14.pdf

Fjeldså, J., C. Carboneras, G. M. Kirwan, F. Jutglar, C. J. Sharpe, and E. F. J. Garcia. 2020. Fea's Petrel (*Pterodroma feae*), version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S.

Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.feapet1.01

Flynn, R. F. J. 2000. Tunnel valleys under the southeastern Scotian Shelf. B. Sc. Thesis. Saint Mary's University, Halifax, N.S. +48 p.

Foley, A. M., Stacy, B. A., Hardy, R. F., Shea, C. P., Minch, K. E., Schroeder, B. A. 2019. Characterizing watercraft-related mortality of sea turtles in Florida. Journal of Wildlife Management. 83(5)

Ford, J., and A. Serdynska. 2013. Ecological Overview of St Anns Bank. Canadian Technical Report of Fisheries and Aquatic Sciences 3023:xiv + 252p.

Fossi, M. C., S. Casini, and L. Marsili. 2007. Potential toxicological hazard due to endocrine-disrupting chemicals on Mediterranean top predators: State of art, gender differences and methodological tools. Environmental Research 104:174–182.

Frank, K.T., F.H. Page, and J.K. McRuer. 1989. Hydrographic effects on the vertical distribution of haddock (*Melanogrammus aeglefinus*) eggs and larvae on the southwestern Scotian Shelf. Can. J. Fish. Aquat. Sci., 46(suppl 1):82-92.

Frank, K. T., B. Petrie, and N. L. Shackell. 2007. The ups and downs of trophic control in continental shelf ecosystems. Trends in Ecology & Evolution 22:236–242.

Frank, K.T., J.E. Carscadden, and J.E. Simon. 1996. Recent excursions of capelin (*Mallotus villosus*) to the Scotian Shelf and Flemish Cap during anomalous hydrographic conditions. Can. J. Fish. Aquat. Sci., 53:1473-1486.

Franks, J. 2000. A review: pelagic fishes at petroleum platforms in the Northern Gulf of Mexico; diversity, interrelationships, and perspective. Pêche thonière et dispositifs de concentration de poissons, Caribbean-Martinique, 15-19 Oct 1999:502–515.

Freeman, E., S.D. Woodruff, S.J. Worley, S.J. Lubker, E.C. Kent, W.E. Angel, D.I. Berry, P. Brohan, R. Eastman, L. Gates, W. Gloeden, Z. Ji, J. Lawrimore, N.A. Rayner, G. Rosenhagen, and S.R. Smith. 2017. ICOADS Release 3.0: A major update to the historical marine climate record. Int. J. Climatol., 37" 2211-2232. https://doi.org/10.1002/joc.4775

Froese, R. and D. Pauly (eds). 2020. FishBase. World Wide Web Electronic Publication. www.fishbase.org. Accessed 2021-02-20.

Fujiwara M, Caswell H. 2001. Demography of the endangered North Atlantic right whale. Nature. 414.

Fuller, S. D., F. J. M. Perez, V. E. Wareham, and E. L. R. Kenchington. 2008. Vulnerable Marine Ecosystems Dominated by Deep-Water Corals and Sponges in the NAFO Convention Area. NAFO Scientific Council Research Document N5524:1–24.

Furness, R.W., P. F. D. Boesman, and E. F. J. Garcia. 2020a. Great Skua (*Stercorarius skua*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.gresku1.01

Furness, R.W., P. F. D. Boesman, and E. F. J. Garcia. 2020b. South Polar Skua (*Stercorarius maccormicki*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.sopsku1.01

Garabana, D., P. Sampedro, R. Dominguez-Petit, C. Gonzalez-Iglesias, A. Villaverde, M. Álvarez, C. González-Tarrío, and M. Hermida. 2016. A review of NAFO 3LMN roughhead grenadier (*Macrourus berglax* Lacepède, 1801) reproductive biology including the evaluation of maturity ogive estimates. NAFO SCR Doc. 16/22. Serial No. N6565:21 pp.

Gaston, A. J. and J. M. Hipfner. 2020. Thick-billed Murre (*Uria lomvia*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.thbmur.01

Gates, A. R., M. C. Benfield, D. J. Booth, A. M. Fowler, D. Skropeta, and D. O. B. Jones. 2017. Deep-sea observations at hydrocarbon drilling locations: Contributions from the SERPENT Project after 120 field visits. Deep-Sea Research Part II: Topical Studies in Oceanography:463–479.

Genelt-Yanovskiy, E., Y. Li, E. Stratanenko, N. Zhuravleva, N. Strelkova, Q. Xu, and S. Nazarova. 2021. Phylogeography of the brittle star *Ophiura sarsii* Lütken, 1855 (Echinodermata: Ophiuroidea) from the Barents Sea and East Atlantic. Diversity 13:40.

Gilkinson, K., and E. Edinger. 2009. The ecology of deep-sea corals of Newfoundland and Labrador waters: Canadian Technical Report of Fisheries and Aquatic Sciences No . 2830.

Girard, F., K. Shea, and C.R. Fisher. 2018. Projecting the recovery of a long-lived deep-sea coral species after the Deepwater Horizon oil spill using state-structured models. Journal of Applied Ecology: 1-11.

Gjerdrum, C., R.A. Ronconi, K.L. Turner, T.E. Hamer. 2021. Bird Strandings and bright lights at coastal and offshore industrial sites in Atlantic Canada. Avian Conservation and Ecology. 16(1):22.

Gjerdrum, C., D.A. Fifield, Wilhelm S.I. 2012. Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms. Canadian Wildlife Service Technical Report Series No. 515. Atlantic Region. Vi +37 pp.

Gochfeld, M. and J. Burger. 2020. Roseate Tern (*Sterna dougallii*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.roster.01

Golikov, A. V., M. E. Blicher, L. L. Jørgensen, W. Walkusz, D. V. Zakharov, O. L. Zimina, and R. M. Sabirov. 2019. Reproductive biology and ecology of the boreoatlantic armhook squid *Gonatus fabricii* (Cephalopoda: Gonatidae). Journal of Molluscan Studies 85:341–353.

Good, T. P. 2020. Great Black-backed Gull (Larus marinus), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.gbbgul.01

Gough, J. 2007. Fisheries Management in the Maritimes Region, 1990-2005. DFO/2007-1177. https://waves-vagues.dfo-mpo.gc.ca/Library/40572146.pdf

Gough, J. and E. James-abra. 2015. History of Commercial Fisheries. In the Canadian Encyclopedia. https://www.thecanadianencyclopedia.ca/en/article/history-of-commercial-fisheries

Government of Canada. 2019. Physical Activities Regulations. Available at: https://laws.justice.gc.ca/eng/regulations/SOR-2019-285/page-3.html#docCont.

Government of Canada. 2021a. Species at Risk Public Registry. Available at species-registry.canada.ca/index-en. Accessed February 23, 2021.

Government of Canada. 2021b. *Gully Marine Protected Area Regulations (SOR/2004-112)*. Available at: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2004-112/page-1.html#h-708865

Government of Canada. 2021c. *Migratory Bird Sanctuary Regulations (C.R.C., c. 1035)*. Available at: https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.%2C_c._1035/index.html

Government of Canada. 2021d. *Canada National Parks Act (S.C. 2000, c. 32)*. Available at: https://laws-lois.justice.gc.ca/eng/acts/n-14.01/page-2.html#h-360375

Government of Canada. 2021e. Consolidation Collision Regulations C.R.C., c. 1416 (Current to February 15, 2021, Last amended on January 29, 2014). https://laws-lois.justice.gc.ca/PDF/C.R.C.,_c._1416.pdf

Government of Canada and Government of Nova Scotia. 2020. *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act (S.C. 1988, c. 28)*. Available at https://laws-lois.justice.gc.ca/eng/acts/c-7.8/page-1.html, accessed March 5, 2021.

Gowans, S., H. Whitehead, J.K, Arch, and S.K. Hooker. 2000. Population size and residency patterns of northern bottlenose whales (*Hyperoodon ampullatus*) using the Gully, Nova Scotia. Journal of Cetacean Research and Management 2(3): 201-210

Graham, L. E. and L. W. Wilcox. 2000. Algae. Prentice Hall, Upper Saddle River, New Jersey.

Grant, S.M. 2006. An exploratory fishing survey and biological resource assessment of Atlantic hagfish (*Myxine glutinosa*) occurring on the southwest slope of the Newfoundland Grand Bank. J. Northw. Atl. Fish. Soc., 36: 91-110.

Greer, C. D., P. V. Hodson, Z. Li, T. King, and K. Lee. 2012. Toxicity of crude oil chemically dispersed in a wave tank to embryos of Atlantic herring (*Clupea harengus*). Environmental toxicology and chemistry 31:1324–1333.

Gregory, D.N. 2004. Ocean Data Inventory (ODI): A Database of Ocean Current, Temperature and Salinity Time Series for the Northwest Atlantic. DFO Canadian Science Advisory Secretariat Research Document 2004/097.

Gulf of Maine Research and University of Maine. 2013. Jonah Crab (*Cancer borealis*): Current Status & Information Sources. In support of Fishery Pre-Assessment Along Marine Stewardship Council (MSC) Standard 31 Principle Indicators. Page 42.

Halliday, R. G., L. V. Guelpen, and D. E. Themelis. 2012a. Demersal fish fauna of the continental slope off Nova Scotia, Canada, based on exploratory bottom trawl surveys in 1994-95. Journal of Northwest Atlantic Fishery Science 44:41–60.

Halliday, R. G., D. E. Themelis, and W. M. Hickey. 2012b. Demersal fishes caught with bottom gillnets and baited gears at 500-2800m on the continental slope off Nova Scotia, Canada. Journal of Northwest Atlantic Fishery Science 44:31–40.

Halliday, R. G., K. J. Clark, and D. E. Themelis. 2015. The biology of *Benthosema glaciale* and *Ceratoscopelus maderensis* (Myctophidae) in the Slope Sea off Nova Scotia, Canada. Journal of Northwest Atlantic Fisheries Science 47:73–87.

Hamel, J.-F., and A. Mercier. 1999. Mucus as a mediator of gametogenic synchrony in the sea cucumber *Cucumaria frondosa* (Holothuroidea: Echinodermata). Journal of the Marine Biological Association of the UK 79:121–129.

Hansen, B. H., L. Sørensen, P. A. Carvalho, S. Meier, A. M. Booth, D. Altin, J. Farkas, and T. Nordtug. 2018. Adhesion of mechanically and chemically dispersed crude oil droplets to eggs of Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*). Science of the Total Environment 640:138–143.

Hargrave, B., V. Kostylev, and C. Hawkins. 2004. Benthic epifauna assemblages, biomass and respiration in The Gully region on the Scotian Shelf, NW Atlantic Ocean. Marine Ecology Progress Series 270:55–70.

Hartung, R. and G.S. Hunt. 1966. Toxicity of Some Oils to Waterfowl. Journal of Wildlife Management. 30:564-570.

Hatch, S. A., G. J. Robertson, and P. H. Baird. 2020a. Black-legged Kittiwake (*Rissa tridactyla)*, version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bklkit.01

Hatch, J. J., M. Gochfeld, J. Burger, and E. F. J. Garcia. 2020b. Arctic Tern (*Sterna paradisaea*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.arcter.01

Hatch, J. J., K. M. Brown, G. G. Hogan, R. D. Morris, J. Orta, E. F. J. Garcia, F. Jutglar, G. M. Kirwan, and P. F. D. Boesman. 2020c. Great Cormorant (*Phalacrocorax carbo*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.grecor.01

Hedd A, Pollet IL, Mauck RA, Burke CM, Mallory ML, McFarlane Tranquilla LA, et al. 2018. Foraging areas, offshore habitat use, and colony overlap by incubating Leach's storm-petrels *Oceanodroma leucorhoa* in the Northwest Atlantic. PLoS ONE 13(5): e0194389. https://doi.org/10.1371/journal.pone.0194389

Hawkes, N., M. Korabik, L. Beazley, H. Rapp, J. Xavier, and E. Kenchington. 2019. Glass sponge grounds on the Scotian Shelf and their associated biodiversity. Marine Ecology Progress Series 614:91–109.

Hazen, E. L., A. B. Carlisle, S. G. Wilson, J. E. Ganong, M. R. Castleton, R. J. Schallert, M. J. W. Stokesbury, S. J. Bograd, and B. A. Block. 2016. Quantifying overlap between the Deepwater Horizon oil spill and predicted bluefin tuna spawning habitat in the Gulf of Mexico. Scientific Reports 6:33824.

Hazin, H. G., F. H. V. Hazin, P. Travassos, and K. Erzini. 2005. Effect of light-sticks and electralume attractors on surface-longline catches of swordfish (*Xiphias gladius*, Linnaeus, 1959) in the southwest equatorial Atlantic. Fisheries Research 72:271–277.

Head, E., and P. Pepin. 2007. Variations in overwintering depth distributions of *Calanus finmarchicus* in the slope waters of the NW Atlantic continental shelf and the Labrador Sea. Journal of Northwest Atlantic Fishery Science 39.

Heery, E. C., M. J. Bishop, L. P. Critchley, A. B. Bugnot, L. Airoldi, M. Mayer-Pinto, E. V. Sheehan, R. A. Coleman, L. H. L. Loke, E. L. Johnston, V. Komyakova, R. L. Morris, E. M. A. Strain, L. A. Naylor, and K. A. Dafforn. 2017. Identifying the consequences of ocean sprawl for sedimentary habitats. Journal of Experimental Marine Biology and Ecology 492:31–48.

Helm, R. C., Costa, D. P., DeBruyn, T. D., O'Shea, T. J., Wells, R. S., and Williams, T. M. 2015. Overview of effects of oil spills on marine mammal. M. Fingas (ed.) In Handbook of Oil Spill Science and Technology. John Wiley & Sons.

Henkel, J.R., Sigel, B.J., and Taylor, C.M. 2012. Large-scale impacts of the Deepwater Horizon oil spill: can local disturbance affect distant ecosystems through migratory shorebirds? Bioscience 62: 676-685.

Henry, L.-A. and M. Hart. 2005. Regeneration from Injury and Resource Allocation in Sponges and Corals–a Review. International Review of Hydrobiology, 90(2): 125-158.

Hill, P. R., and A.J. Bowen.1983. Modern sediment dynamics at the shelf slope boundary off Nova Scotia. In Stanley, D. J. and Moore, G. T. (eds.) The Shelfbreak. Critical Interface on Continental Margins. Society of Economic Palaeontologists and Mineralogists Special Publication. 33.

Hoolihan, J. P., R. J. D. Wells, J. Luo, B. Falterman, E. D. Prince, and J. R. Rooker. 2014. Vertical and Horizontal Movements of Yellowfin Tuna in the Gulf of Mexico. Marine and Coastal Fisheries 6:211–222.

Hope Jones, P. 1980. The effect on birds of a North Sea gas flare. British Birds, 73: 547-555.

Horn, A.G. 2007. Preliminary report on the 2006 Census of Ipswich Sparrows. Unpublished Report for the Sable Island Preservation Trust, Halifax, NS. Provided by Parks Canada Agency under a Data License Agreement.

Horn, A.G. 2013. The 2013 census of Ipswich Sparrows. Unpublished report for Parks Canada and the Canadian Wildlife Service, Dartmouth, NS. Provided by Parks Canada Agency under a Data License Agreement.

Horsman, T., and N. Shackell. 2009. Atlas of important habitat for key fish species of the Scotian Shelf, Canada. Canadian Technical Report of Fisheries and Aquatic Sciences 2835:viii + 82 p.

Hsing, P.Y., B. Fu, E.A. Larcom, S.P. Berlet, T.M. Shank, A.F. Govindarajan, A.J. Lukasiewicz, P.M. Dixon, and C.R. Fisher. 2013. Evidence of lasting impact of the Deepwater Horizon oil spill on a deep Gulf of Mexico coral community. Elementa: Science of the Anthropocene, 1:12.

Hurley, P. C. F., and S. E. Campana. 1989. Distribution and abundance of haddock (*Melanogrammus aeglefinus*); and Atlantic cod (*Gadus morhua*) eggs and larvae in the waters off southwest Nova Scotia. Can. J. Fish. Aquat. Sci., 46(Suppl. 1):103-112.

IAAC (Impact Assessment Agency of Canada). 2020. Regional assessment of offshore oil and gas exploratory drilling east of Newfoundland and Labrador. Available at: https://iaac-aeic.gc.ca/050/documents/p80156/134068E.pdf

ICES (International Council for the Exploration of the Sea). 2009. Report of the ICES-NAFO Working Group on Deep-Water Ecology (WGDEC), 9–13 March 2009 ICES Document CM 2009/ACOM:92 pp.

IIP (International Ice Patrol). 1995. International Ice Patrol (IIP) Iceberg Sightings Database, Version 1, Updated 2020. Boulder, CO: National Snow and Ice Data Center. doi: doi.org/10.7265/N56Q1V5R

IMO (International Maritime Organization). 2021. IMO Conventions. https://www.imo.org/en/About/Conventions/Pages/ListOfConventions.aspx

Incze, L. S., and C. E. Naimie. 2000. Modelling the transport of lobster (*Homarus americanus*) larvae and postlarvae in the Gulf of Maine. Fisheries Oceanography 9:99–113.

Ingvarsdóttir, A., C. Bjørkblom, E. Ravagnan, B. Godal, M. Arnberg, D. Joachim, and S. Sanni. 2012. Effects of different concentrations of crude oil on first feeding larvae of Atlantic herring (*Clupea harengus*). Journal of Marine Systems 93:69–76.

IOGP (International Association of Oil and Gas Producers). 2016. Environmental fate and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. Page 143.

IPIECA (International Petroleum Industry Environmental Conservation Association). 2016. Economic assessment and compensation for marine oil releases: Good practice guidelines for incident management and emergency response personnel. https://www.ipieca.org/resources/good-practice/economic-assessment-and-compensation-for-marine-oil-releases/

ISO (International Organization for Standardization). 2005. ISO/DIS 19901-1, Petroleum and natural gas industries – Specific requirements for offshore structures – Part 1: Metocean design and operating conditions. Available at: www.iso.org. Accessed February 2014.

ITOPF (International Tanker Owners Pollution Federation Limited). 2014. Effects of Oil Pollution on Fisheries and Mariculture: Technical Information Paper. https://www.itopf.org/fileadmin/data/Documents/TIPS%20TAPS/TIP_11_Effects_of_Oil_Pollution_on_Fisheries_and_Mariculture.pdf

Jacobson, E. R. 1998. Buoyancy problems in sea turtles: Causes and diagnosis. in Proceedings of the Seventeenth Annual Sea Turtle Symposium. S. P. Epperl, and J. Braun (eds.). National Marine Fisheries Service. Miami, FL. 67

Jakobsdóttir, K.B. 2001. Biological aspects of two deep-water squalid sharks: *Centroscyllium fabricii* (Reinhardt, 1825) and *Etmopterus princeps* (Collett, 1904) in Icelandic waters. Fisheries Research, 51:247-265.

James, M.C., K. Martin, and P.H. Dutton. 2004. Hybridization between a green turtle, *Chelonia mydas*, and loggerhead turtle, *Caretta*, and the first record of a green turtle in Atlantic Canada. Canadian Field–Naturalist 118:579–582.

James, M. C., Myers, R. A., & Ottensmeyer, C. A. (2005). Behaviour of leatherback sea turtles, Dermochelys coriacea, during the migratory cycle. Proceedings of the Royal Society B: Biological Sciences, 272(1572), 1547-1555.

Järnegren, J., S. Brooke, and H. Jensen. 2017. Effects of drill cuttings on larvae of the cold-water coral *Lophelia pertusa*. Deep-Sea Research Part II: Topical Studies in Oceanography 137:454–462.

Jefferson, T. A., D. Fertl, J. Bolanos-Jimenez, A.N. Zerbini. 2009. Distribution of common dolphins (*Delphinus* spp.) in the western Atlantic Ocean: a critical re-examination. Marine Biology 156(6):1109-1124

Jenner, Kimberley A., David JW Piper, D. Calvin Campbell, and David C. Mosher. 2007. Lithofacies and origin of late Quaternary mass transport deposits in submarine canyons, central Scotian Slope, Canada. Sedimentology 54, no. 1 (): 19-38.

Jiang, Z., Y. Huang, X. Yu, Y. Liao, L. Shou, J. Liu, Q. Chen, and J. Zeng. 2010. Advance in the toxic effects of petroleum water accommodated fraction on marine plankton. Acta Ecologica Sinica, 30:8-15.

Johansen, S., O.N. Larsen, J. Christensen-Dalsgaard, L. Seidelin, T. Huulvej, K. Jensen, S.-G. Lunneryd, M. Boström and M. Wahlberg. 2016. In-air and underwater hearing in the great cormorant (*Phalacrocorax carbo sinensis*). Advances in Experimental Medicine and Biology, 875: 505-512.

Johnson, H. D. 2018. WhaleMap. Available at: https://whalemap.org/. Accessed: March 01, 2021

Karl, S.A., B.W. Bowen, and J.C. Avise. 1995. Hybridization among ancient mariners: characterization of marine turtle hybrids with molecular genetic assays. Journal of Heredity 86:262–268

Keenan, S. F., M. C. Benfield, and J. K. Blackburn. 2007. Importance of the artificial light field around offshore petroleum platforms for the associated fish community. Marine Ecology-Progress Series 331:219–231.

Kelley, D. E., Vlasic, J. P., & Brillant, S. W. (2021). Assessing the lethality of ship strikes on whales using simple biophysical models. Marine Mammal Science, 37(1), 251-267.

Kenchington, E. 2014. A General Overview of Benthic Ecological or Biological Significant Areas (EBSAs) in Maritimes Region. Canadian Technical Report of Fisheries and Aquatic Sciences 3072:iv+45p.

Kenchington, E., D. Power, and M. Koen-Alonso. 2013. Associations of demersal fish with sponge grounds on the continental slopes of the northwest Atlantic. Marine Ecology Progress Series 477:217–230.

Kenchington, E., L. Beazley, C. Lirette, F.J. Murillo, J. Guijarro, V. Wareham, K. Gilkinson, M. Koen Alonso, H. Benoît, H. Bourdages, B. Sainte-Marie, M. Treble, and T. Siferd. 2016. Delineation of Coral and Sponge Significant Benthic Areas in Eastern Canada Using Kernel Density Analyses and Species Distribution Models. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/093. vi + 178 p.

Khan, R. A. 1990. Parasitism in marine fish after chronic exposure to petroleum hydrocarbons in the laboratory and to the Exxon Valdez oil spill. Bulletin of Environmental Contamination and Toxicology 44:759–763.

Khan, R. A. and P. Ryan. 1991. Long term effects of crude oil on Common Murres (*Uria aalge*) following rehabilitation. Bulletin of Environmental and Contaminant Toxicology. 46:216-222.

King, E. L. 2001. A glacial origin for Sable Island: ice and sea-level fluctuations from seismic stratigraphy on Sable Island Bank, Scotian Shelf, offshore Nova Scotia. Geological Survey of Canada Current Research 2001-D19, 11p.

King, E.L. 2015. Canyon-head evolution and the influence of glacial regime along the southeast Canadian margin. Geological Survey of Canada, Open File 7146, 1 sheet, https://doi.org/10.4095/295689

King LH and MacLean B. 1976. Geology of the Scotian Shelf and Adjacent Areas. Marine Sciences Paper 7. 31p. https://doi.org/10.4095/119753

King, M., D. Fenton, J. Aker, and A. Serdynska. 2016. Offshore Ecologically and Biologically Significant Areas in the Scotian Shelf Bioregion. Canadian Science Advisory Secretariat Research Document 2016/007:100.

Kirwan, G. M., C. Carboneras, and F. Jutglar. 2020a. Barolo Shearwater (*Puffinus baroli*), version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.litshe1.01

Kirwan, G. M., C. Carboneras, and F. Jutglar. 2020b. Audubon's Shearwater (*Puffinus lherminieri*), version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.audshe.01

Kjeilen-Eilertsen, G., H. C. Trannum, R. Jak, M. G. D. Smit, J. Neff, and G. Durell. 2004. Literature report on burial: derivation of PNEC as component in the MEMW model tool. ERMS Report No. 9B AM-2004/024:25.

Klinger, D. H., J. J. Dale, B. E. Machado, J. P. Incardona, C. J. Farwell, and B. A. Block. 2015. Exposure to Deepwater Horizon weathered crude oil increases routine metabolic demand in chub mackerel, *Scomber japonicus*. Marine Pollution Bulletin 98:259–266.

Koen-Alonso, M., P. Pepin, and F. Mowbray. 2010. Exploring the role of environmental and anthropogenic drivers in the trajectories of core fish species of the Newfoundland-Labrador marine community. NAFO Scientific Council Research Document Serial no. N5795:16.

Koh, H. L., and S. Y. Teh. 2011. Simulation of Drill Cuttings Dispersion and Deposition in South China Sea. Page Proceedings of the International Multi Conference of Engineers and Computer Scientists. Hong Kong.

Komenda-Zehnder, S., M. Cevallos, B. Bruderer. 2003. Effects of Disturbance by aircraft overflight on waterbirds – an experimental approach (ISSC26/WP-LE2). Warsaw, Poland: International Bird Strike Committee.

Kowarski, K., C. Evers, H. Moors-Murphy, B. Martin. 2015. Year-round monitoring of humpback whale (*Megaptera novaeangliae*) calls in the Gully MPA and adjacent areas. Canadian Acoustics 43 (3)

Kraus, S.D., M.W. Brown, H. Caswell, C.W. Clark, M. Fujiwara, P.K. Hamilton, R.D. Kenney, A.R. Knowlton, S. Landry, C.A. Mayo, W.A. McLellan, M.J. Moore, D.P. Nowacek, D.A. Pabst, A.J. Read, and R.M. Rolland. 2005. North Atlantic right whales in crisis. Science. 309.

Krumhansl, K. A., E. J. H. Head, P. Pepin, S. Plourde, N. R. Record, J. A. Runge, and C. L. Johnson. 2018. Environmental drivers of vertical distribution in diapausing Calanus copepods in the Northwest Atlantic. Progress in Oceanography 162:202–222.

Kulka, D. W., M. R. Simpson, and R. G. Hooper. 2004. Changes in Distribution and Habitat Associations of Wolffish (Anarhichidae) in the Grand Banks and Labrador Shelf. Canadian Science Advisory Secretariat Research Document 113:1–48.

Kutti, T., R. J. Bannister, J. H. Fosså, C. M. Krogness, I. Tjensvoll, and G. Søvik. 2015. Metabolic responses of the deep-water sponge *Geodia barretti* to suspended bottom sediment, simulated mine tailings and drill cuttings. Journal of Experimental Marine Biology and Ecology 473:64–72.

Lacey, N. C., and P. Hayes. 2019. Epifauna associated with subsea pipelines in the North Sea. ICES Journal of Marine Science.

Lacroix, D.L., Lanctot, R.B., Reed, J.A., and McDonald, T.L. 2003. Effect of underwater surveys on molting male Long-tailed Ducks in the Beaufort Sea, Alaska. Canadian Journal of Zoology. 81:1862-1875.

Landsea, C. W. and J. L. Franklin. 2013. Atlantic Hurricane Database Uncertainty and Presentation of a New Database Format. Mon. Wea. Rev., 141:3576-3592.

Laurel, B. J., L. A. Copeman, P. Iseri, M. L. Spencer, G. Hutchinson, T. Nordtug, C. E. Donald, S. Meier, S. E. Allan, D. T. Boyd, G. M. Ylitalo, J. R. Cameron, B. L. French, T. L. Linbo, N. L. Scholz, and J. P. Incardona. 2019. Embryonic Crude Oil Exposure Impairs Growth and Lipid Allocation in a Keystone Arctic Forage Fish. iScience 19:1101–1113.

Lauritsen, A. M., P.M. Dixon, D. Cacela, B. Brost, R. Hardy, S.L. MacPherson, A. Meylan, B.P. Wallace, and B. Witherington. 2017. Impact of the Deepwater Horizon oil spill on loggerhead turtle *Caretta* nest densities in northwest Florida. Endangered Species Research. 33.

Lavers, J., J. M. Hipfner, and G. Chapdelaine. 2020. Razorbill (*Alca torda*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.razorb.01

Lawler, G.C., W. Loong, and J.L. Laseter. 1978. Accumulation of Aromatic Hydrocarbons in Tissues of Petroleum-exposed Mallard Ducks (*Anas platyrhynchos*). Environmental Science and Technology Research. 12:51-54.

Lawson, J. W., & Gosselin, J. F. (2009). Distribution and preliminary abundance estimates for cetaceans seen during Canada's marine megafauna survey-a component of the 2007 TNASS (p. 28). Fisheries and Oceans Canada, Science.

Lawson, J. and J.-F. Gosselin. 2011. Fully-corrected cetacean abundance estimates from the Canadian TNASS survey. Fisheries and Oceans, Canada, Ottawa. 10 pp.

Lawson, J. and J.-F. Gosselin. 2018. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS. NAMMCO Secretariat. Volume NAMMCO SC/25/AE/09. +40 pp.

Lawson, J. and T. Stevens. 2013. Historic and seasonal distribution patterns and abundance of killer whales (Orcinus orca) in the northwest Atlantic. Journal of Marine Biological Association of the United Kingdom.

Lawson, J. W. and V. Lesage. 2013. A draft framework to quantify and cumulate risks of impacts from large development projects for marine mammal populations: A case study using shipping associated with the Mary River Iron Mine Project. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/154 iv +22 p.

Lawson, M.C., J.A. Cullen, C.C. Nunnally, G.T. Rowe, and D.N. Hala. 2021. PAH and PCB body-burdens in epibenthic deep-sea invertebrates from the northern Gulf of Mexico. Marine Pollution Bulletin, 162:111825.

Lee, K., T. Nedwed, R. C. Prince, and D. Palandro. 2013. Lab tests on the biodegradation of chemically dispersed oil should consider the rapid dilution that occurs at sea. Marine Pollution Bulletin 73:314–318.

Lee, K., M. Boufadel, B. Chen, J. Foght, P. Hodson, S. Swanson, and A. Venosa. 2015. The Royal Society of Canada Expert Panel: The Behaviour and Environmental Impacts of Crude Oil Released into Aqueous Environments. Royal Society of Canada, Ottawa, ON.

Lee, D. S., J. C. Haney, C. Carboneras, F. Jutglar, and G. M. Kirwan. 2020. Manx Shearwater *(Puffinus puffinus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.manshe.01

Lepage, D. 2021. Checklist of the birds of Sable Island National Park Reserve. Avibase, the world bird database. https://avibase.bsceoc.org/checklist.jsp?lang=EN&region=cansnpsi&list=clements&format=1

Lesage, V., K. Gavrilchuk, R.D. Andrews, and R. Sears. 2017. Foraging areas, migratory movements, and winter destinations of blue whales from the western North Atlantic. Endangered Species Research 34: 27-43.

Li, M.Z. and Amos, C.L. 1999a. Sheet flow and large wave ripples under combined waves and current: Their field observation, model prediction and effects on boundary layer dynamics. Continental Shelf Research, 19, 637-663.

Li, M.Z. & Amos, C.L. 1999b. Field observations of bedforms and sediment transport thresholds of fine sand under combined waves and current. Marine Geology, 158, 147-160.

Li, M.Z., and E.L. King. 2007. Multibeam bathymetric investigations of the morphology of sand ridges and associated bedforms and their relation to storm processes, Sable Island Bank, Scotian Shelf. Marine Geology, 243.

Li, M. Z., King, E. L. and Prescott, R. H. 2012. Seabed disturbance and bedform distribution and mobility on the storm-dominated Sable Island Bank, Scotian Shelf. In: Li, M. Z., Sherwood, C. & Hill, P. (eds) Sediments, Morphology and Sedimentary Processes on Continental Shelves. International Association of Sedimentologists, Special Publications, 44, 197–227.

Li, M.Z., Amos, C.L. & Heffler, D.E. 1997. Boundary layer dynamics and sediment transport under storm and non-storm conditions on the Scotian Shelf. Marine Geology, 141, 157– 181.

Liefmann, S., J. Järnegren, G. Johnsen, and F. Murray. 2018. Eco-physiological responses of cold-water soft corals to anthropogenic sedimentation and particle shape. Journal of Experimental Marine Biology and Ecology, 504:61-71.

Little, G. 2017, August 1. Gina's Sable Island PhotoBlog, April-July 2017.

Løkkeborg, S., and A.V. Soldal. 1993. The influence of seismic exploration with airguns on cod (*Gadus morhua*) behaviour and catch rates. In: ICES Marine Sciences Symposium, 196: 62-67.

Løkkeborg, S., E. Ona, A. Vold, and A. Salthaug. 2012. Sounds from seismic air guns: gear-and species-specific effects on catch rates and fish distribution. Canadian Journal of Fisheries and Aquatic Sciences, 69(8): 1278-1291.

Lowther, P. E., A. W. Diamond, S. W. Kress, G. J. Robertson, K. Russell, D. N. Nettleship, G. M. Kirwan, D. A. Christie, C.J. Sharpe, E. F. J. Garcia, and P. F. D. Boesman. 2020. Atlantic Puffin (*Fratercula arctica*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.atlpuf.01

Lucas, Z., and C. MacGregor. 2006 Characterization and source of oil contamination on the beaches and seabird corpses, Sable Island, Nova Scotia, 1996-2005. Marine Pollution Bulletin 52: 778-789.

Lucas, Z. N., and L. J. Natanson. 2010. Two shark species involved in predation on seals at Sable Island, Nova Scotia, Canada. Proceedings of the Nova Scotian Institute of Science 45:64–88.

Lucas, Z., P.-Y. Daoust, G. Conboy, M. Brimacombe. 2003. Health status of harp seals (*Phoca groenlandica*) and hooded seals (*Cystophora cristata*) on Sable Island, Nova Scotia, Canada, concurrent with their expanding range. J. of Wildlife Diseases. 39(1).

Lucas, Z., A. Horn, and B. Freedman. 2012. Beached bird surveys on Sable Island, Nova Scotia, 1993 to 2009, show a decline in the incidence of oiling. Proc. Nova Scotian Inst. Sci. 47, 91-129.

MacIsaac, K., C. Bourbonnais, E. Kenchington, D. Gordon Jr, and S. Gass. 2001. Observations on the occurrence and habitat preference of corals in Atlantic Canada. Pages 58–75 Proceedings of the first international symposium on deep-sea corals. Ecology Action Centre and Nova Scotia Museum Halifax, Nova Scotia.

MacKillop, K., G. Fenton, D. Mosher, V. Latour, and P. Mitchelmore. 2019. Assessing submarine slope stability through deterministic and probabilistic approaches: A case study on the west-central Scotia Slope. Geosciences, 9(18)

MacLean B and King LH. 1971. Surficial geology of the Banquereau and Misaine Bank map-area; Information Canada, Ottawa, 19p. https://doi.org/10.4095/102408

MacLean, M., H. Breeze, J. Walmsley, and J. Corkum. (eds.). 2013. State of the Scotian Shelf Report. Can. Tech. Rep. Fish. Aquat. Sci. 3074 https://waves-vagues.dfo-mpo.gc.ca/Library/352339.pdf

Macreadie, P. I., A. M. Fowler, and D. J. Booth. 2011. Rigs-to-reefs: will the deep sea benefit from artificial habitat? Frontiers in Ecology and the Environment 9:455–461.

Mahon, R., and R. W. Smith. 1989. Demersal fish assemblages on the Scotian Shelf, Northwest Atlantic: spatial distribution and persistence. Canadian Journal of Fisheries and Aquatic Sciences 46:s134–s152.

Mallory, M. L., I. J. Stenhouse, H. G. Gilchrist, G. J. Robertson, J. C. Haney, and S. D. Macdonald. 2020a. Ivory Gull (*Pagophila eburnea*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.ivogul.01

Mallory, M. L., S. A. Hatch, and D. N. Nettleship. 2020b. Northern Fulmar (*Fulmarus glacialis*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.norful.01

Maritime Museum of the Atlantic. 2021. Sable Island Shipwrecks and Lifesaving. https://maritimemuseum.novascotia.ca/research/sable-island

Marsili, L., D. Coppola, M. Giannetti, S. Casini, M. C. Fossi, J. H. van Wyk, E. Sperone, S. Tripepi, P. Micarelli, and S. Rizzuto. 2016. Skin Biopsies as a Sensitive Non-Lethal Technique for the Ecotoxicological Studies of Great White Shark (*Carcharodon carcharias*) Sampled in South Africa. Expert Opinion on Environmental Biology 04.

Mathieson, A. C., and C. J. Dawes. 2020. Biology and ecology of Northwest Atlantic seaweeds. Pages 71–90 Handbook of Algal Science, Technology and Medicine. Elsevier.

Matt P., M. Ian, B. Adam, R. Norman, F. Morten, F. Simon, B.R. James. 2008. Seabirds as indicators of the marine environment, ICES Journal of Marine Science, 65(8): 1520–1526. https://doi.org/10.1093/icesjms/fsn155

Mbaye, B., T. Doniol-Valcroze, P. Brosset, M. Castonguay, E. Van Beveren, A. Smith, C. Lehoux, D. Brickman, Z. Wang, and S. Plourde. 2020. Modelling Atlantic mackerel spawning habitat suitability and its future distribution in the north-west Atlantic. Fisheries Oceanography, 29(1):84-99.

McBride, R.S., A.K. Johnson, E.K. Lindsay, H.J. Walsh, and R.A. Richards. 2017. Goosefish *Lophius americanus* fecundity and spawning frequency, with implications for population reproductive potential. Journal of Fish Biology, 90:1861-1882.

McCauley, R.D., J. Fewtrell, A.J. Duncan, M.N. Jenner, C. Jenner, R.I.T. Prince, and J. Murdoch. 2000a. Marine seismic surveys - A study of environmental implications. APPEA (Australian Petroleum Production and Exploration Association) Journal, 40: 692-708.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000b. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles. Prepared for APPEA (Australian Petroleum Production and Exploration Association). Report R99-15.

McCauley, R.D., J. Fewtrell, and A.N. Popper. 2003. High intensity anthropogenic sound damages fish ears. The journal of the acoustical society of America, 113(1): 638-642.

McCauley, R., R.D. Day, K.M. Swadling, Q.P. Fitzgibbon, R.A. Watson, and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology and Evolution, 1: 1-8.

McEwan, E.H. and P.M. Whitehead. 1980. Uptake and Clearance of Petroleum Hydrocarbons by the Glaucous-winged Gull (*Laras glaucescens*) and the Mallard Duck (*Anas platyrhynchos*). Canadian Journal of Zoology. 58:723-726.

Mead, J. G. 1989. Beaked whales of the genus Mesoplodon. In Ridgway, S. H. and R. Harrison (Eds.). Handbook of marine mammals, Vol. 4: River Dolphins and toothed whales. Academic press, San Diego.

Methven, D.A. 1983. Identification, growth and ecology of larval and juvenile *Urophycis chuss* (Walbaum, 1792) and *Urophycis tenuis* (Mitchell, 1815) (Pisces: Gadidae). Thesis submitted to Memorial University of Newfoundland, St. John's, Newfoundland.

Merly, L., Lange, L., Meÿer, M., Hewitt, A. M., Koen, P., Fischer, C., ... & Hammerschlag, N. (2019). Blood plasma levels of heavy metals and trace elements in white sharks (*Carcharodon carcharias*) and potential health consequences. Marine pollution bulletin, 142, 85-92.

Milinkovitch, T., H. Thomas-Guyon, C. Lefrançois, and N. Imbert. 2013. Dispersant use as a response to oil spills: toxicological effects on fish cardiac performance. Fish physiology and biochemistry 39:257–262.

Miller, E.H. 1983. Habitat and breeding cycle of the Least Sandpiper (*Caladris minutilla*) on Sable Island, Nova Scotia. Canadian Journal of Zoology. 61: 2880-2898.

MMS (Minerals Management Service). 2004. Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment. United States Department of the Interior, Gulf of Mexico Outer Continental Shelf Region.

Montevecchi, W.A. 2006. Influences of artificial light on marine birds. In: Rich, C., Longcore, T., (Eds.) Ecological consequences of artificial Night Lighting. Springer, Berlin, pp. 95-113.

Montevecchi, W. A. and I. J. Stenhouse. 2020. Dovekie (*Alle alle*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.doveki.01

Moore, M.J., A.R. Knowlton, S.D. Kraus, W.A. Mclellan, R.K. Bonde. 2004. Morphometry, gross morphology and available histopathology in North Atlantic right whale (*Eubalaena glacialis*) mortalities (1970–2002). J Cetac Res Manage. 6(3)

Moore, M. J., Rowles, T. K., Fauquier, D. A., Baker, J. D., Biedron, I., Durban, J. W., ... & Ziccardi, M. H. (2021). REVIEW Assessing North Atlantic right whale health: threats, and development of tools critical for conservation of the species. Diseases of Aquatic Organisms, 143, 205-226.

Moors, H. B. 2012. Acoustic monitoring of Scotian Shelf northern bottlenose whales (*Hyperoodon ampullatus*). Ph. D. thesis, Dalhousie University, Halifax, N. S.

Moors-Murphy, H. B. 2014. Submarine canyons as important habitat for cetaceans, with special reference to the Gully: A review. Deep Sea Research Part II: Topical Studies in Oceanography 104:6–19.

Morandin, L.A., and P.D. O'Hara. 2016. Offshore oil and gas, and operational sheen occurrence: is there potential harm to migratory birds? Environmental Reviews.

Morris, C.J., D. Cote, B. Martin, and D. Kehler. 2018. Effects of 2D seismic on the snow crab fishery. Fisheries Research, 197: 67-77.

Mosher, D. C., Piper, D. J. W., Campbell, C. D., and Jenner, K. A. 2004. Near-surface geology and sediment-failure geohazards of the central Scotian Slope. American Association of Petroleum Geologists Bulletin. 88(6)

Mowbray, T. B. 2020. Northern Gannet (*Morus bassanus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.norgan.01

Mousseau, L., L. Fortier, and L. Legendre. 1998. Annual production of fish larvae and their prey in relation to size-fractionated primary production (Scotian Shelf, NW Atlantic). ICES Journal of Marine Science 55:44–57.

Murillo, F. J., E. L. R. Kenchington, J. M. Lawson, G. Li, and D. J. W. Piper. 2016. Ancient deep-sea sponge grounds on the Flemish Cap and Grand Bank, northwest Atlantic. Marine Biology 163:1–11.

Myers, R. A., and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. Nature 423:280–283.

NAFO (Northwest Atlantic Fisheries Organization). 2020. Convention on Cooperation in the Northwest Atlantic Fisheries. https://www.nafo.int/Portals/0/PDFs/key-publications/NAFOConvention.pdf

NALWG (Northwest Atlantic Leatherback Working Group). 2018. Northwest Atlantic Leatherback Turtle (Dermochelys coriacea) Status Assessment (Bryan Wallace and Karen Eckert, Compilers and Editors). Conservation Science Partners and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) WIDECAST Technical Report No. 16. Godfrey Illinois. +36 pp.

National Hurricane Centre. 2012. Tropical Cyclone Report, Hurricane Juan 24-29, 2003. Revised September 13, 2012. https://www.nhc.noaa.gov/data/tcr/AL152003_Juan.pdf

Navigation Safety Regulations. 2020. Consolidation: Navigation Safety Regulations 2020 SOR/2020-216 (Current to February 15, 2021)

NEB (National Energy Board), C-NSOPB (Canada-Nova Scotia Offshore Petroleum Board), and C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2009. Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands. National Energy Board, Calgary.

NEB (National Energy Board), CNSOPB (Canada-Nova Scotia Offshore Petroleum Board), and C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2010. Offshore Waste Treatment Guidelines. Page 28.

Neff, J. M. 2010. Fates and effects of water based drilling muds and cuttings in cold-water environments:309.

Nelms, S. E., W.E.D. Piniak, C.R. Weir, B.J. Godley. 2016. Seismic surveys and marine turtles: An underestimated global threat? Biological Conservation. 193.

Neves, B. de M., V. Wareham Hayes, E. Herder, K. Hedges, C. Grant, and P. Archambault. 2020. Cold-Water Soft Corals (Cnidaria: Nephtheidae) as Habitat for Juvenile Basket Stars (Echinodermata: Gorgonocephalidae). Frontiers in Marine Science 7:768.

NOAA (National Oceanic and Atmospheric Administration). 2004. Essential Fish Habitat Source Document: Northern Shortfin Squid, *Illex illecebrosus*, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-191:36.

NOAA (National Oceanic and Atmospheric Administration). 2020a. Current Conditions of the Northeast Shelf Ecosystem: Spring 2020 Update. A summary of temperature, salinity, chlorophyll and other conditions on the Northeast U.S. Continental Shelf during the second half of 2019. Accessible at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/current-conditions-northeast-shelf-ecosystem-spring-2020-update

NOAA (National Oceanic and Atmospheric Administration). 2020b. Sea turtles, dolphins, and whales- 10 years after the Deepwater Horizon oil spill. Accessible at: http://www.fisheries.noaa.gov/national/marine-life-distress/sea-turtles-dolphins-and-whales-10-years-after-deepwater-horizon-oil

Nordstrom, B., James, M. C., & Worm, B. (2020). Jellyfish distribution in space and time predicts leatherback sea turtle hot spots in the Northwest Atlantic. Plos one, 15(5), e0232628.

Normandeau, Alexandre, and D. Calvin Campbell. 2020. Recurrence of turbidity currents on glaciated continental margins: A conceptual model from eastern Canada. Journal of Sedimentary Research 90, no. 10: 1305-1321.

Normandeau, Alexandre, D. Calvin Campbell, and Matthieu JB Cartigny. The influence of turbidity currents and contour currents on the distribution of deep-water sediment waves offshore eastern Canada. Sedimentology 66, no. 5 (2019): 1746-1767.

Normandeau, Alexandre, D. Calvin Campbell, David JW Piper, and Kimberley A. Jenner. 2019a. New evidence for a major late Quaternary submarine landslide on the external western levee of Laurentian Fan. Geological Society, London, Special Publications 477, no. 1: 377-387.

Normandeau, Alexandre, D. Calvin Campbell, David JW Piper, and Kimberley A. Jenner. 2019b. Are submarine landslides an underestimated hazard on the western North Atlantic passive margin? Geology 47, no. 9: 848-852.

Nova Scotia Business. 2016. Nova Scotia Seafood Product and Company Directory. https://www.novascotiabusiness.com/sites/default/files/NS-Seafood-Directory-June-2016.pdf

NSDFA (Nova Scotia Department of Fisheries and Aquaculture). 2015. Commercial Fisheries Industry Overview. https://novascotia.ca/fish/commercial-fisheries/industry-overview/

Oak, T. G. 2020. Oil and gas exploration and production activities in areas with defined benthic conservation objectives: A review of potential impacts and mitigation measures. Canadian Science Advisory Secretariat Research Document 2020/040:vi + 55 p.

OBIS (Ocean Biodiversity Information System). 2018. Electronic Atlas of Ichthyoplankton on the Scotian Shelf of North America - Ocean Biodiversity Information System. https://obis.org/dataset/a595a9a0-642a-473f-8c71-cc535ee29a2b.

Oceans Act. 2019. S.C. 1996, c. 31, as amended to 2019. https://laws.justice.gc.ca/PDF/O-2.4.pdf

Oceanweather, 2019. MSC50 Extremal Analysis. http://oceanweather.net/MSC50WaveAtlas/Extremes/MSC50_M6_Index.htm. Accessed 22 February 2021

OERA (the Offshore Energy Research Association). 2021. Ensuring a sustainable energy future. https://oera.ca/

OGP (International Association of Oil and Gas Producers). 2011. An Overview of Marine Seismic Operations. (April 2011) Report No. 448. Retrieved from: http://www.iogp.org/Our-library

OTN (Ocean Tracking Network). 2021. Notice to Mariners. https://oceantrackingnetwork.org/notice-to-mariners/

Overmans, S., M. Nordborg, R. Díaz-Rúa, D.L. Brinkman, A.P. Negri, and S. Agustí. 2018. Phototoxic effects of PAH and UVA exposure on molecular responses and development success in coral larvae. Aquatic Toxicology, 198: 165-174.

Pace, C. B., J. R. Clark, and G. E. Bragin. 1995. Comparing crude oil toxicity under standard and environmentally realistic exposures. Pages 1003–1004 International Oil Spill Conference. American Petroleum Institute.

Pace III, R. M., Williams, R., Kraus, S. D., Knowlton, A. R., & Pettis, H. M. (2021). Cryptic mortality of North Atlantic right whales. Conservation Science and Practice, 3(2), e346.

Paine, M., W. Leggett, J. McRuer, and K. Frank. 1992. Effects of Hibernia crude oil on capelin (*Mallotus villosus*) embryos and larvae. Marine Environmental Research 33:159–187.

Parks Canada. 2020. Sable Island National Park Reserve. Available at: https://www.pc.gc.ca/en/pn-np/ns/sable/visit/proteger-protect

Parks, S. E., M. Johnson, D. Nowacek, and P.L. Tyack. 2011. Individual right whales call louder in increased environmental noise. Biology Letters. 7.

Passow, U. 2016. Formation of rapidly-sinking, oil-associated marine snow. Deep Sea Research Part II: Topical Studies in Oceanography 129:232–240.

Passow, U., K. Ziervogel, V. Asper, and A. Diercks. 2012. Marine snow formation in the aftermath of the Deepwater Horizon oil spill in the Gulf of Mexico. Environmental Research Letters 7:035301.

Payne, J.F., C.D. Andrews, J. Hanlon, and J. Lawson. 2015. Effects of seismic air-gun sounds on lobster (*Homarus americanus*) with (i) a recorded track from a seismic Survey and (ii) airgun pulse exposures over 5 days. Environmental Studies Research Fund, NRCan, St. John's, NL. Available at: https://www.esrfunds.org/sites/www.esrfunds.org/files/pdf/publications/197.pdf. Accessed February 2021.

Pearce, C. M., and R. E. Scheibling. 1990. Induction of settlement and metamorphosis in the sand dollar *Echinarachnius parma*: Evidence for an adult-associated factor. Marine Biology 107:363–369.

Pearson, W.H., J.R. Skalski, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes* spp.). Canadian Journal of Fisheries and Aquatic Sciences, 49(7): 1343-1356.

Pedrete, T.A., C.C. Coutinho, D. Batista, R.A. Hauser-Davis, H.A. Nudi, and A.L. Wagener. 2017. Toxicity evaluation of PAHs in the sponge *Hymeniacidon heliophila*: field assessment and laboratory assays-a preliminary study. Ecotoxicology and Environmental Contamination, 12(1): 113-131.

Peña, M. 2019. Mesopelagic fish avoidance from the vessel dynamic positioning system. ICES Journal of Marine Science 76:734–742.

Peng, G., J.L. Matthews, M. Wang, R. Vode, and L. Sun. 2020. What Do Global Climate Models Tell Us about Future Arctic Sea Ice Coverage Changes? Climate, 8(15), 24

Pe-Piper, G., and D.J.W. Piper. 2004. The effects of strike-slip motion along the Cobequid-Chedabucto- southwest Grand Banks fault system on the Cretaceous-Tertiary evolution of Atlantic Canada. Can. J. Earth Sc. 41.

Picken, G., and A. McIntyre. 1989. Rigs to reefs in the North Sea. Bulletin of Marine Science 44:782–788.

Piper, D.J.W. 2001. The geological framework of sediment instability on the Scotian Slope: studies to 1999. Geological Survey of Canada. Open file 3920

Piper, D.J.W. 2005. Late Cenozoic evolution of the continental margin of eastern Canada. Norwegian Journal of Geology. 85.

Piper, D.J.W. and D.C. Campbell. 2002. Surficial geology of the Scotian Slope, eastern Canada. Geological Survey of Canada, Current Research. 2002-E15 +10 p.

Piper, D.J.W., D.C. Mosher, and S. Newton. 2002. Ice-margin seismic stratigraphy of the central Scotian Slope. Geological Survey Canada Current Research 2002-E16.

Platt, T., B. Irwin, and D. V. Subba Rao. 1973. Primary productivity and nutrient measurements on the spring phytoplankton bloom in Bedford Basin, 1971. Fisheries Research Board of Canada Technical Report 423:42 pp.

Plourde, S., Lehoux, C., Johnson, C. L., Perrin, G., & Lesage, V. (2019). North Atlantic right whale (Eubalaena glacialis) and its food:(I) a spatial climatology of Calanus biomass and potential foraging habitats in Canadian waters. Journal of Plankton Research, 41(5), 667-685.

Pollet, I. L., D. Shutler, J. W. Chardine, and J. P. Ryder. 2020. Ring-billed Gull (*Larus delawarensis*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.ribgul.01

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, M. B. Halvorsen, S. Lokkeborg, P. H. Rogers, B. L. Southall, D. G. Zeddies, and W. N. Tavolga. 2014. ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer Briefs in Oceanography:1–87.

Popper, A.N. and A. Hawkins (eds.). 2016. The Effects of Noise on Aquatic Life II. Springer, New York, NY.

Prouty, N.G., C.R. Fisher, A.W. Demopoulos, and E.R. Druffel. 2016. Growth rates and ages of deep-sea corals impacted by the Deepwater Horizon oil spill. Deep Sea Research Part II: Topical Studies in Oceanography, 129: 196-212.

Rabe, J. 1999. The behaviour, growth, and survival of witch flounder and yellowtail flounder larvae in relation to prey availability. Thesis submitted to Memorial University of Newfoundland, St. John’s, Newfoundland.

Rabe, J. and J.A. Brown. 2001. The behavior, growth, and survival of witch flounder (*Glyptocephalus cynoglossus*) larvae in relation to prey availability: adaptations to an extended larval period. Fishery Bulletin, 99(3):465-474.

Ragnarsson, S. Á., J. M. Burgos, T. Kutti, I. van den Beld, H. Egilsdóttir, S. Arnaud-Haond, and A. Grehan. 2017. The Impact of Anthropogenic Activity on Cold-Water Corals. Pages 1–35 in S. Rossi, editor. Marine Animal Forests. Springer International Publishing AG.

Ramachandran, S. D., P. V. Hodson, C. W. Khan, and K. Lee. 2004. Oil dispersant increases PAH uptake by fish exposed to crude oil. Ecotoxicology and Environmental Safety 59:300–308.

Rebke, M., V. Dierschke, C. N. Weiner, R. Aumüller, K. Hill, and R. Hill. 2019. Attraction of nocturnally migrating birds to artificial light: The influence of colour, intensity and blinking mode under different cloud cover condition. Biological conservation, 233: 220-227. https://doi.org/10.1016/j.biocon.2019.02.029

Reeves, R. R. and H. Whitehead. 1997. Status of the sperm whale, Physeter macrocephalus, in Canada. Canadian field-naturalist. Ottawa, ON. 111 (2):293-307.

Reiss, C., I. McLaren, P. Avendaño, and C. Taggart. 2005. Feeding ecology of silver hake larvae on the Western Bank, Scotian Shelf, and comparison with Atlantic Cod. Journal of Fish Biology, 66:703-720.

Research Data Archive/Computational and Information Systems Laboratory/National Center for Atmospheric Research/University Corporation for Atmospheric Research, Physical Sciences Division/Earth System Research Laboratory/OAR/NOAA/U.S. Department of Commerce, Cooperative Institute for Research in Environmental Sciences/University of Colorado, National Oceanography Centre/University of Southampton, Met Office/Ministry of Defence/United Kingdom, Deutscher Wetterdienst (German Meteorological Service)/Germany, Department of Atmospheric Science/University of Washington, Center for Ocean-Atmospheric Prediction Studies/Florida State University, and National Centers for Environmental Information/NESDIS/NOAA/U.S. Department of Commerce. 2016, updated monthly. International Comprehensive Ocean-Atmosphere Data Set (ICOADS) Release 3, Individual Observations. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory. https://doi.org/10.5065/D6ZS2TR3. Accessed February 2021.

Richardson, A.J., R.J. Matear, and A. Lenton. 2017. Potential impacts on zooplankton of seismic surveys. Australia: CSIRO, 10.

Rideout, R.M., D.M. Maddock, and M.P.M. Burton. 1999. Oogenesis and the spawning pattern in Greenland halibut from the North-west Atlantic. Journal of Fish Biology, 54:196-207.

Rivkin, R. B., L. Legendre, D. Deibel, J.-E. Tremblay, B. Klein, K. Crocker, S. Roy, N. Silverberg, C. Lovejoy, F. Mesplé, and others. 1996. Vertical flux of biogenic carbon in the ocean: is there food web control? Science 272:1163–1166.

Roberts, L., S. Cheesman, M. Elliott, and T. Breithaupt. 2016. Sensitivity of *Pagurus bernhardus* (L.) to substrate-borne vibration and anthropogenic noise. Journal of Experimental Marine Biology and Ecology, 474: 185-194.

Robertson, G. J. and R. I. Goudie. 2020. Harlequin Duck (*Histrionicus histrionicus*), version 1.0. In Birds of the World (S. M. Billerman, Ed.). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.harduc.01

Ronconi, R.A., K.A. Allard and P.D. Taylor. 2015. Bird interactions with offshore oil and gas platforms: Review of impacts and monitoring techniques. Journal of Environmental Management, 147: 34- 45.

Ronconi, R.A., J.R. Stephens, Z.J. Crysler, I.L. Pollet, D.T. Fife, A.G. Horn, and P.D. Taylor. 2016. Distribution, abundance and trends of gulls and terns breeding on Sable Island, Nova Scotia, Canada. Waterbirds. 39(sp1):44-56.

Rosenberg, K.V., A.M. Dokter, P.J. Blancher, J.R. Sauer, A.C. Smith, P.A. Smith, J.C. Stanton, A. Panjabi, L. Helft, M. Parr, and P.P. Marra. 2019. Decline of North American avifauna. Science. eaaw1313. DOI: 10.1126/science.aaw1313

Rosenberger, A.L.J., M. MacDuffee, A.G.J. Rosenberger, and P.S. Ross. 2017. Oil spills and marine mammals in British Columbia, Canada: Development and application of a risk-based conceptual framework. Arch Environmental Contamination Toxicology. 73

Ross, T., S. E. Craig, A. Comeau, R. Davis, M. Dever, and M. Beck. 2017. Blooms and subsurface phytoplankton layers on the Scotian Shelf: insights from profiling gliders. Journal of Marine Systems 172:118–127.

Røstad, A., S. Kaartvedt, T.A. Klejvar, and W. Melle. 2006. Fish are attracted to vessels. ICES Journal of Marine Science, 63: 1431-1437.

Rozalska, K. and S. Coffen-Smout. 2020. Maritimes Region Fisheries Atlas: Catch Weight Landings Mapping (2014–2018) on a Hexagon Grid. Can. Tech. Rep. Fish. Aquat. Sci. 3373:vi + 68p. http://publications.gc.ca/collections/collection_2020/mpo-dfo/Fs97-6-3373-eng.pdf

Ruckdeschel, G., K. Davies, and T. Ross. 2020. Biophysical Drivers of Zooplankton Variability on the Scotian Shelf Observed Using Profiling Electric Gliders. Frontiers in Marine Science 7.

Sandrini-Neto, L., P. Geraudie, M. S. Santana, and L. Camus. 2016. Effects of dispersed oil exposure on biomarker responses and growth in juvenile wolfish *Anarhichas denticulatus*. Environmental Science and Pollution Research 23:21441–21450.

SARA (Species at Risk Act). 2020a. Species at risk act public registry. Species Profile: Roseate Tern. https://species-registry.canada.ca/index-en.html#/species/40-42

SARA (Species at Risk Act). 2020b. Species at risk act public registry. Species Profile: Leach’s Storm Petrel. https://species-registry.canada.ca/index-en.html#/species/40-42

SARA (Species at Risk Act). 2020c. Species at risk act public registry. Species Profile: Red-necked Phalarope. https://species-registry.canada.ca/index-en.html#/species/1278-929

SARA (Species at Risk Act). 2020d. Species at risk act public registry. Species Profile: Piping Plover. https://species-registry.canada.ca/index-en.html#/species/687-275

SARA (Species at Risk Act). 2021. Regulations made under this Act. Available at: https://laws.justice.gc.ca/eng/acts/S-15.3/.

Saunders, J. and R. Dooling. 1974. Noise-Induced Threshold Shift in the Parakeet (*Melopsittacus undulatus*). Proceedings of the National Academy of Sciences of the United States of America 71(5):1962-1965.

SCC (Supreme Court of Canada). 2021. Cases. Available at: https://www.scc-csc.ca/case-dossier/info/search-recherche-eng.aspx

Scott, J.S. 1980. Occurrence of Pollock, *Pollachius virens*, and Sand Lance, *Ammodytes* sp., Larvae in the Bay of Fundy. J. Northw. Atl. Fish. Sci., 1:45-48.

Scott, W.B. and M.G. Scott. 1988. Atlantic Fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences, 219: 731 pp.

Shackell, N. L., D. W. Brickman, and K. T. Frank. 2013. Reserve site selection for data-poor invertebrate fisheries using patch scale and dispersal dynamics: a case study of sea cucumber (*Cucumaria frondosa*). Aquatic Conservation: Marine and Freshwater Ecosystems 23:723–731.

Shaw, J., P. Gareau, and R.C. Courtney. 2002. Palaeogeography of Atlantic Canada 13-0Kyr. Quaternary Science Reviews. 21

Shepard, A. N., R. B. Theroux, R. A. Cooper, and J. R. Uzmann. 1986. Ecology of Ceriantharia (Coelenterata, Anthozoa) of the Northwest Atlantic from Cape Hatteras to Nova Scotia. Fishery Bulletin 84:625–646.

Sherwood, O. A., and E. N. Edinger. 2009. Ages and growth rates of some deep-sea gorgonian and antipatharian corals of Newfoundland and Labrador. Canadian Journal of Fisheries and Aquatic Sciences 66:142–152.

Siemann L.A., C.J. Huntsberger, J.S. Leavitt, and R.J. Smolowitz. 2018. Summering on the bank: Seasonal distribution and abundance of monkfish on Georges Bank. PLoS ONE, 13(11): e0206829.

Sierra-Flores, R., T. Atack, H. Migaud, and A. Davie. 2015. Stress response to anthropogenic noise in Atlantic cod *Gadus morhua* L. Aquacultural engineering, 67: 67-76.

Skalski, J.R., W.H. Pearson, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp). Canadian Journal of Fisheries and Aquatic Sciences, 49: 1357-1365.

Skene, K. I. and Piper, D. J. W. 2003. Late Quaternary stratigraphy of Laurentian Fan: a record of events off the eastern Canadian continental margin during the last deglacial period. Quaternary International 99-100, 135-152.d

Skomal, G. B., Braun, C. D., Chisholm, J. H., & Thorrold, S. R. (2017). Movements of the white shark Carcharodon carcharias in the North Atlantic Ocean. Marine Ecology Progress Series, 580, 1-16.

Slotterback, J. W. 2021. Band-rumped Storm-Petrel (*Hydrobates castro*), version 1.1. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.barpet.01.1

Smit, M. G. D., J. E. Tamis, R. G. Jak, C. C. Karman, G. Kjeilen-Eilertsen, H. Trannum, and J. Neff. 2006. Threshold levels and risk functions for non-toxic sediment stressors: Burial, grain size change and hypoxia—Summary report. TNO Built Environment and Geosciences.

Smit, M. G. D., R. G. Jak, H. Rye, T. K. Frost, I. Singsaas, and C. C. Karman. 2008a. Assessment of environmental risks from toxic and nontoxic stressors; A proposed concept for a risk-based management tool for offshore drilling discharges. Integrated Environmental Assessment and Management 4:177–183.

Smit, M. G. D., K. I. E. Holthaus, H. C. Trannum, J. M. Neff, G. Kjeilen-Eilertsen, R. G. Jak, I. Singsaas, M. A. J. Huijbregts, and A. J. Hendriks. 2008b. Species Sensitivity Distributions for Suspended Clays, Sediment Burial, and Grain Size Change in the Marine Environment. Environmental Toxicology and Chemistry 27:1006.

Smith, S.J., Z. Lucas, W.T. Stobo. 2003. Estimates of the Ipswich Sparrow population on Sable Island, Nova Scotia, in 1998, using a random-transect survey design. Canadian Journal of Zoology. 81:771-779.

Snell, R. R., P. Pyle, and M. A. Patten. 2020. Iceland Gull (*Larus glaucoides*), version 1.0. In Birds of the World (P. G. Rodewald and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.y00478.01

Soldal, A. 2002. Rigs-to-reefs in the North Sea: hydroacoustic quantification of fish in the vicinity of a semi-cold platform. ICES Journal of Marine Science 59:S281–S287.

Song, H., R. Ji, C. Stock, and Z. Wang. 2010. Phenology of phytoplankton blooms in the Nova Scotian Shelf–Gulf of Maine region: remote sensing and modeling analysis. Journal of Plankton research 32:1485–1499.

Sören Häfker, N., M. Teschke, K. S. Last, D. W. Pond, L. Hüppe, and B. Meyer. 2018. *Calanus finmarchicus* seasonal cycle and diapause in relation to gene expression, physiology, and endogenous clocks. Limnology and Oceanography 63:2815–2838.

Sørensen, L., E. Sørhus, T. Nordtug, J. P. Incardona, T. L. Linbo, L. Giovanetti, Ø. Karlsen, and S. Meier. 2017. Oil droplet fouling and differential toxicokinetics of polycyclic aromatic hydrocarbons in embryos of Atlantic haddock and cod. PloS one 12:e0180048.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals. 33

Stagg, R., C. Robinson, A. McIntosh, C. Moffat, and D. Bruno. 1998. The effects of the 'Braer' oil spill, Shetland Isles, Scotland, on P4501A in fanned Atlantic salmon (*Salmo salar*) and the common dab (*Limanda limanda*). Marine Environmental Research 46:301–306.

Stantec. 2016. Scotian Basin Exploration Drilling Project Environmental Impact Statement Volume 1: Environmental Impact Statement. Report prepared for BP. File No. 121413516 . Page 919.

Stantec. 2017. Shelburne Basin Venture Exploration Drilling Project: Monterey Jack E-43A Sediment Deposition Survey Report. Page 19.

Stantec. 2018, April 16. Scotian Basin Exploration Drilling Project – Aspy D-11 Well CEAA Condition 3.6: Pre-drill Survey Results for Potential Aggregations of Habitat-forming Corals or Sponges, or any Other Environmentally Sensitive Features.

Stantec. 2019a. Middle Scotian Shelf and Slope Strategic Environmental Assessment. Prepared for the Canada-Nova Scotia Offshore Petroleum Board. File No. 121416124.

Stantec. 2019b. Final Report: Scotian Basin Exploration Drilling Project - Aspy D-11A Well Sediment Depostion Survey Report. Prepared for BP Canada Energy Group ULC. Page 18.

Stemp, R. 1985. Observations on the effects of seismic exploration on seabirds. In Proceedings of the Workshop on the Effects of Explosives Use in the Marine Environment, 29–31 January 1985. Edited by G.D. Greene, F.R. Engelhardt, and R.J. Paterson. Tech. Rep. 5, Canada Oil and Gas Lands Administration, Environmental Protection Branch, Ottawa, Ont. pp. 217–231.

Stewart, P. L., R. M. Branton, G. A. Black, H. A. Levy, and T. L. Robinson. 2003. EAISSNA - An Electronic Atlas of Ichthyoplankton on the Scotian Shelf of North America. Canadian Technical Report of Fisheries and Aquatic Sciences 2514:vii + 179 pp.

Stewart, P., and R. Branton. 2004. Electronic Atlas of Ichthyoplankton on the Scotian Shelf of North America. https://obis.org/dataset/a595a9a0-642a-473f-8c71-cc535ee29a2b.

Stieglitz, J. D., E. M. Mager, R. H. Hoenig, D. D. Benetti, and M. Grosell. 2016. Impacts of Deepwater Horizon crude oil exposure on adult mahi-mahi (*Coryphaena hippurus*) swim performance. Environmental toxicology and chemistry 35:2613–2622.

Stortini, C. H. 2015. A description of the habitats and special natural features within the Scotian Slope Ecologically and Biologically Significant Area in the Maritimes Region. Canadian Technical Report of Fisheries and Aquatic Sciences 3136:iv + 53p.

Suzuki, N., T. Ikari, M. Sato, A. Toriba, T. Sekiguchi, Y. Kitani, S. Ogiso, K. Yachiguchi, A. Hattori, Y. Oshima, and others. 2018. Toxicities of Polycyclic Aromatic Hydrocarbons in Fish and Marine Invertebrates. Pages 245–259 Polycyclic Aromatic Hydrocarbons. Springer.

Swail, V.R., and A.T. Cox. 2000. On the use of NCEP/NCAR reanalysis surface marine wind fields for a long term North Atlantic wave hindcast. Journal of Atmospheric and Ocean Technology, 17:532-545.

Swail, V.R., V.J. Cardone, M. Ferguson, D.J. Gummer, E.L. Harris, E.A. Orelup, and A.T. Cox. 2006. The MSC50 Wind and Wave Reanalysis. Presented at the 9th International Wind and Wave Workshop, Victoria, BC.

Tait, R. D., C. L. Maxon, T. D. Parr, and F. C. Newton. 2016. Benthos response following petroleum exploration in the southern Caspian Sea: Relating effects of nonaqueous drilling fluid, water depth, and dissolved oxygen. Marine Pollution Bulletin 110:520–527.

Takeshita, R., L. Sullivan, C. Smith, T. Collier, A. Hall, T. Bronsan, T. Rowles, and L. Schwacke. 2017. The Deepwater Horizon oil spill marine mammal injury assessment. Endangered Species Research. 33.

TC (Transport Canada). 2021. Backgrounder: Protecting North Atlantic right whales. Accessed February 2021. Available at: https://tc.canada.ca/en/backgrounder-protecting-north-atlantic -right-whales-0

Teagle, H., S. J. Hawkins, P. J. Moore, and D. A. Smale. 2017. The role of kelp species as biogenic habitat formers in coastal marine ecosystems. Journal of Experimental Marine Biology and Ecology 492:81–98.

Themelis, D. E., and R. G. Halliday. 2012. Species composition and relative abundance of the mesopelagic fish fauna in the Slope Sea off Nova Scotia. Northeastern Naturalist 19:177–200.

Tjensvoll, I., T. Kutti, J. H. Fosså, and R. J. Bannister. 2013. Rapid respiratory responses of the deep-water sponge *Geodia barretti* exposed to suspended sediments 19:65–73.

Toxværd, K., M. Pančić, H. O. Eide, J. E. Søreide, C. Lacroix, S. Le Floch, M. Hjorth, and T. G. Nielsen. 2018. Effects of oil spill response technologies on the physiological performance of the Arctic copepod *Calanus glacialis*. Aquatic Toxicology 199:65–76.

Tracy, D. M., D. Schamel, and J. Dale. 2020. Red Phalarope (*Phalaropus fulicarius*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.redpha1.01

Tremblay, M. J., G. A. P. Black, and R. M. Branton. 2007. The distribution of common decapod crustaceans and other invertebrates recorded in Annual Ecosystem Surveys of the Scotian Shelf 1999-2006. Canadian Technical Report of Fisheries and Aquatic Sciences 2762:iii + 74 p.

Utne, K. 2017. Effects of produced water components on the early life stages of *Calanus finmarchicus* and *Calanus hyperboreus* reared at different temperatures. M.Sc. Thesis, Norwegian University of Science and Technology, Trondheim.

Vad, J., G. Kazanidis, L.A. Henry, D.O. Jones, O.S. Tendal, S. Christiansen, T.B. Henry, and J.M. Roberts. 2018. Potential impacts of offshore oil and gas activities on deep-sea sponges and the habitats they form. Advances in Marine Biology, 79: 33-60.

Valdemarsen, J. W. 1979. Behavioural aspects of fish in relation to oil platforms in the North Sea. ICES CM 1979/B:27.

Valentine, M.M. and M.C. Benfield. 2013. Characterization of epibenthic and demersal megafauna at Mississippi Canyon 252 shortly after the Deepwater Horizon Oil Spill. Marine Pollution Bulletin, 77(1-2): 196-209.

Vandeperre, F., A. Aires-da-Silva, M. Santos, R. Ferreira, A.B. Bolten, R.S. Santos, and P. Afonso. 2014. Demography and ecology of blue shark (*Prionace glauca*) in the central North Atlantic. Fisheries Research, 152:89-102.

van der Hoop, J., A.S.M. Vanderlaan, and C.T. Taggart. 2012. Absolute probability estimates of lethal vessel strikes to North Atlantic right whales in Roseway Basin, Scotian Shelf. Ecological Applications. 22(7)

van der Hoop, J., M.J. Moore, S.G. Barco, T.V.N. Cole, P.-Y. Daoust, A.G. Henry, D.F. McAlpine, W.A. McLellan, T. Wimmer, and A.R. Solow. 2013. Assessment of management to mitigate anthropogenic effects on large whales. Conservation Biology. 21(1)

van der Hoop, J., A.S.M. Vanderlaan, T.V.N. Cole, A.G. Henry, L. Hall, B. Mase-Guthrie, T. Wimmer, and M.J. Moore. 2015. Vessel strikes to large whales before and after the 2008 ship strike rule. Conservation Letters. 8(1)

Wade, J. A., and B.C. MacLean. 1990. The geology of the southeastern margin of Canada, Chapter 5 in Geology of the Continental Margin of Eastern Canada. M. J. Keen and G. L. Williams (Eds.). Geological Survey of Canada, Geology of Canada.

Wallis, A. 1981. North Sea gas flares. British Birds, 74: 536-537.

Ward-Paige, C. A., and A. Bundy. 2016. Mapping Biodiversity on the Scotian Shelf and in the Bay of Fundy. Canadian Science Advisory Secretariat Research Document 2016/006:v + 90 p.

Ware, D.M. and T.C. Lambert. 1985. Early Life History of Atlantic Mackerel (*Scomber scombrus*) in the Southern Gulf of St. Lawrence. Can. J. Fish. Aquat. Sci., 42:577-592.

Watanabe, S., A. Metaxas, J. Sameoto, and P. Lawton. 2009. Patterns in abundance and size of two deep-water gorgonian octocorals, in relation to depth and substrate features off Nova Scotia. Deep Sea Research Part I: Oceanographic Research Papers 56:2235–2248.

Weber, D. D., D. J. Maynard, W. D. Gronlund, and V. Konchin. 1981. Avoidance reactions of migrating adult salmon to petroleum hydrocarbons. Canadian Journal of Fisheries and Aquatic Sciences 38:779–781.

Weilgart, L. S. 2007. A brief review of known effects of noise on marine mammals. International Journal of Comparative Psychology. 20.

Weise, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Linke. 2000. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin, 42:1285-1290.

Weise, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Link. 2001. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin. 4(12):1285-1290.

Weiser, E. and H. G. Gilchrist. 2020. Glaucous Gull (*Larus hyperboreus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.glagul.01

Weseloh, D. V., C. E. Hebert, M. L. Mallory, A. F. Poole, J. C. Ellis, P. Pyle, and M. A. Patten. 2020. Herring Gull (*Larus argentatus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.hergul.01

Wheelwright, N. T. and J. D. Rising. 2020. Savannah Sparrow (*Passerculus sandwichensis*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.savspa.01

Whitehead, H. 2013. Trends in cetacean abundance in the Gully submarine canyon, 1988-2011, highlight a 21% per year increase in Sowerby's beaked whales (*Mesoplodon bidens*). Can. J. Zool. 91: 141-148

Wiese, F.K. and G.J. Robertson. 2004. Assessing seabird mortality from chronic oil discharges at sea. J. Wildl. Manage. 68:627-638.

Wiese, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A. W. Diamond and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin, 42: 1285-1290.

Wilhelm, S.I., G.J. Robertson, P.C. Ryan, S.F. Tobin, and R.D. Elliot. 2009. Re-evaluating the use of beached bird oiling rates to assess long term trends in chronic oil pollution. Marine Pollution Bulletin 58: 249-255.

Wilhelm, S. 2017. CWS: Waterbird colony database (Atlantic region). Version 1. In OBIS Canada Digital Collections. Bedford Institute of Oceanography, Dartmouth, NS, Canada. Published by OBIS, Digital. Available from: https://doi.org/10.15468/vlrjfx. Accessed 23 Feb 2021.

Wilhelm, S., S. M. Dooley, E. P. Corbett, M. G. Fitzsimmons, P. C. Ryan, and G. J. Robertson. 2021. Effects of land-based light pollution on two species of burrow-nesting seabirds in Newfoundland and Labrador, Canada. Avian Conservation and Ecology 16(1):12.

Williams, R., Wright, A.J., Ashe, E., Blight, L.K., Bruintjes, R., Canessa, R., Clark, C.W., Cullis, Suzuki, S., Dakin, D.T., Erbe, C., Hammond, P.S., Merchant, N.D. O'Hara, P.D., Purser, J., Radford, A.N., Simpson, S.D., Thomas, L., and Wale, M.A. 2015. Impacts of Anthropogenic Noise on Marine Life: Publication Patterns, New Discoveries, and Future Directions in Research. Ocean. Coast. Manage. 115: 17–24.

Wimmer, T., and H. Whitehead. 2004. Movements and distribution of northern bottlenose whales, *Hyperoodon ampullatus*, on the Scotian Slope and in adjacent waters. Canadian Journal of Zoology 82:1782–1794.

Winkler, D. W., S. M. Billerman, and I.J. Lovette. 2020a. Skuas and Jaegers (*Stercorariidae*), version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.sterco1.01

Winkler, D. W., S. M. Billerman, and I.J. Lovette. 2020b. Auks, Murres, and Puffins (Alcidae), version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi-org.proxy1.lib.trentu.ca/10.2173/bow.alcida1.01

Winters, G. H. 1981. Growth patterns in sand lance, *Ammodytes dubius*, from the Grand Bank. Can. J. Fish. Aquat. Sci., 38: 841-846.

Wood Environment & Infrastructure Solutions. 2021. EL 1165b drilling discharges follow-up program: drill cuttings measurements and monitoring 2020 report. Prepared for ExxonMobil Canada Limited, report number TA1913215.

Woolf, D.K., P.G. Challenor, and P.D. Cotton. 2002. Variability and predictability of North Atlantic wave climate. Journal of Geophysical Research, 107:3145-3158.

Worcester, T., and M. Parker. 2010. Ecosystem Status and Trends Report for the Gulf of Maine and Scotian Shelf. Canadian Science Advisory Secretariat Research Document 2010/070.

Wright, A. J., N. Aguilar Soto, A.L. Baldwin, M. Bateson, C. Beale, C. Clark, T. Deak, E.F. Edwards, A. Fernández, A. Odinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L.M. Romero, L. Weilgart, B. Wintle, G. Notarbartolo-di-Sciara, and V. Martin. 2007. Do marine mammals experience stress related to anthropogenic noise. International Journal of Comparative Psychology. 20

WWF (World Wildlife Fund) Canada. 2009. An Ocean of Diversity: The Seabeds of the Canadian Scotian Shelf and Bay of Fundy.

Yender, R., J. M. Michel, and C. Lord. 2002. Managing seafood safety after an oil spill. US Department of Commerce, National Oceanic and Atmospheric Administration, Seattle: Hazardous Materials Response Division, Office of Response and Restoration, National Oceanic and Atmospheric Administration.

Zeller, D., and D. Pauly. 2001. Visualisation of standardized life-history patterns. Fish and Fisheries 2:344–355.

Zetsche, E.-M., T. Baussant, and F. J. R. Meysman. 2016. Direct Visualization of Mucus Production by the Cold-Water Coral *Lophelia pertusa* with Digital Holographic Microscopy. PLoS One:17.

Zhai, L., T. Platt, C. Tang, S. Sathyendranath, and R. Hernández Walls. 2011. Phytoplankton phenology on the Scotian Shelf. ICES Journal of Marine Science 68:781–791.

Zisserson, B.M., B.J. Cameron, A.C. Glass, and J.S. Choi. 2019. Assessment of Scotian Shelf Snow Crab (*Chionoecetes opilio*) in 2017. DFO Can. Sci. Advis. Sec. Res. Doc. 2018/051.

Zitko, V., O. Hutzinger, and P. M. K. Choi. 1972. Contamination of the Bay of Fundy Gulf of Maine area with Polychlorinated Biphenyls, Polychlorinated Terphenyls, Chlorinated Dibenzodioxins, and Dibenzofurans. Environmental Health Perspectives 4:47–50.

Zorz, J., C. Willis, A. M. Comeau, M. G. I. Langille, C. L. Johnson, W. K. W. Li, and J. LaRoche. 2019. Drivers of Regional Bacterial Community Structure and Diversity in the Northwest Atlantic Ocean. Frontiers in Microbiology 10.

Zwanenburg, K. C. T., A. Bundy, P. Strain, W. D. Bowen, H. Breeze, S. E. Campana, C. Hannah, E. Head, and D. Gordon. 2002. Decadal changes in the Scotian Shelf Large Marine Ecosystem. Pages 105–150 Large Marine Ecosystems.

Zwanenburg, K., A. Bundy, P. Strain, W. Bowen, H. Breeze, S. Campana, C. Hannah, E. Head, and D. Gordon. 2006. Implications of ecosystem dynamics for the integrated management of the eastern Scotian Shelf. Fisheries and Oceans Canada.

APPENDIX A: MARINE MAMMAL AND SEA TURTLE COMMON AND SCIENTIFIC NAMES

Common Name	Scientific Name
Blue Whale	*Balaenoptera musculus*
Fin Whale	*Balaenoptera physalus*
North Atlantic Right Whale	*Eubalaena glacialis*
Minke Whales	*Balaenoptera acutorostrata*
Sei Whale	*Balaenoptera borealis*
Humpback Whale	*Megaptera novaeangliae*
Northern Bottlenose Whale	*Hyperoodon ampullatus*
Sowerby's Beaked Whale	*Mesoplodob bidens*
Sperm Whale	*Physeter macrocephalus*
Pygmy Sperm Whale	*Kogia breviceps*
Cuvier's Beaked Whale	Ziphius cavirostris
Blainville's Beaked Whale	Mesoplodon densirostirs
True's Beaked Whale	*Mesoplodon mirus*
Short-finned Pilot Whale	*Globicephala marorhynchus*
Long-finned Pilot Whale	*Globicephala melas*
Beluga Whale	*Delphinaterus leucas*
False Killer Whale	*Pseudorca crassidens*
Killer Whale	*Orcinus orca*
Short-beaked Common Dolphin	*Delphinus delphis*
Atlantic Spotted Dolphin	*Stenella frontalis*
Striped Dolphin	*Stenella coeruleoalba*
Common Bottlenose Dolphin	*Tursiops truncatus*
Risso's Dolphin	Grampus griseus
White-beaked Dolphin	*Lagenorhynchus albirostris*
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*
Harbour Porpoise	Phocoena
Grey Seal	*Halichoerus grypus*
Harbour Seal	*Phoca vitulina*
Ringed Seal	*Pusa hispida*
Harp Seal	*Phoca vitulina*
Hooded Seal	*Cystophora cristata*
Leatherback Sea Turtle	*Dermochelys coriacea*
Loggerhead Sea Turtle	*Caretta*
Kemp's Ridley Sea Turtle	*Lepidochlys kempii*
Green Sea Turtle	*Chelonia mydas*

APPENDIX B: INDIGENOUS AND STAKEHOLDER COMMENTS AND CNSOPB RESPONSE TABLE

Public Comments Middle and Eastern Scotian Slope and Sable Island Bank Areas SEA

5 May, 2022

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	General Comments	Government Policy	N/A	.... the development of oil and gas resources in the Nova Scotian offshore may not be consistent with international efforts to limit the worst impacts of climate change, may result in stranded assets for fossil fuel companies and/or may require significant public investment to make exploration and production drilling activities economically viable.	The CNSOPB does not set energy, economic development, climate change or environmental policies, nor is it responsible for the drafting of legislation (Acts and regulations). Governments are responsible for such matters. These comments have been shared with the federal and provincial governments. The CNSOPB's role is to administer and enforce the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (collectively called, the "*Accord Acts"*) and regulations that are put in place by governments.
WWF	Pg 2, Last para.	Government Policy	Section 2.1	CNSOPB mandate puts the Board in a potential conflict of interest. The knowledge, experience and motivations of the people who form the regulatory system are critical. There is a public expectation that risks from offshore petroleum operations will be properly regulated and controlled.	See response above. Also note, the federal and provincial governments develop legislation and regulations, whereas the CNSOPB administers the regulatory system on behalf of governments. The regulatory framework for managing risk from offshore operations and the CNSOPB's monitoring and oversight is comprehensive. (For additional information on the CNSOPB's monitoring and oversight, refer to https://www.cnsopb.ns.ca/regulatory-framework/monitoring-and-compliance)
Offshore Alliance		Government Policy		The Offshore Alliance calls on the Canada-Nova Scotia Offshore Petroleum Board and the responsible ministers to suspend and terminate the SEA. New oil and gas development is incompatible with Nova Scotia and Canada's climate targets and caring for planet Earth.	See response above.
KMKNO	Pg. 1	Indigenous Participation & Treaty Rights		Future projects could impact future moderate livelihood fishing opportunities and current commercial fishing access in LFA 41. In November 2021, a number of our Mi'kmaw communities partnered on the purchase of Clearwater Seafoods. Any projects offshore in LFA 41 could critically impact this commercial acquisition, and future access to offshore lobster and other species.	An SEA does not authorize activity. Prior to engaging in any exploration activities, an operator must apply for an Activity Authorization, and a project-specific Environmental Assessment (EA)/Impact Assessment (IA) must be submitted to assess their proposed activity as part of the application process. The project-specific EA/IA identifies potential environmental impacts of the proposed exploration activity and describes any precautions that need to be taken to minimize the potential impacts. This would include assessments of potential interactions with Indigenous communities, activities, and fisheries. A further project-specific EA/IA would be required if an oil and gas company was to move forward to production.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
KMKNO	Pg. 1-2	Indigenous Participation & Treaty Rights		Reviewed the proposed footprint for the Middle and Eastern Scotian Slope and Sable Island Bank Areas and while most of the area is in very deep waters, we must re-iterate that The Assembly of Nova Scotia Mi'kmaw Chiefs, KMKNO and the Mi'kmaw Nation in Nova Scotia expect a high level of archaeological investigative diligence and cultural attention when archaeological research is conducted. There is some possibility for archaeological sites or artifacts in the northern portion of this study area, near Sable Island and the Sable Island Bank. We have consistently recommended that in areas with suspected disturbances, which are subsequently deemed low potential due to those disturbances, that subsurface testing should be undertaken to confirm the nature of these disturbances. Additionally, those areas should have detailed paleo-climatic modeling to determine the past nature of the area	An SEA does not authorize activity. Prior to engaging in any exploration activities, an operator must apply for an Activity Authorization, and a project-specific EA/IA must be submitted to assess their proposed activity as part of the application process. The project-specific EA identifies potential environmental impacts of the proposed activity and describes any precautions that need to be taken to minimize the potential impacts. This would include assessments of potential interactions with Indigenous communities, activities, and fisheries. A further project-specific EA/IA would be required if an oil and gas company was to move forward to production. These comments will be communicated to any potential future operators should activities be contemplated.
KMKNO	Pg. 2	Indigenous Participation & Treaty Rights		KMKNO does not represent the communities of Millbrook, Sipekne'katik, Membertou or We'koma'q First Nations. We do however encourage further consultation with these communicates as they may have interest in the proposed project area. Particularly any rights-based issues relating to loss of access to traditional use would require more in-depth consultation with the local Mi'kmaw Communities.	Comment noted. The CNSOPB does communicate with these other communities as part of its normal outreach and engagement activities.
Maritime Aboriginal Peoples Council	(on behalf of Aquatic Resources Secretariate/NCNS) Pg. 2	Indigenous Participation & Treaty Rights		On February 20, 2021, we questioned what type of projects would be excluded from the "project-specific EA" process. Within the Draft Report, we have found no further clarification. The dynamic that will occur between the Environmental Assessment (EA) and the Strategic Environmental Assessment (SEA) still remains unclear.	SEAs will not be used to replace or exempt project-specific EAs. Project-specific EAs/IAs are a key part of the application that an operator must submit when seeking an activity authorization. An oil and gas company is required to conduct a project-specific EA or IA if they plan to conduct any offshore activity such as collecting seismic data or drilling a well. It identifies potential environmental impacts of the proposed activity and describes any precautions that need to be taken to minimize the potential impacts. A further project-specific EA/IA would be required if an oil and gas company was to move forward to production. Section 1.1 (Nature, Purpose and Context of the SEA) has been updated to the following (edits in bold and italics): "A SEA is not intended to be a replacement for a project-specific EA review process ***or to exempt project-specific EAs.***"

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
Maritime Aboriginal Peoples Council	(on behalf of Aquatic Resources Secretariate/NCNS) Pg. 2	Indigenous Participation & Treaty Rights	Section 3.3.4, 9.2.4, 8.3	The NCNS would also like to take this opportunity to express the importance of Communal Commercial Fisheries (CCF) to our communities, and our ask that the importance be emphasized within the SEA. While the prominence of the CCF is touched upon in section 9.2.4 of the SEA. We note that the CCF's importance to our communities is only briefly mentioned in section 3.3.4 and neglected entirely in section 8.4.	Section 3.3.4 (Indigenous Fisheries) and Section 8.3 (Commercial Fisheries and Other Ocean Uses) have been updated to the following to emphasize the importance of CCF to indigenous communities (edits in bold and italics): "Commercial communal fisheries ***are an economically significant resource*** for Indigenous people and revenue from such activities is used to support community programs and services including those that address health, wellness, education and economic development needs ***as well as employment opportunities***." "Much of the commercial fisheries ***data, including commercial communal fisheries*** data and other information is available through DFO." It is also noted in Section 8.4 (Indigenous Fisheries) that: "Commercial communal harvesting data and other information is integrated within the commercial fisheries sources (Section 8.3), subject to the same management regimes and included within the data, discussions and analysis presented in Section 3.3.2. Consequently, pathways, potential effects and mitigative measures would be similar to those for other commercial fisheries."
Maritime Aboriginal Peoples Council	(on behalf of Aquatic Resources Secretariate/NCNS) Pg. 2	Indigenous Participation & Treaty Rights	Section 8.4	…this section does encourage communication with Indigenous groups, section 8.4 is written in a passive tone that is dismissive of the available data; mentioning that "potential effects on Indigenous commercial communal fishing and Aboriginal and Treaty rights by Indigenous group may not be possible without direct input from Indigenous Groups". We find it paramount that this section be reformatted, and emphasis put on proponent's need to acquire both the CCF information from DFO, in addition to seeking input from Indigenous groups.	"Section 8.4 (Indigenous Fisheries) has been updated (edits in bold and italics): "***Commercial communal fisheries information is provided by DFO for commercially harvestable species in the form of IFMPs, CHPs, annual management decisions and notices for each species in each commercial fishing area or NAFO Regulatory Area. This information is presented alongside commercial fisheries data and is subject to the same management decisions. As with any commercial fishing licenses, it is difficult to identify license activity without direct input from the associated groups.*** Therefore, ***Proponents should seek input directly from Indigenous Groups to assist in the*** ~~ability to~~ ***prediction*** of potential effects on Indigenous commercial communal fishing and Aboriginal and Treaty rights." ~~by Indigenous group."may not be possible without direct input from Indigenous Groups."~~ It is important to note that a project-specific EA would identify potential environmental impacts of the proposed activity and describe any precautions that need to be taken to minimize the potential impacts based on the identification of these impacts within the SEA. This would include assessments of potential interactions with Indigenous communities, activities, and fisheries. These assessments would include seeking input from Indigenous stakeholders and acquire necessary CCF data from DFO.
Maritime Aboriginal Peoples Council	(on behalf of Aquatic Resources Secretariate/NCNS) Pg. 2	Indigenous Participation & Treaty Rights		We assert the Off-Reserve Aboriginal Communities, as 91(24) Indians, are undeniably heirs to treaty rights and beneficiaries of Aboriginal rights as substantiated by Canada's own Supreme Court jurisprudence. As such, there is absolutely an obligation to consult with the off-reserve community through their elected representative body of the NCNS, NBAPC and NCPEI.	Comment noted. The CNSOPB recognizes and understands the importance of engaging with Indigenous communities. The CNSOPB does communicate with the off-reserve communities through the noted organizations as part of its normal outreach and engagement.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Pg. 2	SEA References, Process & Scope	Section 1.0	It is concerning that the Middle and Eastern Scotian Slope and Sable Island Bank Areas SEA does not consider any other development alternatives or sustainability goals and instead describes only "the nature, purpose, and results of…potential offshore petroleum exploration activities" (page 1).	SEAs are broad, high-level assessments conducted to proactively ensure that the identified environmental valued components are considered for policies, plans, and program proposals. SEAs conducted by the CNSOPB are designed to allow for the identification, analysis and incorporation of environmental considerations at the earliest stages of potential future physical works. The CNSOPB's approach to SEA broadly aligns with international standards, within the context of its mandate to oversee all activities through the lifecycle of an offshore oil or gas project. The CNSOPB SEA is unique in its intent and purpose. The intent of the CNSOPB's SEA process is to help the CNSOPB and potential future operators make informed decisions related to Call for Bids and licence awards, and to provide a structured review process where environmental risks and benefits of proposed exploration activities can be evaluated and appropriate mitigation measures identified. The CNSOPB's role is to administer and enforce the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (collectively called, the "*Accord Acts"*) and regulations that are put in place by governments. The CNSOPB's mandate is solely focused on offshore petroleum operations and not other forms of energy or industries. While governments have announced their intent to expand the CNSOPB mandate, this mandate is not changed until the Accord Acts are amended.
WWF	Comment #1	SEA References, Process & Scope	Section 1.1	SEA mandate is insufficient as it is limited only to potential offshore petroleum activities. International SEA standard practice calls for an analysis of potential development alternatives against a framework of sustainability objectives. Section 1.1 states that "The CNSOPB approach to SEA broadly aligns with international standards within the context of their mandate to oversee all activities through the full lifecycle of an offshore oil or gas project." This sentence needs to be clarified with better examples provided of the international standards being referenced here. The SEA should analyze the potential effects, risks and benefits of the proposed hydrocarbon development and its alternatives, against a framework of sustainability objectives, principles and criteria tailored to Nova Scotia.	See response above.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Pg. 2	SEA References, Process & Scope		Not clear why an exploratory oil and gas licensing SEA is needed at this time. The CNSOPB's Call for Bids NS21-1 for the southwestern Scotian Slope, which was issued in May 2021, resulted in no bids. The parcels that made up Call for Bids NS21-1 are no longer up for bid and will remain as Crown land. Previous exploration wells in the region have been plugged and abandoned, and development projects have all been decommissioned.	The intent of the CNSOPB SEA process is to help the CNSOPB and potential future operators make informed decisions related to Call for Bids and licence issuance, and to provide a structured review process where environmental risks and benefits of proposed exploration activities can be evaluated and appropriate mitigation measures identified in areas where future Call for Bids may occur. An SEA is not necessarily tied to a specific Call for Bids. An SEA does not authorize activity. An operator must apply for an Activity Authorization, and a project-specific EA must be submitted to assess their proposed activity as part of the application process. If exploration occurs and is successful and an operator intends to seek approval to commence production, an additional, detailed authorization process is undertaken where the potential environmental impacts and economic benefits are assessed with respect to the proposed development.
WWF	Comment #11	SEA References, Process & Scope		The SEA process has not attempted to assess the possible economic benefits to local communities in sufficient detail at various scales of oil and gas development. Without having at least some idea of the potential benefits in relation to the risks, it is difficult for communities to make an informed assessment about offshore oil and gas.	The intent of the CNSOPB SEA process is to help the CNSOPB and potential future operators make informed decisions related to Call for Bids and licence issuance, and to provide a structured review process where environmental risks and benefits of proposed exploration activities can be evaluated and appropriate mitigation measures identified. CNSOPB SEAs are not designed to assess the scale or economic viability of a development project or oil and gas resource. If an operator's exploration activities are successful and they are interested in proceeding to apply for a development plan authorization, there is a detailed authorization process that includes a comprehensive assessment of the economic benefits to communities with respect to the proposed development.
WWF	Comment #12	SEA References, Process & Scope		There are a number of promising economic development alternatives to offshore oil and gas in Nova Scotia, including sustainable fisheries, eco-tourism, and renewable energy opportunities, which are likely less risky and more sustainable over the long term. Before any decision is made on the future of offshore oil and gas in Nova Scotia, robust and reasonable development alternatives to oil and gas, such as the ones discussed in Section 9, must be analyzed for future consideration.	At the SEA stage, the CNSOPB does not know if/when there will be any new offshore oil and gas activity taking place. SEAs are conducted, in part, to inform potential future Call for Bids processes. The CNSOPB does not set energy, economic development, climate change or environmental policies, nor is it responsible for the drafting of legislation (Acts and regulations). Governments are responsible for such matters. These comments have been shared with the federal and provincial governments. The CNSOPB's role is to administer and enforce the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (collectively called, the "*Accord Acts"*) and regulations that are put in place by governments. The CNSOPB's mandate is solely focused on offshore petroleum operations and not other forms of energy or other industries. While governments have announced their intent to expand the CNSOPB mandate, this mandate is not changed until the Accord Acts are amended.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Comment #15	SEA References, Process & Scope		The oil market is incredibly volatile at the moment, and the SEA did not consider the impact of the 'Net Zero Pathway' (International Energy Agency, World Energy Outlook) on the viability of north Atlantic offshore oil. If the global community acts to radically reduce greenhouse gas emissions in the coming years (as demanded by climate science), it is likely that relatively expensive north Atlantic offshore oil and gas will not be economically viable.	The intent of the CNSOPB SEA process is to help the CNSOPB and potential future operators make informed decisions related to Call for Bids and licence issuance, and to provide a structured review process where environmental risks and benefits of proposed exploration activities can be evaluated and appropriate mitigation measures identified. The CNSOPB does not set energy, economic development, climate change or environmental policies, nor is it responsible for the drafting of legislation (Acts and regulations). Governments are responsible for such matters. These comments have been shared with the federal and provincial governments.
WWF	Comment #5	Seismic Testing & Marine Sound	Section 5.1.2 Table 5-1	Treatment of seismic is incomplete, sometimes incorrect and contains scientifically unsubstantiated conclusions and misleading statements, which all tend in the direction of downplaying the harm and risk seismic surveys pose to marine life. Assessment of seismic mitigation measures is also sometimes incorrect or unproven and tends to overstate the effectiveness of proposed mitigation measures, which have largely been developed by industry and regulators and are not necessarily supported by evidence. The "standard" mitigation measures listed on page 235 of the SEA have largely been developed by industry and regulators; they are not always supported by research; and they are in some cases unproven in their effectiveness.	The latest available science on the effects of seismic sound on the marine environment is available to CNSOPB through active participation with the international research community focused on the potential effects of marine sound on marine life (e.g., through participation in the International Offshore Petroleum Environmental Regulators group), and also through its ongoing engagement with experts at other federal departments. Peer reviewed scientific literature was used to inform the SEA. Best available technology is expected to be utilized during offshore operations, and this technology is expected to minimize potential impacts on the marine environment. Also, through MOUs with other government departments, the CNSOPB is provided ongoing advice on mitigation needs. The CNSOPB requires operators of seismic programs to adhere to the mitigation outlined in the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment as a minimum, and enhanced mitigation is required in certain circumstances.
WWF	Pg. 3	Protected Species and Habitat	Figure 3-52	While we are pleased to see that information on the proposed Eastern Canyons marine refuge is now included in the text of the document, it is very confusing as to why the proposed boundaries are not on the map on page 143. This is especially puzzling since the map does include the Fundian Channel-Browns Bank Area of Interest (not Area of Importance as the map says) and the Eastern Shore Islands Area of Interest, both of which are proposed marine protected areas under the Oceans Act. This is extremely pertinent information. A new map should be issued that contains this information.	***Figure 3-52 Protected and Special Areas, has been updated*** to include the proposed boundaries for the Eastern Canyons that is described in Section 3.2.10.2 Marine Refuges. The legend has been clarified to indicate that the Eastern Canyons marine refuge, Fundian Channel-Browns Bank Area of Interest, and Eastern Shore Islands Area of Interest are proposed special areas. The legend has also been updated to indicate "Area of Interest".
WWF	Pg. 3	Protected Species and Habitat		While the SEA does mention that fisheries closures (such as marine refuges) are known to be sensitive to human activities in the offshore, it is also clear in stating that oil and gas exploration is not explicitly prohibited from marine refuges. Just because there is no explicit prohibition does not mean that the CNSOPB should not or cannot follow the precautionary principle and be proactive in removing a known pressure from areas of known ecological importance and sensitivity.	The intent of the CNSOPB SEA process is to help the CNSOPB and potential future operators make informed decisions related to Call for Bids and licence issuance, and to provide a structured review process where environmental risks and benefits of proposed exploration activities can be evaluated and appropriate mitigation measures identified. CNSOPB staff participate on the planning committees for all MPAs that are under development in the Canada-Nova Scotia offshore area. All potential future operators will be required to adhere to MPA-specific regulations and any other Acts or regulations that apply to an MPA area (such as the *Species at Risk Act*), marine refuge or other special area.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Pg. 3	Protected Species and Habitat		WWF-Canada continues to attest that oil and gas activities should not be permissible within marine protected areas or other effective area-based conservation measures and recommends that the CNSOPB prohibit offshore oil and gas development in these areas in order to help conserve biodiversity and uphold Canada's commitments to marine conservation under the Convention on Biological Diversity.	It is the role of governments to put in place prohibitions on oil and gas activity. The federal government legislation and regulations govern marine protected areas and other effective area-based conservation measures. As part of these requirements, petroleum activities are not permitted in existing MPAs and other protected areas where it is established in regulation that the potential effects of these activities are not in line with the conservation objectives for the protected area. Operators are required to follow all of the regulatory requirements associated with MPAs and other protected areas.
WWF	Pg. 3-4	Protected Species and Habitat	Section 7.2.2	Page 289 of the SEA notes that the CNSOPB has the authority to approve offshore activities and can therefore limit the potential for overlap and interaction between individual exploration programs and their potential effects. Therefore, the CNSOPB has the authority to proactively put sites off limit to development and should do so for marine refuges such as the Western/Emerald Banks Conservation Area and the soon-to-be designated Eastern Canyons Conservation Area.	Sensitive marine conservation areas in Canadian waters are directly protected through the *Oceans Act*, the *Canadian Environmental Protection Act*, and the *Canada National Marine Conservation Areas Act*. All potential future operators will be required to adhere to all Acts and regulations that apply to marine conservation areas. Petroleum activities are not permitted where it is established in regulation that the potential effects of these activities are not in line with the conservation objectives for the protected area.
WWF	Pg. 4	Protected Species and Habitat	Table 3-27	While page 151 does note that there are Significant Benthic Areas for large gorgonian corals, small gorgonians corals, sea pens and sponges in the Project Area, it does not provide detail on what mitigations are needed to reduce harm to these habitat forming species.	The CNSOPB does not allow drilling in areas with known congregations of habitat forming corals or sponges. A pre-spud survey must be conducted before any drilling program commences to look for safety and environmental concerns and for these habitat forming benthic species. If any coral or sponges are found, the drill site must be re-located so that they are not affected. Please refer to Section 5.2.2, Table 5-6.
WWF	Pg. 4	Protected Species and Habitat	Section 5.2.3	It is also unclear how on page 262, effects on protected and special areas, including coral and sponge communities, are expected to be minimal when on page 264 it was noted that recovery times for cold-water deep-sea species are likely to be longer than decades were they to be impacted by offshore oil and gas activities. There are several instances where the SEA notes that standard mitigations to reduce impacts on corals and sponges include pre-drilling surveys to assess potential presence of sensitive benthic habitats, but it does not say what will happen if these are found.	The potential effects on protected and special areas is predicted to be minimal from exploration drilling and abandonment activities as noted on page 262 and 263 as they are localized and short term. Pre-drilling surveys must also be conducted before any drilling program to look for safety and environmental concerns and for habitat forming benthic species. If any coral or sponges are found, the drill site must be re-located so that they are not affected. All potential future operators will also be required to adhere to regulations and any other Acts or regulations that apply to protected and special areas. The potential effects on corals on page 264 refer to the potential effects of an accidental release of hydrocarbons on protected and special areas. In this assessment, it is noted that the potential effects on protected and special areas identified for benthic species could be long-term depending on the location, size, duration, and management of such spills. ***The summary of mitigation measures in Section 9.1.2 has been updated to the following (edits in bold and italics) to clarify mitigations if sensitive benthic habitats are found.*** "Pre-drilling surveys of the seabed to assess the potential presence of sensitive benthic habitats. ***If sensitive benthic habitat is identified, the drill site may be re-located or cuttings re-directed such that it is not affected;***"
CPWS NS Chapter		Protected Species and Habitat		In line with the federal minimum protection standards for Marine Protected Areas (MPAs), no oil and gas activity can occur within MPAs. To increase transparency, the SEA should clearly state that no oil or gas activity is allowed within current or future MPAs on the Middle and Eastern Scotian Slope and Sable Island Bank Areas.	Petroleum activities are not permitted in existing MPAs and other protected areas where it is established in regulation that the potential effects of these activities are not in line with the conservation objectives for the protected area. Operators are required to follow all of the regulatory requirements associated with MPAs and other protected areas.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Comment #3	Spill Prevention & Response		The SEA makes no attempt to assess or quantify the risk of oil spills or major accidents, nor does it indicate what the potential consequences of a major oil spill on the regional environment might be. It would be useful for the SEA to provide a numeric estimate of the potential likelihood of a well blowout or major spill in the North Atlantic should oil and gas activity proceed in the offshore and what the potential consequences would be. The SEA Report should have acknowledged the medium-high risk level of offshore oil and gas operations due to the high magnitude consequences of such an event. When assessing the risk of a deep water well blowout, the CNSOPB must consider the possible consequences of an accident along with its potential likelihood. While it may be true that the likelihood of a blowout is very small, the consequences of such an event would be more devastating in the Atlantic offshore than elsewhere, due to the difficulty of ensuring adequate oil spill response in remote offshore locations (hundreds of kilometers from shore) under sometimes extreme weather conditions and exceptionally cold water	Potential effects of accidental events are assessed in the SEA. See Section 2.3, as well as the assessment of potential effects of spills on the valued components (VCs) throughout Section 6. It is important to note that a project-specific EA would identify potential environmental impacts of the proposed activity and describe any precautions that need to be taken to minimize the potential impacts based on the identification of these impacts within the SEA. This would include spill response and prevention. Drilling technology continues to advance and operators make use of best available technology appropriate for their operation. Before any operator can carry out activity in the Canada-Nova Scotia offshore area, they must submit an application to the CNSOPB which demonstrates that they can meet all of the stringent safety and environmental regulatory requirements during their program, and that any potential risks have been mitigated to as low as reasonably practicable. This includes the drilling of deep water wells. The specifics of well depth and the associated risks and mitigation required must be assessed in detail in a project-specific EA/IA. This includes spill modelling, which takes into account the features of the well and the surrounding environment, including depth and any other pertinent topographical features. Project-specific EAs/IAs detail the probabilities of potential spill scenarios as well.
WWF	Comment #4	Spill Prevention & Response	Section 2.2.2	Spill response capabilities in deep water offshore not assessed. Page 17 notes the required procedures and practices but does not state that some standard response devices and equipment are not required on drilling sites by the CNSOPB.	Drilling technology continues to advance and operators make use of best available technology appropriate for their operation. Before any operator can carry out activity in the Canada-Nova Scotia offshore area, they must submit an application to the CNSOPB which demonstrates that they can meet all of the stringent safety and environmental regulatory requirements during their program, and that any potential risks have been mitigated to as low as reasonably practicable. This includes the drilling of deep water wells. (For additional information on operator preparedness and response, refer to https://www.cnsopb.ns.ca/regulatory-framework/operator-preparedness-and-response)
WWF	Comment #6	Spill Prevention & Response	Section 2.3	The SEA notes two blowouts in Canadian waters but neglects to mention other accidents in the Atlantic offshore. Page 15 identified two blowouts and other accidental events in Atlantic Canada but neglects to mention the following: • In June 2018, BP Canada reported an accident in which 136,000 liters of toxic drilling mud was spilled from its West Aquarius platform off the cost of Halifax. • In November 2018, the Husky Sea Rose drilling platform off the coast of Newfoundland spilled at least 225,000 liters of crude oil into the North Atlantic.	Section 2.3 details accidental spill events in Atlantic Canada and the Canada-Nova Scotia Offshore Area. ***This section will be updated to include details of other noted accidental spill events in Atlantic Canada.***

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Comment #7	Spill Prevention & Response	Section 2.2.1, Chapter 5	Some impacts from chronic pollution may be more significant than indicated in the SEA. We recommend that the CNSOPB consult the sources noted in this section to better understand the potential cumulative impacts of ongoing chronic pollution from oil platforms, in addition to: Cordes, Erik E. et al. Environmental Impacts of the Deep-Water Oil and Gas Industry. Environmental Science. September 2016.	Cumulative effects are assessed in detail at the project level. Spatial and temporal issues are fluid in the offshore, and therefore impacts and mitigation must be specific to a project's area. SEAs capture a snapshot in time of the environment and the human use in a specified space. The SEA approach to cumulative effects assessment is based on a general assessment of anthropogenic activity in the area at the time of publication and as anticipated for the near future (approximately 5 years out). CNSOPB SEAs are not intended to be used as a replacement for project-specific EAs/IAs and therefore not intended to determine all appropriate mitigation that could be attributed to cumulative effects.
WWF	Comment #10	Spill Prevention & Response	Section 5.1.3.1.4	The potential ecological consequences of adding dispersants to an oil spill are not well understood. Please review the following additional studies for inclusion: Buskey, E., H. White, and A.J. Esbaugh. 2016. Impact of Oil Spills on Marine Life in the Gulf of Mexico: Effects on Plankton, Nekton, and Deep-Sea Benthos. Oceanography 29(3): 174-181. Paris, C. B. et al. 2018. BP Gulf Science Data Reveals Ineffectual Subsea Dispersant Injection for the Macondo Blowout. Frontiers in Marine Science. November 2018.	A net environmental benefit analysis (NEBA) is required in the preparation of Spill Response Plans for any project-specific EAs/IAs and must be used in the case of a spill that could have an impact on the natural environment. Use of dispersants is only approved for use in circumstances where the net environmental benefit is greater than that of not using dispersants. This is applicable not only for dispersant use, but for all spill response technologies. If a major emergency occurs and an operator was to consider the use of a dispersant, they would need to make the request to the CNSOPB Chief Conservation Officer for approval. The CNSOPB Chief Conversation Officer would request that Environment and Climate Change Canada urgently convene the National Environmental Emergencies Centre's Science Table. Once convened, these experts would evaluate the environmental pros and cons of using a dispersant based on the spill-specific scenario and the best available science to determine if using a dispersant would provide an overall net benefit to the environment. What this means is that the assessment would need to demonstrate that dispersant use for the specific instance will assist in minimizing the overall impacts to the environment. If it is determined that dispersants would be beneficial to mitigate the impact of a spill on the environment, dispersants would likely be approved for use. It should be noted that the Chief Conservation Officer can only authorize the use of dispersants that are legally approved for use in Canada by Environment and Climate Change Canada. As part of the compliance oversight, the CNSOPB is responsible for closely monitoring the operator's actions to ensure dispersant is being used appropriately, continues to be effective and continues to have a net environmental benefit.(For further information on NEBA, and emergency response in general, please refer to https://www.cnsopb.ns.ca/regulatory-framework/operator-preparedness-and-response)

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Comment #8	Cumulative Effects	Section 5.2.1	Air emissions from shipping vessels are noted in the SEA as a potential environmental disturbance that should be mitigated but the SEA does not give sufficient treatment to the contribution of shipping to the climate crisis. Consideration should be given to project specific GHG reduction targets for offshore support vessels.	As noted in Section 2.2.1 (Management of Routine Discharges, Emissions, and Solid Waste from Planned Offshore Exploration Activities), operators will be required at a minimum to follow applicable regulations and guidelines associated with air quality including: • Air Quality Regulations (*Nova Scotia Environment Act)* • Ambient Air Quality Objectives (*Canadian Environmental Protection Act*) It is important to understand that contributions to climate change from offshore oil and gas activities (typically air emissions from offshore infrastructure such as GHGs and fugitive emissions) must be assessed in project-specific EAs/IAs, when the details of specific offshore infrastructure and vessels to be used for a project are known.
WWF	Comment #9	Cumulative Effects	Section 7.2	As industrial activity in the North Atlantic rises so do the pressures on and risks to marine life through cumulative effects, many of which are not well understood. The SEA should have indicated where more research is required before any oil and gas activities take place. The SEA identified many possible cumulative effects but declined to evaluate precisely how future oil and gas activities would or could exacerbate impacts on marine wildlife and ecosystems. More research is needed on the cumulative effects of multiple drillings wells on the north Atlantic marine environments.	Cumulative effects are assessed in detail at the project level. Spatial and temporal issues are fluid in the offshore, and therefore impacts and mitigation must be specific to a project's area. SEAs capture a snapshot in time of the environment and the human use in a specified space. The SEA approach to cumulative effects assessment is based on a general assessment of anthropogenic activity in the area at the time of publication and as anticipated for the near future (approximately 5 years out). CNSOPB SEAs are not intended to be used as a replacement for project-specific EAs/IAs and therefore not intended to determine all appropriate mitigation that could be attributed to cumulative effects.
WWF	Comment #17	Cumulative Effects	Section 5.2.3	The SEA did not fully consider how underwater shipping noise as a result of oil and gas activity can be mitigated. Underwater shipping noise can be decoupled from shipping traffic growth by investing in quiet ship technology (e.g., silent propellers) and operational measures (speed reduction). A precautionary approach is needed to "hold the noise" at current levels until safe noise levels can be determined for the region.	Contributions to underwater sound from offshore oil and gas activities must be assessed in project-specific EAs/IAs, when the details of specific offshore infrastructure and vessels to be used for a project are known. This may include project-specific underwater sound modelling to assess the zone of influence of ship-based exploration activities.
WWF	Comment #13	Greenhouse Gases		Downstream emissions were not considered in the SEA. The CNSOPB should analyze the downstream greenhouse gas (GHG) emissions at various possible scales of offshore oil and activity to determine if and to what extent offshore oil can be developed within national and international carbon reduction targets.	As noted in Section 2.2.1 (Management of Routine Discharges, Emissions, and Solid Waste from Planned Offshore Exploration Activities), operators will be required at minimum to follow applicable regulations and guidelines associated with air quality including: • Air Quality Regulations (*Nova Scotia Environment Act)* • Ambient Air Quality Objectives (*Canadian Environmental Protection Act*) It is important to understand that contributions to climate change from offshore oil and gas activities (typically air emissions from offshore infrastructure such as GHGs and fugitive emissions) must be assessed in project-specific EAs/IAs, when the details of specific offshore infrastructure and vessels to be used for a project are known.

Originator	Document Reference	Theme/Topic	SEA Section Reference	Comment	Response
WWF	Comment #14	Greenhouse Gases		The SEA did not provide any estimates of greenhouse gas emissions associated with offshore oil and gas activity. Potential greenhouse gas emissions from an offshore and gas industry in Nova Scotia must be analyzed at various scales of development. There is a vast difference in emissions between one drilling platform and many dozens. The CNSOPB must consider to what extent large- and small-scale offshore development would impact GHG emissions targets provincially and federally.	A project-specific EA/IA would identify potential environmental impacts of the proposed activity and describe any precautions that need to be taken to minimize the potential impacts based on the identification of these impacts within the SEA. As noted in Section 2.2.1 (Management of Routine Discharges, Emissions, and Solid Waste from Planned Offshore Exploration Activities), operators will be required at minimum to follow applicable regulations and guidelines associated with air quality including: • Air Quality Regulations (*Nova Scotia Environment Act)* • Ambient Air Quality Objectives (*Canadian Environmental Protection Act*) It is important to understand that contributions to climate change from offshore oil and gas activities (typically air emissions from offshore infrastructure such as GHGs and fugitive emissions) must be assessed in project-specific EAs/IAs, when the details of specific offshore infrastructure and vessels to be used for a project are known.
WWF	Comment #16	Greenhouse Gases		The SEA did not consider policies and regulations that may impact future oil and gas development in Nova Scotia. References to major pieces of climate policy are not included in the SEA.	At the SEA stage, the CNSOPB does not know if/when there will be any new offshore oil and gas activity taking place. SEAs are conducted, in part, to inform potential future Call for Bids processes. The CNSOPB does not set energy, economic development, climate change or environmental policies, nor is it responsible for the drafting of legislation. Governments are responsible for such matters. These comments have been shared with the federal and provincial governments. The CNSOPB's role is to administer and enforce the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act* (collectively called, the "*Accord Acts"*) and regulations that are put in place by governments.